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Patterns of Infant Mortality in the Upper St. John Valley French Population: 1791-1838

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ABSTRACT

The purpose of this paper is to provide a descriptive analysis of infant mortality patterns in a pre-industrial North American population, the Madawaska French of the upper St. John Valley. A synchronic approach was taken in examining a series of 320 infant deaths identified through family reconstitution. The infant mortality rate for the series is 132 per 1000, low compared to other pre-industrial populations. The large average completed family size of 11.34 is associated with short birth intervals averaging 21.9 months. Women who experience infant mortality were found to have significantly larger completed families than those who did not. Infant mortality risk was positively associated with larger ultimate family size, but was unrelated to birth order. Patterns of high fertility and low infant mortality are attributed to the process of colonization and population expansion in a relatively isolated area.

Infant mortality is frequently used as an indicator of overall population health, in both recent and historical studies (Jelliffe, 1966; Gortmaker, 1979; Meindl, 1980). It is also a useful tool in historical research on fertility and cultural practices such as weaning, infant feeding, and family limitation (Marcy, 1981; Masnick, 1979). Research on infant mortality plays an important role in the understanding of population change from colonial times through industrial development in Europe and North America (Swedlund, 1978). Due to uneven data sources and under-registration, our knowledge of historical data on North American infant mortality remains limited (Haines, 1977; Vinovskis, 1973; Meindl and Swedlund, 1977). Some studies have reported infant mortality rates (Greven, 1970; Henripin and Péron, 1972), but there has been little systematic examination of the interaction between infant mortality and related factors such as birth order, birth intervals, completed family size, and maternal age (Meindl, 1980). The purpose of this paper is to provide a descriptive analysis of infant mortality patterns in a pre-industrial North American population, the Madawaska French of the upper St. John Valley, located in northern Maine and northwest New Brunswick.

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Materials and Methods

This population is particularly interesting for several reasons. First, it had an extremely high level of fertility. Second, during the study period, it was undergoing settlement formation and population expansion, while maintaining a technologically simple agricultural economic system. Third, it was fairly isolated, both geographically and genetically, from other groups. Last, it has been, until now, unknown demographically. This research is part of a larger project designed to examine the historical demography of the upper St. John Valley from its settlement to 1900.

Colonization began in 1785 with the arrival of 17 families, Acadians exiled by the English from the Bay of Fundy area in 1755, some of whom had intermarried with Québéquois of Kamouraska during the intervening years. They settled along the river in the traditional North American French pattern of "rangs," narrow strips perpendicular to the river which functioned as a primary transportation route. The economic base was subsistence farming; households were composed of economically independent nuclear or stem family units. Until 1838, the entire settlement constituted a single Catholic parish, St. Basile. In 1842, the New Brunswick/Maine border was placed along the river dividing the valley population into two nationalities. It remains today over 95% French-speaking on both sides of the border, retaining also its Acadian cultural identity.

Table 1

Population Size Changes of Madawaska French: 1790–1834

Year	Period	Total Recorded Births	Total Recorded Deaths	Estimated Net In-Migration	Total Size
	1785–1789			+174	
1790					174
	1790–1798	136	6	+201	
1799					331
	1799–1802	40	7	+ 82	
1803					446
	1803–1819	595	139	+212	
1820					1114
	1820–1829	849	261	+601	
1830					2503
	1830–1834	716	171	−261	
1834					2772

As shown in Table 1, the population numbered 174 in the 1790 census, increasing rapidly to 2772 by 1834. The net in-migration for the study period was 850. Out-migration during the 1830-1834 period may be due in part to a crop failure and temporary food shortage in 1833. In general, population density was low during this period, and the group was relatively isolated geographically.

Families were reconstituted by the record linkage of parish baptismal, marriage, and death records, with additional data provided by available census information. Baptismal records included a date of birth; burial records included a date of death and frequently an age. All instances of infant death occurring in the first 12 months of life were identified. Each case was coded for computer-assisted (SPSS) analysis, including variables of sex, birth order, sibship size, birth intervals before and after the index birth, maternal age, consanguinity of parental union, and whether the death was endogenous or exogenous. All cases of death occurring in the first month were considered endogenous, and all cases in the second through twelfth months exogenous. The method of Bourgeois-Pichat (1951) was used to calculate aggregate frequencies of endogenous/exogenous components for comparison with those produced by the "first month" method.

