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The Long-Term Effects of Labor Market Restrictions on Women's Cognitive Aging

Centre for Health Economics, Monash University
no. 2026-13

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Keywords: Cognitive functioning at older age, dementia, access to paid employment, gender disparities

JEL Classification: J16, J19, J24

ABN 12 377 614 012 CRICOS Provider Number: 00008C

The Long-Term Effects of Labor Market Restrictions on Women's Cognitive Aging

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August 26 2026

Abstract

This study examines the causal effect of labor market restrictions faced by women in early adulthood on later-life cognitive functioning. To identify this effect, we exploit an exogenous policy change in the Netherlands that removed restrictions on married women's access to paid employment in 1957.

Our study draws on data from the Longitudinal Aging Study Amsterdam, an ongoing cohort study of older individuals. We focus on individuals aged 75 and older born between 1928 and 1947. We first examine how work restrictions in early adulthood shape lifetime employment. Next, we assess how these work restrictions affect women's later-life cognitive outcomes exploiting an exogenous change in labor restriction laws and complement this with an instrumental variables approach.

The estimation results indicate that restricted access to paid employment for women in early adulthood reduced labor force participation and occupational prestige over the life course. These reduced labor market opportunities, in turn, led to poorer cognitive functioning after age 75. We also find some suggestive evidence that these restrictions resulted in faster cognitive decline.

Taken together, our findings indicate that restrictions on women's access to paid employment adversely affect cognitive functioning, thereby contributing to cognitive disparities between men and women in later life. More broadly, they highlight the long-term cognitive benefits of sustained labor market engagement and cognitively stimulating work, with potential implications for dementia prevention.

Keywords Cognitive functioning at older age, dementia, access to paid employment, gender disparities,

Introduction

As populations age, dementia has emerged as one of the leading causes of disability and mortality worldwide, thereby placing increasing pressure on healthcare systems and societies (World Health Organization, 2021). While age and genetic predisposition are non-modifiable risk factors of dementia, a substantial share of risk — up to 45% — is linked to modifiable factors, including lifestyle, health conditions, and social and intellectual engagement (Livingston et al., 2024). Hence, there may be considerable potential for prevention or delay of cognitive decline.

One of these modifiable factors may be cognitive activity at work. The cognitive reserve (CR) theory posits that the brain copes with cognitive decline through two mechanisms: neural reserve in terms of pre-existing brain capacity, and neural compensation through recruitment of alternative neural processes to maintain function (Stern, 2009). According to this theory, some individuals maintain normal functioning despite pathology that leads to dementia in others. Cognitively and socially stimulating environments, such as certain types of work, are thought to enhance such neural resilience (Stern, 2012). Work may also delay the onset of dementia symptoms by promoting more efficient use of existing neural reserve or the recruitment of alternative brain regions (Alvares Pereira et al., 2022).

A growing body of empirical research examines the relationships between employment and long-term cognitive outcomes. For instance, a recent study finds that higher levels of cognitive activity at work are associated with a lower risk of dementia in later life (Martin-Bassols et al., 2023). Another study indicates that work-related mentally enriching activities, particularly during midlife, play a meaningful role in cognitive aging (Frank et al. 2023). Reversely, weaker labor market attachment and prolonged periods of non-employment are associated with poorer outcomes (Ice et al., 2020, Mayeda et al., 2020). Similarly, a recent study found that later-career unemployment has small, short-term effects on cognitive ability (Freise et al., 2022), whereas another study reported that employment gaps resulting from disability and unemployment are associated with an increased risk of dementia (Pacca et al., 2025). Another branch of the literature examines the effects of retirement on cognitive performance and cognitive decline (e.g., Finkel et al., 2009; Bonsang et al., 2012; Atalay et al., 2019; Clouston & Denier, 2023). For instance, one study demonstrates negative causal effects of retirement on cognitive functioning (Bonsang et al. 2012). Similarly, retirement not only correlates with accelerated cognitive decline, but actively contributes to it (Clouston & Denier, 2023). Research also indicates that differences in occupational complexity contribute to inequalities in cognitive functioning, cognitive decline or even risk of dementia in late life (e.g., Andel et al., 2005; Kroger et al., 2008; Finkel et al., 2009; Smart et al., 2014; Boots et al., 2015; Hyun et al., 2022; Coleman et al., 2023; Soh et al, 2023; Wu & Marois, 2025). However, most relevant studies largely rely on descriptive evidence, do not disentangle causal effects from selection processes and provide therefore limited causal evidence on how access to paid employment influences cognitive functioning and dementia risk at older ages.

With this study we provide evidence on the causal impact of women's labor market participation on cognitive functioning in later life. Historically, access to cognitively stimulating environments has not been equally distributed, with cultural and social norms limiting workforce entry of women (Boserup, 1970). Therefore, women may have had fewer opportunities to engage in cognitively and socially stimulating work, potentially increasing their vulnerability to cognitive decline and dementia later in life. Bertogg and Leist (2023) examined how employment history shapes cognitive outcomes in later life among men and women across 19 European countries. Their findings reveal a notable gender divergence: part-time employment is positively associated with women's cognition in later life, while it carries a negative association for men. Inequalities in labor market participation persist to a considerable extent in many developing countries today (World Bank, 2022). Moreover, gender differences in employment histories pose methodological challenges for research. Women's labor market participation is often more discontinuous, characterized by part-time work and career interruptions. This complicates the measurement of occupational exposure and has led to some studies to exclude women entirely (Martin-Bassols et al., 2023). As a result, the role of women's employment in shaping cognitive aging remains insufficiently understood.

To move beyond correlational evidence, we exploit institutional restrictions that limited married women's access to paid employment in the Netherlands until their abolition in 1957. The Act on the Legal Incapacity of Married Women was introduced in 1838 as part of the Dutch Civil Code and remained in force until 1957. Under this law (in Dutch: *Wet Handelingsonbekwaamheid*), married women could not sign contracts or enter employment without their husband's consent. Between 1925 and 1957, institutional marriage bars were anchored in royal decrees targeting the public sector, but were subsequently adopted by private industry. This process was actively promoted by Protestant-Christian and Catholic trade unions, which leveraged their considerable influence within the pillarized Dutch society. As a result, employers routinely dismissed women upon marriage as a matter of customary practice, obtaining the necessary dismissal permits without meaningful resistance (Hartog and Theeuwes, 1985; Groot, 2023).[1]The institutional constraints sharply limited women's employment opportunities and reinforced the male breadwinner model. Many women were not only forced to exit employment the day after their marriage but also unmarried women faced strong incentives not to enter the labor force, anticipating that they would have to stop working once married.

The removal of labor restrictions in 1957 generates plausibly exogenous, policy-driven variation in women's lifetime employment opportunities. In the current study, we examine the long-term cognitive effects of labor market restrictions in early adulthood, comparing cohorts of women who married before and after the abolition of the marriage bar. We formulate two main hypotheses. First, we hypothesize

[1] The reach of these norms extended into the legislative arena as well: in December 1937, the Minister of Social Affairs introduced a proposal that would have prohibited paid employment for married women across all sectors. The bill encountered widespread societal opposition and was ultimately withdrawn by his successor (van Baalen, 2007).

that marriage bars reduced women's lifetime labor force participation as well as access to higher-prestige occupations. Occupational prestige reflects the type and status of occupations they were able to attain over their working life. Interruptions in employment or delayed entry into the labor market may have limited women's access to higher-prestige occupations, which typically require more cognitive effort. Second, we hypothesize that limited lifetime work opportunities adversely affect not only the level of cognitive functioning in later life, but also the speed of cognitive decline.

