Trends in Low Birth Weight Infants and Changes in Baltimore's Childbearing Population, 1972-77

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PROPONENTS OF FAMILY PLANNING programs argued in the 1960s that fertility declines resulting from widespread adoption of family planning methods would reduce the level of infant mortality and other poor outcomes of pregnancy in the United States. Declines in infant mortality because of shifts in the maternal age and the parity distribution of births were documented for the late 1960s and early 1970s (*1,2*). Despite this earlier, favorable impact of declining fertility, the sustained low fertility levels of the 1970 decade are associated with shifts in the composition of the childbearing population that may reverse or impede further declines in poor outcomes of pregnancy. For example, fertility changes during the mid-1970s included a rise in the proportion of births to teenage mothers (*3*), increasing postponement of first births to later ages (*4*), greater use of induced abortion (*5,6*), and increases in births to unmarried women of all ages (*7*). Since each change gives more weight to groups in the childbearing population at high risk for poor pregnancy outcomes, all other things being equal, infant mortality and morbidity would be expected to rise.

This report is an investigation of the effect of shifts in the characteristics of the childbearing population on trends in low birth weight (LBW) rates in Baltimore City between 1972 and 1977. The relationship of the trends in LBW rates to neonatal mortality is also examined. Unlike neonatal and infant mortality, LBW rates have remained relatively constant in the United States during the mid-1970s (*8,9*) and have actually risen in Baltimore City. Despite recent increases in the survivorship of LBW infants (*9,10*), subsequent morbidity is high for the small neonate (*11*). Consequently, better survivorship of LBW infants may result in greater prevalence of child health problems (*12*).

Trends in LBW rates were investigated in relation to shifts in five characteristics of women giving birth in Baltimore: age, education, gravidity (number of pregnancies), prior pregnancy losses, and marital status. All five have been associated with LBW in previous cross-sectional studies. A J-shaped relationship is commonly reported between LBW rates and maternal age (*13–16*) and birth order (*13,16*). LBW rates vary inversely with maternal education (*17,18*) and directly with prior pregnancy losses (*19–21*). Regardless of age, unmarried women, as compared with married women, are more likely to deliver LBW infants (*7,13*).

Methods

Linked birth and infant death certificates provided a study population of 25,624 single white and 44,011 single nonwhite live births (nearly all nonwhite births are of black infants) to residents of Baltimore City between 1972 and 1977. The 6-year period was chosen because 1972 marked the end of a downward trend in LBW and neonatal mortality rates in the city, and 1977 is the last year for which complete linked records were available for the study.

Yearly trends were investigated for three weight groups: the number of infants weighing 1,500 gm or less, 2,000 gm or less, and 2,500 gm or less in a given year per 1,000 live births in the same year. While these LBW rates are not independent, it would be arbitrary to choose a cut-off for LBW to study trends. LBW rates that included fetal deaths were also examined to insure that changes in reporting fetal deaths and live births did not account for LBW changes among live born infants.

Of the five maternal variables, gravidity and prior pregnancy losses could not be measured for 1972 because of a reporting change on the birth certificate. Beginning in 1973, the history of previous pregnancies was redefined on the birth certificate from "the number

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of stillbirths of 20 weeks or greater gestation" to "the number of pregnancies not ending in a live birth." This new definition includes induced and spontaneous abortions as well as stillbirths. The inferential method (*7*) was used to measure marital status by comparing the surnames of the baby, mother, and father on the certificate.

Analysis of the vital records data involved several steps. In the first, trends in each LBW rate were analyzed with the variance test for homogeneity of the binomial distribution and the test for a linear trend in proportions (*22,23*). The chi-square value obtained in the test for homogeneity of the binomial represents the total variance in the LBW rate over the study period. In the test for a linear trend, this chi-square value is partitioned into a chi-square for the slope of the regression of the LBW rate on the year of birth and a chi-square for the linear fit of the data. This test for linear fit provides greater sensitivity than the test for homogeneity when there is some intrinsic ordering in the data (*23*). It was used primarily to determine an increasing or decreasing trend in the rates; the test for a linear fit is secondary to this trend. The conventional significance level of 0.05 was chosen for each test.

In the second step of the analysis, birth weight specific neonatal mortality rates were examined, and direct standardization of the birth weight distribution (with 1972 as the standard population) was employed to determine the impact of birth weight changes on neonatal mortality; a standardized neonatal mortality rate was computed for each study year based on the 1972 birth weight distribution.

In the third step of the analysis, the distribution of each maternal characteristic was compared by year to investigate changes in the composition of the childbearing population. In the final step, the effect of shifts in the characteristics of the childbearing population on LBW rates was analyzed, using direct standardization for distributional changes in each characteristic. The 1972 distribution provided the standard for maternal age, education, and marital status; 1973, the standard for gravidity and prior pregnancy losses. For example, in the standardization for marital status, the proportion of births to married and to unmarried women was held constant at the 1972 proportions for each subsequent year, and the standardized LBW rate was computed, using the prevailing yearly marital-specific LBW rates.