All completed families were identified. For comparison, all completed families which had experienced no infant mortality were also extracted from the general population data. Following Henry (1970), two approaches were used to identify sibships as complete or incomplete. When maternal age and marriage were known, families of women surviving to age 45 (and whose spouses also survived) were considered complete. When the marriage date, but not maternal age, was known, all unions surviving 27 years or more were considered complete.

Since stillborns are occasionally baptized in Catholic populations, there was no precise way to distinguish them from infants who were born alive and died the same day. Among completed families, 5.6% of infant deaths occurred the same day as the birth; this value includes both still and liveborn infants.

During the first decade of the study period, the parish was served by itinerant priests. Although baptisms and marriages seem not to be underregistered for this period, deaths, particularly infant deaths, are. Data for the years 1800, 1801, 1802, and 1804 are partially missing, and were excluded in calculating an aggregate rate. To further compensate for underregistration, a second aggregate rate of infant mortality was calculated using data from completed sibships where no major recording gaps existed.

Results

Of 2701 births recorded for the years 1803 and 1805-1838, 317 (117 per 1000) resulted in infant death. This is 44% of total mortality for the population. The aggregate rate produced using only completed sibships was higher, 132 per 1000. The overall rate is judged to be between 117 and 132, and probably closer to the latter figure.

Sex is recorded in 87% of cases, yielding a sex ratio of 137. This compares with a sex ratio of 104 for children aged 0-5 at the time of the 1830 census.

Endogenous deaths (in the first month) account for 46.7% of infant mortality and occur at a rate of 55.2 per 1000, compared with 53.3% and a rate of 62.2 per 1000 for exogenous deaths (in the second through twelfth months). Using the method of Bourgeois-Pichat, the level and rate of endogenous mortality are 29.3% and 34.8 per 1000 respectively; those of exogenous mortality are 70.6% and 82.9 per 1000. These two methods, therefore, yield very different estimates (Table 2).

Seasonality

Seasonal patterns of infant mortality are shown in Figure 1. Here the distribution of infant deaths according to month of death is decomposed into mortality due to endogenous and exogenous causes. Exogenous deaths show two peaks, February and September, possibly reflecting the incidence of infectious disease. The two less pronounced peaks of endogenous mortality occur in November and July, and appear to be unrelated to the overall distribution of deaths.

Sibship Size and Risk

Figure 2 shows the relationship between completed family size and risk of dying among 1474 children of 127 completed families. Fertile completed families ranged in size from 2 to 20, with a mean of 11.68. No

Table 2

Distribution of Madawaska French Infant Mortality by Age

Age in Months	1	2	3	4	5	6	7	8	9	10	11	12
Number dying	148	36	23	17	11	11	13	12	11	12	9	17
Cummulative Total	148	184	207	224	235	246	259	271	282	294	303	320

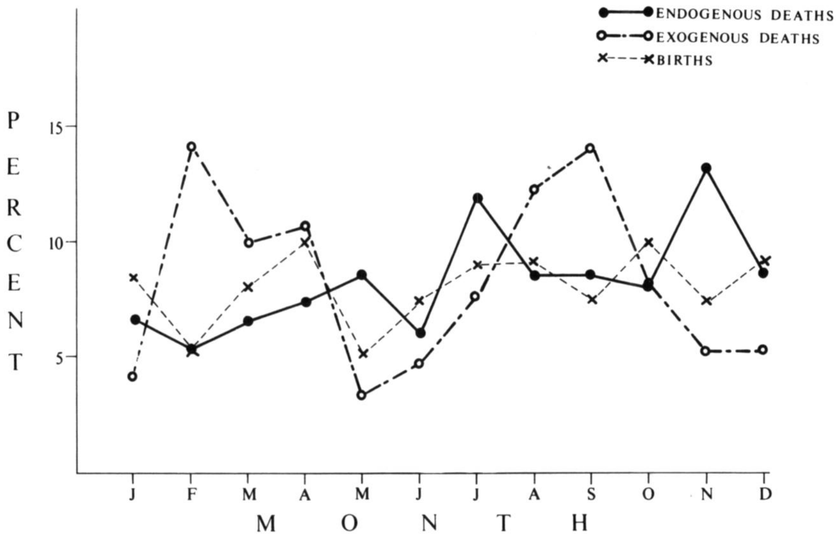

FIG. 1. Seasonality of endogenous mortality, exogenous mortality, and month of birth for infants who died.

family with less than 5 children experienced infant mortality, but only 7 of 127 families were this small. There were only 9 families with 17 or more children. The J-shaped curve in Figure 2 indicates a positive relationship between increased completed family size and infant mortality risk. Curves for the first three and last three birth orders are remarkably similar, indicating a strong relationship between ultimate family size and mortality, regardless of birth order.

