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The Spanish Influenza among Norwegian ethnic minorities 1918-1919

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Title: The Spanish Influenza among Norwegian ethnic minorities 1918-1919

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Abstract

There are few previous studies that have applied multivariate methods to analyse Spanish Influenza mortality, and for the very first time, Spanish Flu morbidity and case fatality rates are analysed. Previous studies have reported that indigenous populations were the prime victims of Spanish Influenza. The explanations put forward in those studies were not convincing, however, as no controls were made for possibly confounding factors. This paper documents for the first time that areas with high shares of an indigenous population, the Norwegian Sami, have high Spanish Influenza mortality and lethality, net of such confounding factors as wealth, crowding, height, occupational structure, settlement patterns and diffusion. The cause is probably a lack of inherited and acquired immunity against influenza among the Sami. Another ethnic Norwegian minority, Kven (Finnish immigrants and their descendants), however, did not differ significantly from the Spanish Influenza mortality and lethality of the Norwegian majority population.

1. Introduction[1]

Spanish Influenza swept the entire globe in four waves in the years 1918-1920, leaving a billion people sick, more than half of the world's population at that time. It killed between 50 and 100 million, five to ten times the death toll of soldiers during World War I (Johnson 2000). The first pandemic wave was relatively mild and started during the spring and summer of 1918, either in China or in USA (Shortridge 1999). The second wave was highly virulent, took a great mortality toll, and occurred during the fall of 1918. The third wave broke out during the first months of 1919, and claimed fewer deaths as the first waves left some immunity and the most susceptible individuals were eliminated by death. A fourth wave occurred in the winter of 1920, basically in small rural or isolated settlements that missed the pandemic in 1918-1919. The flu probably infected 1.2 million Norwegians, and 15,000 deaths were recorded in a population of 2.6 million. The case fatality rate was only 1.2 per cent, however, and less than one per cent of the population died (Mamelund 1998). The socio-economic impact of the flu was considerable, mainly because it took its greatest toll in the age group 20-40 years, i.e., that part of life when people tend to marry, have children and are most economically productive (Mamelund 1999). There were also clear socio-economic, racial and ethnic differences in mortality. The indigenous populations seemed to be particularly hard hit by high mortality. Nevertheless, the pandemic has been largely forgotten and until recently bypassed by demographers.

2. Objective

The objective of this paper is to analyse whether ethnic minorities were harder struck by Spanish Influenza morbidity and mortality than the Norwegians. I use aggregate data for 376

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medical districts in Norway in the years 1918-1919, and apply least square regression to estimate a number of cross sectional regression models. Several authors have documented extremely high mortality among indigenous compared to non-indigenous populations (Pool 1973; Åman 1990; Tomkins 1992; Kelm 1998; Linanmäki 2000). However, these studies were all univariate and could not demonstrate a "minority effect," net of the effect of other variables. For instance, did minority group members have high mortality because they were relatively poor, or can independent effects be demonstrated? The purpose of this paper is to answer such questions. I shall look at two Norwegian minority groups, Finnish immigrants and their descendants (Kven) and the indigenous Sami population (Lapp), and control for possible confounding factors such as poverty, wealth, height (as a proxy of nutrition and disease history), crowding, occupational structure and geography. The paper is structured as follows. First, in sections 3 and 4 I will give an introduction to the geography and economy of the Sami and Kven around 1920 and a review of previous studies on overall mortality patterns of Sami and Kven respectively. Section 5 gives a short story on how the First World War affected ethnic minorities. Next, section 6 presents previous research on Spanish Influenza mortality among indigenous as well as non-indigenous populations. Then, sections 7 and 8 discuss data and methods respectively. Estimation results are presented in section 9.

3. The geography and economy of Sami and Kven around 1920

About two thirds (20,000) of all Sami lived in Norway in 1920. The last third lived in Sweden, Finland and in Russia.[2] The Norwegian Sami generally lived and had the highest shares of the population in the northernmost counties of Finnmark, Troms, and Nordland, but there were also scattered settlings of Sami as far south as Røros-Femund in Hedemark ("South Sami") (Map 1, Table 2). The Sami were originally hunters and fishermen, and the forefathers of the present Sami were probably the first to settle in Scandinavia when the

[2] 7 100 Sami lived in Sweden, 1 600 in Finland and ca. 1 800 in Russia (Statistisk sentralbyrå (SSB) 1923c).

inland glaciers started to melt in the coastal areas 12-15,000 years ago. The Sami people are a minority in Norway. In 1920 less than one per cent of the population was Sami (Table 2).

[Map 1 approximately here]

The main economic base of the Sami in 1920 was fishing (55%), agriculture (27%) and reindeer keeping (7%) (Statistisk sentralbyrå (SSB) 1923c). About two thirds lived by or near the coast, and close to 100 per cent lived in rural areas (Vorren and Manker 1976; Nesheim 1979; SSB 1923c). The Sami can be divided into three groups: The pastoral mountain Sami (10%), the pastoral forest Sami and the resident Sami. The pastoral mountain Sami primarily had their outcome from reindeer, and moved long distances between inland-mountain-winter and summer-forest-coastal grazing land. The mountain nomads had their winter inland grazing land in Kautokeino and Karasjok (Map 1).[3] The forest Sami are known to have small herds of reindeer, and moved shorter distances than the mountain nomads. The resident Sami ("sea and river-Sami") were mostly poor fishermen or crofters with small farms. Their way of life did not differ very much from that of Norwegian or Kven fishermen or crofters in northern Norway.

The second ethnic minority in Norway, Kven (Finnish immigrants and their descendants), generally lived in Finnmark as the Sami, but there were also a substantial number of Kven in three south-eastern communes in the county of Hedmark (Grue, Åsnes and Våler) (Map 2, Table 2). Most of the Kven in Finnmark migrated to Norway during the latter half of the eighteenth century with a peak during the famine in Finland in the 1860s, whereas the Kven in Hedmark migrated as early as in the seventeenth century (Iversen 1959; Eriksen

[3] There were a total of 1,258 pastoral mountain Sami in Norway 1910. 1,070 of the nomads lived in Finnmark (10.2% of all Sami in Finnmark), ca. 600 in Kautokeino and ca. 500 in Karasjok (SSB 1923c). There are no estimates for the number of nomads in 1920, but if the figures from 1910 were valid for 1920, two thirds of the Sami were nomads in Kautokeino (94% of a population of 940 was Sami) and more than half of the Sami were nomads in Karasjok (94% of a population of 960 was Sami).

and Niemi 1981). There were also a substantial number of Kven in northern Sweden and in Russia (SSB 1923c). In 1920 Norway, three out of four Kven made their living in the vulnerable sectors of fishing (51%) and agriculture (25%) (SSB 1923c). As the Sami, most of the Kven (84 per cent) lived in rural areas along the coast and in fjord areas. Of the urban Kven population, most lived in Vadsø, located near the Finnish and Russian borders, where they made up half of the population (see Map 2).

[Map 2 approximately here]

The conditions for agriculture are poor in Finnmark, with long cold winters and short summers. The Sami and the Kven often had land with the poorest suitability for agriculture. The agricultural and fishing population in Finnmark was extremely dependent on, and vulnerable to, climatic conditions and fluctuations in the economy. One crop failure or unsuccessful fishing could be enough to bring distress and famine-like situations. Twice in the 20th century, the last time in 1921, the population in the municipality of Sør-Varanger, Finnmark, for instance, was struck by famines. Areas dominated by Kven were hardest hit by the 1921-famine (Forsdahl and Salmi 1974).

4. Previous studies of mortality among the Sami and Kven

Ever since 1875, the year in which Norwegian mortality statistics for the first time were compiled on a county-level, the northern-most county of Finnmark, the home of the largest shares of Sami and Kven, has topped the list with high total mortality, and especially infant mortality and still births, compared to other Norwegian counties, towns and cities (Wessel 1914; Steen 1956; 1961; Torgersen 1956; Jonassen 1959; 1964; Forsdahl 1967; 1973; 1978; Gjestland 1968; 1970; Thorvaldsen 2001). Mortality due to accidents (esp. drowning), tuberculosis, lung cancer and coronary heart disease has been particularly high in Finnmark compared to the national average. The high mortality of the two latter causes is primarily

explained by widespread cigarette smoking. The highest mortality in Finnmark has been found in coastal areas, rural areas, among fishermen, the Sami and among Kven.

