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Descriptive Finding

The strength and vulnerability of school-age children

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The strength and vulnerability of school-age children

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Abstract

BACKGROUND

Children between the ages of 5 and 14 appear to have a lower risk of dying than both younger and older individuals.

OBJECTIVE

We looked for possible factors influencing the mortality rates of school-age children in Norway during the German occupation from 1940 to 1945, i.e., at a time of poverty and moderate food shortage – and before the general use of vaccines.

METHODS

We used Norwegian mortality data by age and sex, during the period of 1930–1954, from the Human Mortality Database and obtained the main causes of death, as well as age-specific data from different regions of Norway, from Statistics Norway.

RESULTS

Boys and girls aged 5–14 years had lower mortality rates than any other age group below 40, even during the German occupation. However, 5–14-year-old boys as well as 5–9-year-old girls had significantly increased mortality during 1941–1945 as compared to the previous decade. Mortality as a result of diphtheria, pertussis, scarlet fever, and measles increased more than five-fold, surpassing mortality as a result of accidents, whereas mortality from these infections only doubled in adults up to 39 years. During that same period, the body weight of schoolchildren aged 8–13 years dropped slightly.

CONCLUSIONS

Proper nourishment, being of the utmost importance for a functioning immune system,

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is key to understanding the potential vulnerability of children at any age. Our study shows how vulnerable even the most resistant children can be.

CONTRIBUTION

The vulnerability of children 5–14 years old may not have been properly taken into account, as was also shown in the recent upward UN revision of 5–14 age mortality in low- and middle-income countries.

1. Background

A reduced risk of infectious diseases appears to be the main reason for a decrease in mortality in Norway after 1900 (Backer 1961), but also the key reason for the markedly improved life expectancy worldwide over the last decades (World Mortality Report 2013). Young children were hardest hit by infectious diseases before their immune systems had fully developed. On the other hand, children from 5 to 14 years of age were somehow protected from a fatal outcome of infections, despite the fact that they were the ones most often infected, e.g., by new influenza viruses (Glezen 1996; Brundage and Shanks 2008; Rizzo et al. 2010), *Mycobacterium tuberculosis* (Davenport 2013; Marais et al. 2004), and *Plasmodium malariae* (Snow and Omumbo 2006; Filipe et al. 2007). The age period from 4 to 13 has thus been called “the honeymoon period of infectious diseases,” supposedly linked to the capacity of the adaptive immune system that seems to have reached maximal strength at the age of 10 (Ahmed, Oldstone, and Palese 2007; Giuliano et al. 2007). Children around this age, moreover, have the lowest risk of dying even in today’s developing countries plagued with tropical diseases and relatively short life expectancy (World Mortality Report 2013). In order to shed light upon possible reasons for the high resistance of these school-age children, even to fatal accidents (Centers for Disease Control and Prevention 2014), we investigated mortality in Norway during the German occupation from 1940 to 1945, i.e., at a time of poverty and food shortage and before the general use of vaccines.

2. Methods

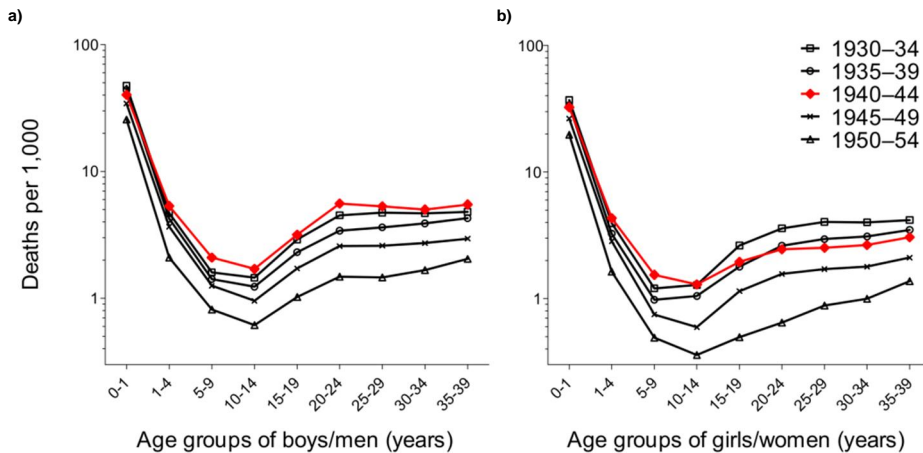
Norwegian mortality data by age, sex, and calendar years was collected from The Human Mortality Database (Human Mortality Database 2014). In addition, the primary causes of death, as well as age-specific mortality data from Finnmark and Hordaland counties of Norway, were obtained from publications by Statistics Norway (Backer

1961; Statistics Norway 1949a; Statistics Norway 1949b). Finally, previously published data on the development of body weights and heights of schoolchildren from the city of Oslo was permitted to be reproduced here (Brundtland, Liestøl, and Walløe 1980).

