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National independence, women's political participation, and life expectancy in Norway

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Abstract

This study investigates the role of national independence and women's political participation on population health using historical lifespan data from Norway. We use time-series methods to analyze data measuring the actual length of time lived by Norwegian birth cohorts spanning a 61 year period surrounding the political emancipation of Norway from Sweden in 1905 and the establishment of a Norwegian monarchy in 1906. The use of a discrete, historical event improves our ability to interpret the population health effects of national independence and women's political participation as causal. We find a large and significant positive effect on the lifespan of Norwegian females born in the 1906 cohort. Interestingly, the effect does not extend to all living females during the Norwegian drive toward sovereignty. We conclude that the beneficial effects were likely conferred through intrauterine biological transfers and/or neonatal investments specific to the first year of life.

Keywords

Norway; Political processes; Life expectancy; Time-series analysis; Intrauterine and neonatal transfers; Historical demography; Women; Lifecourse

Introduction

Recent research documents a robust, positive correlation between civic participation and life expectancy. This observed relationship appears to exist on multiple ecological scales; i.e., across provinces (Young & Lyson, 2001), states (Kawachi, Kennedy, Gupta, & Prothrow-Stith, 1999), and nations (Young, 2001). The relationship between civic engagement and life expectancy has received considerable attention in part because it connects political and social processes that are not usually thought of as direct determinants of health with a robust (albeit cumulative and multi-causal) indicator of human health. Popular participation in political processes may also indicate or correlate with the presence of collective identity, social capital, and collective efficacy and their apparent salutary impact on the male and female lifespan via access to services, social support, or more direct effects on health risk behaviors (Skrabski, Kopp, & Kawachi, 2004). Furthermore, participation in civic or political process is assumed to index individual characteristics that health psychologists have

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long associated with positive health outcomes, such as perceived control and self-efficacy. These psychological characteristics have been linked with better health behaviors (Burns & Dillon, 2005) as well as lower physiological stress (Sapolsky, 1999).

Mounting evidence shows that the salutary impact of political participation on life expectancy is closely linked with women's civic engagement. For example, Miller (2008) found that women's suffrage in the U.S. was linked with legislative changes that favored increased public health spending and a concomitant decrease in child mortality due to infectious disease; benefits from these legislative changes could be observed in the exact year associated with female suffrage in each state. Meanwhile, Kawachi et al. (1999) found women's legal rights and political participation to be associated with both male and female longevity across U.S. states. Furthermore, experimental evidence from India after the mandatory imposition of reserved local council seats for women indicates that female involvement in political decision making increases spending on and availability of public goods salutary to health, such as clean water (Chattopadhyay & Duflo, 2004).

The positive impact of women's decision-making on life expectancy does not stop at the level of the state. Rather, there is mounting evidence of the salutary impact of gender equity and women's empowerment at multiple levels – from household to institution to cultural values – on the health of children (Moss, 2002). At the household level, women with more decision-making power appear to make decisions about fertility timing, total fertility, and resource allocation that favor child health and longevity (Moss, 2002). At the community level, women are often involved in collective organizations designed to increase the public good, including health and well-being (Lapin & Kelber, 1994; Smuts, 2006).

There is considerable evidence that the decisions women make at the household, community, and state level preferentially favor improvements in *female* health and longevity, especially in less developed nations (Williamson & Boehmer, 1997). There may be many reasons for this pattern. For example, Thomas (1994) provides evidence from multiple countries that when in control of household resources, mothers preferentially invest in daughters and fathers invest in sons. At the state level, female legislators may promote gender-specific preferences (Chattopadhyay & Duflo, 2004). Preferential gains in female health and longevity concomitant with female empowerment at multiple levels (from household to state) are often due to the balancing of pre-existing systemic biases favoring male health and longevity (Moss, 2002). For example, female literacy and labor participation is associated with reduced *female disadvantage* in child mortality across states in India (Murthi, Guio, & Dreze, 1995).

Furthermore, female offspring may simply be more *able* to take advantage of broad-based improvements in the physical environment to actualize gains in total lifespan. Partially due to evolved biological reasons, men suffer increased morbidity and mortality due to behaviors that are less amenable to public health intervention (Weden & Brown, 2006). For example, Miller (2008) shows that both male and female infants benefited from lower death rates linked to infectious disease after female suffrage. However, deaths due to violence, accidents, suicide, and cardiovascular disease (all of which men suffer disproportionately) actually increased after women's suffrage in the U.S. These causes of death are multiply determined, largely behaviorally driven, and do not have a single (e.g., infectious) agent that can be easily adjusted.

