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LONG-TERM CONSEQUENCES OF ACCESS TO WELL-CHILD VISITS

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Abstract

A growing literature documents the positive long-term effects of policy-induced improvements in early-life health and nutrition. However, there is still scarce evidence on early-life health programs targeting a large share of the population and the role of such programs in increasing intergenerational mobility. This paper uses the rollout of mother and child health care centers in Norway, which commenced in the 1930s, to study the long-term consequences of increasing access to well-child visits. These well-child visits included a physical examination and the provision of information about adequate infant nutrition. Our results indicate that access to mother and child health care centers had a positive effect on education and earnings: access in the first year of life increased the completed years of schooling by 0.15 years and earnings by two percent. The effects were stronger for children from a low socioeconomic background. In addition, we find that individuals suffer from fewer health risks at age 40 and positive effects on adult height, which support the fact that better nutrition within the first year of life is the likely mechanism behind our findings. While there is increasing knowledge on the benefits of various types of early childhood programs, the costs are often neglected, making it hard to compare different programs. We add to this by showing that investments in mother and child health care centers pass a simple cost–benefit analysis.

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1 Introduction

A large body of evidence shows that early-life exposure to disease and malnutrition has long-term consequences for adult health, education and labor market outcomes (for an overview, see Barker, 1992; Almond and Currie, 2011). As documented in the neuroscience literature, the first three years of life are the most critical period of human brain development and, therefore, a child's health during these early years matters in terms of later human capital investments (see, e.g., Johnson, 2001). Moreover, a growing body of literature documents that policy-induced improvements in early-life health and nutrition have positive long-term effects. For instance, Hoynes, Schanzenbach, and Almond (2015) present evidence that access to the food stamp program during early childhood improved adult health as well as self-sufficiency for women. In addition, the provision of breastfeeding advice is shown to improve children's cognitive development in a large randomized experiment (Kramer, Aboud, Mironova, and et al., 2008) and in quasi-experimental settings (Fitzsimons and Vera-Hernandez, 2013). Furthermore, several papers show that hospital-provided care to specific groups of infants has long-run benefits. Examples include Bharadwaj, Løken, and Neilson (2013), who focus on extra medical care given to very low birth-weight children, Chay, Guryan, and Mazumder (2009), who study the racial integration of hospitals in the South of the United States during the 1960s and Bhalotra and Venkataramani (2012) who analyze the introduction of the first antibiotics. This evidence demonstrates that the provision of appropriate health care services to infants and improved nutrition have the potential to mitigate the negative effects of disease exposure, poverty or low birth weight.

While the existing literature often focuses on hospital-provided care or programs directed at specific groups, we advance the literature by studying the long-term consequences of the provision of universal well-child visits. This is a more basic (and often cheaper) form of infant health care, which may be relevant for a large share of the population. In this paper, we use unique historical data to investigate the long-term consequences of an expansion of health care infrastructure directed at infants. In particular, we exploit the national rollout of mother and child health care centers in Norway, which commenced in the 1930s. Analyzing this rollout provides the first evidence on the long-term economic effects of such health care centers.

From the 1930s onwards, mother and child health care centers were established in local initiatives by philanthropic institutions all over Norway. By 1946, about 26 percent of Norway's municipalities had a functioning mother and child health care center (see Schiøtz, 2003).[1] The mother and child health care centers reduced the cost to the public of infant health care, as the service was free of charge, and increased its availability and convenience because the centers were established in multiple neighborhoods within cities, as well as in small villages, to minimize travel expenses for mothers. The well-child visits at mother and child health care centers included a physical

[1] This initiative, run by a philanthropic women's organization, is a typical example of how Western Europe and the United States were addressing common health threats in the early 20th century (Ludvigsen and Elvbakken, 2005).

examination and provided information about normal development, sleep, safety, diseases and, most importantly, nutrition. Although it was a universal and free program, a key goal was to reach out to poor families. Hence, this program may have been important in reducing inequality and improving social mobility. An additional contribution of this paper is to study the effect of the program on the intergenerational persistence in educational attainment across generations.

Our analysis is based on historical data from different archives documenting the exact timing of the rollout of mother and child health care centers. Then, these data are linked to Norwegian register data, allowing us to follow all births in Norway and outcomes later in life. This historical aspect allows us to evaluate the impact of well-child visits 30 or more years after the first centers were established. Our estimation strategy is a differences-in-differences approach, comparing cohorts that were older than one year at the time a center opened in their municipality of birth (control infants) to cohorts that were born in or after the year a center opened in their municipality of birth (treated infants). The key identification assumption is that the timing of the center openings is not correlated with differential trends in education, earnings or health across municipalities. For this reason, we include municipality-specific time trends and, in a further specification, we compare siblings born before and after the health care centers opened. Our results are robust to adding a set of municipality control variables, and event-study models support the validity of the research design.

We find that access to well-child visits led to a statistically significant increase in school attainment of 0.15 years and lifetime earnings of two percent. The effects are stronger for children from lower socioeconomic backgrounds and the program reduced the intergenerational persistence in educational attainment across generations. A unique feature of our study is the combination of education and labor market outcomes with health outcomes at age 40. In particular, we find a reduction in incidences of 'metabolic syndrome' such as obesity, hypertension and cardiac risk. In addition, we have information on adult height, which is an outcome that is likely to be affected by nutrition in the first years of life (see, e.g., Deaton, 2007; Rivera, Martorell, Ruel, Habicht, and Haas, 1995). Therefore, positive effects on height at age 40 suggest that better nutrition within the first years of life is a likely mechanism behind our findings. Finally, the costs of the program were relatively low and we add a simple cost–benefit analysis, which shows that the program's benefits outweigh its costs in the context that we study.

Our paper builds on earlier studies relating well-child visits to infant health, which indicate a positive 'first stage' effect from these visits. Wüst (2012) shows that infant care provided by home-visiting nurses has positive short-term impacts on infant mortality and maternal health after pregnancy. Bhalotra, Karlsson, and Nilsson (2015) find that an infant care program in Sweden in the 1930s led to a substantial decline in the risk of infant death. Moehling and Thomasson (2014) show that infant mortality decreased in areas with more intense exposure to policies related to the Sheppard–Towner Act, which provided federal funding for maternal and infant health care between

1922 and 1929. In addition, Chen, Oster, and Williams (2015) provide evidence that pediatric well-child visits are likely to be a very important factor explaining the gap in infant mortality rates between Europe and the United States. In developing countries, randomized control trials on neonatal care in the form of home visits by community health workers are associated with reduced neonatal mortality (see, e.g., Gogia and Sachdev, 2010). In addition, our work fits into the growing literature on the importance of information about health. In a recent review, Dupas (2011) suggests that the provision of information about health and health care may significantly affect health behavior. In the context of information on infant nutrition, Fitzsimons, Malde, Mesnard, and Vera-Hernandez (2012) present experimental evidence that the provision of such information to poor families may result in large increases in household consumption of protein-rich food by children. However, it is still not known whether well-child visits and information given to mothers about infant care improve children's outcomes in the long run.[2] As discussed by Chetty, Friedman, Hilger, Saez, Schanzenbach, and Yagan (2011), in the context of Project STAR, short-term and long-term outcomes may not necessarily be the same. Therefore, it is important to analyze whether the impact of well-child visits goes beyond immediate outcomes and has benefits for children's health that can spill over to long-term educational and labor market outcomes.

The remainder of the paper is structured as follows. Section 2 provides some historic background on the mother and child health care centers in Norway. Section 3 describes the data. Section 4 describes the identification strategy and Section 5 presents the empirical findings and robustness checks, which corroborate the main results. Section 6 explores suggested mechanisms behind the results. Section 7 links our results to the previous literature and presents a simple cost–benefit analysis. Section 8 concludes.

2 Historical Background

In the late 19th century, public concern over children's health increased in Europe and the United States. In particular, the high infant mortality rate intensified the public debate.[3] The public concern, referred to as the infant welfare movement, led governments to invest in social and population policies to improve infants' health conditions. As a result, information centers for mothers of newborns were established in birth clinics in many European countries in the late 19th and early 20th centuries. In Norway, mother and child health care centers were established as a result of local initiatives by philanthropic institutions. Most influential was the Norwegian Women's Public

[2] Parallel with our work, Hjort, Sølvsten, and Wüst (2014) analyze the long-term health effects of a Danish home-visiting program rolled out in the late 1930s.

[3] Infant mortality remained very high at the beginning of the 20th century in Europe and the United States. In Norway in 1900, more than 80 out of 1000 children did not survive their first year of life. From that point, increased hygiene and living standards steadily decreased the infant mortality rate, although the decrease slowed during World War I and the economic crises of the 1920s. However, it picked up again in the 1930s, by which time 44.9 out of 1000 infants born alive died within their first year of life in Norway. About one-third died from congenital malformations, 24 percent from pneumonia and 15 percent from diarrhea (Backer, 1963).