In the period 1900-1910, mortality of tuberculosis in Finnmark was twice as high as that for the country as a whole (Wessel 1914).[4] In the municipality of Sør-Varanger, Finnmark, the incidence and mortality of tuberculosis 1886-1899 was highest among Norwegians followed by Sami and Kven (Wessel 1914). This was probably due to the fact that it was Norwegians moving into Finnmark from southern parts of the country who brought tuberculosis with them.[5] After tuberculosis gained a foothold in Sør-Varanger, incidence and mortality of tuberculosis 1900-1910 was highest among Sami, followed by Kven and Norwegians. Wessel (1914) doubts whether the ethnic differences in morbidity and mortality in Finnmark can be explained by genetics. Instead, he emphasises the relatively poor standard of living and low educational level among the Sami and Kven.

Historically high levels of infant mortality among the Sami, both pastoral and resident, have also been linked to poor education (due to shorter school-year than for Norwegian children), poor Norwegian language skills among pre-school Sami children, and poor Sami-language skills among Norwegian teachers (Rein 1956; Eriksen and Niemi 1981).[6]

[4] In the period 1875-1899, however, mortality from tuberculosis was significantly lower in Finnmark compared to the country as a whole. The mortality in other parts of the country, in the capital of Kristiania, as well as in other European cities, was at least as high in the period 1875-1899 as in Finnmark 1900-1910, if not higher (Wessel 1914). The few cases of tuberculosis in Finnmark in the 1880s were probably imported by families from southern parts of Norway, or broke out in years of unsuccsessfull fishing and poor economic situation of the fishermen.

[5] The immigration of Norwegians to Finnmark in this period was partly due to a "settling-programme" to Norwegianize Finnmark (Eriksen and Niemi 1981).

[6] Of the Sami in Finnmark and Troms 1920, only 14 and 26 per cent respectively spoke the Norwegian language on a daily basis (SSB 1923c).

In addition, there were few schools and a shortage of teachers in Finnmark.[7] For the nomads, the school probably represented an unwanted break in their annual lifecycle, as it did nothing to increase profits in reindeer keeping (Aubert 1967). Poor education and poor knowledge of the Norwegian language among Kven may also be an important factor explaining higher mortality among Kven than among the Norwegians.[8] In general, mistrust between the Norwegians (authorities) and ethnic groups (Sami and Kven) lead to discrimination against the latter, not only when it came to education and the right to use and to be educated in the mother language, but also in health, culture and religion. The Sami were seen as primitive and inferior compared to the Norwegians as well as the Kven. The goal of the authorities was to make the Sami live as, and to behave as Norwegians. In the beginning of the 20th century, as a part of the "Norwegianization" policy, if you were to keep the right to land, you had to speak the Norwegian language and you had to have a Norwegian last name. The new law, however, was as much directed towards Kven as the Sami. Ethnic discrimination also took place in the labour market. Non-Norwegians, for instance, were not allowed positions at schools, in churches, the police, or in the forest- and border patrol (Niemi and Eriksen 1981). It became a source of shame to admit you were either Sami or Kven.

Moving could represent a risk factor for the nomadic mountain Sami. Did this result in higher mortality among the nomads compared to the resident Sami? Or was it rather the other way around? Did higher degree of crowding and poorer housing conditions of the resident Sami result in higher mortality of the residents than among the nomads? Among the Sami, the nomads in Karasjok and Kautokeino had the lowest mortality of tuberculosis in Finnmark in the last two decades of the 19th century (Wessel 1914). This was probably due to their isolated

[7] In Finnmark, there were only four boarding schools 1905-1907 and two secondary schools 1912-1936. In the early 1920s, there were only 150 teachers, only a few were Sami, and most did not know the Sami language (Eriksen and Niemi 1981). According to the 1920 census, only 0.3 per cent of the Norwegians in Finnmark spoke the Sami language on a daily basis (SSB 1923c).

[8] Of the Kven population in Finnmark and Troms, 61 and 32 per cent respectively spoke the Norwegian language on a daily basis (SSB 1923c).

winter settlements, little mixing with resident Sami, Kven and Norwegians, and the nomadic life on the move in the open spaces and in well-ventilated tents. Unhygienic conditions did not occur as nature took care of renovation when the nomads and their reindeers went on (Berset 1967). Since the 1890s, however, many gave up the nomadic lifestyle and settled down permanently, generally as fishermen or small farmers (Wessel 1914). The old housing tradition of the movable tent was not easily transferred to permanent residences. Around 1920, the ex-nomads lived in overcrowded and unsanitary turf-huts and most slept on the floor (Sundt 1913; Jonassen 1959; Det civile medisinalvesen (DCM) 1924).[9] As a result, the risk of being infected by tuberculosis as well as the level of mortality increased, as mixing with other people escalated and as housing conditions worsened. Housing, and social and hygienic conditions among Sami who were resident all their life were also generally held to be poor, and some authors link these conditions to the high registered infant mortality in Finnmark 1946-1961 (Rein 1956; Jonassen 1964). The relatively high mortality among Kven in Vadsø, Finnmark, in the 19th century, has also been linked to low standards of housing (Sundt 1913; Niemi 1977).

In the municipality of Sør-Varanger, Finnmark, infant mortality from 1900 until the end of the Second World War was significantly higher among Kven compared to the rest of the population (Forsdahl 1973). Infant mortality in areas of out-migration from 19th century Finland to Norway is also known to be relatively high (Lithell 1981; 1988). Brändström (1984) has found high infant mortality among Kven in 19th century Haparanda, Sweden. Significant excess total mortality has been found among male Kven 1949-1968 in Sør-Varanger compared to the rest of the population in Sør-Varanger, the whole county of Finnmark and the nation as a whole (Forsdahl 1973). Most of the excess total mortality is

[9] According to the 1920 census, approximately 2,000 Sami lived in 409 registered turf-huts or tents, i.e., 4.9 persons per turf-hut/tent (SSB 1923a; SSB 1924). The number of persons per turf-hut/tent is at the same level as the average number of persons in private national occupied dwellings (see Table 4). However, compared to the national average persons per room in private occupied dwellings, the crowding is five times higher in the turf-huts/tents (if one assumes that the turf-huts/tents have only one room).

explained by high arteriosclerotic mortality, a cause of death that has also been found to be particularly high among males living in Finland (Forsdahl 1973).

Are there other possible explanations of high mortality among the Kven? A possible explanation is that the Finnish immigrants brought with them ways of living, habits and traditions that cause high mortality. Four extensive health-studies of the population in the fishing village of Bugøynes, Sør-Varanger, 1968, 1974, 1977 and 1984, however, do not confirm this hypothesis (Forsdahl and Salmi 1974; Forsdahl et al. 1974; Forsdahl and Salmi 1980; Forsdahl and Salmi 1990). The smoking habits of men for example were not "Finnish," but more or less identical to the average (high) male cigarette consumption in Finnmark. The percentage of fat in the diet proved unfavourably high, however, and the average cholesterol level of male Kven was higher than that of the rest of the population. These two factors were not found to be of crucial importance, however. Instead, Forsdahl (1973; 1978) suggests that excess male mortality of arteriosclerotic heart disease in Sør-Varanger in the 1960s and 1970s could be attributed to the economic hardship of the period 1896-1924, which also includes two famines and Spanish Influenza. As a consequence, the oldest in Bugøynes and Sør-Varanger have grown up under conditions that give earlier ageing and lower than optimal body height (Forsdahl et al. 1974).[10] The Finnish population (data from 1977) in the municipalities of Grue, Åsnes and Våler are also generally shorter than the Norwegians in the county of Hedmark are (Prytz and Forsdahl 1977). The health studies in Sør-Varanger, Finnmark, and Grue, Våler and Åsnes, Hedmark, cannot give a satisfactory answer to the question of whether genetic factors explain the high mortality among Kven. However, there are reasons to believe that the high mortality is mainly due to cultural factors as Wessel suggests in the case of explaining mortality due to tuberculosis.