Results

Low birth weight trends. The results of the yearly trend analysis for the 1,500 gm, 2,000 gm, and 2,500 gm rates between 1972 and 1977 are given in table 1. For each year, the rates were considerably greater for nonwhites than for whites. The variance test for homogeneity of the binomal distribution and the test for a linear trend in proportions indicated a significant trend in the 1,500 gm and 2,000 gm rates for both races. Although the rates fluctuated for whites, the test for a linear trend smooths these fluctuations so that the increase in the two rates between 1972 and 1977 becomes apparent. The yearly increment is 0.97 white infants per 1,000 live births for the 1,500 gm rate and 1.30 for the 2,000 gm rate. Among nonwhites, the trend was more consistent and dramatic. The yearly increases for these two birth weight groups were 1.94 and 2.13 LBW infants per 1,000 live births. The deviations from a linear fit were small for the nonwhite 1,500 and 2,000 gm rates; despite fluctuations, they were also small for the white 1,500 gm rate, primarily because of the low rate in 1972 and the high one in 1977 relative to the other years. The slope of the regression of the 2,500 gm rate on year of birth is significant only for nonwhite infants.

For both races, the trends were similar, regardless of whether live births were analyzed alone or fetal deaths were included. Since reporting errors may be large for fetal deaths (*7*) and birth weight data were less complete for fetal deaths than for live births over the study period, only live births were used in subsequent analyses. It should be noted that increases in LBW infants over the study period occurred predominantly in the group weighing 1,500 gm or less. Although standardization of the 1,500 gm rate could be performed for changes in each maternal characteristic separately, the number of infants weighing 1,500 gm or less in each year was too small for more detailed analysis. Accordingly, standardization for each characteristic within subgroups of a second variable is reported only for the 2,000 gm rate. This procedure insured adequate numbers of LBW infants for standardization of the rate as well as for investigation of a significant trend. Indirect standardization is frequently used when numerators are small. In the present study, this approach was inappropriate, since indirect standardized rates could not be compared over years; also, differences in population composition may not be completely adjusted in indirect standardization (*23*).

Birth weight specific neonatal mortality rates fell for all birth weight and race categories between 1972 and 1977 except for white infants weighing between 1,501 and 2,500 gm (an increase occurred for 2,001–2,500 gm infants, a group with very small numbers of deaths in each year); the drop in mortality was especially pronounced among infants weighing between 1,001

Table 1. Low birth weight rates per 1,000 live births and rates for live births and fetal deaths combined, by year and race, Baltimore City, 1972–77

Birth weight	*Rates per 1,000 live births* 1972	1973	1974	1975	1976	1977	[1] *Slope*	*S.D.*
				Live births, whites				
1,500 gm	6.6	10.5	8.4	11.7	8.8	13.6	0.974	[2] 0.354
2,000 gm	17.0	23.8	18.8	26.1	20.2	26.5	1.303	[3] 0.525
2,500 gm	62.5	73.5	66.1	68.9	61.2	71.3	0.388	0.899
Total births	*5,133*	*4,462*	*4,040*	*4,093*	*3,859*	*4,037*	...	...
				Live births and fetal deaths, whites				
1,500 gm	11.2	14.7	14.2	16.2	12.8	17.7	0.871	[3] 0.425
2,000 gm	23.7	28.9	25.9	31.7	24.4	31.9	1.010	0.586
2,500 gm	63.4	79.1	73.5	74.6	66.5	77.3	1.128	0.948
Total births	*5,188*	*4,502*	*4,088*	*4,131*	*3,894*	*4,074*	...	...
				Live births, nonwhites				
1,500 gm	18.6	17.6	21.2	24.2	25.8	26.7	1.939	[4] 0.405
2,000 gm	42.6	41.7	49.5	49.5	48.9	53.1	2.132	[4] 0.584
2,500 gm	126.2	128.3	133.6	134.6	133.3	135.8	1.846	[3] 0.929
Total births	*7,874*	*7,319*	*7,027*	*7,068*	*7,095*	*7,628*	...	...
				Live births and fetal deaths, nonwhites				
1,500 gm	29.2	27.3	29.3	32.1	32.7	34.6	1.302	[2] 0.471
2,000 gm	54.8	52.9	59.2	58.2	57.0	62.5	1.426	[3] 0.633
2,500 gm	139.0	139.9	142.8	143.4	141.7	145.8	1.155	0.950
Total births	*8,023*	*7,432*	*7,128*	*7,155*	*7,190*	*7,745*	...	...

[1] Slopes are the yearly rate of change in the LBW rates per 1,000 births. [2] $P < 0.01$. [3] $P < 0.05$. [4] $P < 0.001$.

and 1,500 gm (table 2). Despite declines within birth weight groups, overall neonatal mortality rates rose slightly for both races over the study period. Direct standardization, using the 1972 birth weight distribution as the standard, yields neonatal mortality rates less than the observed rates in all subsequent years except 1973 for nonwhites. In fact, neonatal mortality rates would have declined for both races if LBW rates had not risen.

