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ABSTRACT

Infant mortality in Åland, Finland, from 1751 to 1935 is examined. The 18th and early 19th century rates in Åland were more characteristic of Eastern European populations than Western Europe or England. A steady decline in the mortality rates and a reduction in the year-to-year variation began about 1810. This decline is linked to medical innovations, decreases in household and family size, and socio-economic changes. Stillbirth ratios appear to be relatively high and stable from 1751 to 1935 (ranging from 17 to 37/1000). Regional variation in infant mortality rates in the Åland archipelago does not appear to be shaped by either geographic location of the parishes or population density. Data are provided for causes of death during the neonatal and postneonatal periods. A time series analysis demonstrated that high birth rates tend to co-occur with periods of high infant mortality. Factors that may have influenced the infant mortality rates include household size and complexity, twinning rates, and breast feeding patterns.

The level of infant mortality is a general indicator of the overall health status of a population (Thompson and Lewis, 1965). Infant mortality rates are preferable to crude death rates because they are not influenced by the age composition of the population (Pressat, 1972). Cultural factors, social and economic conditions, technological developments, and medico-social organizations are all reflected in infant mortality rates. For these reasons, rates of infant mortality provide researchers with a crude, yet reliable, measure of the overall level of health and hygiene of both present and historic groups for whom complete registration of births and deaths is available. Epidemics, famines, and other hardships which a population experiences should also be reflected in the infant mortality patterns when viewed diachronically. The purpose of this paper is to examine infant mortality in an historic, rural, farming-fishing population located on the Åland Islands, Finland, from 1751 to 1935. Emphasis will be placed on both temporal and spatial aspects of the mortality patterns and their relationship to specific diseases and other demographic variables.

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Infant mortality in pre-industrial and early industrial Western Europe has been characterized by high average levels and peaks of mortality that were even higher. According to Pressat (1972), high infant mortality levels in the past varied between 250 to 300 infant deaths per 1000 live births, with much higher rates occurring during catastrophic events such as famines and epidemics. The average level of infant mortality was a result of the balance of rates on the order of 200 to 250 per 1000 during non-catastrophic periods and exceptionally high rates which occurred during frequent catastrophic periods. Pressat also notes a moderate decline of infant mortality in Western Europe during the 19th century. During the first half of the 1800s the rates were approximately 185 per 1000. Examination of mortality data from Europe tend to support the rates suggested by Pressat. In England and Wales during the period 1841-1900 the rates average about 130/1000 (McKeown and Record, 1961). Knodel and van de Walle (1979) provide infant mortality rates (IMRs) for Europe in the 1890s for a number of countries. The highest rates are recorded for Hungary (250), Germany (221), and Sweden (102). Mortality data from Sweden (Statistiska Centralbyrån, 1969) indicate a high of only 216 per 1000 for the period 1751-1850. France also experienced high rates; in selected areas of Brittany (1720-1792) rates were between 285 and 237 per 1000, and in the southwest and Crulai on the order of 191 to 156 (Goubert, 1968). Higher rates appear to be characteristic of Eastern Europe. For example, in three districts in Bavaria from 1862 to 1904, the rates ranged from 144 to 464 per 1000 (Knodel, 1968). Obviously, infant mortality rates vary in different areas of Europe and within countries, and Pressat's levels are only generalizations of infant mortality levels that occurred in past periods in Europe. Historical trends in infant mortality for the Åland Islands will be presented and compared to Pressat's averages and those reported for Finland and Sweden.

Materials and Methods

The Åland Islands, which consist of approximately 6,600 islands and skerries, lie in the Baltic Sea about half-way between Sweden and Finland (Jaatinen, 1960). Since the 16th century the archipelago has been divided into Lutheran parishes which have also served as administrative units (Figure 1). There are currently sixteen parishes: ten are located on the Main Island (Fasta Åland); five constitute the outer islands and skerries; and Mariehamn (the sixteenth parish), which is located on Fasta Åland, is the only urban center in the archipelago. The fifteen rural