[10] Men with arteriosclerotic heart disease in Bugøynes had the lowest body hight compared to men without heart disease in Bugøynes, men in Sør-Varanger generally, and the male national average height (disregarding age) (Forsdahl et al. 1974). See also footnote 11.

Poor disease environment, hygiene and malnutrition during childhood may explain why the population in Finnmark in general, and the Sami in particular, but also Kven, on average are shorter, and have higher total mortality than people in the rest of the country (Jonassen 1959; Waaler 1984).[11] This could, however, also be due to genes (Nesheim 1979). Most likely, however, average height is largely a product of environmental factors (Malcolm 1974).

5. Wartime conditions and ethnicity

Did relatively poor living conditions during the First World War with galloping inflation, rationing of food, severe housing and firewood shortage affect the minorities more than the majority population? If this was the case, were Sami and Kven as a consequence more susceptible to epidemic diseases around 1918 than the Norwegians? And, did poor living conditions 1914-1918 result in higher levels of morbidity and mortality of Spanish Influenza among the minorities than among the Norwegians? There is little evidence that wartime conditions affected minorities more negatively than Norwegians. The pastoral mountain Sami, for instance, earned good money from the sale of reindeer meat in a period with short supply of meat. The average reindeer herd was worth 40,000 Nok and the average annual

[11] Around 1920, the average height of Sami men in Kautokeino, Karasjok (Finnmark county) and Tysfjord (Nordland county) was 159 cm, 164 cm and 162 cm respectively, 168 cm in Finnmark as a whole (Norwegians 171 cm), and the national average was 172 cm (Gjessing 1934; Schreiner 1930; Schreiner 1932). Sami females in Kautokeino and Tysfjord were on average 150 cm and 152 cm tall respectively, the national female average height was 162 cm. Sami boys in Kautokeino 8-12 years were on average 13 cm shorter than the average boy in the county of Oppland, South-East-Norway. Kven in Kautokeino (disregarding sex) was 163-166 cm tall (Gjessing 1934; Schreiner 1932). The height of 20-21 year old (recruits) Sami, Kven and Norwegians in Troms county was 164, 166 and 171 cm respectively (Bryn 1921). The lowest height (167 cm) in Troms is found in municipalities with the highest percentage of Sami (Sørfjord 51% and Lyngen 36%) (Bryn 1921). The Sami recruits from Lyngen had an average height of 162 cm (Schreiner 1930).

income was 5-6,000 Nok. Average income and wealth of the pastoral Sami were well above that of the population in the nation as a whole (DCM 1922, see Table 4). The primary sector generally gained from high prices on food and raw materials (SSB 1917; SSB 1918a; SSB 1918b). As most of the Sami and Kven were still in the subsistence economy, the high inflation did not harm the minorities as much as it did Norwegians who were more integrated in the money economy.[12] The shortage and rationing of food may have caused nutritional problems among low-income groups and labourers on low fixed wages who had to buy food at high prices in shops. Not surprisingly, there were few reports of malnutrition among farmers and fishermen. Among the poorest crofters, the poorest fishermen, and the landless, on the other hand, there were several reports of malnutrition. As a large part of the resident Sami and Kven were in these groups, problems of malnutrition may have existed here as well.

6. Previous research: explanations of high Spanish Influenza morbidity and mortality among indigenous populations

In this section I report previous research on Spanish Influenza among indigenous populations and discuss their explanations of high morbidity and mortality compared to non-indigenous populations. Secondly, findings from studies of Spanish Influenza mortality with other perspectives than ethnicity will be discussed, as the studies help to better understand Spanish Influenza mortality among minority groups in Norway. First, however, I discuss the more or less universal age pattern of morbidity and mortality.

6.1. The peculiar age-sex pattern

[12] In 1920, 17.5%, 13.2% and 3.3% of the Norwegian, Kven and Sami male labour force in Finnmark were occupied in industry respectively. In trade and transport the percentages were 16.6, 4.4 and 3.3 respectively (SSB 1923c).

The influenza-censuses carried out in USA and Norway 1918-1919 give a reliable picture of the age-sex pattern of morbidity (see Vaughan 1921; Hanssen 1923; Collins 1931; Sydenstricker 1931; Britten 1932). These studies clearly show an unusually high incidence under 30 years and a rather rapidly falling incidence above age 30 (Figure 2), a definitive contrast to the w-curve of mortality (Figure 1). In both countries, the female incidence tended to be higher than that for males, except for those below 20 years. This may be explained by the fact that information was obtained from the wife, who probably remembered her own disease better than that of family members.

[Figure 1 approximately here]

[Figure 2 approximately here]

The W-shaped age pattern of influenza-pneumonia death rates 1918-1919 stands in great contrast to the normal U or J shaped age distribution of influenza-pneumonia death rates, here represented by 1917+1921 (Figure 1). In Norway 1918-1919, as well as in several other countries (e.g., New Zealand, Australia, USA, South Africa), men in the age group 20-60, especially those in the ages 25-29, had significantly higher mortality compared to women (Rice 1988; Crosby 1989; Phillips 1990). In 1917 and 1921 combined, however, there was almost no sex difference in these age groups (Figure 1). The male excess mortality in 1918-1919 may be explained by the fact that the male breadwinners in their prime ages felt indispensable regarding family economy, pushing themselves too hard, catching complications of influenza (Åman 1990). There exist no data on age-sex specific Spanish Influenza incidence and mortality for different ethnic groups in Norway. There is no reason, however, to believe that the age-sex specific incidence and mortality rates of minorities depart significantly from that of the total population.

6.2. The Spanish Influenza mortality of indigenous populations

The indigenous minority populations in USA, Canada, New Zealand and Scandinavia experienced three to eight times higher Spanish Influenza mortality than the white majority populations in 1918-1919 (Table 1). During the fourth influenza wave in Scandinavia 1920, however, the difference in mortality between areas with high and low infusion of the indigenous Sami-population was much higher.

[Table 1 approximately here]

Were there any differences in mortality between the nomads and the resident Sami? According to the medical officer in Kautokeino, this was not the case (DCM 1922). The two neighbouring nomadic Sami districts, Karasjok and Alta-Kautokeino, however, took up the second and first place at the list of excess influenza-pneumonia mortality in 1918 and 1919 respectively (Table 1). From this there are reasons to believe that the nomads had higher mortality than the resident sea, river and farming Sami in general. This could, however, also be due to the fact that the nomad districts had the chiefly highest percentages of Sami population in Norway (more than 90% was Sami).

In the international literature, the high indigenous minority Spanish Flu mortality has been explained by poverty (Linanmäki 2000), a failure of nursing, care and food-production when morbidity and mortality peaked (Pool 1973; Åman 1990; Tomkins 1992; Kelm 1998), low inherited immunity against influenza due to little contact with European diseases (Tomkins 1992) and a failure to acquire immunity in the spring wave of 1918 (Åman 1990; Linanmäki 2000), as well as poor understanding of hygiene (Crosby 1989).

6.3. Other findings and their ability to explain Spanish influenza mortality of minority groups in Norway

In this section, results from studies on the effect of occupation, geography, immunity, nutritional status and poverty on Spanish Influenza mortality in non-minority populations are presented as they shed light on the understanding of mortality among minorities in Norway.

As stated earlier, Sami and Kven were mainly poor crofters and fishermen. In a previous study, Mamelund (1998) has found that fishermen experienced higher influenza-pneumonia mortality than farmers and crofters. The high mortality among fishermen and their families is probably due to poor hygiene and nutrition as well as crowding in fishing boats and ashore in the fishing villages. Low mortality in farming districts was explained by proper hygiene, nutrition and less crowding. Several authors have shown that Urban populations experienced higher mortality than rural ones (Phillips 1990; Rice 1988; Åman 1990; Mamelund 1998; Johnson 2000). As most of the Sami and Kven lived in rural areas, it is important to control for the urban/rural effect.

Several authors have also found that the population living in areas heavily affected by the first influenza wave, suffered less in the succeeding waves, as relative immunity was acquired (Rice 1988; Phillips 1990; Åman 1990; Mamelund 1998; Echeverri 2001). The first influenza wave in Norway started in the capital of Kristiania in southern Norway 15 June 1918 and diffused rapidly along the coast towards northern Norway with people travelling with the coastal steamers. Inland areas were affected later than coastal areas, and some areas of Finnmark, such as relatively isolated and Sami dominated Karasjok, did not experience the flu before the second virulent wave appeared in September-October 1918 (Mamelund 1998). Lack of immunity from the first mild influenza wave may explain the high mortality in Karasjok.

