Age-Parity and Marital Status Compositional Influences on the Maternal Mortality Rate in Canada, 1930-1969: A Regional Comparison

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Canadian regional maternal mortality rates were persistently high until 1939, then showed a declining trend. Advances in obstetrics contributed to the declining trend, but compositional influences also were important. Woman's mortality risk varied with her age, parity (previously delivered pregnancies), and marital status. Thus favourable change in mothers' age-parity distributions contributed up to 24 percent of the drop in regional rates between 1939 and 1965-1969. Similarly, differences in age-parity distributions explained up to 22 percent of regional differences in the maternal mortality rate. By constrast, change in mothers' marital status distributions had slight influence on regional trends and differences in the rate.

Au Canada, le taux régional de mortalité lié aux maternités est resté élevé jusqu'en 1939 alors qu'il se mit à décliner grâce, notamment, aux progrès de l'obstétrique et à divers autres facteurs. L'âge, les grossesses rendues à terme, l'état civil ainsi que des changements positifs dans la répartition des variables âge-grossesse ont contribué à une diminution des taux régionaux qui ont pu atteindre 24 p. 100 entre 1939 et 1965-1969. De la même façon, des répartitions différentes des mêmes variables expliquent jusqu'à 22 p. 100 des écarts entre les taux régionaux de mortalité. Par contre, les changements dans la répartition du statut civil ont eu seulement une légère influence sur les tendances régionales et sur les différents taux de mortalité.

Introduction

In Canada and other 'western' nations, the maternal mortality rate held to high historic levels until about 1940, but thereafter showed a declining trend.[1] Canadian mothers experienced fewer than 0.5 deaths per 1,000 live births by the 1960s, compared to five to seven deaths for pre-1940 years.

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1. As calculated with published statistics, the declining trend began about 1938 in Ontario and the western provinces, 1940 for Canada (including Newfoundland) and 1941 in Quebec and the Maritimes.

The literature largely credits medical science for the post-1940 decline. One the one hand, the maternal mortality risk was rather insensitive to improvement in nutrition and living standards, a principal literature explanation for earlier declines in infant and other death rates.[2] Yet it was highly responsive to standards of obstetrical care. These changed slightly before 1937, but then dramatically with the introduction of new drug therapies (sulphanilamides, later antibiotics) to control infection and new blood transfusion techniques (e.g., the use of blood substitutes and blood banking) to deal with haemorrhage. More gradual improvements occurred in prenatal and postnatal care and the detection and management of problem cases.[3] In addition, a growing proportion of births occurred in hospitals. The proportion in Ontario, for example, was one quarter in 1925, one half in 1937, three quarters by 1943, and 100 percent by 1963.

Nevertheless, the literature over-emphasizes obstetrics. It neglects **indirect** maternal deaths, which arise from pregnancy in association with non-obstetric diseases, such as tuberculosis and epidemic influenza. As discussed below, the **indirect** cases comprise some 15 percent of Canada's reported maternal death total for the 1926-1945 period.[4] Yet they are easily missed because published statistics report them under non-obstetric categories (e.g., as **influenza** or **tuberculosis** deaths). The rate for **indirect** maternal deaths also shows a declining trend for the 1940-1969 period, but this primarily was due to morbidity declines for the associated diseases rather than to advances in obstetrics.

The literature also inflates the post-1940 drop in the maternal mortality **risk** by equating the **risk** with the maternal mortality **rate**. The problem here is that woman's risk of death from pregnancy varies with her marital status, age, and parity (number of previous delivered pregnancies). Thus the trend for the **rate** reflects change in risk-factor distributions, as well as change in factor risks. With no change in **age-specific risks**, for example, a drop in the proportion of mothers in the high-risk older age groups would reduce the

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2. Two recent studies find little evidence for the "invisible hand of rising living standards" explanation for general mortality decline. Considerable evidence, however, points to the influence of interventionist public health measures, centred on hygiene and the isolation of infected persons. *See* Simon Szreter, "The Importance of Social Intervention in Britain's Mortality Decline c. 1850-1914: A Reinterpretation of the Role of Public Health", *Social History of Medicine*, 1, 1 (1988): 1-38; Leonard G. Wilson, "The Historical Decline of Tuberculosis in Europe and America: Its Causes and Significance", *Journal of the History of Medicine and Allied Sciences*, 45 (1990): 366-396.

3. Irvine Loudon, "Obstetrics Care, Social Class, and Maternal Mortality", *British Medical Journal*, 293 (1986): 606-608; Roger Schofield, "Did the Mothers Really Die? Three Centuries of Maternal Mortality in 'The World We Have Lost'", in Lloyd Bonfield, Richard M. Smith and Keith Wrightson, eds., *The World We Have Gained: Histories of Population and Social Structure* (Oxford: Basil Blackwell, 1986): 231-260.

4. From 1922 until 1945, *Vital Statistics* published a special table for "Pregnancy-Associated Deaths Not Reported As Such". The study data exclude these deaths because the special tables did not report their age or marital status distributions.

number of deaths and hence the maternal mortality rate. Thus to obtain the trend for the maternal mortality risk (and hence the potential achievement of obstetrical science), one must remove **compositional** influences on the trend for the maternal mortality rate.

To clarify the trend for the maternal mortality **risk**, this paper analyzes marital status and age-parity compositional influences on the maternal mortality rate. Part I discusses definitions, the compositional influences, and the methodology. Part II presents the study findings: the estimates of the age-parity and marital status compositional influences on regional trends and differences in Canada's maternal mortality rate. Appendix I elaborates the methodology for estimating the parity and age-parity compositional influences. Appendix II holds most of the background statistical tables; the numbers for these tables begin with the prefix **A** (e.g., Table **A1** rather than Table **1**, wich is incorporated in the text).

Part I

1. Definitions

Maternal deaths include **direct** maternal deaths (pregnancy as the primary cause) and **indirect** maternal deaths (pregnancy as a contributing cause), but exclude non-obstetric deaths (pregnancy present but incidental). No **statistical definition** accords perfectly with the theoretical definition. The statistical definition used by the International Federation of Gynecology and Obstetrics ("the death of any woman dying of any cause while pregnant or within 42 days of termination of pregnancy"), for example, may include non-obstetric deaths of pregnant women, yet miss obstetric deaths which occurred more than 42 days after pregnancy termination.[5] The statistical definitions used in civil registration change over time and vary by nation, as does the physician reporting of puerperal causes on death certificates. The age-parity and marital status distributions for **reported** maternal deaths, consequently, may differ from those for all maternal deaths. Similarly, Canada's reported distributions may not be wholly comparable to the **reported** distributions for other nations.

Except where otherwise indicated, published vital statistics for the **Puerperal State class** of deaths provide the study data for maternal deaths.

5. The length of the interval is problematic; it misses maternal deaths if too short, but includes non-obstetric deaths if too long. Experts differ on how to resolve the problem. The recommended interval is one calendar month according to the British demographer Roger Schofield, 42 days for the International Federation of Gynecology and Obstetrics, 60 days for French demographers, 90 days for the American Medical Association (1950), and one year for the British Health Ministry (1928). *See* Schofield, "Did the Mothers Really Die?", 234; Derek Llewellyn-Jones, *Human Reproduction and Society* (London: Faber & Faber, 1974): 494-495.

These data omit some pregnancy-related deaths.[6] Especially towards the beginning of the study period, for instance, physicians sometimes did not report the obstetric cause on the death certificate (e.g., **septicaemia** as the reported cause, rather than **puerperal septicaemia**). Canadian classification also followed the **International List of Causes of Death**, which was revised periodically.[7] The revisions in force for the 1922-1940 period assigned **criminal abortion** deaths — about one percent of Canada's **reported** direct maternal deaths — to the **homicide by other means** category in the **Violent or Accidental Deaths class**, not to the **Puerperal State class**.