To test these hypotheses, we draw on data from the Longitudinal Aging Study Amsterdam (LASA), a comprehensive ongoing longitudinal study of older individuals in the Netherlands (Huisman et al., 2011). We employ both an approach that directly exploits the relaxation of the labor market restriction (labelled as 'natural experiment' approach) and an instrumental variables (IV) approach to assess the role of labor market exposure in shaping women's cognitive outcomes in later life. The approaches provide complementary evidence. With respect to the 'natural experiment' approach, our identification strategy assumes that women marrying before and after the abolition of the marriage bar would have followed the same cognitive trajectory in the absence of the reform. Under this assumption, the abolition of the marriage bar provides a source of plausibly exogenous variation in married women's access to paid employment. Complementing this approach, the IV strategy exploits the policy-induced variation in women's access to paid employment and, under the standard identifying assumptions for IV estimation, identifies the causal effect of women's labor market opportunities on later-life cognitive functioning. We conduct separate analyses for women and men to verify that men who married before 1957 were not affected by the policy change, as the abolition of the work restriction law did not apply to them.

2. Data

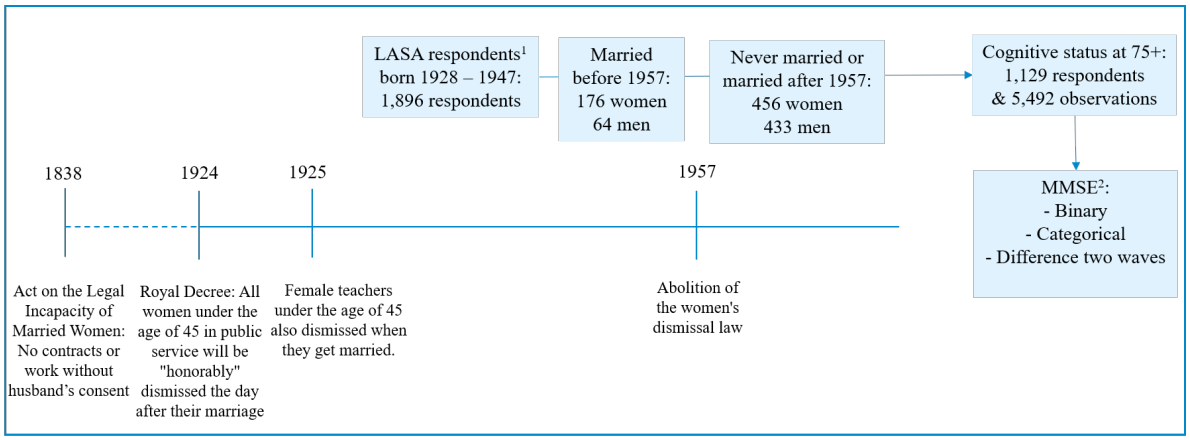
2.1 Dataset and study sample

Data used in this study are derived from LASA, an ongoing Dutch prospective cohort study of older adults initiated in 1992 (Huisman et al., 2011). Extensive longitudinal information is collected, including data on marital status, lifetime labor force participation and cognitive status, making it particularly well-suited for the present research. The original cohort consisted of a nationally representative sample of 3,107 individuals aged 55 to 85 at baseline, born between 1908 and 1937. To maintain sufficient sample size, refresher cohorts of around 1,000 individuals aged 55–65 were added in 2002 (birth cohorts 1938–1947) and in 2012 (birth cohorts 1948–1957) (Hoogendijk et al., 2020). Respondents are assessed every three years, and the last measurement cycle available at the time of this study was conducted in 2021–22. By that time, a total of maximum ten measurement cycles had been performed for the original cohort, seven for the first refresher cohort and four for the second refresher cohort (Hoogendijk et al., 2025).

To limit the effects of structural secular differences between successive cohorts, we restrict the sample to respondents born between 1928 and 1947 (N=1,896). As we are interested in cognitive status at older ages, our main analyses only include measurements from individuals aged 75 years and older at the time of the interview. Birth cohorts of 1948 and later are excluded from the analysis, given that members of these cohorts had not attained the age of 75 by the last measurement cycle available at the time of the current study. This results in a dataset of 5,492 observations from 1,129 unique respondents (632 women and 497 men).[2] Figure 1 illustrates the timeline of important institutional landmarks in relation to the births and selection of the study sample as well as the measurements of cognitive outcomes (in blue).

All female respondents who married before 1957 are included in the exposure group (N=176). These females were aged 19-29 when the law was repealed. The remaining group of women who married after the abolition of the law and those who never married constitute the control group (N=456). These women were aged 10-29 when the law was abolished. Men married before 1957 (N=64) and those never married or after 1957 (N=433) were included in separate analyses.

Figure 1: Institutional context, selection of the study sample and cognitive outcomes



1: Longitudinal Aging Study Amsterdam
2: Mini-Mental State Examination

2.2. Work exposure variables[3]

We used two variables that reflect work exposure. The first work-related variable is a binary indicator coded as 1 if an individual had ever worked and held a paid job during his lifetime and 0 otherwise. This measure captures the extensive margin of labor market participation, distinguishing between individuals who have ever been exposed to paid work and those who have not.

The second work-related variable is an occupational prestige scale developed by Sixma and Ultee (1984). In their study, occupations were first coded according to the Standard Occupational

[2] This age and cohort selection implies a maximum of six measurement cycles per individual in the original LASA cohort (2005-06 to 2021-22) and three in the first refresher cohort (2015-16 to 2021-22). As part of the sensitivity analyses, we re-estimate all models using slightly different birth cohorts and age selection to assess the robustness of our results.

[3] Our choice of variables is constrained by the information available in the LASA dataset on work histories. In particular, the data do not include historical information on working hours or on the timing of women's entry into and exit from paid employment.

Classification system of Statistics Netherlands and subsequently linked to a Dutch occupational prestige scale based on a nationwide survey of the societal valuation of occupations. The resulting interval-level prestige score ranges from 13 (lowest) to 87 (highest). We assigned occupational prestige according to the longest-held occupation for participants in the original cohort and the last occupation for participants in the refresher cohort. The prestige score is set to missing for respondents who had never been employed.

2.3 Cognitive outcomes

Our main dependent variable is cognitive functioning assessed with the Mini-Mental State Examination (MMSE), a widely used screening instrument (Folstein, Folstein, McHugh, 1975). The MMSE consists of 23 items, and the total score ranges from 0 to 30 where higher scores indicate better cognitive functioning. We employ three complementary measures of cognitive status based on the MMSE to ensure that our results are not driven by a specific operationalization. First, we construct a binary indicator of cognitive impairment using the widely applied cutoff of 24, which distinguishes individuals with (scores < 24) from those without clinically relevant impairment (scores ≥ 24) (Tombaugh & McIntyre, 1992). Second, MMSE scores were divided into four categories (≥ 27, 24–26, 21–23, ≤ 20). We used a wide lowest category, as very few individuals in population-based samples score below 20, similar to the broad-category approach used in other cohort studies to ensure adequate group sizes (e.g., An et al., 2018; Duan et al., 2022). Third, we examine differences in individual MMSE scores between consecutive waves (measured as t minus (t-1)) to assess speed of cognitive decline. Taken together, these measures provide an assessment of both the level and the progression of cognitive functioning.

2.4. Control variables

It is important to account for differences in age and educational attainment when using the MMSE as outcome. Age is categorized into four groups (75–79, 80–84, 85–89, and ≥ 90 years) to account for potential non-linear age effects. Educational attainment is categorized into three groups: (1) primary education or less; (2) lower to intermediate general education or lower vocational education; and (3) intermediate vocational education or higher general education.

