

A B S T R A C T

Objective: To examine trends and regional variations in perinatal mortality and low birthweight (LBW) and regional variations in socio-economic risk factors.

Methods: Population-based study of Central West Region of Ontario with approximately 28,000 births annually during the period 1988-1995 using vital statistics records and Census data.

Results and Conclusions: There was no significant change in the perinatal mortality rate averaging 9.4 per 1,000 births per year. The LBW rate increased from 49.7 to 54.8 per 1,000, while the prematurity rate increased from 56.1 to 75.8 per 1,000. Significant variation occurred in outcomes among different regions, which was partially explained by socio-economic factors. The increases in LBW and prematurity rate emphasize the need for effective targeted services and programs. In their planning and implementation, regional variations in socio-economic factors, and other factors such as: the availability and utilization of services and barriers to access in services, require further evaluation and consideration.

A B R É G É

Objectif: examiner les tendances et les variations régionales dans la mortalité périnatale et le nombre de naissances de faible poids, et les variations régionales au niveau des facteurs de risque socio-économiques.

Méthodologie : étude démographique de la région centre-ouest de l'Ontario, où l'on a compté approximativement 28 000 naissances par an entre 1988 et 1995, à partir des statistiques de l'état civil et du recensement.

Résultats et conclusions : on n'a constaté aucun changement significatif dans le taux de mortalité périnatale, qui se situe en moyenne à 9,4 pour 1 000 naissances par année. Le taux des faibles poids à la naissance est passé de 49,7 pour 1 000 à 54,8 pour 1 000, tandis que le taux de prématurés est passé de 56,1 pour 1 000 à 75,8 pour 1 000. On a constaté des variations significatives dans les résultats entre les différentes régions, ce qui est en partie dû à des facteurs socio-économiques. L'augmentation des taux de faibles poids à la naissance et de prématurés met en lumière le besoin de mettre en oeuvre des programmes et des services efficaces à l'intention de ces populations. Dans la planification et la mise en oeuvre de ces services et programmes, les variations régionales des facteurs socio-économiques ainsi que d'autres facteurs comme la disponibilité et l'utilisation des services, sans oublier les obstacles à leur accès, exigent une évaluation plus poussée.

Trends and Variations in Perinatal Mortality and Low Birthweight: The Contribution of Socio-economic Factors

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Over the past 40 years advances in medical technology, positive changes in socio-economic conditions, and improvements in maternal health status have made significant contributions to the reduction in perinatal mortality rates (PMR) worldwide.^{1,2} In Canada, there had been a significant decline in low birthweight (LBW) across all provinces in the 1970s, however, since the 1990s there has been an increase in the province of Ontario from 5.8% to 6.0%.³ Recent Canadian data suggest that the rates of preterm birth have also increased.⁴ LBW or premature births are associated with approximately 75% of all infant deaths within the first week of life.⁵ The costs of caring for LBW infants in hospital, and of dealing with the sequelae, are significant.⁶ In Ontario, one of the mandatory objectives of the Provincial Core Programs for public health units is to reduce the rate of LBW to 4% by the year 2010.⁷

The purpose of this study was to examine trends and variations in PMR and LBW, and regional variations in socio-economic risk factors. This information may provide insight into pregnancy outcomes in different regions, and may help in the planning of preventive programs, and in formulating hypotheses for research.

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METHODS

Study population

The Province of Ontario has a population of approximately 11 million people and is divided into six health care planning regions: Eastern, Central East, Central West, Southwest, Northeast and Northwest. A regional network of facilities and community agencies services each region. This paper focusses on the Central West Region, which has a population of approximately 1.9 million people and approximately 28,000 births annually in Brant, Haldimand-Norfolk, Halton, Hamilton-Wentworth, Niagara, Waterloo and Wellington-Dufferin counties.

