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# Beyond Hot Flashes: The Career Cost of Menopause

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# ABSTRACT

## Beyond Hot Flashes: The Career Cost of Menopause*

Menopause marks a crucial juncture in women's lives and careers. We provide novel evidence on the effects of menopause onset on labor and health outcomes. Combining Norwegian register with survey data from the HUNT study on self-reported menopause age, we apply a stacked difference-in-differences design. Our findings show declines in earnings, increased sick leave, and more diagnoses related to menopause. Additionally, women without symptoms, and those with mild symptoms who seek care, do not experience earnings losses. Moreover, timely healthcare-seeking and treatment onset can mitigate earnings losses. This suggests that policies promoting menopause awareness could alleviate individual and societal burdens.

**JEL Classification:** I10, I12, J16, J24

**Keywords:** menopause, women's health, administrative health data, labor market outcomes, HUNT

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# 1 Introduction

Health is a key determinant of individuals' success in the labor market (e.g., Stephens & Toohey, 2022). Previous research has documented that beyond societal factors –such as the unequal distribution of caregiving responsibilities and differences in occupational choices (e.g., Blau & Kahn, 2017; Cortés & Pan, 2023; Erosa et al., 2022; Goldin, 2014, 2024)– gender disparities in health experiences, particularly childbirth, contribute to the gender gap in labor market outcomes (e.g., Ahammer et al., 2023; Andresen & Nix, 2022; Barschkett & Bosque-Mercader, 2024; Kleven et al., 2019a,b). However, economists have paid little attention to the end of the reproductive period: menopause, which typically occurs between ages 45 and 55, and is linked to a wide variety of negative health symptoms, including hot flashes, disrupted sleep, and mental health challenges (e.g., Monteleone et al., 2018). These health disruptions may lead to reductions in women's productivity that coincide with the peak of their careers, reducing their earnings and further contributing to the gender gap. Since menopause affects nearly half the population, understanding the effect of this common biological event on individual labor market outcomes is important. It is also relevant from a broader societal perspective, as it has potential implications for overall productivity, tax revenues, social benefit payments and healthcare expenditures. To date, however, evidence on these relationships remains scarce.

We address this gap using Norwegian register data that contains a wealth of administrative information on individuals' health, education and labor market outcomes. Norway is an ideal setting in which to examine the effects of menopause because its universal healthcare system ensures that healthcare consumption is not driven by healthcare costs. Importantly, we also link these data to information from a large health survey (the Trøndelag Health Study (HUNT)) which provides individual reports of the age of menopause onset. The register data covers the entire population of Norway, while the HUNT study includes a sample of women from one region (Northern Trøndelag), which is fairly representative of the rest of Norway. Together these data allow us to extend and enrich contemporaneous work by Conti et al. (2024), who also consider the impacts of menopause on a wide variety of health and labor market outcomes, by substantially reducing measurement error in the timing of menopause and uncovering the underlying mechanisms.

We show that this contribution is important. Unlike childbirth, menopause is a less distinct event and harder to pinpoint in (administrative) data. We define menopause onset using self-reported age at menopause from the HUNT study. In medical registers, menopause can only be identified if a GP diagnoses serious symptoms related to menopause.

In Norway, only 26% of women receive a menopause-related diagnosis with an average delay of 3.6 years after menopause onset. The delay in diagnosis introduces measurement error when using age at diagnosis to identify menopause onset. However, we show in robustness checks that measurement error in the self-reported menopause age does not play a role in this setting. Additionally, diagnosed women likely differ from undiagnosed ones, perhaps due to symptom severity or awareness, as only diagnosed women receive treatment. By examining both groups, we provide a comprehensive picture of menopause's impact on both diagnosed (treated) and undiagnosed (untreated) women. A survey of women in the UK found that only 45% had discussed their menopause symptoms with their GP, and 31% reported needing multiple appointments before receiving an accurate diagnosis (The Lancet, 2022), suggesting that stigma and silence surrounding menopause could play a role in explaining differences between women with and without a diagnosis. We also leverage our data to disentangle underlying mechanisms, and investigate the role of healthcare consumption and treatment.

Our analysis focuses on women with "normal" menopausal ages (45 to 55) and includes a range of labor market outcomes (including earnings, (long-term) sick leave, work hours) and health outcomes (such as healthcare utilization and specific diagnoses). To examine the effects of menopause onset on health and labor market outcomes, we use a *stacked* difference-in-differences (DiD) model, which accounts for the heterogeneity in age at menopause. First, to understand these heterogeneities in age at menopause, we investigate the predictors of menopausal age by using fixed effects and flexible parametric duration models. Our results suggest that women from higher SES background tend to experience menopause later than those from lower SES backgrounds. This highlights the importance of accounting for heterogeneity in menopausal age when assessing the consequences of menopause. Therefore, we estimate the effects of menopause separately by age at onset, using age-specific control groups comprising not-yet-treated women who enter menopause at slightly older, comparable ages (Cengiz et al., 2019; Melentyeva & Riedel, 2023). This design circumvents the methodological challenges of Kleven et al. (2019b)'s standard approach to estimate child penalties associated with two-way fixed effects (TWFE) models with staggered roll-out and heterogeneous treatment effects (de Chaisemartin & D'Haultfoeuille, 2023).

Our findings reveal that menopause onset is associated with lasting declines in earnings, reaching up to 3.7% four years after onset, which is six times smaller than the child penalty in Norway (Andresen & Nix, 2022) but comparable to the effect of job loss on earnings (Huttunen et al., 2011). This decline is driven by an increase in (long-term) sick

leave rather than changes in work hours. The rise in sick leave appears to be linked to menopausal symptoms, as evidenced by an increased likelihood of receiving a menopause-related diagnosis after menopause onset, with no significant changes observed in most other health conditions, such as mental disorders or musculoskeletal diagnoses.

To disentangle the underlying mechanisms, we conduct additional analyses using data on self-reported symptoms and related doctor visits, leading to five key conclusions: First, women without symptoms do not experience earnings losses, suggesting that labor market effects are driven by health deterioration. Second, women with a menopause-related diagnosis experience greater earnings losses compared to those without a diagnosis, suggesting that they may face more severe symptoms. We corroborate this by showing that diagnosed women have more pronounced health effects, particularly worse mental health and musculoskeletal problems. Third, the timing of the diagnosis plays a crucial role. Women whose age at diagnosis closely aligns with their menopause age do not experience earnings losses, while those with delayed diagnoses suffer substantial losses (up to 5.3%). This suggests that timely healthcare-seeking and treatment can mitigate the labor market impacts of menopause onset, even for women with severe symptoms. A descriptive analysis provides suggestive evidence that diagnosis delays can, in part, be attributed to delayed healthcare-seeking behavior by women as well as to delayed diagnosis of GPs. Fourth, among women without a diagnosis (those with presumably milder symptoms), healthcare-seeking behavior helps mitigate earnings losses. For symptomatic women, seeking care can fully offset these losses. One reason for not seeking care despite experiencing symptoms could be a lack of awareness that these symptoms are related to menopause and could be managed with treatment. Lastly, the earnings decline appears to be predominantly driven by less educated and low-income women, suggesting disparities in menopause awareness across socioeconomic groups. This finding underscores the importance of targeting awareness campaigns specifically towards women from lower socioeconomic backgrounds.

Our results indicate that treatments provided by GPs and specialists for women who seek care – whether for milder or more severe symptoms – are effective. Women with milder symptoms are largely able to maintain their pre-menopause labor market potential, while those with severe symptoms see their earnings losses reduced by half when they seek care. Since only 26% of women receive a menopause-related diagnosis and only 9% of women without a diagnosis but with symptoms seek care, most appear to navigate the menopause transition without professional support. One reason for this could be that women often feel uncomfortable disclosing their menopausal symptoms or status at work or to their GP, preferring to leave their jobs or taking sick leave rather than seek a mutually supportive

solution with their employer and GP (Atkinson et al., 2021; Beck et al., 2020; Griffiths et al., 2013). Hence, raising awareness about women's health needs is a crucial first step toward change (McGregor, 2020), and could support women during the menopausal transition.

Our study makes several contributions. Broadly, we contribute to the literature on health shocks and labor market outcomes, particularly those specific to women. While prior research has established that better health improves labor market outcomes (e.g., Stephens & Toohey, 2022), studies on health shocks have mainly focused on severe cases, such as cancer diagnoses or hospitalizations (e.g., Dobkin et al., 2018; Fadlon & Nielsen, 2021). Our study, however, examines a health shock that eventually affects nearly all women, varies in severity, and is generally milder for most. We specifically add to the limited research on female-specific health shocks, which has largely focused on fertility and childbirth (Andresen & Nix, 2022; Angelov et al., 2016; Kleven et al., 2019a,b).

Second, we are one of the first studies to document the relationship between menopause onset, health and labor market outcomes. To our knowledge, only two studies establish causal links between menopause and these outcomes.[1] Bryson et al. (2022) analyze the effects of early menopause (before age 45) on labor market outcomes in the UK, finding that early menopause reduces women's employment rates. However, this study is limited to drawing conclusions about women experiencing early menopause (approximately 5% of women) and is based on a relatively small sample size.

We also advance contemporaneous work by Conti et al. (2024) in several ways. To begin with, as described previously, our estimates are based on "actual" (self-reported) age of menopause onset rather than age of medical diagnosis, which reduces measurement error in event timing. Using age at diagnosis as the "event time" is problematic, as women have already entered menopause during the reference period, potentially biasing the results. On top of the delay of diagnosis after menopause onset, symptoms often begin in perimenopause, which can start several years before menopause, further amplifying the measurement error in age at diagnosis. To account for this, we use two years before menopause as the reference period in our event study design and demonstrate that our results are robust to shifting the reference period to earlier ages. Second, as only 26% of women receive a menopause-related diagnosis, relying on self-reported menopause age provides a more comprehensive picture of the impact of the menopause on health and labor

[1]Some medical literature explores links between menopause and health and labor market outcomes, though without establishing causality. For example, two recent reviews associate the presence and severity of menopausal symptoms with declines in job performance, productivity, motivation, and work commitment, as well as a reduced overall quality of life (Theis et al., 2023; Verdonk et al., 2022). Additionally, a growing body of management literature addresses menopause in the workplace, highlighting the need for increased awareness and further research to understand the bidirectional relationship between menopausal symptoms and work performance (e.g., Atkinson et al., 2021; Beck et al., 2020, 2021).

market outcomes across the general population. Furthermore, our approach allows us to disentangle the mechanisms driving these effects. Finally, we account for heterogeneity in menopause age in our stacked DiD approach, which may also explain parts of the diverging effect sizes.

Third, we add to research on predictors of natural menopausal age. Evidence from the medical literature indicates that higher education, higher occupational level and physical activity are associated with later menopause age, while smoking, African, Latin American, Asian and Middle Eastern origin and overweight contribute to an earlier menopause age (Dratva et al., 2009; Schoenaker et al., 2014; Von der Lippe & Prütz, 2016). Premature menopause is associated with family history of premature or early menopause, being a multiple-birth child, certain genetic variants, early menarche, nulliparity, smoking and underweight (Mishra et al., 2017). Much of this evidence comes from relatively small surveys that capture only some influencing factors. Our study builds on this literature by systematically analyzing the associations between socioeconomic and medical characteristics and menopausal age, using linked survey and administrative data.

This paper is structured as follows. We first outline the institutional setting in Section 2, and describe our data in Section 3. Next, we explain the empirical strategy and show our findings for the predictors of menopausal age in Section 4. For the effect of menopause onset on women's health and labor market outcomes, we detail the empirical methodology and identification strategy, and discuss our results in Section 5. We conclude in Section 6.

# 2 Menopause & Healthcare System

In the following section we provide background information on the definition of menopause and the healthcare system in Norway.

## 2.1 Menopause

Menopause marks the end of a woman's reproductive years and occurs when the ovaries cease hormone production, resulting in the cessation of menstrual periods. A woman is considered in menopause when she has not had a menstrual period for 12 consecutive months. A wide range of symptoms can be associated with menopause, varying in severity, including hot flashes, sleep disturbances, mood swings, anxiety, depression, irritability, palpitations, dizziness, and migraines. Symptoms often begin earlier, during the premenopausal phase, and can persist for several years before and after menopause occurs.

The factors predicting the age at menopause remain largely unclear. However, the medical literature suggests that it is influenced by various elements, including country of origin, socio-economic status, modifiable factors such as smoking, and non-modifiable conditions like a family history of premature or early menopause (Dratva et al., 2009; Schoenaker et al., 2014). In Section 4, we explore the association between medical and socio-economic characteristics and age at menopause. Most women experience menopause between ages 45 and 55 (World Health Organization, 2024), while those who enter menopause before 45 are classified as experiencing "early menopause" (Peacock et al., 2024).

## 2.2 The Norwegian Health Care System

All Norwegian citizens and legal residents in Norway have universal access to publicly financed health services in Norway. The first level of care, primary care, is organized at the municipality level and includes general practitioners (GPs), emergency rooms (ERs), infant and child health care centers, school health services, and elderly care. Specialist care is organized in four health regions and includes somatic specialist care, psychiatric health services, and private referral specialists.

All Norwegian citizens and residents have the right to a specific GP who is responsible for providing primary health care. The GP's tasks include making accurate diagnoses, certifying sick leave, prescribing treatment, and referring patients to specialist care if needed. Specialized care is provided through public hospitals, although certain private specialists can also be contracted. Patients must be referred to specialist care via GPs or ERs to access specialized treatment (Helfo, 2024).

In Norway, as in many other countries, Hormone Replacement Therapy (HRT) is the recommended treatment for menopausal symptoms. HRT is only provided to women who have entered menopause, which must be determined by a doctor. The purpose of hormone therapy is to replace the declining estrogen levels in the body. The most common treatment involves a combination of estrogen and progesterone. The medication can be locally acting, in the form of creams and suppositories, or systemic, taken as tablets, gels, sprays, or patches. It is recommended to start treatment at the onset of menopause and before the age of 60. HRT is particularly recommended for women who experience early menopause due to the associated health risks, as well as for those who suffer from estrogen deficiency symptoms, such as hot flashes. However, women undergoing HRT may face associated health risks, including an increased risk of cardiovascular diseases and a small increase in the risk of breast and ovarian cancer (Helsebiblioteket/BMJ, 2023). Therefore, HRT

is only prescribed to women with severe symptoms. Following the black box warning in 2003, only 1.3% of the Norwegian population received HRT treatment in 2021, compared to 3.9% in 2001 (Larsen, 2023).

# 3 Data

For this study, we obtain information from multiple individual-level Norwegian administrative datasets, and supplement it with a representative health survey. This combination of data sources allows us to match self-reported information on menopause onset, symptoms, and associated healthcare consumption with register information on (menopause-related) diagnoses, healthcare consumption and labor market outcomes.

## 3.1 Individual Level Data

We utilize a compilation of various Norwegian administrative registers, including health registers, central population registers, tax and earnings registers, social security registers, employment registers, and education registers. These registers contain information on all Norwegian citizens and permanent residents from 1967 to 2020, detailing individuals' places of residence, immigration status, earnings, social benefit uptake, and education status. Through a unique personal ID, we can track all citizens and registered residents over time. The health registers include data on visits and diagnoses from both GPs, ERs, and specialists.

We specifically use two administrative health registers. All visits to GPs and ERs are recorded in the Control and Payment of Health Refunds database (KUHR), available from 2006 to 2019. To receive payments, GPs and ERs report all consultations using International Classification of Primary Care (ICPC-2) codes. These codes provide insights into the GP's assessment of the patient's health issues and the type of care provided. In the context of menopause, GPs assign diagnoses using ICPC codes "X11" (menopausal symptoms/complaints) or "X12" (postmenopausal bleeding) to women experiencing issues related to the menopause.

To investigate the impact of menopause onset on women's health, we combine KUHR with the Norwegian Patient Registry (NPR). NPR includes information on anyone who has received specialized healthcare at a hospital, outpatient clinic, or contracted specialists, covering the years 2009 to 2019. Specialists report all consultations using the International Classification of Diseases (ICD-10). N95 (disorders of menopause and other

perimenopausal complaint) is the ICD-10 code associated with menopause. From KUHR and NPR, we can calculate both the probability of a visit and the number of visits to GPs/ERs and specialists. Additionally, we use KUHR data to assess the probability and frequency of visits to GPs and ERs for specific ICPC-2 codes: Codes starting with "P" for psychological symptoms, "N" for neurological symptoms, and "L" for musculoskeletal disorders. Musculoskeletal disorders include disorders related to bone density – a common disorder among older and postmenopausal women. We focus on these three categories, as they represent some of the most common reasons for women's sick leave in Norway, excluding pregnancy-related causes and respiratory diseases (Nossen, 2019), and are related to the most common menopause symptoms. We also investigate codes for diabetes – "T89" for insulin dependent diabetes and "T90" for non-insulin dependent, as menopause is associated with changes in body composition, which are closely linked to adverse effects on insulin sensitivity and glucose metabolism (Szmuilowicz et al., 2009).[2]

To assess the effects of menopause onset on earnings, we utilize the tax register. This register includes labor earnings, taxable sickness benefits, and parental leave payments from 1967 to 2021. Earnings are not top-coded. Data on income from work is available for the period 1993 to 2017. We treat earnings and income recorded as zero as missing because the tax registry reports zero income in the year following an individual's emigration from Norway. We inflation adjust earnings and income from work to 2015 Norwegian Kroner (NOK). The Register on Employers and Employees provides information on working hours from 2000 to 2017. We define an individual as being in the workforce if she has positive earnings in a given year. Information on welfare dependency comes from various social security registries, and we particularly focus on sickness absence, both short- and long-term. Sickness benefits can be received for a maximum of 52 weeks and fully compensate individuals income.[3] If an individual remains unable to work after this period due to illness or injury, she may be entitled to employment verification benefits (long-term sickness benefits) or disability benefits. Long-term sickness benefits are provided only after one year of sick leave and individuals receive 66% of their net pre-sickness income. Data on sickness benefits are available from 1989 to 2019, while data on long-term sickness benefits span from 2010 to 2020.

Educational attainment is obtained from the Norwegian Education Database (NUDB), which provides information on individuals' years of education from 1967 to 2021. We use

[2]We are not able to link diagnoses to specific GPs or specialists as we do not have doctor IDs or more specific information about GPs or specialists.

[3]Sickness benefits are capped at NOK 744,168 in 2024, equivalent to six times the national insurance basic amount.

this register both for predicting the age at menopause and for heterogeneity analysis. In a robustness check, we use data from the cancer registry, available for the years 1964 to 2018, to exclude women who ever had breast cancer. Breast cancer treatment often causes women to enter menopause prematurely.