Health Association (NKS),[4] which opened the first center in 1914 in Oslo and ran the majority of the 400 centers that were still existing in 1946. Centers led by NKS were opened through local initiatives and run by local NKS chapters, according to guidelines provided by the national NKS governing body. This national body provided local chapters with financial support. In addition, the NKS undertook intense outreach activities to inform women about their services. Although the centers were mainly targeted at poor families, they were open to everyone. In the beginning, the uptake was rather low and the centers attempted to encourage mothers to have their infants examined, by serving coffee and pastries. However, after a slow start, the mother and child health care centers quickly became widely popular and, by 1930, the take-up rate in Oslo was 60 percent of all babies (Schiøtz, 2003). The centers had two main goals: first, they provided medical check-ups by doctors and nurses for the infants, free of charge. Infants were measured and examined during each visit and doctors and nurses at the centers kept records of infants' health status on standard forms. Ill infants were referred to doctors or hospitals. On average, a child would visit a mother and child health care center three to four times during his or her first year of life. Second, the centers provided mothers with advice on adequate infant nutrition and tools to decrease infant mortality, such as infant hygiene measures and adequate infant clothing. Breastfeeding rates between 1920 and the late 1960s were relatively low and declining in Norway (Liestøl, Rosenberg, and Walløe, 1988) as milk formulas, a mix of cows' milk, water, cream and sugar or honey, became more and more popular and evaporated milk began to be widely available at low prices. However, formula-fed babies exhibited vitamin C and D deficiencies and bacterial infections, resulting from diluted water.[5] As a result of the increased risk of gastrointestinal diseases for formula-fed babies, breastfeeding was promoted, particularly among poor women and single mothers (Styr, 1937).[6] In addition, mothers were taught to make adequate milk formulas and some of the centers supplied them with evaporated milk and with cod liver oil to reduce diseases related to vitamin D deficiencies. Professor Frøhlich, the first Norwegian professor of pediatrics, was interested in the research on child nutrition and, in particular, in research on vitamins. He was actively involved in the initiative to establish the first mother and child health care center in Norway (Toverud, 1945). As Frøhlich comments, proper nutrition was an important focus of the health care centers: "The cause behind the high mortality rate is almost solely inappropriate nutrition, leading to intestinal sickness, rickets, skin diseases and cramps. Children raised with milk formulas have little resistance against children's diseases

[4]The NKS is the largest women's organization in Norway. Established in 1896, it was and is involved largely in humanitarian work. The association has about 750 local chapters and, after World War II, it had about 250,000 members (out of a total of 3 million inhabitants). The mother and child health care centers were not the only way the NKS attempted to improve living conditions in Norway. As tuberculosis was a very large health threat in Norway during the early 20th century, the NKS was involved in infection control through strengthening hygiene measures and it opened the first tuberculosis sanatoria in 1903. In 1919, the NKS started establishing nursing schools and, later, it established orphanages. During World War II, the NKS distributed food and established military hospitals.

[5]Milk formulas often included honey, which increases the risk of infant botulism (Arnon, Midura, Damus, Thompson, Wood, and Chin, 1979).

[6]The situation of children born to single mothers and children born out of wedlock was of special concern, as these children had 70 to 100 percent higher mortality rates than children born to married mothers in the 1930s.

and, horrifyingly, many children die every year because of their mother's illness or ignorance. The mother and child health care centers shall first and foremost give young and inexperienced mothers competent guidance and then, also, through encouragement and reward, give the women inspiration to breastfeed their own children." Some mother and child health care centers provided pregnant women with advice on nutrition and a code of conduct during pregnancy. In addition, some centers provided smallpox vaccinations and, later, diphtheria vaccinations for infants and small children.

Doctors and nurses were paid an annual salary and their traveling expenses were reimbursed. Moreover, a substantial share of the centers' yearly budgets was spent on printing information materials for mothers. As well as philanthropic contributions, the health care centers were financed largely by funds from the state lottery, with some centers receiving additional financial support from local governments, counties and the state. In 1972, municipalities were given the obligation to run the mother and child health care centers. The services provided by the centers were regulated by the Health Directorate through official guidelines and handbooks. Thus, the municipalities gradually took over the 1400 centers that had mostly been privately run in the late 1960s (Ludvigsen and Elvbakken, 2005). The goal was to reach out to everyone and to establish a unified primary health care system for infants and small children. Although the mother and child health care centers have changed over time, they are still in place today as a free and universal service on offer to all infants and small children during their first six years of life and to their mothers. The centers offer health controls, vaccinations and health education. An average child visits the center about 10 to 15 times during their first six years of life (most of the visits occur in the first year of life). The municipalities are responsible for the services. Centers are mainly staffed by medical doctors, nurses and midwives, but also physiotherapists and psychologists.[7]

3 Data

This paper links unique historical data on the rollout of mother and child health care centers in Norway with individual administrative data from various sources. Our primary data source is the Norwegian Registry Data, a linked administrative data set that covers the population of Norwegians up to 2012. These data are maintained by Statistics Norway and are a compilation of different administrative registers, including the central population register, the family register, the education register and the tax and earnings register. The data provide information about place of birth and residence, educational attainment, labor market status, and earnings, as well as a set of demographic variables and information on families. The historical data on the mother and child health care centers are collected from public and private archives. In the following subsections, we describe our data.

[7] Similar types of mother and child health care centers with universal access exist in other European countries.

3.1 Historical Data

We use a variety of data sources to document the rollout of mother and child health care centers from 1936 to 1955. We collected all available records from the NKS health care centers for this period. Our efforts have yielded records from approximately 400 different centers established between 1936 and 1955. The year in which each center was established is obtained from two surveys that the NKS sent out to all mother and child health care centers in 1939 and 1955. The surveys included a question on the date of establishment of the center. In addition, these surveys provide information on the exact address of the center, the community it served, the founder of the center, the number and qualifications of employees and the approximate budget of the center. Furthermore, we collected data on the centers' yearly expenses and on the types of services provided. All centers provided well-child visits for infants, but some also provided immunizations. In addition, the data are verified using other primary sources, including local NKS sections' yearly budgets. Our final database on the health care centers' operation contains information on: (1) the year in which the municipality mother and child health care centers were established and in which years they were actively providing services; and (2) more detailed information on the types of services the centers provided in 1941, 1943, 1947, 1948 and 1951. Figure 1 shows the rollout of the mother and child health care centers between 1935 and 1955. For presentational purposes, the dates of the openings are grouped into four periods: municipalities with centers established before 1935; municipalities with centers established between 1936 and 1945; municipalities with centers established between 1946 and 1955; and municipalities without centers in 1955.[8] The first center was opened in Oslo in 1914. In 1927, the city of Kristiansand in southern Norway established a center and, in 1933, a center was established in Lillehammer, which was a small town at that stage. As the NKS expanded its numbers of service providers, well-child visits achieved broad geographic coverage. The first center in the northern-most county was established in 1936 in Hammerfest. Note that there is considerable within-region variation in establishment dates. Figure 2 shows in how many municipalities a mother and child health care center was opened in each year between 1910 and 1955. Mother and child health care centers that were established in municipalities with an already operating health care center are not included. A large portion of the health care centers were opened in the years 1937–1939, 1941, and 1945–1947. Comparing the size of a birth cohort in a municipality with the number of children checked at a health care center in each year, we find that the uptake rate was about 40 percent in the year of the center opening (see Figure 3). Two to four years after the opening of a health care center, the uptake rate was about percent.

3.2 Administrative Data

The central population register contains the municipality of birth. We allocate a municipality of residence during the first year of life to each individual by assuming that they were residing in their

[8]In the regressions, we use the exact opening dates, not the four broad categories used in Figure 1.

municipality of birth. The central population register includes identifiers for parents that enable us to identify socioeconomic background and an individual's siblings. Educational attainment is taken from the educational database provided by Statistics Norway. Since 1979, educational institutions have provided annual reports on educational attainment directly to Statistics Norway, thereby minimizing any measurement error due to misreporting. We consider the completed years of education as our measure of educational achievement. Lifetime income is measured by average discounted earnings from 1967 to 2010. The earnings measure is not top-coded and includes labor earnings, taxable sick benefits, unemployment benefits, parental leave payments and pensions.

3.3 Municipality-Level Data

Several specifications include municipality-level data, such as the numbers of inhabitants per doctor and per midwife in the municipality of birth in the year of birth. The data on the population size, the numbers of doctors and midwifes in each municipality and the tuberculosis infection rates are collected from Statistics Norway's historical yearly health statistics. The student–teacher ratio in the year an individual enrolled at school and the percentage of missing school days are collected from Statistics Norway's historical yearly school statistics. The infant mortality rate—the rate of children passing away within their first year of life—is collected from historic birth and death certificates in 1930 and 1936. The number of inhabitants per municipality with a high school diploma is collected from the censuses of 1930 and 1946.[9] The average income per municipality is collected from the 1930 Census. The 1930 Census was the second census in Norway, collecting data on income, wealth, tax and unemployment, with the first taking place in 1910. A municipality is defined as an urban area if Statistics Norway classified the municipality as a city in 1930 or 1940.

3.4 Health Data

The data on an individual's health status comes from the Cohort of Norway (CONOR) data and the National Health Screening Service's Age 40 Program data. These are two population-based and nationwide surveys carried out from 1988 to 2003 by the National Institute of Public Health. The information contained in both surveys was gathered through questionnaires and short health examinations. For the most part, the same information was collected in both surveys. The unique aspect is that the health examination component was conducted by medical professionals and provides detailed medical information, including data from blood tests and medical exams. The goal of the Age 40 Program was to survey all men and women aged 40 to 42 between 1988 and 1999. The response rate was between 55 and 80 percent over these years, yielding 374,090 observations. In addition, we use data from the CONOR survey, which was carried out between 1994 and 2003

[9] Owing to the Nazi occupation of Norway from 1940 to 1945, no census was undertaken in 1940.

and which includes 56,863 respondents.[10] The oldest cohorts in the health data were born in 1942. Therefore, we are only able to examine center openings after 1942 when focusing on health outcomes.

From the health surveys, we can observe an individual's health status when they are about 40 years old. As previous research suggests that better nutrition early in life decreases the later incidence of obesity, high blood pressure and cardiac risk (see, e.g., Hoynes, Schanzenbach, and Almond, 2015), we include several health measures related to 'metabolic syndrome,' including obesity and hypertension. An individual is defined as obese by the age of 40 if his or her body mass index (BMI) is higher than 30. Hypertension is a chronic medical condition in which the blood pressure in the arteries is elevated. We define an individual as having high blood pressure (hypertension) if both the systolic blood pressure is above 140 mmHg and the diastolic blood pressure is above 90 mmHg. High blood pressure is predictive of heart disease, heart failure, stroke and kidney failure. In addition, we use two measures for risky biomarkers: cholesterol risk and cardiac risk. Furthermore, adult height is sensitive to nutrition and health in childhood. In particular, the period from birth to age three is critical to adult height (see, e.g., Deaton, 2007; Rivera, Martorell, Ruel, Habicht, and Haas, 1995). Therefore, we include height in centimeters among our health measures.

