ORIGINAL ARTICLE

Socioeconomic status and preterm birth: New Zealand trends, 1980 to 1999

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Arch Dis Child Fetal Neonatal Ed 2002;**86**:F142–F146

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Accepted
23 November 2001

Background: While a number of countries have reported rising preterm birth rates over the past two decades, none has examined the effects of socioeconomic status on preterm birth at a national level.
Aim: To document the changing incidence of preterm birth in New Zealand over the past 20 years and to determine whether particular socioeconomic or ethnic subsections of the population have contributed disproportionately to the changes seen.
Methods: Birth registration data routinely available from the New Zealand Health Information Service were analysed for the period 1980–99. Information for a total of 1 079 478 singleton live births was linked by Domicile Code to the New Zealand Deprivation Index, a small area index of deprivation.
Results: Singleton preterm birth rates rose by 37.2% during the 20 year period, from 4.3% in 1980 to 5.9% in 1999. Rates increased by 71.9% among those living in the most affluent areas, but by only 3.5% among those living in the most deprived areas, resulting in the disappearance of a socioeconomic gradient in preterm birth that had existed during the early 1980s.
Conclusions: This study challenges traditional thinking on the associations between socioeconomic status and preterm birth. Further research is necessary if the changes that have occurred in New Zealand over the past 20 years are to be fully understood.

In 1980 4.3% of singleton live births in New Zealand occurred prior to 37 weeks gestation. Since that time several developed countries have reported increasing rates of preterm birth. In the USA preterm birth rates have increased by 23% since 1981, with rates among non-Hispanic whites increasing 20% since 1989.[1] In Canada, singleton preterm birth rates rose by 5% between 1981 and 1994.[2] In contrast, rates in Australia[3] have remained static over the past decade, while France reported declining preterm birth rates between 1981 and 1989.[4] None of these studies, however, examined the influence of socioeconomic status on the changes seen.

A number of reasons have been given for the rising preterm birth rates in North America. While an increase in the number of multiple gestations is a likely contributor, trends persist when analysis is limited to singleton births.[2] Similarly, increasing reliance on ultrasound dating of pregnancy, rather than the traditionally used last menstrual period (LMP) may have increased preterm birth rates as the proportion of women scanned increased.[5] In addition, increasing obstetric intervention over the same time period (as indicated by declining stillbirth rates and rising numbers of caesarean sections) may have been responsible for the birth of a number of preterm infants who would not otherwise have survived.[2]

To date, no similar analysis of preterm birth rates has been published for New Zealand. Such information is vital not only for clinical practice, but for the future delivery of health services in this country. Furthermore, with the recent introduction of the Deprivation Index,[6] New Zealand births can now be assigned a small area index of deprivation, making it possible to track socioeconomic differences in preterm birth over a 20 year period.

METHODS

Birth registration data for this study were obtained from the New Zealand Health Information Service, a group within the Ministry of Health responsible for the collection and dissemination of health related data. Information was available for 1 079 478 singleton live births and 5146 singleton stillbirths between 1980 and 1999. Of these 1 084 624 births, 28 084 (2.6%) were excluded on the basis of incomplete gestational age information. The majority of these omissions (73%) occurred during 1998 as a result of changes in data collection arrangements at that time.

Collected birth data were allocated a Statistics New Zealand Area Unit Code, or Domicile Code based on the usual residential address at the time of delivery. This allowed the linking of births with the New Zealand Deprivation Index (NZDep), a small area index of deprivation based on a number of socioeconomic variables as measured by the 1991 and 1996 censuses.[6] For most analyses this index is converted into a decile scale, with decile 1 representing the least deprived 10% of small areas and decile 10 representing the most deprived 10% of small areas.

Because the NZ Deprivation Index was based on Statistics New Zealand's smallest geographic unit, the meshblock (covering a population of approx. 100), and the Health Information Service's Birth Data were assigned a Census Area Unit Code (representing the next administrative tier, and a population of approx. 3000), births could not be assigned directly to a Deprivation Index decile. This necessitated the creation of a number of weighted averages, with each Census Area Unit being assigned a Deprivation Index decile based on the averaged deprivation scores of the various meshblocks within its boundaries. As in the original scale, those residing in the least deprived 10% of Census Area Units received a Deprivation Index decile of 1, while those residing in the most deprived 10% of Census Area Units received a Deprivation Index decile of 10. For births occurring prior to 1994 deciles were derived from the NZDep91 Index, while those from 1994 onwards utilised the NZDep96.