## 3.2 Survey Data

The Trøndelag Health Study (the HUNT Study) is Norway's largest health study ever conducted. HUNT includes health information and biological material from a sample of 230,000 unique participants living in Trøndelag, collected between 1984 and 2019 (NTNU Trondheim, 2025). We have data from the latest survey wave (HUNT4), collected in the years 2017–2019. HUNT4 includes information on 56,044 people from Northern Trøndelag (Åsvold et al., 2023).[4] Northern Trøndelag had about 140,000 inhabitants in 2018, and includes mainly rural and some smaller urban areas (Haugen & Rosvold, 2024). In Section 3.4, we compare women in HUNT with all Norwegian women to evaluate the representativeness of women participating in HUNT. We present summary statistics measured at age 50 to ensure a consistent age across observations, enabling a more accurate assessment of representativeness. Using the unique personal ID, we can link survey participants to the administrative registers.

In the context of menopause, women are asked several questions regarding their experience of menopause in HUNT:

1. How old were you when your menstruation ended?
2. Are you, or have you been in menopause?
    (a) (If in or have been in menopause:) Do you, or did you have, hot flashes due to menopause?
        i. (If hot flashes related to menopause:) Have you been to a doctor because of hot flashes?

Additionally, HUNT includes data on participants' age at menarche. We use age at menarche to predict age at menopause, as there is evidence for a correlation between age at menarche and the timing of menopause (Thomas et al., 2001).

[4]HUNT initially included only participants from Northern Trøndelag, but in 2018, Northern and Southern Trøndelag merged into one region. No participants from Southern Trøndelag answered menopause-related questions (Åsvold et al., 2023; NTNU Trondheim, 2025).

## 3.3 Definition of Menopause Onset

Defining the onset of menopause is challenging, as it is a less distinct event compared to more clearly defined occurrences like childbirth. Menopause onset is typically not documented in official health records, as it does not involve a formal medical diagnosis. To address this, we rely on self-reported information on menopause onset obtained from the HUNT survey. Specifically, we define the onset of menopause as the age at which women report their menstruation ended.[5]

We restrict our sample to individuals born between 1951 and 1973 who entered the menopause between the ages of 45 and 55, as KUHR data only starts in 2006. Women who experience menopause before age 45 are classified as having early menopause, a condition for which HRT treatment is consistently recommended. Since these women differ significantly from those with a "normal" menopause age, they are excluded from our analysis.

In contemporaneous work, Conti et al. (2024) define the age at menopause based on the age at which women received a menopause-related diagnosis. We use these information in supplementary analyses to explore the mechanisms driving the observed effects. However, we decide to use self-reported age at menopause to define menopause onset for two main reasons. First, self-reported age at menopause significantly differs from the age at which women receive a menopause-related diagnosis. Among cohorts born between 1951 and 1973 who participated in HUNT, the average self-reported age at menopause is 48.6 years. In contrast, for HUNT women who visited their GP and were diagnosed with X11 and/or X12, the average age at diagnosis is 52.5 years.[6] Figure 1 illustrates the distribution of age at menopause for women self-reporting their menopausal entry age (panel (a)) and those receiving a diagnosis (panel (b)), with both distributions resembling a normal distribution. We address potential concerns related to age heaping or measurement error in the age at menopause in Section 5.2.2. 26.2% of women in the HUNT sample visited their GP and received a menopause-related diagnosis (X11 and/or X12). These women were diagnosed on average 3.6 years after their actual self-reported age at menopause, as shown in panel (c).[7,8] Consequently, using the timing of the diagnosis to define menopause onset in an

[5] According to the medical definition, a women is said to be in menopause when she did not have a period for 12 consecutive months. Hence, our measure captures the beginning of this phase, i.e., the age at which women had their last period.

[6] These averages apply to all women in HUNT born between 1951 and 1973. When restricting the sample to women who are part of the estimation sample (menopause age between 45 and 55), the average age at menopause is 50.5 and the average age at diagnosis remains 52.5 years (Table 1).

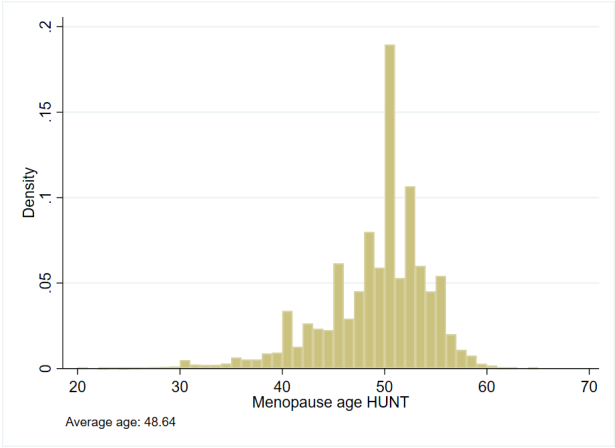
[7] Conti et al. (2024) define menopause onset using both GP diagnosis codes X11 and X12, and specialist diagnosis N95. We exclude the specialist diagnosis in our measure for age at diagnosis as in Norway, a referral to a specialist requires first a diagnosis from the patient's GP. Average age for being diagnosed with "N95" from a specialist is 55.5 As a result, the gap between the actual age at menopause and the age at which a specialist confirms the diagnosis is even greater, averaging 5.6 years.

[8] When restricting the sample to our estimation sample, i.e., only including women who entered the

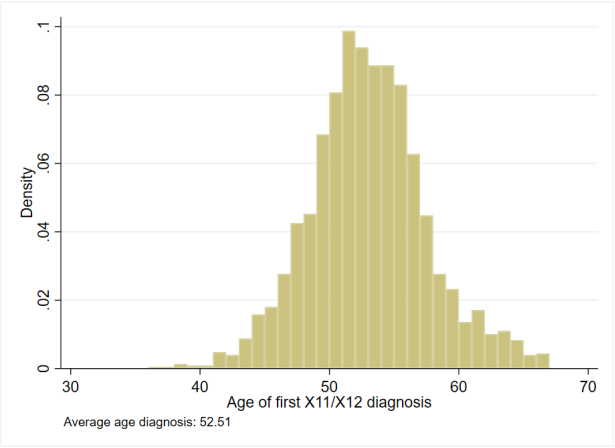
event study would likely introduce bias, as women are typically already postmenopausal in the reference year (e.g., when using two years before the diagnosis as the reference year).

Figure 1: Distribution Age at Menopause

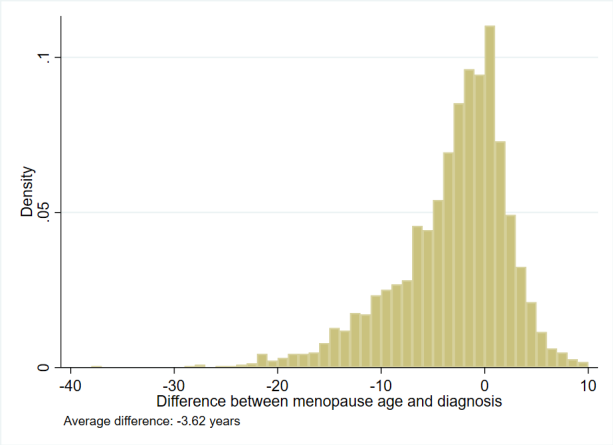
(a) Self-reported age at menopause (HUNT)




(b) Age at menopause diagnosis (HUNT)




(c) Difference between age at menopause and age at diagnosis (HUNT)




*Note*: Distribution of (a) self-reported age at onset of the menopause based on the full HUNT sample (women born 1951-1973, all menopause ages), (b) age at receiving menopause-related diagnosis based on the full HUNT sample (women born 1951-1973, all menopause ages, received an X11 and/or X12 diagnosis) and (c) the difference between age at menopause and age at diagnosis. *Source*: HUNT and KUHR, own calculations.

Second, only 26.2% of women in our sample receive a menopause-related diagnosis from their GP. This share aligns with the general population of Norwegian women, where an average of 2.5% of women in each age cohort between 40 and 60 receive a diagnosis, with the prevalence peaking between ages 50 and 55 (Figure A.1). This means that defining menopause onset based on such diagnoses captures only a small subset of the population. In Section 5, we demonstrate that women who receive a diagnosis likely experience more

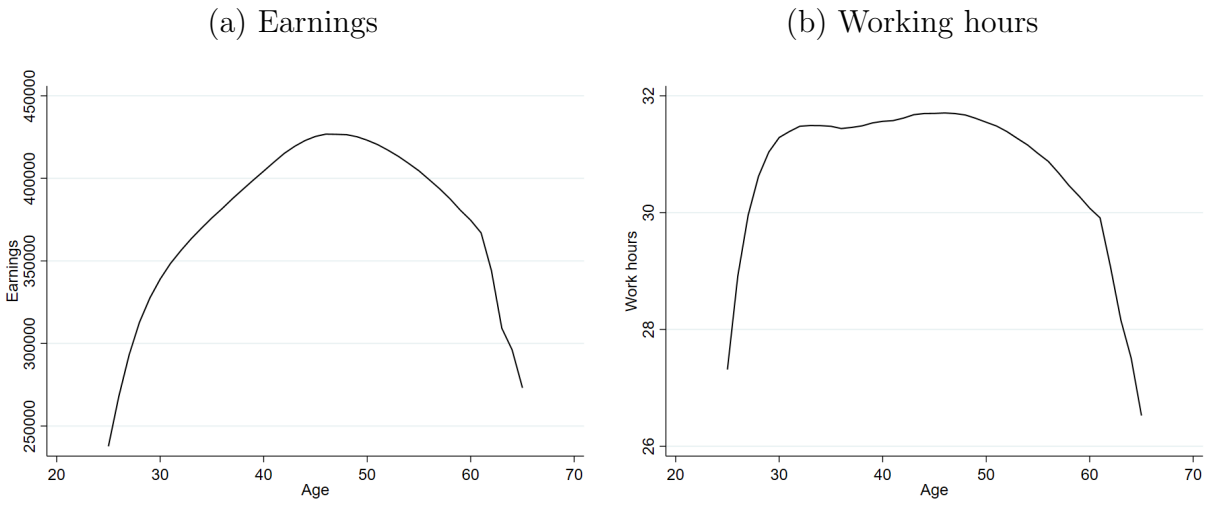
menopause between ages 45 and 55, the difference between age at menopause and age at diagnosis reduces to 2.1 years.

severe symptoms and differ in their healthcare-seeking behavior. Beyond the significant gap between self-reported age at menopause and age at diagnosis, the relatively low proportion of women receiving a diagnosis emphasizes the importance to assess the impact of menopause onset not only on those who visit their GP for related issues but also the general population of women to understand its broader effects on labor and health outcomes.

## 3.4 Descriptive Statistics

Figure 2 illustrates that menopause occurs at a crucial time in women's careers, coinciding with peak earnings and working hours.[9] Thus, the potential health consequences of menopause, which can reduce work ability and employability, come at a particularly high cost during this stage of life.

Figure 2: Earnings and Working Hours for Norwegian Women




*Note*: Average earnings (a) and work hours (b) of Norwegian women aged 25–65. *Source*: Norwegian Central Population Registry, Earnings and Tax Registry, and Employment Registry, own calculations.

Table 1 presents individual-level summary statistics for our outcomes and several control variables for different samples. In our main analysis we restrict our sample to women born between 1951 and 1973. We present summary statistics for women measured at age 50, to keep age constant, and measure representativeness accurately across samples. This restricts the sample to individuals born 1956–1969. Column 1 details the full population of Norwegian women, while Column 2 includes the full HUNT sample, and Column 3 our estimation sample, i.e., restricting HUNT women to menopausal ages 45 to 55. Columns 4 and 5 highlight differences between Columns 1 and 2, and Columns 1 and 3, respectively,

[9] In Norway, as opposed to other countries, the majority of women return to full-time work after child birth. Therefore, work hours and earnings peak before the transition phase into (early) retirement begins.

indicating the representativeness of the HUNT sample compared to women from Norway. Panel A presents the means and standard deviations of SES characteristics, panel B shows age at menopause (diagnosis) and panel C shows the same for our main outcomes. Some SES variables are surveyed in HUNT and therefore only available for women who participated in HUNT. Panel B displays the average across the samples not restricted to a certain age.

While women participating in HUNT are comparable to the general population in terms of education, work hours and healthcare consumption, they are are slightly older, less likely to be immigrants, have more children, are more likely to be married, have lower earnings, and are more likely to be on sick leave. This is in line with official HUNT statistics, stating that HUNT is fairly representative of Norway, except covering a more rural and native population (Åsvold et al., 2023). Although the differences between the samples in some dimensions may reduce the external validity of our results beyond the HUNT sample, it does not pose a threat to our identification strategy, which focuses on women participating in HUNT.

In our sample, women report an average menopause onset age of 50.5 years, while those diagnosed with X11 and/or X12 are, on average, 52.5 years old at the time of diagnosis. Regarding menopause symptoms, 86% of women report experiencing hot flashes due to menopause, yet only 26% sought medical attention for these symptoms. Additionally, the average age at first menarche in our sample is 13.2 years.

# 4 Age at Menopause

## 4.1 Empirical Strategy

To estimate the association between socio-economic and medical characteristics and the age of menopause we estimate the following OLS model:

$$am_{it} = X'_{it}\beta + \theta_t + \varepsilon_{it} \tag{1}$$

where $am_{it}$ denotes the age at menopause for women $i$ born in year $t$. $X_{it}$ contains various SES and medical characteristics measured at age 40, prior to the onset of menopause, as listed in Table 2.[10] Additionally, we control for birth cohort ($\theta_t$) fixed effects.

[10]Since the characteristics in $X_{it}$ are measured at age 40 and our medical data begins in 2006, the prediction analysis using Equation 1 is restricted to cohorts born between 1966 and 1973.

Table 1: Summary statistics

| | All women (1) | Full sample HUNT (2) | Estimation sample HUNT (3) | Differences (1)-(2) (4) | (1)-(3) (5) |
|---|---|---|---|---|---|
| | Panel A: Characteristics | | | | |
| Birth year | 1962.82 | 1961.17 | 1961.13 | -1.63*** | -1.67*** |
| | (4.08) | (3.58) | (3.46) | [-29.12] | [-26.80] |
| Immigrant | 0.14 | 0.04 | 0.04 | -0.10*** | -0.10*** |
| | (0.35) | (0.20) | (0.20) | [-21.66] | [-19.38] |
| Years of education | 13.35 | 13.37 | 13.44 | -0.16*** | -0.09* |
| | (2.60) | (2.30) | (2.29) | [-4.50] | [-2.23] |
| University | 0.38 | 0.36 | 0.37 | -0.03*** | -0.02** |
| | (0.48) | (0.48) | (0.48) | [-4.76] | [-3.03] |
| Number of children | 2.05 | 2.33 | 2.34 | 0.33*** | 0.34*** |
| | (1.21) | (1.08) | (1.08) | [19.95] | [18.47] |
| Married/cohabiting | 0.57 | 0.63 | 0.62 | 0.12*** | 0.12*** |
| | (0.50) | (0.48) | (0.49) | [17.46] | [15.16] |
| Hot-flashes symptoms | | 0.86 | 0.86 | | |
| | | (0.31) | (0.31) | | |
| Visited doctor due to hot-flashes | | 0.28 | 0.26 | | |
| | | (0.38) | (0.38) | | |
| Age at menarche | | 13.14 | 13.18 | | |
| | | (1.46) | (1.46) | | |
| Observations | 474,031 | 5,686 | 4,502 | 52,688 51,504 | |
| | Panel B: Age at menopause onset (not restricted to age 50) | | | | |
| Age diagnosed X11/X12 | 51.28 | 52.48 | 52.46 | 1.20*** | 1.18*** |
| | (2.05) | (2.33) | (2.11) | [54.28] | [45.17] |
| Age menopause | | 48.64 | 50.46 | | |
| | | (5.27) | (2.63) | | |
| Observations | 87,9789 | 8,700 | 6,174 | 88,8489 | 88,5963 |
| | Panel C: Main outcomes | | | | |
| Earnings | 432513.72 | 388638.52 | 392179.22 | -31005.46*** | -27464.76*** |
| | (242417.05) | (159202.26) | (161819.78) | [-10.86] | [-8.61] |
| Work hours | 31.61 | 30.55 | 30.73 | -0.98*** | -0.80*** |
| | (7.10) | (8.14) | (8.10) | [-9.91] | [-7.33] |
| Days sick leave | 21.85 | 27.31 | 27.04 | 3.81*** | 3.54*** |
| | (59.28) | (65.24) | (64.85) | [4.39] | [3.68] |
| Months long-term sick leave | 0.79 | 0.93 | 0.95 | 0.20*** | 0.21*** |
| | (2.41) | (2.37) | (2.42) | [6.15] | [5.97] |
| Number of GP visit | 10.22 | 10.50 | 10.16 | 0.98*** | 0.63** |
| | (14.80) | (14.67) | (14.42) | [4.91] | [2.87] |
| Observations | 474,031 | 5,686 | 4,502 | 52,688 51,504 | |

*Note*: *p<0.1; **p<0.05; ***p<0.01. Summary statistics of certain characteristics and outcome variables, measured at at age 50. Panel B is based on all ages across our samples. Column (1) includes the full population of Norwegian women born 1951–1973, column (2) includes HUNT women born 1951–1973, column (3) includes HUNT women born 1951–1973 who had their menopause between age 45 and 55. Columns (4) and (5) show the differences between the full population of Norwegian women vs. full sample of HUNT women, and the full population of Norwegian women vs. estimation sample of HUNT women. Standard errors are shown in parenthesis and t-statistics in square brackets. We replace missing with sample average to keep the number of observation constant for all variables. Immigrant = 1 if not born in Norway, university education = 1 if at least 16 years of education, childless =1 if no children, married/cohabiting = 1 if married or cohabiting, hot-flashes symptoms = 1 if experienced hot flashes due to menopause, age at menarche = age at first period, earnings = annual earnings in NOK, work hours = weekly work hours, days/months (long-term) sick leave = number of days or months on (long-term) sick leave per year, number of GP visit = number of GP visits per year. *Source*: HUNT, Norwegian Central Population Registry, Earnings and Tax Registry, and Employment Registry, and KUHR, own calculations.

## 4.2 Results

Table 2 shows the association between a range of socio-economic status (SES) and medical characteristics and age at menopause. In column 1, we investigate predictors of early menopause (before the age of 45) based on the full HUNT sample. The estimations in columns 2 to 5 are based on our estimation sample, including women who are entering menopause between ages 45 and 55. Specifically, in column 2 we employ menopause age linearly as the outcome, in column 3 we use a binary variable indicating whether a women

is entering menopause at age 50 or later. Column 4 restricts our estimation sample to those women that received a diagnosis and uses age at diagnosis as the outcome. In column 5 we predict the probability to receive a diagnosis based on the estimation sample, while column 6 is based on the full KUHR sample employing age at diagnosis as the outcome variable.

