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Social class and excess mortality in Sweden during the 1918 influenza pandemic

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Running head: Social class and excess mortality in 1918 Sweden

Abstract

There is no consensus in the literature about the role of socioeconomic factors on influenza mortality during the 1918 pandemic. While some scholars have found that social factors were important, others have not. In this study, we analyzed differences in excess mortality by social class in Sweden during the 1918 pandemic. We analyzed individual-level mortality of the entire population aged 30-59, by combining information from death records with census data on occupation. Social class was measured by an occupation-based class scheme. Excess mortality during the pandemic was measured as mortality relative to the same month the year before. Social class differences in mortality were modeled using a complementary log-log model, adjusting for potential confounding at the family, the residential (urban/rural) and the county levels. Our findings indicated notable class differences in excess mortality but no perfect class gradient. Class differences were somewhat larger for men than for women.

Keywords: 1918 pandemic, influenza, mortality, occupation, social class, Sweden, individual level, longitudinal

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Even though the influenza pandemic of 1918 affected millions of people worldwide over a short period, it did not strike blindly. Women were more likely to contract influenza, especially if pregnant, but men had slightly higher mortality (1, 2). A specific feature was the dramatic mortality among young adults (3, 4). Moreover, it is commonly believed that in the 1918 pandemic, "the flu hit the rich and the poor alike" (5). Indeed, many contemporary scientists claimed that the influenza during the pandemic did not have a social gradient (6). Based on surveys on sickness among all the employed, in some cases including their families, physicians working at factories in different parts Sweden found similar incidence rates for different groups of employees (7, 8, 9). They found that age, but not occupation and housing, were important. However, other contemporary scientists found socioeconomic differences in mortality during the pandemic (5, 10, 11). Recently, an analysis of two socially contrasting parishes in Oslo showed that the working classes and those living in small apartments had the highest mortality in influenza (12) and in Chicago, social factors at the local level, such as literacy, homeownership, and unemployment were associated with influenza and pneumonia mortality in 1918 (13). Thus, we are faced with two contrasting views on the role of socioeconomic factors in determining influenza mortality during the 1918 pandemic.

In this study, we analyzed differences in excess mortality during the pandemic by social class, using individual-level data for the entire population of Sweden aged 30-59. We combined information from the death records for the period 1915 to 1921 on precisely when the deaths occurred with data on occupation, family characteristics, and residence from the population census of 1910.

Close to 35,000 people, out of a population of 5.8 million, died from influenza and pneumonia during the three waves of the pandemic (14, 15, 16, see 2 p. 63). The first reports of influenza came in the last week of June 1918 and in the following month, 52 persons died from the disease (2, 17). While the number of deaths was higher, and started earlier, than for

the seasonal influenza, it was still considered as very mild by the medical authorities (2, p. 42). The second wave, which started in September, was far more violent and the number of deaths quickly increased to reach a peak in October and November. A third, and milder, wave came in April of 1919 and then gradually vanished (17).

At the time of the pandemic, Sweden was in the middle of its industrial transition and showed higher rates of economic growth than most other Western countries (18, p. 191). Still, the number of people employed in agriculture was larger than in the industrial sector and the degree of urbanization was low, with only four towns having a population above 50,000 (19). This means that most industrial workers also lived in rural areas.

METHODS

Data sources

The 1910 census (20) provided individual-level demographic, geographic and occupational information for the entire population residing in Sweden on December 31, 1910. Data on deaths were taken from the Swedish death index (21), including all deaths recorded in Sweden between 1901 and 2013, which corresponded almost exactly to the official numbers published by Statistics Sweden (22). It provided name and the dates and places of birth and death.

The linking of individuals between the census and the death index was made by matching people based on parish and year of birth, sex, and names, since personal identification numbers were not introduced until much later. The selection of identifying variables followed well-established best practices and only included time-invariant variables to avoid introducing bias into the linked sample (23). In order to match an individual between the death index and the census, he/she had to be recorded with the same sex, birth parish and year of birth. We allowed for some differences in spelling of names, using the Jaro-Winkler algorithm (24, 25). Using this algorithm, we compared the text strings and allocated a score

between 0 (no similarity) and 1 (exact match) based on the number of single character transpositions required to turn one text string into another. Furthermore, the algorithm penalized differences occurring in the beginning relative to the end of the compared strings more severely. To be considered a match, we required the similarity scores of both first names and surnames to exceed 0.85. This threshold was chosen based on the achieved match rate and evaluations of how many of the matches that could be confirmed as true, based on comparisons of auxiliary identifying characteristics that were not themselves used to identify matches (26). An individual that was matched to more than one other individual in either the death index or the census was deemed an ambiguous match and therefore not retained as a link between the sources. In total, this procedure succeeded in linking 72% of all deaths for men, and 68% for women, in our sample. We analyzed 81,867 linked deaths in the period 1915 to 1921, of which 18,691 occurred between July 1, 1918 and June 30, 1919.

The occupational titles in the 1910 census were HISCO-encoded (27), which allowed for the transformation of occupations into social classes using the HISCLASS scheme, which was based on skill level, degree of supervision, whether manual or non-manual (28). Because a majority of married women had no recorded occupation in the census, we used the occupation of the husband to assign their class. For unmarried women, and women whose husbands had no occupational title, we used women's own occupations. From the HISCLASS scheme, we constructed five aggregated classes: white collar (HISCLASS 1-5), skilled manual (6-7), low-skilled manual (9-10), unskilled manual (11-12), and farmers (8). Frequent occupations among the different classes included, for the white-collar class, proprietors, bookkeepers, and teachers. The skilled workers included carpenters, blacksmiths, tailors, etc. The class of low-skilled workers contained loggers, painters, and fishermen, and among the unskilled workers were farmworkers, laborers, and unspecified workers. Farmers were difficult to put in the class scheme because we lacked information on the size of their

landholdings or number of employees. The group included anything from small subsistence farmers to big landowners. For this reason, we put this group outside the hierarchal class scheme, leaving white-collar workers at the top and unskilled workers at the bottom. Social class in this way reflected life chances related to such factors as wealth, education, income, and social status (28, 29).