Data sources

Data on PMR and LBW were obtained from the vital statistics records of the Registrar General which include records of live births, stillbirths, and neonatal deaths. Data inaccuracies which may have falsely elevated LBW for Ontario for 1993 and 1994^{8,9} were corrected, and these new data were used for this analysis. For socio-economic data missing at the individual level from vital statistics records, aggregate data for the county of residence from the 1991 Canadian census were used as an indicator of the socio-economic characteristics for the residents of each of the counties. Individual-level data obtained from vital statistics records included maternal age (teens and age ≥ 35 years) and mother's marital status; aggregated data obtained from census data included low income, low education, immigrant status, and non-English or non-French speaking. Causes of PMR were those listed as "underlying cause" on the death file

derived from the International Classification of Diseases, 9th Revision, Clinical Modification codes.¹⁰

Definitions

The definitions of perinatal mortality in this report were adapted from other reproductive health reports in Canada.¹¹ These definitions include 1) live birth: a birth of any weight who shows signs of life at birth; 2) stillbirth (SB): a fetus weighing 500 grams or more, who shows no signs of life at birth; 3) total births: the sum of the live births and stillbirths; 4) early neonatal death (END): death of a live-born infant regardless of weight up to 7 days of life; and 5) perinatal death: the sum of SB and END. Although SB and END have standard definitions, these definitions may be applied differently by different individuals or institutions. In the lowest birthweight categories, the prevention of a SB may merely prolong the death into the neonatal period¹² and there are local and regional variations in the aggressiveness with which LBW births are managed.¹³ Thus, the PMR is most likely to be robust to local variations in the definitions of SB and END.

LBW rate was defined as the proportion of live births weighing less than 2500 grams at birth. The LBW infants were categorized into groups: 1) < 500 grams; 2) 500-749 grams; 3) 750-1499 grams; 4) 1500-2499 grams. The region of death or LBW birth was assigned to the region of residence of the mother. Definitions of socio-economic factors were adapted from Statistics Canada.¹⁴

Analyses

PMR are reported as rates per 1,000 total births (live births and SB) and LBW births are reported as rates per 1,000 live births. Trends of rates over time were measured using chi-square test for linear trend in proportions.¹⁵ Bivariate analysis using Spearman rank correlation was used to assess the associations between risk factors and outcomes.

RESULTS

From 1988-1995, there were a total of 2,076 perinatal deaths in the Central West Region of Ontario. There were 1,350 (65%)