Under-nourishment does not increase the risk of viral infections, such as influenza (Scrimshaw et al. 1959). Malnutrition associated with low intake of nitrogen on the other hand, results in definite impairment of immune response and a corresponding increase in susceptibility to bacterial diseases (Fox et al. 1970). Consequently, the Spanish Influenza did not pay attention to whether its victims were hungry or not. Bacterial complications like pneumonia, however, took a greater toll among the poorly fed. There are reasons to believe

that a large part of the poorest Sami and Kven experienced malnutrition, partly due to the shortage and rationing during the war and that the risk of dying of complications due to the flu was high as a result of this. Thus, in order to demonstrate any independent effect of belonging to a minority group, one should control for nutrition status.

Did Spanish Influenza hit rich and poor alike? The dominant view in 1918 (partly also later) was that influenza morbidity and mortality were class neutral. There is no doubt that Spanish Influenza took a great toll among both rich and poor classes, but nevertheless there were clear differences. In a number of cities in the United States, Christchurch in New Zealand, and in Bergen, Norway, a relatively strong negative relationship between living conditions (crowding), socio-economic status (measured by income) and mortality (death rate and case fatality rate) was observed. A negative relationship was also observed between morbidity (incidence) and socio-economic status, but this was not as strong as that between mortality and socio-economic status (Vaughan 1921; Hanssen 1923; Sydenstricker 1931; Rice 1979; 1988). In an "influenza census" in four cities in England, on the other hand, no clear relationship between influenza morbidity/mortality and occupation/overcrowding were found (Great Britain Ministry of Health 1920). In a multivariate study of the city of Sydney, Australia, McCracken and Curson (2001) found that status of occupation and indoor space or standard of housing was negatively associated with mortality. In another multivariate study, of England and Wales, Johnson (2000) found no clear relationship between Spanish influenza mortality and social class. Given these mixed findings, it is important to control for poverty status.

7. Data

7.1. Study populations

In the 1920 census, as was also the case in censuses since 1845, Kven (Finnish immigrants and their descendants) and Sami were the only ethnic groups that were systematically enumerated (Table 2). An important reason for enumerating Kven was the fear of a Finnish

(or Russian) invasion of Norway, or that the Finnish population would claim an independent state in Finnmark (Eriksen and Niemi 1981).

[Table 2 approximately here]

The registration of ethnicity in the censuses was based on self-reporting. In 1920, questions about nationality (ethnicity) of each parent were asked allowing each parent to come from mixed heritage (Lie 2001). Local reindeer inspectors had good knowledge of the family background of the minorities, and they checked the consistency of the answers on ethnicity (Hansen and Meyer 1991). There were also asked questions regarding language in the 1920 census. The definition of a Sami or Kven used in this paper is individuals of "pure" origin, regardless of language, and individuals of "mixed" populations of first generation (Sami-Kven or Sami-Norwegian who speak Sami on a daily basis and Kven-Sami or Kven-Norwegian who speaks Kvenish on a daily basis respectively) and second generation (Sami/Norwegian-Sami or Sami/Kven-Sami regardless of language and Kven/Norwegian-Kven or Kven/Sami-Kven regardless of language). The total Sami and Kven population according to this definition is 19 300 and 7,300 in 1920 respectively (Table 2, Table 4). Individuals of other ethnic groups than Sami and Kven were registered as Norwegians. This rule also counted even if he or she married a person from one of the minority groups (Lie 2001).

Comparing the census of 1920 with that of 1930, persons regarding themselves as Kven from some municipalities of Troms in 1930 reported themselves as Norwegians or Sami in 1920. Kven in the county of Troms were consequently underestimated, probably by close to 500 persons (SSB 1933). The underreporting is probably due to the goal of the Norwegian minority policy to keep the non-Norwegian population at a minimum level in the censuses (Saressalo 1996). The regional distribution of Kven in Troms 1920, however, was probably not disturbed by the underreporting. Kven were registered in 53 out of 376 medical districts. Two thirds of the Kven lived in Finnmark, where they constituted 12 per cent of the total population (Table 2). In 1920, the Sami population was registered in 91 out of 376 medical

districts. Near 100 per cent of the population lived in the three northernmost counties (Table 2). The Sami population is probably also undercounted in the 1920-census. First, Sami moving to the southern parts of Norway were often considered Norwegians. Secondly, due to the "Norwegianization" policy, many Sami (as well as Kven and the genealogically mixed population) living in Northern Norway were considered Norwegians if they spoke the Norwegian language (Steen 1956; Lie 2001). Thirdly, many Sami did not want to admit they were Sami as they were seen as inferior to Norwegians as well as the Kven. The registration of ethnicity in the late 19th century censuses is generally, however, known to be good (Hansen and Meyer 1991). This is probably also the case for the 1920 census.

7.2. Data for dependent variables and their reliability

Reported cases (482,400)[13] and deaths (16,000) of influenza and pneumonia, in addition to all cause mortality (80,000 deaths) in medical districts 1918-1919 are the raw data input for the dependent variables in this paper (DCM 1922; DCM 1923). Influenza was a reportable disease in Norway long before 1918, as opposed to most other countries. After some time, however, it was realised that reported cases of influenza fell short of actual morbidity (DCM 1922). The disease probably struck 1.2 million Norwegians whereas only a third of the cases were reported (Mamelund 1998). The underreporting is explained by short supply of doctors (especially in Finnmark), overworked health staff, and physicians hesitating to report the new disease as influenza in the early phase of the pandemic (Ramberg 1969). In addition, in many families, doctors were only called to the breadwinner or to the person that had to claim sickness benefits when reporting unfit for work to a sickness insurance fund (Kristiania Sundhetskommision 1919). The underreporting was probably lowest in urban and small rural districts as well as during the highly virulent fall wave of 1918 generally (Skajaa 1921;

[13] Cases are new cases reported monthly in the years 1918-1919. According to the influenza-census in Bergen, 6.5 per cent of those infected during the summer 1918 were-infected in the fall of 1918 (Hanssen 1923). One person could thus be reported with influenza more than once.

Hanssen 1923; Ramberg 1969).[14] In the analysis I assume no spatial or temporal difference in underreporting.

Although doctors and local health departments were overworked and failed to report complete morbidity figures, every death was probably reported (Ramberg 1969). In 1918, cause of death was registered by secondary cause of death, i.e., the last cause that ultimately ended a person's life (Backer 1961). Fatal cases usually occurred when Spanish influenza was followed by pneumonia. As a consequence, pneumonia, not influenza was sometimes reported as the cause of death (Ramberg 1969). The question of diagnosis is easily solved if the two causes are analysed together in 1918-1919, and if one assumes no secondary effects other than pneumonia, as is done in this paper.[15] Another motivation for analysing these two causes of disease and death jointly is that there are few observations (especially influenza-pneumonia deaths) in the smallest medical districts. All deaths are registered at place of permanent residence irrespective place of death.

7.3 Definitions of dependent variables

[14] If the "Influenza-census" of Bergen is compared to official statistics, only 27.3 per cent of influenza cases were reported during the mild summer wave of 1918. During the highly virulent fall-wave of 1918, however, 98 per cent of the cases were reported. An estimated 35.5 per cent of the cases were reported during the first quarter of 1919 (Hanssen 1923).

[15] Another problem, not very different from the question of diagnosis, is how to separate between cases and deaths caused by Spanish Influenza and cases and deaths that would have come independently of Spanish Influenza. A way of overcoming the two problems is to calculate "excess" mortality or "net mortality," i.e., "gross mortality" subtracting a chosen "normal year" or "normal period," applying data for mortality of all causes or influenza-pneumonia. Applying this method, I found that there was little difference in regional mortality (SMR) in a "normal period" (1915-1917) and the corresponding SMR in the crisis years 1918-1919. As this method left little variance to be explained ("normal" mortality explained most of the variance in SMR 1918-1919), the models presented are those considering "gross" morbidity and mortality.