3. Results

During the five-year period from April 1940 until May 1945, when Norway was occupied by German troops, the mortality rates of Norwegian males of all age groups from 1 to 39 years were higher than during the preceding 10 years (Figure 1a). These rates deviated from the expected pattern of a near constant reduction of mortality with each time period from 1930–1934 until 1950–1954. In females, however, higher mortality rates during the occupational period, as compared to the preceding two five-year periods, were evident only for children 1–4, 5–9, and 10–14 years old, whereas the pattern of reduced mortality within each time period resumed from the age of 20 (Figure 1b). This was also the case in infant boys and girls, who demonstrated higher mortality than any of the other age groups investigated – the pattern of reduced mortality with time seemed largely uninterrupted during the war (Figures 1a and 1b).

Figure 1: Mortality in groups of a) boys/men and b) girls/women, from 0–1 to 35–39 years of age during five-year periods from 1930–1934 to 1950–1954



The lowest mortality rates, as compared to any other age group within the same gender, were seen in 5–9- and 10–14-year-old boys and girls, as was also clearly evident during the period from 1940 to 1944 (Figures 1a and 1b). When measuring the mortality rates year-by-year, however, 5–9-year-old boys and girls and 10–14-year-old boys had a significantly increased risk of dying during the years 1941–1945, as compared to the previous decade (Figures 2a and 2b, and Table 1a). This pattern remained also after removing from the analysis the number of age-related deaths from the county of Finnmark during the period 1942–1945 and the county of Hordaland during 1944, to avoid the impact of deportation and actions of war.

Figure 2: Mortality in groups of a) boys/male youths and b) girls/female youths, from 1–4 to 15–19 years of age, during each year from 1930 to 1954

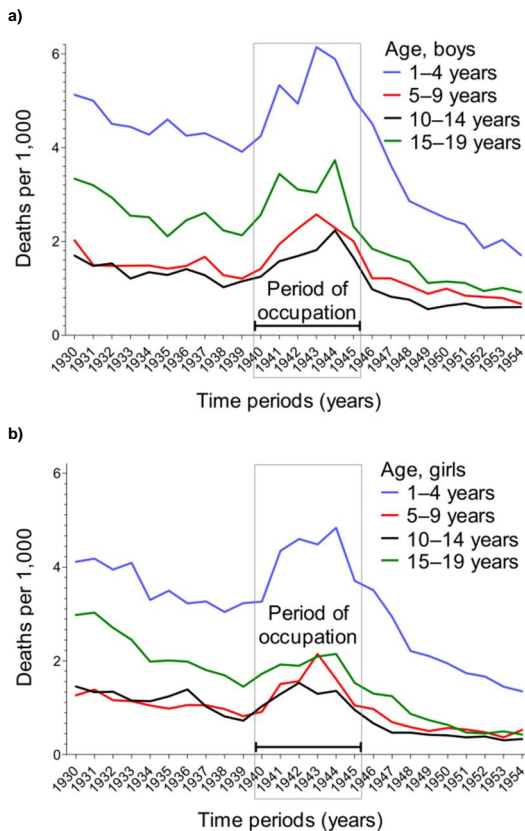


Table 1: The percent increase (+) or decrease (–) of mortality rates, in groups of males and females, during the periods a) 1941–1945 versus the previous 10-year period 1931–1940, and b) 1940–1944 versus the previous 10-year period 1930–1939

a)

Age	Males		Females	
	Change %	<i>P values</i>	Change %	<i>P values</i>
0–1 years	–11.9	0.005	–6.3	n.s.
1–4 years	+25.3	0.001	+25.4	0.005
5–9 years	+53.8	<0.001	+49.8	0.013
10–14 years	+40.0	0.001	+15.0	n.s.
15–19 years	+23.7	n.s.	– 8.1	n.s.

b)