Maternal characteristics. To give a first approximation of the impact of a changing childbearing population on LBW rates, the distributions by year according to maternal age group, education, gravidity, prior pregnancy losses, and marital status are presented in table 3 for white births and in table 4 for nonwhite births. These tables also provide 2,000 gm rates for the study period for each maternal characteristic. The LBW rates vary significantly for all variables with one exception—gravidity for nonwhites. Within each category of each maternal variable, the rates are higher for nonwhites than for whites.

Some shifts are apparent in the distribution of each characteristic of women delivering a live infant in Baltimore over the study period, but they are greatest for marital status and prior pregnancy losses. Between 1972 and 1977, the percentage of births to unmarried women rose substantially, from 10.4 to 17.7 percent among whites and from 60.1 to 70.4 percent among nonwhites. In addition, the percentage of births to women with at least one prior pregnancy loss increased for both races, but the increase was much greater among nonwhites. Births to women with one such loss increased from 9.5 to 12.2 percent among whites between 1973 and 1977 and from 12.1 to 22.0 percent among nonwhites; births to women with two or more prior losses rose from 2.5 to 3.9 percent among whites and from 2.8 to 7.3 among nonwhites.

Minor fluctuations in the distribution of births by maternal age between 1972 and 1977 included a rise in the percentage of births to white women aged 30–34 years. Among nonwhites, there was an increase in births to 20–29-year-old women and a decline for teenage mothers. The childbearing population was slightly more educated in 1977 than in 1972 for both races. Gravidity changes were small among whites; they included a slight rise in births to women of gravidity two. Among nonwhites, the combined percentage of women of gravidity two, three, and four or more rose by about 6 percentage points between 1973 and 1977. These gravidity changes among nonwhites reflect the greater

Table 2. Birth weight specific neonatal mortality rates (NMR), total neonatal deaths, and NMRs standardized for the 1972 birth weight distribution, by race, Baltimore City 1972–77

	Rate per 1,000					
Birth weight	*1972*	*1973*	*1974*	*1975*	*1976*	*1977*
White births						
1,000 gm or less	909.1	736.8	944.4	913.0	785.7	760.7
1,001–1,500 gm	391.3	250.0	187.5	320.0	200.0	166.7
1,501–2,500 gm	24.4	46.3	42.9	38.5	59.4	51.5
2,501 gm or more	3.9	2.9	2.6	2.6	2.6	2.4
Neonatal deaths	*45*	*46*	*40*	*48*	*37*	*45*
Total NMR	8.8	10.3	9.9	11.7	9.6	11.1
Standardized NMR	8.8	7.8	7.8	8.0	8.4	7.3
Nonwhite births						
1,000 gm or less	836.1	761.9	700.0	868.4	730.4	742.3
1,001–1,500 gm	352.9	321.8	236.0	189.5	313.3	158.9
1,501–2,500 gm	20.1	22.2	29.1	19.2	19.7	9.6
2,501 gm or more	4.4	4.4	3.6	3.1	3.9	3.6
Neonatal deaths	*121*	*106*	*108*	*118*	*138*	*121*
Total NMR	15.4	14.5	15.4	16.7	19.4	15.9
Standardized NMR	15.4	15.6	14.1	13.5	14.6	11.6

Table 3. Percentage distribution of live births to whites by year and 2,000 gm rates (per 1,000 births) by maternal characteristics of age, education, gravidity, prior pregnancy losses, and marital status, Baltimore City, 1972–77

Maternal characteristics [1]	*1972*	*1973*	*1974*	*1975*	*1976*	*1977*	*2,000 gm rate*
Age group (years)							
19 or under	20.63	20.21	21.46	20.67	20.86	19.72	33.93
20–24	36.74	35.19	33.89	33.35	35.24	34.65	20.67
25–29	28.60	29.92	30.37	30.78	29.39	29.60	15.36
30–34	9.78	10.96	10.57	11.41	11.38	12.61	20.89 (30–34 and 35 or more)
35 or more	4.25	3.72	3.71	3.79	3.14	3.42	
Total number	*5,133*	*4,462*	*4,040*	*4,093*	*3,859*	*4,037*	*560*
Education							
9 years or less	20.61	20.78	20.31	20.67	20.39	19.92	27.97
10–11 years	22.49	21.80	20.46	20.99	19.67	19.47	27.74
12 years	37.29	38.42	38.75	37.09	38.15	37.95	18.13
Some college	9.54	9.42	9.62	9.17	9.70	10.19	13.82 (Some college and 4 years or more of college)
4 years or more of college	10.07	9.58	10.86	12.08	12.07	12.48	
Total number	*5,093*	*4,404*	*3,959*	*3,982*	*3,761*	*3,966*	*535*
Gravidity							
One	N.A.	41.98	42.85	40.82	42.72	41.81	26.04
Two	N.A.	30.92	30.91	32.06	32.68	32.89	21.62
Three	N.A.	14.14	13.43	14.68	13.34	14.70	17.02
Four or more	N.A.	12.95	12.80	12.43	11.27	10.60	23.94
Total number	N.A.	*5,127*	*4,454*	*4,037*	*4,086*	*4,035*	*473*
Prior pregnancy losses							
None	N.A.	87.93	84.97	83.73	83.33	83.87	21.47
One	N.A.	9.53	11.59	12.19	12.94	12.24	31.03
Two or more	N.A.	2.53	3.44	4.08	3.73	3.89	36.11
Total number	N.A.	*4,458*	*4,039*	*4,093*	*3,856*	*4,037*	*473*
Marital status							
Unmarried	10.40	11.39	12.85	14.93	16.92	17.67	40.43
Married	89.60	88.61	87.15	85.07	83.08	82.33	18.89
Total number	*5,133*	*4,459*	*4,039*	*3,853*	*3,853*	*4,035*	*560*