The dependent variables in this paper are SMR (standardised mortality ratio), SIR (standardised incidence ratio) and case fatality rate (lethality) (Table 3). To control for the peculiar age and sex patterns of morbidity and mortality 1918-1919 and differences in age and sex composition across medical districts, reported cases and deaths are calculated relative to expected cases and deaths by age and sex according to a set of standard rates.

[Table 3 approximately here]

The age and sex distributions of the populations in medical districts are taken from the census of 1920. The age-sex specific incidence rates from the "influenza-census" of Bergen June 1918-March 1919 are used as the standard rates for age-sex morbidity (Hanssen 1923, see Figure 2). For mortality, the standard consists of the national age-sex specific influenza-pneumonia death rates and national age-sex specific all cause mortality rates 1918-1919 (DCM 1922-1923 (Table 3, see also Mamelund and Borgan 1996). An SIR or SMR above 100 indicates that the medical district in question has higher (worse than expected) morbidity or mortality than the standard rates, while ratios below 100 represent lower than average (better than expected) morbidity or mortality. A lethality ratio is defined as the share of cases of influenza/pneumonia in a certain district, which resulted in a death due to these causes. Standardisation is not necessary, since cases and deaths arise from the same population.

7.4. Independent variables

I have utilised three main categories of variables from the census of 1920: ethnicity, occupation and housing. Table 4 gives definitions and descriptive statistics on these and other independent variables (Socio-economic status and geography).

[Table 4 approximately here]

8. Methods

Least squares estimation was applied to estimate an assumed linear relationship between the independent and the dependent variables. Models for four independent variables are analysed: 1) SMR (total mortality), 2) SMR (Influenza/pneumonia), 3) SIR (Influenza and pneumonia), and 4) Lethality (influenza/pneumonia). All four variables apply to the period 1918-1919. They are in logarithmic form, since they cannot attain negative values. Because the SMRs and the SIRs are not observed, but estimated, weighted least squares (WLS) estimation was applied, using the inverse of the estimated variance for each SIR or SMR as weights.[16]

9. Results

The percentage Sami and Kven out of total population are both positively and significantly associated with *total mortality* 1918-1919 (Table 5, models 1a and 1b). When possible confounding factors are not included in the models, an increase by one percentage point in the share of Sami and Kven populations leads to an increase in SMR of 0.4 and 0.5 per cent respectively (coefficients not shown in Table 5). When likely and known confounding factors are controlled for, both minorities still seem to have a positive, significant and independent effect on total mortality. An increase by one percentage point in the share of Sami and Kven populations leads to an increase in SMR of around 0.25-0.35 per cent, all other factors the same (models 1a and 1b).[17] The effects of the other socio-economic and regional variables are basically in the expected direction (to the extent that they were significant).

[16] The estimated variance of SMR is D/E^2, where D is the observed number of deaths and E the expected number (Namboodiri 1991:59). The estimated variance of log(SMR) is approximately equal to (using the Delta method) $1/(SMR)^2 * (D/E^2) = 1/D$. Thus the weight of log(SMR) is equal to D. Similarly, the weight of log(SIR) equals the observed number of cases.

[17] I also tried a model excluding the medical districts of southern Norway without Sami and Kven population, leaving only medical districts in the counties of Trøndelag, Nordland Troms and Finnmark (N=124), but found no significant difference in the parameter estimates (for Sami and Kven) compared to the model for the whole country (N=376).

The Sami population and the Kven did not affect Spanish influenza *morbidity* in a significant way (Table 5, models 2a and 2b). Any assumed effect may be due to confounding factors such as wealth, crowding, occupational structure, or geography in the districts concerned. It seems as if those working in the primary sector, i.e., those living in rural areas, had lower morbidity than those working in the secondary and tertiary sectors living in the cities (reference groups). This result, however, may be biased because there was less underreporting in the cities and towns than in rural medical districts. Similarly, the surprisingly negative but insignificant parameter estimates for Sami and Kven may be due to underreporting in Finnmark with shortage of doctors and long distances to the nearest doctor. In addition, only 11 per cent of the population in Finnmark could afford private or public sickness insurance. As a result, few called a doctor to report unfit for work and to claim sickness benefits from a sickness insurance fund (Riksforsikringsanstalten 1920). Moreover, it is reasonable to believe that the Sami practising traditional medicine did not seek Norwegian district physicians.

Of the two ethnic minorities, only the Sami population is positively, significantly and independently associated with Spanish influenza mortality (SMR) and lethality (Table 5, models 3a-b and 4a-b). An increase by one percentage point in the share of Sami population leads to an increase in SMR and lethality of 0.7-0.8 per cent, all other factors the same. The effect of the share of Sami is thus stronger on influenza mortality and lethality than for total mortality. If the likely confounding factors are not included in models 3-4, an increase by one percentage point in the share of Sami population leads to an increase in SMR and lethality of 0.8 per cent and 1.0 per cent respectively.[18] The parameter estimate of Sami lethality must be

[18] I also tried a model (for SMR) excluding the medical districts of southern Norway without Sami and Kven population, leaving only medical districts in the counties of Trøndelag, Nordland Troms and Finnmark (N=116), but found no significant difference in the parameter estimates (for Sami and Kven) compared to the model (for SMR) for the whole country (N=351).

considered with caution. If cases of influenza-pneumonia are underestimated in Sami areas, lethality is overestimated.

[Table 5 approximately here]

10. Discussion and conclusion

There are few previous studies that have applied multivariate methods to analyse Spanish Influenza mortality. Previous studies have reported that indigenous populations were the prime victims of Spanish Influenza. The explanations put forward in those studies were not convincing, however, as no controls were made for possibly confounding factors. In the present study I document for the first time that areas with high shares of an indigenous population, the Norwegian Sami, have high Spanish Influenza mortality and lethality, net of such confounding factors as wealth, crowding, height (as a proxy of disease and nutritional history), occupational structure, settlement patterns and diffusion. The cause is probably a lack of inherited and acquired immunity against influenza among the Sami. Another ethnic Norwegian minority, Kven, did not differ significantly from the Spanish Influenza mortality and lethality of the Norwegian majority population. This is probably explained by higher degree of both inherited and acquired immunity against influenza in the Kven than in the Sami.

The results of multivariate ecological regressions must be interpreted with caution. This is especially due to the problem of the ecological fallacy (Thorndike 1939; Robinson 1950; Selvin 1958). The ecological fallacy is linked to the methodological problem of inferring characteristics of individuals from aggregate data referring to a population. The finding that results from aggregate studies often do not correspond to the results at the individual level has created the view that ecological studies only can be used to generate new hypotheses. Moreover, critics of ecological analysis claim that true causal mechanisms can be demonstrated at the individual level only (Piantadosi 1994; Poole 1994). Such a view is, however, somewhat defensive, and only valid if potentially confounding factors are unknown

or unmeasured (Morgenstern 1982; Cohen 1994; Schwartz 1994). I will discuss the question of confounding factors and the interpretations of the results of this paper below.

When well-developed theory provides precise hypotheses as to the expected form of the relationship, ecological regressions can offer strong clues as to individual relationships. Moreover, if the same relationship is found in different populations from a wide variety of geographical regions with various socio-economic conditions, a causal interpretation in ecological analyses is enhanced. The results of this paper confirm the results of previous papers on the Spanish Influenza among indigenous populations from three corners of the world, North America, the Pacific and Scandinavia. Well-grounded theory documented in this paper provided the hypothesis that areas with a high share of Sami-population have high Spanish Influenza mortality. The results are, as we have seen, in accordance with the hypothesis.

I have controlled for a range of possible confounding factors in the models. There may, however, be relevant factors that are not controlled for. Education might be one. As we know from above, a low level of education among both Sami and Kven may explain high mortality due to tuberculosis as well as infant mortality (Wessel 1914; Rein 1956). Possibly the single most important precautionary message from the health authorities during Spanish Influenza, “go to bed as early as possible when infected, and stay until you feel well” (as was printed in the papers and elsewhere), probably reached fewer of the lower than the well educated. Moreover, the poorest in society and the poorest educated classes had probably fewer chances of being away from work when ill, as they could not live on saved capital and benefit from sickness insurance. The poor (Sami) were therefore forced to go late to bed, and probably they did not stay long enough to avoid pneumonia and other bacterial complications with higher risk of death than influenza.