Thus, there are multiple reasons to expect that the health benefits of female empowerment and political participation should be more pronounced among female offspring. Nonetheless, female empowerment in more developed environments (where basic public health measures are already in place) may incur further benefits in both male and female longevity, as shown

by Kawachi et al. (1999) analysis of variation in gender equity across U.S. states, as well as similar evidence from Mexico (Idrovo & Casique, 2006). Some evidence suggests that in highly equitable societies – for example, Sweden in the present period – additional blurring of gender lines with respect to political participation is correlated with illness and shortened life expectancy for both women *and men* (Backhans, Lundberg, & Månsdotter, 2007). While the contexts of these studies vary, their findings highlight the importance of looking for health effects of emancipation and civic participation in both female and male populations.

The above literature focuses on health transfers to the next generation that appear to occur through the process of parental investments in children. Another relevant pathway through which national independence and civic participation is likely to influence the health of the next generation is through biological transfers that happen *in utero*. For example, neighborhood measures of collective efficacy and trust were found to be associated with lower prevalence of low birthweight infants in the United States (Morenoff, 2003). Related research demonstrated that birth outcomes among children born to Arabic-named women in California significantly worsened in the months following the September 11th, 2001 attacks (Lauderdale, 2006); this finding was attributed to the stressful experiences of discrimination. Moreover, stressful exogenous shocks show clear evidence of reducing the sex ratio (less males born), likely via differentially high spontaneous abortion of male conceptuses (e.g., Catalano & Bruckner, 2005; Catalano, Bruckner, Marks, & Eskenazi, 2006).

Both human and animal literature on the transfer of intrauterine conditions to offspring frequently finds sex differences. Often, research has found that prenatal conditions more readily transfer to *female* offspring, including prenatal effects on birth weight (Schneider, Moore, Kraemer, Roberts, & DeJesus, 2002), endocrine function (McCormick, Smythe, Sharma, & Meaney, 1995), learning (Gue et al., 2004), and pain perception (Sternberg, 1999). Sex differences in sensitivity to the mother's nutritional (Metcalfe & Monaghan, 2001) and hormonal (Grigore, Ojeda, & Alexander, 2008) state have also been documented in animal models, and observational evidence in humans indicates sex-specific sensitivity in the biological programming of the cardiovascular system via maternal nutritional state (Adair, Kuzawa, & Borja, 2001). It is clear then that the transfer of noxious contextual conditions onto offspring can have lasting population health effects and that these effects can be sex-specific. However, what might be the effect of a presumably *positive* exogenous shock; a peaceful political emancipation and dramatic upswing in female political participation?

Existing tests of the relationship between civic engagement/political participation (whether female-specific or not) have nearly all involved comparing a cross-sectional indicator of political participation with concurrent population averages for life expectancy. Miller's study (2008) is unusual, in that it utilizes differences in the timing of women's suffrage across states to better assess the potentially causal nature of female political participation on child health. Notably, Miller's (2008) analysis finds that reductions in mortality rates are linked to the precise year of female suffrage, suggesting a very rapid and temporally specific effect of female political participation on population health.

To complement existing literature, we conducted a prospective test of the relationship between national sovereignty, female political participation and human longevity, using time series methods to detect changes in cohort life expectancy for a population affected by acute changes in political context. To do this, we capitalize on a unique historical event and unusually comprehensive data set. The approach provides an important methodological complement to the more common method of documenting the relationship between political context and population health, which traditionally measures *regional* covariance of the two phenomena. Interpreting a regional correlation as evidence of causation requires consistent

measures of geopolitical context and women's status across regions as well as accurate measures of "control" concepts to adequately rule out competing explanations. Both measures are difficult to develop (e.g., Mason & Smith, 2000, Moss, 2002). The use of a discrete and dramatic historical event with population data measured both before and after the event's occurrence allows us to navigate several sources of potential attribution error.

Our event of interest is the independence of Norway from Sweden in 1905. This largely peaceful separation provides a unique opportunity to measure the potentially salutary effects of political emancipation because unlike most political separations, war and an attendant mortality spike did not accompany Norwegian independence. We describe the details of this period below, but it is useful to note here that the separation 1) saw a dramatic political mobilization around the issue of sovereignty, particularly among women, 2) had an important temporal component, and 3) indirectly led to a large public health intervention focused on mothers and children.

Political mobilization included a referendum in which 85% of the male population voted. Norwegian women, who were not allowed to vote in the referendum, organized a petition in favor of sovereignty that over 250,000 women signed. This period was marked by an upsurge in hope for the establishment of a democratic republic in Norway; hopes that were rapidly dashed by the institution of a new monarchy in 1906. It was also marked by the galvanization of the women's movement in Norway, which featured the establishment of the Women's Public Health Organization (Sainsbury, 2001). The organization was created to provide medical care to soldiers involved with what was thought to be an inevitable war with Sweden. When this did not occur, the organization turned rapidly to broad public health measures, including a focus on maternal and child health. Shortly after Norway's emancipation from Sweden, however, class ruptures in the women's movement re-directed efforts away from maternal and child welfare and towards an emphasis on domesticity and moral purity (Sainsbury, 2001).

