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War- and famine-related excess mortality among civilians in the Netherlands, 1944–1945

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ABSTRACT

National estimates exist for war- and famine-related deaths in the Netherlands during the last stages of World War II, but no such estimates are available at the local level. To fill this information gap, this article aims at mapping and visualizing the timing of war- and famine-related excess mortality by municipality among the civilian population within the Netherlands. We use mortality statistics at the level of municipalities because these are the smallest administrative units for which this information is available. We use a seasonally adjusted mortality model combined with a difference-in-difference approach to estimate the number of excess deaths in the period between January 1944 and July 1945 separately for each Dutch municipality.

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1. Introduction

The Second World War caused enormous numbers of deaths, not only in terms of military casualties but also civilian casualties. Davies (2006) estimated total losses in Europe at almost 38 million deaths of which around 28 million civilians. The total war losses in the Netherlands during the occupation of the country have been estimated at 210,000 fatalities (CBS, 1948a). These numbers include Jewish victims and political prisoners deported to Germany, prisoners of war and forced labourers in Germany as well as civilian victims of military operations, executions and famine in the Netherlands, but not excess disease-related mortality within the country as an indirect result of the war.

Within the Netherlands, occupied from 10 May 1940 until 5 May 1945, mortality strongly increased towards the end of the war (CBS, 1957). The crude mortality rate of 11.8 deaths per 1000 inhabitants in 1944 was almost 40% higher than the 8.6 deaths per 1000 inhabitants in the pre-war year 1939. The crude mortality rate further increased by another 30% to 15.3 per 1000 in 1945. The estimated increases of the mortality rates for 1944 and 1945 are conservative, as not all war-related deaths could be taken into account. The Dutch national death statistics over the war years 1940–1945 do not include persons who were administratively removed from the local population registers on deportation to Germany and died abroad. These individuals are missing from the national death statistics as they could no longer be reported as deceased by local authorities. This especially applies to the

approximately 104,000 Jewish citizens and 18,000 political prisoners who were deported to Germany (and German-occupied Poland), the 27,000 conscripted labourers who were forced to work in Germany, and the 7500 persons missing in Germany who were presumably no longer alive (CBS, 1948a). Ignoring these predominantly deceased abroad missing from the Dutch national death statistics, the war-related excess mortality within the Netherlands in the final war years 1944–1945 has been estimated at 91,000 deaths (Ekamper et al., 2017). In the Dutch collective memory, the hunger and cold during the Dutch famine or *Hongerwinter* in the winter of 1944–1945 in the urban west of the country have always been seen as the most important causes of excess mortality during the last stages of the war in the Netherlands (Barnouw, 1999). Ekamper et al. (2017) estimated, however, using three broad regions (urban west, rural west, and the rest of the country), that almost half of the excess mortality in that period occurred outside the west of the country.

This article aims at mapping and visualizing the timing of war-related excess mortality of the civilian population *within* the Netherlands during the liberation of the country at a much more detailed spatial level than in previous studies. We use mortality statistics at the level of municipalities – the smallest spatial entities of Dutch local administrative authorities available – compiled from a previously unavailable database from Statistics Netherlands. All individuals who died abroad fall beyond the scope of this article.

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2. The liberation of the Netherlands

The liberation of the Netherlands started in September 1944. After the Normandy landings D-Day June 6th, it took almost 100 days before the Allied Forces reached the Dutch border. During the advance of the Allied Forces, the American 30th Infantry Division entered the south of the Netherlands on September 12th 1944 (Klep & Schoenmaker, 1995). Mesch, in the province of Limburg, south of the city of Maastricht and close to the southern border with Belgium, was the first Dutch village liberated that day. Two days later Maastricht was the first Dutch city liberated from German occupation. With *Operation Market Garden* between

17 and 25 September the Allied Forces tried to seize a series of bridges of key strategic importance over the Meuse, Rhine and Waal rivers to secure an invasion route into Germany (Klep & Schoenmaker, 1995). Although larger parts of the south of the Netherlands were liberated, the Allied offensive failed to achieve the Rhine crossing and stranded around Arnhem. By mid-December the Allied advance in the Netherlands was stopped at the river region (Figure 1). The focus of the Allied military activities shifted eastwards (Klep & Schoenmaker, 1995). In February 1945, the Allied Forces started *Operation Veritable* to move to the Rhine in Germany. It was not until the end of



Figure 1. The liberation of the Netherlands during the final stages of World War II*.
 *Frontlines reconstructed from municipal liberation data (NIMH¹) and Klep and Schoenmaker (1995).