Birth Order and Risk

Figure 3 shows the risk of dying from competing causes of death during the first year among completed families according to birth order. Birth orders ranging from 1 to 20 are shown in groups of two in this distribution. Although exogenous mortality risk increases for birth orders 17 and above, this may be due to the rather small population size. In general, the endogenous and exogenous curves are similar to each other and rather flat, reflecting a lack of association between birth order and mortality risk.

Infant Mortality and Fertility

Of the 193 sibships in which at least one infant death occurred, 40% were complete, 41% were not observed long enough to identify as com-

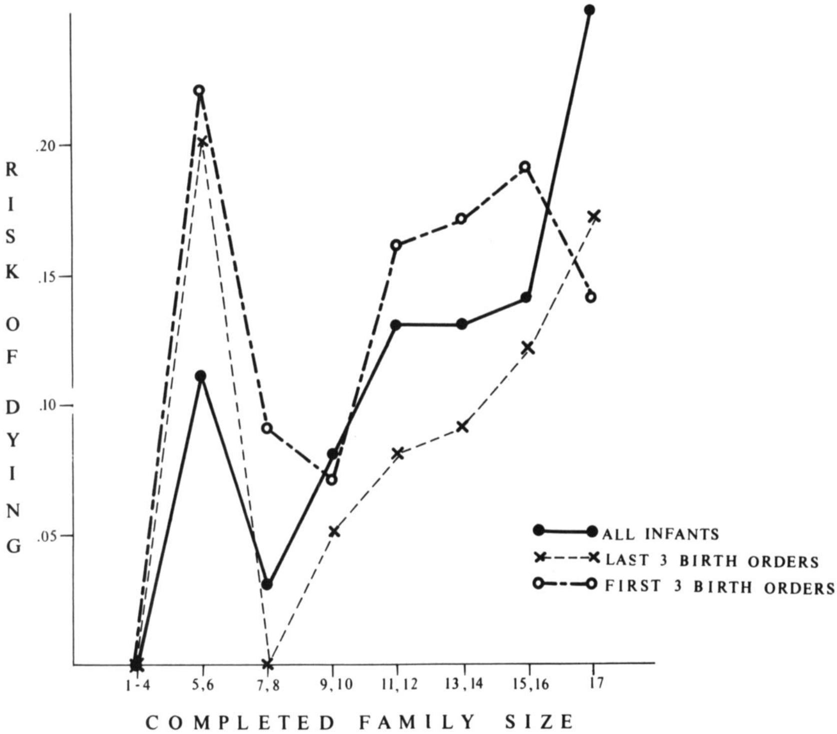

FIG. 2. Risk of dying by completed family size comparing all infants to those in first three birth orders, and to those in last three birth orders.

plete, and 18% were incomplete due to the death of one spouse. The average sibship size for all three categories combined is 10.75 (s.d. = 4.52). The average completed family size for fertile unions (N = 127) is 11.34 (s.d. = 4.05); 3 unions in 130 completed families were sterile.

A comparison was made between (A) completed families who experienced one or more infant deaths (N = 67), and (B) those where no infant deaths occurred (N = 60). The average completed family size for A was very high, 12.85 (s.d. = 3.17). Even when sibship sizes were corrected for possible stillbirths by subtracting infants who had the same birth and death day, the mean was 13.12 (s.d. = 2.91). Sibships for which this was the only death (N = 8) were removed from the sample, resulting in an increase of the mean. In group B the average completed family size was only 9.91 (s.d. = 3.77). The difference between groups A and B was