[1] Unknowns for each maternal characteristic are omitted from table; therefore column totals vary accordingly.
NOTE: NA = not applicable.

Table 4. Percentage distribution of live births to nonwhites by year and 2,000 gm rates (per 1,000 births) by maternal characteristics of age, education, gravidity, prior pregnancy losses, and marital status, Baltimore City, 1972–77

Maternal characteristics [1]	*1972*	*1973*	*1974*	*1975*	*1976*	*1977*	*2,000 gm rate*
Age group (years)							
19 or under	38.62	39.16	38.04	37.42	36.28	35.16	54.33
20–24	34.89	34.51	35.38	34.96	35.48	35.64	44.94
25–29	15.11	15.96	17.13	18.00	18.99	19.40	38.82
30–34	7.45	7.32	6.43	6.81	6.69	6.76	46.94
35 or more	3.92	3.05	3.12	2.82	2.57	3.03	
Total number	*7,874*	*7,319*	*7,027*	*7,068*	*7,095*	*7,628*	*2,090*
Education							
9 years or less	20.98	21.21	19.51	19.01	18.24	17.11	52.67
10–11 years	33.53	32.40	31.42	31.09	30.64	29.35	49.05
12 years	35.57	35.05	38.10	37.94	38.41	38.65	42.73
Some college	6.57	7.44	7.20	8.06	8.89	10.40	38.69
4 years or more of college	3.35	3.81	3.78	3.91	3.83	4.50	
Total number	*7,764*	*7,182*	*6,834*	*6,780*	*6,887*	*7,405*	*1,978*
Gravidity							
One	N.A.	43.41	41.46	40.96	38.00	37.03	45.65
Two	N.A.	26.97	28.11	28.06	29.11	29.00	51.09
Three	N.A.	13.61	14.39	15.26	15.96	16.57	49.41
Four or more	N.A.	16.00	16.02	15.72	16.93	17.42	50.56
Total number	N.A.	*7,274*	*7,004*	*7,027*	*7,093*	*7,624*	*1,754*
Prior pregnancy losses							
None	N.A.	85.09	80.17	75.96	73.63	70.70	42.80
One	N.A.	12.09	16.05	18.75	20.28	21.98	62.02
Two or more	N.A.	2.83	3.77	5.29	6.09	7.32	88.83
Total number	N.A.	*7,315*	*7,021*	*7,067*	*7,095*	*7,624*	*1,754*
Marital status							
Unmarried	60.14	61.97	64.01	65.84	68.05	70.42	53.13
Married	39.86	38.33	35.99	34.16	31.95	29.58	36.99
Total number	*7,875*	*7,315*	*7,021*	*7,064*	*7,092*	*7,624*	*2,089*

[1] Unknowns for each maternal characteristic are omitted from table; therefore column totals vary accordingly.
NOTE: NA = not applicable.

shifts in the distribution of births by prior pregnancy losses.

When the composition of the population of women delivering live infants in Baltimore City is standardized over the study period for the five maternal variables, only the distributional shifts for marital status and prior pregnancy losses affect the LBW rate. Figures 1 and 2 include the unstandardized white and nonwhite 1,500 gm and 2,000 gm rates between 1972 and 1977 and rates standardized on the marital status and prior pregnancy loss distributions. They also contain rates standardized jointly for marital status and prior pregnancy losses; standardization involved holding the frequency of births to unmarried and married women within prior pregnancy loss groups constant over the study period at the 1973 level.