Analysis of factors relating to preterm birth was then carried out using logistic regression, with births under 37 weeks gestation being the outcome variable of interest. Explanatory variables included year of birth, Deprivation Index decile, parity, age of mother, and infant gender. Year of birth and decile were treated as continuous variables while parity (nulliparous versus multiparous) and gender were

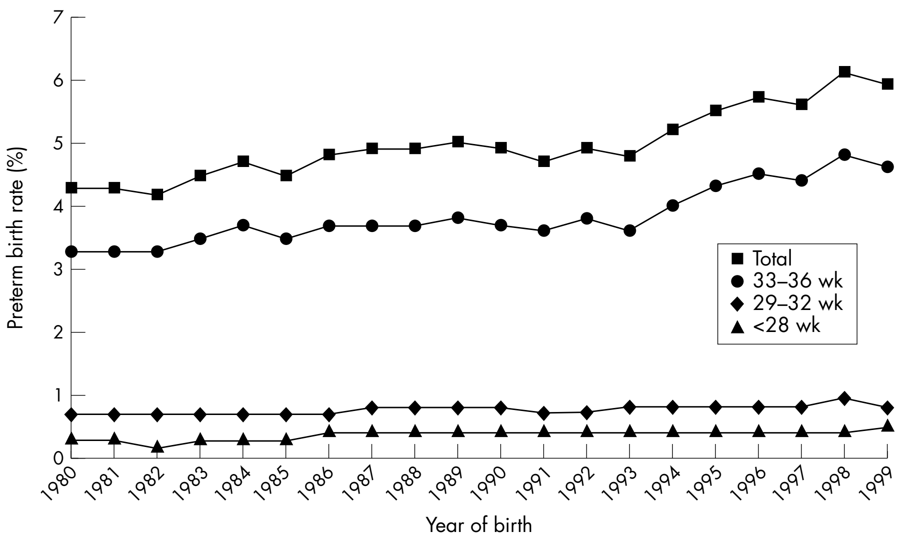

Figure 1 Rates of preterm birth by gestational age group; New Zealand singleton live births 1980–99.

treated as categorical. Maternal age, because of its U shaped association with preterm birth was also treated as categorical, rather than using linear or quadratic terms. Interactions terms placed in subsequent models included year*decile, year*age, year*parity, decile*age, decile*parity to allow for changes in maternal age and parity over the 20 year period, as well as for differences in age and parity between Deprivation Index deciles.

The babies' ethnicity was also reported in this dataset, but changes in definition during 1995 made information collected prior to this date incomparable with that collected afterwards. Prior to 1995 ethnicity was defined by ancestry (with those having half or more Maori or Pacific blood meeting ethnic group criteria) while after 1995 parents were asked to which ethnic groups their babies belonged and a priority rating introduced for those reporting multiple ethnic affiliations. Thus while ethnicity is an essential element in any discussion on preterm birth, changes in definition during the study period prevented detailed analysis of its effects during the period of most rapid change.

RESULTS

Due to the large sample size (n = 1 051 394) all associations seen in this study reached statistical significance unless otherwise indicated, and thus it is necessary to focus on the size of the effect rather than the level of significance for any particular association.

Figure 1 summarises rates of preterm birth by gestational age group over the past 20 years. Preterm birth rates during this period rose by 37.2%, from 4.3% in 1980 to 5.9% in 1999. Not all gestational age categories contributed equally to this rise, with rates among those in the 20–28 week category increasing only marginally in absolute terms, from a rate of 0.3% in 1980 to a rate of 0.5% by 1999. In proportional terms however, this represented an 81.5% increase over 1980 figures. For those in the 33–36 week category, preterm rates rose by 37.3%, from 3.3% in 1980 to 4.6% in 1999. By contrast, rates for those in the 29–32 week category changed very little, either in absolute or relative terms.

Table 1 summarises univariate and multivariate models (minus interaction terms) for the associations between infant gender, maternal age, parity, year of birth, Deprivation Index decile, and preterm birth. As noted previously a U shaped association exists between maternal age and preterm birth, with excess risk being present among those under 25 and over 35 years. While the magnitude of this association is diminished with multivariate modelling, it still remains significant. Similarly parity exhibits a U shaped association, with the highest risks being experienced by nulliparous women. Multivariate modelling only reduces this additional risk marginally. Year of birth and Deprivation Index decile both increase risk linearly. The risk associated with year was equivalent to a 1.37 increase in risk for the 20 year period, while that associated with decile was equivalent to a 1.24 difference between those living in decile 10 areas and those living in decile 1.