March that the Allied Forces had won this battle and the river region front line in the Netherlands had moved up north with the start of the liberation of the east and north of the country. It took until the 2nd of May 1945 before the north-eastern mainland of the Netherlands was liberated. In the meantime the west of the country was still occupied; an area with about 4.3 million people out of the total Dutch population of 9.3 million at the time (CBS, 1948b). Especially the urban areas in the west, with a total population of 2.3 million, faced a severe famine during that period.

The Dutch famine resulted from an embargo on the transport of food supplies imposed by the German occupying forces in early October 1944 as a reprisal for a wave of partisan activity including a national railway strike called for by the Dutch government in exile in London to support the Allied war efforts and hinder German military activities. Before the embargo, the food situation in The Netherlands was generally satisfactory, but official food rations dropped sharply thereafter and reached a low of 500 kcal per day by April 1945 in the large cities in the west of the country (Trienekens, 2000). The famine was exacerbated by the unusually harsh winter conditions in January 1945. The famine was terminated by the German surrender in May 1945 when Allied food supplies were rapidly distributed across the country. The severity and widespread nature of the famine have been fully documented by Burger et al. (1948).

3. Data and methods

3.1. Data sources

The main data source used for estimating and mapping the war- and famine-related excess mortality among civilians in The Netherlands is the national cause of death registry of Statistics Netherlands. This non-public electronic micro database includes all formally registered deaths in The Netherlands from January 1936 to the current date and has relatively recently become available to academic researchers through the secured remote data access environment of Statistics Netherlands. This database includes individual death records with data on date of death, age at death, sex, cause of death, place of death, and place of residence. With respect to the war period, the dataset has some limitations. Deaths among individuals deported to Germany and administratively removed from local population registers, for instance, are not included in the national death registry. Destruction (by sabotage) of municipal population registers, war related damage and disorganization of the administrative system has also lead to deficits or backlogs in the central reporting of deaths (Ekamper et al., 2017). We observed a backlog of war-related deaths in some municipalities, particularly in some frontline areas (around the city of

Arnhem and the village of Montfort). We were able to add these deaths (around 900), which were registered as having occurred several months after the war had ended, to the appropriate months. Especially in the last years of the war, cause of death information was not always recorded or incomplete for several reasons. During the war, doctors' tasks were more arduous and individuals in hiding might not always have been able to seek medical attention even in the case of serious illness, for fear of discovery. Medical confirmation of death certificates could not always take place, and burials were held clandestinely (Boerema, 1947).

From the Statistics Netherlands cause of death micro database we used a subset of 407,300 records of all deaths for the years 1944–1947. These are the records of a total of 249,500 deceased in the war years 1944–1945 (108,100 in 1944 and 141,400 in 1945) of which 9,500 (3.8%) with unknown place of death, and another 157,800 deceased in the immediate post-war years 1946–1947 (80,200 in 1946 and 77,600 in 1947). It's unknown how many of the 9500 deceased with unknown place of death died within the Netherlands or abroad. Those from this group who were not administratively removed from the local population registers but died abroad as well as an additional 37,000 (Harts & Broekhuis, 2007) who died abroad in 1944–1945 and who were removed from the population registers, fall beyond the scope of the article.

The national cause of death registry provides numbers of deaths for each municipality in The Netherlands. However, to allow estimation of (relative) mortality rates we need the population at risk for all municipalities. Annual population counts per January 1st by municipality are available from the *Demografische databank Nederlandse gemeenten* (Demographic database Dutch municipalities; Beekink & Van Crujningen, 1995).