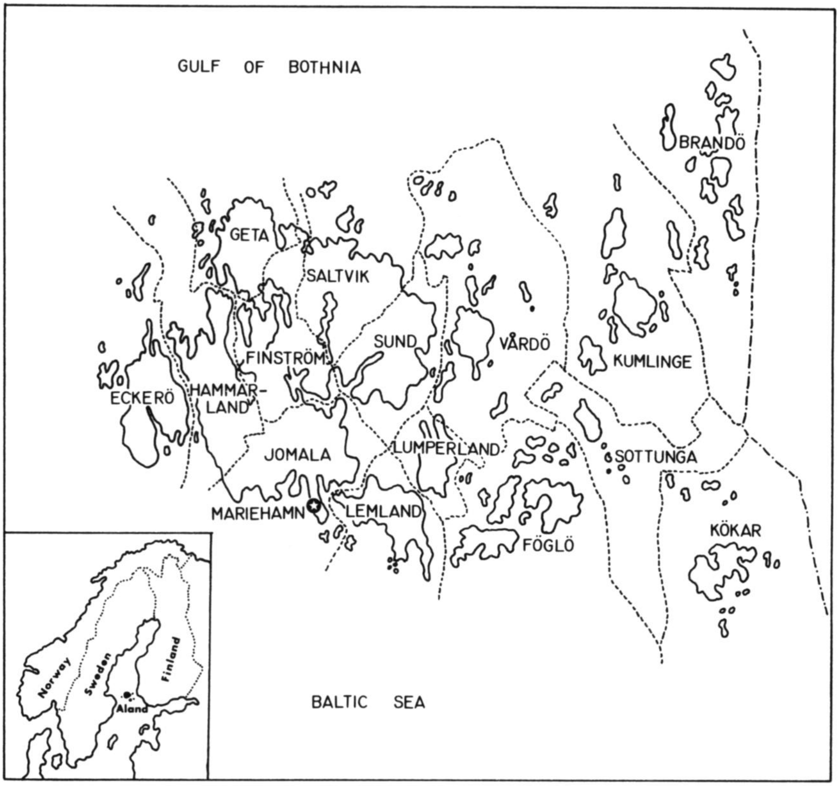

FIG. 1. Map of the Åland Islands, Finland, showing parish subdivisions. Location of the archipelago is shown in the insert.

parishes were established prior to 1650, while the town of Mariehamn was founded in 1861.

The population of the archipelago at the beginning of the 17th century was between 10,000 and 16,500 (Sundqvist, 1931; Wallen, 1932; Jutikkala, 1957). Following several years of crop failure, famine, and epidemics in the 1690s and the Great Northern War, the population was reduced to about 5,200 individuals by 1721 (Jutikkala, 1945). The majority of the present population is descended from these individuals (Eriksson, 1980). For a detailed treatment of the history of Åland, see Eriksson (1980) and Mielke, et al. (1982).

Swedish ecclesiastical law of 1686 prescribed that Lutheran ministers should keep a registry of all their parishioners. Thus, extensive records of births, deaths, baptisms, marriages, inter-parish migration, and population composition are available for Åland. This study is primarily based upon the birth and death records. The birth records include date and place of birth, mother's and/or father's name(s) and occupation(s), mother's age (occasionally), and the name of the child. The death records for each parish usually consist of the date of death and burial, the name of the individual, his or her occupation, the place of residence (parish, village, and often farm number), the age at death, and the cause of death. We have supplemented and cross-checked these records with the statistical summary sheets for each year. The records are relatively complete from 1750 to the present; however, minor problems in registration do occur and occasionally there has been damage due to fire or flooding. There is also variation due to the recording idiosyncrasies of the various priests. These differences do not, however, follow a consistent pattern throughout the archipelago and should not be construed as a systematic bias. Underregistration is often a problem when one is attempting to examine infant mortality and stillbirth ratios. Our data may be missing some cases, and we will point out these cases during the examination of the actual rates.