It is plausible to examine Norway's emancipation from Sweden as a dramatic shift in political context with potentially detectable effects on cohort life expectancy for those born during the height of mobilization. One might expect that the effects of this political engagement would be particularly pronounced for a limited time period, due to the rapid reversion to a monarchy (rather than the desired and anticipated republic) after Norway's emancipation (National Library of Norway, National Archives of Sweden, National Archives of Norway, & Royal Library in Stockholm, 2005). Similarly, although progress in women's rights began before and continued to accrue after emancipation, this period has been characterized as a golden age in the rise of the Norwegian women's movement, when populist interests were most strongly represented, consensus was high, and the welfare of mothers and children was at the forefront of the political agenda and health intervention efforts (Sainsbury, 2001).

To examine whether the process of national independence improved longevity among the men and women born during this period, we use actual lifespan data collected on birth cohorts of Norwegian women and men spanning a sixty year period from 1855 to 1915. We test whether sovereignty and the attendant surge in female political involvement, consensus, and mobilization around child and maternal welfare yielded a benefit for children born at the time. Based on previous literature, we hypothesized that the experience of sovereignty, rise in women's civic engagement, and associated public health interventions should improve population health in Norway and particularly so for Norwegian females.

Norwegian independence and civic engagement

Norway separated from Sweden through a series of politically charged events that, while initially involving heavy troop mobilization, culminated without armed conflict. Most political emancipation events throughout history have involved significant bloodshed and infrastructural disruption. This concomitance of independence and violence makes it generally difficult to detect any salutary impact of the mobilization surrounding national emancipation events. In addition, the gendered nature of such effects are difficult to disentangle from the fact that women often disproportionately bear the burden of declines in life expectancy during periods of war (Plümper & Neumayer, 2006). In this unique case, all of the usual elements of national independence occurred, including the mobilization of a large military force; however, actual military conflict and bloodshed was avoided when Sweden conceded the official separation of Norway in a treaty signed September 23, 1905 (National Library of Norway et al., 2005).

The separation was supported by a majority of the Swedish population; a popular referendum on the issue drew 85.4% voter turnout (men only), with 368,208 voting for the resolution, and only 184 against. Following the September 23 treaty, public hopes were high for the establishment of a republic and were marked by street protests of up to 5000 republic "agitators." However on November 13 the Norwegian legislative body – the Storting – appointed Prince Carol of Denmark as the new King of Norway, dashing Norwegians' hopes for the establishment of a republic (National Library of Norway et al., 2005).

Though the period marked an increase in voter turnout for men (the 1900 and 1903 Storting elections saw 56% voter turnout), the most remarkable shift in civic engagement occurred among the female population. During the separation, Norwegian women self-organized to conduct their own unofficial referendum. On August 22, 1905, a mass mobilization of women developed to support the dissolution of Norway's union with Sweden. Over 250,000 Norwegian women (nearly 70% of the population) signed and submitted a petition to the Storting (National Library of Norway et al., 2005). This was soon followed by a change in official regulations, allowing Norwegian women to vote in national elections in 1907 (Inter-parliamentary Union, 2008).

The nationalist push for independence in Norway is inseparable from the rise of the Norwegian women's movement and the Norwegian welfare state. According to Sainsbury (2001, p. 117), "The intensified struggle for nationhood coincided with women's demands for enfranchisement and hastened its introduction." The drive for sovereignty saw a unification of women's interest groups for a short time period, and galvanized the creation of the Women's Public Health Association. This association was originally established to provide medical care to soldiers in what was perceived as an impending war with Sweden. After Norway's peaceful separation in late 1905, however, it "turned to the improvement of health and social conditions, undertaking a campaign to eradicate tuberculosis, setting up nurses' training programs, and establishing clinics for mothers and children" (Sainsbury, 2001, p. 121). But class ruptures in the women's movement began to show soon after the return to a monarchy. By 1914, elite, non-working women held almost all of the power in the movement, and began to emphasize "women's domesticity and moral purity" over more practical, public health concerns (Sainsbury, 2001). This later focus came at the expense of programs oriented towards contraception and the welfare of single mothers.

Thus, during political emancipation, the Norwegian population can reasonably be considered to have been "exposed" to a dramatic upsurge in civic engagement, and particularly in women's civic engagement, in late 1905–1906. This exposure was notable for its focus on public health efforts to reduce infectious disease and increase maternal and child health. Based on the existing literature indicating a particular yield for women's

empowerment on child health and female child health in particular, we expected to find improvements in the longevity of offspring born in 1906, as the galvanization of the women's movement by Sweden's independence took place in late 1905. We hypothesized that the effect would be larger for female offspring than for male offspring. However, given some evidence for the positive impact of gender equity on male health (Kawachi et al., 1999), we expected that the effect on male cohort lifespan would also be positive.