Because of the large number of health outcome variables, we follow Kling, Liebman, and Katz (2007) and aggregate the variables relating to BMI, blood pressure, height, and cardiac and cholesterol risk into summary standardized indices. As discussed by Kling et al. (2007), this improves statistical power. The summary health index is an average across standardized z-score measures of each health outcome. The z-score is calculated by subtracting the mean and dividing by the standard deviation. In particular, we follow Hoynes, Schanzenbach, and Almond (2015) and mimic Kling, Liebman, and Katz (2007)'s approach for a quasi-experimental setting by using the mean and standard deviation of the cohorts born before the rollout of the mother and child health care centers began. Most components of the health index are 'bads' (e.g. obesity, hypertension and cardiac risk).[11] Hence, a decrease in the health index indicates an increase in overall health at age 40.

3.5 Sample Selection

For our analysis, we include data for cohorts born between 1936 and 1960 in Norway who were still alive in 1967. Individuals born outside of Norway are excluded because our identification strategy relies on knowing the municipality of birth. We do not impose any further sample restrictions, although some individuals with missing information on outcome variables naturally drop out. For

[10]Black, Devereux, and Salvanes (2012) provide a more detailed description of the dataset and of the representativeness of the sample of respondents.

[11]Adult height is the only outcome included in the index that is not a 'bad' and it therefore enters the health index negatively.

lifetime earnings (the average of earnings between 1967 and 2010), we have observations for all individuals, whereas for years of education we are missing information for 12.8 percent of the sample. For missing observations on background characteristics, we include a dummy variable indicating that the variable is missing to keep the sample constant across the specification with and without control variables. Table 1 contains the summary statistics of the various outcomes and control variables.

4 Identification Strategy

Our identification strategy aims at overcoming the inherent endogeneity between health care access, health and adult outcomes. We use the variation in exposure to infant health care services driven by mother and child health care center openings, and the scope of the services provided. We use a differences-in-differences setup, exploiting the rollout of newly established mother and child health care centers across municipalities over time. In particular, we estimate the following reduced form model:

$$y_{ict} = \alpha + \gamma D_{ct} + \beta X_{ict} + \lambda_c + \theta_t + \rho_c t + \varepsilon_{ict}, \qquad (1)$$

where y_{ict} are the outcomes of interest for individual i born in municipality c at time t. D_{ct} is an indicator variable equal to one if an individual is born in the year of, or after, the center opening in their municipality of birth, and zero otherwise. X_{ict} is a set of individual characteristics including gender and birth order, and parental background characteristics (mother's education, age and marital status and father's education and age) and municipality-specific characteristics (inhabitants per doctor at year of birth and student–teacher ratio at the time of school enrollment). λ is a set of municipality fixed effects and θ is a set of cohort fixed effects. Hence, common time shocks are controlled for by the year fixed effects, and unobservable determinants of the long-term outcomes, which are fixed at the municipality level, are absorbed by the municipality fixed effects. To distinguish the effect of an opening from differential secular trends, we allow for linear municipality-specific time trends. ρ_c is the coefficient of a municipality-specific time trend multiplied with a linear time trend variable, t. The variable of interest is γ, which shows the effect of the access to well-child visits on various outcomes, including schooling, earnings and health. As we are including municipality-specific time trends, the identification of γ is determined by whether a center opening led to deviations from a preexisting linear municipality-specific time trend.

Our empirical strategy uses variations in when and where mother and child health care centers were established to evaluate their effects on long-term economic outcomes. Hence, we assume that the timing of an opening of a mother and child health care center is uncorrelated with other determinants of changes in long-term economic outcomes. As an empirical test for the key identifying assumption, we analyze whether the demographics from 1930 for municipalities that received a center can predict when centers would be established. Table 2 (Columns (i)–(iii)) shows that most of the municipality characteristics in 1930 fail to predict the opening dates of centers. The exceptions are an indicator variable for urban areas, a municipality's population, and the inhabitants per doctor. Hence, more densely populated places and municipalities with more inhabitants per doctor were more likely to establish mother and child health care centers very early. These are classical supply-side-driven factors. Therefore, we include the number of inhabitants per doctor in the year of birth in the municipality of birth in our specification and exclude individuals born in the two largest cities (Oslo and Bergen) from our sample in our baseline specifications. In addition, we analyze whether changes in the demographics of municipalities from 1930 to 1946 can predict when a center would be established. The results are presented in Columns (iv)–(vi) of Table 2.[12] There does not appear to be a significant correlation between the timing of the centers opening and changes in municipality demographics from 1930 to 1946. Importantly, the rollout of infant health care centers does not seem to be significantly correlated with background variables including average schooling, income in a municipality and infant mortality rates, which could be important predictors of our main outcome. Although imprecisely estimated, the coefficients in Table 2 are relatively large. Hence, the concern remains that nonrandom migration might change the composition of people in the municipality over time or that the location choice might be endogenous. Therefore, as well as including municipality-specific time trends, we estimate specifications including sibling fixed effects, as follows:

$$y_{ict} = \alpha + \gamma D_{ct} + \beta X_{ict} + \lambda_c + \theta_t + \eta_f + \varepsilon_{ict}, \tag{2}$$

where η is a set of family fixed effects. Then, variation is based on differences in access to the health care centers between children within the same families, thereby differentiating out any factors that are constant within families.

As we are not able to observe the factors that influence opening decisions and the exact location of a new mother and child health care center, it is of particular concern whether mother and child health care centers are influenced by preopening trends; for example, whether centers are established in municipalities where the education level is increasing. Therefore, we test for the existence of preopening trends as a function of the future opening of a center. We use the following event-study specification: (see, e.g., Jacobson, LaLonde, and Sullivan, 1993; Autor, 2003; Bailey and Goodman-Bacon, 2015):[13]

$$y_{ict} = \alpha + \sum_{\tau=0}^{m} \delta_{-\tau} D_{c,t-\tau} + \sum_{\pi=1}^{q} \delta_{+\tau} D_{c,t+\tau} + \beta X_{ict} + \lambda_c + \theta_t + \varepsilon_{ict}, \tag{3}$$

The specification allows for m post-treatment effects $(\delta_{-1}, \delta_{-2}, ..., \delta_{-m})$ and q anticipatory effects

[12] As income is not included in the 1946 Census questionnaire, changes in the average income in a municipality cannot be considered.

[13] The specification is also known as a Granger causality test.

$(\delta_{+1}, \delta_{+2}, ..., \delta_{+q})$ and it enables us to test whether contemporaneous and lagged values of the center openings predict the outcome variables, whereas lead values do not. In addition, the pattern of lagged effects is of interest, as it shows whether the causal effects grow or fade over time.

A further potential methodological issue is the presence of measurement error in our treatment measure. We consider centers operated by the NKS and, although this includes the majority of centers in Norway in the period of interest, it may not cover all centers in every year, as similar centers could have been established by other private or philanthropic initiatives. Thus, it is possible that there are health care centers providing well-child visits that we do not observe in our data. The fact that some municipalities received greater well-child treatment than indicated by our data should attenuate our results. Therefore, in our main sample, we only include municipalities that eventually opened an NKS-run mother and child health care center. We provide some additional analysis including the municipalities that did not have an NKS health care center by 1960.

5 Empirical Results

5.1 Long-Term Effects on Education and Earnings

The results presented in this section suggest that the access to mother and child health care centers had substantial long-term consequences. Table 3 presents the baseline estimates of the effect of access to a mother and child health care center on education and earnings using Equation (1). The main sample includes only individuals born in municipalities where an NKS-run center was opened between 1936 and 1955. In Column (i), we show the average pre-reform values. In Column (ii), we present the estimates for the effect on completed years of education and average discounted earnings from 1967–2010 and for individuals between age 31 and 50. The specification includes a dummy variable indicating the gender of the individual, an individual's birth order and background characteristics of the parents, such as the mother's education, age and marital status and the father's education and age. Moreover, a full set of municipality and cohort fixed effects are included, as well as the municipality-specific variables, the number of inhabitants per doctor in the municipality of birth in the year of birth and the student–teacher ratio in the municipality of birth in the year of school enrollment. The specification in Column (iii) does not include any individual or municipality-specific control variables, whereas the sample in Column (iv) includes individuals born in municipalities where no NKS-run center was opened between 1936 and 1955.[14] Each cell in Table 3 comes from a separate regression. Because education and earnings are likely to be serially correlated within municipalities over time, all standard errors are clustered at the

[14] As discussed in Section 4, we consider only mother and child health care centers operated by the NKS. Although the NKS operated the majority of mother and child health care centers in Norway until the late 1960s, similar centers were established by other private or philanthropic initiatives in municipalities without an NKS health care center. We know the location of the non-NKS centers in 1960 but not their opening dates. Hence, some municipalities without an NKS health care center received more well-child treatments than indicated by our data.

municipality level.

The first row of Table 3 shows estimates of γ in Equation (1) for the completed years of education. Across different specifications and samples, the estimated coefficients show a consistent positive effect of the access to a mother and child health care center on the completed years of education. More specifically, having access to well-child visits in the first year of life increases education by 0.15 years. The estimates are all statistically significantly different from zero at the one percent level and they are sizable in magnitude. As the average years of education for the cohorts born before the opening of a center was 10.5 years, the effect of access to well-child visits amounts to an increase in education of about 1.4 percent. There are several reasons why mother and child health care centers could lead to increased educational attainment. First, there could be a direct biological effect of health on cognitive ability. Second, children may miss less school due to poor health. Third, there could be a parental response to the improved infant health. That is, parents may reinforce the positive health shock by investing more in their children. We will investigate these channels more in Section 6. The subsequent rows of Table 3 show estimates of γ in Equation (1) for average discounted earnings from 1967 to 2010 and earnings between age 31 and 50. The first measure utilizes all years of earnings from the data, whereas the last measure involves a constant measure across the age range. We find a significantly positive effect of the access to mother and child health care centers on earnings. More specifically, having access to well-child visits in the first year of life increases adult earnings by about two percent compared with the pre-reform cohorts.

When dropping the control variables in Column (iii), the estimated effects are slightly higher for all outcome measures. However, they are never statistically different from the baseline effect. The estimated effects in Column (iv), where we also include individuals born in municipalities where the NKS did not open a center until 1960, are similar to the baseline in Column (ii).