Several standard demographic/epidemiologic indices were used in this study. These rates were used to standardize the data, thereby facilitating comparisons. Infant mortality rates (IMRs) are calculated as follows:

$$\text{IMR} = \frac{\text{Total no. of deaths less than 1 year old}}{\text{Total no. of live births during the period}} \times 1000$$

Stillbirth ratios are calculated by:

$$\frac{\text{Number of stillbirths}}{\text{Number of live births}} \times 1000$$

And following Shah and Abbey (1971) we also calculated neonatal and postneonatal mortality rates as follows:

$$\text{Neonatal Mortality Rate} = \frac{\text{No. of deaths under 28 days}}{\text{No. of live births}} \times 1000$$

$$\begin{matrix}\text{Postneonatal} \\ \text{Mortality Rate}\end{matrix} = \frac{\text{No. of deaths 28 days through 1 year}}{\text{No. of live births minus neonatal deaths}} \times 1000$$

In order to obtain a general view of the major trends in infant mortality rates, the data were resistant smoothed. Resistant smoothers are built up by successive applications of simple smoothers. This process consists of replacing each data value (IMR) with the running median of 4, then 2, then 5, and then 3 data values immediately before and after the reference data point. This procedure is followed by Hanning, a running average computed as z(t) = 0.25y(t−1) + 0.5y(t) + 0.25y(t+1) (Ryan, et al. 1980).

To test the possibility of delayed effects in the relationship between infant mortality and birth rates, a sliding correlation test was used. The sliding correlation is a simple modification of the product-moment correlation. Instead of calculating a single correlation, r, between series x_t and series y_t, a vector of correlations, r(k), is calculated between x_{t-k} and y_t. The "lag" term, k, can take negative values, and r(0) corresponds to the usual product-moment correlation.

Results and Discussion

Temporal Variation in Infant Mortality

The infant mortality rates (IMRs) for Åland for the period 1751 to 1935 are depicted in Figure 2. The rates are generally very high between 1751 and 1839 (between 230-400/1000). The IMRs slowly decrease between 1840 and 1904, with the rates on the order of 120 to 240 per 1000. There is a further decrease (values range between 40 and 120) starting in 1905.

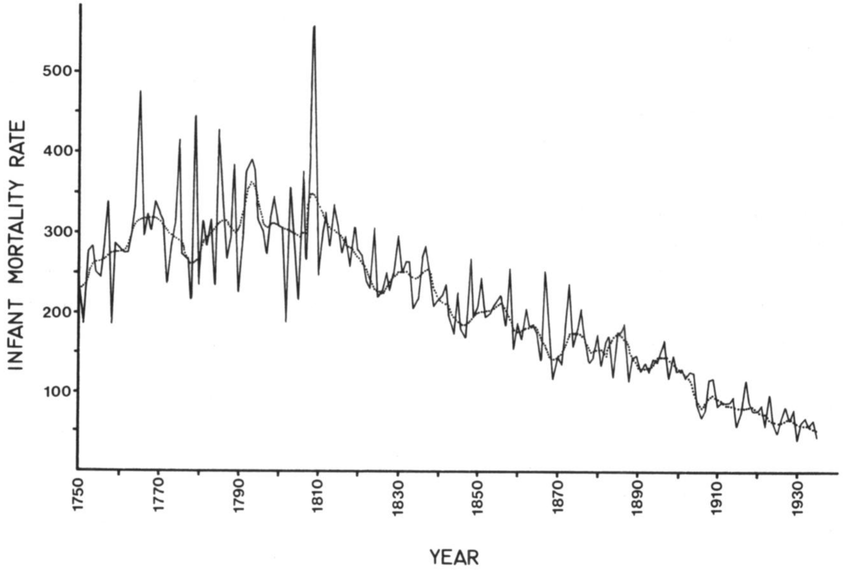

FIG. 2. Infant mortality rates in Åland from 1750 to 1935. Dotted line indicates data after resistant smoothing (see text).

Another characteristic that is clearly depicted in Figure 2 is the extreme variation and fluctuation of rates between 1750 and 1810. After 1810 there is less variation and a smoother decline in values. The extremely high peaks (i.e., 1765, 1775, 1789) reflect epidemic episodes (e.g., smallpox, typhoid fever) and years of poor harvests. The extreme value (557/1000 births) in 1809 corresponds to the 1808-09 war with Russia in which, Mean and Jaatinen (1975) estimate, 30% of Åland's population died. Most of the early rates (1750-1810) depicted in Figure 2 are much higher than the average level (250-300) or even the non-catastrophic levels (200-250) suggested by Pressat (1972) as characteristic of historic populations. Åland's background rates, without episodes of epidemics and famines, fluctuate between 240 and 360 deaths per 1000 births. This level suggests that the overall health in Åland was not as good as most of Europe during the late 18th and early 19th centuries. Åland displays rates that are more characteristic of Eastern European populations.