Methods

The data for this study come from the Human Mortality Database (n.d.), a registry of births and deaths collected from vital statistics records in 36 countries and maintained by the University of California, Berkeley and the Max Planck Institute in Rostock, Germany. We use these data to compute our outcome of interest: average length of life for Norwegian birth cohorts. We will refer to these estimates of cohort life expectancy at birth as "lifespan" to avoid confusion with estimates, based on age-specific mortality rates, of life expectancy at birth among living cohorts. Dates of death are observed from 1855 through 2006. We start with 1855 because data collection protocols in Sweden stabilized at that time and because this start year provides the 50 pre-event data points thought needed to use the time-series methods described later in this section. We end with the last birth cohort (i.e., 1915) in which a sufficient proportion of members have died to allow for lifespan estimation. Each of the 61 cohorts includes, on average, 63,828 births (standard deviation = 58).

We use an estimation strategy designed to assess whether the observed lifespan of Norwegians born in 1906 deviates from the lifespan we would expect to find if the Norwegian Independence had no effect on longevity. Traditional tests of differences between observed and expected values calculate the expected value as the mean of all observed values. Yet when considering fluctuations or discontinuities in time series data, it is critical to account for oft-exhibited autocorrelation patterns, such as trends, cycles, and the tendency to remain elevated or depressed after high or low values. Autocorrelation complicates tests like ours because *the expected value of an autocorrelated series is not its mean*. In other words, we would not expect that lifespan for the 1906 birth cohort should simply be the mean of all other observed years in the *absence* of an effect of the 1906 Norwegian Independence.

Researchers frequently solve this autocorrelation problem through one of two approaches. The first approach is a purely empirical one that identifies the autocorrelation and expresses it mathematically as the effect of earlier values of the dependent variable itself (Granger, 1969; McCleary & Hay, 1980). A second approach measures the dependent variable in a comparison population and uses the series as a control variable in the test equation (Catalano & Serxner, 1987). This approach assumes that the comparison population shares many environmental, biological, and cultural circumstances, but not the exposure of theoretical interest, with the test population. Estimating the dependent variable as a function of the same phenomenon in a comparison population provides the benefit of the purely empirical approach in that doing so removes any autocorrelation induced in the test population by forces that also affect the comparison population. The approach has the added benefit of controlling third variables that exhibit no autocorrelation but affect both populations (for example, particularly hard winters). The intuitive logic behind this approach is similar to that described as "placebo" tests in biomedical and economic literatures.

In this analysis, we combine both the empirical and comparison population approaches. In each estimation, we model the lifespan of the Norwegian population of interest – full birth cohorts, female birth cohorts, and male birth cohorts – as a function of the lifespan of previous and subsequent birth cohorts of the population of interest as well as the lifespan

exhibited by comparison populations. These predictors essentially serve as important "controls." The longevity of Norwegians born in the late nineteenth and early twentieth centuries was certainly influenced by a range of experiences accrued over many decades. Measuring lifespan *variation* across annual birth cohorts helps us to "hold constant" these decades of experience because the same broad twentieth-century technological development and social change should have been experienced similarly by Norwegians born in 1906 and Norwegians born in, for example, 1907 or 1908 – or Danes born in 1906. By contrast, we would expect that effects of an acute event might be realized by the subpopulation at a critical etiologic period of development during the event's occurrence: specifically, those in infancy.

When predicting lifespan for the total population, we use full birth cohorts of Danes from the same years as the comparison population. The estimates of Norwegian female lifespan include controls for the lifespan of Danish females and Norwegian males. The estimates of Norwegian male lifespan include controls for the lifespan of Danish males and Norwegian females. We inspect the residuals of each of these models for autocorrelation using the strategy attributed to Box and Jenkins (1976). This method – Auto Regressive, Integrated, Moving Average (i.e., ARIMA) modeling – draws from a large family of patterns to empirically describe autocorrelation in a time series. ARIMA models can be usefully thought of as mathematical expressions of various filters through which temporally unpatterned series can pass. Each filter imposes a unique pattern of autocorrelation.

To this model, we add a binary variable scored 1 for 1906 and 0 for other years. If Norwegian sovereignty positively influenced lifespan, we expect that the coefficient for this binary variable will be greater than its 95% confidence interval. To assess whether a discontinuity was limited to the year in question, we include two more binary variables. The first is scored 1 for 1905 and 0 for other years; the second is scored 1 for 1907 and 0 for other years.

Finally, we add a control to capture temporal changes in cohort size. Our analysis emphasizes theories that assume parental investment, either biologically during gestation or materially early in children's lives, affect the longevity of offspring. Another mechanism, however, could also explain a positive discontinuity in lifespan. Norwegians may have decided to postpone fertility or faced difficulty conceiving during this period of uncertainty –a finding common to periods of instability and hostility in many populations (e.g., Agadjanian & Prata, 2002). If this were the case, infants born into a smaller cohort might simply have less competition for existing resources than those born in temporally neighboring cohorts and thus live longer. To consider this competing explanation, we include a control measuring the number of cohort members born in each year.