It is important to note that the estimates in Table 3 are intent-to-treat estimates. That is, these estimates average across individuals with a higher and lower likelihood of receiving care at a mother and child health care center. Not all mothers took their newborns to a mother and child health care center. The uptake two to three years after a center opening was about 60 percent, on average. Hence, to convert our estimates to the treatment on the treated, one should divide the estimated effects by 0.6.

5.2 Sensitivity Analysis

We present a variety of sensitivity analyses. First, we use methods to control for differences in preprogram time trends in municipalities that received or did not receive a center. Second, we exclude the birth cohorts born during World War II. Third, we control for a country-wide school reform affecting cohorts born between 1946 and 1961. Last, we use infant mortality to compute a lower bound for our estimates on education.

As pointed out above, we try to distinguish the effect of an opening from differential secular trends by including municipality-specific time trends. In addition, we consider two alternative specifications: first, we test for the existence of preopening trends with an event-study framework and second, we use quadratic and cubic municipality-specific time trends.

Figure 4 plots event-study estimates as well as the 90 percent and 95 percent confidence intervals from Equation 3 for (a) education and (b) earnings, and includes municipality and cohort fixed effects and a vector of control variables. The results provide no evidence of a differential trend in either education or earnings in treated municipalities before the centers were opened. The estimates of the preopening effects are relatively small in magnitude and not statistically different from zero at the 5 percent significance level. In the year following the opening of a mother and child health care center, education and earnings increase and all effects are statistically significant at the 5 percent significance level (except for earnings in year four after a center opening).

When adding quadratic and cubic municipality-specific time trends, the identification of the effects of access to well-child visits comes from whether such an opening leads to deviations from preexisting quadratic or cubic municipality-specific time trends. Table 4 (Columns (ii) and (iii)) shows that the effect of the access to better infant care remains apparent and significant for both education and earnings when using quadratic or cubic municipality-specific time trends. However, the effects are slightly smaller for the quadratic time trends. When including cubic time trends, the effects are almost the same for the education outcome and slightly larger for the earnings outcomes. Thus, differences in time trends are not driving the effect of the center openings on education and earnings.

The period we analyze in our baseline specification includes World War II. Norway was occupied by Nazi Germany from April 1940 until May 1945. Areas most affected by the acts of war and the occupation were the bigger cities, including Oslo, Bergen, Trondheim, Stavanger and Kristiansand, and points of strategic interest, including Narvik. Norway incurred a low number of fatalities compared with other European nations, but basic commodities, including food, were scarce during the war.[15] Thus, cohorts born during the war may differ from pre- and postwar cohorts. Thus, as a robustness test, we exclude cohorts born in the years 1940 to 1944.[16] The results are presented in Column (iv) of Table 4. The estimated effects are slightly larger for the education outcome and slightly smaller for the earnings outcomes when the five cohorts born during World War II are excluded.

In 1959, the Norwegian Parliament passed a law on mandatory schooling, which extended the number of compulsory years of schooling from seven years to nine years. The reform was gradually implemented across the country over the years 1960 to 1972. Hence, the cohorts born between

[15]Norway did not suffer from hunger episodes during World War II and the Nazi occupation, in contrast to The Netherlands and France, for example.

[16]It is important to note that the NKS mother and child health care centers remained operative during the Nazi occupation of Norway.

1946 and 1961 were affected by this school reform (for a detailed description of the school reform, see Black, Devereux, and Salvanes, 2005).[17] As several cohorts in our sample are exposed both to the health care center openings and the school reform, we include an indicator variable equal to one when an individual's birth cohort in the municipality of birth was affected by the school reform. The results are presented in Column (v) of Table 4. When controlling for the exposure to the school reform, the estimated effects are in line with the baseline results.

We do not observe adult outcomes of individuals who do not survive until 1967. Thus, our sample of individuals might be altered as a result of reductions in infant mortality caused by the policy we analyze. As shown by Wüst (2012), infant mortality decreased as a result of a home-visiting program in Denmark that was rolled out from 1937 to 1949. More precisely, Wüst (2012) finds a positive effect on infant survival rates of almost one percent. Moreover, when comparing the number of individuals born in each municipality from 1936 to 1960 and the number of individuals we observe in our education and earnings data, we find that the opening of a mother and child health care center may have led to a four percent decrease in the number of individuals who did not reach the sample age where we observe adult outcomes. These findings have two implications for the long-term effects we observe. First, there might be a 'selection effect' as lower infant mortality may lead to a larger number of unhealthy survivors. This would lead to a downward bias in our estimates. Second, when infant mortality is seen as a proxy for the general disease environment (see Bozzoli, Deaton, and Quintana-Domeque, 2009), lower infant mortality should be associated with better health. Hence, this 'scarring effect' indicates that the health of the survivors generally improved. As described by Hatton (2011), the scarring effect may have been more important in Europe in the early 20th century than the selection effect. Therefore, we estimate lower bounds for the effect of center openings on education.

We assume that the short-term effect on infant mortality rates of the mother and child health care centers are comparable to the estimated reduction in infant mortality after the introduction of the Danish home-visiting program (Wüst, 2012). Therefore, we drop one percent of the treatment group at different percentiles of the education distribution and re-estimate Equation 3. In addition, to account for mortality past the first year of life, we drop four percent of the treatment group at different percentiles of the education distribution. As shown in Table 5, dropping one or four percent of the treatment group at the 60th, 70th, 80th, 90th or the top percentile of the predicted education distribution does not substantially alter our findings. The estimated effect is fairly stable and statistically significant in all subsamples.

5.3 Mother-Specific Fixed Effects

Table 6 displays the results for Equation 2, which includes mother-specific fixed effects. That is, our effect is identified by comparing infants exposed to mother and child health care centers with

[17] The most affected cohorts are the birth cohorts 1951, 1952 and 1953.

their older siblings who had no center access.[18] The estimates of γ from Equation 2 are smaller than the estimates from Equation 1 for the education outcome, but they remain significant. More specifically, access to well-child visits increased the years of education by 0.9 percent. On the other hand, the estimates are larger for the earnings outcomes and indicate that access to well-child visits increased the earnings by two to three percent. There are several possible reasons why the estimates from the mother-specific fixed effects estimation could be different. First, families with more than one child might differ from families with only one child. When limiting the sample to the individuals who had at least one sibling in the sample and estimating Equation 1 (see Column (iii)), the estimates of γ are slightly smaller for the education outcome than for the baseline specification in Table 3. Second, positive spillovers from the center visit by the youngest sibling to the older siblings might attenuate the estimated effects. Last, if positive health shocks are reinforced by parental investment, the estimated coefficients might be larger when family fixed effects are included. We will discuss this further when we consider likely mechanisms in Section 6.

5.4 Heterogeneity by Gender, Family Background and Municipality Health Status

As labor market chances for men and women in the cohorts under consideration were different, we consider heterogeneous effects by gender. In Panel A of Table 7, we present the main results by gender. In the baseline specification, we find that the effects on education are statistically significant for both genders, but larger for men. Again, the effects on lifetime earnings are mostly statistically significant for men and women and larger for men. However, the differences in effects for men and women are not significant. Therefore, we conclude that the program of center openings was important for both men and women.

As mentioned in Section 2, the mother and child health care centers were mainly targeted at poor families. We have information on the fathers' education and use this as a proxy for socioeconomic background.[19] To analyze whether children with a low socioeconomic background benefitted more from these health care centers, we present the baseline results separately for individuals whose fathers had some high school education and for individuals whose fathers had no high school education. The results are displayed in Panel B of Table 7. For years of education and earnings from 1967 to 2010, the effects are significantly larger, at the 5 percent and 1 percent significance levels, for the subsample for which the father had not completed high school.

The benefits from mother and child health care centers might also differ by the health status of each municipality. Unfortunately, health indicators at the municipality level are very scarce for the 1930s. One available health indicator at the municipality level is the proportion of inhabitants infected with tuberculosis. Norway had one of Europe's highest tuberculosis rates in the early 20th

[18]We observe no municipalities where all mother and child health care centers were closed in the period of interest. However, we observe that some municipalities merged their centers when traveling time and costs decreased.

[19]As there is little variation in mothers' education, we focus on fathers' education.

century (Blom, 1998). To promote the fight against tuberculosis, registration of new tuberculosis cases became mandatory in 1900 and these data are published in Statistics Norway's yearly health statistics at the municipality level. Active tuberculosis is closely linked to overcrowding, malnutrition and compromised immune systems. Hence, we use the tuberculosis infection rate as a proxy for the overall health status in a municipality. In Panel C of Table 7, we split our sample into individuals born in municipalities with above- and below-median tuberculosis infection rates.[20] The results show that the effects are significantly larger (at the 5 percent significance level) for individuals living in municipalities with above-median tuberculosis infection rates.

In a further step, we aim to examine the role of the mother and child health care centers in shaping intergenerational mobility. We follow Pekkarinen, Uusitalo, and Kerr (2009) and estimate the effect of the health care center openings on the persistence of educational attainment across generations. We use a specification relating the completed years of education of the son or the daughter to the completed years of education of the father $EDUF_{ict}$, interacted with D_{ct}, an indicator variable equal to one if an individual is born in or after the year of a center opening in the municipality of birth, and zero otherwise, and a full set of interactions between municipality and cohort dummies and the father's years of education $EDUF_{ict}$:

$$\begin{aligned} Y_{ict} = \alpha + \mu EDUF_{ict} + \eta EDUF_{ict} D_{ct} + \beta X_{ict} + \\ \phi EDUF_{ict} X_{ict} + \tau_c EDUF_{ict} + \delta_t EDUF_{ict} + \varepsilon_{ict}. \end{aligned} \tag{4}$$

We identify the effect of the health care center openings on the persistence of educational attainment across generations from the changes in the effect of the father's education occurring at the time of the center opening. Table 8 shows how the intergenerational persistence in educational attainment varies with access to the health care centers. For men, the coefficient of the interaction term of interest is –0.044, indicating that the intergenerational persistence of educational attainment is lower for individuals exposed to mother and child health care centers. The estimate is statistically significant at the 10 percent significance level. This represents a 10 percent reduction in the persistence of educational attainment across generations compared with the pre-reform level of 0.450. This finding suggests that access to mother and child health care centers significantly enhances intergenerational education mobility for boys. For women, the coefficient of the interaction term of interest is negative, but not statistically significant at the 10 percent significance level.