The broken line in Figure 2 represents the resistant-smoothed data. Again, during the period 1750-1810 the levels are extremely high with peaks in 1766-1770 (a period of poor harvests followed by famine and epidemics in both Finland and Sweden), 1793-4 (epidemics and war with Russia on mainland Finland), and 1808-09 (a period of war with Russia which resulted in the displacement of much of Åland's population and ensuing epidemics). The general decline in rates can also be seen starting about 1810; however, the rates are still maintained at higher levels than suggested by Pressat (1972). This decline in IMRs coincides with the Russian domination of Åland, and the period during which trade embargoes were placed upon the Ålanders (Mead and Jaatinen, 1975). Because of the embargoes, Åland was somewhat isolated. Fisher's (1929) test for white noise was applied to the infant mortality series to test for periodicity. The test showed there was no significant periodicity in the data.

We have divided the period (1750-1930) into 10-year intervals in order to examine the magnitude of the mortality and to facilitate comparison with IMRs of Sweden and mainland Finland during the same period. Table 1 presents the IMRs for these 10-year periods. As can be seen, the rates are much higher than those of Sweden and mainland Finland. Åland's highest rate is 330/1000 births during 1791-1800, and the lowest rate (68/1000) occurs during 1921-30. The average difference in rates between Åland and Sweden is 67 deaths per 1000 births, with a range from 9 to 134. The largest differences in rates are during the periods from 1751 to 1810 (mean difference is 101). The average difference then decreases to 62 during the periods from 1811 to 1900, and this is followed

Table 1

Infant Mortality Rates for Åland, Sweden, and Finland

Year	Åland	Sweden[1]	Finland[2]
1751–60	262	205	224.3
1761–70	323	216	241.5
1771–80	298	202	210.0
1781–90	303	200	215.7
1791–1800	330	196	207.2
1801–10	307	199	214.1
1811–20	294	183	200.1
1821–30	251	167	198.3
1831–40	242	167	196.9
1841–50	207	153	172.9
1851–60	226	146	177.2
1861–70	173	139	195.0
1871–80	171	130	166.6
1881–90	152	111	152.4
1891–1900	137	102	141.7
1901–10	103	85	123.8
1911–20	84	69	111.8
1921–30	68	59	91.9

[1]Historisk Statistik för Sverige, Del 1. Befolkning, Andra Upplangan 1720–1967, Page 115.

[2]Strömmer (1969).

with an even greater reduction to only 14 during 1901 to 1930. These differences indicate that living conditions were harsher in Åland than in Sweden during the 18th and 19th centuries. The rates are then nearly equal during the 20th century. Åland's rates are higher than Finland's in the earlier periods (before 1860), and the rates then become similar to those of mainland Finland after that time. The similarities between Åland and Finland beginning in 1860 are probably the result of Åland's newly gained freedom of trade. In 1856 the trade embargo placed on the archipelago by Russia was lifted, allowing trade between Finland and Åland (Dreijer, 1968; Mead and Jaatinen, 1975).

Regional Variation in Infant Mortality

There is also regional variation within the Åland archipelago if the data are examined at the parish level. In general, all parishes show a decrease in the IMRs over time, except during the first three periods, in which there are increases in about half the parishes (Table 2). The highest rate is 461/1000 births for Vårdö in 1776-1800 and the lowest rates is also in Vårdö (64 in 1901-1925). Outer island parish (Figure 1) groupings of Föglö/Sottunga/Kökar and Kumlinge/Brändö exhibit high IMRs for 1751-1775; and Vårdö, a peripheral parish between the Main Island and the outer islands, shows consistently high IMRs from 1751 to 1825. The variation in rates among parishes does not appear to be systematically related to population density and/or geographic location within the archipelago. Centrally located (Fasta Åland) parishes with relatively high population densities do exhibit higher rates than other parishes for some selected periods, but the pattern is not consistent through time. In fact, there are both low negative and positive correlations between population density and IMRs, suggesting that there is no consistent pattern or association between population density and IMRs in Åland. However, at least one factor should be pointed out: since population densities are not high anywhere in Åland, the influence may only be slight. The lowest density is 4.76 individuals per square kilometer (Vårdö in 1751-1775) and the highest is only 19.6 per square kilometer (Jomala in 1901-1925). The variation in rates across the archipelago is apparently not being heavily conditioned by either spatial location or population density.