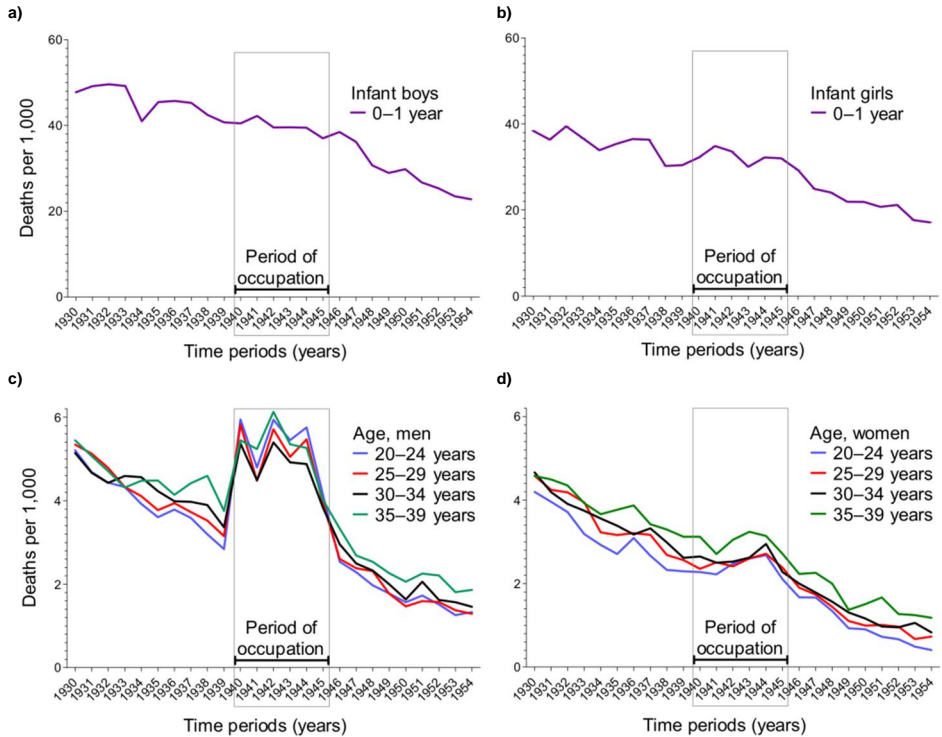
Age	Males		Females	
	Change %	<i>P values</i>	Change %	<i>P values</i>
20–24 years	+40.9	0.001	–20.7	0.028
25–29 years	+26.9	0.013	–28.0	0.005
30–34 years	+17.0	0.019	–25.5	0.005
35–39 years	+20.8	0.010	–20.7	0.003

Note: n.s. = not significant. The probability, as *P-values*, of higher or lower values was determined with use of the nonparametric Mann-Whitney test.

Similar increased mortality rates during the war were seen in both boys and girls 1–4 years old (Figures 2a and 2b, and Table 1a). Girls aged 10–14 and male youths aged 15–19, on the other hand, appeared to have increased mortality rates during the period 1941–1945, when measured year-by-year, but not significantly different from those of the previous 10 years. Moreover, female youths aged 15–19 showed an insignificant reduction in their mortality rates during the same war period (Table 1a).

In infants, as suggested above, the year-by-year death rates were also seemingly not influenced by the war (Figures 3a and 3b). Infant males had a significantly *lower* risk of dying during these years, as compared to the previous decade, whereas this difference was not significant for the infant females (Table 1a). In contrast, adult males of ages 20–24 to 35–39 showed an abrupt increase in mortality rates as soon as the war started, whereas women of the same ages experienced significantly reduced mortality during the years of occupation (Figures 3c and 3d, and Table 1b).

Figure 3: Mortality in a) infant boys and b) infant girls, and in groups of c) men and d) women, from 20–24 to 35–39 years of age, during each year from 1930 to 1954



4. Discussion

Despite the fact that Norway was not as badly hit as many other European countries during World War II, increased mortality rates were observed in children of both sexes, as well as in adult males. Even in these times of hardship, children from 5 to 14 years of age stayed within the pattern of having lower overall mortality rates than any other age group.

Whereas death rates of 20–39-year-old males increased abruptly as soon as the war started, the increased rates in children were evident only after about a year, i.e., from 1941. Although 61 boys lost their lives in 1944 when a school close to the city of Bergen was hit by airstrike bombs (Statistics Norway 1949a), we found no evidence

that this action had significant impact on the mortality of school-age children in Norway. Similarly, there was little impact observed as a result of the near total destruction of the northernmost county of Finnmark, and deportation or hiding of its population, before being invaded by Soviet troops in 1944, when calculations were made collectively for the period 1941–1945.