Where the death certificate reported more than one cause, officials followed "rules for choice" to determine the "underlying cause" which was to prevail for classification. Beginning in 1950, international practice was to class by the **physician's choice** for the underlying cause on the death certificate. For earlier years, each nation followed its own rules. Thus in 1931, when the United States Children's Bureau asked different national jurisdictions to classify 1,073 U.S. medical certificates on which pregnancy or childbirth was mentioned, the proportions assigned to the **Puerperal State class** ranged from 77 to 99 percent.[8] Although giving high priority to puerperal causes, Canada's rules ranked some obstetric causes below infectious diseases (influenza, typhoid) and various general diseases (cancer, tuberculosis).[9] The rules also favoured a non-obstetric classification where "the certificate merely makes reference to pregnancy or childbirth without indicating any puerperal disease or abnormality." The effect of the 1925-1949 period rules was the assignment of 15 percent of Canada's **reported** maternal deaths (largely the **indirect** maternal deaths) to non-obstetric categories.

The **Maternal Mortality Rate**, the number of maternal deaths per 1,000 live births, crudely measures the risk of death from pregnancy. As noted above, compositional influences on the **rate** mask the trend for the **risk**. Additionally, whereas the denominator allows **one** pregnancy outcome (live

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6. A fuller discussion is in George Emery, *"Facts of Life" : The Social Construction of Ontario Vital Statistics, 1869-1972* (Montreal and Kingston: McGill-Queen's University Press, forthcoming), chap. 6, "Fatal Pregnancies, 1920-35: A Study of the Nature of Statistics for Deaths by Cause".

7. Canadian civil registration used the third (1920) revision of the **List** for the 1922-1930 period, the fourth (1929) revision for the 1931-1940 period, the fifth (1938) revision for the 1941-1949 period, the sixth (1948) revision for the 1950-1957 period, the seventh (1955) revision for the 1958-1968 period, and the eighth (1965) revision for 1969. For each period, one must consult the *Manual* for the revision in force to determine how pregnancy-related causes were reported.

8. Elizabeth C. Tandy, *Comparability of Maternal Mortality Rates in the United States and Certain Foreign Countries* (Washington: United States Department of Labor, Children's Bureau, 1935), Publication No. 229: 6-7. *See also* "Classification of Joint Causes of Death", *Vital Statistics—Special Reports*, 5, 47 (Washington: Bureau of the Census, August 30, 1938): 385-469.

9. E.S. MacPhail, "Rules for Choice of Causes of Death in the Dominion Bureau of Statistics", *Canadian Public Health Journal*, 24 (1933): 413-419.

birth), the numerator allows **four** (live birth, stillbirth, abortion, and maternal death with no delivery).[10] Civil registration also underreports live births, the data for the denominator, albeit slightly for the study period.[11] Finally, as discussed above, published vital statistics for the **Puerperal State class** of deaths, the conventional source of numerator data, exlude some of the pregnancy-related deaths.

To summarize, the study findings reported below should be taken cautiously. The maternal mortality rate is a crude measure of the maternal mortality risk, and the data used for its calculation also are flawed. The age-parity and marital status distributions also may differ between the **Puerperal State class** of deaths (the study data) and all maternal deaths.

2. The Compositional Influences and the Methodology for Their Measurement

A. The Marital Status Compositional Influence

Single mothers had a greater mortality risk than married mothers, primarily due to their concealment of pregnancy and hence poorer access to prenatal and postnatal care.[12] Otherwise, the single mothers benefitted from a concentration in the younger age/low parity groups, which carried a below-average risk.[13]

The calculation of the marital status risks is not straightforward. Should one ignore the deaths with no information about marital status, or were these likely to have involved single mothers?[14] Should one include widows in the married group, or were widows, like single women, under pressure to conceal pregnancy? In the circumstances, the writer calculated two sets of estimates of the marital status compositional influence. Deaths of widows and women of unknown marital status were assigned to the **married** group for the first estimate and the **single** group for the second estimate.[15]

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10. Induced abortions present a special problem. Each **induced abortion death** adds one to the numerator but not to the denominator; at the same time, each **induced abortion, fatal or not,** is likely to substract one from the denominator by eliminating a prospective live birth. *See* L.H. Roht *et al.*, "The Impact of Legal Abortion — Redefining the Maternal Mortality Rate", *Health Services Report*, 89 (1974): 267-273.

11. The writer estimates that Ontario registrations of live births were 96% complete by 1925. *See* George Emery, "Incomplete Registration of Births in Civil Systems: The Example of Ontario, Canada, 1900-1960", *Historical Methods*, 23, 1 (1990): 5-21. For other provinces, *see* Robert K. Kuczynski, *Birth Registration and Birth Statistics in Canada* (Washington: The Brookings Institution, 1930).

12. Carolyn Makinson, "The Health Consequences of Teenage Fertility", *Family Planning Perspectives*, 17, 3 (May-June 1985): 132-139.

13. *See* Tables A7 and A4 (relative risk patterns 2 and 5).

14. Quebec birth registrations often omitted detail for illegitimate births. In 1944, for example, the registrations reported the mother's age **and** parity for over 99% of the legitimate births. The single mother registrations alone, however, omitted age for 6% and parity for 24%.

15. These deaths were between 1 and 3% of Ontario's reported maternal deaths for the 1921-1969 period.

Ontario's rate for illegitimate births more than doubled between the 1921-1924 and 1940-1944 periods, then fell sharply through to the 1950s, and then rose to record historic levels for the period 1965-1969. In this context, the **relative category risk** (the category risk divided by the general risk) was about average (1.0) for married mothers, but up to 3.3 times greater for single mothers, depending on the data used for calculation and the time period. Thus the marital status compositional influence reflected: i) change in the illegitimacy rate; and ii) change in the relative risks for married and single women.

To measure the compositional influence, one calculates a **standardized** trend for the maternal mortality rate — a rate which holds constant the compositional influence.[16] The maternal mortality rate is first calculated separately by category (single mothers, married mothers) for each time period. Secondly, each period's category-specific rates are applied to a standard marital status distribution for births; to this end, the writer uses the 1939 distribution for the standard, principally because 1939 approximates the final year before a definitive decline in the maternal mortality rate occurred. The result is each period's **standardized** death total: the number which would have been obtained with the 1939 totals for legitimate and illegitimate births. Thirdly, the **standardized** death total, divided by the 1939 (standard population) birth total and multiplied by 1,000, yields each year's **standardized** maternal mortality rate. Since all periods have the 1939 marital status distribution, the effect of the compositional influence has been removed.

Finally, to measure the compositional influence, each period's standardized rate is divided by its crude rate. In Table 1, for example, the resulting statistic for the 1930-1934 period (**1.01** in both calculations) shows that the crude rate was one percent **lower** than it would have been with the 1939 marital status distribution for births. Thus movement towards a less advantageous 1939 distribution (a rise from 41 to 45 in the illegitimate birth rate) exerted a one percent negative influence on the 1.2 drop in the crude rate between 1930-1934 and 1939. Similarly, the statistic for 1965-1969 (0.997) shows a crude rate 0.3 percent **higher** than the standard rate. Thus movement from the 1939 distribution towards a less advantageous 1965-1969 distribution (a rise from 45 to 68 in the illegitimate birth rate) exerted a 0.3 percent negative influence on the 4.1 drop in the reported crude rate between 1939 and 1965-1969. In general, for the period 1921-1924 to 1965-1969, the estimated marital status compositional influence is slight, regardless of which data are used for calculation.

16. For standardization procedures, *see* Linda G. Berry, "Age and Parity Influences on Maternal Mortality: United States, 1919-1969", *Demography*, 14, 3 (August 1977): 297-310; Henry S. Shryock, Jacob S. Siegel and Associates, *The Methods and Materials of Demography* (New York: Academic Press, 1976), 241-243.

Table 1 **Ontario: Illegitimacy Rate, Crude Maternal Mortality Rate, Relative Rates by Marital Status and Estimated Compositional Influence for Two Methods of Calculation**

A. Married = married + widow + no data; Single = single

Period	Illegitimate births per 1,000 live births	Crude MMR	Relative Risk Married	Relative Risk Single	Standard MMR/ Crude MMR	Estimated percentage influence
1930-4	41	5.5	1.0	1.9	1.01	-1
1939	**45**	**4.3**			**standard year**	
1965-9	68	0.2	0.9	2.0	0.997	-0

B. Married = married; Single = single + widow + no data

1930-4	41	5.5	1.0	2.1	1.01	-1
1939	**45**	**4.3**			**standard year**	
1965-9	68	0.2	0.9	2.3	0.99	-1

B. The Age Compositional Influence

A mother's relative mortality risk was lowest during her early 20s and then rose with age (Table A1). A mother's parity increased with age, and she became increasingly vulnerable to non-obstetric diseases (e.g., nephritis) which complicated pregnancy. Although below average, the risk for ages 10-19 was higher than for ages 20-24, primarily for social reasons. The younger ages held disproportionate numbers of unmarried mothers who were unusually subject to pregnancy complications arising from inadequate prenatal care. Biological factors may have slightly increased the mortality risk. At very young ages (10-15), a woman's body was sometimes insufficiently developed to withstand the stress of pregnancy, and the process of biological selection — the death of mothers with congenital defects (e.g., narrow hips) — was least complete. Finally, the younger mothers had an above-average proportion of first births, which had higher risk than second and third births.