For mainland Finland, Turpeinen (1978) reports an urban/rural contrast in IMRs for 1749-1773. The mean rate for the urban parts of Finland was 290 (range: 201.7 to 341.7) and for the rural areas it was only 197 (range: 93.3 to 545.7). Turpeinen (1973) also found rural/urban contrasts during the period 1816-1865, with some of the highest rates on the coastal areas of the Gulf of Bothnia. He attributes the regional variation in rates to epidemics and secondarily to poor nutrition or famine. Utterström (1954) also reports a similar contrast for Sweden where the rural rates are lower than the urban. From 1750 to 1935 the Åland archipelago would be classified as a rural area (Mariehamn was just starting to become the only major urban center in the early 20th century). As such, we cannot contrast rural *versus* urban within the archipelago, but the rates for rural Åland when compared to both rural and urban rates for Sweden and Finland clearly demonstrate that the conditions in the archipelago were much harsher than mainland Sweden or Finland.

Relationship Between Infant Mortality and Births

Numerous studies have examined the relationship between mortality and fertility, especially the degree to which changes in mortality patterns

Table 2

Regional Variation in Infant Mortality Rates in Åland Parishes

Parish	1751–1775	1776–1800	1801–1825	1826–1850	1851–1875	1876–1900	1901–1925
Ec/Ha	280	258	230	197	156	191	94
Geta	275	286	269	239	179	150	87
Finström	392	357	265	263	183	136	92
Saltvik	322	336	310	208	—	156	115
Sund	352	309	312	232	—	158	80
Vårdö	434	461	345	221	—	114	64
Jomala	283	300	329	263	209	134	102
Lemland	277	280	369	254	218	150	73
Lumparland	277	371	293	236	188	149	81
Fö/So/Kö	343	287	291	256	179	142	81
Ku/Br	423	314	224	142	127	116	84
Mariehamn	—	—	—	—	—	125	92

(Ec = Eckerö, Ha = Hammarland, Fo = Föglö, So = Sottunga, Kö = Kökar, Ku = Kumlinge, and Br = Brändö) can be correlated with changes in fertility patterns (e.g., Knodel, 1968; Preston, 1978). As part of our investigations, we were interested in determining whether there were any relationships between births and infant mortality in Åland which might provide more insight into the role and impact of infant mortality in the archipelago. The data are aggregate level statistics, so we cannot comment on changes at the family level.

A simple and direct way to test the relationship between two time series is to calculate the product-moment correlation between them. Using the total number of births and infant deaths for the years 1760 to 1935 as the input series, a correlation of 0.0004 was obtained. Since the effects of birth rate on infant death rate (and vice-versa) could plausibly be delayed by a certain number of years, the sliding correlation test was applied. Application of this test to the data yielded a puzzling result: all of the correlations in the vicinity of $-10 \leq k \leq 10$ (i.e., lag values between -10 and 10) were very low, while the correlation largest in absolute value (-0.84) was seen at $k = -49$. At negative lag values, the birth series leads the infant death series. This result thus implies that a high birth rate in 1800, for example, produces a low infant mortality rate 49 years later. Even if a two-generation effect did occur here, it is difficult to imagine the mechanism that would produce this finding. Examination of the plotted time series indicated that the result is actually an artifact of long-term trend in both series. Infant mortality declines steadily from 1760 to 1935, while the number of births increases until 1880 and then declines rapidly. By allowing the birth series to lead the infant death series by 49 years, the last 49 years of the birth series are omitted from the analysis (i.e., the last usable birth rate year is 1886, which "matches" the infant death rate for 1935). Thus, the correlation is computed between two fairly straight lines when $k = -49$.