The results indicate that age at menopause is associated with various SES and health factors. Specifically, having a low income (bottom quartile), being an immigrant, and having a history of sick leaves are associated with an earlier age at menopause and increases the probability of early menopause. Conversely, higher education, high income, parity, working full-time and being married or cohabiting are linked to a later onset. The estimates maintain consistent direction for most predictors across specifications, with increased statistical significance observed in column 6. This increased significance is attributable to the use of the full KUHR sample, which provides greater statistical power due to its larger sample size. Childlessness and age at menarche show no clear correlation with menopausal age. In general, women with higher SES tend to experience menopause later, are less likely to experience early menopause and less likely to receive a menopause-related diagnosis than those from lower SES backgrounds.

Given the association between SES (income and education) and age at menopause onset, we perform additional analysis to understand the link between SES and menopause age across the age distribution. Specifically, we estimate a flexible parametric duration model, following Royston & Lambert (2011). The model allows for hazard rates that vary flexibly across time, and non-proportionate interactions with social characteristics. It takes the form:

$$ln[H_i(t|X_i)] = \alpha f(t) + \beta X_i + \theta f(t) * X_i \tag{2}$$

Where $H_i$ is the hazard rate, $f(t)$ is a restricted cubic spline with 5 knots, and $X_i$ is a characteristic of interest. We follow women from age 40–59 or until menopause, and all characteristics are observed at age 40. Women who reached menopause before age 40 are excluded.

Figure 3 shows survival curves for menopause, by education and relative income. We see that age is a dominant determining factor for transitioning to menopause. The model estimates that at age 50, 39% have reached menopause among women without lower secondary education or less, compared to 30% among those with higher tertiary education, which is a statistically significant difference. Similar estimates for income show 41% reaching menopause by age 50 in the bottom income quartile, compared to 36% in the top

Table 2: Predictors of menopause age

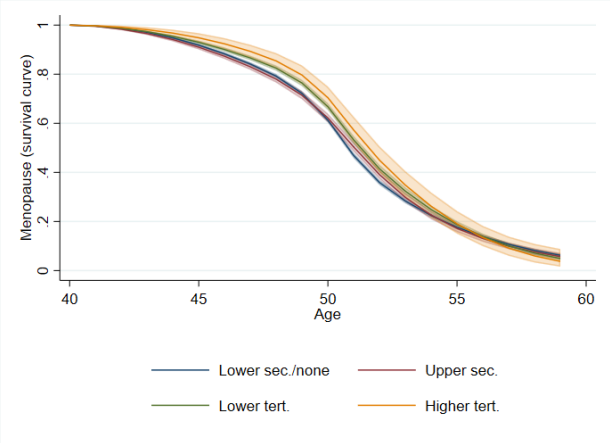
| | Full HUNT sample | Estimation sample HUNT | | | | KUHR |
|---|---|---|---|---|---|---|
| | P(<45=1) | Age at menopause | P(≥ 50 = 1) | Age diagnosed X11/X12 | P(Ever diagnosed X11/X12=1) | Age diagnosed X11/X12 |
| Immigrant | -0.012 | -0.440* | -0.116** | 0.916 | -0.053 | -0.085*** |
| | (0.065) | (0.252) | (0.056) | (0.823) | (0.077) | (0.031) |
| University | -0.035 | 0.112 | 0.049 | -0.023 | 0.028 | 0.146*** |
| | (0.030) | (0.138) | (0.034) | (0.368) | (0.039) | (0.023) |
| P25 | 0.057** | -0.020 | 0.016 | -0.166 | 0.028 | -0.049*** |
| | (0.026) | (0.113) | (0.029) | (0.365) | (0.031) | (0.017) |
| P50 | 0.004 | -0.052 | 0.011 | 0.104 | 0.069 | -0.017 |
| | (0.035) | (0.152) | (0.039) | (0.483) | (0.044) | (0.027) |
| P75 | 0.011 | 0.100 | -0.050 | 0.901** | -0.076* | 0.025 |
| | (0.034) | (0.162) | (0.039) | (0.454) | (0.045) | (0.029) |
| Working fulltime | -0.019 | 0.004 | 0.052 | -0.099 | 0.038 | 0.040*** |
| | (0.032) | (0.153) | (0.037) | (0.475) | (0.043) | (0.013) |
| Sick leave | 0.057* | -0.048 | -0.004 | 0.556 | -0.024 | -0.092*** |
| | (0.034) | (0.153) | (0.037) | (0.469) | (0.041) | (0.025) |
| Diabetes diagnosis | 0.107 | 1.014** | -0.030 | . | -0.303*** | -0.137 |
| | (0.180) | (0.453) | (0.035) | (.) | (0.074) | (0.109) |
| Number of children | 0.015 | -0.028 | 0.007 | -0.305 | -0.005 | 0.028** |
| | (0.015) | (0.076) | (0.017) | (0.207) | (0.019) | (0.012) |
| Childless | 0.027 | -0.307 | -0.025 | -0.293 | -0.076 | -0.048 |
| | (0.059) | (0.284) | (0.065) | (0.668) | (0.071) | (0.043) |
| Married/cohabiting | 0.023 | 0.116 | -0.020 | 0.345 | -0.017 | 0.054** |
| | (0.029) | (0.137) | (0.034) | (0.372) | (0.038) | (0.022) |
| Menarche age≥13 | 0.007 | 0.148 | -0.012 | 0.194 | 0.013 | |
| | (0.028) | (0.131) | (0.032) | (0.427) | (0.036) | |
| Observations | 1088 | 661 | 661 | 172 | 661 | 32210 |
| F-stat | 0.256 | 0.419 | 0.573 | 0.000 | 0.017 | 0.000 |
| $R^2$ | 0.184 | 0.355 | 0.213 | 0.258 | 0.033 | 0.266 |

*Note*: *p<0.1; **p<0.05; ***p<0.01. OLS regression results based on equation 1. In column (1), we investigate the predictors or early menopause (before age 45) based on the full HUNT sample (all menopause ages included). Column (2) to (5) are based on our estimation sample (menopause ages 45-55). In column (2) menopause age is the outcome variable, in column (3) entering the menopause at age 50 or later is the outcome, in column (4) the age at X11/X12 serves as the outcome and in column (5) being diagnosed with X11/X12 coded as a dummy variable is the outcome. Column (6) is a based on the full KUHR sample and uses age at diagnosis as the outcome variable. Predictors are measured two years before menopause. Immigrant = 1 if not born in Norway, university education = 1 if at least 16 years of education, P25 = 1 if earnings are equal to or below the 25th percentile, P50 = 1 if earnings are above or equal to the median, P57 = 1 if earnings are above or equal to the 75th percentile. Full-time = 1 if at least 37.5 work hours are reported in the firm registry for one year, sick leave = 1 if at least one time on sick leave during the year, Nb children = number of children, childless =1 if no children, married/cohabiting =1 if married or cohabiting, menarche ≥ age 13 = 1 if the woman reported experiencing her first menstrual period at age 13 or later. We add control variables for missing to keep the sample constant. Standard errors are shown in parenthesis. *Source*: HUNT, Norwegian Central Population Registry, Earnings and Tax Registry, Employment Registry, and KUHR, own calculations.

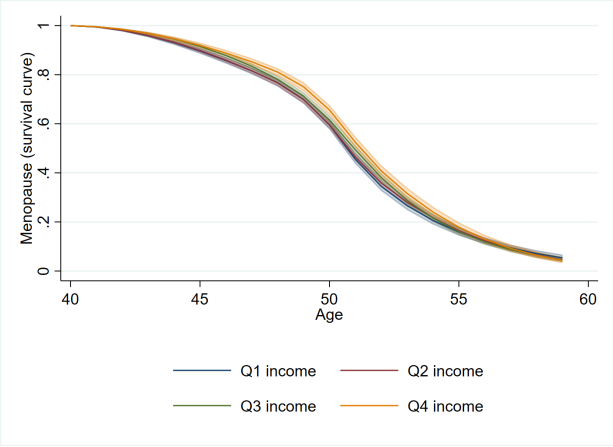
quartile, also significantly different. The survival curves by SES confirm that women from lower SES backgrounds tend to experience menopause earlier.

Figure 3: Predicted menopause by education and relative income

(a) Education




(b) Relative income




*Note*: Predicted survival curves from duration model, by education and relative income quartile. The model uses restricted cubic splines with five knots and fits curves separately for each category. *Source*: HUNT, Norwegian Central Population Registry, Earnings and Tax Registry, and KUHR, own calculations.

Given that menopausal age is not random, we investigate whether women with different ages at menopause follow distinct labor market and health trajectories for our primary outcomes: earnings and health. Figure A.2 descriptively illustrates that labor market and health outcomes vary over time among women with different menopause ages. Especially women who experience menopause at a later age show lower healthcare consumption in their early 40s (panel (b)), though these differences disappear by age 60 when all groups have entered menopause. Earnings (panel (a)) also vary across menopausal age groups over time, underscoring that women with earlier and later menopause follow distinct labor market and health trajectories. This highlights the importance of accounting for these differences when evaluating the impact of menopause on these outcomes.

# 5 Effects of Onset of Menopause

## 5.1 Empirical Strategy

In the child penalty literature event study approaches as proposed by Kleven et al. (2019b) are well-established (e.g., Andresen & Nix, 2022; Kleven et al., 2023). The reasoning behind this approach is that while fertility decisions are not exogenous, childbirth likely

induces changes in the outcome that are orthogonal to the unobserved determinants of the outcome. This concept can be extended to the menopause context, where, although the timing of menopause is not exogenous, its onset generates reasonably exogenous changes in the outcome. However, even under this assumption, the approach can yield biased estimates, as highlighted by recent literature on TWFE models with staggered roll-out and heterogeneous treatment effects (see, e.g., de Chaisemartin & D'Haultfoeuille, 2023). New estimators address the issue of "forbidden comparisons," i.e., using already-treated units as controls, by constructing more appropriate control groups. For instance, Cengiz et al. (2019) propose a *stacked* DiD estimator, where not-yet-treated units –women who experience menopause later– act as the control group. This approach, however, only produces valid estimates if women with earlier and later menopause are comparable and would follow similar trajectories in the absence of menopause. Melentyeva & Riedel (2023) show that this assumption is problematic in the context of childbirth, as age significantly influences fertility, labor market outcomes, and health. Women who give birth in their 30s are likely on different career and health paths compared to those who give birth in their early 20s, making older first-time mothers unsuitable as control groups for younger ones.

As demonstrated in Section 4.2, age at menopause is determined by individuals' medical histories and socio-economic characteristics. We also show that women with earlier and later menopause ages follow different labor market and health trajectories. Therefore, we adapt the stacked DiD approach outlined in Melentyeva & Riedel (2023), constructing a control group that includes only women with menopause ages similar to those in the treatment group. Specifically, for each age-at-menopause cohort $s$, we create a sub-panel that includes all women who enter the menopause at a given age, plus women whose menopause age is up to five years later. Each sub-panel thus covers women aged $[a, a + 5]$, where $a$ represents the age at menopause.[11] We focus on menopause cohorts aged 45 to 55, along with four pre- and four post-menopause years. We exclude women who experience menopause at significantly younger or older ages, as they differ from those entering menopause around the average age and are not comparable.

[11] As soon as a control-women reaches her menopause age, she is excluded from the control group in the respective subpanel. Our results are robust to also excluding women from the control group in the year before menopause.

We then estimate the following DiD model using a TWFE regression for each sub-panel:

$$y_{iast} = \sum_{\substack{l=-4 \\ l\neq -2}}^{4} \beta_l^s \times \mathbf{I}[a-s=l] \times \mathbf{I}[a_i^0 = s] + \sum_{\substack{l=-4 \\ l\neq -2}}^{4} \alpha_l^s \times \mathbf{I}[a-s=l] + \gamma_a + \lambda_i + \theta_t + \varepsilon_{iast} \tag{3}$$

where $y_{iast}$ denotes the outcome for women $i$ at age $a$ who belongs to the age-at-menopause cohort $s \in [45, 55]$ and is entering menopause in year $t$. The term $\mathbf{I}[a-s=l]$ represents an indicator for the years relative to the age-at-menopause cohort, while $\mathbf{I}[a_i^0 = s]$ identifies treated women within each sub-panel– those who actually experience menopause at age $a_i^0$, coinciding with age-at-menopause cohort $s$. This approach allows the treatment to vary across sub-panels, meaning women can belong to the control group in some sub-panels but be part of the treatment group in the sub-panel for their respective age-at-menopause cohort. The coefficients of interest, $\beta_l^s$, measure the effect of menopause onset on women's outcomes $l$ years away from entering the menopause. $l = -2$ is the reference category to allow for an anticipation effect during the perimenopause phase. Additionally, we include age, $\gamma_a$, individual, $\lambda_i$, and year, $\theta_t$, fixed effects. Standard errors are clustered at the individual $\times$ sub-panel level.

We stack these TWFE regressions for all sub-panels across age-at-menopause cohorts and employ the corrective sample weights developed by Wing et al. (2024) in order to correct for the bias derived from weighting treatment and control trends differently across sub-panels in conventional stacked DiD regressions.[12] Finally, we express the stacked coefficients as percentages of the average pre-menopause outcome for treated women.

The main identifying assumption behind the stacked DiD approach is that outcomes of treated and control women would have evolved in parallel in absence of menopause. We provide evidence for the plausibility of this assumption and other robustness checks in Section 5.2.2.

## 5.2 Results

### 5.2.1 Main Results and Discussion

In Figure 4, we plot the weighted average across age-at-menopause cohorts, illustrating the impact of menopause onset on women's labor market outcomes compared to their average

[12] Our results are robust to stacking the TWFE regressions for sub-panels across age-at-menopause cohorts without employing corrective sample weights and are available in Figure B.1.

outcomes two years before menopause onset. Panel (a) suggests that menopause onset leads to a decline in earnings, reaching up to 3.7% four years after menopause onset. This effect is significantly, namely six times, smaller than the motherhood penalty in Norway (3.7% vs. 23%, Andresen & Nix, 2022). Compared to the findings of Huttunen et al. (2011), who study job displacement in Norway and report that the long-term impact of job loss on earnings is about 3%, our estimated earnings decline is similar. Additionally, our earnings effect is significantly smaller than the effect reported by Conti et al. (2024), who find a 20% earnings decline four years after a menopause diagnosis among Norwegian women. Our study differs from theirs in two key ways. First, we measure the age at menopause onset rather than the age at diagnosis. Second, unlike Conti et al. (2024), we account for differences among women entering menopause at various ages by constructing control groups for each menopause-age cohort, consisting of women who experience menopause at most five years later.

This earnings decline may be driven by several factors, including reduced work hours and increased sick leave. Panels (b)–(f) indicate that the primary contributor to the earnings decline is an increase in long-term sick leave. First, panel (b) shows that the decline in income from work (excluding other income such as sickness benefits) is larger than the overall earnings decline (5% vs. 3.7%). Second, while contracted work hours remain unchanged (panel (e)), the number of short-term sick leave days rises in the first year after menopause onset (panel (c)), followed by an increase in long-term sick leave from the second year onward (panel (d)). Specifically, four years after menopause onset, women take, on average, 0.36 more months of long-term sick leave compared to two years prior to menopause. With a pre-menopause average of 0.78 months, this increase results in an average of 1.14 months of long-term sick leave four years after menopause onset. The effects of menopause onset on sick leave are even more pronounced at the extensive margin, i.e., there is an elevated probability of being on (long-term) sick leave after menopause onset (Figure A.3). Lastly, we can rule out that the earnings decline is driven by job switches from the private (on average higher wages) to the public sector (on average lower wages) as evidenced by panel (f).[13] The observed decline in earnings is likely attributable to women taking long-term sick leave and receiving sickness benefits, which amount to 66% of their pre-sickness income, rather than to women leaving their jobs or reducing their contracted work hours.

[13]There is no observed effect on the likelihood of participating in the labor force, which we define as having strictly positive annual earnings. Similarly, there is no effect on the likelihood of receiving a disability pension. Results are available upon request.

In Figure 5, we explore the types of health issues that may explain the increase in sick leave. Panel (a) shows that the probability of receiving an X11 and/or X12 diagnosis increases by 46% around the time of menopause onset. However, starting three years after menopause onset, the probability of receiving an X11 and/or X12 diagnosis declines compared to two years before menopause onset. As 52% of women who receive a diagnosis do so within two years before or after menopause onset, the likelihood of receiving a diagnosis several years after menopause onset is lower than that in the two years leading up to menopause onset. Additionally, GPs refer women with menopause-related symptoms to specialists, leading to a consistent increase in menopause-related diagnosis (N95) at specialists in the first four years after menopause onset (panel (h)). Besides an increase in menopause diagnoses, the risk of being diagnosed with diabetes increases steadily after menopause onset, consistent with findings in the medical literature (Szmuilowicz et al., 2009). Beyond this, we find limited evidence of significant health effects, aside from small increases in the likelihood of receiving a mental health disorder diagnosis. The limited health impacts observed in the overall sample suggest that the decline in earnings and the rise in sick leave are likely driven by a subset of women experiencing severe symptoms that impair their ability to work. The increase in menopause diagnoses suggests potential differences in symptom severity, care-seeking behaviors, and treatment, among diagnosed versus undiagnosed women. For instance, diagnosed women may experience more severe symptoms, while undiagnosed women may not seek care or may be misdiagnosed, leading to a lack of appropriate treatment. To explore these mechanisms, we conduct several heterogeneity analyses using additional information on education, symptoms, healthcare seeking behavior and treatment from the HUNT survey in Section 5.2.3.

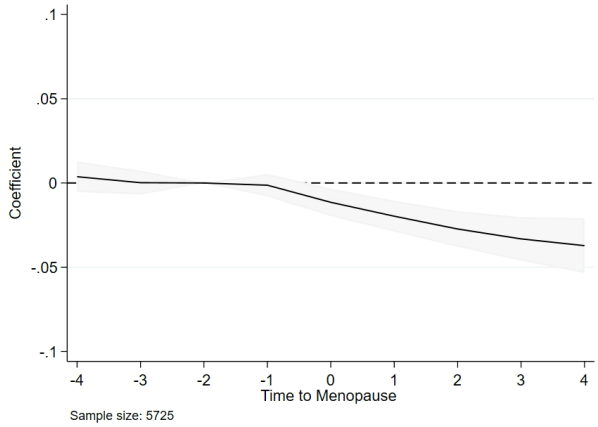
### 5.2.2 Robustness

As outlined in Section 5.1, the parallel trend assumption needs to hold to ensure that the approach in equation (3) generates valid estimates. By examining the pre-trends in Figures 4 and 5, it can be observed that the coefficients at period $l = -3$ and $l = -4$ for all outcomes are (close to) zero. This provides evidence supporting the plausibility that the labor and health outcomes for treated and control women would have evolved in parallel in absence of menopause.