As Ontario's maternal mortality rate fell after 1939, the age differences in mortality risk became sharper. As a multiple of the general rate, for example, the risk for ages 40+ moved from 2.1 in the 1930-1934 period to 4.4 for the period 1965-1969. For the age group 20-24, on the other hand, the relative risk fell from 0.7 to 0.3. The decline in the general rate chiefly benefitted those groups which started with relatively low risk. On the other hand, the categories of greatest risk held the smallest proportions of mothers.

Between 1930-1934 and 1965-1969, the proportion in the relatively high-risk categories (ages 30+) dropped from 38 to 27 percent. With no change in age-related risks, therefore, change in maternal age distributions would have lowered maternal death totals, and hence the maternal mortality rate. As

Table A1 reports, Ontario's maternal mortality rate for 1930-1934 period was 3 percent higher than would have been the case with the standard population distribution, while the 1965-1969 crude rate was 17 percent lower. Thus change in the mothers' age distribution contributed 20 percent (0.03 + 0.17) of the decline in the province's maternal mortality rate between 1930-1934 and 1965-1969.

C. The Parity Compositional Influence

Canadian birth registrations began to report the mother's parity in 1920. Except in New South Wales, Australia, however, death registrations have never reported parity. Thus knowledge of parity-specific risks has come from special investigations which used one or both of the following methods to document parity for maternal deaths:

i) linking a mother's death registration to her infant's birth or stillbirth registration; this method documents parity for maternal deaths which involved **reportable** pregnancy outcomes — i.e., **live birth** and **stillbirth**, but not **abortion** and **death with no-delivery**;

ii) soliciting information about parity from physicians who reported the deaths.

Table A2 reports 18 sets of documented **relative parity risks** (the parity risk divided by the general risk), and Table A3 summarizes the data used to calculate them.[17] Like the pattern of risk for age, the parity risk pattern shows a U-shape: a high relative risk for first births, a low relative risk for second or third births, and a progressively higher relative risk for the higher parities.

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17. For discussion of the **1930 Ontario** pattern, *see* Emery, *"Facts of Life"*, chap. 6. As discussed below, the **adjusted** version of the **1930 Ontario** pattern compensates for bias in the source data. For the other patterns, or data for their calculation, see *Report on An Investigation into Maternal Mortality* (England: Ministry of Health, 1937): 87-111, 131-136; Jacob Yerushalmy, Carroll E. Palmer, and Morton Kramer, "Study in Childbirth Mortality. II. Age and Parity as Factors in Puerperal Fatality", *Public Health Reports*, 55 (1940): 1195-1220; Mary Dublin, "Maternal Mortality and the Decline of the Birth Rate", *Annals of the American Academy of Political and Social Science*, 188 (1936): 107-116; W.J. Wilcocks and H.O. Lancaster, "Maternal Mortality in New South Wales with Special Reference to Age and Parity", *The Journal of Obstetrics and Gynaecology of the British Empire*, 63 (1951): 945-960; P.L. McKinlay, "The Influence of Changes in the Age and Parity Constitution of Mothers on the Trend of Foetal and Maternal Mortality in Recent Years", *Health Bulletin*, 8, 1 (1950): 16-19; Charlotte A. Douglas and Peter L. McKinlay, *Report on Maternal Morbidity and Mortality in Scotland* (Edinburgh: H.M.S.O., 1935); E.S. MacPhail, "A Statistical Study in Maternal Mortality", *American Journal of Public Health and the Nation's Health*, 22 (1932): 612-626; J.T. Phair and A.H. Sellers, "A Study of Maternal Deaths in the Province of Ontario", *Canadian Public Health Journal*, 25, 12 (1934): 563-579; F.W. Jackson, R.D. Defries, and A.H. Sellers, "A Five-Year Survey of Maternal Mortality in Manitoba, 1928-32", *Canadian Public Health Journal*, 25, 3 (1934): 103-119; F.W. Jackson, N.R. Rawson, E. Couture, "Maternal Mortality in Manitoba, 1933-37 (Second Five-Year Period)", *Canadian Public Health Journal*, 31, 7 (1940): 307-321; Noel R. Rawson, "Maternal Deaths in Manitoba", *Canadian Public Health Journal*, 32 (1941): 55-69.

Above-average proportions of teen-age and unmarried mothers contribute to the high risk for first births. In the higher parities, the contributing factors inclue ageing and greater risk of pregnancy complication from non-obstetric disease.

As shown in the sequential patterns for Manitoba, New York State, and New South Wales, the drop in the general risk led to a fall in the relative risk for first births and a rise in the relative risk for the higher parities. This change was predictable given: i) the strong correlation between age and parity (woman's parity tends to increase as she moves through the age categories); and ii) the similar change in the pattern for age (a drop in the relative risk for the younger ages and a rise in the relative risk for the older age groups).

Because civil registration does not report parity distributions for maternal deaths, one must estimate the compositional influence indirectly, in two stages. One first uses documented patterns of relative parity risk for other populations to estimate the parity distribution for Ontario's maternal deaths in each period (*see* Appendix I for discussion). Then, in the fashion described above for the other two compositional influences, one calculates each period's parity-specific maternal mortality rates, the parity-standardized rate, and estimate of the compositional influence.

As noted above, the pattern of risk varies with the level of general risk (the maternal mortality rate). For the stage one estimates, therefore, one ideally would select a high general risk pattern for high general risk years (1925-1937), a medium general risk pattern for medium general risk years (1938-1949), and a low general risk pattern for low general risk years (1950-1970). Because the literature does not provide a low general risk pattern, however, medium risk pattern estimates must serve for both medium and low general risk periods.

Based on stage one estimates from the **1933 Ontario** pattern, the parity compositional influence was zero during the 1925-1937 period, when the maternal mortality rate remained high and stable.[18] A 4 percent drop in the proportion of mothers in the parity six-plus group, which carried above-average risk, was offset by an 8 percent rise in the proportion for the parity one group, which also carried above-average risk. Based on stage one estimates from the **1943-1948 New South Wales** pattern, parity compositional change contributed 12 percent of the steep drop in the maternal mortality rate between 1938 and 1969. The principal elements of the influence were: i) an 11 percent

18. Canadian published statistics for the 1928-1943 period reported age-parity distributions for **legitimate** live births and stillbirths only. To include illegitimate births in the study data for the earlier period, the writer gave them the parity distribution for the 1944-1951 period illegitimate births. Beginning in 1952, *Vital Statistics* did not report parity statistics by province, but the Ontario Registrar-General's *Annual Report* reported them for **live** births, whose parity distribution was similar to that for live births and stillbirths combined.

drop in the proportion of mothers in the parity four-plus group, which carried above-average risk; ii) far higher relative risks for the higher parities than obtained under the **1933 Ontario** pattern; iii) a small 4 percent increase in the proportion of mothers in the parity one group; and iv) a lower relative risk for first births than obtained under the **1933 Ontario** pattern.

D. A Birth Spacing Compositional Influence?

According to the **maternal depletion** hypothesis, "a close succession of pregnancies and periods of lactation worsens the mother's nutritional status because there is not adequate time for the mother to recover from the physiological stresses of the preceding pregnancy before she becomes subject to the stresses of the next pregnancy."[19] A 1945 study argues that either too short or too long an interval can increase the maternity risk.[20] For want of data, however, one cannot separate the birth interval influence from the confounding effects of maternal age, parity, and socioeconomic status.[21] Civil registration does not provide the data to test the maternal depletion hypothesis effectively, and the literature is inconclusive about it.