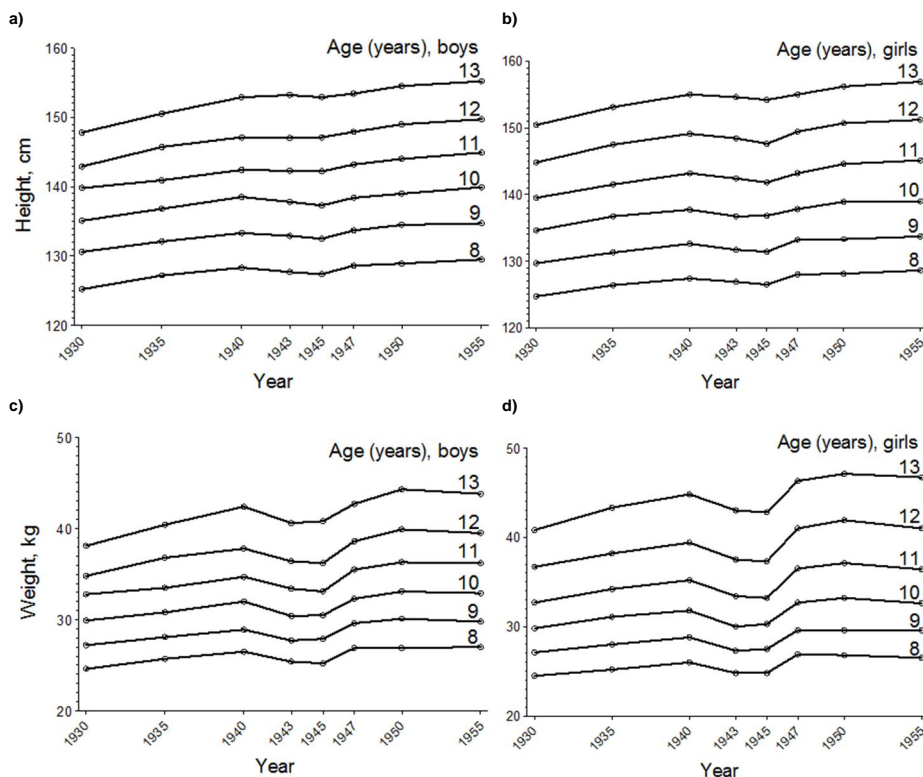
On the other hand, infections turned out to be the most common cause of child death during that period, surpassing accidents even in 5–14-year-old boys (Backer 1961). The mortality due to so-called common infections, i.e., diphtheria, scarlet fever, pertussis, and measles increased more than five-fold in school-age children of both genders, whereas they were responsible for only a doubling of the mortality figures for adults up to 39 years of age (Backer 1961). Such infections, having a marked effect on mortality rates in all groups of children, were not surprising in those under five with an immature immune system. In 5–14-year-old children, however, they turned out to be responsible for almost one in five deaths during that period. It is likely, thus, that their immune system had in some way been affected, e.g., by the common shortage of food (Statistics Norway 1949b).

In fact, health controls of school-age children from the city of Oslo in 1943 and 1945 revealed a small and transient drop in body weight, and less so of height, compared to measurements in 1940 (Brundtland, Liestøl, and Walløe 1980). These findings were consistent for every age group from 8 to 13 (Figure 4). Moreover, postwar analyses seemed to indicate that their diets at that time had been largely deficient in fat, but not in carbohydrates or proteins (Strøm 1948).

Even though this drop in weight of children during the war was just as evident in girls as in boys (Brundtland, Liestøl, and Walløe 1980, see Figure 4), the supposed influence on the immune system in the present study seemed to be greater in boys. This is in line with findings that boys in general have higher mortality rates than girls from birth, whether it is due to infections (Muenchhoff and Goulder 2014) or accidents (Sekii et al. 2013). However, the results of this study seem to indicate that girls up to the age of 10 were equally vulnerable to this kind of strain as were boys – and that a greater resistance might be connected to the development of puberty.

It was surprising that the infant mortality in Norway was not influenced by World War II, although the same lack of a war effect was observed in Britain during World War I (Winter 1977). In our study, the infant boys' risk of dying in Norway during World War II was actually lower than during the previous ten years. This might be ascribed to their breastfeeding mothers not being significantly affected by the food shortage, as indicated by our finding that the mortality rates in women of childbearing age were also lower during the war than before.

Figure 4: Mean heights of a) boys and b) girls, and mean body weights of c) boys and d) girls, aged 8 to 13 years, in Oslo from 1930 to 1955



Note: From Brundtland, Liestøl, and Walløe (1980), with permission.

The evidence from Norway is thus consistent with the fact that proper nourishment, being of the utmost importance for a functioning immune system (Rytter, Kolte, and Briend 2014), is also key to understanding the vulnerability of children at any age – and how easily their health can be compromised. Even the strong immune systems of 5–14-year-old boys and girls seemed easily targeted by a moderate shortage of food. This view is further highlighted by the recent analysis that the calculated mortality rates in 5–14-year-old children living in low-income and middle-income countries were actually higher than expected on the basis of historical evidence, and higher than estimates from the UN World Population Prospects (WPP) 2012 Revision, and the Institute of Health Metrics and Evaluation’s Global Burden of Disease (GBD)

2010 Study (Hill, Zimmerman, and Jamison 2015). It thus appears that the vulnerability of this age group of children has not been properly taken into account (Mathers 2015).

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