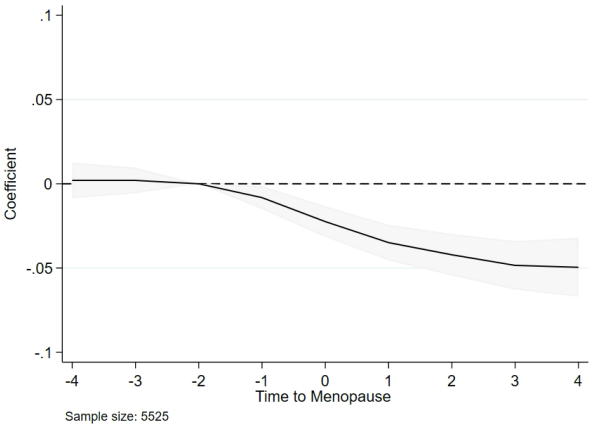
Symptoms of menopause can begin several years before its onset (World Health Organization, 2024). Although our earnings estimates show no pre-trends, we validate that our reference category, $l = -2$, does not influence the point estimates by shifting the reference category to $l = -3$ in Figure B.2. The estimated earnings effect four years after

Figure 4: The effects of menopause on labor market outcomes

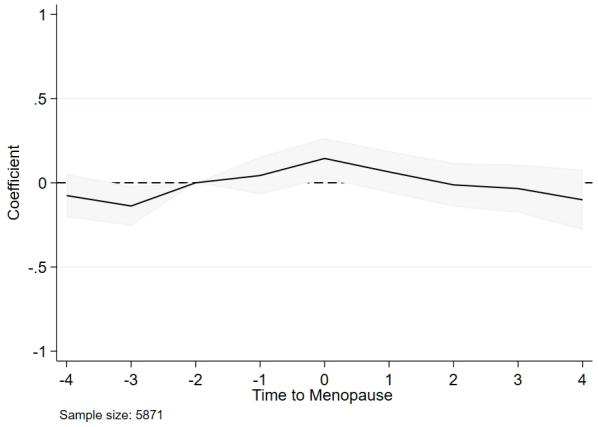
(a) Earnings



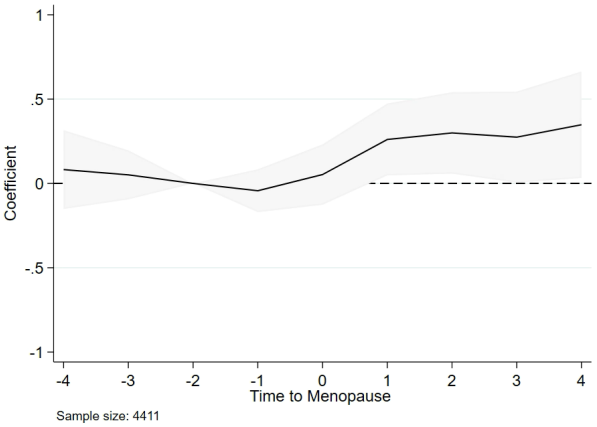

(b) Income from work



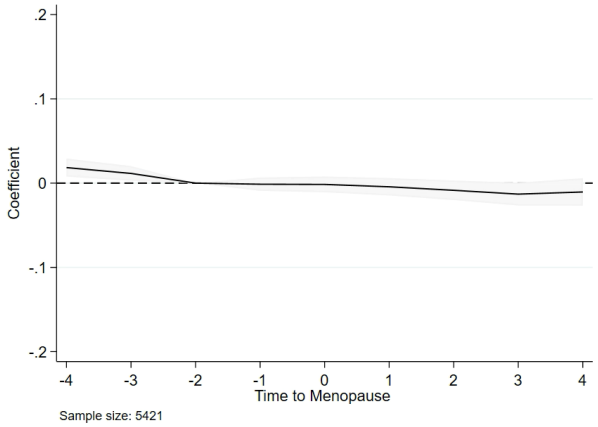

(c) Days on short-term sick leave



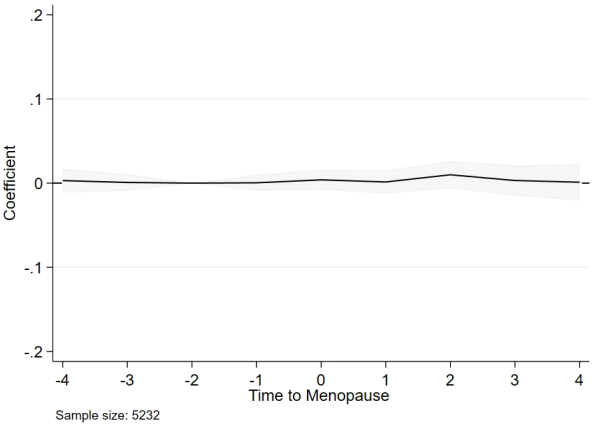

(d) Months on long-term sick leave




(e) Work hours



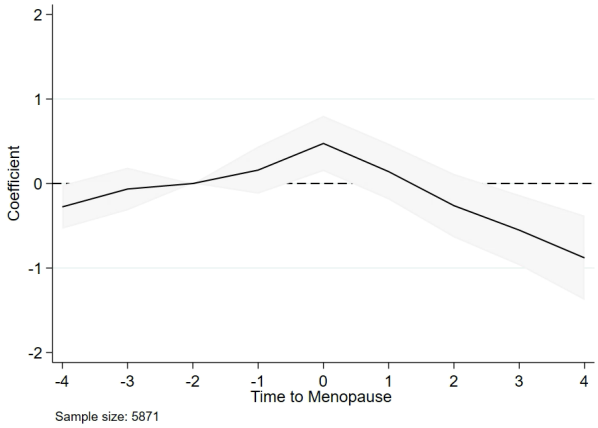

(f) Job change to public/private sector



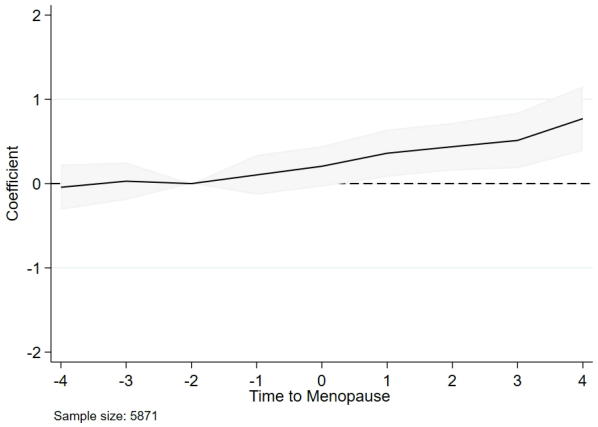

*Note*: Pre- and post-menopause estimates of the effects of menopause on women's labor market outcomes based on equation (3). The graphs plot the weighted average of the age-at-menopause cohort-specific estimates relative to the pre-menopause average of the labor market outcomes in year $l = -2$. *Source*: HUNT, Norwegian Central Population Registry, Earnings and Tax Registry, Social Security Records, Employment Registry, KUHR, and NPR, own calculations.

Figure 5: The effects of menopause on health outcomes

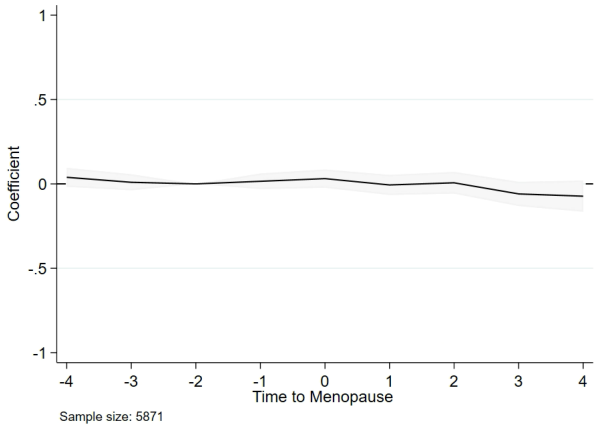
(a) Menopause diagnosis (X11/X12)



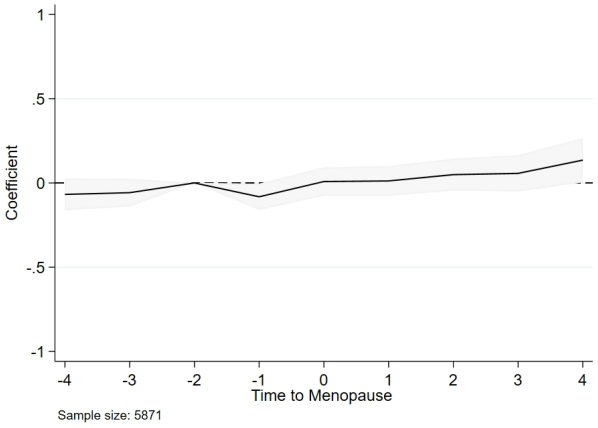

(b) Diabetes diagnosis



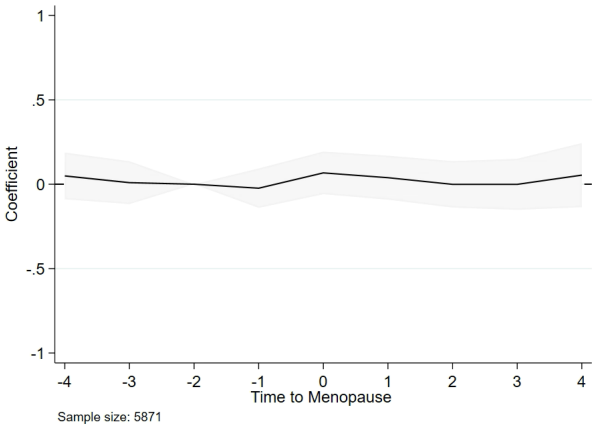

(c) Number of GP visit




(d) Mental disorders diagnosis




(e) Neurological diagnosis




(f) Muscular/skeleton diagnosis

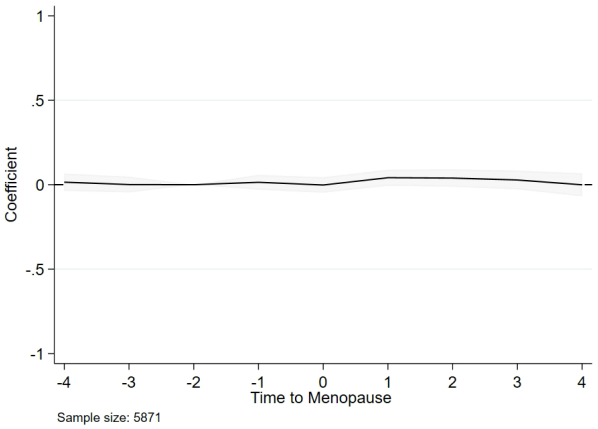
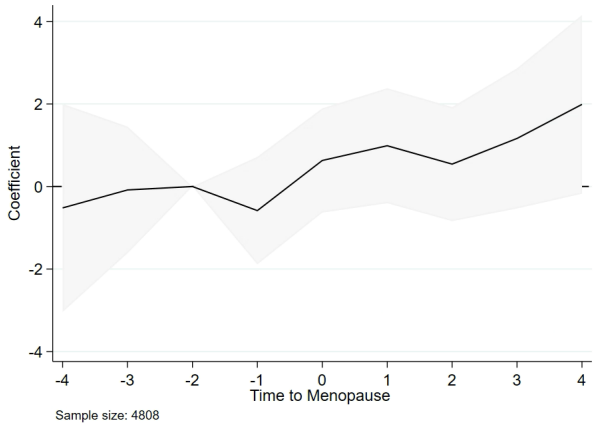
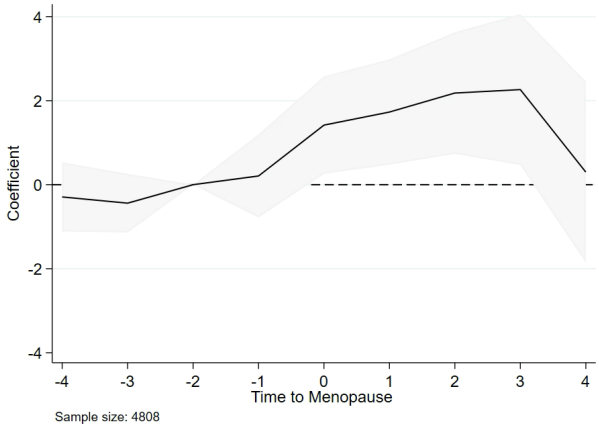


Figure 5: The effects of menopause on health outcomes (*continued*)

(g) Number of hospital visits




(h) Menopause diagnosis hospital (N95)




*Note*: Pre- and post-menopause estimates of the effects of menopause on women's health outcomes based on equation (3). The graphs plot the weighted average of the age-at-menopause cohort-specific estimates relative to the pre-menopause average of the health outcomes in year $l = -2$. *Source*: HUNT, Norwegian Central Population Registry, Earnings and Tax Registry, Social Security Records, Employment Registry, KUHR, and NPR, own calculations.

menopause onset remains consistent, at 3.8% compared to our baseline estimate of 3.7%. Furthermore, to verify that our estimates do not just reflect age or time trends, we assign placebo menopause ages to a sample of men who are comparable in terms of age and birth cohorts to our sample of women. Specifically, we assign placebo menopause events to men participating in HUNT4, using the same birth cohorts as women, by approximating the factual distribution of women's age at menopause by a log-normal distribution. Additionally, we assign the menopause age to brothers of the women in our sample (if they have a brother) to verify that the effects are not driven by genetic factors correlated with menopause symptoms and shared within the family. Figure B.3 suggests that our estimates are truly capturing the menopause effect on earnings, as the coefficients of the placebo tests are close to zero and statistically not significant for all $l$.

Our approach relies not only on the parallel trend assumption but also on the accuracy of self-reported menopause information. A potential concern is that women may not precisely recall the age at which their menstruation ceased, introducing measurement error into the menopause age variable. The presence of age heaping in this variable, as evident in Figure 1 panel (a), suggests that women who cannot remember their exact menopause age tend to round to certain numbers. For instance, a significant proportion of women report their menopause age as 50. To address concerns that systematic measurement error in the menopause age variable might drive our results, we perform several checks. First, we demonstrate that age heaping is not systematic by showing similar distributions of

menopause age across different subgroups: older and younger cohorts (Figure B.4), higher and lower earnings groups (Figure B.5), women with and without university degrees (Figure B.6), women reporting and not reporting hot flashes (Figure B.7) and women with and without an X11 and/or X12 diagnosis (Figure B.8). Second, we re-run our analysis excluding the age categories where age heaping is most prominent (ages 45, 47, 50, 52, and 55), as shown in Figure B.9. The results closely align with our main findings.[14] Third, we split our sample into younger and older cohorts, again finding consistent results (Figure B.10).

Next, we introduce random measurement error to the menopause age variable to test the robustness of our findings. Specifically, we introduce controlled perturbations to the age at menopause variable. We randomly select 20% of the sample and adjust their reported menopause age by $\pm 1$, $\pm 2$, or $\pm 3$ years, while maintaining the overall mean of the variable. Figure B.11 illustrates that as we increase the magnitude of introduced measurement error, our estimates become smaller and less precise. This pattern suggests that our findings are not driven by systematic measurement error; rather, random errors tend to attenuate the observed effects. Lastly, to rule out that our results are driven by women with an artificially induced menopause onset, we exclude women who had breast cancer during the observation period. The results closely resemble our main estimates (Figure B.12).

### 5.2.3 Heterogeneity Analysis

This section explores the mechanisms underlying the observed decline in earnings and health. We conduct several analyses across various subgroups, including individuals with and without diagnoses, those experiencing symptoms versus those who are asymptomatic, individuals with and without menopause-related healthcare consumption, and those with and without a university degree. It is important to note that the subgroup analyses involve smaller sample sizes, which can lead to reduced statistical power and wider confidence intervals. Consequently, many of the estimates, despite differing considerably in magnitude, are not statistically significantly different from each other. Nevertheless, we consider these results valuable and present them as suggestive evidence, offering insights into potential underlying mechanisms.

First, we categorize women by whether they report symptoms and present the results in Figure C.1. The decline in earnings is driven solely by women who report symptoms. Specifically, women with symptoms experience a 4.5% earnings decline, while women with-

[14] The results remain robust when excluding these age categories individually. Results are available upon request.

out symptoms do not show significant earnings changes. This finding reinforces that the labor market effects are rooted in (untreated) menopause-related health effects, not in unrelated trends coinciding with menopause onset.

Second, we compare outcomes for HUNT women with and without an X11 and/or X12 diagnosis in KUHR (Figure C.2). Diagnosed women suffer greater earnings losses (4.9% vs. 3.2%), suggesting that women with a diagnosis may experience more severe symptoms, impairing their work ability despite seeking healthcare. We corroborate this finding by demonstrating that women with a diagnosis experience more pronounced health effects, particularly an increase in mental health disorders and a slight rise in musculoskeletal diagnoses (Figure C.3). Notably, the number of GP visits for diagnosed women decreases two years after menopause onset, indicating that treatment initiation reduces the need for further care. In contrast, women without a diagnosis do not exhibit significant changes in the likelihood of other diagnoses or in healthcare consumption, suggesting that they experience milder symptoms (Figure C.4). However, undiagnosed women are the main driver of the post-menopause increase in diabetes diagnoses. This finding implies that: (i) women without a diagnosis do still seek healthcare, indicating that differences in diagnosis probability are an indication of health/symptom differences and not solely attributable to differences in healthcare-seeking behavior, and (ii) this aligns with medical literature suggesting that HRT treatment, often initiated after an X11 and/or X12 diagnosis, may reduce the risk of developing diabetes (Szmuilowicz et al., 2009).

Third, in Section 3, we have established that there is an age gap of about 2.1 years between self-reported onset of the menopause and a menopause diagnosis in our sample. To analyze the role of diagnosis timing, we divide HUNT women with an X11 and/or X12 diagnosis into those diagnosed before or in the year of self-reported menopause onset and those diagnosed afterward. Figure C.5 shows that earnings effects are smaller and less significant for women with an accurate diagnosis timing and are large (5.3%) for the delayed-diagnosis group, suggesting that timely diagnosis and care may mitigate menopause's labor market impact, even for women with severe symptoms. The diagnosis delays may arise from delayed care-seeking by women or delayed diagnosis by GPs.