Table 1 Odds ratios for preterm birth: univariate and multivariate models

Continuous variables	Univariate model (95% CI)	Multivariate model (95% CI)
Infant gender		
Male	1.13 (1.11 to 1.15)	1.13 (1.11 to 1.15)
Female	1.00	1.00
Maternal age		
<20 years	1.55 (1.50 to 1.60)	1.28 (1.24 to 1.33)
20–24 years	1.16 (1.13 to 1.19)	1.07 (1.04 to 1.10)
25–29 years	1.00 (0.98 to 1.03)	0.98 (0.95 to 1.00)
30–34 years	1.00	1.00
35+ years	1.23 (1.19 to 1.27)	1.21 (1.17 to 1.25)
Parity		
0	1.47 (1.44 to 1.50)	1.40 (1.37 to 1.43)
1	1.00	1.00
2	0.94 (0.91 to 0.97)	0.94 (0.91 to 0.97)
3	1.02 (0.97 to 1.07)	1.01 (0.96 to 1.05)
4+	1.22 (1.16 to 1.29)	1.14 (1.0 to ,1.21)
Continuous variables	Beta (95% CI)	Beta (95% CI)
Year of birth	1.018 (1.016 to 1.019)	1.016 (1.015 to 1.018)
Deprivation Index decile	1.029 (1.026 to 1.033)	1.022 (1.019 to 1.026)

Figure 2 summarises changes in preterm birth rates by Deprivation Index decile between 1980 and 1999. During this period rates of preterm birth rose from 5.6% to 5.9% among those living in the most deprived areas (a 5.4% increase), from 4.3% to 5.9% among those living in average areas (a 37.2% increase) and from 3.2% to 5.5% among those living in the least deprived areas (a 71.9% increase). Thus while in 1980 a marked social gradient in preterm birth existed, by 1999 this had virtually disappeared.

Table 2 shows odds ratios for preterm birth by Deprivation Index decile for the years 1980, 1990, and 1999. These odds

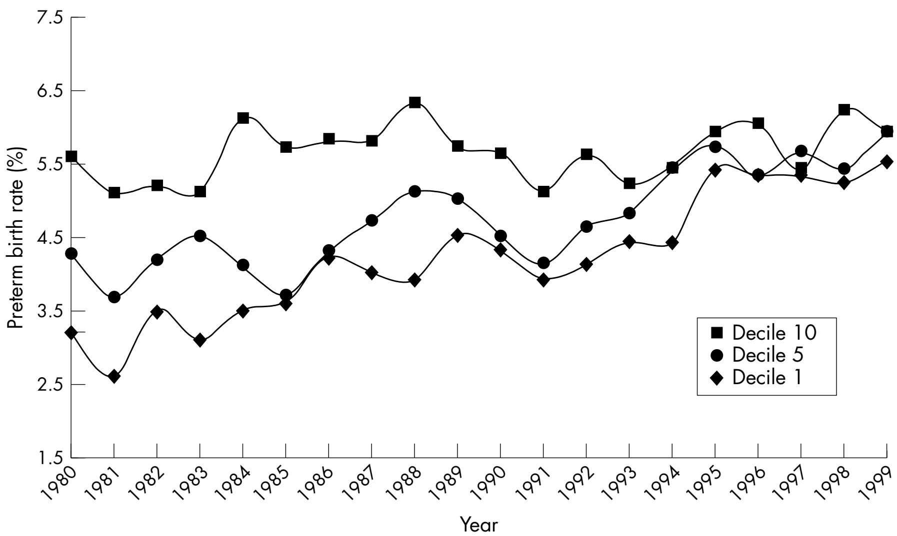

Figure 2 Rates of preterm birth by Deprivation Index; New Zealand singleton live births 1980–99.