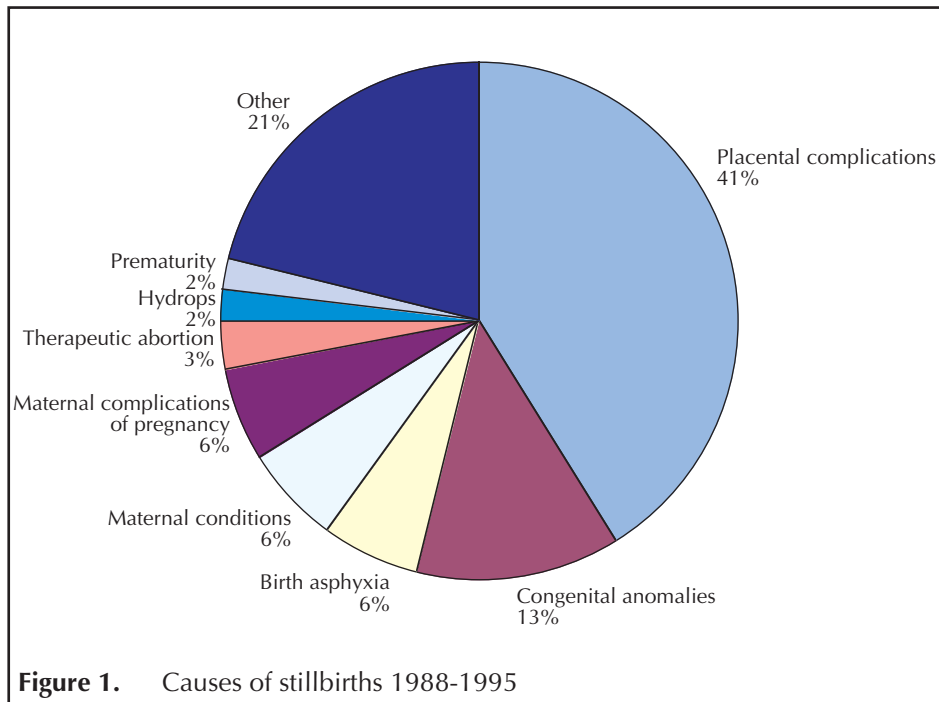


Figure 1. Causes of stillbirths 1988-1995

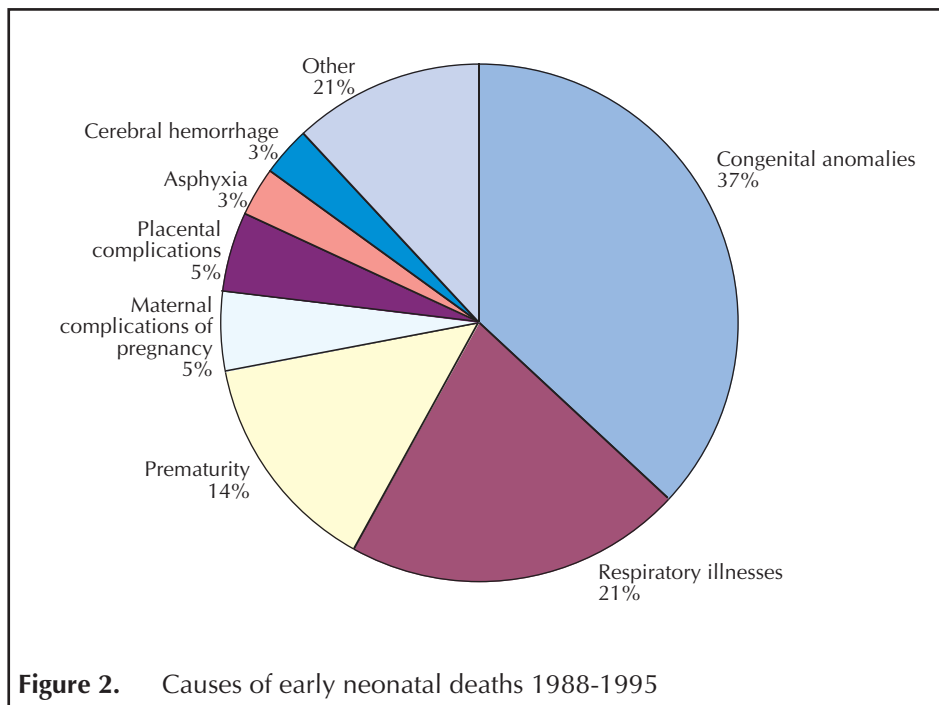


Figure 2. Causes of early neonatal deaths 1988-1995

SB and 726 (35%) END. Eight major categories of causes accounted for 79% of all SB. The causes and proportions for these causes are reported in Figure 1. Seven major categories of causes accounted for 88% of all END. The causes and proportions for these causes are reported in Figure 2.

Table I reports the trends in SB, END, PMR, LBW and gestational age rates in Central West Region from 1988-1995.

The PMR over the 8 years averaged 9.4 (range 8.8 to 10.8) per 1,000; SB rates averaged 6.1 (range 6.1 to 7.3) per 1,000; and END rates averaged 3.3 (range 2.4 to 3.8) per 1,000. No significant changes occurred in these rates over the eight-year period. LBW rates increased from 49.7 to 54.8 per 1,000. Within this group, there was an increase in the rate of live births for infants in the birthweight groups < 500

TABLE I
Stillbirth, Early Neonatal Death, Perinatal Death, Low Birthweight and Gestational Age Rates (per 1,000)
in Central West Region