As explained below, lifestyle factors are used in sensitivity analyses. They include smoking, alcohol consumption, physical and social activity (e.g., Zotcheva et al., 2023; Jaarsma et al., 2024), which were identified as modifiable risk factors of dementia (Livingston et al. 2020). The LASA dataset does not contain information on lifestyle during young adulthood, so we use contemporaneous lifestyle characteristics as proxies for earlier-life behaviors.

Smoking status is coded as current smoker versus current non-smoker. Alcohol consumption is categorized into four groups: no or light consumption ($\leq$ four glasses alcohol a week), moderate consumption (five to ten glasses alcohol a week), excessive consumption (ten to 30 glasses a week) and

more than 30 glasses alcohol a week.[4] Physical activity is assessed using Metabolic Equivalent of Task (MET) scores, where one MET represents the ratio of energy expenditure during a specific activity to energy expenditure at rest (Jaarsma et al., 2024). MET values are assigned to reported activities, including walking outdoors (3.5 METs), cycling (4.5 METs), light household activities (2.5 METs), heavy household activities (4.5 METs), and gardening (4.5 METs). Based on these MET scores, a dichotomous variable (norm-active) is created to indicate whether participants met the Dutch exercise guidelines for healthy physical activity for adults aged 55 years and older. Participants are classified as norm-active if they accumulate $\geq$ 21 minutes per day of activities with MET values $\geq$ 3 (Gezondheidsraad, 2017). Finally, social network size is assessed via the number of people in each respondent's current personal network. Respondents were asked to report each person who is important in their social network.

2.5 Descriptives

Table 1 summarizes the descriptive characteristics of the female study sample per exposure status. Exposed women are significantly less likely to have ever worked compared to controls, and if they had ever worked, they also exhibit lower average occupational prestige scores. Mean MMSE scores are lower in the exposed group across all age intervals, with statistically significant differences observed at ages 75 – 80 and 80 – 85. Consistent with this pattern, the prevalence of cognitive impairment (i.e. score lower than 24) is higher among exposed women, with significant differences at age 80 – 85. The categorical MMSE results are consistent with those for continuous and binary MMSE scores. The decline in MMSE scores between consecutive waves is also significantly larger among exposed women than among controls (−0.7 vs. −0.4, p-value = 0.02). Overall, the results suggest that exposure status is associated with weaker labor market attachment and poorer cognitive performance among women. Exposed women are also on average seven years older and have lower levels of educational attainment than controls. Differences in smoking behavior and social network diversity are small and statistically insignificant. Table A1 in Appendix A reports the descriptives for males. No significant differences in cognitive status are observed among exposed and unexposed men (except at ages 75 - 80).

[4] We use the classification proposed by LASA (Table B1, Appendix B).

Table 1. Descriptive statistics of the female study sample

	# obs.	Exposed[1]	Controls[1]	P-value[2]
Work status				
Ever worked (yes = 1 vs no =0) (%)	628	83.5	93.4	<0.001
Occupational prestige score (from 16 = low to 87 = high) (Mean, SD)[3]	573	30.4 (11.5)	36.2 (14.6)	<0.001
Cognitive ability[4]*:*				
MMSE continuous[5] *(Mean, SD):*				
Score at age 75 - 80	756	27.3 (2.5)	27.7 (2.3)	0.04
Score at age 80 - 85	396	26.7 (3.2)	27.5 (2.3)	0.01
Score at age 85+	173	26.7 (3.1)	27.1 (2.0)	0.32
MMSE binary indicator[5] *(%):*				
Score at age 75 - 80	756	6.9	4.1	0.15
Score at age 80 - 85	396	13.6	5.1	0.01
Score at age 85+	173	16.2	9.5	0.29
MMSE categorical variable[6] *(%):*				
MMSE score ≥ 28	790	54.2	62.5	<0.001
MMSE score 24 - 27	443	34.9	32.7	
MMSE score 21 - 23	62	7.5	3.2	
MMSE score ≤ 20	30	3.5	1.6	
Difference in MMSE score (t - (t-1)) (Mean, SD):	1,187	-0.7 (2.5)	-0.4 (2.0)	0.02
Marriage				
Married before 1957 (yes = 1 vs no =0) (N)	632	176	456	
Additional variables				
Birthyear	632	1930.6	1937.4	<0.001
Age (%)[4]				
75 - 80	903	44.1	59.2	<0.001
80 - 85	506	29.2	30.7	
85 - 90	213	19.5	9.0	
90 and older	55	7.2	1.1	
Attained education (number of years)	632	8.3	9.8	<0.001
Education category (in %|)				
Low	193	48.3	23.7	
Middle	361	46.0	61.4	<0.001
High	78	5.7	14.9	
Current smoking[4] (%)	530	6.43	7.0	0.81
Alcohol[4] (%) (less than 4 glasses per week)	530	84.4	77.3	<0.001
Norm physical activity[4] (% yes ≥ 20 minutes physically active /day)	552	66.7	75.0	<0.001
Social network diversity[4] (size network)	526	4.9	5.0	0.17

[1] Females who married before 1957 were forced to stop working (exposed) while those who married after 1957 were not (controls).

[2] We test differences between groups using t-tests and chi-square tests.

[3] Sixma, H. & Ultee, W.C. (1984)

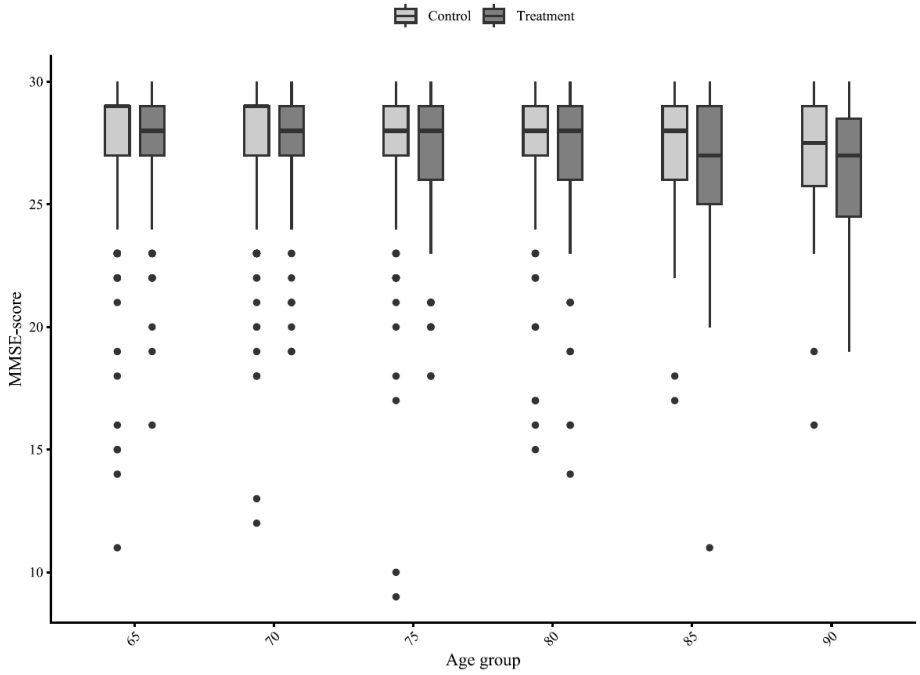
[4] Women who participated in multiple measurement cycles contribute multiple observations to the calculated average.

[5] Mini Mental State Examination (Folstein, Folstein, McHugh, 1975): scores from 0 to 30 and scores lower than 24 indicate cognitive impairment.