To reconstruct the timing of the liberation we used liberation data provided by the so-called *Burgemeestersverklaringen, 1940–1945* (Mayor declarations 1940–1945) available from the archives of the Netherlands Institute of Military History (NIMH)¹. In March 1947, the Ministry of War sent a letter and two forms to all mayors in the Netherlands requesting details about the occupation and the exact liberation date of the municipality. These forms were filled in and returned to the Ministry in 1947 and 1948. We verified the liberation dates against other sources, added missing dates for a few municipalities from regional archive sources, and corrected some obvious typographic errors.

The Netherlands has had many municipal boundary changes over time resulting in a net decline of the number of municipalities from around 1250 in the early nineteenth century to 355 in 2020 (CBS, 2019; Van der Meer & Boonstra, 2006). During the years 1943–

1948, there were 1016 municipalities and no municipal boundary changes. To map the war- and famine-related excess mortality by municipality and to reconstruct the advance of the frontline during the liberation we used a vectorised and georeferenced version of the map of The Netherlands with the historical municipal boundaries of the year 1945 taken from the NLGis (Netherlands Geographic Information System) project (Boonstra, 2007). This map reflects the local administrative situation at the time and is fully consistent with the municipal classification of the mortality and population data used as well as the liberation data source used in our analyses.

3.2. Methods

Excess mortality was analysed by month because for the years 1944 and 1945 daily or weekly deaths were not available. We found however, monthly data are detailed enough to show relevant changes in data patterns over time and space. We compared monthly changes in municipal mortality rates by calculating the number of deaths per 1000 of the (average) population. We estimated the municipal monthly populations at risk in a specific year by interpolating the monthly average population between January 1 and December 31 of that year.

To compare changes in mortality in the years 1944 and 1945 relative to more normal circumstances, we used a non-war reference period. Around the World War II period, mortality rates in The Netherlands strongly decreased. The age and sex standardized mortality rate decreased from about 11 deaths per 1000 inhabitants in the early 1920s to about 6 deaths per 1000 inhabitants in the early 1950s (CBS, 1957). Also, the difference in the standardized mortality rate between the immediate pre-war and post-war years was relatively large: 8.4 deaths per 1000 in 1938–1939 vs. 7.5 in 1946–1947. From 1948 to the 1950s the mortality decline was even stronger. Since the mortality rates of the years 1946–1947 fit within the longer-term mortality decline trend and these are the non-war years closest to the 1944–1945 period, we used these years as the reference period. Monthly mortality patterns were calculated as deviations from the reference, taking seasonal mortality fluctuations into account using a similar approach as and in line with Ekamper et al. (2017). The estimates of war- and famine-related excess mortality 1944–1945 are based on two steps:

1. Estimating the number of deaths per month by municipality in the absence of the event (i.e. under ‘normal’ circumstances), and
2. Subtracting this estimate from the observed number of deaths in the presence of the event.

The baseline mortality level is estimated by applying a linear model to the monthly mortality rates, m_{rt} , in 1946 and 1947:

$$m_{rt} = \beta_{r0} + \beta_{r1} \cos\left(\frac{\pi t}{6}\right) + \beta_{r2} \sin\left(\frac{\pi t}{6}\right) + \varepsilon_{rt}$$

with r as the region (municipality) and t as the month number since December 1943. The model contains seasonal adjustments by sine and cosine functions in line with Lui and Kendal (1987). The observation period is too short to require a trend parameter like in similar models used for estimating seasonal mortality patterns over long time periods (Eilers et al., 2008; Ekamper et al., 2009).

The estimation is carried out separately for each of the two sexes and municipalities. Based on these estimations, we obtain the expected sex- and municipality-specific mortality rates for each month of 1944 and 1945, \widehat{m}_{rt} and subtract these from the observed mortality rate to obtain the excess mortality rate e_{rt} :

$$e_{rt} = m_{rt} - \widehat{m}_{rt}$$

In the next step we calculated for each month in the years 1944–1945 a difference-in-difference (Cameron & Trivedi, 2005) of the excess mortality rates. The difference-in-difference (DiD) value d_t^r reflects the difference between the excess mortality rate in a given month in the years 1944–1945 in a particular region e_{Ft} and the excess mortality rate in that same month in another region e_{rt} :

$$d_t^r = e_{Ft} - e_{rt}$$

The DiD filters out excess deaths associated with regions unaffected by the studied events and corrects for changes in deaths over time that affected all regions. DiD excess mortality rates can be transformed into actual numbers of excess deaths by multiplying with the relevant populations at risk. We used the standard error of the predictions to calculate 95% confidence intervals around the excess death rates and to derive standard errors for the DiD estimates.