To disentangle these mechanisms, we analyze healthcare consumption for women with an accurate diagnosis compared to those with a delayed diagnosis, both before and after menopause onset. Figure C.6 panel (a) illustrates that women with an accurate diagnosis consistently seek more healthcare, with the difference widening around the time of menopause onset. This suggests that at least part of the diagnosis delay may stem from delayed care-seeking behavior on the part of the women. Since women with an accurate

diagnosis experience minimal earnings losses, the disparity in care-seeking behavior is unlikely to be driven solely by underlying health differences. Panel (b) focuses on GP visits specifically associated with female-specific diagnoses, excluding X11 and X12. Beginning two years prior to menopause onset, women who ultimately receive a delayed diagnosis exhibit a higher frequency of doctor visits for female-specific conditions compared to those who receive an accurate diagnosis. This pattern suggests that the delay in diagnosis is not solely attributable to a delay in care-seeking, but may also be influenced by a delay on the GP's side. It appears that GPs might initially misdiagnose these women, failing to connect their symptoms to menopause until later. Hence, raising awareness of menopausal symptoms and treatment options among women (or society at large) and healthcare professionals may reduce diagnosis delays, enhance women's health, and support productivity.

Fourth, we analyze women with presumably milder symptoms, specifically those reporting symptoms in HUNT without an X11 and/or X12 diagnosis. As shown in Figure C.1, these symptomatic women experience earnings losses. We further distinguish between those who report seeing a doctor for menopause symptoms and those who do not. Figure C.7 shows a marked difference in earnings. Seeing a doctor fully mitigates the earnings decline, whereas women who do not seek care suffer earnings losses of up to 4.3%. These findings suggest that encouraging women to seek care for menopause-related issues may reduce or even offset the labor market impact of menopause onset.

Finally, we stratify our sample based on educational attainment and relative earnings at age 40. We compare women with and without a university degree at age 40 (Figure C.8), and women above and below the median income at age 40 (Figure C.9). Our analysis reveals that the earnings effect is predominantly driven by women without a university education (4.2%) compared to women with a university degree (2.6%). Similarly, women with below median earnings at age 40 experience larger earnings penalty (5%) compared to women above median earnings at age 40 (3.6%) This finding suggests that a lack of awareness regarding menopause and its implications may be particularly pronounced among women with lower educational and earnings levels. Consequently, campaigns aimed at raising awareness about menopause symptoms and available treatment options should prioritize targeting women from lower socioeconomic backgrounds.

# 6 Conclusion

This study sheds light on the significant health and labor market implications of menopause onset, demonstrating its multifaceted impact on women's lives. We leverage comprehensive

Norwegian administrative and survey data to investigate the predictors of menopausal age and assess the impact of menopause onset on women's labor market and health outcomes. Norway, with its universal healthcare system, provides an ideal setting for this analysis, as healthcare consumption is not driven by costs. First, our analysis of menopausal age predictors reveals that women from higher socioeconomic backgrounds tend to experience menopause later. This finding emphasizes the importance of accounting for heterogeneity in menopausal age when assessing the consequences of menopause.

Second, accounting for these age heterogeneities, we assess the effects of menopause onset using a stacked difference-in-differences model, where women with a slightly later menopause age serve as control units to address variations in menopausal age. Our findings demonstrate that menopause leads to lasting declines in earnings, reaching up to 3.7% four years after onset. The magnitude of the effect is about six times smaller than the motherhood penalty in Norway (Andresen & Nix, 2022). The earnings decline is primarily driven by increased long-term sick leave rather than changes in work hours. We can relate the increase in sick leave to a rise in menopause-related diagnoses and an increased likelihood of diabetes diagnosis post-menopause. Our heterogeneity analysis reveals that women experiencing symptoms, those receiving a menopause-related diagnosis, and those from lower SES backgrounds face more pronounced earnings losses. Importantly, timely diagnosis and care-seeking behavior significantly mitigate these negative effects, even for women with severe symptoms.

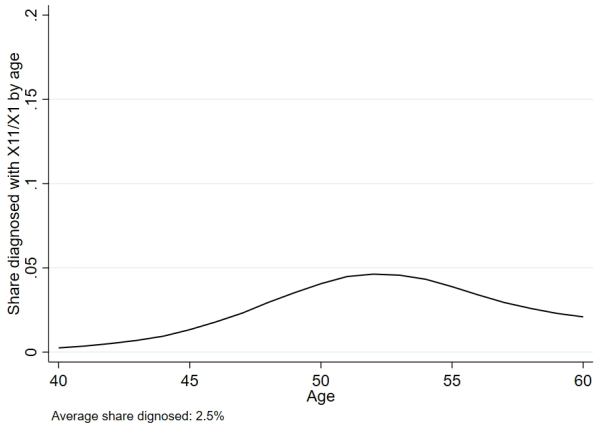
Our results underscore the importance of raising awareness about menopause and its potential impacts, both within healthcare settings and society at large. The observed delay between symptom onset and diagnosis, coupled with the mitigating effects of timely care, highlights the need for improved education and awareness among healthcare providers and women themselves. Targeted awareness campaigns, particularly for women from lower socioeconomic backgrounds, could help reduce diagnosis delays and encourage proactive healthcare-seeking behavior. Future research should build upon these findings to more precisely disentangle the driving factors behind delays in menopause diagnosis, enabling more targeted and effective awareness campaigns. Additionally, future studies could explore potential spillover effects on other family members and investigate how the work environment influences women's ability to navigate the menopausal transition. By addressing the knowledge gap surrounding menopause, we can reduce its personal and societal costs, supporting women's health and productivity during this critical stage of life.

# Appendices

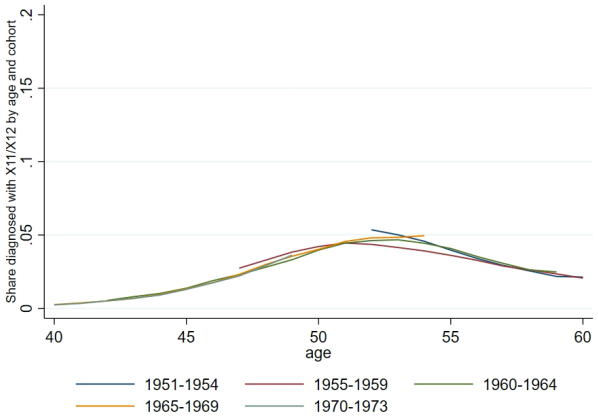
## A Additional results

Figure A.1: Share of Women Diagnosed with a Menopausal-Related Diagnosis by Age and Cohorts

(a) Age



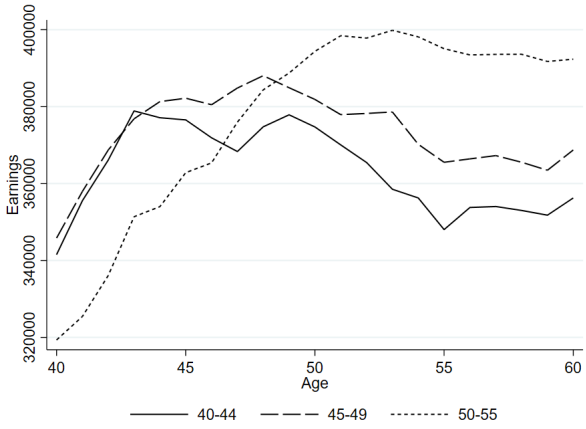

(b) Age and Cohorts



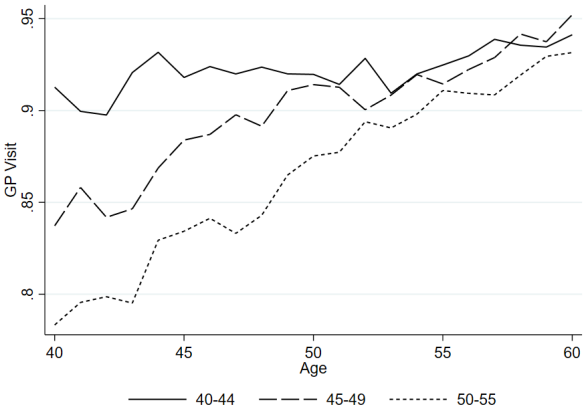

*Note*: Share of women with a menopause-related GP diagnosis (X11 and/or X12) by age (a) and different birth cohorts (b). *Source*: Norwegian Central Population Registry and KUHR (2006–2019), own calculations.

Figure A.2: Healthcare consumption and earnings by age at menopause

(a) Earnings



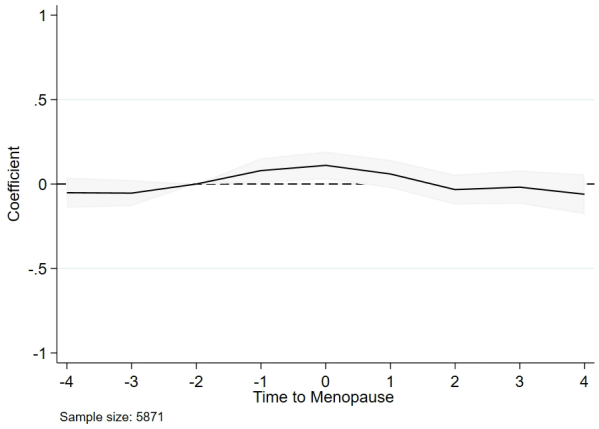

(b) GP visits



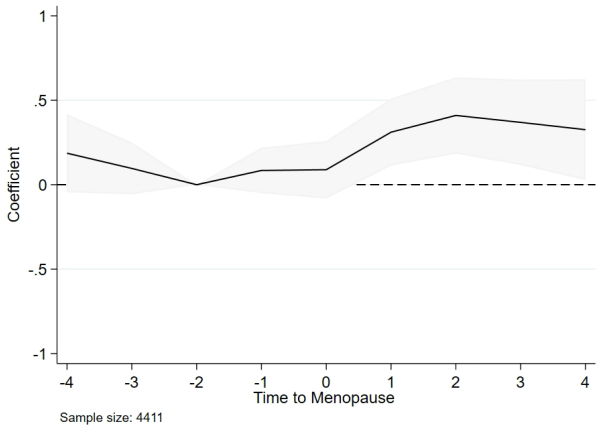

*Note*: Earnings and GP visits across age by different menopausal age groups (40–44, 45–49 and 50–55). *Source*: HUNT, Norwegian Central Population Registry, Earnings and Tax Registry, and KUHR, own calculations.

Figure A.3: The effects of menopause on sick leave (extensive margin)

(a) Sick leave



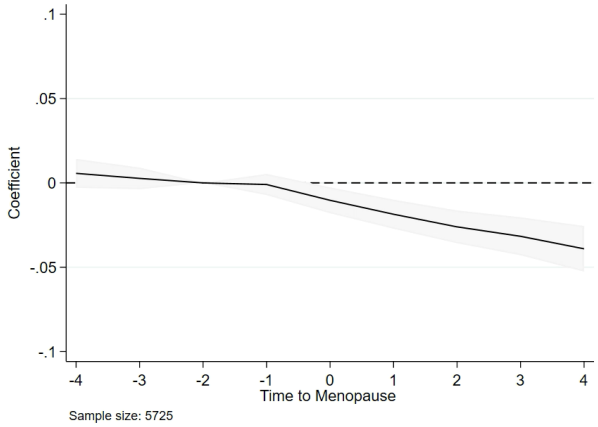

(b) Long-term sick leave




*Note*: Pre- and post-menopause estimates of the effects of menopause on women's sick leave based on equation (3). The graphs plot the weighted average of the age-at-menopause cohort-specific estimates relative to the pre-menopause average of the health and labor market outcomes in year $l = -2$. The outcome variables represent the extensive margin, i.e., the variable indicates if a women was at least one day / month on sick leave in given year. *Source*: HUNT, Norwegian Central Population Registry, Earnings and Tax Registry, Social Security Records, Employment Registry, KUHR, and NPR, own calculations.

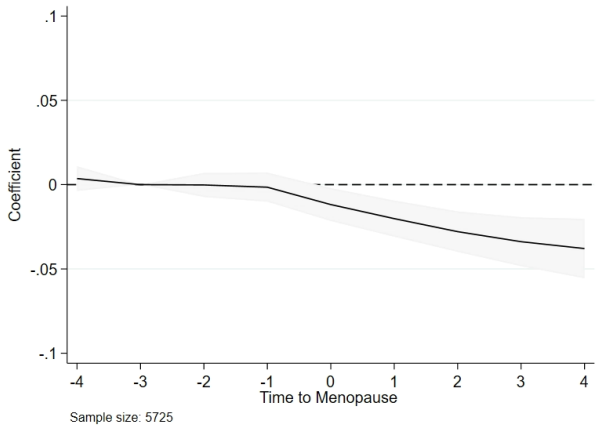
# B Robustness

Figure B.1: The effects of menopause on earnings without corrective sample weights




*Note*: Pre- and post-menopause estimates of the effects of menopause on women's earnings based on equation (3). The graphs plot the weighted average of the age-at-menopause cohort-specific estimates relative to the pre-menopause average of the labor market outcomes in year $l = -2$. Corrective sample weights are excluded. *Source*: HUNT, Norwegian Central Population Registry, Earnings and Tax Registry, Social Security Records, Employment Registry, KUHR, and NPR, own calculations.

Figure B.2: The effects of menopause on earnings using $l = -3$ as reference category

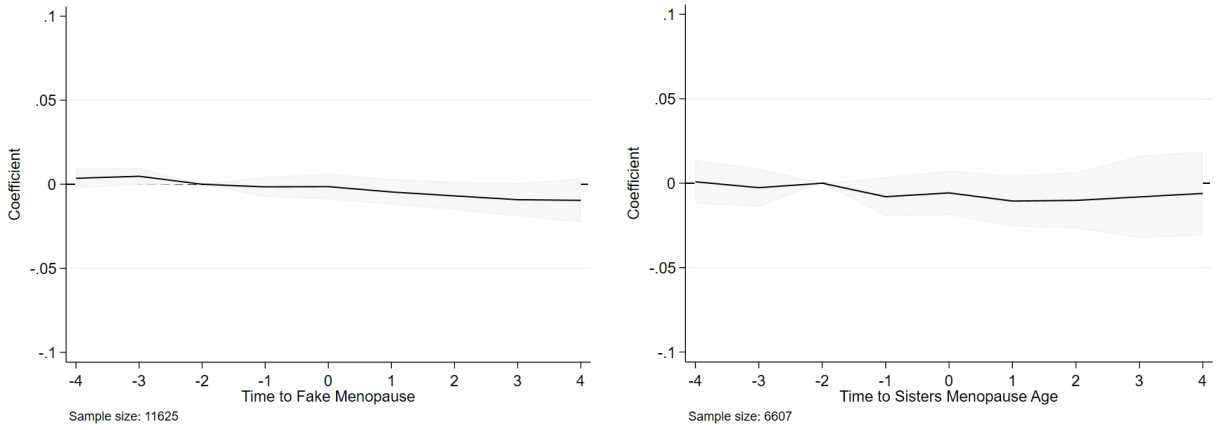



*Note*: Pre- and post-menopause estimates of the effects of menopause on women's earnings based on equation (3). The graphs plot the weighted average of the age-at-menopause cohort-specific estimates relative to the pre-menopause average of the labor market outcomes in year $l = -3$. *Source*: HUNT, Norwegian Central Population Registry, Earnings and Tax Registry, Social Security Records, Employment Registry, KUHR, and NPR, own calculations.

Figure B.3: Placebo test on men and brothers: The effects of menopause on earnings

(a) Men from HUNT

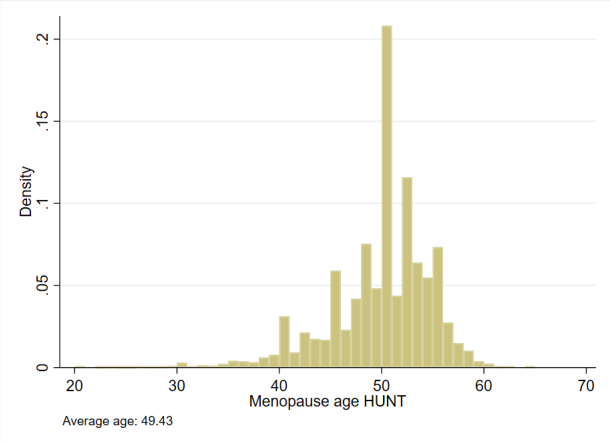
(b) Brothers of HUNT women



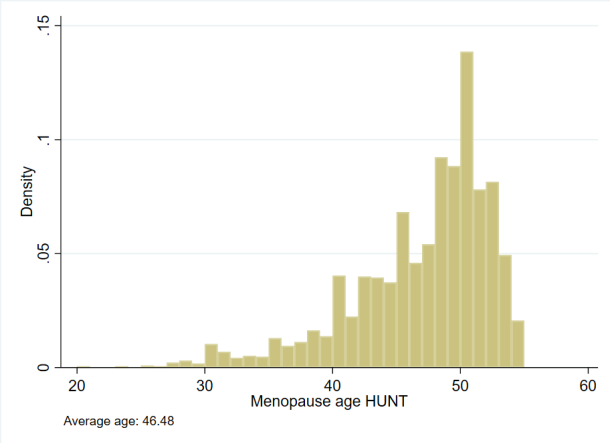

*Note*: Placebo pre- and post-menopause estimates of the effects of menopause on (a) men's and (b) brother's earnings based on equation (3). Placebo menopause age are assigned to men by approximating the factual distribution of women's age at menopause by a log-normal distribution. Brothers are assigned the menopause age of their sister (the closest sister if he has multiple sisters). The graphs plot the weighted average of the age-at-menopause cohort-specific estimates relative to the pre-menopause average of the labor market outcomes in year $l = -2$. *Source*: HUNT, Norwegian Central Population Registry, Earnings and Tax Registry, Social Security Records, Employment Registry, KUHR, and NPR, own calculations.