For both races, the slope of the line estimated from the test for a trend in proportions declines when the 1,500 and 2,000 gm rates are standardized over the study period on the distributions of marital status, prior pregnancy losses, and the joint distribution of the two variables; the declines are greatest for the third standardization. Among whites, for both the 1,500 and 2,000 gm rates, the slope is statistically significant for the unstandardized and standardized rates between 1972 and 1977, with the exception of the rates standardized on the joint distribution of marital status and prior pregnancy losses. The slope of the unstandardized 1,500 gm rate is 0.974 (S.D. = 0.354) and 0.646 (S.D. = 0.344) for the rate standardized on the joint distribution of the two variables; the respective slopes for the 2,000 gm rate are 1.303 (S.D. = 0.525) and 0.889 (S.D. = 0.515) LBW infants per 1,000 live births per year. When the joint distribution of marital status and prior pregnancy losses is held constant for nonwhites over the study period, the trend in the 2,000 gm rate is not statistically significant, but it remains significant for the 1,500 gm rate. The respective slopes for the 1,500 gm and 2,000 gm LBW rates are 1.940 (S.D. = 0.405) and 2.132 (S.D. = 0.584) for the unstandardized rates and 1.284 (S.D. = 0.392) and 1.050 (S.D. = 0.569) for the rates standardized simultane-

Figure 1. Unstandardized and standardized rates for 1,500 gm births, by year of the birth and race, Baltimore City, 1972–77

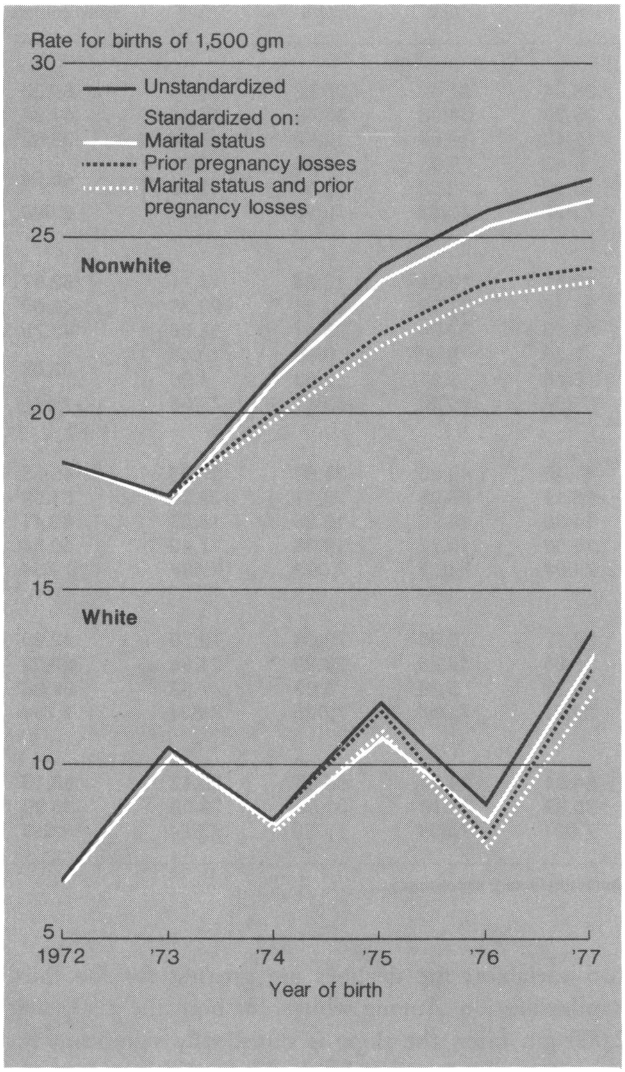
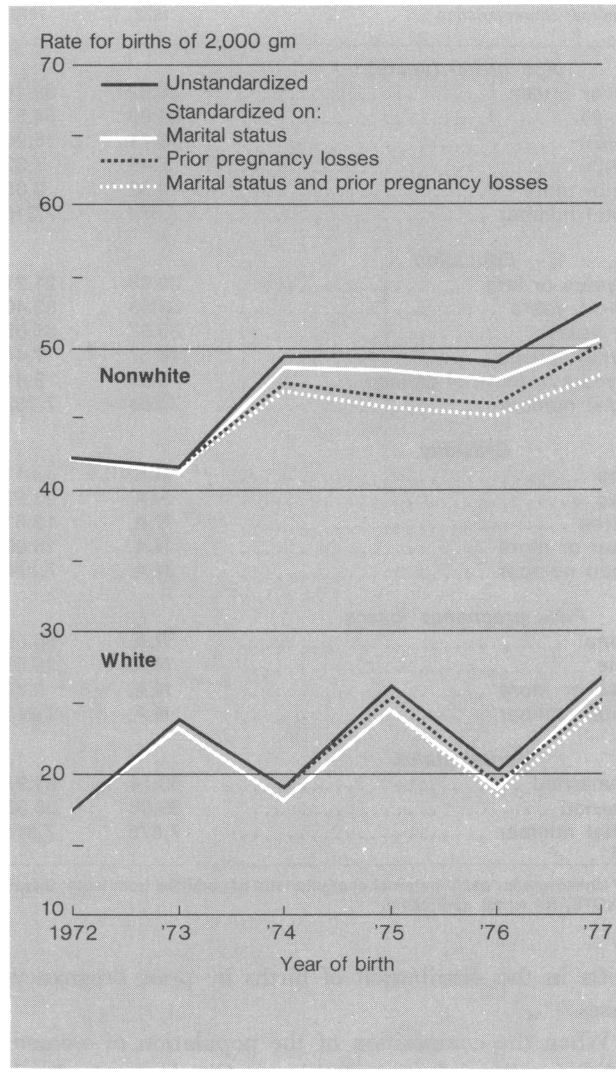