[6] 0 = no impairment (score ≥24), 1 = moderate (score 18–23), 2 = severe (score ≤ 17) (Tombaugh and McIntyre, 1992)

Figure 2 shows boxplots of MMSE scores of participating women by age group for the exposure group (women married before 1957 and therefore forced to stop working) and the control group (women not married before 1957). The corresponding figure for men is presented in Appendix A (Figure A1). The exposure group showed a wider interquartile range, driven by a higher share of women with lower MMSE scores among women aged 75–90 years. Especially in the highest age groups (≥ 85 years), the median MMSE score appeared to be lower in the exposed group than in the control group. We find no differences in the younger age groups (≤ 70 years).

Figure 2. Clustered boxplot MMSE-score of females by age group and exposure status[1]



1: Females who married before 1957 were forced to stop working (exposed) while those who married after 1957 were not (controls).

Finally, as sample attrition may affect cohort studies among older persons, Table 2 presents descriptive statistics on the relationships between loss to follow-up and cognitive status among study participants. Average MMSE scores at the last available observation are lower among women who subsequently drop out of the study (across the different loss-to-follow-up categories) than among women who are included in the main analyses. The pattern in MMSE scores across the different attrition categories is similar between the exposed and control group. Results for men are similar and presented in Table A2 of Appendix A. Overall, the descriptive patterns suggest that cognitive status is associated with loss to follow-up, indicating potential selective attrition.

Table 2. Loss to follow-up and cognitive status in female LASA respondents

	Exposed[1]		Controls[2]	
	N	Mean MMSE[3]	N	Mean MMSE[3]
Women included in the main analyses	176	27.32	456	27.63
Loss to follow-up during observation window:				
Deceased	56	25.50	42	26.79
Refusals	14	26.14	20	27.30
Ineligible	11	25.91	9	25.11
Not contacted	2	25.50	1	24.00

1: Married before the abolition of the law; 2: Not married before the abolition of the law.

3: Mini Mental State Examination (Folstein, Folstein, McHugh, 1975)

3. Analytical strategy

We perform two main analyses, one with an approach that directly exploits the (exogenous) change in the 1957 work restriction (labelled 'Natural experiment' approach), and the other with an IV approach. In addition, we conduct various sensitivity analyses.

3.1 'Natural experiment' approach

The abolition of the work restriction law in 1957 provides exogenous variation in the work status of married women. To examine whether women who married before 1957 had indeed different employment experiences in adulthood than women who married after 1957, we estimate regression models for two work-related outcome variables: (1) a binary indicator of whether an individual has ever held paid employment and (2) a continuous variable for occupational prestige for those who had ever worked. The first outcome is estimated using a probit model while the second outcome is examined using a linear regression model. All models include a binary indicator for being married before 1957 and are corrected for educational attainment.[5]

Next, to examine the relationships between being exposed to the labor market restriction law and cognitive functioning at older ages, probit regression models are estimated for the binary MMSE outcome while ordered probit regression models are used for the categorical MMSE outcome. Differences in MMSE scores between adjacent waves are analyzed using linear regression. Again, all models include a binary indicator for being married before 1957. All three specifications are adjusted for educational attainment and age in categories. As noted above, lifestyle factors are measured as current characteristics in the LASA waves and may therefore be endogenous. Consequently, they are not included in the main analyses. Standard errors are clustered at the individual level to account for within-person correlation across repeated measurements. Coefficients, standard errors, average marginal effects (AME) and p-values are reported.

3.2 Instrumental variable approach

The 1957 policy change generated a clear distinction between women who married before and after the removal of the labor restrictions. However, in some sectors, women who married before 1957 were exempted from the labor restrictions and had the option to continue working after marriage. Furthermore, nothing precluded women who married before 1957 to start working (again) after the removal of the labor restriction law. Therefore, the 1957 policy change indicator in the regression models captures an intention-to-treat effect and serves as an instrument for labor participation on the IV analyses.

[5] We do not adjust for age because the work-related variables reflect employment characteristics during adulthood, for which age at the time of data collection is not relevant.

Because labor force participation and the first cognitive outcome are binary variables, we estimate a recursive bivariate IV probit model. This model jointly estimates the probability of labor force participation and the probability of poor cognitive functioning, while allowing the error terms of the two equations to be correlated. The first equation models labor force participation as a function of the policy change, age and educational attainment, whereas the second equation models cognitive functioning as a function of labor force participation and the same set of covariates. Estimating both equations jointly accounts for the potential endogeneity of labor force participation arising from unobserved factors that may simultaneously affect employment decisions and late-life cognitive functioning. As there is no direct analogue of the conventional first-stage F-statistic for recursive bivariate IV probit models, we assess instrument strength using the Wald χ^2 statistic from the first-stage probit model. For comparability with the IV literature, we additionally estimate a linear first-stage model and report the corresponding first-stage F-statistic.

We also use the policy change as an instrument for occupational prestige. Because occupational prestige scores can be treated as a continuous endogenous variable and the cognitive outcome is binary, we estimate an IV probit model by maximum likelihood. The model specifies occupational prestige as a linear function of the policy change, age, and education, while the probit equation models cognitive functioning as a function of occupational prestige, age, and education. The two equations are estimated jointly, allowing the error terms to be correlated and thereby accounting for potential endogeneity of occupational prestige due to unobserved factors associated with both occupational attainment and late-life cognitive functioning. To assess instrument relevance, we additionally estimate a separate linear regression of occupational prestige on the policy change and the same covariates and report the F-statistic for the instrument.

Finally, we use two-stage least squares IV regression to examine the relationship of "ever having worked" with change in MMSE score between two adjacent waves. Given the binary endogenous variable, the first-stage equation is estimated using a probit model, and instrument relevance is assessed using a Wald test. We also use two-stage least squares IV regression to examine the relationship of occupational prestige with change in MMSE score between two adjacent waves. Again, policy change is used as an instrument for ever having worked and occupational status in the two models. Instrument relevance is assessed using the first-stage F-statistic. Standard errors are clustered at the respondent level to account for repeated observations within individuals.

3.2 Sensitivity analyses

We also conduct a series of robustness checks. We estimate models using the continuous MMSE score and models using MMSE scores adjusted for education level (Kempen, Brilman & Ormel, 1995; Aaltonen et al., 2020). We also examine whether the results are robust to excluding never-married women, and using slightly different age and education categories. Furthermore, we assess the

sensitivity of our findings to alternative sample restrictions, including a narrower birth cohort (1930 – 1945 instead of 1928 – 1947; see Figure 1) and samples restricted to participants aged 70 years and older or 80 years and older. In addition, all models are re-estimated including lifestyle factors. As these factors may be endogenous, their inclusion could attenuate the estimated effect of work restrictions on cognitive outcomes. Finally, we examine whether loss to follow-up (mostly due to mortality) is associated with cognitive impairment and whether accounting for it alters the estimated association between exposure to the 'natural experiment' and cognitive impairment, and, if so, the likely direction of this potential bias.

All analyses are performed using R (version 4.5.2; R Core Team, 2025) in RStudio (version 2025.09.2; Posit Software, 2025).

4. Estimation results

4.1 'Natural experiment' approach

Table 3 presents the results examining the relationship of being married before 1957 with work-related outcomes. Women who were married before 1957 are significantly less likely to have ever worked than women who married later. On average, exposure to work restriction before 1957 is associated with a 5.3 percentage point lower probability of having ever worked (AME = −0.053, p-value = 0.033). Exposure to work restriction is also associated with lower occupational prestige, with an average decrease of 2.292 points in occupational prestige (p-value = 0.032). Results for males are presented in Table A3 in Appendix A.