3. The Collective Compositional Influence

The Age-Parity Compositional Influence

Because parity increases with maternal age, the parity and age compositional influences overlap. To estimate the joint age-parity influence on the maternal mortality rate, one uses a documented pattern of relative age-parity risk to estimate the parity distribution for maternal deaths in each age group. One then estimates the compositional influence in the same fashion as for parity. Table A4 reports five patterns of relative parity risk: a 1930 Ontario pattern from the writer's research; an adjusted version of the Ontario pattern (to compensate for bias in its source data); and three patterns for New South Wales).[22]

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19. Jane E. Miller, "Birth Intervals and Perinatal Health: An Investigation of Three Hypotheses", *Family Planning Perspectives*, 23, 2 (March-April, 1991): 64; *see also* Robert Buchanan, "Effects of Childbearing on Maternal Health", *Population Reports* (November 1975): J125-J139; Icie G. Macy *et al.*, "Physiological Adaptation and Nutritional Status During and After Pregnancy", *Journal of Nutrition*, 52 (supplement, 1954): 3-92.

20. *See* J. Yerushalmy, "The Existence of an Optimum Interval Between Births", *Human Fertility*, 10, 4 (1945): 106-111; and "On the Interval Between Successive Births and Its Effect on Survival of Infant. I. An Indirect Method of Study", *Human Biology*, 17 (1945): 65-106.

21. Beverly Winikoff, "The Effects of Birth Spacing on Child and Maternal Health", *Studies in Family Planning*, 14, 10 (October 1983): 231-245.

22. For experimentation, I also calculated estimates from five other patterns (Canada 1927-1928; New York State 1936-1938; and New South Wales patterns for 1901-1907, 1911-1920, and 1921-1930). *See* note 17 for references.

The patterns clarify the separate effects of age and parity on the maternal mortality risk. Movement along the rows shows the trend for age controlling for parity; movement down the columns shows trend for parity controlling for age. In all patterns and for all parities, the relative risk increases with age. Within age groups, especially the older groups, first births carry higher risk than parities two and three. The extra risk associated with parities four and higher, on the other hand, probably reflects the effect of age rather than parity. As one moves down the columns for a given age group in the different New South Wales patterns, for example, no consistent linear pattern of change in the risk is obtained.[23]

Estimates from ten different age-parity risk patterns (the five in Table A4 and five others) are more similar than obtained for estimates of the parity compositional influence (e.g., a 7 percent range for the 1939-1969 period). Given considerations elaborated above for parity risk patterns, the writer prefers the **adjusted 1930 Ontario** pattern for the **high mortality level** period (1925-1938) and the **1943-1948 New South Wales** pattern for the **medium mortality level** and **low mortality level** periods (1939-1949 and 1950-1969). Although the **New South Wales** pattern is for married women only, the writer's experimental adjustment to the pattern for marital status bias did not change the stage two estimates.[24]

As Table A5 shows, the proportion of Ontario mothers in the categories carrying above-average risk dropped 6 percent between 1935-1939 and 1940-1944, and then showed a flat trend until 1965-1969, when it fell another 7 percent. Based on the risk-pattern selection described above, the writer estimated a negligible age-parity compositional influence for the **high mortality level** years (1925-1938), then a growing influence through to 1965 and a dramatic influence for later years. The 1968 maternal mortality rate was 27 percent lower than would have obtained with the 1939 (standard)

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23. *See* Wilcocks, "Maternal Mortality in New South Wales", 952; for the opposite argument, *see* Llewllyn-Jones, *Human Reproduction and Society*, chap. 19.

24. Published sources report 44 deaths of single mothers and 675 other maternal deaths for Ontario during the 1945-1949 period. One single mother was under 15 years of age, and 31, 11, and 1 respectively were in the age groups 15-24, 25-44, and 45-60. Based on the 1944 age category distribution for Ontario's illegitimate births, single mother totals were adjusted to fit the different age categories (10-19, 20-24, 25-29, 30-34, 35-39, and 40+) used for the estimates. The estimated totals for single mothers (17.4, 14.5, 6.7, 3.1, 1.0, and 1.3) were then substracted from the totals for all mothers to obtain the age category distribution for married mothers. By using the **1943-1948 New South Wales** (married women) pattern and the 1945-1949 Ontario births for the standard distribution, I estimated the age-parity distribution for the 675 married women deaths. Based on the age-parity distribution for 1944 Ontario illegitimate births, I estimated the parity distribution for the single mothers in each category. I next combined the age-parity totals for married and single women deaths. Finally, using the combined age-parity totals for maternal deaths and the 1945-1949 age-parity distribution for Ontario births, I calculated age-parity-specific mortality rates, and from these, the relative age-parity-specific rates for the adjusted pattern.

population distribution; 5 percent reflected change in relative category risks (i.e., the difference between the **adjusted 1930 Ontario** and **1943-1948 New South Wales** pattern estimates), and 22 percent reflected the 1939-1968 differences in age-parity distributions for births. An unusual age distribution for maternal deaths explained the huge estimate for 1969 (57 percent, compared to 30 and 27 percent respectively for the years preceding and following). Eighty percent of the 1969 deaths were for mothers aged 30 or more, as compared to 50 percent for 1968 and 1970. Their unusual age distribution, in turn, probably reflected a random fluctuation in the increasingly small numbers of maternal deaths.

Notwithstanding the high estimate for 1969, the (medium mortality level) **1943-1948 New South Wales** pattern estimates may be low for years of low general risk (1950-1969). Based on trends in the sequence of patterns for New South Wales (1931-1940, 1938-1942 and 1943-1948), one might project higher relative risks for the high parity/older age categories in a low mortality level pattern. The proportion of Ontario mothers in these high risk categories also increases as one moves back through time to 1939.

4. Scope of the Investigation

A. The Infeasibility of a Combined Estimate for the Age-Parity and Marital Status Compositional Influence

The age-parity and marital status compositional influences overlap. Single mothers, for example, concentrate in the categories for younger ages and first births. The published statistics for the **Puerperal State class** of deaths, however, do not support an estimate of single compositional influence for age-parity and marital status. The broad age categories in the tables for cause of death by marital status (15-24, 25-44, 45-64) differ from the categories in the tables for cause of death by age and are inappropriate for the study of maternal death. Especially towards the end of the study period, moreover, random fluctuations in small numbers influence the age-parity distributions for deaths of single mothers.

B. Periods and Regions rather than Years and Provinces

Towards the end of the study period, and especially for the smaller provinces, random fluctuations in small numbers of reported maternal deaths make annual estimates for provinces problematic. During the 1960s, for example, Prince Edward Island did not report a maternal death for several years, and even the larger provinces sometimes reported only one or two deaths involving single mothers. To mitigate the problem of small numbers, Part II reports estimates for five-year periods rather than years and Prairie and Maritime regions rather than provinces.

C. Data Limitations

Canadian and provincial published statistics for maternal deaths by marital status are continuous for Ontario and British Columbia, and also for Canada, except for the 1952-1961 period. To estimate for the other provinces or regions, the writer purchased data from Statistics Canada for the period 1961-1970. Because the marital status compositional influence was slight, the writer did not purchase data for earlier years.

Dominion and provincial published statistics did not report age-parity distributions for births and age distributions for maternal deaths for Manitoba and New Brunswick, nor for seven provinces for the period 1960-1970. Because the age-parity compositional influence was considerable, the writer purchased the missing data from Statistics Canada. Statistics Canada did not have data on age-parity distributions for Newfoundland births; hence the study area excludes that province.

Part II — The Study Findings

1. The Marital Status Compositional Influence

As shown below in Section A of Table 2, illegitimacy rates for the regions varied. In general, the British Columbia, Prairie, and Quebec rates showed a gradual rising trend through to the 1950s; the Ontario and Maritime rates showed a gradual rising trend through to the 1940s, and then a declining trend during the 1950s; and the rates for all regions rose sharply during the 1960s.

Section B reports two statistics for relative category risk. For calculation of the first statistic, the **married** group includes deaths of widows and women whose marital statistics is unknown; for calculation of the second statistic, the **single** group includes these deaths. As the table data shows, the mortality risk was higher for single mothers than for married mothers, with the exception of Quebec for the 1965-1969 period and British Columbia for the 1965-1969 period (the second statistic only). The relative risks for single women changed over time and varied regionally.