6 Suggestive Mechanisms

As described in Section 2, well-child visits at mother and child health care centers had two main components: first, medical check-ups for infants and second, advice to mothers on adequate infant

[20] Note that 55 percent of the individuals with a father without high school education live in a municipality with high tuberculosis infection rates.

care and nutrition. To obtain an idea of the importance of better health during the first year of life, we study whether effects are larger for individuals in municipalities with centers that provided a larger variety of health care services and we examine whether there are effects on different health outcomes that are potentially caused by malnutrition early in life. In particular, effects on height are important, as height is likely to be determined early in life (see, e.g., Case and Paxson, 2010). We cannot rule out that other health effects at age 40 can be explained by more education and higher labor market incomes. However, studies causally estimating the effects of education on health find that education has little or no effect on health (see, e.g., Clark and Royer, 2013).

The mother and child health care centers may have contributed to a decrease in malnutrition by providing mothers with nutritional advice and by promoting breastfeeding. There are specific mechanisms by which childhood nutrition affects long-term health outcomes. For example, malnutrition among children may lead to diseases such as anemia and may change the developmental trajectory of a child's body. Based on early-life periods of malnutrition, an infant's body may predict future malnutrition episodes and adapt its development to better handle these expected episodes even if they do not arise (see Gluckman and Hanson, 2004). Even if there are no hunger episodes later in life, health problems may arise. For example, Barker (1992) shows that poor nutrition in early life may impair development and that it increases the incidence of so-called metabolic disorders, such as high blood pressure, type II diabetes, obesity and cardiovascular diseases. Furthermore, adult height is a marker of early life health and nutrition. Case and Paxson (2010) state that adult height depends on a combination of factors, including genes, environmental conditions (particularly malnutrition and illness) and gene–environment interactions. Nutrition in the period from birth to age three is an important determinant of adult height.[21] Growth is most rapid during the first three years and nutritional needs are greatest during this period. Gastrointestinal infections during this period may substantially impair growth (Crimmins and Finch, 2006).

Therefore, we examine the effect on adult health and height of the establishment of mother and child health care centers, which may have improved nutrition for infants and lowered their probability of suffering gastrointestinal diseases.[22] If the nutrition channel is an important mechanism, we expect that infants who were exposed to a center after birth would be less likely to have maladapted to future expected episodes of malnutrition. Thus, we presume that these individuals would experience a lower incidence of obesity, high blood pressure and cardiac events by the age of 40. While the age of 40 may be rather early to measure cardiac events or hypertension, obesity serves as a good indicator of an increased risk of health problems related to the metabolic syn-

[21] Rivera, Martorell, Ruel, Habicht, and Haas (1995) examine the effect of a randomized early childhood nutritional intervention in rural Guatemala during 1969–1977 on health outcomes and find that treated individuals were taller, weighed more and had greater fat-free masses than control subjects at ages 16 to 18.

[22] In the context of developing countries, there is evidence that information campaigns about oral rehydration therapy for infants suffering from diarrhea decreased infant diarrhea-related deaths dramatically (Levine, Group, and Kinder, 2004), and that campaigns promoting hand washing with soap led to a sustained reduction in diarrhea episodes (Wilson and Chandler, 1993).

drome. In addition, we expect that infants who were exposed to a center after birth will be taller on average.

Table 9 displays the effect of a center opening on the health index described in Section 3.4 and a set of different health outcomes. We find a significant effect on the health index and several health outcomes for men and women.[23] The effect of access to a mother and child health care center is –0.286 for men and –0.172 for women and is statistically significant at the one percent level for men and the five percent level for women. The magnitude of the coefficient implies that health care center access reduces the index for bad health by almost 0.19 to 0.29 standard deviations. In addition, men exposed to a mother and child health care center as an infant have significantly lower BMIs and blood pressure, a significantly lower probability of being obese or having hypertension, a significantly lower cholesterol risk at the age of 40 and are taller. For women, we find a significant health improvement in terms of height. The larger effects for men are in line with the main results presented above and with previous evidence that boys are affected more than girls by adverse events in utero and early life (see, e.g., Almond and Currie, 2011). In addition, our results correspond with Hjort, Sølvsten, and Wüst (2014), who show that postnatal care positively affects heart health. In particular, they find that infants who had access to a universal home-visiting program in Denmark in the 1930s were less likely to be diagnosed with cardiovascular diseases in adulthood or to die from cardiovascular or heart disease in middle age.

The Norwegian mother and child health care centers varied in terms of the health services they offered. From the yearly reports, we are able to evaluate two different forms of extra health care services offered by some centers, namely testing for tuberculosis and immunization. Early detection of tuberculosis is instrumental in successful treatment and helps hinder the spread of the disease. Hence, testing infants for tuberculosis could have important long-term consequences. Vaccinations offered by the health care centers included small pox vaccines and, later, diphtheria vaccines. The previous literature presents evidence that protecting children from infectious diseases potentially has positive effects on cognitive ability.[24] Therefore, access to immunization may be an important contribution of the mother and child health care centers. Hence, we expect that the centers offering the extended health care services would have a larger positive health impact.[25] Table 10 analyzes

[23] In addition, we plot event-study estimates and the 90 percent and 95 percent confidence intervals in Figure 5 from Equation 3 for (a) the health index and (b) height. The event-study models support the validity of the research design.

[24] For instance, Bloom, Canning, and Shenoy (2012) use data from vaccination programs in the Philippines and show that childhood vaccinations for measles, polio, tuberculosis, diphtheria and pertussis significantly increase cognitive test scores.

[25] As discussed in Section 4, we use the variation in when and where mother and child health care centers with extended medical services were established to identify the effects of interest. We apply the same empirical test as in Section 4 for the key identifying assumption and analyze whether 1930 demographics or changes in demographic characteristics between 1930 and 1946 in municipalities establishing a center that offered extra health care services may predict when such a center was established. We find very similar results as in Table 2. Importantly, we find that the rollout of infant health care centers with extra services does not seem to be correlated with background variables including average schooling and income in municipalities. Results are available on request.

the effect of the opening of a center offering extended health care services. We find that such centers had larger effects on education and earnings. However, the differences are not significant. Nevertheless, these results indicate that the extra services of tuberculosis testing and vaccination, provided in addition to the nutritional advice, may have been important and contributed to the positive long-term effects on economic outcomes arising from access to well-child visits.

In addition to the direct effects from better health care during the first year of life, indirect mechanisms may explain the effects of the centers on education and earnings. If children are healthier during adolescence, they might miss less school and therefore achieve better long-term school outcomes. A further indirect mechanism is changes in parental behavior in response to access to the health care centers—for example, changes in relation to fertility choices and application of nutritional knowledge to other family members—with these changes either reinforcing or counteracting the direct effects of the program. We analyze some of these indirect mechanisms. First, we use data on missed school days at the municipality level for the years 1940–1950.[26] The results are presented in Table 11 and show that access to mother and child health care centers did not significantly affect the number of missed school days owing to sickness. Testing the behavioral responses of parents is difficult (see, e.g. Almond and Mazumder, 2013), as a second source of exogenous variation is needed to identify the exact mechanisms. However, we can provide two tests for parental behavior. First, we test whether a mother's completed fertility changes when her children have access to mother and child health care centers. The number of children a woman has is an important family choice and a determinant of children's outcomes. Second, we study spillovers to older siblings to analyze whether mothers acquire general knowledge at a mother and child health care center that is not age specific but useful to all children in the family. The effect of access to a mother and child health care center on mothers' fertility is shown in Table 11. Mothers did not change their fertility when gaining access to mother and child health care centers for their children. In addition, Column (iv) of Table 6 shows that any changes in parental behavior as a response to the health care center openings is child-age specific (including breastfeeding and nutrition within the first year of life). In particular, we find that completed years of education and the incomes of older siblings of infants exposed to mother and child health care centers are not affected by the health care center openings. These findings support the fact that the provision of information about proper infant nutrition is an important mechanism for our findings of the positive economic effects of the centers.

7 Discussion

In this section, we link our results to the previous literature and provide a simple cost–benefit analysis.

[26]As the number of missing school days are no longer recorded in Statistics Norway's yearly school statistics after 1950, this test only includes the birth cohorts from 1936 to 1944.

7.1 Comparison with Previous Studies

As this is the first paper, to our knowledge, that measures the long-term economic consequences for infants of access to mother and child health care centers, it is not straightforward to compare our results to the existing literature. However, we can compare our results with other studies analyzing the long-term effects of various policy-induced variations in early-life health.

First, Chay, Guryan, and Mazumder (2009) examine a somewhat related increase in infant health care by looking at the hospital integration that occurred in the South of the United States in the 1960s. They show that a black child who gained hospital admission as an infant experienced a 0.75 to 0.95 standard deviation increase in the Armed Forces Qualifying Test score. Our estimated effect on years of education is smaller, at about 0.2 standard deviations. As IQ tests and education are not perfectly correlated, a direct comparison is difficult. Second, our results indicate that nutritional advice for mothers and promotion of breastfeeding may have played an important role in the positive economic effects of the centers. The estimates found in this paper are mostly smaller in magnitude but still comparable to those found in existing studies of policy changes and interventions that increased breastfeeding or improved early life nutrition. In a randomized breastfeeding promotion intervention in Belarus, Kramer, Aboud, Mironova, and et al. (2008) find that cognitive ability at age 6.5 years is increased by about one standard deviation if the infant was in the treatment group. As we look at outcomes more than 20 to 40 years later in life, it is not surprising that our effects on education are substantially smaller. Paid maternity leave might also increase breastfeeding rates. In the context of Norway, Carneiro, Løken, and Salvanes (2015) examine the impact on children of the introduction of four months of paid maternity leave in 1977. They find that children's educational attainment increases by 0.4 years and earnings at age 30 increase by five percent. Again, our effects are smaller. However, as the take-up rates in their paper are close to 100 percent, whereas the take-up rate for the health care centers was around 60 percent, the estimated treatment effects on the treated group are quite similar between their paper and ours. Finally, when analyzing the health effects of early access to food stamps, Hoynes, Schanzenbach, and Almond (2015) find an increase in the likelihood of metabolic syndrome that is mostly driven by obesity. This finding matches well with our results for male health outcomes at age 40.