Figure B.4: Distribution menopause age by cohort groups

(a) Cohorts 1951–1962



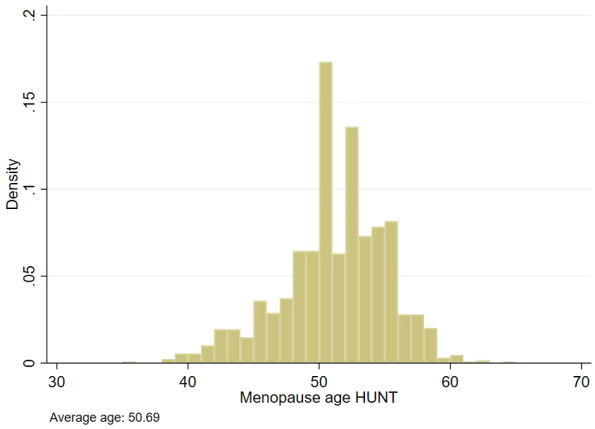

(b) Cohorts 1963–1973



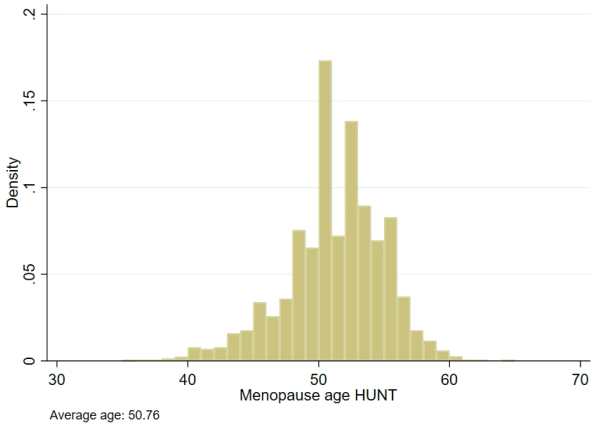

*Note*: Distribution of menopause age by cohort groups. *Source*: HUNT, Norwegian Central Population Registry, Earnings and Tax Registry, Social Security Records, Employment Registry, KUHR, and NPR, own calculations.

Figure B.5: Distribution menopause age by earnings

(a) Earnings below median



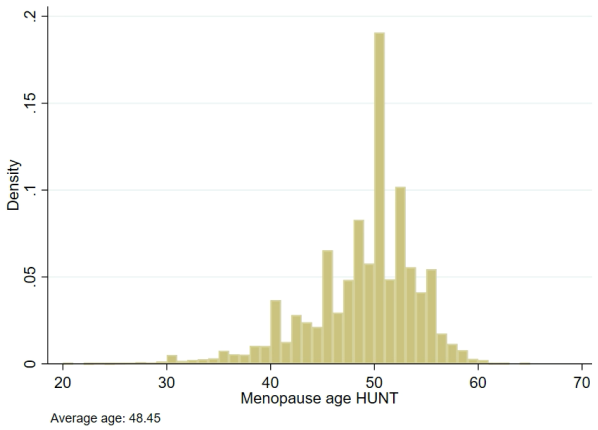

(b) Earnings above median



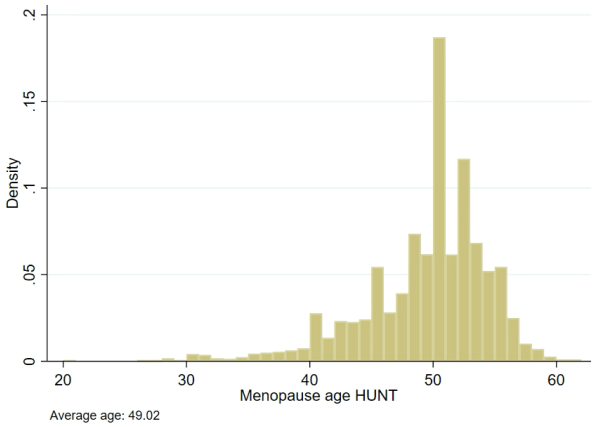

*Note*: Distribution of menopause age by earnings. *Source*: HUNT, Norwegian Central Population Registry, Earnings and Tax Registry, Social Security Records, Employment Registry, KUHR, and NPR, own calculations.

Figure B.6: Distribution menopause age by education

(a) University degree



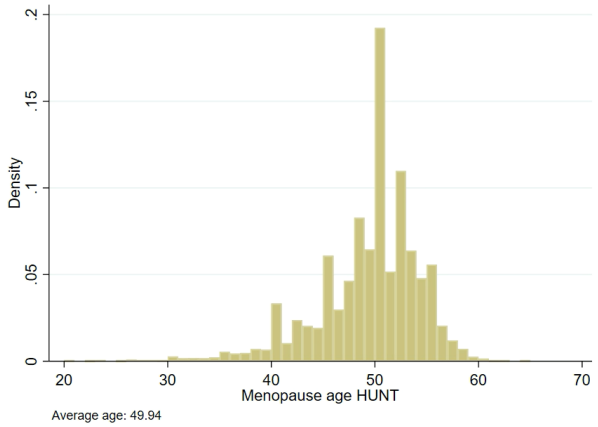

(b) No university degree



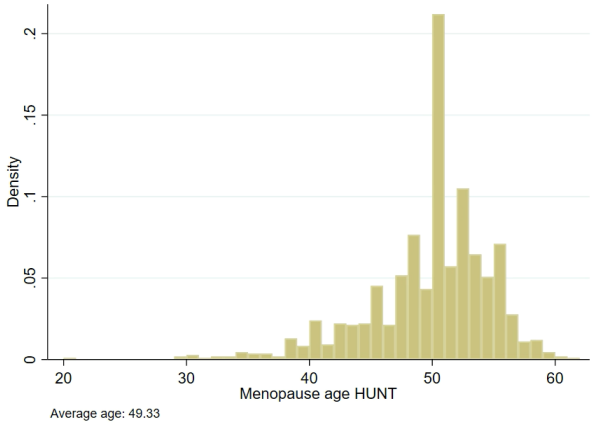

*Note*: Distribution of menopause age by education. *Source*: HUNT, Norwegian Central Population Registry, Earnings and Tax Registry, Social Security Records, Employment Registry, KUHR, and NPR, own calculations.

Figure B.7: Distribution menopause age by reporting of hot flash symptoms

(a) Symptoms



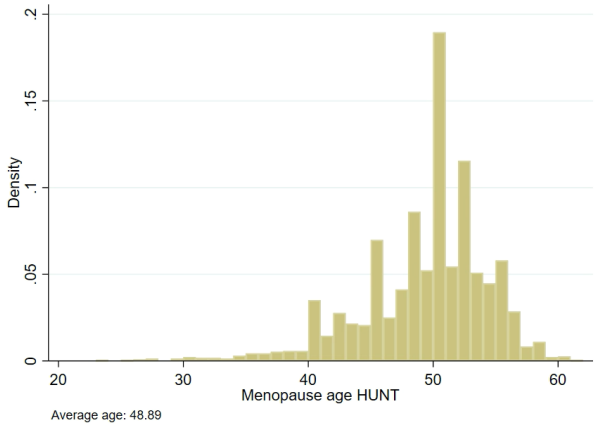

(b) No symptoms



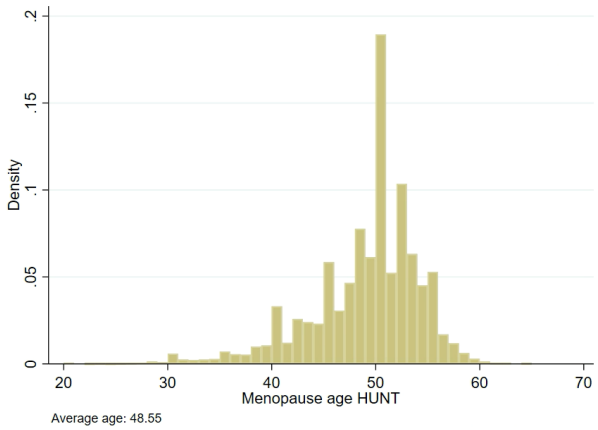

*Note*: Distribution of menopause age by reporting of hot flash symptoms. *Source*: HUNT, Norwegian Central Population Registry, Earnings and Tax Registry, Social Security Records, Employment Registry, KUHR, and NPR, own calculations.

Figure B.8: Distribution menopause age by diagnosis status

(a) X11 and/or X12 diagnosis

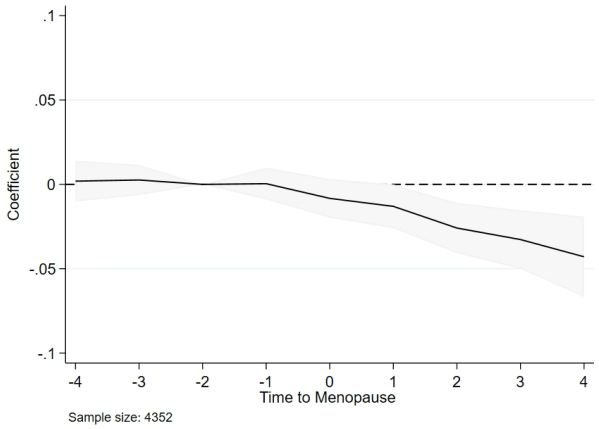



(b) No X11 and/or X12 diagnosis




*Note*: Distribution of menopause age by diagnosis status. *Source*: HUNT, Norwegian Central Population Registry, Earnings and Tax Registry, Social Security Records, Employment Registry, KUHR, and NPR, own calculations.

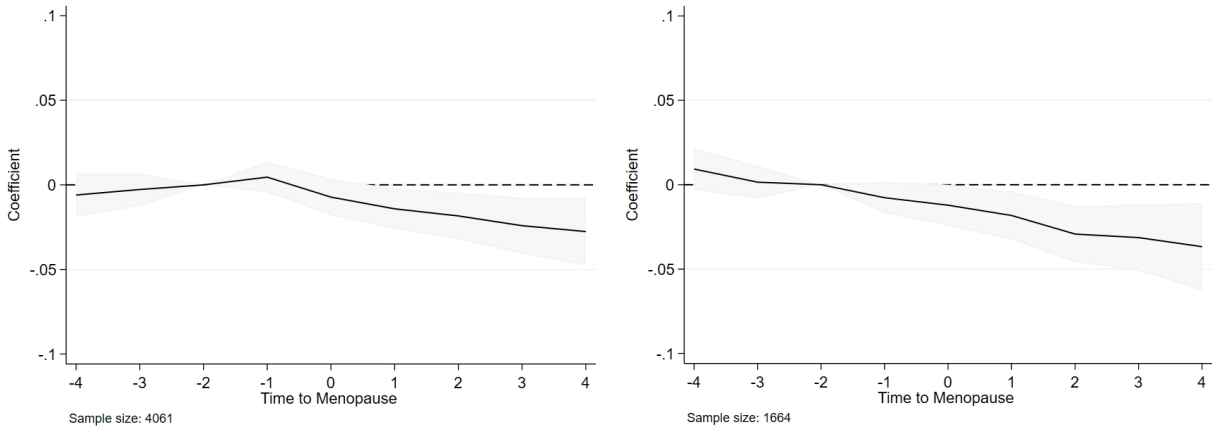
Figure B.9: The effects of menopause on earnings without age heaping




*Note*: Pre- and post-menopause estimates of the effects of menopause on women's earnings based on equation (3). The graphs plot the weighted average of the age-at-menopause cohort-specific estimates relative to the pre-menopause average of the labor market outcomes in year $l = -2$. We exclude age categories where age heaping is most prominent (45, 47, 50, 52, and 55). *Source*: HUNT, Norwegian Central Population Registry, Earnings and Tax Registry, Social Security Records, Employment Registry, KUHR, and NPR, own calculations.

Figure B.10: The effects of menopause on earnings by cohort groups

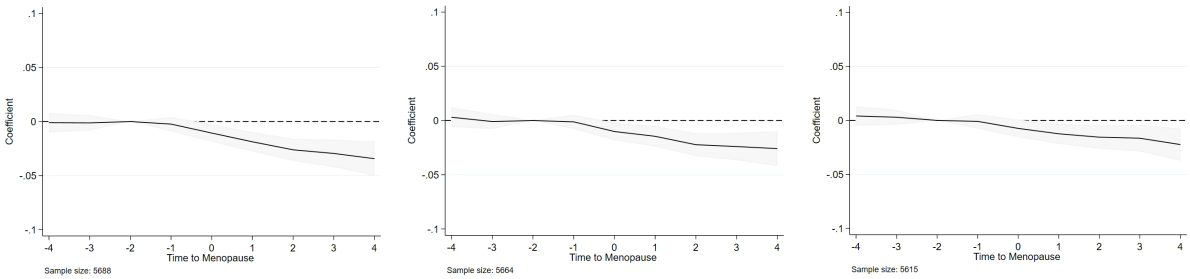
(a) Cohorts 1951–1962 (b) Cohorts 1963–1973




*Note*: Pre- and post-menopause estimates of the effects of menopause on women's earnings based on equation (3) by cohort groups. The graphs plot the weighted average of the age-at-menopause cohort-specific estimates relative to the pre-menopause average of the labor market outcomes in year $l = -2$. *Source*: HUNT, Norwegian Central Population Registry, Earnings and Tax Registry, Social Security Records, Employment Registry, KUHR, and NPR, own calculations.

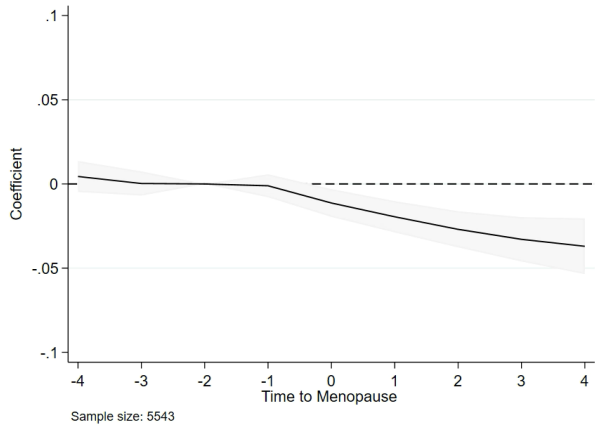
Figure B.11: The effects of menopause on earnings with measurement error

(a) 1-year error (b) 2-year error (c) 3-year error




*Note*: Pre- and post-menopause estimates of the effects of menopause on women's earnings based on equation (3). The graphs plot the weighted average of the age-at-menopause cohort-specific estimates relative to the pre-menopause average of the labor market outcomes in year $l = -2$. We randomly add measurement bias to the age at menopause for 20% of the sample. In panel (a) we add or subtract 1 year to the age at menopause variable of 20% of the sample keeping the mean of the age at menopause variable fixed. In panel (b) and (c) we do the same, but adding/subtracting 2 and 3 years, respectively. *Source*: HUNT, Norwegian Central Population Registry, Earnings and Tax Registry, Social Security Records, Employment Registry, KUHR, and NPR, own calculations.

Figure B.12: The effects of menopause on earnings: Women without breast cancer

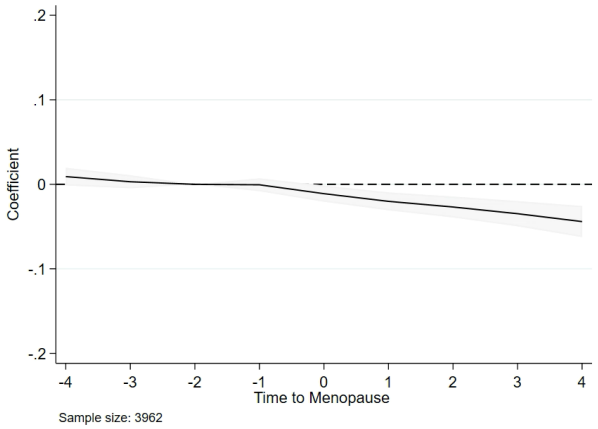



*Note*: Pre- and post-menopause estimates of the effects of menopause on women's earnings based on equation (3). The graphs plot the weighted average of the age-at-menopause cohort-specific estimates relative to the pre-menopause average of the labor market outcomes in year $l = -2$. Women with a breast cancer diagnosis are excluded. *Source*: HUNT, Norwegian Central Population Registry, Earnings and Tax Registry, Social Security Records, Employment Registry, KUHR, and NPR, own calculations.

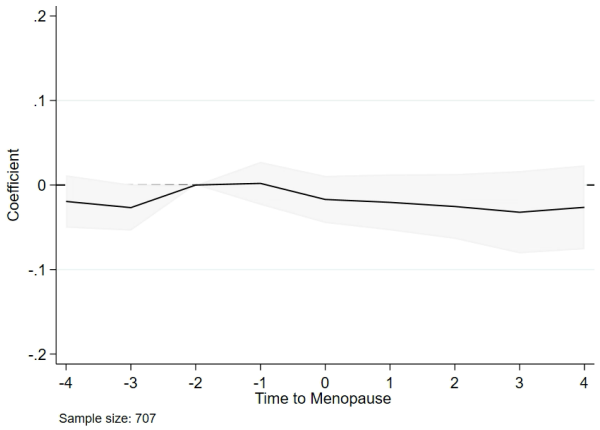
# C Heterogeneity Analysis

Figure C.1: The effects of menopause on earnings by self-reported menopause symptoms

(a) Earnings (Symptoms)



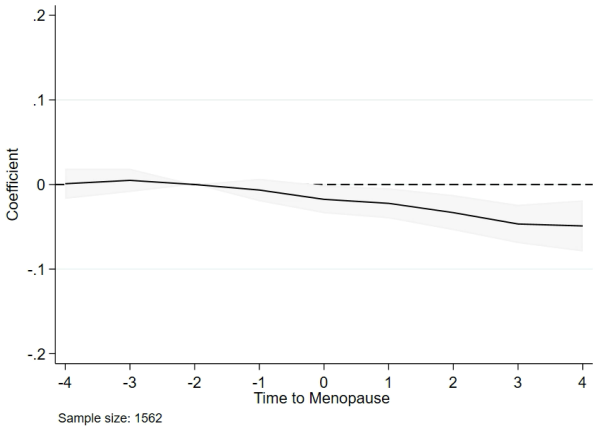

(b) Earnings (No symptoms)



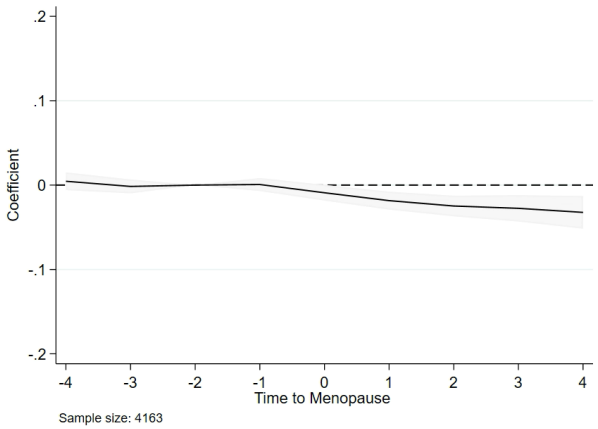

*Note*: Pre- and post-menopause estimates of the effects of menopause on women's earnings based on equation (3). The graphs plot the weighted average of the age-at-menopause cohort-specific estimates relative to the pre-menopause average of the health and labor market outcomes in year $l = -2$. The graphs on the left are based on women reporting symptoms while the graphs on the right are based on women without symptoms. *Source*: HUNT, Norwegian Central Population Registry, Earnings and Tax Registry, Social Security Records, Employment Registry, KUHR, and NPR, own calculations.