The strategy described above requires that the following general equation be estimated.

$$\nabla Y_t = c + \sum_{1}^{n} \omega_n \nabla X_{nt} + \omega_2 \nabla X_{2t} + \omega_3 I_t + \omega_4 J_t + \omega_5 K_t + \frac{(1 - \theta B^q)}{(1 - \varphi B^p)} e_t \quad [1]$$

∇ is the difference operator that indicates a series was differenced at lag (i.e., values at time t subtracted from values at time $t-1$) to remove secular trends detected by the Dickey–Fuller test (Dickey & Fuller, 1979).

Y_t is the lifespan of Norwegian cohort born in year t.

X_{nt} is the lifespan of the comparison cohorts born in year t.

X_{2t} is the number of cohort members born in year t (in 1000's).

I_t is a binary variable scored 1 for 1906 and 0 otherwise.

J_t is a binary variable scored 1 for 1905 and 0 otherwise.

K_t is a binary variable scored 1 for 1907 and 0 otherwise.

ω_1 to ω_5 are the effect coefficients.

B^n is the "backshift operator" or value of the series to which it applies at quarter $t-n$.

φ is an autoregressive parameter. Autoregressive parameters are estimates of behavior analogous to long term memory. The parameters measure, in other words, a series' tendency to remain above or below its expected value after a perturbation.

θ is the "moving average" parameter. Moving average parameters are analogous to short term memory in time series. They measure the tendency of perturbations to be present for more than one time period.

e_t is the error term in year t.

We begin by examining the average lifespan by birth cohort for Norwegians visually in graphical form and consider it in tandem with a graphical representation of lifespan for Danes. We next use the approach described above to assess whether a significant discontinuity in lifespan is observed for the cohort born during Norwegian independence but prior to the establishment of the monarchy.

Results

Sovereignty and discontinuities in Norwegian lifespan

In Fig. 1, the lifespan of Norwegians and Danes is plotted over 20 years centered on 1905, the year of Norwegian independence. As expected, we observe a secular increase in lifespan throughout the period for all populations. Interestingly, we observe what appears to be an uptick in lifespan for Norwegians in 1906 that is not matched by the Danes born in the same year. Disaggregated by sex, we observe a smaller uptick in lifespan for Norwegian men born in 1906 and a large uptick in lifespan for Norwegian women born in 1906. To assess whether these are statistically meaningful discontinuities in the secular trend, we examine the data series in a regression framework using the aforementioned ARIMA models, essentially taking the first difference of each of the series to render them stationary in their means.

Table 1 shows the results of these analyses. The first column presents results from the estimates of lifespan for the full birth cohorts (females and males combined). The second and third columns present results from estimates of lifespan for Norwegian females and Norwegian males, respectively. The fourth column explicitly considers the *difference* between male and female lifespan within cohorts.

As hypothesized, the Norwegians born in 1906 exceeded the upper confidence interval of the value expected from history (i.e., autocorrelation) as well as from the lifespan of Danes born in the same year. Children born in 1906 lived significantly longer than expected in the absence of the sovereignty movement. By contrast, the estimated coefficients for 1905 and 1907 reveal that neither birth cohort lived longer than expected in the absence of the emancipation. The results suggest that the lifespan discontinuity is limited to those born in 1906.

When we turn to examine the results disaggregated by sex (columns 2 & 3), we observe that the population-level finding for the 1906 cohort is driven entirely by the increased lifespan of females born in this year. The difference between the expected and observed values is relatively large in magnitude. The coefficient for 1906 shown in Column 2 of Table 1 suggests that Norwegian women born in that year lived on average .68 years, or 8.1 months, longer than expected in the absence of the events of this period. This association suggests that national independence allowed Norwegian society to enjoy approximately 20,500 additional life years contributed by the 30,141 women born in 1906.

Males, alternatively, did not appear to live longer than predicted by history and by the lifespan of Danish males and Norwegian females born in 1906. As mentioned, a number of previous studies have suggested that improving women's well-being and extending their rights have effects that extend to men as well (e.g., Idrovo & Casique, 2006). We tested this possibility by repeating the above test for men with and without Norwegian women as a control variable. The coefficients for 1905, 1906 and 1907 fell well within their 99% confidence intervals in all tests. In contrast to our hypothesis, the move to sovereignty does not appear to have had an effect on the health and longevity in men.