7.2 Cost–Benefit Analysis

In this section, we study whether the benefits of introducing universal well-child visits outweigh the costs of the program.[27] The costs are incurred when the children are zero to one year old, whereas the benefits in terms of earnings arise only when the children enter the labor market as adults. We have very direct measures of costs based on direct data collection on costs per child

[27] We will build on the assumptions made in Fredriksson, Öckert, and Oosterbeek (2013), who calculates the cost–benefit of reducing class size.

and per consultation from the NKS archives. These are available for all health care centers for the years 1938, 1941 and 1948. We assume that these reflect the costs for the whole period of study and calculate the average costs across the three years. Adjusting for inflation, the costs per child in 2014 are USD 22 per child (USD 6 per consultation). Note that this is the present value of costs because costs occur only at the start of the child's life. To calculate benefits, we need to make some assumptions. We assume that people work from age 21 to 65 and that average annual earnings from ages 31 to 50 reflect the average annual lifetime earnings. Then, the present value of the benefits is given by $\sum_{t=21}^{65} \frac{0.027w}{(1+r)^t}$, where 0.027 is the program effect on earnings of the treated group and w is average annual earnings. Then, the internal rate of return (IRR), which is the discount rate that equalizes the present values of costs and benefits, is 0.084. This exercise assumes that the supply of more skilled labor (a more highly educated labor force) does not affect the earnings return to the well-child program. The IRR will be lower if this assumption does not hold. Under the extreme assumptions that the costs are doubled and the benefits halved, the IRR would be 0.050, which is still a reasonably high return.[28] Finally, we have only included the returns related to higher wages in the labor market. There may be additional benefits from the effects of the program on education and health and also effects on the next generation, which are excluded from this cost–benefit analysis. We conclude that, given these conservative assumptions, this program passes a cost–benefit analysis in the context that we study.

8 Conclusion

In this paper, we present evidence that access to well-child visits for infants can significantly improve long-term economic outcomes. Our study analyzes the rollout of mother and child health care centers in Norway that commenced in the 1930s. We find that access to free well-child visits in the first year of life leads to a significant increase in education and lifetime earnings and reduces health risks at the age of 40. The effects are stronger for children from low socioeconomic backgrounds and we find a significant reduction in the intergenerational persistence in educational attainment levels. These results pass several robustness tests, including controlling for municipality-specific time trends, mother-specific fixed effects and event-study models. In general, the results imply that improved infant health has long-term effects on human capital accumulation, labor market success and adult health.

An important strength of our analysis is, at the same time, a drawback because, to study the long-term effects of well-child visits, we need to study reforms that happened a long time ago.

[28]The current cost for health care centers and other health services for children in 2014 was USD 288 per child. This is substantially more than the costs of the health stations between 1936 and 1955. However, the services provided today include more visits, all childhood vaccines and health care services that are technically much more advanced than those provided before 1960. Using current costs and a proxy of current benefits based on the program effect on earnings from the subsample that had access to extra services, including smallpox vaccination (where the program effect on earnings was 0.048), yields an IRR of 0.037.

Today's health situation for infants in the developed world is dramatically different. This makes it difficult to generalize our results to current policies (see Ludwig and Miller, 2007, for a discussion). However, we note that the infant mortality rates in Norway in the 1930s and 1940s are comparable to the rates in developing countries today and that infectious diseases and diarrhea are main causes of death in the first year of life in developing countries as it was in Norway in the study period.[29] Therefore, it is likely that infants in developing countries would benefit from well-child visits in the long run.

[29] In 1930, 44.9 out of 1000 infants born alive died within their first year of life in Norway (Backer, 1963). This number is comparable to the 2014 values from countries including Ghana, Malawi and Timor-Leste (You, 2015).

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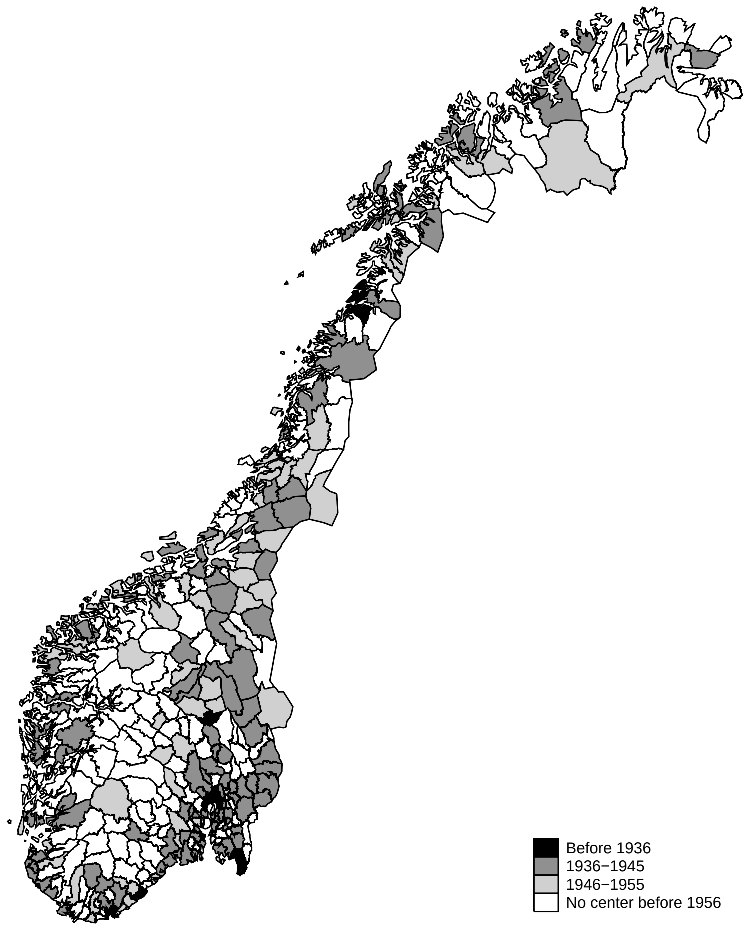
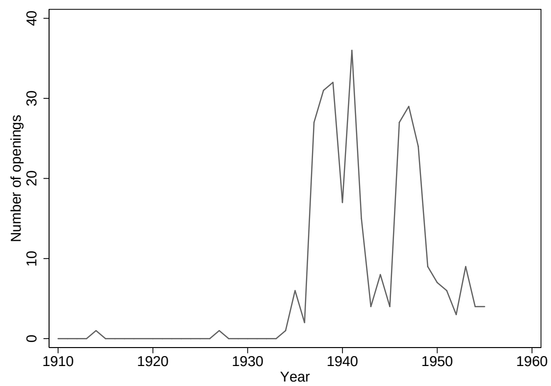
9 Tables and Figures

Figure 1: Rollout of Mother and Child Health Care Centers



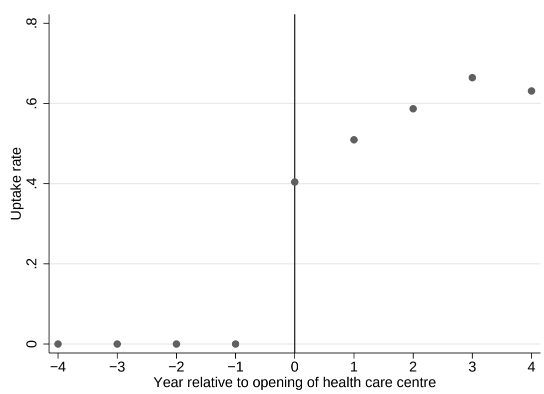
Notes: The map displays Norway's 428 municipalities. The different colors indicate when the first NKS mother and child health care center was opened in these municipalities. In the red municipalities, a health care center was opened before 1936. In the blue municipalities, a health care center was opened between 1936 and 1945. In the green municipalities, a health care center was opened between 1936 and 1955. There were no NKS mother and child health care centers opened in the white municipalities in the period of interest.

Figure 2: Number of Openings per Year



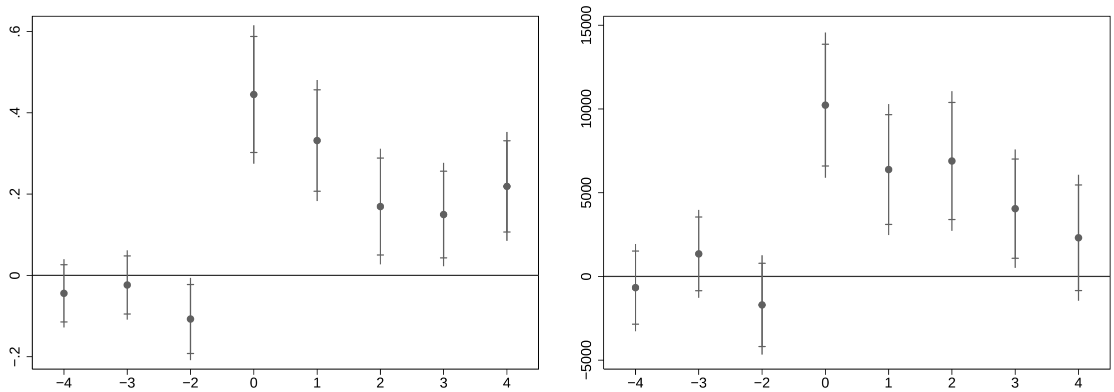
Notes: The figure displays in how many municipalities a mother and child health care center was opened in each year between 1910 and 1955. Centers that were placed in municipalities with an already operating health care center are not included.