The estimated numbers of monthly excess deaths per municipality can be used to visualize the spatio-temporal pattern of war-related excess deaths. The numbers of excess deaths provide a good indication of the impact of the war on the civilian population in an absolute sense and of the regions and municipalities that had to deal with the most civilian victims. However, the spatio-temporal pattern of the relative impact might be different. In less populated areas the absolute numbers of war-related excess deaths among the civilian population might be rather low whereas the relative increase in mortality could be much larger. We, therefore, use two indicators to visualize and analyze both the absolute and the relative magnitude of war-related excess mortality among the civilian population in thematic maps:

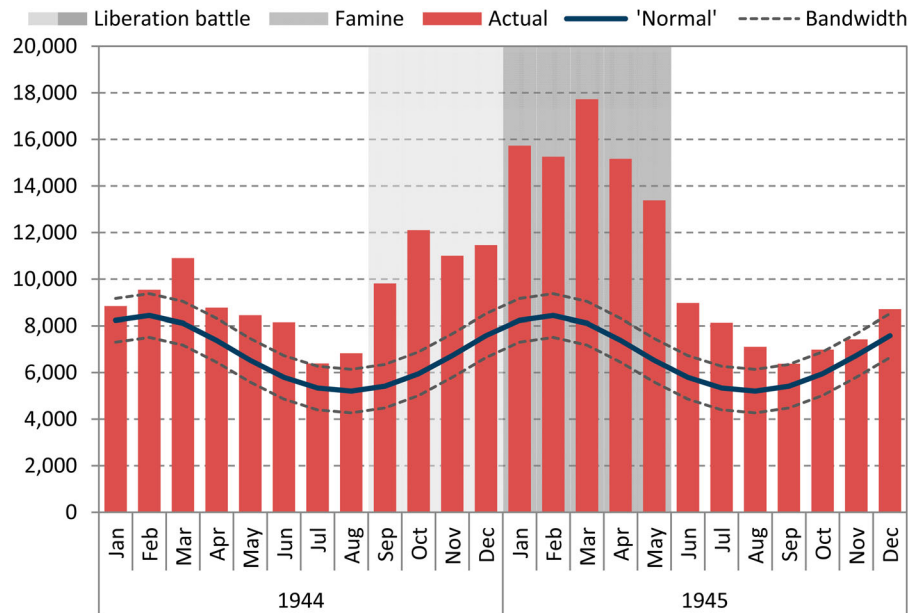


Figure 2. Actual number of deaths of civilians and the estimated 'normal' seasonal mortality pattern* by month, within The Netherlands, 1944-1945**.

Notes: * Estimation of 'normal' pattern and 95% confidence interval bandwidth based on seasonal adjusted mortality trends 1946-1947. ** The liberation battle lasted from September 12th, 1944 to May 5th, 1945. Source: Calculations by NIDI using non-public microdata from Statistics Netherlands.

- Number of excess deaths = the actual number of observed deaths minus the expected number of deaths in 'normal' circumstances.
- Excess mortality ratios = the number of actual deaths divided by the expected number of deaths in 'normal' circumstances (an excess mortality ratio of 3 means 3 times as many deaths as normally).

Where the number of excess deaths is an absolute indicator to be visualized in proportional symbol maps and the excess mortality ratio is a relative indicator to be visualized in choropleth maps.

4. Results

The total number of war- and famine-related excess deaths of civilians in the Netherlands in the period between January 1944 and July 1945 has been estimated at around 91,000 excess deaths (Ekamper et al., 2017), which amounts to 75 per cent of all mortality over that period. The number of deaths among civilians started to increase sharply from September 1944, when the liberation battle in the Netherlands began, again from January 1945, when the famine began to take its toll, and finally from March 1945 when the liberation battle was intensified again after the deadlock during the winter months (see Figure 2). Mortality remained higher than normal after the liberation of the country due to delayed impact of the war-time and famine situation.