	1988	1989	1990	1991	1992	1993	1994	1995	1995:1988 ratio (95% CI)	1988-1995
Stillbirth	6.4	7.3	7.0	*	6.4	6.2	6.1	6.9	1.08 (0.88, 1.34)	6.1
Early neonatal death	3.3	3.1	3.8	3.4	2.4	3.5	3.6	3.3	1.01 (0.75, 1.36)	3.3
Perinatal death	9.6	10.4	10.8	*	8.8	9.6	9.7	10.2	1.06 (0.89, 1.26)	9.4
BW < 500 grams†	0.3	0.3	0.4	0.7	0.6	0.9	0.6	0.6	1.98 (0.85, 4.63)	0.5
BW 500-749 grams	1.4	1.2	1.7	1.2	1.1	1.0	1.6	1.1	0.76 (0.47, 1.22)	1.3
BW 750-1499 grams†	6.1	5.5	5.7	5.9	6.6	7.1	7.0	6.6	1.06 (0.86, 1.32)	6.3
BW 1500-2499 grams†	41.9	42.7	43.5	43.3	45.7	46.5	47.4	46.5	1.10 (1.01, 1.19)	44.8
Total BW < 2500 grams†	49.7	49.7	51.2	51.2	53.9	55.5	56.5	54.8	1.09 (1.01, 1.18)	52.9
GA < 24 weeks	1.0	0.5	1.0	0.7	0.9	1.0	0.9	0.5	0.48 (0.25, 0.92)	0.8
GA 24-26 weeks	1.3	1.6	1.6	1.6	1.3	1.5	1.7	1.6	1.19 (0.76, 1.86)	1.5
GA 27-36 weeks†	53.8	55.5	53.3	58.3	60.1	69.9	71.3	73.7	1.38 (1.28, 1.48)	62.0
Total GA < 37 weeks†	56.1	57.5	55.9	60.6	62.4	72.4	73.9	75.8	1.36 (1.26, 1.45)	64.4

From vital statistics records
 * for 1991, the number of stillbirths in Ontario with an unknown location was 328, therefore data for stillbirths and perinatal mortality for 1991 were not included in the analysis
 † chi-square test for linear trend in proportions statistically significant at $p < 0.05$

TABLE II
Stillbirth, Early Neonatal Death, Perinatal Death, Low Birthweight and Gestational Age Rates per 1,000
in the Counties of Central West Region 1988-1995 (rank from highest to lowest in brackets)

	Brant	Haldimand-Norfolk	Halton	Hamilton-Wentworth	Niagara	Waterloo	Wellington-Dufferin	rank 1: rank 7 ratio (95% CI)	Central West
Stillbirth	5.3 (6)	8.0 (1)	5.5 (5)	7.2 (2)	6.4 (3)	5.2 (7)	5.7 (4)	1.55 (1.20, 1.99)	6.1
Early neonatal death	3.4 (3)	3.2 (4)	2.7 (7)	3.8 (1)	3.6 (2)	3.0 (5)	3.0 (6)	1.43 (1.12, 1.83)	3.3
Perinatal death	8.7 (4)	11.2 (1)	8.2 (7)	11.0 (2)	9.9 (3)	8.2 (6)	8.7 (5)	1.37 (1.10, 1.70)	9.4
BW < 500 grams	0.2 (7)	0.9 (1)	0.3 (6)	0.9 (2)	0.5 (3)	0.4 (5)	0.5 (4)	3.81 (1.03, 14.08)	0.5
BW 500-749 grams	1.3 (5)	1.4 (2)	1.2 (6)	1.4 (3)	1.4 (1)	1.3 (4)	1.0 (7)	1.36 (0.84, 2.20)	1.3
BW 750-1499 grams	7.3 (3)	7.3 (2)	5.3 (6)	7.8 (1)	6.2 (4)	5.5 (5)	5.3 (7)	1.50 (1.22, 1.83)	6.3
BW 1500-2499 grams	49.0 (3)	49.3 (2)	38.6 (7)	51.4 (1)	44.7 (4)	42.9 (5)	39.4 (6)	1.35 (1.26, 1.44)	44.8
Total BW < 2500 grams	57.8 (3)	58.8 (2)	45.4 (7)	61.5 (1)	52.8 (4)	50.2 (5)	46.1 (6)	1.38 (1.29, 1.46)	52.9
GA < 24 weeks	0.9 (3)	1.2 (1)	0.7 (7)	1.0 (2)	0.8 (4)	0.7 (5)	0.7 (6)	1.79 (0.89, 3.59)	0.8
GA 24-26 weeks	1.5 (4)	1.5 (3)	1.2 (7)	2.0 (1)	1.8 (2)	1.3 (5)	1.2 (6)	1.73 (1.21, 2.49)	1.5
GA 27-36 weeks	71.5 (2)	65.8 (4)	59.6 (6)	76.5 (1)	66.4 (3)	62.1 (5)	58.8 (7)	1.30 (1.22, 1.39)	62.0
Total GA < 37 Weeks	74.2 (2)	68.8 (4)	61.7 (6)	80.0 (1)	69.4 (3)	64.2 (5)	60.9 (7)	1.31 (1.23, 1.40)	64.4