The death certificates did not include information on cause of death, which made it impossible to study mortality in influenza directly. Instead, we analyzed the pattern of deaths by month in ages 30-59, separately for men and women, for the pre-pandemic, pandemic and post-pandemic periods, starting in 1915 and ending in 1921. We also measured monthly excess mortality by comparing the number of deaths a certain month to the number the same month the preceding year in each social class, to get an estimate of the excess mortality during the pandemic and to remove seasonal variation in mortality. The argument for this approach was that while the occupational structure changed profoundly in the long term, the change from one year to the next was limited, especially when compared with the great increase in the number of deaths related to influenza. Since the timing of the excess mortality peaks differed slightly across social classes, we also analyzed the cumulative monthly excess death rates.

Statistical model

We studied differences in excess mortality between social classes in the pre-pandemic and pandemic periods using discrete event history analysis. We followed all individuals aged 30-59 from January 1, 1915 through June 30, 1919. The period between January 1915 and June 1918 was our control period while the 12 months from July 1, 1918 to June 30, 1919 was the pandemic period. This periodization of the pandemic was based on reports on the distribution of deaths due to influenza in the period (17). The result would be the same using information

on the morbidity of the disease (15, 16, see 2, p. 59). Data was structured in one-month spells with a binary variable indicating whether the individual died during the month or not. All covariates except age and pandemic period were time-invariant and referred to information in the 1910 census.

Mortality was modeled using a complementary log-log model (estimated using the cloglog command in STATA 14), which is suitable for binary data with an asymmetric distribution of the dependent variable (30, p. 446).

The complementary log-log model takes the following form:

$$\Pr(y = 1|\mathbf{x}) = 1\text{-}\exp\{\exp(\mathbf{-x'\beta})\}$$

where y is an indicator variable with the value one if the individual died during the month, or zero otherwise, **x** is a vector of covariates, and **β** is the vector of parameters to be estimated. Results were reported as relative mortality risks, which were derived by exponentiating the parameter estimates. In a sensitivity analysis, we calculated clustered standard errors to account for repeated monthly observations for each individual, which gave almost identical confidence intervals. We also estimated logit models, which gave highly similar results (see Web Table 4).

In the analysis, we adjusted for marital status, presence of children and migration history because they are known to influence mortality and are associated with social class (31, 32). Moreover, we adjusted for urban residence, which may have affected overall mortality, social-class specific mortality as well as the timing and incidence of the influenza deaths during the pandemic (2, 31).

We estimated five different models, separately by gender. Model 1 only adjusted for age in five-year categories, and Model 2 for age and social class. Model 3 added interaction effects between pandemic period and social class. Model 4 further added individual-level control variables: marital status, presence of children, migrant status, and urban residence. Model 5 added county-level fixed effects, which accounted for unobserved heterogeneity at the county level (25 counties). The variables of main interest were social class interacted with pandemic period (July 1918 – June 1919), which showed the differential excess mortality during the pandemic by social class.

RESULTS

Descriptive results

The linked sample captured a constant share of the deceased throughout the period, and so did the linked sample with information of occupation, as shown in Figure 1. The timing and number of deaths were highly similar for men and women, and similar in the pre- and post-pandemic period. There were some variations in the pre- and post-pandemic periods, with higher mortality during the winter. Figure 2 shows excess mortality where these seasonal variations were removed by divided the monthly deaths with the value the same month the year before. The low mortality in the fall of 1919 was due to the fact the deaths in these months were divided with the many deaths the same months of 1918, during the pandemic. The similarity in the mortality patterns between the death index and the linked samples reassured us that the linking procedure was a credible method for reconstructing a historical population register.

Figure 1-2 here

Figure 3 displays excess mortality by social class. The first wave, in July and August, was very mild. The numbers of deaths were too few to identify any class differences. Excess

mortality started to emerge in all classes by September 1918, for both men and women. It peaked in different months for different classes (October or November), and there were gender differences in these patterns.

Figure 3 here

Figure 4 shows the cumulative monthly deaths by class and gender. For men, there were marked class differences, but no perfect gradient (Figure 4a). Farmers had the lowest excess mortality in the pandemic period; and white-collar workers had the second lowest, followed by skilled, unskilled and low-skilled workers.

For women, the pattern was somewhat different (Figure 4b). Overall, the social class differences in excess mortality were smaller than for men. Low-skilled and unskilled manual workers had the highest excess mortality, and the skilled manual workers had the lowest. Farmers and white-collar workers fell in between, but the differences between these classes were small.

Figure 4 here

Regression results

The descriptive statistics of the analytical sample are presented in Table 1. 22-23% of the study population were farmers, and 20-21% unskilled manual workers, while about 12% belonged to the white-collar class. 10% of men and 16% of women did not have information about social class. About 65% of men and 68% of women in the sample were married, and a majority (about 60-65%) had children at home. About 25% were migrants, and a bit more than 20% lived in urban areas.

Table 1 here

Tables 2 and 3 show relative risks from complementary log-log models for the age group 30-59, at risk from January 1915 through June 1919. Results for men are shown in

Table 2, and for women in Table 3. There was a clear excess mortality in the pandemic period, about 80% higher mortality for men and 70% higher for women when adjusting only for age (Model 1). The excess mortality in the pandemic period was only slightly reduced when adjusting for additional variables and interactions between class and pandemic period (Model 2-5). For men the relative risks declined from 1.79 (95 % CI: 1.74, 1.83) in Table 2, Model 1 to 1.69 (95 % CI: 1.58, 1.80) in Model 5. For women the corresponding change was from 1.69 (95 % CI: 1.65, 1.74) in Table 3, Model 1 to 1.55 (95 % CI: 1.43, 1.67) in Model 5.

Tables 2 and 3 here

Overall, men in the farmer group had lower mortality, while there were only small differences between the other classes (Table 2, Model 2). For women the pattern was quite different, with higher mortality for the unskilled and somewhat lower mortality in the white-collar class (Table 3, Model 2). More importantly, there were also social class differences in the excess mortality during the pandemic, when adjusting for all the potential confounders as shown by the interaction effects. Among men low-skilled manual workers had the largest excess mortality (Table 2, Model 3-5, see also Web Table 3), and farmers the lowest. Unskilled workers had the second highest excess mortality. For the other classes there were no statistically significant differences in excess mortality during the pandemic. Women in the low-skilled and unskilled classes suffered the greatest excess mortality, while there were no statistically significant differences between the other classes (Table 3, Model 3-5, see also Web Table 3).