Table 2 **Estimates of the Marital Status Compositional Influence for Canada and Five National Regions 1930-1934 to 1965-1969**

A Illegitimate births per 1,000 live births

	Canada	Maritime	Quebec	Ontario	Prairie	B.C.
1930-4	36	44	30	41	34	31
1935-9	39	49	33	45	37	38
1939	**40**	**50**	**34**	**45**	**37**	**41**
1940-4	41	55	31	47	38	46
1945-9	41	59	29	44	45	59
1950-4	38	51	32	32	45	60
1955-9	40	53	33	32	50	63
1960-4	50	60	40	38	67	77
1965-9	83	87	64	68	109	126

B. Single woman mortality rate as a multiple of the rate for married women

Two calculations: a) Married = includes widow + no data
b) Single = includes widow + no data

	Canada		Maritime		Quebec		Ontario		Prairie		B.C.	
	a	b	a	b	a	b	a	b	a	b	a	b
1930-4	1.7	1.9	—	—	—	—	2.0	2.2	—	—	2.0	2.9
1935-9	1.6	1.8	—	—	—	—	1.5	1.8	—	—	1.8	2.3
1940-4	1.7	1.8	—	—	—	—	1.9	2.1	—	—	2.1	2.2
1945-9	1.6	1.9	—	—	—	—	1.4	1.6	—	—	2.2	2.6
1950-4	1.7	2.1	—	—	—	—	2.2	2.8	—	—	2.7	3.3
1955-9	—	—	—	—	—	—	2.6	3.6	—	—	1.3	1.7
1960-4	1.3	1.7	1.2	1.4	1.2	1.5	1.8	2.4	1.1	2.2	1.1	1.6
1965-9	1.3	1.5	2.3	2.3	0.6	0.6	2.1	2.5	1.4	1.7	0.8	1.2

C. Percentage contribution

Two calculations: a) Married = includes widow + no data
b) Single = includes widow + no data

	Canada		Maritime		Quebec		Ontario		Prairie		B.C.	
	a	b	a	b	a	b	a	b	a	b	a	b
1930-4	-0	-1	—	—	—	—	-1	-1	—	—	-1	-2
1935-9	+0	+0	—	—	—	—	-1	-1	—	—	-0	-0
1940-4	-0	-0	—	—	—	—	+1	+0	—	—	-1	-1
1945-9	-0	-0	—	—	—	—	+1	+1	—	—	-2	-3
1950-4	-0	-0	—	—	—	—	+3	+4	—	—	-3	-4
1955-9	—	—	—	—	—	—	+5	+6	—	—	-1	-2
1960-4	-0	-1	-0	+1	-0	-0	+3	+3	0	-3	-0	-2
1965-9	-1	-2	-5	-5	+53	+53	-0	-1	-3	-5	+2	-2

Thus estimates of the compositional influence, shown in Section C, reflect two factors: the illegitimacy and the relative category risks. For example, the relatively high estimates for Ontario in the 1955-1959 period (5 and 6 percent) reflect: i) the drop in the illegitimacy rate from 45 in 1939 to 32 in 1955-1959; and ii) the relatively high maternal mortality risk for single mothers in 1955-1959 — from 2.6 to 3.6 the risk for married women, depending on the data used for calculation. Similarly, the huge Quebec estimate for the 1965-1969 period (53 percent for both calculations) reflects a rise in the illegitimacy rate from 50 to 87 and an extraordinarily low relative mortality risk for single mothers (0.6).

For want of theory to support a lower mortality risk for single mothers, the writer discounts the Quebec estimate for 1965-1969. The atypical low mortality risk for single mothers probably evidences the effect of random fluctuations in small numbers. Thus the overall marital status compositional influence on the maternal mortality rate was small. A 5 percent level of influence obtained only for Ontario during the 1955-1959 period (a positive influence) and the Maritime and Prairie regions for the 1965-1969 period (a negative influence).

Table 3 shows the percentage change in a region's maternal mortality rate when its category risks are applied to the category distributions for other regions. As one moves along the rows, the regional category risk rates are held constant, while the regional distributions change sequentially. Thus the Maritime maternal mortality rate for the 1965-1969 period drops by 2 or 3 percent if its category risk rates are applied to the Quebec or Ontario marital status distributions for births, but rises 3 and 5 percent respectively if its category risks are applied to the Prairie or British Columbia marital status distributions.

Table 3 Contribution of Differential Regional Risk Rates by Marital Status to Regional Diffenrences in Crude Rates: Percentage Change to Crude Rate when Regional Category Risks for Marital Status Are Applied to Other-Region Distribution

Columns = constant distribution, variable category risks
Rows = category risks constant, variable distributions

1930-4 Region	Maritime		Quebec		Ontario		Prairie		B.C.	
Ontario	+0	+0	-1	-1	5.55	same	-1	-1	-1	-1
B.C.	+2	+3	-0	-0	+1	+2	+0	+1	5.46	same
1935-9 Region	Maritime		Quebec		Ontario		Prairie		B.C.	
Ontario	+0	+0	-1	-1	4.78	same	-0	-1	-0	-0
B.C.	+1	+1	-0	-1	+1	+1	0	-0	4.21	same

Continued on the next page

Table 3 — *Continued*

1940-4 Region	Maritime		Quebec		Ontario		Prairie		B.C.	
Ontario	+1	+1	-1	-2	2.82	same	-1	-1	-0	-0
B.C.	+1	+1	-2	-2	+0	+0	-1	-1	2.70	same
1945-9 Region	Maritime		Quebec		Ontario		Prairie		B.C.	
Ontario	+0	+1	-1	-1	1.45	same	+0	+0	+1	+1
B.C.	+0	+0	-3	-4	-2	-2	-2	-2	1.46	same
1950-4 Region	Maritime		Quebec		Ontario		Prairie		B.C.	
Ontario	+2	+3	0	-0	.704	same	+2	+2	+3	+5
B.C.	-1	-2	-4	-6	-4	-6	-2	-3	.643	same
1955-9 Region	Maritime		Quebec		Ontario		Prairie		B.C.	
Ontario	+3	+5	+0	+0	.469	same	+3	+4	+5	+8
B.C.	-0	-1	-1	-2	-1	-2	-0	-1	.403	same
1960-4 Region	Maritime		Quebec		Ontario		Prairie		B.C.	
Maritime	.385	same	-0	-1	-1	-1	+0	+0	+0	+1
Quebec	+1	+1	.525	same	0	-0	+1	+1	+1	+2
Ontario	+2	+3	+0	+0	.339	same	+2	+4	+3	+5
Prairie	+0	-1	-0	-3	-0	-3	.300	same	+0	+1
B.C.	0	-1	-0	-2	-0	-2	+0	-1	.310	same
1965-9 Region	Maritime		Quebec		Ontario		Prairie		B.C.	
Maritime	.300	same	-3	-3	- 2	- 3	+ 3	+ 3	+ 5	+ 5
Quebec	+49	+50	.385	same	+51	+51	+48	+48	+47	+47
Ontario	+ 2	+ 3	-0	-1	.228	same	+ 4	+ 6	+ 6	+ 8
Prairie	- 1	- 2	-2	-3	- 2	- 3	.219	same	+ 1	+ 1
B.C.	+ 1	- 1	+2	-1	+ 2	- 1	+ 1	- 0	.285	same

Provided that one discounts the high 1965-1969 period estimates for Quebec, the compositional influence was small. It was less than 5 percent into the 1940s. Thereafter, the relatively high illegitimacy rates for British Columbia pushed some of the estimates over the 5 percent level. Ontario's maternal mortality rate for the 1955-1959 period, for example, would have been from 5 to 8 percent higher if its category risks had been applied to the British Columbia category distribution. Similarly, British Columbia's rate for the 1950-1954 period would have dropped by 4 or 6 percent, had its category risks been applied to the Quebec or Ontario marital status distributions.

2. The Age-Parity Compositional Influence

Table A5 shows the proportion of mothers in categories which carried above-average risk. The category boundaries changed somewhat as the general rate fell, as is evident from a comparison of the relative risk rates for the **Adjusted Ontario 1930** and **1943-1948 New South Wales** patterns (*see* Table A4). Thus, for example, mothers aged 35 or more carried above-average risk during the two periods of high general risk (1930-1934, 1935-1939), as compared to mothers aged 30 or more for later periods of lower general risk.