The spatial pattern of the numbers of excess deaths by municipality during the entire period from

September 1944 to May 1945 is dominated by the three largest cities: Amsterdam, Rotterdam and The Hague (Figure 3). These cities, all in the urban west of the country, which were only liberated after the German surrender in May 1945, suffered heavily from the famine. The total excess death toll over the entire period was 6800 deaths in Amsterdam of which 85% over the famine period from January 1945 to May 1945, 5700 in Rotterdam of which 91% over the famine period, and 4300 in The Hague of which 95% over the famine period, but including around 550 deaths accidentally caused by a misplaced Allied bombing on March 3, 1945 (Korthals Altes, 2014). Other municipalities in the west show relatively high numbers of excess deaths as well. Another region with a relatively high excess death toll is the area around the cities of Arnhem and Nijmegen where *Operation Market Garden* started and stranded in September 1944. The area remained in the frontline until the frontline moved north from March 1945 onwards (Klep & Schoenmaker, 1995). Over time the concentration of the civilian excess death toll shifted from the frontline areas in September 1944 – December 1944 to the famine areas in the urban west in December 1944 – May 1945 (Main Map).

The spatial pattern of the numbers of excess deaths is clearly dominated by the famine-related mortality in the urban west of the Netherlands. However, using a relative indicator, the excess mortality ratio, shows a different spatial pattern (Figure 4). The average excess mortality ratio for the country as a whole over the period from September 1944 to May 1945 was 1.97 (almost 100% more deaths compared to normal circumstances), and in Amsterdam, Rotterdam,