Figure 2. Unstandardized and standardized rates for 2,000 gm births, by year of the birth and race, Baltimore City, 1972–77

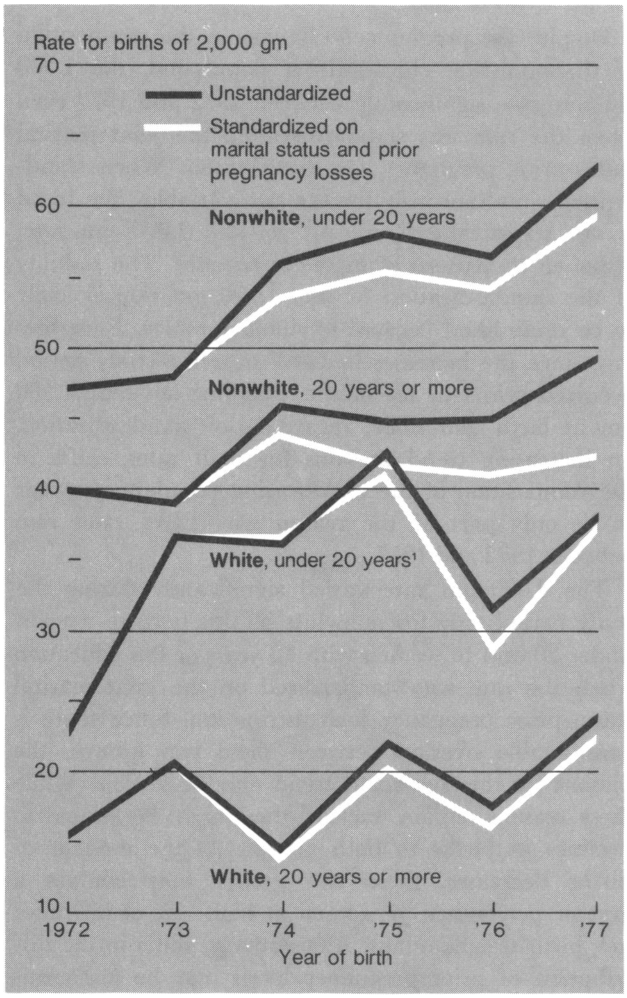


ously for marital status and prior pregnancy losses. It should be noted that, regardless of statistical significance, all slopes are greater than zero.

A pattern similar to that for the entire study population emerges when trends in the 2,000 gm rate are investigated within maternal age (fig. 3), education (fig. 4), and gravidity (fig. 5) groups. Unstandardized LBW rates between 1973 and 1977 are generally greater than rates standardized on the 1972 marital status distribution and the 1973 prior pregnancy loss distribution. The rates are lowest when standardized on the 1973 joint marital status and prior pregnancy loss distribution. Differences between unstandardized and standardized LBW rates increase with the more recent birth years and are greater for nonwhites than for whites. For the sake of simplicity, figures 3–4 contain only the unstandardized rates and rates standardized on the joint marital status-prior pregnancy loss distribution.

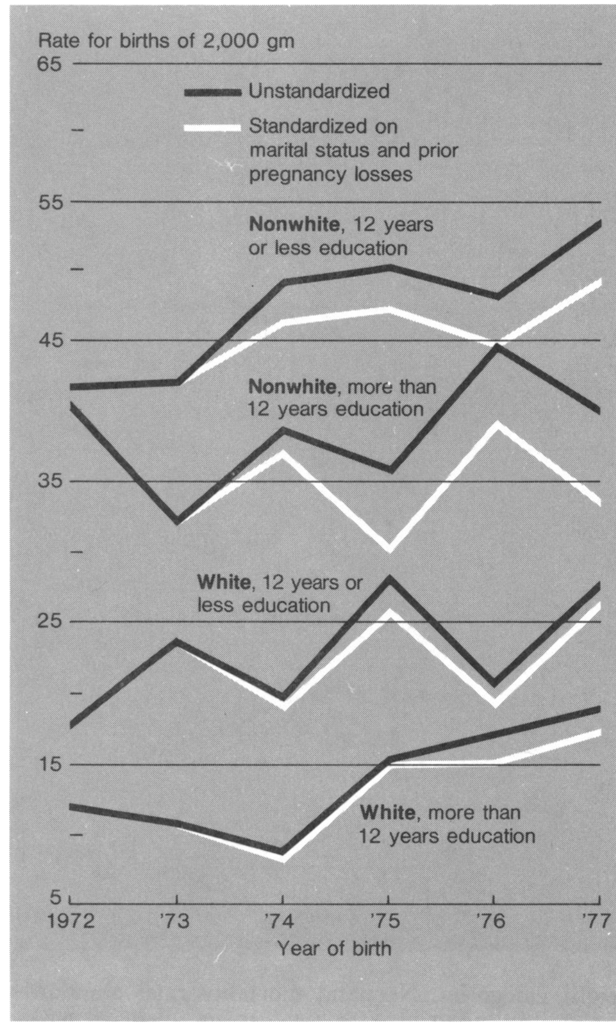
Differences in the unstandardized and standardized rates for 2,000 gm infants are similar within maternal age and education groups for both races. However, the rates vary significantly over the study period for infants born to nonwhite women under 20 years or nonwhites with 12 years or less education, regardless of standardization. For births to nonwhite teenage mothers, the slope of the line estimated for the 2,000 gm rate is 3.040 (S.D. = 1.022) for the unstandardized rate and 2.299 (S.D. = 1.005) for the rate standardized on the joint marital status-prior pregnancy loss distribution. For births to nonwhite women with 12 years or less education, the slopes are 2.284 (S.D. = 0.628) for the unstandardized rate and 1.352 (S.D. = 0.614) for the standardized rate. There were no sig-