Overall, Quebec's age-parity distributions were the least favourable to a low maternal mortality rate, followed respectively by the distributions for the Maritimes, the Prairie, Ontario, and British Columbia. The proportion of mothers in categories of above-average risk declined in all regions between 1940-1944 and 1965-1969. Quebec registered the greatest decline (14 percent) and British Columbia the least (3 percent).

As shown in Table 4, the compositional influence was small and negative for the two high mortality periods (1930-1934, 1935-1939), except for the Maritime region, where it was small and positive. Then favourable changes in mothers' age-parity distributions (a decline in the proportions of mothers in the higher parity-older age groups, plus a decline in the relative risk for the younger-low parity groups) contributed from 18 to 34 percent of the drop in the maternal mortality rate between 1939 and 1965-1969. As expected, the compositional influence was greatest for Quebec and least for British Columbia.

Table 4 **Estimated Compositional Influence for Age-Parity**

Year	Canada	Maritime	Quebec	Ontario	Prairies	British Columbia
			Adjusted Ontario 1930 pattern for stage one estimates			
1930-4	- 2	+ 1	- 4	- 1	- 1	- 0
1935-9	- 1	+ 0	- 1	- 0	- 1	- 1
			1943-1948 New South Wales pattern for stage one estimates			
1940-4	+ 3	+ 3	+ 4	+ 2	+ 3	+ 3
1945-9	+ 8	+ 5	+ 9	+ 6	+ 9	+ 4
1950-4	+12	+ 6	+13	+11	+12	+ 4
1954-9	+12	+ 5	+14	+ 8	+13	+ 3
1960-4	+16	+10	+19	+12	+15	+ 5
1965-9	+29	+28	+34	+24	+23	+18

As shown below in Table 5, regional differences in age-parity distribution contributed substantially to regional differences in the maternal mortality rate. When Ontario's age-parity risks were applied to Quebec age-parity distributions for corresponding time periods, its maternal mortality rate increased by up to 19 percent (1950-1954). British Columbia's rate would have increased by as much as 22 percent (1940-1944) had its category risks been applied to the Quebec age-parity distribution. Similarly, Quebec's maternal mortality rate would have decreased by as much as 16 percent (1965-1969) had its age-parity risks been applied to the British Columbia age-parity distribution.

Table 5 **Percentage Change to a Region's Maternal Mortality Rates when Its Age-Parity Risks Are Applied to Other Regions' Age-Parity Distributions for Corresponding Time Periods**

Pattern of risk for estimation:					Pattern of risk for estimation:			
Adjusted Ontario 1930					New South Wales, Australia, 1943-1948			
	1930-1934	1935-1939	1940-1944	1945-1949	1950-1954	1955-1959	1960-1964	1965-1969
A. When period distribution = the Maritime distribution								
Quebec	-1	-6	- 5	- 6	- 4	- 2	- 6	- 6
Ontario	-4	-4	+ 5	+ 7	+13	+10	+ 8	+ 6
Prairie	-0	+2	+ 4	+ 7	+10	+12	+ 8	+ 4
B.C.	-3	-3	+13	+11	+ 9	+14	+11	+11
B. When period distribution = the Quebec distribution								
Maritime	+1	+8	+ 6	+ 7	+ 4	+ 5	+ 7	+ 8
Ontario	-1	+3	+13	+14	+19	+14	+14	+11
Prairie	+2	+6	+12	+13	+16	+14	+14	+11
B.C.	+0	+6	+22	+19	+11	+15	+17	+16
C. When period distribution = the Ontario distribution								
Maritime	+4	+6	-4	- 6	-11	- 9	- 6	- 5
Quebec	+3	-1	-9	-12	-14	-12	-13	-11
Prairie	+4	+3	-1	- 1	- 3	- 2	- 2	- 2
B.C.	-0	+2	+6	+ 3	+ 1	+ 0	+ 2	+ 5
D. When period distribution = the Praire distribution								
Maritime	+1	+0	-3	- 5	- 9	- 8	- 6	- 4
Quebec	-0	-6	-8	-11	-13	-11	-12	-10
Ontario	-3	-4	+1	+ 2	+ 3	+ 1	+ 1	+ 2
B.C.	-3	-3	+8	+ 5	+ 1	+ 3	+ 3	+ 6
E. When period of distribution = the B.C. distribution								
Maritime	+6	+6	- 8	- 9	-12	-10	- 8	-12
Quebec	+5	-0	-12	-15	-15	-12	-14	-16
Ontario	+1	-0	- 5	- 3	- 1	- 1	- 2	- 5
Prairie	+5	+2	- 6	- 5	- 4	- 3	- 3	- 7

Conclusion

The literature inflates the contribution of obstetrical innovation to the decline in the maternal mortality risk after 1939. The principal evidence for its putative achievement is the maternal mortality rate. However, the conventional numerator data for calculating the rate (statistics for the **Puerperal State class** of deaths) exclude indirect maternal deaths, whose declining incidence over time arises primarily from non-obstetric causes.

The declining trend for the maternal mortality rate was a compositional as well as a technological process. During the 1930-1969 study years, the compositional influences varied regionally and over time. On the one hand, the marital status compositional influence was slight. It contributed a maximum of 5 percent of the decline in regional maternal mortality rates between 1939 and 1965-1969, and a maximum of 8 percent of regional differences in the maternal mortality rate. On the other hand, the age-parity compositional influence was substantial. It contributed between 18 and 34 percent of the fall in the regional maternal mortality rates between 1939 and 1965-1969, and up to 22 percent of regional differences in the rate for a particular period.

The importance of compositional influences, in turn, points to a revision of the common assumption in the literature about economic influences on the maternal mortality rate. The literature correctly assigns small importance to **direct** economic influences, such as crowding and low nutritional status, but it misses how economic influences acted **indirectly** by influencing age-parity and marital status distributions. During the 1960s, for example, new gender arrangements in Canada's capitalist economy contributed to rising illegitimacy rates in all regions. Similarly, Quebec's pre-1950s history of labout-intensive family economies (based variously on light industry, subsistence agriculture, and an *agro-forestier* mix of subsistence farming and forest industry wage labour) favoured large families and above-average proportions of mothers in the high risk older-age/high parity categories.

Appendix I

Methodology for Estimating the Parity and Age-Parity Compositional Influences

In her 1977 study for the United States, Linda Berry estimated the parity distributions for maternal deaths from documented patterns of relative parity risk (the rate for each parity divided by the general rate). Through a literature search, she obtained patterns for three populations (New South Wales, 1894-1907; New York State, excluding New York City, 1936-1938; and Scotland, 1930-1932).[25] Despite the different time periods and geographic locations involved, the three **patterns** were similar, which caused her to judge that the **pattern** was "fairly stable". Thus she used an "average" of the three literature patterns to estimate parity distributions for United States maternal deaths over the period 1919-1969.

Although promising, Berry's methodology was flawed. She did not investigate whether the estimates were sensitive to differences among the broadly similar patterns of relative parity risk. She also ignored the sources of the pattern differences: i) the type of source data used for calculation; and ii) the level of general risk. For estimation, in other words, certain of her literature patterns required adjustment for biased source data. Finally, as discussed above, a given pattern was appropriate only for years in which the United States had a comparable level of general risk. Given that the general rate in the United States fell sharply during the period 1919-1969, Berry's estimates from a single "averaged" pattern were problematic.[26]

Differences among the 18 Table A2 patterns cause substantial variation in the estimates of the parity compositional influence. The estimates for the 1925-1939 period, for example, range from -3 to +9, a spread of 12 percent. The estimates for the 1939-1969 period range from +1 to +17, a spread of 16 percent. Because the estimates vary, one must consider the statistical properties of the patterns used for calculation.

Differences in source data clearly contribute to differences among the patterns. The 1930 Ontario pattern, for example, is only for maternal deaths involving reportable pregnancy outcomes (live birth and still birth), whereas the 1933 Ontario pattern is also for maternal deaths with non-reportable outcomes (abortion and no-delivery). As shown in Table A6, for England in

25. Berry, "Age and Parity Influences".

26. Berry's "averaged" pattern also is miscalculated; her "averaged" risks for parities two through five, for example, are lower than the comparable risks in any of her literature patterns. Her assumption of a "stable" pattern of relative parity risk also clashes with her restrictive assumption about relative age-parity risk (308): "Relative risks by age and by parity are similar for populations **with similar crude rates.**" Since the crude rate fell sharply during her 1919-1969 study period, the relative risks could not have been stable.