Figure 5 shows the net effects of the interactions between social class and pandemic period (based on Model 5 in Tables 2 and 3). The reference category was skilled manual workers in the pre-pandemic period (1915-1917). Both men and women in the farmer group, and women in the white-collar class, had lower mortality than the other classes in the pre-pandemic period. There were only small differences between the other classes in this period,

and none of them was statistically significant. As was clear from Tables 2 and 3, there was substantial excess mortality in all social classes in the pandemic period.

Figure 5 here

For men, low-skilled workers had the highest mortality in the pandemic period and farmers the lowest. This difference was also highly statistically significant. White-collar workers had lower mortality in the pandemic period than the manual workers, but not as low as the farmers. The difference was only statistically significant in relation to the low-skilled workers. The skilled workers had statistically significantly lower mortality in the pandemic period than the low-skilled and unskilled workers. The difference between the low-skilled and the unskilled was not statistically significant. The group with missing information on social class looked similar to the low-skilled workers in the pandemic period but had higher mortality than the other social classes in the pre-pandemic period.

For women, the pattern was similar, but the differentials narrower. In the pandemic period, mortality was highest among low-skilled and unskilled workers compared to all other groups, while there were no statistically significant differences between women in white-collar, skilled manual or farmer classes. The missing category had similar mortality as low-skilled and unskilled workers in the pandemic period, and higher mortality than other classes in the pre-pandemic period. Hence, class differences in mortality during the pandemic were more consistent than during the pre-pandemic period, but there was no perfect social class gradient in excess mortality in the pandemic period, nor in the pre-pandemic period.

DISCUSSION

We lack a clear understanding of the role of socioeconomic factors in the 1918 influenza pandemic. There are different hypotheses in the literature about likely differences and their explanations. Our findings showed that there were notable social class differences in excess

mortality for both men and women during the pandemic period of July 1918 – June 1919. For women the social class differences were smaller than for men. Among men, farmers were least affected by the pandemic and low-skilled manual workers were most affected. Unskilled workers had lower excess mortality than the low-skilled workers, but higher than skilled and white-collar workers. For women there was a similar pattern with the highest excess mortality in the pandemic for low-skilled and unskilled workers and no differences between the other classes. In other words, there was no perfect social class gradient in excess mortality during the pandemic, where higher class was associated with lower excess mortality in a hierarchical way.

Class differences among women were more pronounced in the pre-pandemic period than they were for men, but less distinctive during the pandemic. Specifically, white-collar men did not enjoy a mortality advantage compared to the working classes, which may seem surprising, but which is well in line with other recent research studying a larger number of cohorts in the first half of the 20th century. It has not been fully established what explained the gender differences in class-specific mortality during this period, but it has been hypothesized that it was related to life style factors (31).

These results point to other mechanisms than pure income and standard of living as the main explanation behind the social class differentials in excess mortality during the pandemic. If differences in nutrition or housing conditions were the only explanations, we would have expected to see a clear social class gradient and not just a difference between unskilled/low-skilled workers and the other classes. It was impossible to draw firm conclusions about what explained the observed social class differences in excess mortality, but possibly work-related differences in the degree of interpersonal interaction could have been important. More research on occupational differences in mortality would be highly valuable to advance knowledge on this issue.

There are some important limitations to our study. We did not have access to time-varying occupational information but relied on the information given in the census of 1910, which was 5-9 years before the observations analyzed. However, since we did not analyze detailed occupations, but broader social classes, intragenerational mobility was expected to be quite limited. As the census of 1920 was not available, we looked at intragenerational class mobility between 1900 and 1910 for the age group 35-59 in 1910 (Web Table 2). Among white-collar, skilled workers and farmers, between 70% and almost 90% of individuals stayed in the same class, while this applied to only about 50% of the low-skilled and unskilled workers. Between these two classes, there was considerable mobility, and when viewing them as one class, mobility was similar as for the other classes. Our results also showed similar excess mortality for the low skilled and unskilled, which further indicated that the boundary between these two classes was not very clear.

Another possible limitation was the linking procedure. Not all individuals could be linked between the census and the death register, most often because there was more than one possible match. Our analysis showed that the mortality pattern before and during the pandemic was highly similar in the linked sample and among all deaths. Moreover, the distribution of social classes was also similar in the linked sample and the census of 1910 (see Web Table 1). Hence, the sample analyzed was highly representative of both the death registers and the census of 1910, and for this reason, we did not expect any significant selection bias to have affected our results.

Even though there was some reporting of occupation among married women, most of them did not work regularly outside the household in this period, which made the husband's occupation the best indicator available for their class position (33, 34).

Finally, the death registers did not provide information on the cause of death. Instead, we based the analysis on the estimation of excess mortality, using a method that

eliminated the normal seasonality almost completely (Figures 2a-b). According to our estimates, there were 42,454 excess deaths in all ages in the pandemic period. The numbers of proven and likely influenza deaths in the same period, reported by Statistics Sweden, was 34,374, corresponding to 81% of our estimates (17). Thus, our excess deaths included about 8,000 deaths not diagnosed as influenza, of which almost 3,000 were deaths in pneumonia (17).

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Figure 1. Number of deaths in Sweden, 1915-1921, men (A) and women (B) aged 30-59.

Figure 2. Number of deaths in Sweden relative to the same month in the preceding year, 1915-1921, men (A) and women (B) aged 30-59.

Figure 3. Number of deaths in Sweden relative to the same month in the preceding year, 1915-1921, men (A) and women (B) aged 30-59, by social class.

Figure 4. Cumulative monthly deaths in Sweden from July 1918 to June 1919 relative to the average of cumulative monthly deaths 1915-17, men (A) and women (B) aged 30-59, by social class.