If one accepts that the models in this paper control for the most important confounding factors, it can be concluded that a high percentage of Sami make an independent contribution explaining (high) Spanish Influenza mortality, and that the results also offer strong clues as to individual causal relationships. The explanation of why Sami had higher

risks may be genetic and/or epidemiological, i.e., lack of inherited and/or acquired immunity. Due to lack of roads and poor communications, Spanish Influenza did not reach the inland grazing land of the nomads in Karasjok and Kautokeino before October 1918 and January 1919 respectively. During the summer (May-September) the nomads are either on the move or at their summer grazing land closer to the coast. It is possible that the nomads experienced the mild summer wave of 1918 and that they brought with them the virulent fall virus on their way to the winter grazing land at the end of 1918.[19] Most likely, however, the nomads escaped the mild summer epidemic, and when they brought with them the fall virus, both nomads and resident Sami experienced high excess mortality in Karasjok 1918 and Kautokeino 1919. A large part of the nomads had built themselves winter turf-huts in Karasjok, but a substantial number also rented rooms of the resident Sami (DCM 1925). As a result of this high degree of mixing, the virus was easily transmitted from the nomads to the resident Sami. As close to 100 percent of the resident Sami live in rural and often isolated areas that might have missed relative protection from the mild spring wave, excess influenza-pneumonia mortality in areas with high shares of Sami was from 350 to 550 per cent (Table 1). This theory is consistent with studies of Åman (1990) and Linanmäki (2000), which suggest that the high mortality among Sami in isolated Arjeplog and Enare during the fourth wave in 1920 may largely be due to lack of immunity from the previous waves.

The Sami may also have escaped the first influenza wave for another reason than relative isolated settlement patterns per se. The Sami have traditionally tried to prevent and cure diseases. One way to escape infectious diseases was flight. Sköld (1997) describes how Swedish Sami in the eighteenth and nineteenth century fled to the mountains to escape smallpox. The fear, haste and resolution were so great that old people were left at home and

[19] I have controlled for the variation in the diffusion of the epidemic, but the variable for diffusion (experienced summer wave or not) has several major weaknesses. Not everybody is infected although the virus is registered in a medical district during the summer. In addition, at least 7 per cent of those previously infected were reinfected (Hanssen 1923).

relatives infected on the way were left behind. Nothing could induce the Sami to visit infected people. The result was much lower smallpox mortality rates than those experienced by the rest of the Swedish population. In the health reports from Finnmark, there are no indications of Sami leaving for the mountains to escape the summer influenza wave. In Kautokeino, however, when the nomad winter school opened in the beginning of January 1919, several Sami were infected by influenza. To reduce further contagion, the Sami escaped into the mountains to their respective villages (DCM 1922). The destiny of the 60-70 Sami school children and their parents are not known. The flight came probably too late, however. The medical district of Alta and Kautokeino had the highest registered excess influenza-pneumonia mortality of 545 per cent in 1919 (Table 1).

It is also possible that the Sami had little experience with annual influenza epidemics, and thus low inherited immunity to fight Spanish Influenza. The "virgin soil" hypothesis is especially relevant for the nomads as they lived at their inland grazing land during the high season for influenza epidemics (October-April), strongly isolated and far away from other people and navigable roads. The resident Sami in the nomad areas also lived in relative isolation, but they lived in more congested households and had more contacts with other populated regions, and thus higher risk of gaining immunity. Pool (1973) and Tomkins (1992) have also suggested that low inherited immunity against "European" diseases like influenza may be the main reason for high Spanish Influenza mortality among natives in New Zealand and in the Pacific generally. Tuberculosis was almost non-existent among the Sami in Finnmark until the two last decades of the 19th century (Wessel 1914). The first cases and the highest incidence and mortality was registered among South-Norwegians moving into Finnmark. Some years later, however, when tuberculosis gained a foothold, the highest incidence and mortality was registered among the resident Sami with low inherited immunity against tuberculosis. In Norbotten county, Sweden, tuberculosis was also more frequent among resident Sami (3.6%) than among the nomads (2.3%) (Wessel 1914).

Why did not Kven have an independent (or dependent) effect on Spanish Influenza mortality and lethality? One reason may be that they had some inherited immunity against

influenza. The question of inherited immunity is debatable, however. The influenza viruses in annual epidemics change their genetic characteristics by antigenic drifts, and leave only partial immunity from previous epidemics. The Spanish Influenza pandemic broke out as a result of antigenic shift. The new virus spread quickly as it found little or no inherited immunity in the population at risk. There is little or no reason to believe that the last pandemic before Spanish Influenza, the "Russian Flu" of 1889-1891, left any immunity in those infected. Several contemporary writers, among them Hanssen (1923), however, have used this theory to explain why people above 40 years of age were less affected by high mortality than those in the age bracket 15-40. Anyway, it is more likely that the Kven had some inherited immunity as they to a larger degree (than the Sami) were assimilated in the Norwegian society and the money economy (see footnote 12). This was partly due to a particularly tough "Norwegianization" of the Finnish immigrants and their descendants (Niemi and Eriksen 1981). Moreover, most of the immigrants did not have a strong national consciousness, and accepted early assimilation and loyalty to their new homeland. There was also little difference in the occupational structure of the Kven and the Norwegian population. The Kven did not show any significant difference in mortality compared to the Norwegians (reference group). This does not mean that the Kven experienced low mortality. On a national level, the influenza-pneumonia death rate July 1918-June 1919 was 5.7 per 1,000, and in a period of less than a year, 15,000 lost their lives (Mamelund 1998).

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Table 1. Spanish Flu mortality of indigenous and non-indigenous populations 1918-1920

		Indigenous populations (IP)			Non-indigenous populations (NP)			*Ratio of IP to NP IDR*
Country	*Year*	*IP*	*IDR*	*SMR*	*NP*	*IDR*	*SMR*	
New Zealand	1918	Maori	42.3	-	White	6.1	-	6.9
Canada	1918	Eskimo	46.0	-	White	6.2	-	7.4
USA	1918	Indian	41.2	-	White	6.3	-	7.7
Sweden (Arjeplog) [1]	Feb 1920	Sami	27.0	-	Norrbotten county	1.2	-	22.5
Finland (Enare) [2]	Jan-Feb 1920	Sami	98.0	-	Finish cities	1.4	-	70.0
Norway (Lebesby) [3]	1918	Sami	25.8	588	Norway	4.7	100	5.9
Norway (Karasjok) [3]	1918	Sami	22.3	446	Norway	4.7	100	4.5
Norway (Kistrand) [3]	1918	Sami	20.1	430	Norway	4.7	100	4.3
Norway (Alta-Kautokeino) [3]	1919	Sami	9.6	645	Norway	1.5	100	6.5
Norway (Talvik) [3]	1919	Sami	6.4	432	Norway	1.5	100	4.3
Norway (Loppa) [3]	1919	Sami	4.4	314	Norway	1.5	100	3.1

Sources: Pool (1973), Rice (1988), Åman (1990), Tomkins (1992), Kelm (1998), Mamelund (1998), Steele (1998), Linanmäki (2000).

Definitions: IDR = Influenza-pneumonia deaths per 1 000, SMR = Standardized mortality ratio for influenza-pneumonia deaths

Footnotes:
[1] In Arjeplog, the population consisted partly of ethnic Swedish settlers and partly of Sami who had given up their nomadic life and settled down permanently.
[2] Half of the population in Enare was Sami.
[3] Lebesby (30% Sami, 4% Kven), Karasjok (94% Sami, 1% Kven), Kistrand (46% Sami, 33% Kven), Alta-Kautokeino (32% Sami, 14% Kven. In Kautokeino alone, 94.3% were Sami), Talvik (26% Sami, 3% Kven), Loppa (26% Sami, 5% Kven).

Table 2. Geographical distribution of Sami and Kven in Norway 1920

	Sami			Kvens		
County	Number	%	Share of total population	Number	%	Share of total population
Finnmark	10 508	54.4	23.8	5 485	75.1	12.4
Troms	6 792	35.1	7.5	1 410	19.3	1.6
Nordland	1 721	8.9	1.0	69	0.9	0.0
Trøndelag	275	1.4	0.1	6	0.1	0.0
Other	32	0.2	0.0	338	4.6	5.2
Norway	19 328	100	0.7	7 309	100	0.3

Source: SSB (1923c), Norwegian Social Science Data Services (NSD).