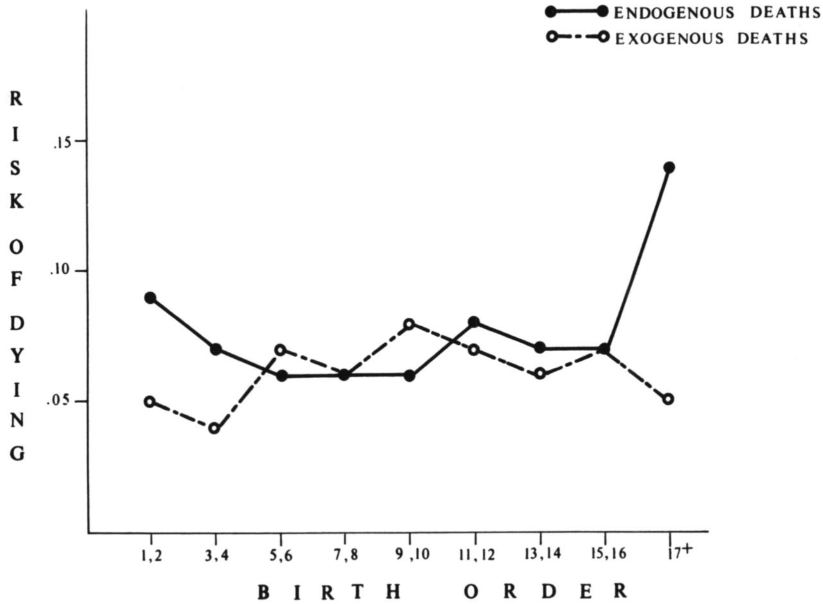

FIG. 3. Risk of dying by birth order, decomposed into endogenous and exogenous mortality components.

significant whether possible stillbirths were removed or not (t-test: $p < .001$). The difference in fertility between groups A and B is not due to a difference in age at first marriage. The average age for women in group A was 20.9. it was 21.4 for those in group B. The difference between group means was not significant (t-test: $p > .05$).

It appears that women who experience infant death either are more fertile than those who do not or are simply replacing dead infants, and not producing significantly more children who will survive infancy. To test these competing hypotheses, all infants from completed families who died were subtracted from the completed family size for those women in group A. The resultant average completed family size was 10.51, still slightly larger than the mean of 9.91 in group B; but this difference was not significant (t-test: $p > .05$). Thus, although women produced more offspring if one or more of their children died in infancy, the average number of children who survive infancy in these sibships is not significantly larger than the average number of children in sibships with no infant mortality.

Previous Pregnancy Experience

On average, a fertile woman surviving to complete her family had a 52% chance of experiencing at least one infant death. If, however, she had had one infant death, her chances of experiencing another increased to 67%. Having had two infant deaths, the chances of having another dropped to 32%. Endogenous deaths occurred more frequently among completed sibships with more than one infant death, and exogenous deaths were significantly more frequent among sibships with single infant deaths ($\chi^2 = 3.8705$; $p < .05$).

Maternal Age

Maternal age, known for 223 infant deaths, ranged from 17 to 49, with a mean of 29.23 (s.d. = 7.23). Infant deaths were subdivided by maternal age and cause of death. Endogenous mortality occurred more frequently among women 35 years of age and older than among those under 35 ($\chi^2 =$ 4.5759; $p < .05$).

Consanguinity

Pedigree analysis based on linked records was used to evaluate the relationship between consanguinity and mortality. The frequency of consanguineous unions (2nd and 3rd degree) was higher among parents of completed families who experienced infant mortality, 25.0% (N = 16 out of 64), than among those who do not, 15.4% (N = 8 out of 52). This difference, however, was not significant using chi-square.

Birth Intervals

Birth intervals before and after the birth of infants who died are known for 82% (N = 262) of the infant deaths. The average interval before the birth of the index infant is 21.9 months (s.d. = 12.46). This is longer than the average interval between the births of the index infant and the subsequent sib, 19.70 months (s.d. = 11.76), and is probably associated with a shortened lactation period. Use of the t-test indicates these means are not significantly different, however.

The average birth interval between livebirths was calculated using the intervals before births resulting in exogenous death. First births as well as all cases where the previous child had died in infancy were excluded in this comparison. The resultant average birth interval is 22.09 months. In contrast, for the 45 cases where the date of birth and death were the same and where the subsequent birth interval is known, the average was 15.53

months (range 7-37; s.d. = 7.32). The length of lactation in such cases is hypothetically zero. Thus, the birth interval after such a birth subtracted from the average interval between livebirths (6.56 months) is an estimate of the effectiveness of lactation amenorrhea in suppressing fecundity.

Discussion

The study population is closely related, both culturally and biologically, to the Acadians and the French Canadians of the 18th century. Research indicates, however, that both these groups differ demographically from their Madawaskan descendents in both fertility levels and mortality rate (Hynes, 1973; Henripin, 1954; Henripin and Péron, 1972; Charbonneau, 1975). The higher fertility and lower infant mortality of the Madawaska French may be related to the fact that they were undergoing colonization and population expansion in a relatively isolated area, as well as to their cultural practice of not limiting family size.