Table 2 Multivariate odds ratios for preterm birth by gestational age category and Deprivation Index decile; New Zealand singleton live births 1980, 1990, and 1999

		Gestational age category			
Year	NZDep decile	All preterm OR*	20–28 wk** (n=2693) OR*	29–32 wk (n=12669) OR*	33–36 wk (n=36266) OR*
1980	1	1.00	1.00	1.00	1.00
1980	5	1.26	1.12	1.25	1.19
1980	10	1.67	1.28	1.66	1.48
1990	1	1.19	1.58	1.19	1.17
1990	5	1.43	1.82	1.42	1.32
1990	10	1.79	2.17	1.76	1.55
1999	1	1.40	2.39	1.40	1.34
1999	5	1.61	2.83	1.58	1.45
1999	10	1.91	3.48	1.85	1.60

Multivariate analysis adjusted for gender, maternal age, parity, birth year, decile and birth year*decile, year*age, year*parity, decile*age, decile*parity.
*Odds ratio with reference category Deprivation Index decile 1, 1980.
*Odds ratios for the 20–28 week category did not reach statistical significance.

ratios are derived from multivariate modelling and include interaction terms that adjust for differences in maternal age, parity, and Deprivation Index decile over the 20 year period, as well as terms that adjust for differences in maternal age and parity by decile of deprivation. Such corrections were necessary as age distribution by Deprivation Index decile changed markedly during the study period, with teenage pregnancies among decile 10 mothers falling from 20.3% in 1980 to 12.9% in 1999, while for decile 1 mothers births in the 35+ age group rose from 4.7% in 1980 to 18.4% in 1999. Odds ratios for each gestational age group category thus compare risk of preterm birth with the lowest risk group, that of decile 1 women in 1980. As this table demonstrates, risk of preterm birth increased most dramatically over the study period among those born at less than 28 weeks gestation, although the numbers in this category were small and the differences did not reach statistical significance. Significant but smaller increases in risk were seen for the other gestational age categories.

Table 3 is derived from the adjusted multivariate odds ratios calculated in table 2 and reflects the risk of preterm birth for decile 10 mothers, as compared to decile 1 mothers within each year. It is thus an approximation of the social gradient in preterm birth for that year. For births prior to 28 weeks gestation there was a modest, non-statistically significant increase in the social gradient over time, with those in decile 10 experiencing higher risks of preterm births in 1999 than they did in 1980. As gestational age increased over 28 weeks, however, this social gradient began to disappear. Thus for births in the 33–36 week category, the 48% additional risk experienced by decile 10 women in 1980 was reduced to 19% by 1999.

Figure 3 summarises changes in preterm birth rates by baby's ethnic group between 1980 and 1994. As mentioned previously, changes in the definitions of ethnicity in 1995 make data before and after this year incomparable and thus ethnicity is not included in final models for the full dataset. During this period preterm birth rates among Maori and Pacific Islander infants both fell by 4.7%, from 6.4% to 6.1% for Maori and from 4.2% to 4.0% for Pacific infants. In contrast, rates among the "other" ethnic group rose by 27.5%, from 4.0% in 1980 to 5.1% in 1994.

At univariate level, Maori infants were more likely to be delivered preterm than infants from "other" ethnic groups (OR 1.44; 95% CI: 1.40 to 1.48). This decreased slightly but remained significant in the multivariate model (OR 1.29; 95% CI: 1.26 to 1.33). Pacific infants showed no difference in risk compared to infants from "other" ethnic groups at the univariate level (OR 1.02; 95% CI: 0.98 to 1.06) but this became slightly protective in multivariate modelling (OR 0.95; 95% CI: 0.91 to 0.99).

Finally during this period, stillbirth rates for those 28 weeks gestation and over fell by 54%, from 0.63% in 1980 to 0.29% in 1999, with the most rapid declines occurring between 1980 and 1993. Thereafter stillbirth rates remained relatively static.

Table 3 The "social gradient in preterm birth"; risk of preterm birth among decile 10 women compared to decile 1 women (same year), New Zealand singleton live births 1980, 1990, and 1999

		Gestational age category		
Year	All preterm OR*	20–28 wk** (n=2693) OR*	29–32 wk (n=12669) OR*	33–36 wk (n=36266) OR*
1980	1.67	1.28	1.66	1.48
1990	1.50	1.37	1.47	1.32
1999	1.37	1.46	1.32	1.19

Multivariate analysis adjusted for gender, maternal age, parity, birth year, decile, and birth year*decile, year*age, year*parity, decile*age, decile*parity.
*Odds ratios for preterm birth among decile 10 women compared to those in decile 1 for each particular year reflects to social gradient for that year.
**Odds ratios for the 20–28 week category did not reach statistical significance.