Figure 3: Uptake Relative to the Opening Years of Mother and Child Health Care Centers



Notes: The figure displays uptake rate of services at a mother and child health care center relative to the opening year of the health care center. In particular, the plotted numbers show what proportion of the children born in a municipality were registered as receiving care at a mother and child health care center in their municipality of birth.

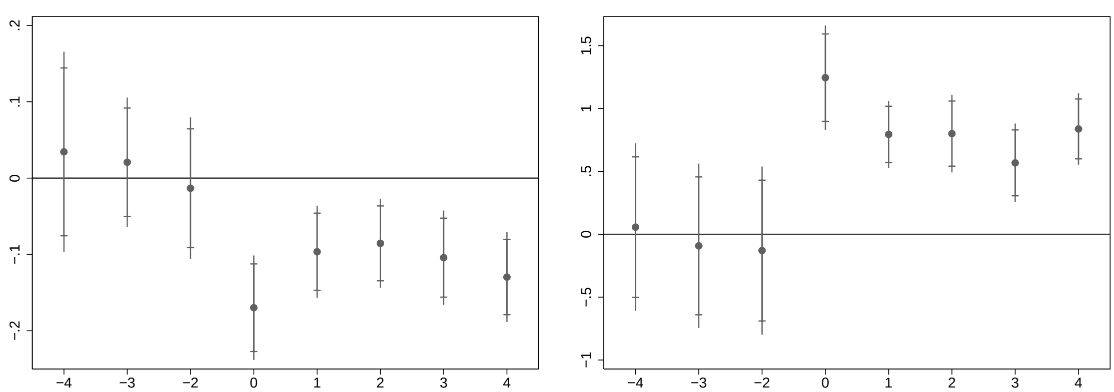
Figure 4: Event-Study Estimates of the Impact of Exposure to a Mother and Child Health Care Center on Education and Income



(a) Education (b) Income

Notes: The figures plot the post-treatment δ_τ and anticipatory effects δ_π from the event-study specification (Equation 3) as well as the 90 percent and 95 percent confidence intervals. The set of control variables includes municipality and cohort fixed effects and control variables, including mother's education, age and marital status and father's education, age and gender. Robust standard errors adjusted for clustering at the level of the municipality of birth are shown in parentheses. We include birth cohorts from 1936 to 1960. Health care centers opened from 1937 to 1955. Earnings presented are average discounted earnings from 1967 to 2010.

Figure 5: Event-Study Estimates of the Impact of Exposure to a Mother and Child Health Care Center on Health Outcomes



(a) Health Index (b) Height

Notes: The figures plot the post-treatment δ_τ and anticipatory effects δ_π from the event-study specification (Equation 3) as well as the 90 percent and 95 percent confidence intervals. The set of control variables includes municipality and cohort fixed effects and control variables, including mother's education, age and marital status and father's education, age and gender. Robust standard errors adjusted for clustering at the level of the municipality of birth are shown in parentheses. We include the birth cohorts from 1936 to 1960. Health care centers opened from 1937 to 1955. Earnings presented are average discounted earnings from 1967 to 2010.

Table 1: Descriptive Statistics

	Whole Sample	Men	Women
Outcomes			
Years of education	11.79	11.89	11.66
	(2.78)	(2.82)	(2.74)
Earnings 1967–2010	168,113	211,863	116,733
	(108,343)	(118,096)	(65,241)
Earnings ages 31–50	213,652	269,213	148,402
	(156,955)	(178,119)	(91,781)
Body mass index	25.18	25.85	24.51
	(3.71)	(3.29)	(3.98)
Blood pressure (systolic)	130.31	135.15	125.46
	(14.34)	(13.15)	(13.82)
Height	172.81	179.40	166.19
	(9.02)	(6.45)	(5.81)
Municipality-level controls			
Inhabitants per	0.064		
doctor	(0.276)		
Percentage with	0.022		
high school degree in 1930	(0.019)		
Percentage of with some	0.010		
high school education 1930	(0.043)		
Average income of men in 1930	1602		
(in 1930 NOK)	(751)		
Average income of women in 1930	683		
(in 1930 NOK)	(273)		
Urban area	0.122		
	(0.327)		
Population in 1000s	7.10		
	(11.2)		
Infant mortality rate in 1930	31.11		
(per 1000 live births)	(12.84)		
Tuberculosis infections	0.861		
per 100 inhabitants in 1930	(0.378)		
Number of observations	310,516	165,348	145,168

Table 2: Test of the Identifying Assumption: The Effect of Municipality Characteristics on the Timing of a Center Opening

	1930 Municipality Characteristics			**Changes in Municipality Characteristics (1930 to 1940)**		
	Opening before 1935	Opening 1935-1940	Opening 1940-1945	Opening before1935	Opening between 1935-1940	Opening 1940-1945
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
High school	-0.030	-0.377	-1.157	-0.154	-0.433	0.724
	(0.532)	(0.940)	(1.159)	(0.331)	(0.950)	(0.801)
Some high school education	-0.073	-0.287	0.049	0.158	-0.163	-0.358
	(0.137)	(0.419)	(0.516)	(0.154)	(0.441)	(0.371)
Income men	0.000	0.000	0.000			
	(0.000)	(0.000)	(0.042)			
Income women	-0.010	0.020	0.045			
	(0.045)	(0.136)	(0.168)			
Inhabitants per doctor	-0.006***	-0.020**	-0.018**	0.001	-0.007	0.001
	(0.002)	(0.007)	(0.009)	(0.003)	(0.007)	(0.006)
Inhabitants per midwife	0.006	0.014	0.025	0.005	0.001	0.003
	(0.004)	(0.013)	(0.017)	(0.004)	(0.002)	(0.006)
Urban	0.030	0.179***	0.147**	-0.000	-0.008	0.034
	(0.015)	(0.047)	(0.058)	(0.000)	(0.024)	(0.021)
Population	0.003***	0.002	0.002	-0.004	0.001	0.003
	(0.000)	(0.001)	(0.001)	(0.009)	(0.002)	(0.002)
Tuberculosis infection rate	0.006	-0.026	-0.048	-0.071	1.421	0.804
	(0.007)	(0.021)	(0.026)	(0.449)	(1.290)	(1.088)
Infant mortality rate	0.003	-0.024	-0.018	0.003	0.062	0.079
	(0.013)	(0.040)	(0.049)	(0.031)	(0.029)	(0.076)
Obs.	624	624	624	624	624	624

Significance levels: *** 1% level, ** 5% level, * 10% level

Notes: Each column represents a separate linear probability model of the likelihood of a center opening in a given period in relation to various municipality characteristics or changes in various municipality characteristics. The number of individuals with a high school degree and some high school education are taken from the 1930 and 1946 Censuses. The average earnings are taken from the 1930 Census, but the 1946 Census did not collect data on earnings. The number of doctors and midwifes, the population size and the tuberculosis infection rates are collected from Statistics Norway's yearly health statistics from 1930 and 1940. The infant mortality rate—the rate of children passing away within their first year of life—is collected from historic birth and death certificates in 1930 and 1936.

Table 3: Long-Term Effects of Access to a Mother and Child Health Care Center on Education and Earnings

	Mean prereform (i)	Baseline (ii)	No control variables (iii)	All municipalities (iv)
Years of education	10.53	0.149***	0.173***	0.158***
		(0.035)	(0.040)	(0.033)
Observations		310,516	310,516	484,444
Earnings 1967-2010	155,408	3673***	4821***	3551***
		(1189)	(1628)	(1172)
Observations		310,930	310,930	485,027
Earnings age 31-50	168,684	2644***	3888***	2721**
		(1204)	(1883)	(1207)
Observations		310,930	310,930	485,027

Significance Levels: *** 1% level, ** 5% level, * 10% level

Notes: Each parameter is from a separate regression of the outcome variable on access to a mother and child health care center. Robust standard errors adjusted for clustering at the level of the municipality of birth are shown in parentheses. We include birth cohorts from 1936 to 1960. Health care centers opened from 1937 to 1955. Earnings presented are average discounted earnings from 1967 to 2010. All specifications include a full set of cohort and municipality fixed effects. Additional control variables in Columns (ii) and (iv) are mother's education, age and marital status and father's education, age and gender, as well as birth order and the number of inhabitants per doctor.

Table 4: Robustness Test: Municipality-Specific Time Trends, World War II, and School Reform

		Municipality specific time trends			Controlling for school reform
	Baseline	Quadratic	Cubic	Excluding World War II	
	(i)	(ii)	(iii)	(iv)	(v)
Years of education	0.149***	0.108***	0.140***	0.161***	0.152***
	(0.035)	(0.37)	(0.040)	(0.038)	(0.035)
Observations	310,516	310,516	310,516	289,657	310,516
Earnings 1967-2010	3673***	2491**	3352***	2649***	3643***
	(1189)	(1200)	(1261)	(1343)	(1188)
Observations	310,930	310,930	310,930	290,061	310,930
Earnings ages 31-50	2644***	2509*	2974**	2467*	2724*
	(1204)	(1283)	(1321)	(1397)	(1214)
Observations	310,930	310,930	310,930	290,061	310,930

Significance levels: *** 1% level, ** 5% level, * 10% level

Notes: Each parameter is from a separate regression of the outcome variable on access to a mother and child health care center. Robust standard errors adjusted for clustering at the level of the municipality of birth are shown in parentheses. We include birth cohorts from 1936 to 1960 in Columns (i), (ii), (iii) and (v). Column (iv) includes birth cohorts from 1936 to 1939 and birth cohorts from 1945 to 1960; cohorts born during the Nazi occupation of Norway are excluded. Health stations opened from 1937 to 1955. Earnings presented are average discounted earnings from 1967 to 2010. All specifications include a full set of cohort and municipality fixed effects, mother's education, age and marital status, father's education, age and gender, as well as birth order, the number of inhabitants per doctor and the student–teacher ratio. Column (i) includes county-specific linear time trends; Column (ii) includes municipality-specific quadratic time trends; Column (iii) includes municipality-specific cubic time trends; and Column (v) includes an indicator variable on whether the individual was affected by the school reform, which increased the number of compulsory years of education from seven to nine years.