Figure 5. Relative risks and 95% confidence intervals for the interaction between social class and pandemic period. Men (black markers) and women (white markers) in Sweden aged 30-59, January 1915 to June 1919.

Note: Relative risks from a complementary log-log model controlling for marital status, presence of children, migrant status, urban/rural residence, and county and age fixed effects (Table 2, Model 5).

Table 1. Descriptive statistics, men and women in Sweden aged 30-59, January 1915-June 1919.

	Men (n = 736,604)[a]	Women (n = 716,185)[b]
Characteristic	**%**	**%**
Age		
30-34	21.3	18.4
35-39	19.7	19.5
40-44	17.7	18.1
45-49	15.0	15.8
50-54	15.0	16.1
55-59	11.2	12.1
Social class		
White collar	12.5	12.5
Skilled manual	15.4	13.4
Lowskilled manual	17.7	16.0
Unskilled manual	21.8	20.3
Farmer	23.1	21.5
Missing	9.6	16.4
Marital status		
Unmarried	33.0	28.3
Married	64.7	67.5
Previously married	2.2	4.2
Children		
0	41.8	35.2
1	12.8	13.4
2	13.3	14.3
3	10.7	11.9
4 or more	21.4	25.1
Migrant	23.1	24.5
Urban resident	21.4	23.7

a 33,864,311 person months, 27,916 events (deaths)

b 33,552,942 person months, 26,033 events (deaths)

Table 2. Relative risks of mortality for men in Sweden aged 30-59 years, January 1915-June 1919 (complementary log-log model, n = 33,864,311 person months).

	Model 1[a]		Model 2[a]		Model 3[b]		Model 4[c]		Model 5[c]	
Period and Social class	**RR**	**95% CI**	**RR**	**95% CI**	**RR**	**95% CI**	**RR**	**95% CI**	**RR**	**95% CI**
Period										
Pre-pandemic	1	Reference	1	Reference	1	Reference	1	Reference	1	Reference
Pandemic	1.79	1.74, 1.83	1.77	1.73, 1.81	1.71	1.61, 1.83	1.69	1.59, 1.80	1.69	1.58, 1.80
Social class										
White collar			1.04	0.99, 1.09	1.05	1.00, 1.11	1.02	0.97, 1.08	1.00	0.94, 1.05
Skilled manual			1	Reference	1	Reference	1	Reference	1	Reference
Lowskilled manual			1.03	0.99, 1.08	0.96	0.91, 1.01	0.96	0.92, 1.01	0.97	0.92, 1.02
Unskilled manual			1.06	1.02, 1.10	1.03	0.99, 1.09	1.00	0.96, 1.05	1.04	0.99, 1.09
Farmer			0.75	0.72, 0.78	0.79	0.75, 0.83	0.82	0.78, 0.86	0.89	0.85, 0.93
Missing			1.26	1.20, 1.32	1.23	1.16, 1.30	1.12	1.06, 1.19	1.20	1.13, 1.27
Pandemic x Social class										
Pandemic x White collar					0.96	0.87, 1.06	0.96	0.87, 1.05	0.96	0.87, 1.05
Pandemic x Skilled manual					1	Reference	1	Reference	1	Reference
Pandemic x Lowskilled manual					1.25	1.14, 1.36	1.24	1.14, 1.35	1.24	1.14, 1.35
Pandemic x Unskilled manual					1.08	0.99, 1.17	1.08	0.99, 1.17	1.08	1.00, 1.17
Pandemic x Farmer					0.85	0.78, 0.92	0.85	0.78, 0.93	0.85	0.78, 0.93
Pandemic x Missing					1.07	0.98, 1.18	1.08	0.98, 1.18	1.08	0.98, 1.19

Abbreviations: RR, relative risk; CI, confidence interval.

a Models 1, 2, and 3 adjusts for age (5 year categories)

b Model 4 adjusts for age (5 year categories), marital status, number of children, and migrant status

c Model 5 adjusts for age (5 year categories), marital status, number of children, migrant status, urban status, and county of residence

Table 3. Relative risks of mortality for women in Sweden aged 30-59 years, January 1915-June 1919 (complementary log-log model, n = 33,552,942 person months).

	Model 1[a]		Model 2[a]		Model 3[b]		Model 4[c]		Model 5[c]	
Period and Social class	**RR**	**95% CI**	**RR**	**95% CI**	**RR**	**95% CI**	**RR**	**95% CI**	**RR**	**95% CI**
Period										
Pre-pandemic	1	Reference	1	Reference	1	Reference	1	Reference	1	Reference
Pandemic	1.69	1.65, 1.74	1.69	1.64, 1.73	1.55	1.43, 1.67	1.55	1.43, 1.67	1.55	1.43, 1.67
Social class										
White collar			0.91	0.87, 0.96	0.90	0.85, 0.96	0.89	0.84, 0.95	0.88	0.83, 0.94
Skilled manual			1	Reference	1	Reference	1	Reference	1	Reference
Lowskilled manual			1.09	1.04, 1.14	1.05	0.99, 1.10	1.03	0.98, 1.09	1.02	0.96, 1.07
Unskilled manual			1.13	1.08, 1.18	1.08	1.03, 1.14	1.05	1.00, 1.11	1.04	0.98, 1.09
Farmer			0.98	0.94, 1.02	0.96	0.91, 1.02	0.97	0.92, 1.02	0.95	0.90, 1.00
Missing			1.26	1.20, 1.31	1.21	1.15, 1.28	1.12	1.06, 1.18	1.11	1.05, 1.17
Pandemic x Social class										
Pandemic x White collar					1.04	0.93, 1.16	1.04	0.93, 1.16	1.04	0.93, 1.16
Pandemic x Skilled manual					1	Reference	1	Reference	1	Reference
Pandemic x Lowskilled manual					1.15	1.04, 1.27	1.15	1.04, 1.27	1.15	1.04, 1.27
Pandemic x Unskilled manual					1.14	1.04, 1.25	1.13	1.03, 1.24	1.13	1.03, 1.24
Pandemic x Farmer					1.06	0.96, 1.16	1.06	0.96, 1.16	1.06	0.96, 1.16
Pandemic x Missing					1.11	1.01, 1.22	1.11	1.01, 1.22	1.10	1.00, 1.21

Abbreviations: RR, relative risk; CI, confidence interval.

a Models 1, 2, and 3 adjusts for age (5 year categories)

b Model 4 adjusts for age (5 year categories), marital status, number of children, and migrant status

c Model 5 adjusts for age (5 year categories), marital status, number of children, migrant status, urban status, and county of residence

Table 1.