To eliminate the distortion caused by these trends, a second-degree polynomial regression (with a linear series of integers, 1,2,3,4,..., as the independent variable) was performed on each series, and the analysis was repeated on the residuals. The highest correlation ($r = 0.3140$, $p < 0.01$) is now seen at $k = 0$, with the $r(k)$ values tending rapidly toward zero at positive and negative lags. Plotting the two series against each other indicates that there are no outliers producing a spurious correlation. Also, the auto-correlation values of the two series are very low, indicating that the correlation test is legitimate. This correlation shows that periods of high birth rates tended to co-occur with periods of high infant mortality, lending some support to the hypothesis that early weaning and abandonment of breast-feeding, in causal association with high fertility, may have been responsible for high infant mortality rates.

Stillbirth Ratios

Few historic studies include stillbirth ratios because stillbirths were not consistently recorded in historical accounts. In Åland, however, stillbirths are recorded in both the birth and death records of each parish as "deadborn". The stillbirth ratios (Table 3) for Åland from 1761 to 1930 are comparable to those from Sweden. These stillbirth ratios show very little fluctuation which is characteristic of stillbirth ratios. For example, the stillbirth ratios for Sweden do not change substantially from 1750 to 1950 (Statistiska Centralbyrån, 1969). Again, however, the ratios for Åland are slightly higher than those for Sweden from 1791 to 1850. Åland's higher

Table 3

Stillbirths per 1000 Births for Åland and Sweden

Year	Åland	Sweden[1]
1751–60	14.18[2]	24.82
1761–70	22.41	25.57
1771–80	27.90	27.52
1781–90	27.54	27.20
1791–1800	35.71	28.29
1801–10	35.69	24.69
1811–20	37.75	24.67
1821–30	34.17	26.18
1831–40	34.68	29.73
1841–50	37.04	31.22
1851–60	31.27	32.29
1861–70	26.60	32.73
1871–80	26.52	30.78
1881–90	31.74	27.11
1891–1900	24.20	25.76
1901–10	17.46	24.79
1911–20	20.63	23.85
1921–30	22.11	25.25

[1]Historisk Statistik för Sverige, Del 1. Befolkning, Andra Upplagan 1720–1967, Page 109.

[2]Data missing for a number of parishes.

stillbirth ratios possibly reflect the same disparity between Sweden and Åland in general health demonstrated by the differences in IMRs.

Finström, a Case Study of One Parish

In order to obtain a more detailed picture of the IMRs, we have examined one parish in depth. Finström (Figure 1) has very high IMRs with a decline over time similar to that of Åland as a whole (Table 4); therefore, it should be a representative parish in which to examine differential mortality by sex, causes of death, and neonatal and postneonatal mortality rates. The highest infant mortality level for Finström is 459/1000 births for the period 1781-90, and the lowest rate is 83/1000 for 1901-10. Male IMRs are consistently higher than female IMRs (Table 4, male excess mortality), with the male rate 21% higher on the average (ranges from 2% to 58%). Again, these rates are well above the mean level for historic populations suggested by Pressat (1972).

Table 4

Infant Mortality Rates for Finström, Åland

Year	Males	Females	Male Excess Mortality	Total
1751–1760	—	—	—	—
1761–1770	394	385	102	388
1771–1780	359	350	103	357
1781–1790	459	338	136	402
1791–1800	381	303	126	340
1801–1810	295	271	109	283
1811–1820	294	266	111	283
1821–1830	261	245	107	253
1831–1840	319	250	128	289
1841–1850	232	201	115	217
1851–1860	202	191	106	217
1861–1870	162	152	107	161
1871–1880	216	137	158	174
1881–1890	196	150	131	172
1891–1900	151	105	144	130
1901–1910	91	75	121	83
1911–1920	109	69	158	90
1921–1930	85	93	91	89

Male and female infant mortality rates are per 1000 male and female births, respectively. Male excess mortality is defined as: (male IMR/female IMR) × 100.

The risk of death derived from the infant's constitution, congenital malformations, and circumstances of birth is defined as neonatal (sometimes endogenous) mortality. During the first month of life the predominant causes of death are usually linked with physiology and the circumstances of accouchement. Infant deaths occurring after 28 days of life are usually attributed to environmental causes such as infectious diseases, alimentary troubles, and respiratory problems (Wrigley, 1968; Beaujeu-Garnier, 1966). Mortality occurring during the period from 28 days to less than one year is termed postneonatal mortality (sometimes exogenous). Because death records for Finström record deaths of infants in days (and in some cases hours), we have been able to divide the data into these two categories.