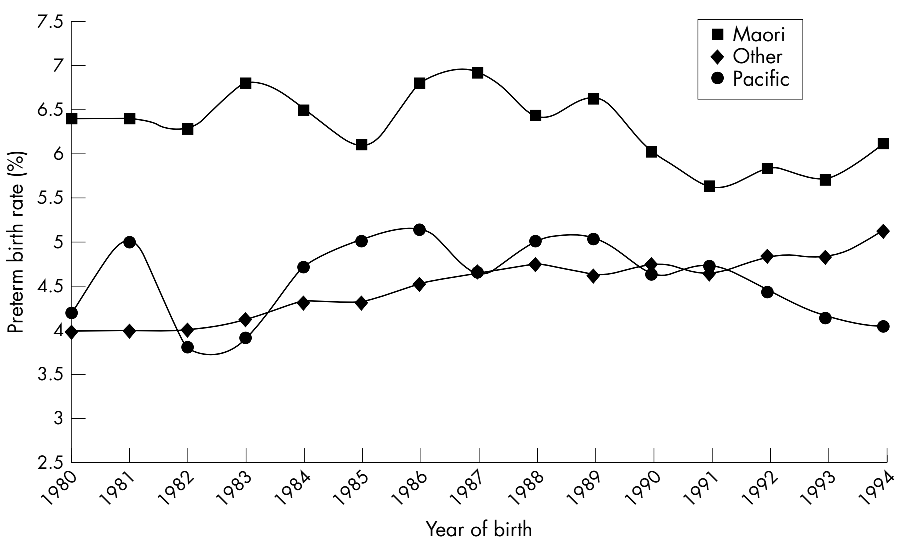

Figure 3 Rates of preterm birth by ethnic group; New Zealand singleton live births 1980–94.

DISCUSSION

In New Zealand during the period 1980 to 1999 rates of singleton preterm birth rose from 4.3% to 5.9%, with the largest absolute increases occurring among infants born after 32 weeks gestation. This rise is higher than that reported by many other developed countries and appears to be confined to specific socioeconomic and ethnic subsections of the New Zealand population.

A number of possible explanations have been put forward for the apparent rise in preterm births that has occurred in some other developed countries over the past two decades.[2] One possibility is an increasing reliance on ultrasound dating of pregnancy, rather than the traditionally used LMP. Ultrasound dating has been shown in a number of studies to reduce the estimated duration of pregnancy by several days and as a consequence to increase the rates of preterm birth in the populations studied.[7] Whether this was responsible for the rise in preterm birth rates seen in New Zealand during the 1990s is debatable, as ultrasound scanning had become routine in many New Zealand hospitals by the late 1980s. Bange and Gendall,[8] in a records based study at Waikato Hospital in 1984, noted that 92.6% of all antenatal patients over a six month period had undergone at least one ultrasound scan, with 86.2% of patients being scanned prior to 26 weeks gestation. A similar study in Dunedin during 1988–89 documented an antenatal scanning rate of 74%.[9] While small increases in antenatal scan uptake over the next decade may have continued to influence preterm birth rates, it is questionable whether this would have been of sufficient magnitude to account for the majority of the change seen during this period.

Similarly changes in birth registrations and the age of viability may have influenced preterm birth rates at earlier gestations. In 1995 changes in legislation altered stillbirth notification requirements, with the traditional gestational age of 28 weeks being reduced to 20 weeks. Thus live born infants who at very early gestations may have been considered non-viable, after 1995 legally required assignment to a live or stillbirth category. The two- to threefold increase in preterm birth rates seen among infants in the <29 weeks category possibly reflects this transition, although no marked increases were evident among this group during 1995. Changes in birth registration, however, are unable to explain the marked rise in preterm birth rates among infants born after 28 weeks, who in absolute terms make the largest contribution to the increases seen in New Zealand over the past two decades.

In addition increased obstetric surveillance, as shown by the marked decline in stillbirth rates during the period 1980–99, may have increased preterm birth rates among those previously at risk of delivering a stillborn infant. During this period stillbirth rates fell from 0.63% to 0.29%, with the most rapid declines occurring between 1980 and 1993. In contrast rates of preterm birth rose from 4.3% to 5.9% during the same period, with the most rapid rises occurring after 1990. Unfortunately, the numbers of stillbirths averted cannot be assumed to have a one-to-one correlation with the number of additional indicated preterm deliveries occurring during this period, as several infants may have had to be delivered early to avert a single in utero death. Thus the impact of increased obstetric intervention during this period, while probably considerable, is difficult to quantify using the data available.