Table 3. Estimation results for the relationship of marriage before 1957 with women's employment status

	Ever worked (0 = no; 1 = yes) Probit model			Occupational prestige scores[1] Linear regression model	
	AME[2]	*Coef. (SE)*	*p-values*	*Coef. (SE)*	*p-values*
Constant				27.921 (1.008)	<0.001
Married before 1957 (0 = no, 1= yes)	-0.053	-0.333 (0.156)	0.033	-2.292 (1.114)	0.032
Education level attained					
Category 1 (Low; reference)					
Category 2 (Middle)	0.089	0.503 (0.154)	0.001	6.483 (1.111)	<0.001
Category 3 (High)	0.137	1.152 (0.401)	0.004	26.858 (1.601)	<0.001
# Unique respondents		628		573	

[1] The occupational prestige score ranges from 13 (low) to 87 (high) (Sixma and Ultee, 1984).

[2] Average marginal effect

In addition, women with intermediate and higher educational attainment are significantly more likely to have ever worked than women with low educational attainment, with average increases in probability of 8.9 and 13.7 percentage points, respectively. Higher educational attainment is strongly associated with higher occupational prestige, with the largest effects observed for individuals with high educational attainment.

Table 4 presents the results examining the relationship of work restriction with cognitive outcomes at older ages for females. Work restriction is related to a higher probability of cognitive impairment. On average, exposure to work restriction before 1957 led to a 3.5 percentage point higher probability of cognitive impairment (AME = 0.035; p-value = 0.044). The positive coefficient for the marriage indicator in the ordered probit model (β = 0.231; p-value = 0.040) suggests that exposure to the pre-1957 institutional marriage bar increased the likelihood of more severe cognitive impairment among women. The intra-individual difference in MMSE scores is larger among women married before versus after 1957 (β = -0.222; p-value = 0.083) suggesting that the institutional context before 1957 was disadvantageous for women in terms of later-life cognitive development. Results for males are presented in Table A4 in Appendix A.

Age is also significantly associated with a higher likelihood of cognitive impairment and greater declines in MMSE scores between measurement cycles. Educational attainment shows a strong and consistent association with cognitive impairment, with higher education levels linked to better cognitive outcomes for the first two MMSE measures, but not for the difference in MMSE scores.

Taken together, these findings suggest that work restriction due to marriage in the pre-1957 context results in weaker labor market outcomes and poorer cognitive performance at older ages among women, while corresponding differences among men are not found.

Table 4. Estimation results for the relationship of marriage before 1957 on women's cognitive ability at older ages exploiting an exogenous change in labor laws

	MMSE dummy[1] (0 = no impairment; 1 = impairment)			MMSE category[2] (0 = no impairment => 3 = severe impairment)		Difference in MMSE score between waves[1]	
	Probit model[3]			Ordered probit model[3]		Lineair model[3]	
	AME[4]	*Coef. (SE)*	*p-values*	*Coef. (SE)*	*p-values*	*Coef. (SE)*	*p-values*
Constant		-1.475 (0.139)	<0.001			-0.289 (0.130)	0.026
Married before 1957 (0 = no, 1= yes)	0.035	0.269 (0.134)	0.044	0.131 (0.075)	0.080	-0.222 (0.128)	0.083
Education level attained							
Category 1 (Low; reference)							
Category 2 (Middle)	-0.059	-0.411 (0.135)	0.026	-0.362 (0.077)	<0.001	0.038 (0.125)	0.762
Category 3 (High)	-0.071	-0.541 (0.240)	0.028	-0.806 (0.133)	<0.001	0.083 (0.160)	0.603
Age reference category (75-79)							
Age (80-84)	0.029	0.237 (0.119)	0.066	0.185 (0.077)	0.016	-0.287 (0.041)	0.938
Age (85-89)	0.071	0.486 (0.164)	0.009	0.321 (0.118)	0.006	-0.590 (0.215)	0.007
Age (90 and older)	0.025	0.211 (0.367)	0.642	0.301 (0.261)	0.248	-0.346 (0.352)	0.325
# Observations		1,325		1,325		1,087	
# Unique respondents		552		552		516	

[1] MMSE: Mini Mental State Examination (Folstein, Folstein, McHugh, 1975): scores lower than 23 indicate cognitive impairment.

[2] 0 = no impairment (score ≥28), 1 = mild (score 24 – 28), 2 = moderate (score 21– 23), 3 = severe (score ≤ 20)

[3] SE clustered at the individual level

[4] Average marginal effect

4.2 Instrumental variables approach

We now examine the relationship between work restriction and cognitive impairment, using the abolition of the work restriction law as an instrument. Two potential endogenous variables are considered: "ever having worked" and occupational prestige.

Table 5a reports the results of the (recursive) IV probit models for the binary MMSE outcome. The first-stage results indicate that being married under the work restriction law is negatively related to the probability of ever having worked and to occupational prestige. The first-stage F-statistic for the ever-worked specification exceeds the conventional threshold of 10 (F-statistic = 20.36) and the corresponding Wald χ^2 statistic is 17.94, which both suggest a sufficiently strong instrument. This is equally true for the occupational prestige specification, where the first-stage F-statistic equals 13.94.

Turning to the second-stage results, the IV estimates suggest that ever having worked led to a significantly lower probability of cognitive impairment at older ages (β = -1.513; p-value = -0.022). Similarly, an one-point increase in the occupational prestige score is related to a lower probability of cognitive impairment ($\beta = -0.084$; p-value < 0.001). The estimated error correlation parameter is statistically significant in both IV specifications (β = 0.642; p-value < 0.05 respectively β = 0.790; p-value = 0.004), providing evidence of endogeneity and supporting the use of an IV approach.

Table 5a. Instrumental variables estimates of the effect of restrictions on paid employment in young adulthood (marriage before 1957) on cognitive impairment among older women

	Recursive bivariate IV probit model				IV probit model			
	(1) First stage Ever worked[1] (0=no,1= yes)		(2) Second stage MMSE dummy (0 = no impairment; 1 = impairment)[2]		(1) First stage Occupational prestige[3] (13: low to 87: high)		(2) Second stage MMSE dummy (0 = no impairment; 1 = impairment)[2]	
	Coef. (SE)	*p-values*	*Coef. (SE)*	*p-values*	*Coef. (SE)*	*p-values*	*Coef. (SE)*	*p-values*
Constant	1.166 (0.162)	<0.001	0.009 (0.648)	0.989	28.48 (1.065)	<0.001	1.397 (0.710)	0.049
Married before 1957 (0 = no, 1= yes)	-0.417 (0.189)	0.027			-2.681 (1.196)	0.025		
Ever worked (0= No, 1= Yes)			-1.513 (0.658)	0.022				
Occupational prestige[5]							-0.084 (0.013)	<0.001
Education level attained								
Category 1 (Low; reference)								
Category 2 (Middle)	0.536 (0.182)	0.003	-0.317 (0.136)	0.020	5.776 (1.190)	<0.001	0.316 (0.200)	0.114
Category 3 (High)	0.961 (0.436)	0.028	-0.437 (0.235)	0.062	27.373 (1.779)	<0.001	2.049 (0.540)	<0.001
Age reference category (75-79)								
Age (80-84)	-0.134 (0.090)	0.138	0.225 (0.114)	0.049	0.879 (0.641)	0.170	0.175 (0.098)	0.075
Age (85-89)	-0.058 (0.127)	0.646	0.447 (0.169)	0.008	0.134 (0.899)	0.881	0.309 (0.203)	0.127
Age (90 and older)	-0.339 (0.350)	0.333	0.153 (0.346)	0.657	2.522 (2.124)	0.235	0.222 (0.313)	0.484
Error correlation (p-value)	0.642 (<0.05)				0.790 (0.004)			
First-stage F-test[4]	20.36				13.94			
Wald $\chi 2$	17.94							
# Observations	1,313				1,185			
# Unique respondents	628				502			

[1] Being married before 1957 is used an instrument for "ever worked"

[2] MMSE: Mini Mental State Examination (Folstein, Folstein, & McHugh , 1975): scores lower than 23 indicate cognitive impairment, models are estimated with control variables.