Table 3. Dependent variables

Dependent variables (1918-1919)	N=	Source	Descriptive statistics				
			Count	*Min*	*Max*	*Mean*	*St. dev.*
SMR (total mortality)	376	DCM 1922, 1923	80 039	44.7	229.4	99.7	25.0
SMR (influenza-pneumonia)	351	DCM 1922, 1923	16 005	0.0	499.0	98.0	54.2
SIR (influenza-pneumonia) *	351	DCM 1922, 1923	482 403	0.0	157.7	39.7	27.5
Lethality (influenza-pneumonia)	351	DCM 1922, 1923	-	0.0	48.0	3.1	4.7

* The mean SIR is far from 100 as incidence in the standard population (the city of Bergen) is based on a census (with incidence close to actual incidence) whereas the incidence in each medical district is based on reported figures (with high degree of underreporting).

Table 4. Independent variables

Variables	Period	Source	Descriptive statistics (N= 376 medical districts)				
			Count	*Min*	*Max*	*Mean*	*St. dev.*
Ethnicity:							
% Kven	1920 census	SSB 1923c	7 309	0.0	46.8	0.6	3.7
% Sami	1920 census	SSB 1923c	19 328	0.0	93.8	1.7	8.0
Socio-economic status:							
Average income per person (in 1918 Nok.)[1]	1918-1919	SSB 1920	7.3 bill. Nok	130.2	6 664	661	641
Average wealth per person (in 1918 Nok.)[2]	1918-1919	SSB 1920	10.2 bill. Nok	399.3	26 271	2 848	2 442
% of population receiving public support due to poverty [3]	1918	SSB 1922a	66 851 persons	0.4	9.4	2.4	0.9
Average height of recruits 20-21 years old (in cm)[4]	1919-1922	Bryn 1925, Bryn and Schreiner 1929, Schreiner 1930	11 748 recruits	163.9	178.1	172.3	1.7
Housing:							
Occupied tents or turf-huts as a % of all dwellings	1920 census	SSB 1923a, 1924	409 tents or turf-huts	0.0	32.1	0.3	2.1
Average number of persons per room (occupied private dwelling) [5]	1920 census	SSB 1923a, 1924	2 102 245 rooms	0.7	2.5	1.2	0.2
Geography:							
Urban (1), rural (0)	1918	Mamelund 1998	63 (1)	0	1	0.2	0.4
Coast (1), inland (0)	1920 census	SSB 1922b	267 yes	0	1	0.7	0.5
Experienced summer wave 1918, yes (1), no (0)	June-Aug (1), Sep-Dec (0)	Mamelund 1998, DCM 1922	338 yes	0	1	0.9	0.3
% (15-70+) occupied in:[6]							
Fishing	1920 census	SSB 1923b	57 719	0.0	43.3	5.6	9.3
Agriculture, forestry, hunting and cattle breeding	1920 census	SSB 1923b	667 800	0.0	55.0	25.2	14.8

[1] The income measure is *antatt intekt* or net income after deductions but before exemptions (Soltow 1965).
[2] This includes an estimate of cash holdings and the value of among others real estate and furniture (Soltow 1965).
[3] The poor relief was given to cover expenses to medicine, visit doctors, clothing and food to children, hospitalisation (regular/mental), funerals, in addition to weakness of old age, illness, disabling, blindness, mentally disordering, he/she has had an accident, unemployment, laziness, breadwinner deceased, run away or migrated. The data is given for the 65 cities including 56 rural areas by sub-county (fogderi). I have assumed that the percentage poor by sub-county (fogderi) applies for the medical districts within the boundary of a sub-county.
[4] The data is primarily given for municipalities (which are aggregated up to medical districts), but also for primary court districts. I have assumed that the height of recruits in primary court districts applies for the medical districts within the boundaries of a primary court district.
[5] Kitchen and servant rooms are included. For 19 of the smallest cities (population below 2 000), that is 5 per cent of my units of study (N=376), data for overcrowding is not presented in the 1920 census (SSB 1923a). Statistics for the 19 cities are, however, published as averages for three groups of smaller cities. I have therefore, for each of the 19 cities, used the average value for one of the three categories of cities that the respective cities falls into.
[6] In those parts of the country where fishing was combined with farming (for example in Finnmark), it was difficult (for the enumerators) to decide which of the two occupational groups an individual belonged. Only 36 per cent of those who reported fishing to be their main occupation had fishing as their only occupation. In addition, 45 per cent reported fishing as their second occupation (SSB 1923b, 1926).

Table 5. Results of linear regression analyses for total mortality and Spanish Influenza incidence, mortality and lethality in Norway 1918-1919

	Model 1a	**Model 1b[5]**	**Model 2a**	**Model 2b[5]**	**Model 3a**	**Model 3b[5]**	**Model 4a**	**Model 4b[5]**
Dependent variable	LogSMR, all causes [1]	LogSMR, all causes [1]	LogSIR, Influenza-pneumonia	LogSIR, Influenza-pneumonia	LogSMR, Influenza-pneumonia	LogSMR, Influenza-pneumonia	Loglethality, Influenza-pneumonia	Loglethality, Influenza-pneumonia
Percentage Sami [2]	0.0025***	0.0031***	- 0.0014	- 0.0049	0.0072***	0.0068***	0.0080***	0.0071***
Percentage Kven [2]	0.0031**	0.0035***	- 0.0042	- 0.0056	- 0.0004	- 0.0012	0.0070	0.0081
Average height of recruits (in cm) [3]	- 0.0034	- 0.0067***	- 0.0094	0.0011	- 0.0012	- 0.0039	0.0140	- 0.0067
Percentage of population receiving public support due to poverty	0.0191***	0.0062	0.0035	- 0.0135	- 0.0011	- 0.0001	- 0.0679***	- 0.0392*
Wealth per person [4]	- 0.0058***	- 0.0106***	- 0.0133**	- 0.0069	- 0.0123***	- 0.0108***	- 0.0123	- 0.0080
Average number of persons per room	0.0104	0.0170	- 0.0360**	- 0.0355**	- 0.0043	- 0.0071	0.0097	- 0.0031
Percentage of population (15+) employed in fishing [5]	0.0016***	-	- 0.0136***	-	- 0.0005	-	0.0123***	-
Percentage of population (15+) employed in agriculture, forestry, hunting and cattle breeding [5]	- 0.0010***	-	- 0.0043***	-	- 0.0017***	-	0.0030***	-
Coast (1), inland (0) [6]	-	- 0.0032	-	- 0.1449***	-	0.0287	-	0.2388***
Urban (1), rural (0) [6]	-	0.0836***	-	0.2507***	-	0.0540	-	- 0.2912***
Experienced summer wave 1918, yes (1), no (0)	-	-	-	- 0.0338	-	- 0.0583	-	- 0.0839
Constant	2.5445***	3.1238***	3.5092*	1.6611	2.3150*	2.7514	-2.1095	1.5233
N	376	376	351	351	351	351	351	351
Adjusted R^2	0.2716	0.3044	0.2007	0.2533	0.1011	0.1134	0.2163	0.2687

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

[1] 19 per cent of the deaths in 1918-1919 (15 000 out of 80 000) are due to Spanish Influenza (Mamelund 1998).

[2] The reference category is percentage Norwegians.