Another possible cause of increasing preterm birth rates is assisted conception, which has been shown to increase the risk of preterm births among women becoming pregnant by this means. While little information is available on the total numbers of assisted conceptions in New Zealand over the past 20 years, deliveries resulting from IVF/GIFT rose from 160 in 1994 to 274 in 1997,[10] with preterm birth rates among singletons ranging from 12.5% for GIFT pregnancies to 12.7% for IVF pregnancies.[10] In absolute terms these two procedures probably account for a total 35 additional preterm births per year or an increase in rate of 0.07%. The contribution other forms of infertility treatment made to preterm birth rates, however, may be somewhat higher.

While each of these factors may have made a small but significant contribution to the changing preterm birth rates over the past 20 years, they are unable to adequately explain the marked rises seen among the more affluent sections of the population. While in 1980 socioeconomic gradients in preterm birth were similar to those reported in other developed countries,[11 12] by 1999 virtually no socioeconomic gradient in preterm birth existed in New Zealand. As table 3 shows, it is births among infants over 28 weeks gestation that account for the bulk of this change, with social gradients among those born under 28 weeks moving in the opposite direction. This paradox is biologically plausible, as a number of studies have suggested that the role of infection in preterm birth is inversely related to gestational age. Notably, preterm births between 34 and 36 weeks gestation are rarely associated with infection, while those less than 30 weeks gestation typically have an infectious origin.[13] Persisting social gradients in preterm birth at very early gestations could thus be possibly explained by an ongoing social gradient in genital tract infection.[14] The loss of a social gradient at later gestations, however, while being partially explained by changes in maternal age and parity, suggests another aetiology.

Known risk factors that could possibly account for changes in preterm birth rates at later gestations include maternal smoking, low prepregnancy weight, stress, anxiety, and maternal workload.[15] In New Zealand over the past two decades smoking rates among women 15–34 years have shown a modest decline, from 36% at the 1981 census to 28% by 1996.[16] Whether such figures reflect smoking patterns during pregnancy, however, is uncertain. Similarly little information is available on changes in prepregnancy weight during this period, although the 1997 National Nutrition Survey indicated that rates of obesity among females had risen from 13% in 1989–90, to 19% in 1997, with obesity among women of reproductive age in 1997 being in the order of 17%.[17] Thus it is unclear whether changes in the prevalence these two risk factors could have contributed to the rise in preterm births seen during this period.

Women's participation in the workforce is another potential explanation for the loss of social gradient among higher gestation preterm births. Kelsey,[18] when commenting on the impact of a period of promarket reform that began in New Zealand in the mid 1980s, noted that during this period a fall in real wages placed pressure on all adult members of households to join the workforce, especially part time and that employment tended to cluster around households who already had jobs. Whether this significantly increased women's workforce participation is difficult to determine, as baseline trends in New Zealand have shown a steady increase from 47.2% in 1981 to 57.9% in 1996,[19] in keeping with international trends.[20] In addition, number of hours worked increased markedly, with the period 1994 to 1999 seeing a 29.2% increase in women working 45–49 hours per week and a 28% increase in women working 50 hours or more.[19] Whether such changes impacted significantly on rates of preterm birth, either directly or via their effects on perceived stress, is difficult to determine, although several studies have shown strong associations between the number of hours worked and preterm delivery, especially among nulliparous women.[21 22]

Thus while a number of possible explanations exist for New Zealand's increasing preterm birth rates over the past 20 years, none alone is sufficient to account for the magnitude of change seen. In addition, data limitations prevent the differentiation of preterm birth into its iatrogenic and idiopathic subcategories, making it difficult to assess the impact of obstetric intervention during this period. Thus further research is necessary if the apparent increases in preterm birth over the past 20 years are to be fully understood. Similarly, reviews from other developed countries may be necessary to determine whether these findings are restricted to New Zealand or an emerging international trend.

ACKNOWLEDGEMENTS

Dr ED Craig is currently funded by a Training Fellowship from the Health Research Council of New Zealand. Dr JMD Thompson is currently funded by a Child Health Research Foundation Rotary Research Fellowship.

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