Characteristic	Men (n = 736,604)[a] %	Women (n = 716,185)[b] %
Age		
30-34	21.3	18.4
35-39	19.7	19.5
40-44	17.7	18.1
45-49	15.0	15.8
50-54	15.0	16.1
55-59	11.2	12.1
Social class		
White collar	12.5	12.5
Skilled manual	15.4	13.4
Lowskilled manual	17.7	16.0
Unskilled manual	21.8	20.3
Farmer	23.1	21.5
Missing	9.6	16.4
Marital status		
Unmarried	33.0	28.3
Married	64.7	67.5
Previously married	2.2	4.2
Children		
0	41.8	35.2
1	12.8	13.4
2	13.3	14.3
3	10.7	11.9
4 or more	21.4	25.1
Migrant	23.1	24.5
Urban resident	21.4	23.7

Table 2.

	Model 1[a]		Model 2[a]		Model 3[b]		Model 4[c]		Model 5[c]	
Period and Social class	**RR**	**95% CI**	**RR**	**95% CI**	**RR**	**95% CI**	**RR**	**95% CI**	**RR**	**95% CI**
Period										
Pre-pandemic	1 Reference		1 Reference		1 Reference		1 Reference		1 Reference	
Pandemic	1.79	1.74, 1.83	1.77	1.73, 1.81	1.71	1.61, 1.83	1.69	1.59, 1.80	1.69	1.58, 1.80
Social class										
White collar			1.04	0.99, 1.09	1.05	1.00, 1.11	1.02	0.97, 1.08	1.00	0.94, 1.05
Skilled manual			1 Reference		1 Reference		1 Reference		1 Reference	
Lowskilled manual			1.03	0.99, 1.08	0.96	0.91, 1.01	0.96	0.92, 1.01	0.97	0.92, 1.02
Unskilled manual			1.06	1.02, 1.10	1.03	0.99, 1.09	1.00	0.96, 1.05	1.04	0.99, 1.09
Farmer			0.75	0.72, 0.78	0.79	0.75, 0.83	0.82	0.78, 0.86	0.89	0.85, 0.93
Missing			1.26	1.20, 1.32	1.23	1.16, 1.30	1.12	1.06, 1.19	1.20	1.13, 1.27
Pandemic x Social class										
Pandemic x White collar					0.96	0.87, 1.06	0.96	0.87, 1.05	0.96	0.87, 1.05
Pandemic x Skilled manual					1 Reference		1 Reference		1 Reference	
Pandemic x Lowskilled manual					1.25	1.14, 1.36	1.24	1.14, 1.35	1.24	1.14, 1.35
Pandemic x Unskilled manual					1.08	0.99, 1.17	1.08	0.99, 1.17	1.08	1.00, 1.17
Pandemic x Farmer					0.85	0.78, 0.92	0.85	0.78, 0.93	0.85	0.78, 0.93
Pandemic x Missing					1.07	0.98, 1.18	1.08	0.98, 1.18	1.08	0.98, 1.19

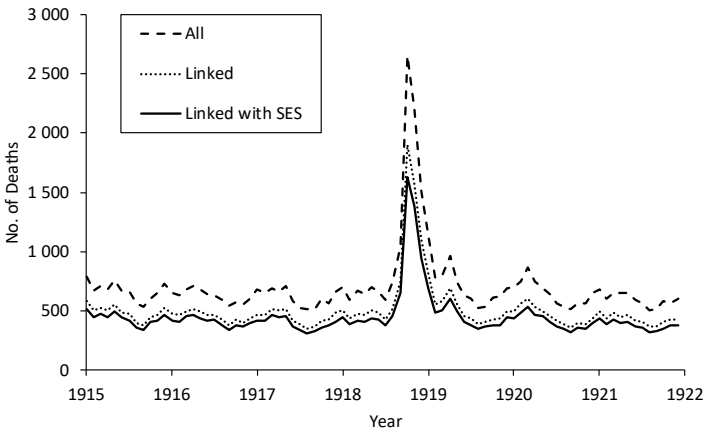
Table 3.

	Model 1[a]		Model 2[a]		Model 3[b]		Model 4[c]		Model 5[c]	
Period and Social class	**RR**	**95% CI**	**RR**	**95% CI**	**RR**	**95% CI**	**RR**	**95% CI**	**RR**	**95% CI**
Period										
Pre-pandemic	1 Reference		1 Reference		1 Reference		1 Reference		1 Reference	
Pandemic	1.69	1.65, 1.74	1.69	1.64, 1.73	1.55	1.43, 1.67	1.55	1.43, 1.67	1.55	1.43, 1.67
Social class										
White collar			0.91	0.87, 0.96	0.90	0.85, 0.96	0.89	0.84, 0.95	0.88	0.83, 0.94
Skilled manual			1 Reference		1 Reference		1 Reference		1 Reference	
Lowskilled manual			1.09	1.04, 1.14	1.05	0.99, 1.10	1.03	0.98, 1.09	1.02	0.96, 1.07
Unskilled manual			1.13	1.08, 1.18	1.08	1.03, 1.14	1.05	1.00, 1.11	1.04	0.98, 1.09
Farmer			0.98	0.94, 1.02	0.96	0.91, 1.02	0.97	0.92, 1.02	0.95	0.90, 1.00
Missing			1.26	1.20, 1.31	1.21	1.15, 1.28	1.12	1.06, 1.18	1.11	1.05, 1.17
Pandemic x Social class										
Pandemic x White collar					1.04	0.93, 1.16	1.04	0.93, 1.16	1.04	0.93, 1.16
Pandemic x Skilled manual					1 Reference		1 Reference		1 Reference	
Pandemic x Lowskilled manual					1.15	1.04, 1.27	1.15	1.04, 1.27	1.15	1.04, 1.27
Pandemic x Unskilled manual					1.14	1.04, 1.25	1.13	1.03, 1.24	1.13	1.03, 1.24
Pandemic x Farmer					1.06	0.96, 1.16	1.06	0.96, 1.16	1.06	0.96, 1.16
Pandemic x Missing					1.11	1.01, 1.22	1.11	1.01, 1.22	1.10	1.00, 1.21