Table 5: Bounds Accounting for Infant Mortality

	Baseline (i)	Dropping 60th percentile (ii)	Dropping 70th percentile (iii)	Dropping 80th percentile (iv)	Dropping 90th percentile (v)	Dropping 100th percentile (vi)
Dropping one percent	0.149***	0.147***	0.149***	0.146***	0.146***	0.147***
	(0.035)	(0.035)	(0.034)	(0.034)	(0.034)	(0.035)
Observations	310,516	307,453	307,436	307,405	307,335	307,672
Dropping four percent	0.149***	0.141***	0.148***	0.139***	0.139***	0.145***
	(0.035)	(0.035)	(0.034)	(0.034)	(0.035)	(0.035)
Observations	310,516	298,305	298,231	298,106	297,850	298,180

Significance levels: *** 1% level, ** 5% level, * 10% level

Notes: Each parameter is from a separate regression of the outcome variable on access to a mother and child health care center. Robust standard errors adjusted for clustering at the level of the municipality of birth are shown in parentheses. We include birth cohorts from 1936 to 1960. Health care centers opened from 1937 to 1955. All specifications include a full set of cohort and municipality fixed effects, mother's education, age and marital status, father's education, age and gender, as well as birth order, the number of inhabitants per doctor and the student–teacher ratio. In Columns (iii) to (vii), we drop one percent of individuals receiving treatment. In Column (iii) we drop individuals in the 60th percentile of the predicted education distribution. In Columns (iv) to (vii), this procedure is repeated for individuals in the 70th, 80th, 90th and 100th percentiles of the predicted education distribution.

Table 6: Mother-Specific Fixed Effects

	Mean prereform (i)	Mother fixed effects (ii)	OLS fixed effect sample (iii)	OLS older siblings (iv)
Years of education	10.54	0.090**	0.120***	-0.074
		(0.043)	(0.040)	(0.053)
Observations		235,609	235,609	15,024
Earnings 1967-2010	156,593	4639***	3379***	342
		(1482)	(1292)	(1678)
Observations		235,610	235,610	15,024
Earnings age 31-50	169,087	3389**	2665*	589
		(1675)	(1412)	(1621)
Observations		218,715	218,715	15,024

Significance levels: *** 1% level, ** 5% level, * 10% level

Notes: Each parameter is from a separate regression of the outcome variable on access to a mother and child health care center. Robust standard errors adjusted for clustering at the level of the municipality of birth are shown in parentheses. We include birth cohorts from 1936 to 1960. Health care centers opened from 1937 to 1955. Earnings presented are average discounted earnings from 1967 to 2010. All specifications include a full set of cohort and municipality fixed effects and gender, birth order, the number of inhabitants per doctor and the student–teacher ratio.

Table 7: Heterogeneous Effects

	Panel A: Gender			
	Women		Men	
	Mean prereform (i)	Baseline (ii)	Mean prereform (iii)	Baseline (iv)
Years of education	10.21	0.088*	10.77	0.182***
		(0.048)		(0.048)
Observations		145,168		165,348
Earnings 1967-2010	94,923	2883***	199,141	2930***
		(1361)		(1677)
Observations		145,353		165,577
Earnings age 31-50	97,148	1683	216,931	1356
		(1385)		(1948)
Observations		131,013		145,353
	Panel B: Father's Education			
	Some high school		No high school	
	Mean prereform	Baseline	Mean prereform	Baseline
Years of education	9.98	0.071	11.13	0.247***
		(0.047)		(0.064)
Observations		139,979		140,128
Earnings 1967-2010	148,570	1455	162,581	8484***
		(1399)		(2480)
Observations		140,036		140,449
Earnings age 31-50	165,950	2772*	180,112	8401***
		(1653)		(2667)
Observations		140,036		140,449
	Panel C: Tuberculosis Infection Rates			
	Above median		Below median	
	Mean prereform	Baseline	Mean prereform	Baseline
Years of education	10.53	0.205***	10.54	0.063
		(0.043)		(0.059)
Observations		167,741		142,776
Earnings 1967-2010	157,296	5552***	153,084	478
		(1615)		(1783)
Observations		167,974		42,957
Earnings age 31-50	174,677	4474***	170,606	-202
		(1483)		(1928)
Observations		167,974		142,957

Significance levels: *** 1% level, ** 5% level, * 10% level

Notes: Each parameter is from a separate regression of the outcome variable on access to a mother and child health care center. Robust standard errors adjusted for clustering at the level of the municipality of birth are shown in parentheses. We include birth cohorts from 1936 to 1960. Health care centers opened from 1937 to 1955. Earnings presented are average discounted earnings from 1967 to 2010. All specifications include a full set of cohort and municipality fixed effects, mother's education, age and marital status, father's education and age, as well as gender birth order, the number of inhabitants per doctor and the student–teacher ratio.

Table 8: Effect of Access to Mother and Child Health Care Center on Intergenerational Persistence in Educational Attainments Across Generations

	Father–Son		Father–Daughter	
	(i)	(ii)	(iii)	(iv)
Father's years of education	0.445***	0.451***	0.380**	0.389**
	(0.116)	(0.116)	(0.0168)	(0.168)
Father's years of education		-0.044*		-0.030
× access to a health care center		(0.024)		(0.027)
Observations	149,461	149,461	130,646	130,646

Significance levels: *** 1% level, ** 5% level, * 10% level

Notes: Each column is from a separate regression of the years of education on cohort and municipality fixed effects, mother's education, age and marital status, father's education and age, gender, birth order, the number of inhabitants per doctor and the student–teacher ratio. In Columns (ii) and (iv), we include a dummy variable indicating whether an individual has access to a mother and child health care center at birth, an interaction of this dummy variable indicating whether an individual has access to a mother and child health care center at birth in relation to the father's education, as well as the interaction of the father's education with all other control variables. Robust standard errors adjusted for clustering at the level of the municipality of birth are shown in parentheses. We include birth cohorts from 1936 to 1960. Health care centers opened from 1937 to 1955. All specifications include a full set of cohort and municipality fixed effects.

Table 9: Long-Term Effects of Access to a Mother and Child Health Care Center on Health at Age 40

	Men and Women		Men		Women	
	Mean prereform	Baseline	Mean prereform	Baseline	Mean prereform	Baseline
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Index for bad health	0.00	-0.239***	0.00	-0.286***	0.00	-0.188**
		(0.028)		(0.039)		(0.046)
Observations		135,992		68,051		67,922
BMI	25.05	-0.339***	25.72	-0.536***	24.21	-0.179
		(0.124)		(0.158)		(0.174)
Observations		136,353		68,352		68,001
Obesity	0.093	-0.016**	0.100	-0.043***	0.087	0.015
		(0.007)		(0.011)		(0.012)
Observations		137,121		68,450		68,671
Blood pressure	133.65	-1.022**	138.20	-0.898*	127.98	-1.210
		(0.423)		(0.755)		
Observations		136,252		68,160		68,092
Hypertension	0.170	-0.018*	0.222	-0.028*	0.105	-0.008
		(0.010)		(0.015)		(0.018)
Observations		137,121		68,329		68,671
Cardiac risk	0.109	-0.010	0.196	-0.025*	0.001	0.001
		(0.008)		(0.002)		
Observations		137,121		68,450		68,671
Cholesterol risk	0.072	-0.031***	0.096	-0.049***	0.042	-0.011
		(0.007)		(0.012)		(0.008)
Observations		137,121		68,450		68,671
Height	170.84	1.870***	176.97	1.885***	163.18	1.830***
		(0.183)		(0.336)		
Observations		136,428		68,362		68,066

Significance levels: *** 1% level, ** 5% level, * 10% level

Notes: Each parameter is from a separate regression of the outcome variable on access to a mother and child health care center. Robust standard errors adjusted for clustering at the level of the municipality of birth are shown in parentheses. We include birth cohorts from 1936 to 1960. Health care centers opened from 1937 to 1955. All specifications include a full set of cohort and municipality fixed effects, mother's education, age and marital status, father's education and age, gender, birth order, the number of inhabitants per doctor and the student–teacher ratio.

Table 10: Long-Term Effects of Access to Different Types of Mother and Child Health Care Centers on Education and Earnings

	Baseline (i)	Centers with extra services (ii)	Centers without extra services (iii)
Years of education	0.149***	0.233**	0.154***
	(0.035)	(0.087)	(0.045)
Observations	310,516	95,120	188,230
Earnings 1967-2010	3673***	7379**	3859***
	(1189)	(2911)	(1411)
Observations	310,930	95,120	188,230
Earnings age 31-50	2644***	4690*	4561***
	(1204)	(2431)	(1597)
Observations	310,930	95,120	188,230

Significance levels: *** 1% level, ** 5% level, * 10% level

Notes: Each parameter is from a separate regression of the outcome variable on access to a mother and child health care center. Robust standard errors adjusted for clustering at the level of the municipality of birth are shown in parentheses. We include birth cohorts from 1936 to 1960. Health care centers opened from 1937 to 1955. Earnings presented are average discounted earnings from 1967 to 2010. All specifications include a full set of cohort and municipality fixed effects, mother's education, age and marital status, father's education and age, gender, birth order, the number of inhabitants per doctor and the student–teacher ratio.

Table 11: Effects of Access to Mother and Child Health Care Center on Missed School Days and Mother's Fertility

	Mean prereform (i)	Baseline (ii)
Percent of missed school days	0.086	-0.001
		(0.003)
Observations		1826
Mother's fertility	2.43	-0.054
		(0.039)
Observations		277,538

Significance levels: *** 1% level, ** 5% level, * 10% level

Notes: Each parameter is from a separate regression. Column (ii) shows the effect of access to a mother and child health care center on the percent of school days missed from 1940 to 1950. Column (iv) shows the effect of access to a mother and child health care center on a mother's fertility. In Column (iv), we include birth cohorts from 1936 to 1960. Health care centers opened from 1937 to 1955. Robust standard errors adjusted for clustering at the level of the municipality of birth are shown in parentheses. All specifications include a full set of cohort and municipality fixed effects.

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