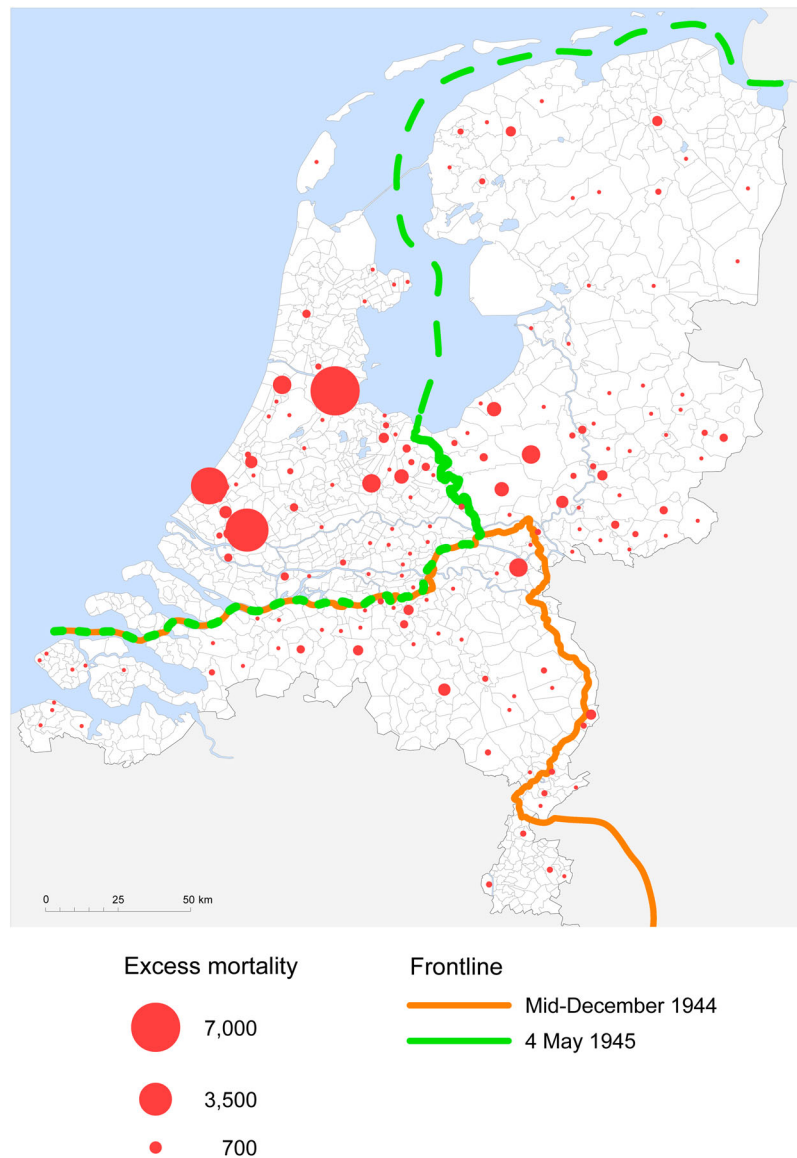


Figure 3. Estimated numbers of civilian excess deaths during World War II from September 1944 to May 1945* by municipality in the Netherlands.

* Only values for municipalities with at least 50 civilian excess deaths are shown. Source: Calculations by NIDI using non-public microdata from Statistics Netherlands.

and The Hague around 2.40. Excess mortality ratios were much higher in areas strongly affected by operations of war. In the province of Zeeland in the southwest of the country, civilian mortality ratios were high mainly due to the *Battle of the Scheldt*, a series of military operations in October and the beginning of November 1944 to open up the shipping route over the river Scheldt to the harbour of Antwerp in Belgium. For instance, due to bombings, the excess mortality ratio in the municipality of Westkappelle was 14.7 (almost fifteen times as many deaths compared to normal circumstances). Also, the river area in the centre of the country showed high mortality ratios. This region was in the frontline for several months since the Allied forces were not able to cross this natural barrier during the winter months. However, some areas in this region, for example in and around the city of Arnhem showed no increased mortality. In

these areas, almost all of the civilian population had been evacuated. Another region with relatively high excess mortality ratios was the Roer Triangle area in the province of Limburg in the southeast. In January 1945 the Allied forces started *Operation Blackcock* to clear the German troops from this area involving heavy artillery firing, and several bombings of the village of Montfort (Klep & Schoenmaker, 1995). The excess mortality ratio in the municipality of Montfort was 23.6 over the entire nine-month period from September 1944 to May 1945. Since most military operations in specific areas took place within a limited time span (from days to weeks), excess mortality ratios for the specific months covering those time spans were even much higher. Over time the concentration of the relatively highest civilian excess death toll primarily shifted along with the frontline (Main Map).