From vital statistics records
 Numbers reported as identical had rank adjudicated by the next decimal point

grams, 750-1499 grams, and 1500-2499 grams. In the gestational age category, there was an increase in infants < 37 weeks from 56.1 to 75.8 per 1,000. Most of this

increase was due to an increase in infants born at 27-36 weeks.

Table II presents PMR, SB, END, LBW and gestational age rates in each county.

Prevalence of risk factors in each of the counties and the rank of the county for the risk factor are reported in Table III. Of note, Hamilton-Wentworth ranked high

TABLE III
Prevalence of Socio-economic Factors in the Counties of Central West Region (rank from highest to lowest in brackets)

	Brant	Haldimand-Norfolk	Halton	Hamilton-Wentworth	Niagara	Waterloo	Wellington-Dufferin
Average annual births*	1628 (6)	1283 (7)	4393 (4)	6307 (1)	5035 (3)	5790 (2)	2992 (5)
Low income†	119 (3)	84 (6)	68 (7)	174 (1)	125 (2)	114 (4)	88 (5)
Low education†	93 (5)	117 (1)	44 (7)	108 (2)	100 (3)	94 (4)	78 (6)
Single mothers*	180 (1)	131 (5)	76 (7)	142 (3)	151 (2)	130 (4)	114 (6)
Teen mothers*	83 (1)	57 (2)	26 (7)	57 (3)	54 (4)	54 (5)	41 (6)
Maternal age ≥ 35 years*	80 (7)	81 (6)	138 (1)	101 (2)	84 (5)	90 (4)	101 (3)
Immigrants†	21 (6)	19 (7)	41 (3)	46 (2)	23 (5)	57 (1)	31 (4)
Non English or French speaking†	5 (7)	6 (6)	7 (4)	18 (1)	7 (4)	17 (2)	7 (4)

* data from vital statistics records 1988-1995

† data from Census Canada 1991

Reported as rates per 1,000

(rank of 1 or 2) and Halton ranked low for most risk factors and outcomes.

The associations between pregnancy outcomes and socio-economic variables are shown in Table IV. Low income and single mothers were associated with END. Low education was associated with PMR, BW < 500 grams, 500-749 grams, 750-1499 grams, and 1500-2499 grams. Teen mothers were associated with BW 750-1499 grams, and 1500-2499 grams. Maternal age ≥ 35 years, immigrant status and non-English or non-French speaking characteristics were not significantly associated with any of the outcomes.

DISCUSSION

Our results show that although there has been no significant change in the PMR in the Central West Region of Ontario for the period 1988-1995, the LBW has increased 1.09-fold from 49.7 per 1,000 in 1988 to 56.5 per 1,000 in 1995, and the prematurity rate has increased 1.36-fold over the eight-year period. These rates of LBW in the Central West Region are somewhat lower than those reported nationally (56.2 per 1,000 in 1988 to 59.3 per 1,000 in 1994)⁸ and provincially (54.6 per 1,000 in 1988 to 59.8 per 1,000 in 1995).⁹ Joseph and Kramer speculated that their finding of an increase in LBW in Ontario may be due to data inaccuracies.⁸ However, we used corrected data and obtained results which support an increase in the LBW and prematurity rates in the Central West Region of Ontario. Corrected data for LBW rate in Ontario also show an increase in LBW rates.⁹ These findings should be viewed with concern.