Table 5 presents the IMRs separated into these two components. Neonatal mortality is consistently lower than postneonatal mortality, ranging from 19 to 128 deaths per 1000 births (or from 37% to 47% of the

Table 5

Neonatal (Less Than 28 Days) and Postneonatal (28 to Less Than 1 Year) Mortality Rates (MR) for Finström, Åland

	Neonatal		Postneonatal	
Year	MR	%	MR	%
1751–1760[1]	—	32	—	68
1761–1770	128	33	296	67
1771–1780	122	34	262	66
1781–1790	115	29	314	71
1791–1800	107	32	242	68
1801–1810	109	41	174	59
1811–1820	67	24	228	76
1821–1830	96	38	180	62
1831–1840	88	30	214	70
1841–1850	89	41	135	59
1851–1860	72	37	134	63
1861–1870	76	47	92	53
1871–1880	77	44	112	56
1881–1890	67	39	113	61
1891–1900	34	27	99	73
1901–1910	22	26	63	74
1911–1915	19	24	63	76

[1]1751–1760 is an estimate based on partial data.

total infant mortality). Postneonatal mortality ranges from 63 to 314/1000 (or from 53% to 76% of the total infant deaths). There is a steady decrease, with some variation, in the postneonatal component of infant mortality until 1861-70 when it reaches 53%. Then there is a steady increase to 76%. This pattern is not characteristic of other populations and would not be predicted based upon the eradication of infectious diseases and improvements in living conditions and hygiene. As such, it is an interesting anomaly in the Åland data. In mainland Finland during the 1950s, between 66% and 71% of the IMR was due to endogenous factors (Beaujeu-Garnier, 1966). Wrigley (1968) reports figures of 45% to 60% for the endogenous component for England (16 populations) and for France (from the 1500s to the 1800s). Smallpox vaccination was introduced into Åland around 1805, and most of the population were periodically vaccinated from that date to the present. Other infectious diseases and childhood maladies received continual and increasing medical attention; and one would predict that, rather than increasing, the postneonatal component should have continued to drop steadily from the mid 1850s.

There is, however, a general decline in the IMRs (both neonatal and postneonatal components) over time, as would be expected. McKeown and Brown (1955) state that postneonatal mortality is more sensitive to changes in the environment than is either the conception rate or prenatal mortality. They list several possible causes for the reduction in infant mortality over time: (1) specific preventive or curative measures, (2) improvements in the immediate environment, and (3) a change in the balance between host resistance and the virulence of the infective organism. The general socioeconomic conditions of Åland improved during the early half of the 19th century, with considerable improvements after 1850; and there were medical innovations that appear to have played a role in the changes in infant mortality. These changes seem to be reflected in the decrease in the IMRs over time, but they do not explain the increase in the postneonatal component of the infant mortality.

In order to obtain a clearer understanding of the role of neonatal and postneonatal factors as they contribute to the IMRs, we have examined the causes of death in Finström for three periods: 1751-1800, 1801-1850, and 1851-1900 (Table 6). A major problem encountered with this analysis was the fact that most of the deaths were attributed to unknown childhood disease, and have been placed under "Non-Specific Cause" in the table. This category accounts for 89%, 76%, and 43% of the deaths in the neonatal period and 72%, 60%, and 34% in the postneonatal period for the three time categories, respectively. Even with the large percentages at-

Table 6

Causes of Death for Finström, Åland. All Figures are in Percent

Cause of Death	1751–1800		1801–1850		1851–1900	
	Neonatal	Postneonatal	Neonatal	Postneonatal	Neonatal	Postneonatal
Infectious and Parasitic	2.8	15.0	1.7	12.9	4.6	23.3
Respiratory	1.6	4.1	1.1	3.2	0.0	4.0
Digestive	1.2	2.4	2.3	3.2	0.0	1.0
Circulatory	0.4	1.1	14.3	10.0	8.8	7.9
Non-Specific (Probably infectious, digestive, respiratory)	89.2	72.2	76.0	60.1	42.8	34.2
Unknown/Not specified	4.8	5.2	4.6	10.6	43.8	29.6
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

tributed to non-specific causes, the other percentages are instructive. Infectious diseases do not play a major role in the causes of death in the neonatal period, although they do contribute slightly as indicated in the table. Infectious diseases do account for 15%, 13%, and 23% of the postneonatal deaths for the three time periods (which may partially explain the increase in postneonatal percentage of deaths). Measles, smallpox, typhoid, typhus, and dysentery are the major contributors to this category. The other causes contribute less than 10% in all cases except for the 1801-50 period when circulatory complications account for approximately 14% and 10% of the deaths (neonatal and postneonatal, respectively).