We explicitly considered whether these sex-specific patterns translated into a shift in the similarity in lifespan length among females and males (Column 4). Consistent with the results described above, we observed that the gap between female and male lifespan was significantly larger among children born in 1906. Norwegian women born following the emancipation from Sweden exhibited a lifespan advantage relative to men born in that year that was, on average, an *additional* 6 months longer than the expected gap between female and male lifespan. The finding provides a useful comparison for related investigations. Some research demonstrates that an increase in women's civic participation in equitable, resource-rich societies is correlated with a convergence in male and female lifespan (Backhans et al., 2007). In the present study, we observe that in a less developed society with marked gender-based hierarchy, the surge of female civic engagement correlates with increased *divergence* in lifespan.

The estimated coefficient on cohort size is in Column 2 is significant and negative, revealing that women born into larger cohorts had shorter lifespans, on average, than those born into smaller birth cohorts. Including this control allows us to rule out the explanation that the upcoming war resulted in fewer births, and cohort *size* itself drove the observed longer lifespan of the females born in 1906.

The moving average parameter in each estimate suggests that year-to-year changes in life span of Norwegians exhibited "echoes"; shocks to the system tended to be followed by small movements in the opposite direction. The existence of this pattern underscores the importance of using a method that looks for discontinuities while addressing such underlying autocorrelation structures.

We used multiple tests to assess the possibility that artifacts in the data affected our central finding. First, we determined whether outliers in the lifespan of Norwegian women born in years *other than 1906* distorted the estimated confidence interval of ω_3 (Chang, Tiao, & Chen, 1988). None were found. Second, we assessed whether variability in the *variation* over time in the lifespan of Norwegian women could have affected our estimates. We transformed the lifespan variables to their natural logarithms and re-estimated equation (1). The results of the test remained unchanged.

Period vs. cohort changes in lifespan

Did the process of political emancipation improve health only for the 1906 birth cohort or all of those living during the 1905–1906 period? We used the methods described above to determine if period life expectancy at birth for women born in 1906 exceeded that predicted from period life expectancy of Norwegian men, Danish women, and from autocorrelation (results not shown). Period life expectancy essentially summarizes the age-specific mortality exhibited by women of all ages during a given period. We observed no difference in period life expectancy from predicted values for 1906 – implying that women born in that year, and not earlier, enjoyed the health benefit of sovereignty. This finding echoes other research emphasizing contextual effects on the very young (e.g., Lauderdale, 2006, Moore et al., 1999). Miller (2008), for example, found that the decreases in mortality accompanying female suffrage in the United States were limited to children and did not extend to the entire living population.

Discussion

We set out to consider how the process of emancipation from a colonial political arrangement and the accompanying surge of female civic engagement influenced the health of the population of Norway. The event provided a rare occasion to consider the hypothesized benefits of emancipation; unlike most other political emancipations, the event in Norway occurred in the absence of war or high mortality among population members. Furthermore, the national emancipation event was coincident with a large-scale mobilization of popular political participation, marked a golden age in the establishment of women's political rights, and coincided with public health investments targeting maternal and child health in Norway. Thus, we tested the impact of a peaceful emancipation, marked by high levels of female civic engagement, political consensus, and public health activism on the health of Norwegians born during this period.

By considering the health implications of this event, we aimed to contribute to a larger body of research linking macro-social and macro-political events to population health. Identifying the effects of a discrete and highly salient historical event allowed us to build on this previous research by observing a population both before and after the event's occurrence. This approach allowed us to navigate several of the sources of potential attribution error introduced by the more traditional approach of considering regional covariance with cross-sectional data.

Based on previous research, we hypothesized that the experience of political emancipation and coincident civic engagement should improve longevity in Norway and particularly so for Norwegian females. Using a rigorous and conservative approach to the analysis of time series data, we found a strong, significant temporal correlation between the event of emancipation and female length of life. Interestingly, this correlation could only be observed for the cohort of women *born* in the year following the political separation of Norway from Sweden. Using a series of regression diagnostics, we concluded that this finding was robust to sources of potential bias arising from the selection of the underlying autoregressive parameters used to identify the temporal discontinuity.

The finding is consistent with the theory that contextual events can influence the biological transfers between women and their children; many of the children displaying the positive effect of national independence were *in utero* during its occurrence. However, roughly half of the children born in 1906 were conceived *after* the initial emancipation event. A limitation of this study is that we cannot disentangle the relative contribution of prenatal vs. neonatal developmental influence in creating the extended lifespan observed in Norwegian females born in 1906. It is possible, that the increase in length of life for female children

born in 1906 benefited from differential investments in girls following the increase in female status that accompanied the political emancipation or from the rapid increase in public health investments due to the efforts of the Women's Public Health Association. Notably, other cohorts who were young children during the shift to political sovereignty and the initial post-sovereignty months did not demonstrate significant deviation from expected length of life. However, nutritional and infectious exposures during infancy can have a profound impact on longevity (e.g., Bengtsson & Lindstrom, 2003; Crimmins & Finch, 2006; Moore et al., 1999).