Figure 1

Men 1

A)



Women 1

B)

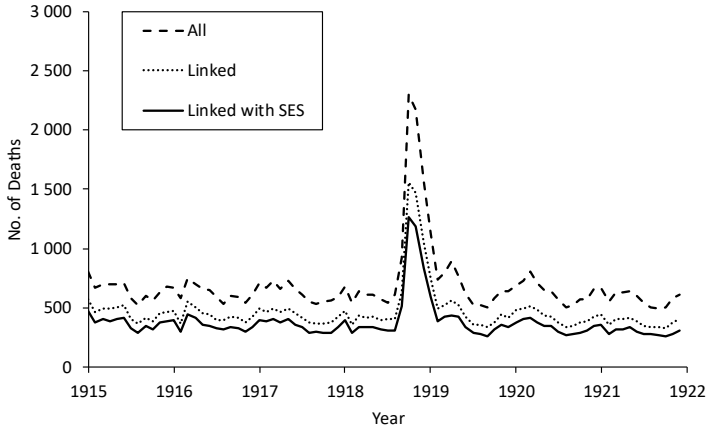
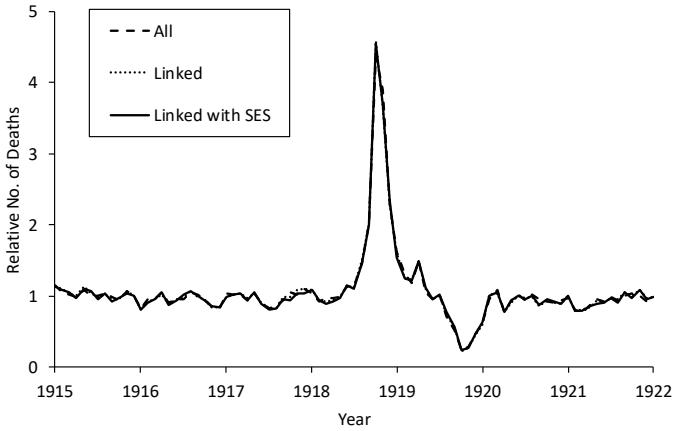


Figure 2

Men 2

A)



Women 2

B)

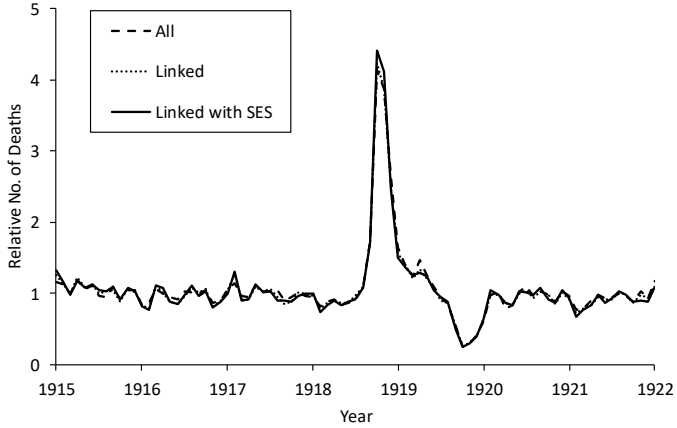
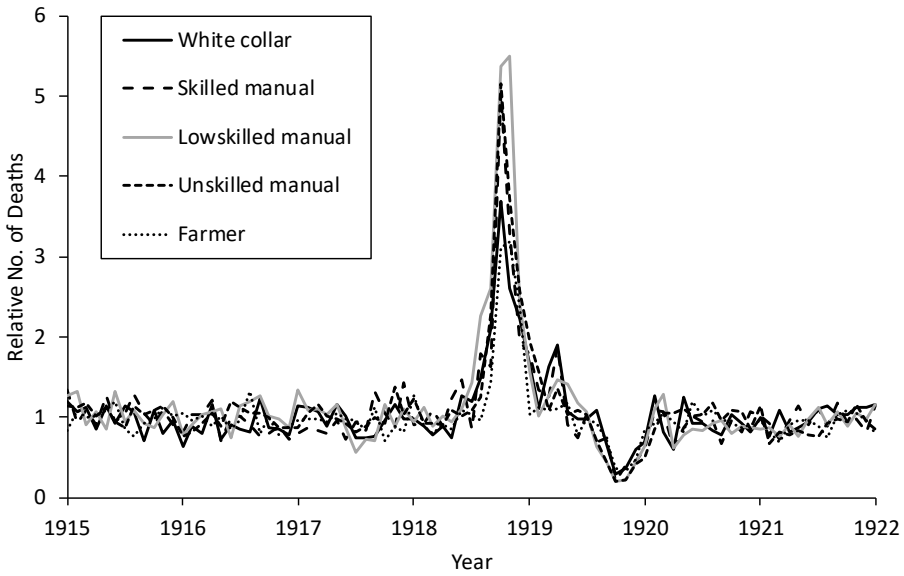


Figure 3

Men 3

A)



Women 3

B)