1935, deaths with reportable outcomes have a higher proportion of first births than all maternal deaths.[27] Significantly, when the 1930 Ontario pattern is adjusted for bias on the basis of the 1935 English data, it produces the same estimates for the 1925-1937 period as the 1933 Ontario pattern.[28] A different source bias is realized from the 1927-1928 Canadian and New South Wales patterns, which are only for married women. Although far fewer in number than married mothers, single mothers have a much greater concentration in the first birth and 10-19 and 20-24 age categories (*see* Table A7) and face a higher mortality risk (*see* Table 1). By excluding unmarried women, therefore, these patterns may understate the risks for first births in the younger age categories.[29]

The relationship between the pattern of relative risk and the level of general risk is the second consideration. As shown in the Table A2 patterns for Manitoba, New York State, and New South Wales, the decline in the general risk led to a drop in the relative risk for first births and a rise in the relative risks for the higher parities. In this context, the 1925-1969 study years in Ontario divide conveniently into periods of high, medium, and low general maternal mortality levels (1925-1937, 1938-1949, and 1950-1969), marked respectively by rates of five plus, 3.8 to 1.3, and less than one. Based on their respective maternal mortality levels, the 1938-1939 Manitoba and 1943-1948 New South Wales patterns reflect medium general risk; the 1938-1942 New South Wales and 1936-1938 New York State pattern are transitional between the high and medium risk levels; and all other Table 3 patterns reflect high general risk.

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27. *Report on an Investigation into Maternal Mortality* (England: Ministry of Health, 1937): 105. Although differences in parity proportions by pregnancy outcome are suggestive, the actual **proportions** reported for English parities in 1935 cannot be generalized. The English definition of parity included previous abortions, whereas the Canadian definition did not. The English definition of stillbirth required a foetal gestational age of seven months, compared to five months in the New York State study for 1936-1938; and six months for Canada until 1932, then 28 weeks (6.5 months). The relative frequency of deaths with abortion and no-delivery outcomes was variable. In data for Ontario for 1927-1928 and 1933, abortion and no-delivery outcomes were 34 and 32% respectively of maternal deaths, but for other provinces, in 1927-1928, the proportions ranged from 24% (New Brunswick) to 42% (British Columbia). MacPhail, "A Statistical Study in Maternal Mortality"; J.T. Phair and A.H. Sellers, "A Study of Maternal Deaths in the Province of Ontario", *Canadian Public Health Journal*, 25 (1934): 563-579.

28. Based on 1935 English differences in parity proportions between deaths with reportable pregnancy outcomes and all maternal deaths, the adjustment reallocated 7% of the parity one deaths among the other parities.

29. Whereas the Canadian and American counts of parity excluded abortions, the Scottish and English counts included them. Most patterns were for **direct** maternal deaths (i.e., classed as having a puerperal "primary cause"), but the Scottish and 1930 Ontario patterns also were for **indirect** maternal deaths. Finally, as discussed above, national differences in "rules for choice" influenced international statistics for the **Puerperal State class** of deaths.

In terms of the above periodization and pattern typology, a high general risk pattern is needed to estimate for the 1925-1938 period. A medium general risk pattern inflates the compositional influence by i) exaggerating the effect of the declining proportion of parity four-plus births, and ii) understating the offsetting effect of the rising proportion of first births. A medium mortality level pattern is needed to estimate for the 1938-1949 period. A high general risk pattern inflates the effect of proportionate shifts for first births, while understating the effect of proportionate changes for the higher parities. One ideally would use a low general risk pattern to estimate for the post-1950 period, but the literature does not provide one.

In the circumstances, the writer preferred the **Adjusted 1930 Ontario** or **1933 Ontario** pattern estimates for the 1925-1937 high mortality period, and the **1938-1939 Manitoba** or **1943-1948 New South Wales** pattern estimates for the 1938-1949 and 1950-1969 periods. Of the two medium risk level patterns, the 1943-1948 New South Wales pattern may be preferable for the 1950-1969 period because it expresses a lower general risk (2.11 versus 3.26). The 1938-1939 Manitoba pattern, on the other hand, is for all maternal deaths, whereas the New South Wales pattern is only for married women.

The Age-Parity Compositional Influence

Berry estimates parity distributions for maternal deaths within each age category from a documented age-parity relative risk pattern (1936-1938 New York State). Her estimates are problematic. Despite acknowledging that the relative risk pattern varied with the level of general risk, she estimates from the one (medium general risk) pattern for the entire 1919-1969 period. Her discussion, therefore, misleads because it is limited to her standard year, 1940, in which the U.S. crude rate was similar to that for New York State, 1936-1938. She also does not adjust the pattern for bias in the numerator data used to calculate it (only those maternal deaths which involved live-birth and stillbirth pregnancy outcomes).

Appendix II

Supplementary Statistical Tables

Table A1 Estimates for the Age Distribution Influence

A. Relative age-specific rates for maternal mortality

Period	10-19	20-24	25-29	30-34	35-39	40+	Total
1930-4	0.8	0.7	0.8	1.1	1.5	2.1	**1.0**
1965-9	0.8	0.3	0.6	1.7	2.9	4.4	**1.0**

B. Percentage age category distribution for mothers

Period	10-19	20-24	25-29	30-34	35-39	40+	Total
1930-4	8	26	27	20	13	5	**99**
1939	8	28	28	20	11	4	**99**
1965-9	12	33	28	16	8	3	**100**

C. Estimates of the age compositional influence (age-standardized maternal mortality rate divided by the crude maternal mortality rate)

Period	Crude MMR	Standard MMR/ Crude MMR	% Influence
1930-4	5.5	0.97	+ 3
1939	4.3	standard year	
1965-9	0.2	1.17	+17

Table A2 Relative Parity-Specific Maternal Mortality Rates

1. Ontario 1930 Parity:	One	Two	Three	Four	Five	Six-Seven	Eight-Nine	Ten Plus
1930	1.36	0.82	0.65	0.69	0.86	0.90	1.40	1.42
Adjusted	1.15	0.86	0.75	0.83	1.07	1.00	1.52	1.45

2. Ontario 1933 Parity:	One	Two	Three	Four	Five	Six	Seven	Eight Plus
	1.13	0.83	0.92	0.85	0.82	1.16	1.35	1.26

3-5. Manitoba Parity:	One	Two	Three-Five	Six Plus	**Crude**
1928-32	1.36	0.58	0.58	1.18	**4.9**
1933-37	1.32	1.05	0.73	0.93	**4.4**
1938-39	0.83	0.79	1.11	2.30	**3.26**
Change:	-0.53	+0.21	+0.53	+1.12	**-1.164**

6. Canada, 1927-28 Parity:	One	Two	Three	Four-Six	Seven-Nine	Ten Plus
	1.36	0.71	0.67	0.80	1.14	1.69

7-9. New York State Patterns (* = deaths with reportable pregnancy outcomes only)

New York State Parity:	One	Two	Three	Four	Five	Six-Seven	Eight-Nine	Ten Plus	Rate
1923-26	1.27	0.83	0.73	0.76	0.87	0.99	1.25	1.83	**3.87***
1931-34	1.18	0.73	0.73	1.06	1.02	1.20	1.31	1.59	**3.74***
1936-38	1.05	0.74	0.69	0.99	1.27	1.41	2.36	1.64	**2.67***
Change:	-0.22	-0.09	-0.04	+0.22	+0.40	+0.52	+1.11	-0.19	**-1.20**

10-11. Scotland, 1930-32 and England, 1935 Parity:	One	Two	Three	Four	Five	Six-Seven	Eight-Nine	Ten Plus
Scotland	1.12	0.68	0.84	0.79	1.18	1.18	1.29	2.06
England	1.24	0.84	0.68	0.71	0.82	1.08	1.25	2.29

12-18. New South Wales, 1894-1907 (Dublin Study) Parity: One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten Plus
1.43	0.63	0.73	0.81	0.93	0.90	0.99	1.13	1.37	1.41