Figure C.2: The effects of menopause on earnings by diagnosis status

(a) Earnings (Diagnosis)



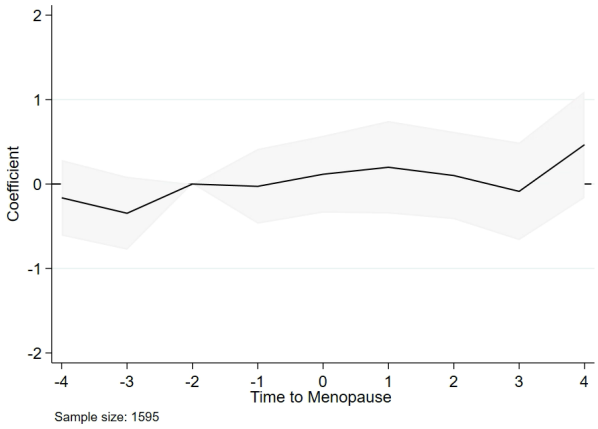

(b) Earnings (No diagnosis)




*Note*: Pre- and post-menopause estimates of the effects of menopause on women's earnings based on equation (3). The graphs plot the weighted average of the age-at-menopause cohort-specific estimates relative to the pre-menopause average of the health and labor market outcomes in year $l = -2$. The graphs on the left are based on women with an X11 and/or X12 diagnosis while the graphs on the right are based on women without a diagnosis. *Source*: HUNT and Norwegian Central Population Registry, Earnings and Tax Registry, Social Security Records, Employment Registry, KUHR, and NPR, own calculations.

Figure C.3: The effects of menopause on health outcomes for diagnosed women

(a) Diabetes diagnosis




(b) Number of GP visit

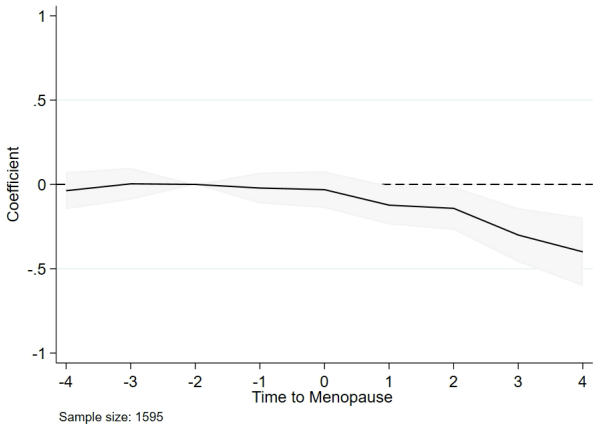
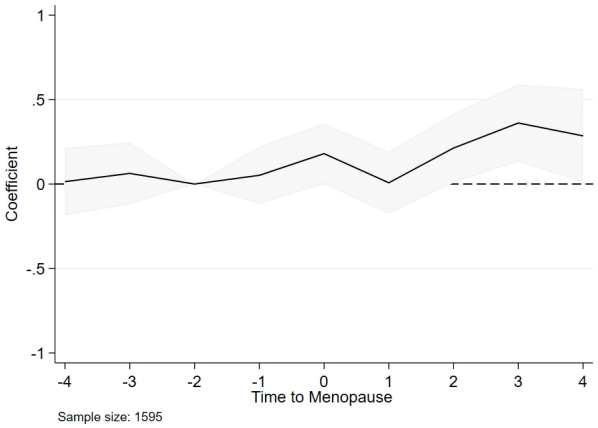
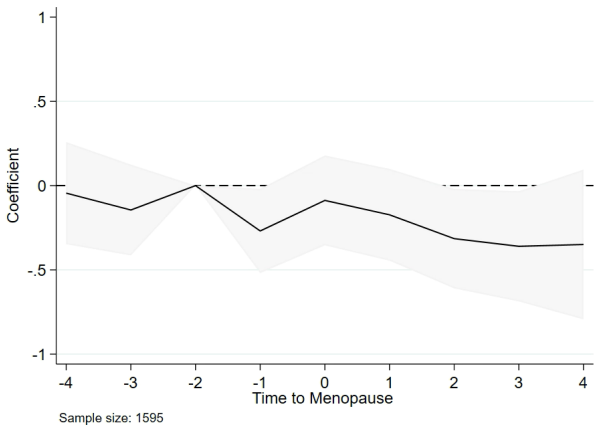


Figure C.3: The effects of menopause on health outcomes for diagnosed women (*continued*)

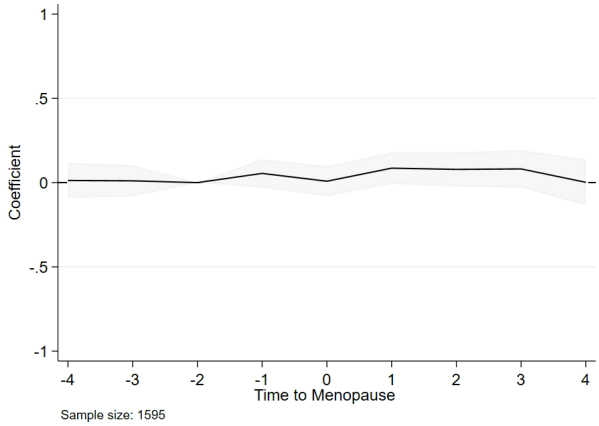
(c) Mental disorders diagnosis



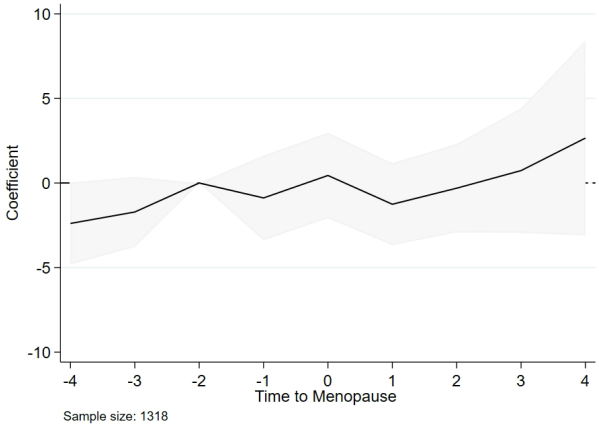

(d) Neurological diagnosis



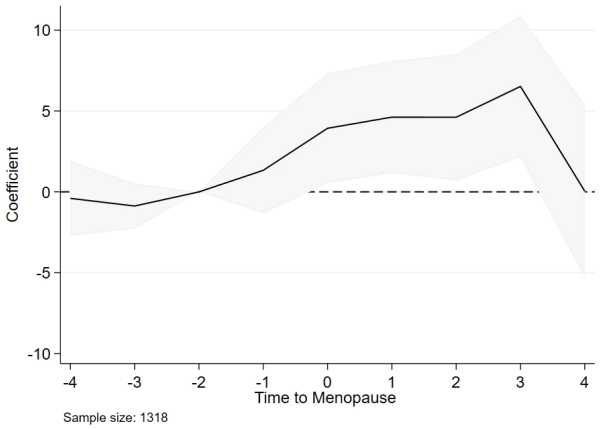

(e) Muscular/skeleton diagnosis




(g) Number of hospital visits



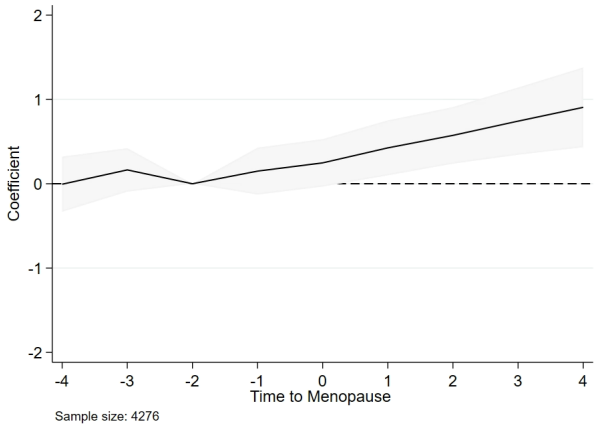

(h) Menopause diagnosis hospital (N95)



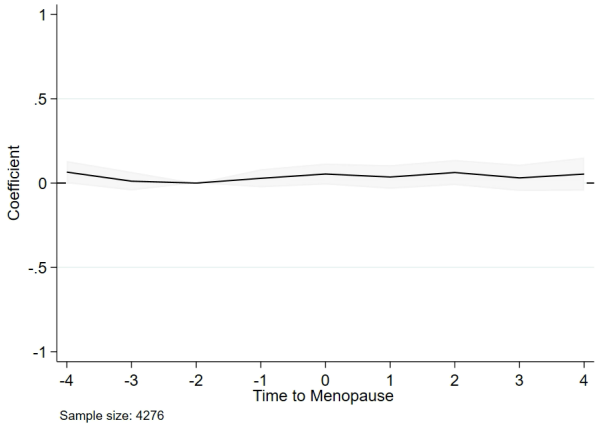

*Note*: Pre- and post-menopause estimates of the effects of menopause on women's health outcomes based on equation (3) for diagnosed women. The graphs plot the weighted average of the age-at-menopause cohort-specific estimates relative to the pre-menopause average of the health outcomes in year $l = -2$. *Source*: HUNT and Norwegian Central Population Registry, Earnings and Tax Registry, Social Security Records, Employment Registry, KUHR, and NPR, own calculations.

Figure C.4: The effects of menopause on health outcomes for undiagnosed women

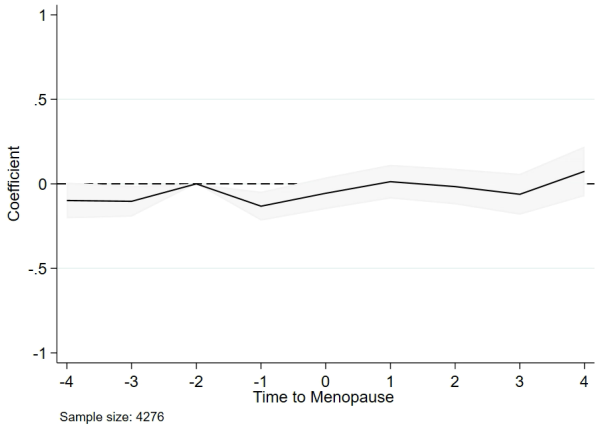
(a) Diabetes diagnosis



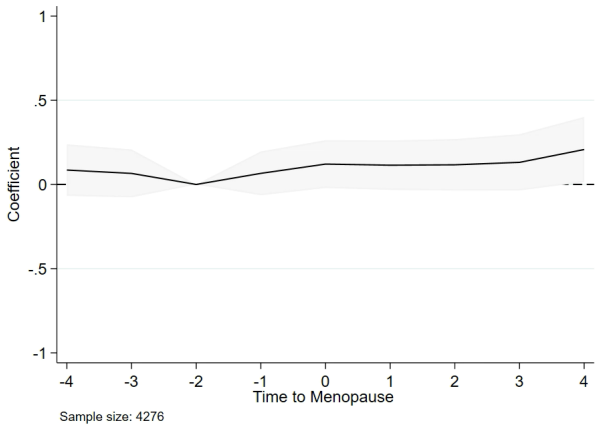

(b) Number GP visit




(c) Mental disorders diagnosis




(d) Neurological diagnosis




(e) Muscular/skeleton diagnosis

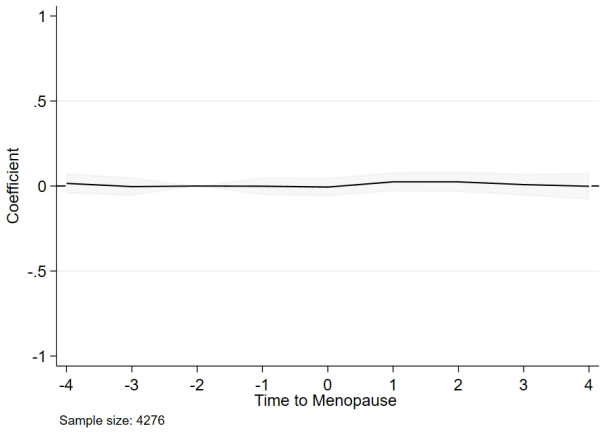
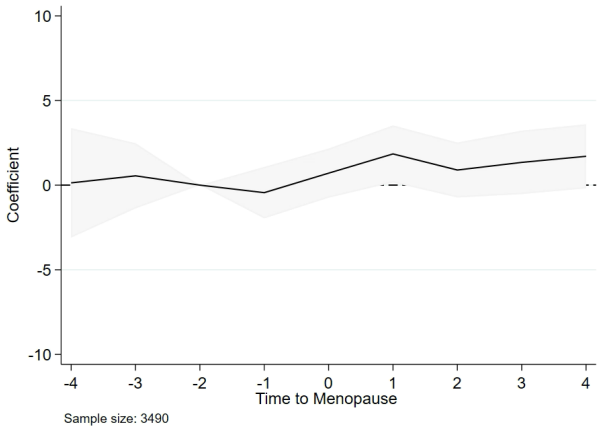
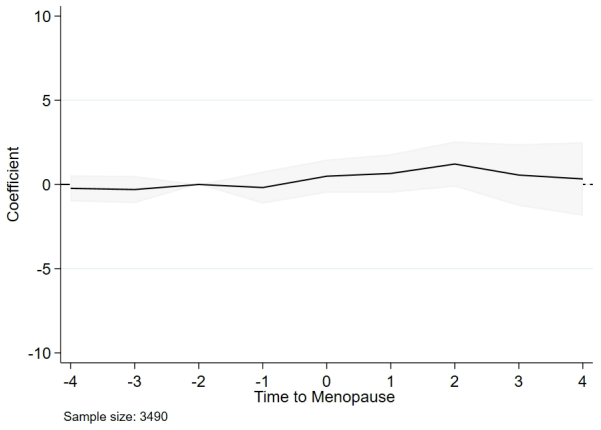


Figure C.4: The effects of menopause on health outcomes for undiagnosed women (*continued*)

(g) Number of hospital visits



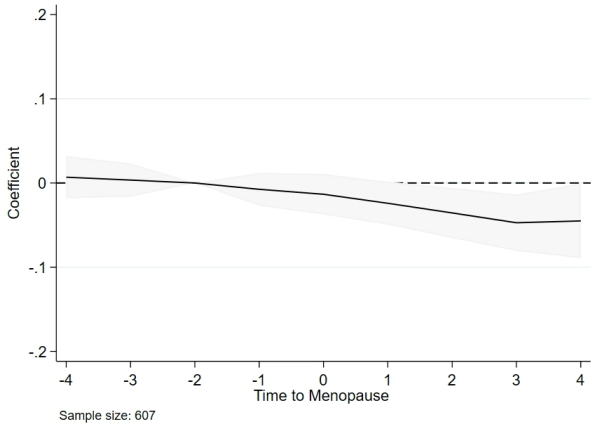

(h) Menopause diagnosis hospital (N95)



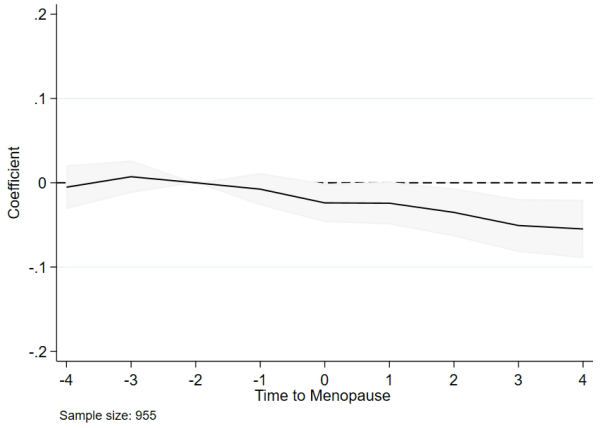

*Note*: Pre- and post-menopause estimates of the effects of menopause on women's health outcomes based on equation (3) for undiagnosed women. The graphs plot the weighted average of the age-at-menopause cohort-specific estimates relative to the pre-menopause average of the health outcomes in year $l = -2$. *Source*: HUNT and Norwegian Central Population Registry, Earnings and Tax Registry, Social Security Records, Employment Registry, KUHR, and NPR, own calculations.

Figure C.5: The effects of menopause on earnings by diagnosis timing

(a) Earnings (Accurate diagnosis)



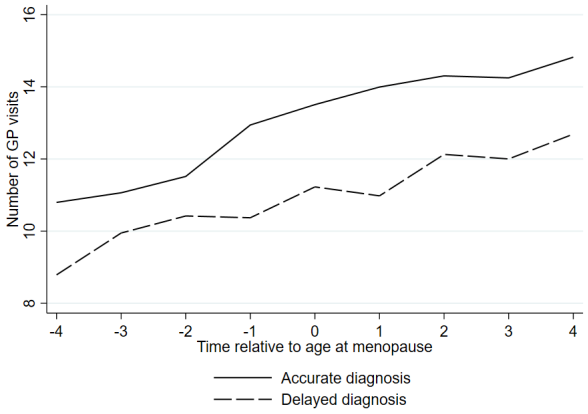

(b) Earnings (Delayed diagnosis)



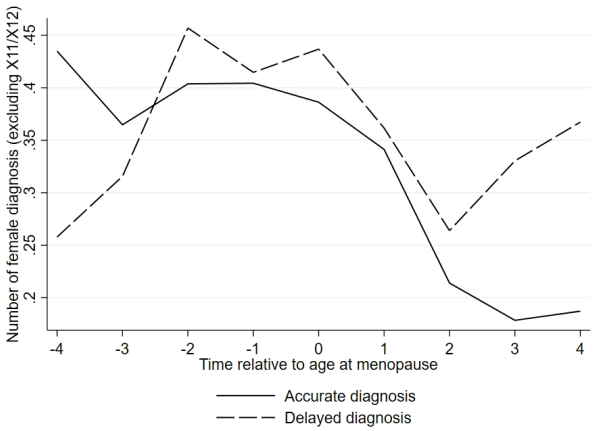

*Note*: Pre- and post-menopause estimates of the effects of menopause on women's earnings based on equation (3). The graphs plot the weighted average of the age-at-menopause cohort-specific estimates relative to the pre-menopause average of the health and labor market outcomes in year $l = -2$. The graphs on the left are based on women with an X11 and/or X12 diagnosis received at or before self-reported menopause age while the graphs on the right are based on women with an X11 and/or X12 diagnosis received after self-reported menopause age. *Source*: HUNT, Norwegian Central Population Registry, Earnings and Tax Registry, Social Security Records, Employment Registry, KUHR and NPR, own calculations.