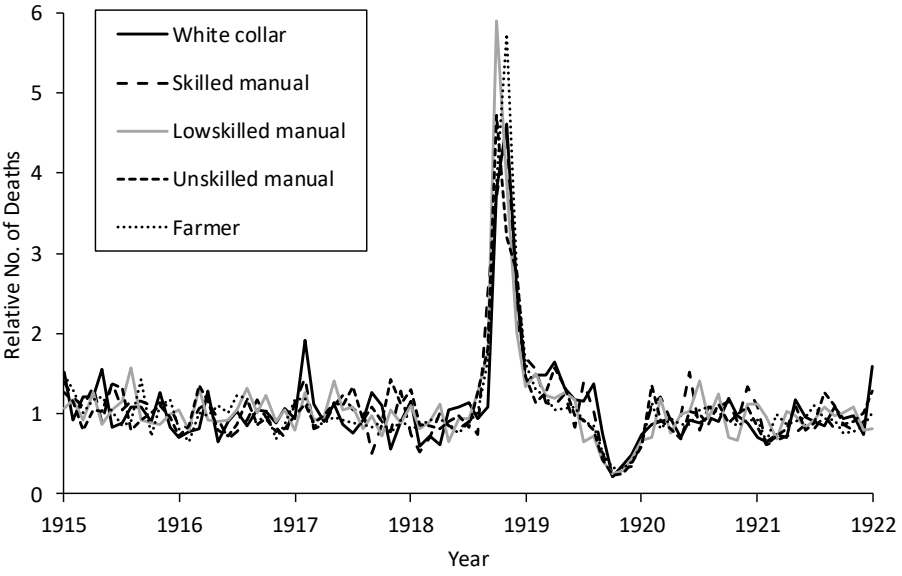
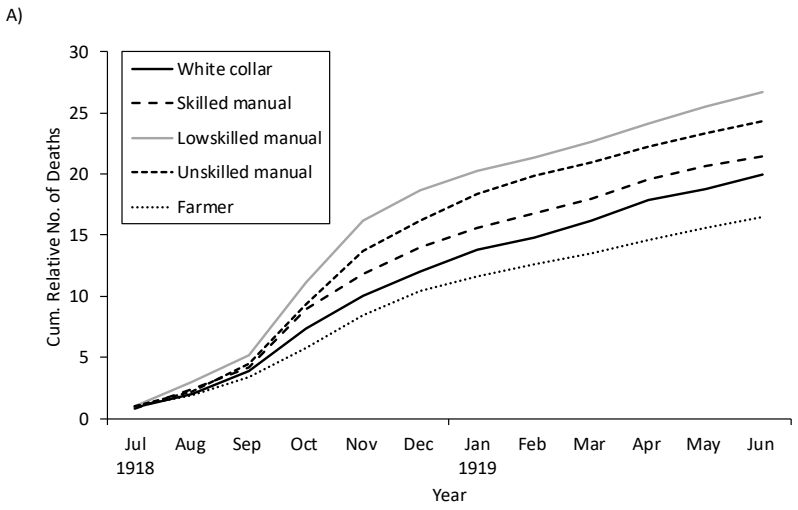
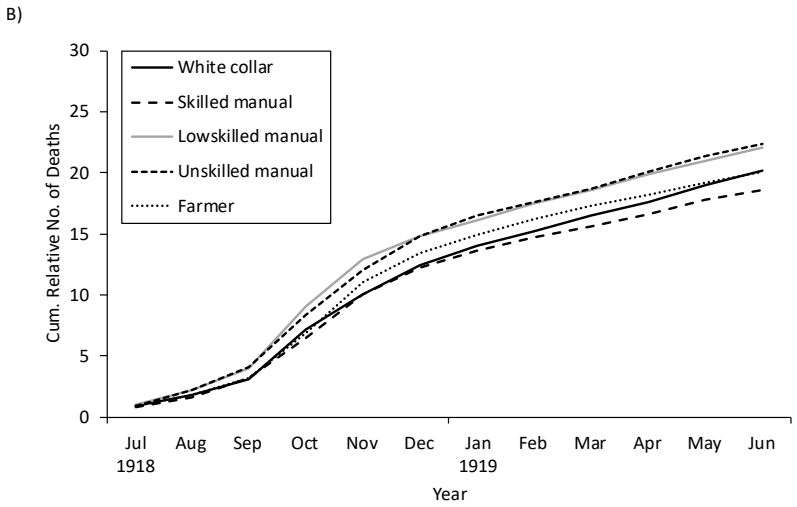