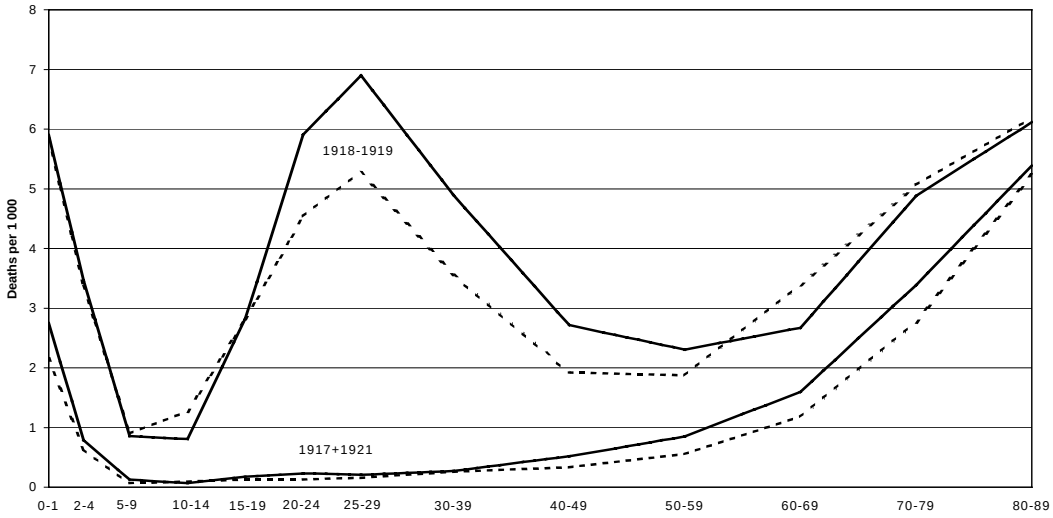
[3] The relatively high correlation between the Sami population and height (r = - 0.66) cause multicolinearity. Therefore estimated standard errors for the effect of height and Sami were corrected by coefficients from Skog (1998:274). (a correlation of 0.7 give 40 per cent higher standard error).

[4] Income per person is not included as an independent variable in the model as the correlation between income and wealth is high (r = 0.83). Similarly, the percentage of persons living in turf-huts/tents is not included in the model as this variable is strongly correlated with the percentage of Sami (r = 0.78).

[5] The reference category is percentage of population (15+) occupied in Industry and service (trade, transportation etc.)

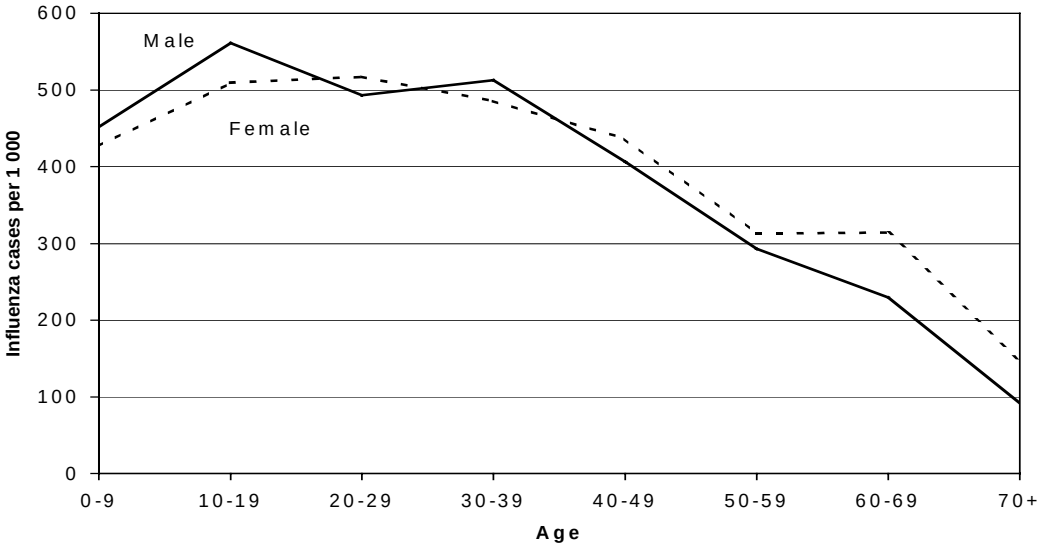
[6] In model 1b, 2b, 3b and 4b, percentage occupied in agriculture etc. is not included as this variable is highly correlated with the urban-rural variable (r = - 0.73) as well as with the cost-inland variable (r = - 0.43). The percentage occupied in fishing is also relatively strongly correlated with the cost-inland variable (r = 0.46)

Figure 1. Age specific death rates of influenza-pneumonia, Norway 1918-1919 and 1917+1921 (male solid and female dotted).



Source: DCM (1921, 1922, 1923, 1925).

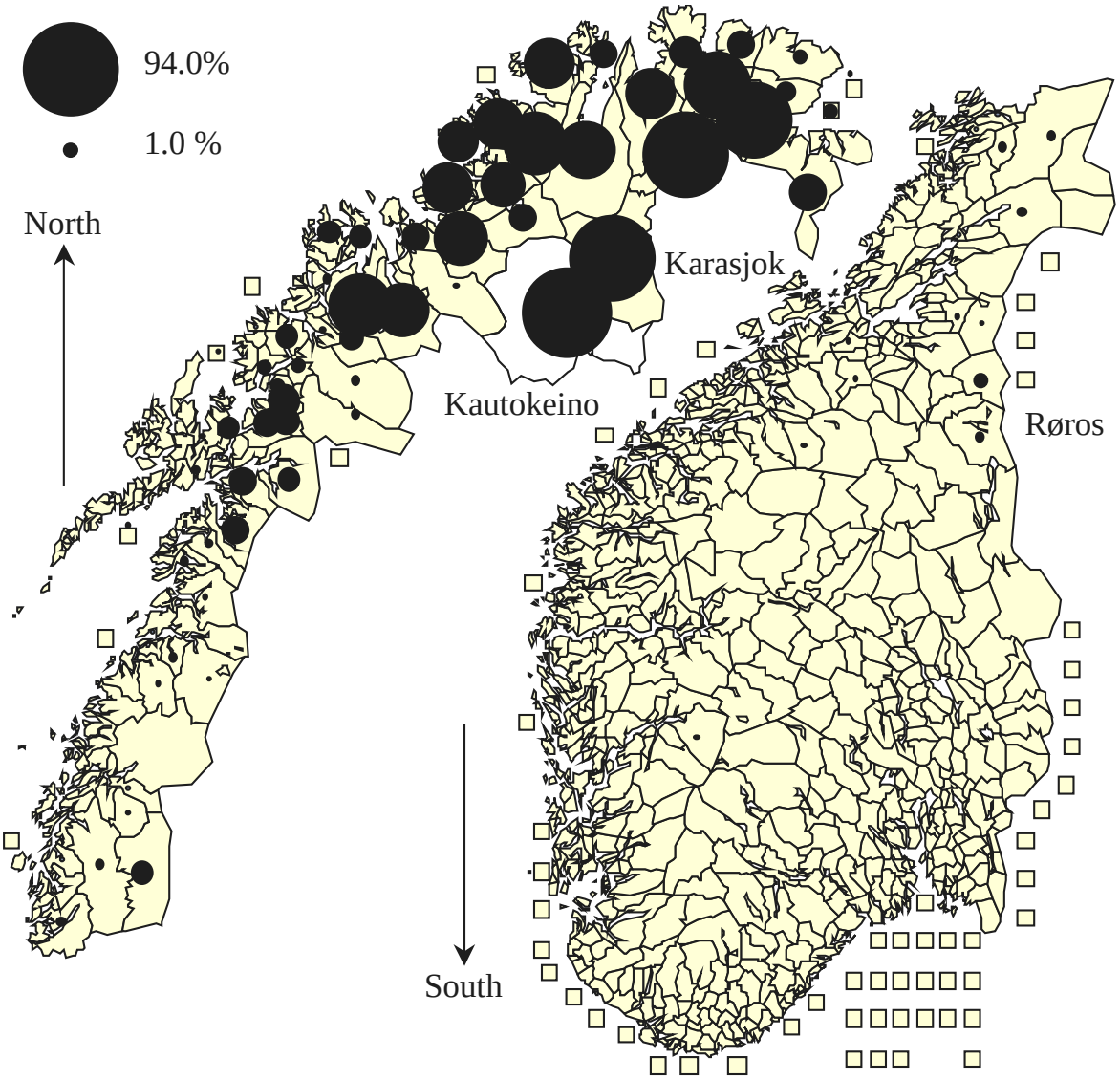
Figure 2. Age-sex incidence of Influenza in the city of Bergen, July 1918-March 1919



Source: Hanssen (1923)

Map 1. Percentage Sami in Norwegian municipalities 1920

[1] Cities are represented by the squares. Source: SSB 1923c.



Map 2. Percentage Kven in Norwegian municipalities 1920

[1] Cities are represented by the squares. Source: SSB 1923c