Figure C.6: Healthcare consumption by time to menopause by diagnosis timing

(a) Number of GP visits



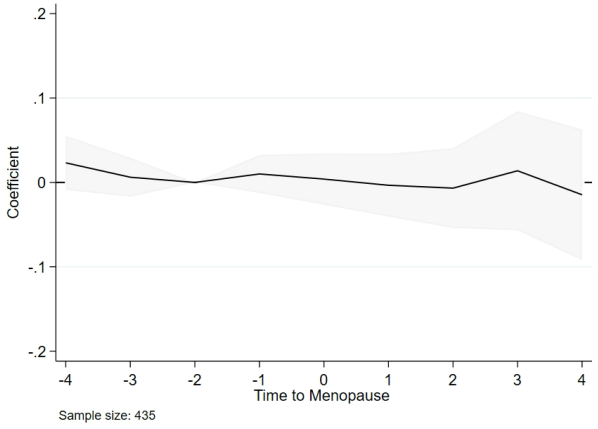

(b) Number of GP visits for female-specific diagnosis



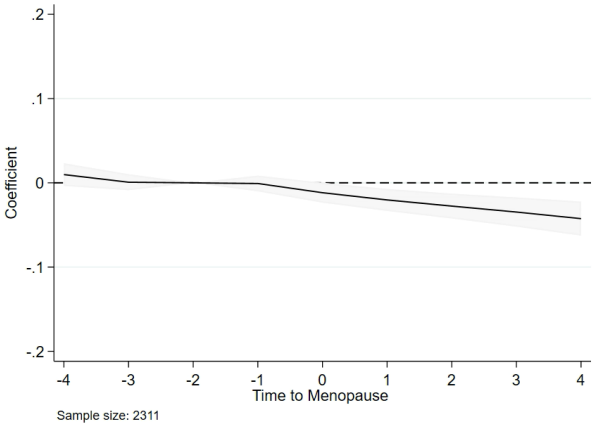

*Note*: Number of GP visits and number of GP visits for female-specific diagnosis (excluding X11 and X12) for women being diagnosed with "X11 – Menopausal symptoms/complaints" and/or "X12 – Postmenopausal bleeding" at their GP. Women diagnosed with X11 and/or X12 either before or in the same year they report experiencing menopause are categorized as having an "Accurate diagnosis", while those diagnosed with X11 and/or X12 after reporting menopause are classified as having a "Delayed diagnosis." *Source*: HUNT, Norwegian Central Population Registry, Earnings and Tax Registry, Social Security Records, Employment Registry, KUHR, and NPR, own calculations.

Figure C.7: The effects of menopause on earnings by self-reported healthcare seeking behavior (symptoms, no X11 and/or X12 diagnosis)

(a) Earnings (Self-reported doctor visit)



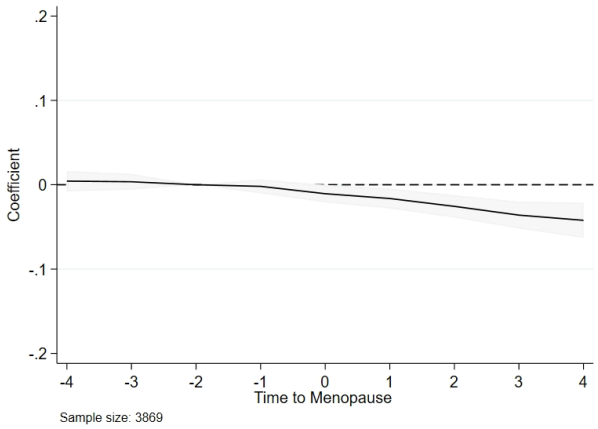

(b) Earnings (No self-reported doctor visit)



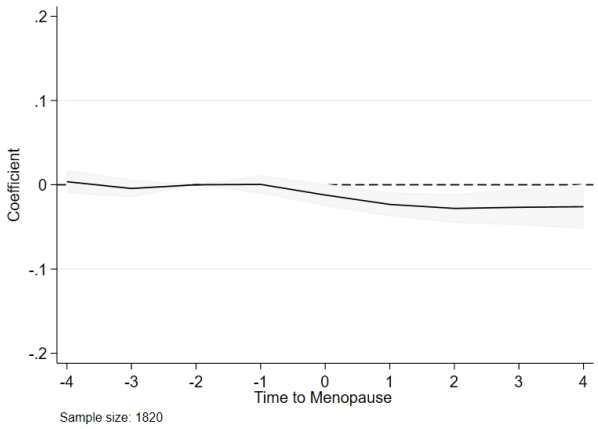

*Note*: Pre- and post-menopause estimates of the effects of menopause on women's earnings based on equation (3). The graphs plot the weighted average of the age-at-menopause cohort-specific estimates relative to the pre-menopause average of the health and labor market outcomes in year $l = -2$. The graphs on the left are based on women with symptoms, without an X11 and/or X12 diagnosis but who report that they visited a doctor due to their menopause symptoms while the graphs on the right are based on women with symptoms, without an X11 and/or X12 diagnosis who do no report that they visited a doctor due to their menopause symptoms. *Source*: HUNT, Norwegian Central Population Registry, Earnings and Tax Registry, Social Security Records, Employment Registry, KUHR, and NPR, own calculations.

Figure C.8: The effects of menopause on earnings by education

(a) No university degree



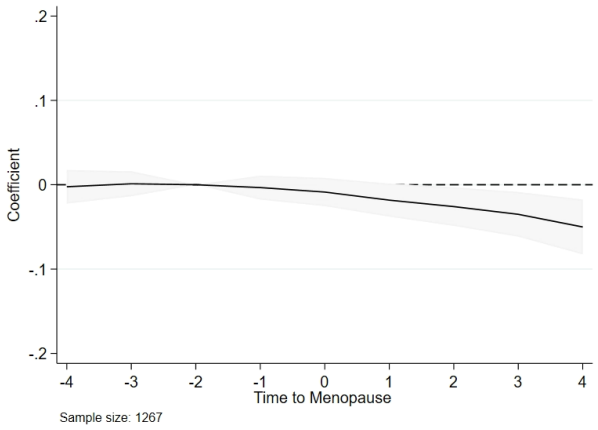

(b) University degree



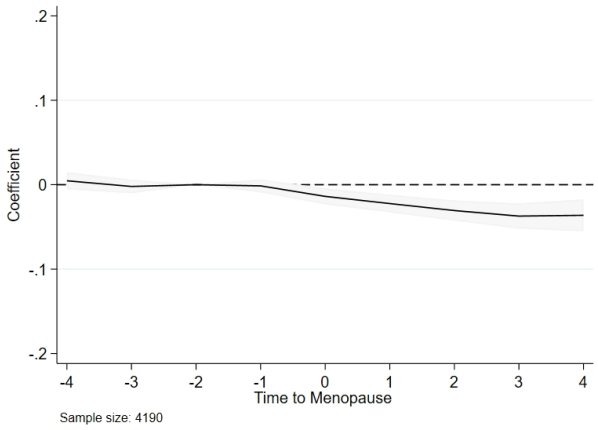

*Note*: Pre- and post-menopause estimates of the effects of menopause on women's earnings based on equation (3) by education. The graphs plot the weighted average of the age-at-menopause cohort-specific estimates relative to the pre-menopause average of the labor market outcomes in year $l = -2$. *Source*: HUNT, Norwegian Central Population Registry, Earnings and Tax Registry, Social Security Records, Employment Registry, KUHR, and NPR, own calculations.

Figure C.9: The effects of menopause on earnings by relative income at age 40

(a) Below median income




(b) Above median income




*Note*: Pre- and post-menopause estimates of the effects of menopause on women's earnings based on equation (3) by income. The graphs plot the weighted average of the age-at-menopause cohort-specific estimates relative to the pre-menopause average of the labor market outcomes in year $l = -2$. *Source*: HUNT, Norwegian Central Population Registry, Earnings and Tax Registry, Social Security Records, Employment Registry, KUHR, and NPR, own calculations.

# References


Ahammer, A., Glogowsky, U., Halla, M., & Hener, T. (2023). *The Parenthood Penalty in Mental Health: Evidence from Austria and Denmark.*

Andresen, M. E., & Nix, E. (2022). What Causes the Child Penalty? Evidence from Adopting and Same-Sex Couples. *Journal of Labor Economics*, *40*(4), 971–1004. doi: 10.1086/718565

Angelov, N., Johansson, P., & Lindahl, E. (2016, 7). Parenthood and the Gender Gap in Pay. *Journal of Labor Economics*, *34*(3), 545–579. doi: 10.1086/684851

Åsvold, B. O., Langhammer, A., Rehn, T. A., Kjelvik, G., Grøntvedt, T. V., Sørgjerd, E. P., ... Krokstad, S. (2023). Cohort Profile Update: The HUNT Study, Norway. *International Journal of Epidemiology*, *52*(1), e80-e91. doi: 10.1093/ije/dyac095

Atkinson, C., Beck, V., Brewis, J., Davies, A., & Duberley, J. (2021). Menopause and the workplace: New directions in HRM research and HR practice. *Human Resource Management Journal*, *31*(1), 49–64. doi: 10.1111/1748-8583.12294

Barschkett, M., & Bosque-Mercader, L. (2024). Building Health across Generations: Childbirth, Childcare and Maternal Health. *HEDG University of York*, *24/08*.

Beck, V., Brewis, J., & Davies, A. (2020). The remains of the taboo: experiences, attitudes, and knowledge about menopause in the workplace. *Climacteric*, *23*(2), 158–164. doi: 10.1080/13697137.2019.1656184

Beck, V., Brewis, J., & Davies, A. (2021). Women's experiences of menopause at work and performance management. *Organization*, *28*(3), 510–520. doi: 10.1177/1350508419883386

Blau, F. D., & Kahn, L. M. (2017). The Gender Wage Gap: Extent, Trends, and Explanations. *Journal of Economic Literature*, *55*(3), 789–865. doi: 10.1257/jel.20160995

Bryson, A., Conti, G., Hardy, R., Peycheva, D., & Sullivan, A. (2022). The consequences of early menopause and menopause symptoms for labour market participation. *Social Science & Medicine*, *293*, 114676. doi: 10.1016/j.socscimed.2021.114676

Cengiz, D., Dube, A., Lindner, A., & Zipperer, B. (2019). The Effect of Minimum Wages on Low-Wage Jobs. *The Quarterly Journal of Economics*, *134*(3), 1405–1454. doi: 10.1093/qje/qjz014

Conti, G., Ginja, R., Persson, P., & Willage, B. (2024). *The menopause "penalty".*

Cortés, P., & Pan, J. (2023). Children and the Remaining Gender Gaps in the Labor Market. *Journal of Economic Literature*, *61*(4), 1359–1409. doi: 10.1257/JEL.20221549

de Chaisemartin, C., & D'Haultfoeuille, X. (2023). Two-way fixed effects and differences-in-differences with heterogeneous treatment effects: a survey. *The Econometrics Journal*, *26*(3), C1-C30. doi: 10.1093/ectj/utac017

Dobkin, C., Finkelstein, A., Kluender, R., & Notowidigdo, M. J. (2018). The Economic Consequences of Hospital Admissions. *American Economic Review*, *108*(2), 308–352. doi: 10.1257/aer.20161038

Dratva, J., Gómez Real, F., Schindler, C., Ackermann-Liebrich, U., Gerbase, M. W., Probst-Hensch, N. M., ... Zemp, E. (2009). Is age at menopause increasing across Europe? Results on age at menopause and determinants from two population-based studies. *Menopause*, *16*(2), 385–394. doi: 10.1097/gme.0b013e31818aefef

Erosa, A., Fuster, L., Kambourov, G., & Rogerson, R. (2022). Hours, Occupations, and Gender Differences in Labor Market Outcomes. *American Economic Journal: Macroeconomics*, *14*(3), 543–590. doi: 10.1257/mac.20200318

Fadlon, I., & Nielsen, T. H. (2021). Family Labor Supply Responses to Severe Health Shocks: Evidence from Danish Administrative Records. *American Economic Journal: Applied Economics*, *13*(3), 1–30. doi: 10.1257/app.20170604

Goldin, C. (2014). A Grand Gender Convergence: Its Last Chapter. *American Economic Review*, *104*(4), 1091–1119. doi: 10.1257/aer.104.4.1091

Goldin, C. (2024). Nobel Lecture: An Evolving Economic Force. *American Economic Review*, *114*(6), 1515–1539. doi: 10.1257/aer.114.6.1515

Griffiths, A., MacLennan, S. J., & Hassard, J. (2013). Menopause and work: An electronic survey of employees' attitudes in the UK. *Maturitas*, *76*(2), 155–159. doi: 10.1016/j.maturitas.2013.07.005

Haugen, M. O., & Rosvold, K. A. (2024). *Nord-Trøndelag - former county in the Great Norwegian Encyclopedia.* Retrieved from `https://snl.no/Nord-Tr%C3%B8ndelag_-_tidligere_fylke`

Helfo. (2024). *The right to a doctor.* Retrieved from `https://www.helsenorge.no/en/gp/about-gp/the-right-to-a-doctor/`

Helsebiblioteket/BMJ. (2023, 2). *Overgangsalder: Bør eg ta østrogen?* Retrieved from `https://www.helsenorge.no/nn/medisiner/menopause-ostrogen/`

Huttunen, K., Møen, J., & Salvanes, K. G. (2011, 10). How destructive is creative destruction? Effects of job loss on job mobility, withdrawal and income. *Journal of the European Economic Association*, *9*(5), 840–870. doi: 10.1111/j.1542-4774.2011.01027.x

Kleven, H., Landais, C., & Leite-Mariante, G. (2023). *The Child Penalty Atlas.* NBER Working Paper No. 31649.

Kleven, H., Landais, C., Posch, J., Steinhauer, A., & Zweimüller, J. (2019a). Child Penalties across Countries: Evidence and Explanations. *AEA Papers and Proceedings*, *109*, 122–126. doi: 10.1257/PANDP.20191078

Kleven, H., Landais, C., & Søgaard, J. E. (2019b). Children and Gender Inequality: Evidence from Denmark. *American Economic Journal: Applied Economics*, *11*(4), 181–209. doi: 10.1257/APP.20180010

Larsen, H. (2023). *20 år gammel sjokkrapport hindrer kvinner i å få hjelp.* Retrieved from `https://www.nrk.no/tromsogfinnmark/leger-kvier-seg-fortsatt-for-a-gi-ostrogen-til-kvinner-i-overgangsalder-1.16212108`

McGregor, A. J. (2020). *Sex Matters: How Male-Centric Medicine Endangers Women's Health and What We Can Do About It* . NY: Hachette Go.

Melentyeva, V., & Riedel, L. (2023). Child penalty estimation and mothers' age at first birth. *ECONtribute Discussion Paper*, *No. 266*.

Mishra, G. D., Pandeya, N., Dobson, A. J., Chung, H.-F., Anderson, D., Kuh, D., ... Weiderpass, E. (2017). Early menarche, nulliparity and the risk for premature and early natural menopause. *Human Reproduction*. doi: 10.1093/humrep/dew350

Monteleone, P., Mascagni, G., Giannini, A., Genazzani, A. R., & Simoncini, T. (2018, 4). Symptoms of menopause — global prevalence, physiology and implications. *Nature Reviews Endocrinology*, *14*(4), 199–215. doi: 10.1038/nrendo.2017.180

Nossen, J. P. (2019). Kjønnsforskjellen i sykefravær: hvor mye er det mulig å forklare med registerdata? *Arbeid og velferd*, *4*.

NTNU Trondheim. (2025). *The HUNT Study - a longitudinal population health study in Norway.* Retrieved from `https://www.ntnu.edu/hunt/about-hunt`

Peacock, K., Carlson, K., & Ketvertis, K. M. (2024). *Menopause.*

Royston, P., & Lambert, P. C. (2011). *Flexible Parametric Survival Analysis Using Stata: Beyond the Cox Model* (1st ed.). Stata Press.

Schoenaker, D. A., Jackson, C. A., Rowlands, J. V., & Mishra, G. D. (2014). Socioeconomic position, lifestyle factors and age at natural menopause: a systematic review and meta-analyses of studies across six continents. *International Journal of Epidemiology*, *43*(5), 1542–1562. doi: 10.1093/ije/dyu094

Stephens, M., & Toohey, D. (2022). The Impact of Health on Labor Market Outcomes: Evidence from a Large-Scale Health Experiment. *American Economic Journal: Applied Economics*, *14*(3), 367–399. doi: 10.1257/app.20180686

Szmuilowicz, E. D., Stuenkel, C. A., & Seely, E. W. (2009). Influence of menopause on diabetes and diabetes risk. *Nature Reviews Endocrinology*, *5*(10), 553–558. doi: 10.1038/nrendo.2009.166

The Lancet. (2022). Attitudes towards menopause: time for change. *The Lancet,*, *399*(10343, 2243). Retrieved from `https://www.thelancet.com/action/showPdf?pii=S0140-6736%2822%2901099-6`

Theis, S., Baumgartner, S. J., Janka, H., Kolokythas, A., Skala, C., & Stute, P. (2023). Quality of life in menopausal women in the workplace – a systematic review. *Climacteric*, *26*(2), 80–87. doi: 10.1080/13697137.2022.2158729

Thomas, F., Renaud, F., Benefice, E., Meeus, T. d., & Guegan, J.-F. (2001). International Variability of Ages at Menarche and Menopause: Patterns and Main Determinants. *Human Biology*, *73*(2), 271–290. doi: 10.1353/hub.2001.0029

Verdonk, P., Bendien, E., & Appelman, Y. (2022). Menopause and work: A narrative literature review about menopause, work and health. *Work*, *72*(2), 483–496. doi: 10.3233/WOR-205214

Von der Lippe, E., & Prütz, F. (2016). Age at natural menopause: Results from the German Health Interview and Examination Survey. *European Journal of Public Health*, *26*. doi: 10.1093/eurpub/ckw172.078

Wing, C., Freedman, S. M., & Hollingsworth, A. (2024). *Stacked Difference-in-Differences.* NBER Working Paper No. 32054.

World Health Organization. (2024, 10). *Menopause.* Retrieved from `https://www.who.int/news-room/fact-sheets/detail/menopause`