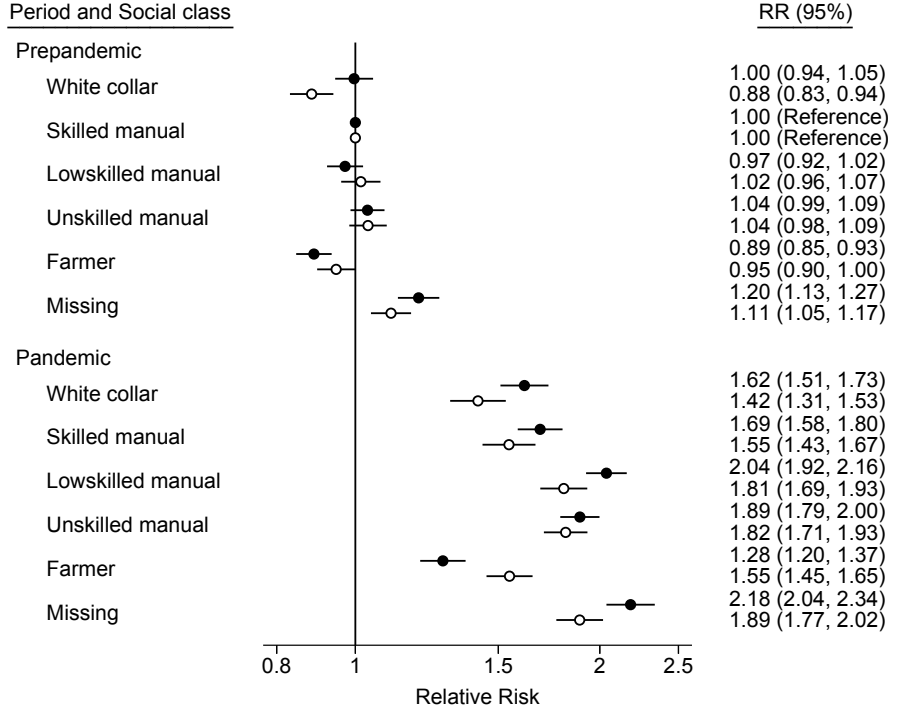
Figure 4

Men 4



Women 4




Period and Social class
RR (95%)
Prepandemic
White collar
1.00 (0.94, 1.05)
Skilled manual
0.88 (0.83, 0.94)
Lowskilled manual
1.00 (Reference)
Unskilled manual
1.00 (Reference)
Farmer
0.97 (0.92, 1.02)
Missing
1.02 (0.96, 1.07)
1.04 (0.99, 1.09)
1.04 (0.98, 1.09)
0.89 (0.85, 0.93)
0.95 (0.90, 1.00)
1.20 (1.13, 1.27)
1.11 (1.05, 1.17)
Pandemic
White collar
1.62 (1.51, 1.73)
Skilled manual
1.42 (1.31, 1.53)
Lowskilled manual
1.69 (1.58, 1.80)
Unskilled manual
1.55 (1.43, 1.67)
Farmer
2.04 (1.92, 2.16)
Missing
1.81 (1.69, 1.93)
1.89 (1.79, 2.00)
1.82 (1.71, 1.93)
1.28 (1.20, 1.37)
1.55 (1.45, 1.65)
2.18 (2.04, 2.34)
1.89 (1.77, 2.02)
0.8
1
1.5
2
2.5
Relative Risk

Web Tables 1-4

Web Table 1. Occupational distribution of the analytical sample and corresponding cohorts in the 1910 census.

	Analytical sample				1910 census			
	Men		Women		Men		Women	
Social class	n	%	n	%	n	%	n	%
White collar	89,246	12.1	86,618	12.1	144,857	12.7	146,812	12.3
Skilled manual	110,124	15.0	92,728	12.9	169,881	14.9	140,814	11.8
Lowskilled manual	129,821	17.6	112,014	15.6	203,318	17.9	177,713	14.9
Unskilled manual	163,955	22.3	149,280	20.8	261,958	23.0	241,305	20.3
Farmer	162,775	22.1	149,745	20.9	216,150	19.0	205,626	17.3
Missing	80,683	11.0	125,800	17.6	140,628	12.4	278,735	23.4
Total	736,604		716,185		1,136,792		1,191,005	

Web Table 2. 1900-1910 Social class mobility

a. Men

		Social class in 1910 (%)	
Social class in 1900	n	Same	Different
White collar	57,232	82.0	18.0
Skilled manual	82,788	73.3	26.7
Lowskilled manual	78,261	58.1	41.9
Unskilled manual	153,786	49.8	50.2
Farmer	134,801	86.5	13.5
Total	506,868		

b. Women

		Social class in 1910 (%)	
Social class in 1900	n	Same	Different
White collar	44,247	79.1	20.9
Skilled manual	59,540	70.1	29.9
Lowskilled manual	64,354	59.3	40.7
Unskilled manual	157,049	48.7	51.3
Farmer	126,028	87.3	12.7
Total	451,218		

Web Table 3. Excess hazard by social class during the pandemic relative to the pre-pandemic period.

	Men		Women	
Social class	**RR**	**95% CI**	**RR**	**95% CI**
White collar	1.62	1.51, 1.74	1.60	1.48, 1.74
Skilled manual	1.69	1.58, 1.80	1.55	1.43, 1.67
Lowskilled manual	2.10	1.98, 2.22	1.78	1.67, 1.90
Unskilled manual	1.83	1.73, 1.92	1.75	1.66, 1.85
Farmer	1.44	1.36, 1.53	1.64	1.54, 1.73
Missing	1.82	1.70, 1.96	1.71	1.61, 1.81

Abbreviations: RR, relative risk rate; CI, confidence interval.

Web Table 4. Alternative models

	a. Men (*n* = 33,864,311 person months)				b. Women (*n* = 33,552,942 person months)			
	Model 1[a]		Model 2[b]		Model 3[a]		Model 4[b]	
	RR	95% CI	OR	95% CI	RR	95% CI	OR	95% CI
Period								
Pre-pandemic	1	Reference	1	Reference	1	Reference	1	Reference
Pandemic	1.69	1.58, 1.80	1.69	1.59, 1.80	1.55	1.43, 1.67	1.55	1.43, 1.67
Social class								
White collar	1.00	0.94, 1.05	1.00	0.94, 1.05	0.88	0.83, 0.94	0.88	0.83, 0.94
Skilled manual	1	Reference	1	Reference	1	Reference	1	Reference
Lowskilled manual	0.97	0.92, 1.02	0.97	0.92, 1.02	1.02	0.96, 1.07	1.02	0.96, 1.07
Unskilled manual	1.04	0.99, 1.09	1.04	0.99, 1.09	1.04	0.98, 1.09	1.04	0.98, 1.09
Farmer	0.89	0.85, 0.94	0.89	0.85, 0.93	0.95	0.90, 1.00	0.95	0.90, 1.00
Missing	1.20	1.13, 1.27	1.20	1.13, 1.27	1.11	1.05, 1.17	1.11	1.05, 1.17
Pandemic x Social class								
Pandemic x White collar	0.96	0.87, 1.05	0.96	0.87, 1.05	1.04	0.93, 1.16	1.04	0.93, 1.16
Pandemic x Skilled manual	1	Reference	1	Reference	1	Reference	1	Reference
Pandemic x Lowskilled manual	1.24	1.14, 1.35	1.24	1.14, 1.35	1.15	1.04, 1.27	1.15	1.04, 1.27
Pandemic x Unskilled manual	1.08	1.00, 1.17	1.08	1.00, 1.17	1.13	1.03, 1.24	1.13	1.03, 1.24
Pandemic x Farmer	0.85	0.78, 0.93	0.85	0.78, 0.93	1.06	0.96, 1.16	1.06	0.96, 1.16
Pandemic x Missing	1.08	0.98, 1.19	1.08	0.98, 1.19	1.10	1.00, 1.21	1.10	1.00, 1.21

Abbreviations: OR, odds ratios; RR, relative risk rate; CI, confidence interval.

a Model 2 and 4 adjusts for age (5 year categories), marital status, number of children, migrant status, urban status, and county of residence. Estimated using complementary log-log model, Standard errors clustered at the individual level.

b Model 1 and 3 adjusts for age (5 year categories), marital status, number of children, migrant status, urban status, and county of residence, Estimated using logistic model.