We tested for increases in lifespan for males born during the same period but found none. The sex-specific nature of our findings is consistent with a wide range of biological evidence indicating sex-specific sensitivity to prenatal conditions across both human and non-human studies. Furthermore, sex differences in cause of death show a preponderance of behaviorally-driven pathways; this has made the male lifespan less amenable (than that of females) to public health interventions that have targeted exposure to infectious agents or other specific causes of death (Weden & Brown, 2006). Whatever the benefits incurred by females via the hypothesized transfer in Norway, it is possible that male cohorts were simply unable to capitalize on such benefits in the way that females did due to the downward pressure of multiple sources of mortality in adulthood (violence, accidents, cardiovascular disease). Indeed, previous research (Miller, 2008) shows that the health benefits of female civic engagement and associated public health interventions are effective at reducing the impact of infectious disease, but not in reducing deaths to these male-biased sources of mortality.

A few competing explanations for our finding remain untested and must be considered limitations of this study. If another short-term occurrence took place in 1905–1906 that produced a differentially healthier birth cohort of females, we could be misattributing the effect of that occurrence to the political transformation experienced by Norway. A possible candidate explanation is the mass relief experienced when war with Sweden was avoided. If the avoided war produced a significant abatement of stress among the Norwegian population that was transferred to 1906 birth cohort, it is possible that sovereignty and civic participation have smaller health effects than we demonstrate here. Unfortunately, we cannot rule out this explanation.

A second competing explanation arises from our inability to account for immigration or emigration of persons from Norway. Prior to periods of war, it is not uncommon for a population to experience substantial increases in emigration. Norway experienced several emigration peaks and valleys over the period of observation in this study (see Baevre, Riis, & Thonstad, 2001, figure 1). Yet in 1903 and 1904, emigration rates were more than double the average annual emigration rate observed between 1855 and 1915 (Statistics Norway, authors' calculation). If these emigrants were differentially *unhealthy*, than the remaining population of women would have been differentially healthy and could have produced the particularly healthy cohort of offspring that we observe in 1906.

Previous research provides some evidence about this issue. Odegaard (1932, described in Kringlen, 2004) famously wrote about the poor mental health among Norwegian immigrants to the United States, arguing that this condition was a motivation for leaving Norway and not a product of life in the receiving country. For this process to explain the observed *discontinuity* in lifespan, emigration in subsequent years would either have had to slow or the health composition of the emigrant population would have had to significantly shift. An examination of Norwegian data reveals that high rates of emigration did not slow and were in fact experienced through 1907 (Statistics Norway). However, we do not have sufficient data to test whether the health *composition* of emigrants over this period changed.

Given the peak of female consensus, activism, and public health mobilization at the time of Norway's emancipation from Sweden, we argue that the post-sovereignty environment of 1906 plausibly conferred a particularly beneficial effect on the health of infants born in this year. Specifically, it appears as if the Women's Public Health Association rapidly channeled goods and human capital stockpiled for the event of war with Sweden towards efforts to reduce infectious disease and improve maternal and child health. While female civic engagement continued to play a role in Norwegian politics after the emancipation, this engagement was increasingly fractured along class lines and moralistic, with less emphasis on the rights and health of mothers (Sainsbury, 2001). Wealthier, non-working women began to dominate the movement, and mobilized against some of the earlier efforts of the Women's Public Health Association (such as clinics for single mothers). As lifespan increases were observable only for Norwegian girls born in 1906, this speaks to the potential importance of the nature, quality, and emphasis of female political involvement in the conferral of benefits for population health.

Our results open the door for several further aspects of study, including issues of generalization. Is sovereignty broadly beneficial (when not burdened by the consequences of warfare), or is the effect we observed tied to the fortuitous re-channeling of resources originally destined for military health to maternal and child health? Is female political participation generally beneficial through a wide variety of mechanisms ranging from the state to the family or only because it tends to be linked with health and legislative changes and direct public health interventions? These are questions we can not answer with our present analysis, but suggest as an avenue for future research.

This study adds a rigorous, event-focused case study to the mounting body of evidence that political context has the potential to influence health and longevity. Akin to previous research (e.g., Morenoff, 2003), we observe a link between contextual occurrences and the health of those in infancy. As such, our results emphasize the value of considering the biological pathways through which contextual events are experienced. With respect to intrauterine transfers, hormone production in the placenta may serve as an important mechanism through which stress is transferred from mother to child (see Lauderdale, 2006). Future work would benefit from increased attention to this and other biological means through which the material and psychosocial gains from political context, or emancipation more broadly, may affect health and longevity.