Seasonal conditions also appear to influence mortality rates, especially deaths caused by typhoid, typhus, and dysentery, which were diseases of the summer and autumn (Jutikkala and Kauppinen, 1971). For Sweden from 1749 to 1872 the worst seasons in terms of total mortality were spring and winter (Berg, 1879, cited in Utterström, 1954). This same trend is seen in Finström for the period 1801-1900, but the reverse is true for the earlier period, 1751-1800, when summer and fall show the highest rates of infant deaths. This trend is unclear and needs further research, especially at the family and household level.

As mentioned earlier, smallpox vaccination was introduced about 1805, and there are also indications that Åland's economy and standard of living steadily improved after the 1808-09 war. These improvements and medical innovations should have been responsible for a greater proportional decrease in the postneonatal component of IMRs compared to the neonatal component; they were, however, probably responsible for the general decline in the IMRs over time. There is some literature which suggests that a number of the infant deaths were caused by feeding cow's milk from a cow horn (accounts written in the 18th and 19th centuries attribute a number of infant deaths to this practice). Turpeinen (1978) has dismissed this practice as a causative factor; however, reports during the time periods under consideration do indicate that this was a practice of many peasant farmers (Radloff, 1795), especially when the males were absent from the farmsteads for long periods of time and the women were working intensively in the fields and did not breast-feed their infants regularly. Considering the evidence presented by Knodel and van de Walle (1967) and Knodel (1977), this may indeed have been an important factor influencing infant mortality rates. Also, the co-occurrance of deaths and births as shown by the time series analysis lends support to this idea.

A number of researchers contend that the opportunity for infection (especially postneonatal mortality) in children increases with increasing family size (Cohen, 1975; Heady, et al. 1955; Douglas and Bloomfield, 1958; Dingle, et al. 1964). Heady et al. (1955) caution that a decrease in family size cannot be the major cause of the decline in postneonatal mortality, but that it does contribute some unknown amount. Data on household size and composition for Finström during the 18th and 19th centuries indicates a decrease in mean size and complexity (Devor, 1979; Nerdrum, 1978). The late 18th century average household in Åland was large, consisting of about 9 persons (servants included). These households were multigenerational, complex structures with a core consisting of at least 7 persons. At the beginning of the 19th century social and economic conditions started to change in Åland (Nerdrum, 1978; Devor, 1979). In Finström there was an increase in tenant farming (crofting) with a decrease in family and household sizes. After the 1808-09 war with Russia and the trade embargo, Åland was forced into self sufficiency and the number of smaller households increased. Devor (1979) notes decreases in complex (multiple family) households from 54.9% (1760) to 40.8% (1800) to 30.7% (1840) and to 25.5% (1880). Mean household size also decreased during these same time periods from 8.9 to 5.3 to 5.1 and finally to 4.9 individuals.

Our data on postneonatal mortality have not yet been linked to households; however, if the trend in reduction in household size and complexity influences the spread of infection and/or parasitic diseases, we would expect a decrease in IMRs over time. To what extent IMRs are conditioned by changing household patterns must be thoroughly analyzed, but the data presented for Åland suggest that there may be a relationship between household size and complexity and infant mortality.

Eriksson (1973) also suggests that the relatively high mortality may have been partially due to the large sibships and the high rate of twinning. Eriksson (1973, p. 118) states that "of liveborn children in twinning families 64.6% of the twins and 39.4% of the singletons died during the first year" (from 1749 to 1790). It is also interesting to note that Åland's twinning rates are among the highest in Europe, and that they decreased from 21.0 ‰ to 17.7 ‰ from 1750-1849 to 1850-1949 (Eriksson, 1973). The initial decline started about 1825, corresponding roughly with the decline in IMRs.

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