Figure 3. Unstandardized and standardized rates for 2,000 gm births to women under 20 years and 20 years or older, by race and year of the birth, Baltimore City, 1972–77



¹ Adjustment for both marital status and prior pregnancy losses could not be performed because of the very small numbers in many cells.

Figure 4. Unstandardized and standardized rates for 2,000 gm births to women with 12 years or less education and more than 12 years education, by race and year of birth, Baltimore City, 1972–77



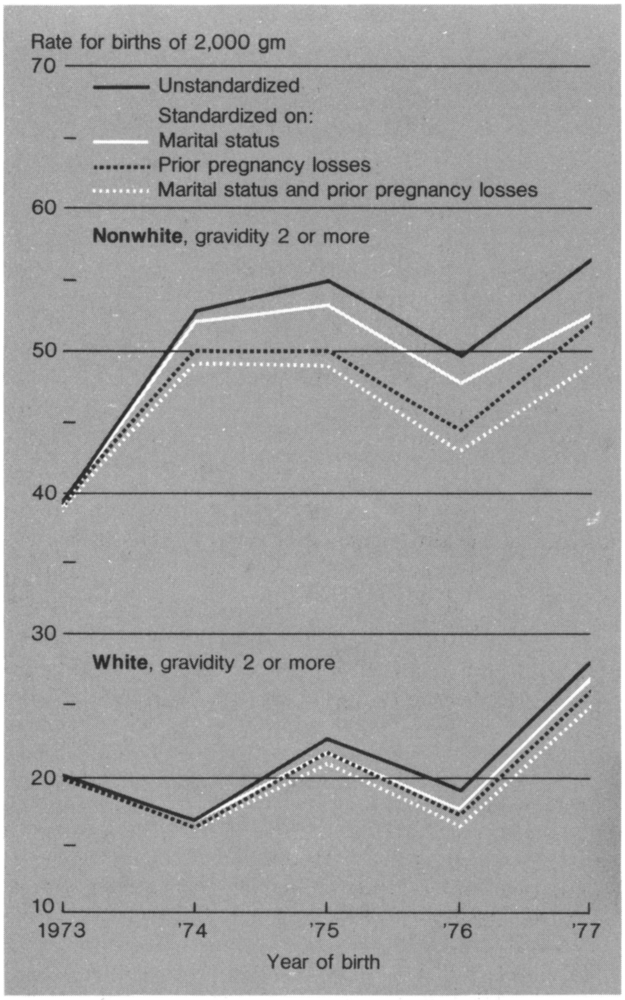
nificant differences in the rates over the study period for infants born to white teenage mothers or infants born to women with more than 12 years of education for either race.

Regardless of standardization, trends in the 2,000 gm rate for births to women experiencing their first pregnancy between 1972 and 1977 are not statistically significant (not plotted in figure 5). For gravidities two or more, standardization on the joint distribution of marital status and prior pregnancy losses has a pronounced effect on LBW rates, especially for nonwhites. The slope for the 2,000 gm rate among white infants is 1.776 (S.D. = 0.921) for the unstandardized rate and 0.999 (S.D. = 0.890) for the rate standardized on the joint distribution of the two variables; among nonwhites, it is 3.201 (S.D. = 1.044) compared with 1.376 (S.D. = 0.996) LBW infants per 1,000 live births per year. For both races, the difference between the slopes for the unstandardized and standardized rates is greater for infants born to women experiencing their second or later pregnancy than for those born to all women during the study period.