TABLE IV
Relationship Between Outcomes and Socio-economic Factors

	Stillbirth	Early Neonatal Death	Perinatal Death	BW < 500 g	BW 500-749 g	BW 750-1499 g	BW 1500-2499 g
Low income	0.11	0.89*	0.43	0.18	0.46*	0.54	0.61
Low education	0.68	0.71	0.89*	0.82*	0.86*	0.82*	0.86*
Single mother	-0.07	0.82*	0.43	-0.07	0.50	0.57	0.61
Teen mother	0.29	0.71	0.75	0.21	0.50	0.82*	0.86*

Values represent Spearman's rank correlation coefficient

* p-value statistically significant at < 0.05

The decreased availability of prenatal care due to a shortage of obstetrical care providers, the effects of the worsening economy, decreased social assistance, and the lack of province-wide comprehensive prenatal programs may be contributing to the increased LBW and prematurity rates. Although not addressed in this report, factors such as obstetrical intervention and increase in multiple births may be part of the explanation for the increase in prematurity rate.⁴ The odds ratio for the increase in prematurity was greater at 1.36 than the odds ratio for the increase in LBW at 1.09. This discrepancy may be due to a secular trend for increases in birthweight for premature infants and/or the more prevalent use of ultrasounds for the assessment of gestational age.⁴

As found by Joseph and Kramer,¹⁶ we also found an increase in live births < 500 grams, which may contribute to an increase in infant mortality. Svenson et al. found that only 3% of infants with birthweight < 500 grams born in Alberta in 1994 survived beyond the first year of life.¹⁷ Among the pregnancy outcomes measured, the regional variation was highest for live births with birthweight < 500

grams with a 3.81-fold difference between the region with the lowest level and the region with the highest level. Infants with birthweight < 500 grams may survive beyond the first week of life such that the counties that report infants < 500 grams as live births are more likely to have a lower PMR but a higher infant mortality rate.

Differences in pregnancy outcomes were evident among the different counties within the Central West Region, ranging from 1.30 to 3.81-fold differences for the various outcomes analyzed. We found that some counties had a high rank in PMR with only a moderate rank in socio-economic risk factors. This is possibly due to our reliance upon county-level rather than individual indicators of socio-economic status. However, other studies have also shown that a region's socio-economic profile does not fully predict the region's rate of adverse pregnancy outcomes.^{18,19} Further evaluation is required to assess what additional factors may be affecting these rates.

Our results are consistent with previous research that demonstrated the association of LBW with the socio-economic risk factors of low income, low education, and

teen mothers.^{18,20} Hamilton-Wentworth had the largest number of total births, the highest prevalence of socio-economic risk factors, and the highest rate for most of the adverse outcomes. In light of these findings, a careful analysis of perinatal services in Hamilton-Wentworth is required.

CONCLUSION

Over the past eight-years, there has been no significant change in PMR in the Central West Region of Ontario. Of concern, there has been an increase in the proportion of LBW and premature infants. These findings emphasize the need for an improvement in services and programs affecting pregnant women. Prenatal initiatives using a community-based and comprehensive approach, that focus on reducing the underlying determinants of health contributing to LBW, have the potential both to be cost-effective and to improve long-term health outcomes.²¹⁻²⁴ Cost-benefit analyses reveal a savings of \$3.66 in hospital care for every dollar invested in prenatal care.

Health units are mandated to develop prevention and risk reduction programs that address modifiable factors such as cigarette smoking.^{7,25} Community-based programs should be developed to reach specific populations, in particular adolescent mothers, who are at increased risk of adverse pregnancy outcomes.^{26,27} Health units can assist in the identification of barriers to accessing prenatal care among specific populations in each community.²⁸ Universal programs should be developed to educate all women about the early recognition of pre-term labour.²⁹ Communities must be willing to develop a system of prenatal care that is coordinated, responsive and relevant. The new Healthy Babies, Healthy Children initiative with a focus on

early identification of risk has the capacity to reach a large number of women prenatally in the province of Ontario.³⁰

In the planning and implementation of these services and programs, factors other than socio-economic may be important to further evaluate and consider. These factors include: 1) resource input such as health care provider availability, quality of service provision, availability of prenatal/community-based programs; 2) service utilization at various levels; and 3) barriers to accessing services.

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