[3] Prestige score ranked from 13: low to 87: high; Being married before 1957 is used an instrument for occupational prestige.

[4] Because the first-stage equation is estimated as a probit model, the conventional first-stage F-statistic is unavailable.
We therefore also estimate a linear probability model with the same first-stage specification and report the corresponding F-statistic.

Lastly, Table 5b presents the results of two IV models using the change in MMSE score between two consecutive waves as the outcome and marriage before 1957 as an instrument for ever having worked and occupational prestige, respectively. The first-stage results also show that exposure to the work restriction law is associated with a lower probability of ever having worked and with lower occupational

prestige. The second-stage estimated coefficients (β = 2.170 and β = 0.102, respectively) indicate a smaller decline in MMSE scores between consecutive waves among females who have ever worked and with an higher occupational prestige. However, the coefficients do not reach statistical significance (p-value = 0.158 respectively p-value = 0.083).

Table 5b. Instrumental variables estimates of the effect of restrictions on paid employment in young adulthood (marriage before 1957) on speed of cognitive decline among older women

	2SLS				2SLS			
	(1) First stage Ever worked[1] (0=no,1= yes)		(2) Second stage Difference in MMSE scores between consecutive waves[2]		(1) First stage Occupational prestige[3] (13: low to 87: high)		(2) Second stage Difference in MMSE scores between consecutive waves[2]	
	Coef. (SE)	*p-values*	*Coef. (SE)*	*p-values*	*Coef. (SE)*	*p-values*	*Coef. (SE)*	*p-values*
Constant	1.133 (0.090)	<0.001	-2.209 (1.307)	0.091	27.648 (0.657)	<0.001	-3.067 (1.610)	0.057
Married before 1957 (0 = no, 1= yes)	-0.375 (0.091)	<0.001			-2.532 (0.640)	<0.001		
Ever worked (0= No, 1= Yes)			2.170 (1.536)	0.158				
Occupational prestige[3]							0.102 (0.059)	0.083
Education level attained								
Category 1 (Low; reference)								
Category 2 (Middle)	0.549 (0.091)	<0.001	-0.137 (0.218)	0.529	6.491 (0.664)	<0.001	-0.669 (0.409)	0.102
Category 3 (High)	1.060 (0.216)	<0.001	-0.158 (0.312)	0.612	28.059 (0.975)	<0.001	-2.834 (1.681)	0.092
Age reference category (75-79)								
Age (80-84)	-0.140 (0.099)	0.158	-0.250 (0.153)	0.102	0.964 (0.649)	0.137	-0.396 (0.170)	0.020
Age (85-89)	-0.094 (0.132)	0.475	-0.598 (0.213)	0.005	-0.264 (0.909)	0.772	-0.649 (0.236)	0.006
Age (90 and older)	-0.285 (0.219)	0.192	-0.178 (0.542)	0.743	0.234 (1.743)	0.893	-0.464 (0.473)	0.326
Wald-test	16.76							
First-stage F-test					15.64			
# Observations	1,179				1,072			
# Unique respondents	513				470			

[1] Being married before 1957 is used an instrument for "ever worked"

[2] MMSE: Mini Mental State Examination (Folstein, Folstein, & McHugh , 1975)

[3] Prestige score ranked from 13: low to 87: high; Being married before 1957 is used an instrument for occupational prestige.

Overall, the IV results are consistent with the hypothesis that labor market exposure has a causal effect on later-life cognitive functioning, although the magnitude and statistical significance of the effect vary across model specifications and measures of cognitive impairment.

4.3 Sensitivity analyses

In general, most sensitivity analyses yield comparable findings to the main analyses.[6] First, the analyses using continuous MMSE scores and MMSE scores corrected for education level (Kempen, Brilman & Ormel, 1995; Aaltonen et al., 2020) show effects in the expected direction, although they are not consistently statistically significant. Also, analysis using slightly different age or education categories, after exclusion of the women who never marry (1%), and analyses run on narrower birth cohort (1930 – 1945 instead of 1928 – 1947) yield results that are highly comparable with the main results. The results are slightly more significant for the analyses on the individuals aged 80 and older than in the individuals aged 70 and older. For the MMSE dummy specification, the coefficient for the variable "being married before 1957" is 0.260 (p-value = 0.056) for those aged 70 and older and 0.398 (p-value = 0.038) for those aged 80 and older. For the MMSE categorical specification, the coefficient for the variable "being married before 1957" equals 0.230 (p-value = 0.062) for those aged 70 and older and 0.355 (p-value = 0.027) for those aged 80 and older. The results on changes in MMSE between waves

[6] The full results of the sensitivity analyses are available on request from the authors.

were not significant for those aged 70 and older. For age 80 and older, the coefficient equals -0.396 (p-value 0.060).

Second, when lifestyle variables are included, the estimated effects become slightly smaller and are less statistically significant or no longer statistically significant (see Table 4). For example, in the first model specification (binary MMSE outcome), the coefficient for the variable "being married before 1957" is 0.243 (p-value = 0.096), while in the second specification (categorical MMSE outcome) the corresponding coefficient is 0.198 (p-value = 0.121). The modest attenuation of the estimated effects after adjustment for current lifestyle factors is consistent with our hypothesis that lifestyle partly mediates the relationship between labor market exposure and later-life cognitive functioning. However, because lifestyle was measured contemporaneously with cognitive functioning, these results should not be interpreted as evidence of a causal mediation pathway.

As noted earlier, MMSE scores differ between deceased and non-deceased respondents, and respondents who subsequently dropped out of the sample exhibited worse MMSE scores prior to attrition than those who remained. Importantly, however, no systematic difference in attrition is observed between treated and control groups, suggesting that selective attrition does not differentially affect the two groups being compared. As a back-of-the-envelope exercise, we nonetheless assess the potential role of selective attrition by including an indicator for future attrition in the regression models. After this adjustment, the estimated coefficient for the 1957 policy change indicator becomes smaller and is no longer statistically significant, although it remains positive (from $\beta = 0.269$; p-value = 0.018 to $\beta = 0.176$; p-value = 0.164). This coefficient should not be interpreted causally, as attrition may itself be endogenous.

5. Discussion

Our results show that women exposed to marriage-based labor market restrictions are significantly less likely to have participated in paid employment and are more likely to have worked in lower-prestige occupations than women who are not exposed to such restrictions. Moreover, the results provide evidence of a causal relationship between reduced labor force participation in early adulthood and poorer cognitive functioning after the age of 75 in women. Finally, we find some suggestive evidence of a faster cognitive decline, although this effect is only significant at the 10% level and is not robust across all model specifications. No such disadvantages appear among men — consistent with the gender-specific legislation. These results are robust across different methodological approaches and in most sensitivity analyses. The sensitivity analyses adjusting for contemporaneous life style factors or selection bias result in smaller effect sizes that are not statistically significant.