Parity:	One	Two	Three	Four-Five	Six-Eight	Nine Plus	**Crude**
1901-07	1.34	0.68	0.78	1.02	1.11	1.78	**6.63**
1911-20	1.05	0.74	0.90	1.06	1.29	1.33	**5.57**
1921-30	1.04	0.67	0.92	1.08	1.35	1.77	**5.42**
1931-40	0.87	0.67	0.97	1.35	1.61	2.40	**5.11**
1938-42	0.94	0.64	1.05	1.36	1.75	2.07	**4.04**
1943-48	1.02	0.73	0.80	1.32	1.95	2.53	**2.11**
Change:	-0.32	+0.05	+0.02	+0.30	+0.84	+0.75	**-4.52**

Table A3 Types of Source Data Used to Calculate the Different Patterns of Relative Parity-Specific Risks

Pattern	Numerator	Denominator
Ontario 1930	Deaths Classed as Puerperal and Other Deaths Involving Pregnancy and Linked to a Birth/Stillbirth Registration. Parity Count Excludes Abortions.	Live Births and Stillbirths
Ontario 1933	Deaths Classed as Puerperal (Physician Questionnaires). Parity Count Excludes Abortions.	Live Births and Stillbirths
Manitoba 1928-32 1933-37 1938-39	Deaths Classed as Puerperal (Physician Questionnaires). Parity Count Excludes Abortions.	Live Births and Stillbirths
Canada 1927-28	Deaths of Married Women Classed as Puerperal and Linked to a Birth or Stillbirth Registration. Parity Count Excludes Abortions.	Legitimate Live Births and Stillbirths
New York State 1923-26 1931-34 1936-38	Deaths Classed as Puerperal and Linked to a Birth or Stillbirth Registration. Parity Count Excludes Abortions.	Live Births and Stillbirths
Scotland 1930-32	Deaths Classed as Puerperal and Other Deaths Involving Pregnancy. Parity Count Includes Abortions.	Live Births and Stillbirths, January-June, 1932
England 1935	Deaths Classed as Puerperal and Involving a Fetal Gestational Age of Seven Months or More. Parity Count Includes Abortions.	Legitimate Live Births, Parity Distribution Estimated from Data for Manchester
New South Wales 1894-1907 1901-48	Deaths of Married Women and Classed as Puerperal. Parity Count Excludes Abortions and Stillbirths.	Legitimate Live Births, Australian Parity Distributions by Age Assumed for Pre-1938

Table A4 Documented Relative Age-Parity Maternal Mortality Risks

1. Ontario 1930 (Crude Rate = 6.17)

Parity	10-19	20-24	25-29	30-34	35-39	40+	Total
1	1.193	1.063	1.340	2.160	3.268	4.999	1.360
2	0.262	0.598	0.759	1.285	1.247	2.398	0.819
3		0.398	0.576	0.852	0.774	1.779	0.652
4-5		0.186	0.712	0.386	1.376	2.067	0.759
6-7			1.194	0.455	0.827	1.993	0.900
8+			1.038	0.390	1.385	2.331	1.413
Total	0.986	0.767	0.908	0.895	1.314	2.281	1.000

2. **Adjusted Ontario 1930** (Crude Rate = 6.17)

Parity	10-19	20-24	25-29	30-34	35-39	40+	Total
1	1.008	0.899	1.133	1.826	2.762	4.225	1.149
2	0.272	0.621	0.789	1.336	1.296	2.493	0.851
3		0.457	0.661	0.977	0.887	2.040	0.747
4-5		0.223	0.873	0.473	1.682	2.512	0.927
6-7			1.317	0.502	0.913	2.198	0.993
8+			1.124	0.423	1.458	2.458	1.493
Total	0.842	0.704	0.916	0.912	1.408	2.457	1.000

3. **New South Wales 1931-40** (Married Women) (Crude Rate = 5.11)

Parity	10-19	20-24	25-29	30-34	35-39	40+	Total
1	0.50	0.51	0.98	1.47	2.36	4.02	0.87
2	0.52	0.49	0.60	0.72	1.53	1.95	0.67
3		0.74	0.76	0.98	1.49	2.93	0.97
4-5		0.93	0.95	1.29	1.84	2.67	1.35
6-7			1.53	1.47	1.71	2.07	1.61
8+					2.84	2.37	2.40
Total	0.52	0.55	0.85	1.15	1.85	2.48	1.00

4. **New South Wales 1938-42** (Married Women) (Crude Rate = 4.04)

Parity	10-19	20-24	25-29	30-34	35-39	40+	Total
1	0.56	0.50	1.00	1.90	2.67	4.60	0.94
2	0.46	0.34	0.62	0.71	1.51	2.75	0.64
3		0.72	0.80	0.82	2.28	3.45	1.05
4-5		0.85	0.87	1.52	1.81	2.39	1.36
6-8			1.27	1.25	2.04	2.63	1.75
9+				1.89	2.23	1.93	2.07
Total	0.54	0.49	0.85	1.23	2.03	2.69	1.000

5. **New South Wales 1943-48** (Married Women) (Crude Rate = 2.11)

Parity	10-19	20-24	25-29	30-34	35-39	40+	Total
1	0.69	0.68	0.85	1.82	2.80	7.31	1.02
2	0.88	0.36	0.64	0.73	1.95	3.24	0.73
3		0.56	0.51	0.85	1.47	1.39	0.80
4-5		0.50	1.16	1.01	2.01	1.91	1.32
6-8			2.22	1.01	1.89	4.01	1.95
9+				1.14	2.89	2.88	2.53
Total	0.73	0.58	0.78	1.06	2.03	3.20	1.00

Table A5 Proportion of Mothers in Above-Average Risk Categories for Age-Parity (*see* Table A4 for risk pattern display)

A. High general risk years: adjusted Ontario 1930 pattern of risk

	Maritime	Quebec	Ontario	Prairie	B.C.
1930-4	35	36	36	34	36
1935-9	35	38	37	34	37

B. Medium/low general risk years: 1943-1948 New South Wales pattern of risk

	Maritime	Quebec	Ontario	Prairie	B.C.
1940-4	38	44	31	33	26
1945-9	37	42	29	31	26
1950-4	40	42	29	31	28
1955-9	40	42	31	34	31
1960-4	39	39	32	34	31
1965-9	31	30	25	28	23

Table A6 Percentage Parity Distributions by Pregnancy Outcome for Maternal Deaths in England in 1935

Parity	% Live Birth	% Still-Birth	% Abortion	% No Delivery	% All Outcomes
1	50	50	12	36	43
2	19	15	21	20	18
3	10	9	19	11	11
4	6	6	15	8	7
5	3	5	13	7	5
6+	12	15	20	18	16
Total	100	100	100	100	100
N =	909	476	244	197	1,826

Table A7 **Percentage Age-Parity Distribution for Births (including stillbirths) by Legitimacy, Ontario, 1944**

Parity	10-19	20-24	25-29	30-34	35-39	40+	All Ages
			Illegitimate Births				
1	28.6	25.6	7.9	3.6	1.2	0.3	67.1
2	2.0	7.4	3.3	1.3	0.6	0.2	14.9
3	0.3	2.8	2.1	0.9	0.5	0.1	6.8
4-5		1.5	2.3	1.8	0.8	0.3	6.8
6-7			0.8	0.9	0.8	0.2	2.8
8+			0.2	0.6	0.6	0.3	1.7
Total	30.9	37.4	16.7	9.3	4.4	1.3	100.0
			Legitimate Births				
1	4.7	14.4	9.2	4.4	1.4	0.3	34.3
2	1.2	8.3	8.9	6.0	2.2	0.3	27.1
3	0.2	3.5	5.0	4.2	2.0	0.4	15.3
4-5		1.8	4.3	4.0	2.6	0.8	13.5
6-7		0.2	1.2	2.0	1.5	0.6	5.4
8+			0.3	1.1	1.8	1.2	4.4
Total	6.1	28.2	28.9	21.8	11.5	3.5	100.0
			All Births				
1	5.8	14.9	9.1	4.3	1.4	0.3	35.9
2	1.3	8.3	8.6	5.8	2.2	0.3	26.5
3	0.2	3.5	4.9	4.1	1.9	0.4	14.9
4-5		1.8	4.2	3.9	2.5	0.7	13.2
6-7		0.1	1.2	1.9	1.4	0.6	5.3
8+			0.3	1.1	1.7	1.1	4.4
Total	7.3	28.7	28.3	21.2	12.2	3.4	100.0