The Madawaska French had a very large mean completed family size, 11.34 (mode = 13; s.d. = 4.05). Their average age at first marriage for women, 21 years, is well within the North American range for pre-industrial groups; the average birth interval, on the other hand, is shorter (Table 3). The comparative data suggest that their higher fertility is due to a shortened birth interval, rather than an extended childbearing period.

In general, pre-industrial populations are reported to have rates of infant mortality between 150 and 250 (Jones, 1976); the estimated rate for the study population, 132 per 1000, falls slightly below that range. It is

Table 3

Completed Family Size and Average Birth Intervals among North American Pre-industrial Populations

Population	Dates	Completed Family Size	Birth Interval	Source
Acadians	1600–1755	9.5	28.11	Hynes, 1973
French Canadians	1700–1730	8.4	24.96	Henripin & Péron, 1972
Andover	1705–1724	7.5	26.5	Greven, 1970
Quakers	1700–1749	7.5	27.7	Wells, 1972
Deerfield	1810	8.4		Swedlund, 1971
Madawaska French	1971–1838	11.34	21.19	

also lower than values reported for other North American pre-industrial groups (Table 4). This low level is probably associated with several factors, including: low levels of infectious disease, low population density, relatively stable food supply, and relatively high numbers of births.

In this research, both endogenous and exogenous mortality patterns have been described. Endogenous mortality is generally attributed to a range of factors, including: congenital malformations, immaturity, birth injuries, and postnatal respiratory collapse. On the other hand, exogenous mortality is usually attributed to external factors such as infectious disease and accidents (Gortmaker, 1979). Along these lines, the higher frequency of endogenous mortality observed among women over 35 confirmed the hypothesis that rates of congenital problems are associated with increased maternal age. Also, exogenous mortality is distributed seasonally, with peaks in late winter and late summer, corresponding to the higher incidence of infectious diseases during these periods (Jones, 1976). The peaks for endogenous mortality in July and November, however, were unexpected. Although one can hypothesize that in July women are under greater physical stress due to their increased farm duties, the November peak remains unexplained.

Studies in Europe and the United States have examined the risk of infant mortality in relationship to completed family size and birth order (Cohen, 1975; Magand and Henry, 1968; Meindl, 1980). In general, mortality risks are higher among large families, but are unrelated to birth order. Both of these patterns were also found in this study. In fact, we found that even infants with birth orders 1-3 are at greater risk depending

Table 4

Infant Mortality Rates in North American and European Pre-industrial Populations

Population	Dates	Rate per 1000	Source
French Canadians	1700–1750	246	Henripin & Péron, 1972
Andover	1700–1759	152–156	Greven, 1970
France	1740	280	6e Rapport, 1977
	1840	170	
Finland	1776–1800	210	Turpeinen, 1979
N. Shropshire, England	1750–1800	130–170	Jones, 1976
Madawaska French	1791–1838	132	

on ultimate family size. As Meindl (1980) points out, the idea that higher risk in larger families is due to increased opportunity for the spread of infectious disease would also suggest that risk should increase with birth order; the absence of such an association in the study indicates that another factor may be operating.

We suspect the increased risk with larger completed family size is associated with a maternal factor other than age which is present throughout the childbearing period. It may be that relatively higher levels of fertility and shorter periods of postpartum sterility may increase the risk of producing a child who will die in infancy. Lithell (1981) examined the hypothesis that shorter birth intervals increase the risk of infant mortality, particularly if the shortened birth interval was due to short or absent lactation periods, and thus poorer infant health. In our study, there is no evidence that infants were inadequately nourished, nor that the lactation period was abnormally shortened. Frisancho, Klayman, and Matos (1976) found in their work that the best predictor of total livebirths, after maternal age, is the number of childhood deaths. This suggests that there may be additional factors underlying the relationship between higher fertility and higher risk. Comparisons within our population between women who had experienced infant death and those who did not suggest that women who are more fertile may also be at greater risk for infant mortality. We plan to explore this hypothetical relationship in future research by examining the association between shorter birth intervals and increased risk.

In conclusion, this article has focused on variables associated with infant mortality or with its endogenous and exogenous components. Although aggregate rates of infant mortality were reported, the approach was synchronic, and demographic trends were not explored. The research reported here represents a preliminary attempt to describe the interaction of a range of factors which may have conditioned infant mortality in the Madawaska French population. The results add weight to calls for further research on the influence of ecological and economic factors on population expansion, fertility, and mortality (Swedlund, 1978), and suggest a need for further analysis of the influence of very high fertility on infant mortality in non-malthusian populations.

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