Several limitations of the present study should be acknowledged. To begin with, the underlying assumptions of the 'natural experiment' approach deserve critical examination. Most importantly, the

identification strategy relies on the assumption that the timing of the policy change was exogenous. As noted earlier, the introduction of work restrictions for married women was a gradual process, initially applying to civil servants before extending to the education sector and subsequently to other sectors (van Baalen, 2007). Similarly, the abolition of the restrictions did not immediately translate into a sharp behavioral change. Deeply rooted cultural norms meant that many women continued to exit the labor market upon marriage even after the formal barriers were lifted, as full-time homemaking remained the prevailing social expectation for many years (Hartog & Theeuwes, 1985). However, women had no influence on the timing or implementation of the policy change. Consequently, exposure to work restriction can be considered as-if random with respect to unobserved determinants of late-life cognitive functioning. Moreover, to improve comparability of the exposed and control groups in our study, they are constructed to be as similar as possible. The analysis is restricted to women from adjacent birth cohorts, and controls are included for differences in age and educational attainment.

We partially address the gradual introduction of the policy change by complementing the 'natural experiment' analysis with an IV approach, using the 1957 reform as an instrument for women's labor market outcomes. By exploiting the variation in labor market participation and occupational prestige induced by the reform, the IV estimates are less sensitive to the fact that not all women adjusted their labor market behavior immediately following the abolition of the restrictions. In addition, the exclusion restriction requires that the policy change affected later-life cognitive functioning only through its impact on women's labor force participation. Although this assumption cannot be tested directly, it is considered plausible given the institutional context.

Another potential concern is that the abolition of the marriage bar may have affected later-life cognitive functioning through alternative pathways, such as changes in women's social networks or household circumstances. However, such pathways are unlikely to operate entirely independently of changes in labor force participation. The marriage bar was a labor market regulation specifically designed to restrict married women's employment, and its abolition directly expanded women's opportunities to remain employed after marriage. We therefore consider labor force participation to be the primary mechanism through which the reform affected cognitive functioning later in life, while acknowledging that other, related pathways cannot be entirely ruled out.

A final limitation concerns the lack of detailed lifetime employment data. Ideally, we would observe whether women remained employed after marriage, and the timing, duration and intensity of their life course (non-)employment (Pacca et al., 2025; Wu et al., 2025). Such information would allow us to verify more directly that exposure to work restriction resulted in meaningful differences in actual labor market participation between consecutive cohorts. It would also help distinguish whether an effect on late-life cognitive functioning was driven by longer employment, greater work intensity or the cognitive demands of certain occupations. In the absence of such data, our estimates should be interpreted as the

reduced-form effect of exposure to the policy change rather than as the effect of a specific dimension of employment.

6. Conclusion

This study provides novel evidence on the long-term causal consequences of restrictions on women's access to paid employment for cognitive functioning in later life. By exploiting the abolition of the Dutch marriage bar as a 'natural experiment' and complementing this approach with instrumental variables analyses, we move beyond the associations between employment and cognition documented in previous research. We conclude that barriers to paid employment in women's young adulthood hinder cognitive functioning, thereby contributing to cognitive disparities between men and women in later life. More broadly, our results provide support for the long-term cognitive benefits of sustained labor market engagement and cognitively stimulating work.

Our findings have implications that extend beyond the cohort of women studied here. The Netherlands is not the only country where an employment gender gap between men and women exists. From the 1960s onward, increasing numbers of women gradually entered the workforce, though the real catch-up did not occur until the 1980s and 1990s. In 2024, the gender employment gap in the EU still stood at 10.0 percentage points (80.8% for men versus 70.8% for women), ranging from 0.7 percentage points in Finland to 18.1 percentage points in Romania (Eurostat, 2026). Based on the findings of our study, we might therefore expect that closing this gap could yield meaningful cognitive benefits for women across Europe in the decades ahead.

At the same time, the patterns we document may diminish in future generations. As women's labor force participation has risen substantially over recent decades, younger cohorts of women are far less likely to experience prolonged absence from paid work like the women in our sample. To the extent that occupational engagement provides cognitive stimulation and builds cognitive reserve, this secular shift may translate into more favorable cognitive trajectories for women in later life. Our findings point to the value of labor market policies aimed at increasing or sustaining women's employment. Accessible childcare, flexible working arrangements and return-to-work programs may serve as non-medical approaches to decrease dementia prevalence in the future, though future research is needed to substantiate these potential effects.

Finally, previous research has reported no sex differences in dementia incidence within the same birth cohorts, although dementia prevalence remains higher among women, largely because of their longer lifespan (Huque et al., 2023). As women's labor force participation has increased substantially across successive cohorts, we would expect dementia incidence among women to decline, thereby narrowing the sex difference in dementia prevalence. This interpretation is consistent with recent evidence

showing that dementia incidence has declined more rapidly among women than among men over the past two decades (Hegelund et al., 2022).

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Appendix A:

Table A1 summarizes the descriptive characteristics of the male study sample per exposure group. Table A1 shows almost no differences in cognitive outcomes by exposure status. Only exposed men aged 75 – 80 have significantly lower average MMSE scores. No differences are observed regarding work-related outcomes. Employment histories are nearly universal in both groups, and no meaningful differences are observed in occupational prestige between the exposed and control groups.

Table A1. Descriptive statistics for male study sample

	# obs.	Exposed[1]	Controls[1]	P-value[2]
Work status				
Ever worked (yes = 1 vs no =0) (%)	496	100.0	99.5	1.00
Occupational prestige score (from 16 = low to 87 = high) (Mean, SD)[3]	494	44.6	44.7 (12.5)	0.54
Cognitive ability[4]				
MMSE continuous[5] *(Mean, SD):*				
Score at age 75 - 80	617	27.0 (3.2)	27.5 (2.7)	0.02
Score at age 80 - 85	314	27.2 (2.7)	27.1 (2.8)	0.76
Score at age 85+	118	26.2 (2.6)	26.8 (2.1)	0.40
MMSE binary indicator[5] *(%):*				
Score at age 75 - 80	617	11.2	6.0	0.12
Score at age 80 - 85	314	9.6	9.2	1.00
Score at age 85+	118	16.7	7.4	0.32
MMSE categorical variable[6] *(%):*				
MMSE score ≥ 28	790	54.2	62,5	
MMSE score 24 - 27	443	34.9	32.7	0.18
MMSE score 21 - 23	62	7.5	3.2	
MMSE score ≤ 20	30	3.5	1.6	
Difference in MMSE score (t - (t-1)) (Mean, SD):	940	-0.7 (2.5)	-0.4 (2.2)	0.35
Marriage				
Married before 1957 (yes = 1 vs no =0) (N)	497	64	433	
Additional variables				
Birthyear	497	1930.0	1936.6	<0.001
Age (%)[4]				
75 - 80	685	46.2	58.8	
80 - 85	368	31.0	30.4	<0.001
85 - 90	130	17.8	9.4	
90 and older	24	5.1	1.4	
Attained education (number of years)	497	10.4	11.1	<0.001
Education category (in %)				
Low	83	26.6	14.2	
Middle	263	54.7	52.7	0.02
High	151	18.7	23.1	
Current smoking[4] (%)	438	8.4	7.6	0.86
Alcohol[4] (%) (less than 4 glasses per week)	438	45.4	57.8	0.04
Norm physical activity[4] (% yes ≥ 20 minutes physically active /day)	462	69.9	82.8	<0.001
Social network diversity[4] (size network)	444	4.6	4.5	0.39

[1] Males who married before 1957 (exposed) while those who married after 1957 were not (controls).

[2] We test differences between groups using t-tests and chi-square tests.

[3] Sixma, H. & Ultee, W.C. (1984)

[4] Men who participated in multiple measurement cycles contribute multiple observations to the calculated average.