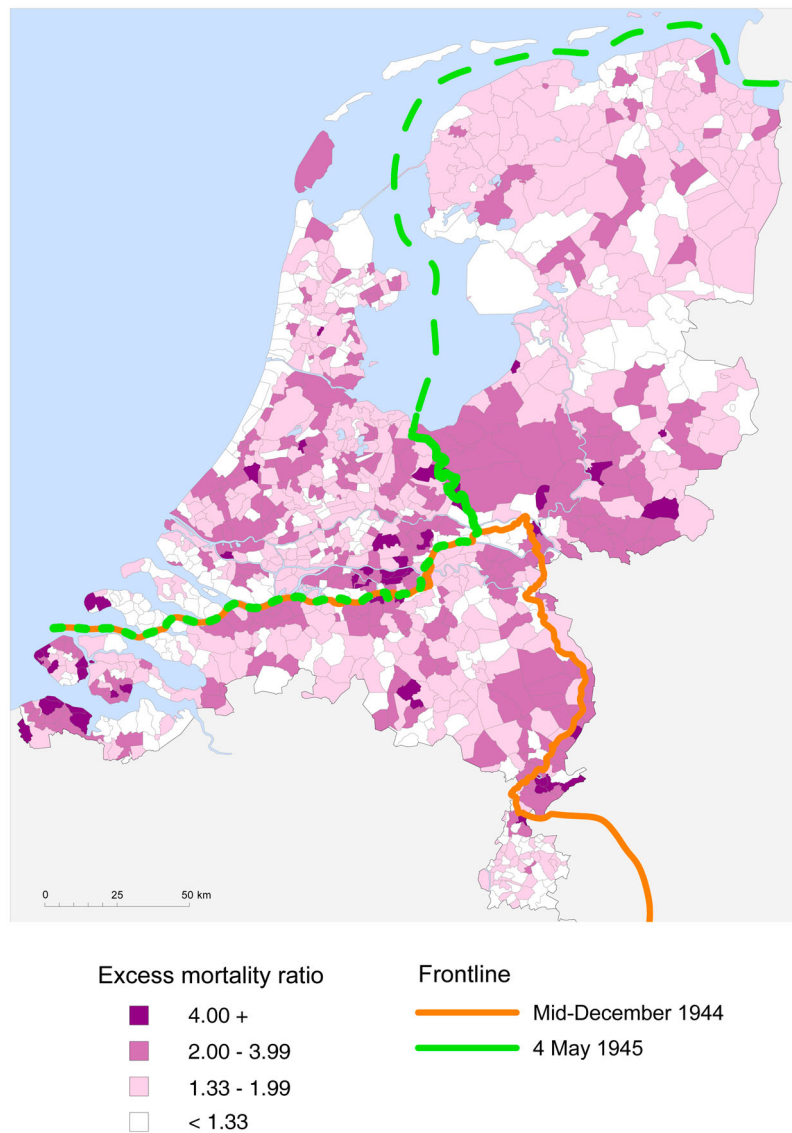


Figure 4. Estimated civilian excess mortality ratios* during World War II from September 1944 to May 1945 by municipality in the Netherlands.

Source: Calculations by NIDI using non-public microdata from Statistics Netherlands.

5. Summary and conclusions

This article aimed at mapping and visualizing war-related excess mortality of the civilian population within the Netherlands during the liberation of the country in World War II. The mapping is at the level of municipalities, the smallest available administrative unit. It contributes to a better understanding of the war- and famine-related excess mortality in both space and time. Although the available microdata have some limitations, they clearly show the varying pattern of excess mortality in space and time within the Netherlands in the years 1944–1945 (*Main Map*). Unfortunately, the data do not include individuals who were administratively removed from the local population registers upon deportation. We do know however that the vast majority of these individuals died in Nazi concentration camps outside the Netherlands. We also observed missing and delayed

registrations of war-related deaths in some of the Dutch municipalities and corrected for this. Since the cause of death information was incomplete this could not be used to estimate famine-related mortality. As the famine, however, was the most important war-related cause of death in the urban west, our estimate of excess mortality for the urban west reasonably is likely to reflect the true impact of the famine.

The two indicators used, the number of excess deaths and the excess mortality ratios, show both similarities and differences in the spatial mortality patterns. Whereas the spatial pattern of high absolute numbers of excess deaths is dominated by the famine-struck urban west of the country, the pattern of relative excess mortality is strongly affected by warfare intensity. Hunger and cold have always been seen as the most important cause of excess mortality during the final stages of the war as seems to be confirmed by the spatial pattern

of the absolute numbers of excess deaths. However, almost half of all war-related excess mortality in that period occurred outside the famine area. The area outside the west accounted for over 70 percent of all excess mortality in the period September–December 1944 and 30 percent in the period January–May 1945. This shows that the activities of war during the liberation of the non-famine area outside the west of the country also dramatically contributed to excess mortality among the civilian population. As it becomes clear from the spatial pattern of excess mortality ratios, the relative indicator, this impact was at least as dramatic for the civilian population outside the famine area as the impact of the famine in the west. In some areas, especially the Scheldt estuary in the southwest and the Roer Triangle in the southeast, the relative impact on the population as measured through the excess mortality ratios appeared to be even more dramatic than in the famine area.

Software

All the maps were created in MapInfo Pro v17. The supplementary map was finalized in Adobe Acrobat Pro DC. All the data visualized in the maps were estimated with Stata version 14.

Note

1. Netherlands Institute of Military History (NIMH), The Hague, The Netherlands, *Burgemeestersverklaringen (1940-1945)*, call nr. 420, inv. nrs. 25-50. ["Declarations of the Dutch mayors concerning (a.o.) the liberation date, acts of resistance, members of the resistance and those who died during acts of resistance."]

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