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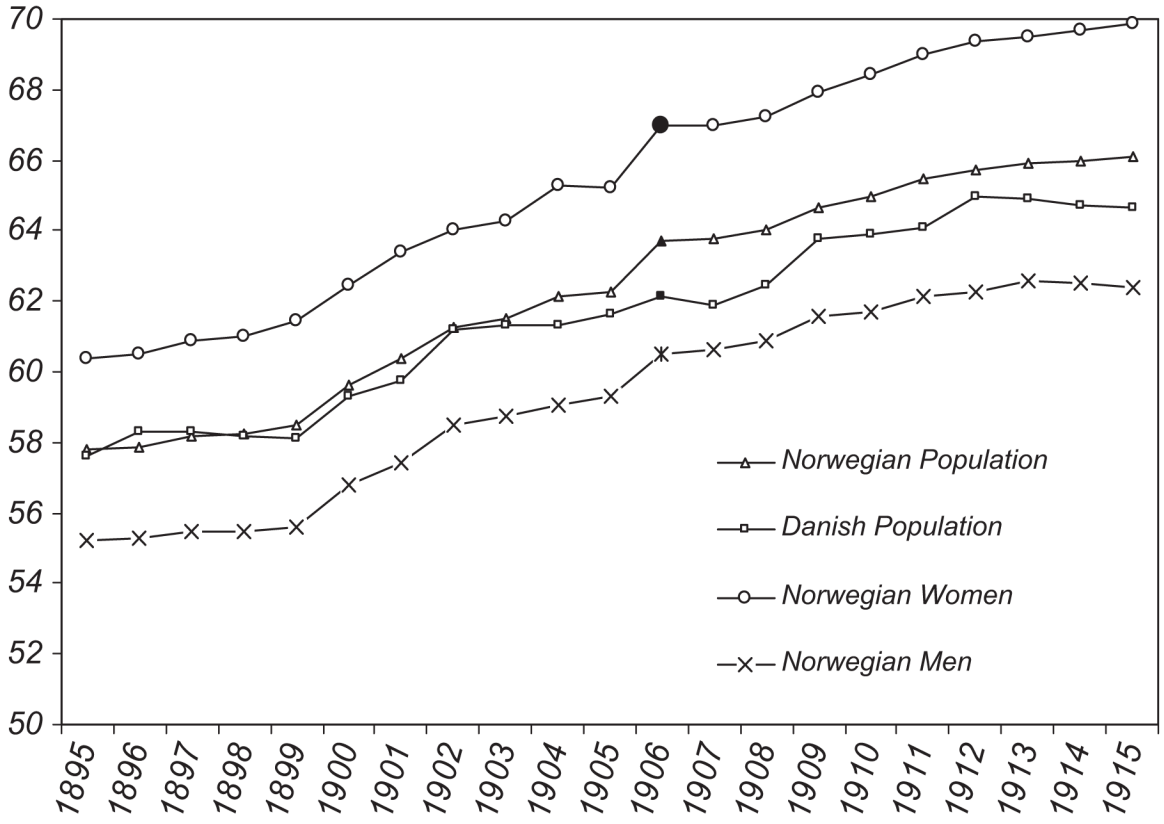

Note: Year 1906 darkened in each series. Data from Human Mortality Database.

Fig. 1.
Lifespan (in years) for Norwegian and Danish birth cohorts over the period spanning 1895–1915.

Table 1

Coefficients for test equations predicting the lifespan of annual birth cohorts of Norwegians from 1855 through 1915 ($N = 61$; standard errors in parentheses).

Parameter	Outcome			
	Length of life in years: Norwegian population	**Length of life in years: Norwegian females**	**Length of life in years: Norwegian males**	**Difference in length of life: Norwegian females minus Norwegian males**
Birth cohort of 1905	−.176 (.553)	−.147 (.292)	−.176 (.312)	−.113 (.292)
Birth cohort of 1906	.978 * (.556)	.682 ** (.309)	−.451 (.366)	.523 ** (.311)
Birth cohort of 1907	−.253 (.558)	−.166 (.282)	.219 (.318)	−.156 (.283)
Controls				
Population in birth cohort (1000's)	−.049 (.049)	-	-	
Females in birth cohort (1000's)	-	−.096 * (.055)	-	−.059 (.056)
Males in birth cohort (1000's)	-	-	.042 (.059)	
Lifespan of Danish population	.074 (.129)			
Lifespan of Norwegian males	-	.801 ** (.057)	-	−.214 ** (.054)
Lifespan of Danish females	-	.117 * (.066)	-	.257 * (.147)
Lifespan of Norwegian females	-	-	.965 ** (.064)	
Lifespan of Danish males	-	-	−.026 * (.069)	
Constant	.229 ** (.105)	.097 ** (.036)	−.071 ** (.034)	.116 ** (.033)
ARIMA parameters	θB = −.305 ** (.151)	θB = .457 ** (.151)	θB = .523 ** (.124)	θB = −.156 ** (.283)

* $p < .05$, single-tailed test.

** $p < .01$, single-tailed test.

Note: Data from the Human Mortality Database.