[5] Mini Mental State Examination (Folstein, Folstein, McHugh, 1975): scores from 0 to 30 and scores lower than 24 indicate cognitive impairment.

[6] 0 = no impairment (score ≥24), 1 = moderate (score 18–23), 2 = severe (score ≤ 17) (Tombaugh and McIntyre, 1992)

Figure A1 shows boxplots of MMSE scores for males by age group for the exposure group (men married before 1957) and the control group (men not married before 1957). As expected, the differences in MMSE score between those who married before and after the abolition of the marriage bar are much less pronounced for males than for females.

Figure A1. Clustered boxplot MMSE-score for males by age groups and exposure groups

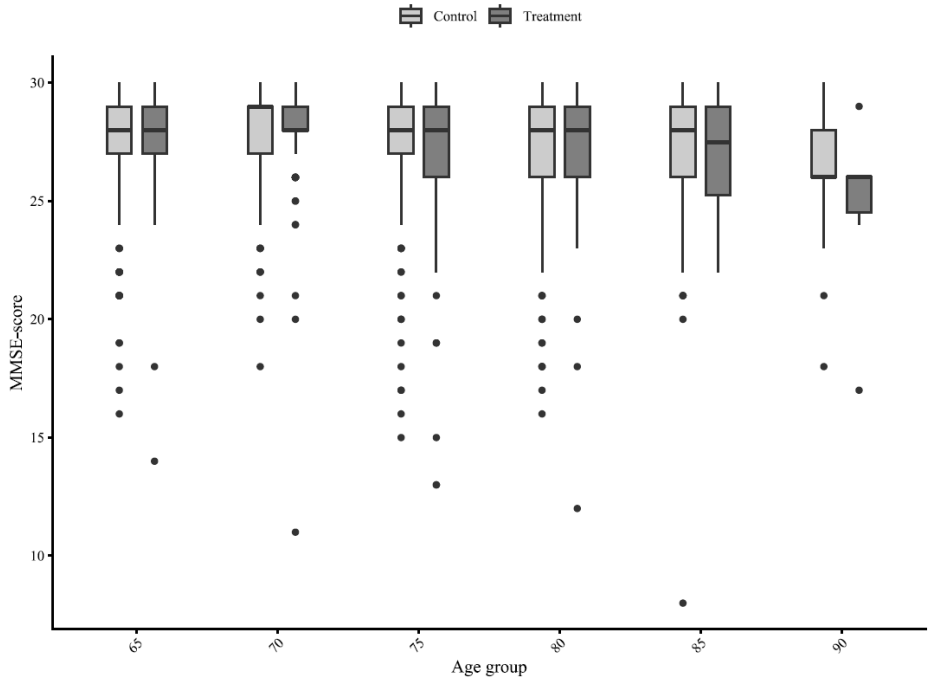

Table A2 summarizes MMSE scores at the last attended wave by loss-to-follow-up status and exposure group for males. As for females, average MMSE scores at the last available observation among men are generally lower for respondents who subsequently dropped out of the study than for those who remained in the study and were included in the main analyses.

Table A2. Loss to follow-up and cognitive status in male LASA respondents

	Exposed[1]		Controls[2]	
	N	Mean MMSE[3]	N	Mean MMSE[3]
Men included in the main analyses	64	27.10	433	27.63
Loss to follow-up during observation window:				
Deceased	29	27.40	99	25.90
Refusals	2	26.30	16	28.00
Ineligible	4	28.00	7	27.10
Not contacted	0	NA	0	NA

1: Married before the abolition of the law; 2: Not married before the abolition of the law.
3: Mini Mental State Examination (Folstein, Folstein, McHugh, 1975)

Table A3 presents the estimation results examining the relationships between being married before 1957 and work-related outcomes. As noted, men's employment histories were nearly universal, we do not present effects on "ever worked" for them. Among men, marrying before 1957 is associated with higher occupational prestige, i.e. it is associated with an average increase of 3.956 points (p-value = 0.026). A possible explanation for higher occupational prestige for men in our exposure group lies in the composition of the groups: the exposure group includes only married men, while the control group also includes unmarried men. Since marriage was the dominant social norm at the time, marital status had a significant effect on men's status, career trajectory, and income (Korenman & Neumark, 1991). In men, like in women, higher educational attainment is strongly associated with higher occupational prestige, with the largest effects observed for individuals with high educational attainment.

Table A3 Being married before 1957 and occupational prestige for males ('natural experiment' approach)

	Occupational prestige scores[1] Lineair regression model	
	Coef. (SE)	*p-values*
Constant	35.009 (1.486)	<0.001
Married before 1957 (0 = no, 1= yes)	3.956 (1.766)	0.026
Education level attained		
Category 1 (Low; reference)		
Category 2 (Middle)	6.521 (1.657)	<0.001
Category 3 (High)	19.273 (1.803)	<0.001
# Unique respondents	494	

[1] The occupational prestige score ranges from 13 (low) to 87 (high) (Sixma and Ultee, 1984).

Table A4 presents the regression results examining the relationship between being married before 1957 and cognitive outcomes at older ages for males. As expected, being married under the pre-1957 regime is not associated with the probability of cognitive impairment among males in any of the three specifications for cognitive impairment based on the MMSE.

Table A4. Estimation Results for the Relationship Between Marriage Before 1957 and Men's Cognitive Ability at older ages ('Natural Experiment' approach)

	MMSE dummy[1] (0 = no impairment; 1 = impairment)			MMSE category[2] (0 = no impairment => 3 = severe impairment)		Difference in MMSE score between waves[1]	
	Probit model[3]			Ordered probit model[3]		Lineair model[3]	
	AME[4]	*Coef. (SE)*	*p-values*	*Coef. (SE)*	*p-values*	*Coef. (SE)*	*p-values*
Constant		-1.027 (0.171)	<0.001			-0.330 (0.146)	0.025
Married before 1957 (0 = no, 1= yes)	0.036	0.038 (0.019)	0.191	0.116 (0.117)	0.318	-0.152 (0.211)	0.470
Education level attained							
Category 1 (Low; reference)							
Category 2 (Middle)	-0.043	-0.244 (0.180)	0.132	-0.321 (0.105)	0.002	0.022 (0.161)	0.889
Category 3 (High)	-0.075	-0.510 (0.217)	0.009	-0.792 (0.121)	<0.001	-0.015 (0.172)	0.930
Age reference category (75-79)							
Age (80-84)	0.024	0.169 (0.131)	0.199	0.253 (0.087)	0.004	-0.331 (0.176)	0.061
Age (85-89)	0.028	0.189 (0.184)	0.361	0.323 (0.105)	<0.001	-0.354 (0.211)	0.094
Age (90 and older)	-0.011	-0.096 (0.193)	0.842	0.784 (0.179)	<0.001	-0.569 (0.532)	0.286
# Observations		1,049		1,049		940	
# Unique respondents		462		462		434	

[1] MMSE: Mini Mental State Examination (Folstein, Folstein, McHugh, 1975): scores lower than 23 indicate cognitive impairment.

[2] 0 = no impairment (score ≥28), 1 = mild (score 24 – 28), 2 = moderate (score 21– 23), 3 = severe (score ≤ 20)

[3] SE clustered at the individual level

[4] Average marginal effect

Appendix B:

Table B1. Alcohol consumption index for LASA

Number of days drinking alcohol	Number of alcohol consumption each time			
	6 or more	**4-5**	**2-3**	**0-1**
5-7 days per week	very excessive	excessive	moderate	light
3-4 days per week	excessive	moderate	moderate	light
1-2 days per week	excessive	moderate	light	light
1-3 days per month	moderate	light	light	light
< 1 day per month	light	light	light	light