Discussion

An analysis of trends in LBW in Baltimore City between 1972 and 1977 indicated a rise in the 1,500 gm and 2,000 gm rates of approximately 1 LBW infant per 1,000 live births per year among whites and 2 per 1,000 live births among nonwhites. In absolute numbers, the rise amounts to an additional 5 white and 15 nonwhite LBW infants per year. These birth weight changes were sufficiently large that they resulted in increases in overall neonatal mortality rates for both races, despite declining neonatal mortality in most birth

Figure 5. Unstandardized and standardized rates for 2,000 gm births to women of gravidity two or more, by race and year of the birth, Baltimore City, 1973–77



weight categories. Neonatal mortality rates standardized for the 1972 birth weight distribution are lower than the actual rates for 1973 to 1977 for whites and those for 1974 to 1977 for nonwhites. The high morbidity rates of LBW infants during the first year of life (*11*) suggest that similar changes could be expected for infant morbidity.

Although the population of women delivering in Baltimore City during the study period became slightly older, slightly more educated, and of higher gravidity, these changes had little impact on the trends in LBW rates. In contrast, a rise in births to unmarried women and to women with at least one prior pregnancy loss was associated with the increase in both the 1,500 and 2,000 gm rates. Nonwhites experienced the greatest increase in births to women with some prior pregnancy loss. For both races, within maternal age and education groups and for women experiencing their second or greater pregnancy, standardization on marital status and on prior pregnancy losses reduces the increase in the 2,000 gm rate over the study period, especially when the standardization is performed simultaneously for the two variables.

Despite the pronounced changes in the composition of the nonwhite child-bearing population, the 1,500 gm rate rose significantly between 1972 and 1977 even when the rate was standardized on the joint marital status-prior pregnancy loss distribution. When standardized simultaneously for the two variables, the trend is not statistically significant for the 2,000 gm rate, although its pattern of increases remains. The stability of the standardization for the 1,500 gm rate is likely to be diminished because of small numbers. Nevertheless, since the increases in LBW over the study period occurred primarily for infants weighing less than 1,500 gm at birth and since, regardless of standardization, an increasing trend remains for both rates, shifts in the composition of the childbearing population appear to be only part of the reason why LBW rates rose between 1972 and 1977.

The 2,000 gm rate varied significantly during the study period only for nonwhite infants born to women under 20 and to women with 12 years or less education when the rate was standardized on the joint marital status-prior pregnancy loss distribution. Since there is considerable overlap between these two groups, the reasons for the significant trend may be similar. While these reasons remain unclear, they might be related to declines in births to both groups. As the number of births decreases, these two groups may contain a greater percentage of women at high risk of having a low birth weight infant. Alternatively, shifts in the distribution of prior pregnancy losses may be underestimated because of reporting errors on the birth certificate. Results of the National Natality Survey (*24*) indicate underreporting of prior fetal losses on the birth certificate as well as less consistent reporting of selected items for young women and for women with less than a high school education.

Although marital status changes between 1972 and 1977 in Baltimore City are compatible with national data (*7*), results for prior pregnancy losses have not been documented elsewhere in the United States. However, based on reports of related events, it seems likely that the distributional shifts in prior pregnancy losses are attributable to increases in births to women with one or more prior induced abortions. For example, induced abortion rates rose in Maryland during the mid-1970s (*6*). Secondly, between 1972 and 1974, these rates were two times greater among black women than white women in the United States. In Baltimore City, there was little change between 1970 and 1972 in the percentage of births to women experiencing a prior stillbirth; this percentage, as reported on the birth certificate before 1973, was 5.7 percent in 1970 compared with 6.3 percent in 1972. Neither a change in this percentage, by extrapolation, nor, by inference, a rise in the percentage of births to women with a prior spontaneous abortion seems to be a likely explanation for the noticable increase in childbearing women with prior losses.

The evidence is mixed concerning the effect of an induced abortion on the weight of a subsequent infant (*25–30*). Maine (*30*) concluded that although study results are ambiguous, there is evidence of risk for future childbearing as a result of a single induced abortion. Although the magnitude of the risk is not established, it appears to be related to abortions performed by dilation and curettage (*27,30*). The work of Oppel and his associates (*31*) suggests an increased risk of delivering a very small infant (1,500 gm or less) following an induced abortion, but only for the third or greater pregnancy. Despite the unclear results for a single induced abortion, a substantial risk is consistently reported for subsequent childbearing following repeat abortions (*30,32*).

A direct link between induced abortions and LBW rates cannot be established in this study. However, Baltimore's closest urban neighbor, the District of Columbia, has experienced similar increases in LBW rates. Like Baltimore, the majority of its births occur to nonwhites and, between 1972 and 1974, its abortion ratio was the highest in the nation, with abortions exceeding live births by close to twofold (*6*).

Alternative explanations for the rise in LBW rates in Baltimore should be considered. One explanation, that the distinction between a live birth and a fetal death had changed, seems unlikely since both the 1,500 and 2,000 gm rates rose for live births and stillbirths combined as well as for live births alone. Furthermore, a change in this distinction (now reporting a live birth which previously would have been a fetal death) should result, for later years, in a higher percentage of neonatal deaths occurring on the first day of life. In fact, this did not occur. Deaths occurring within 24 hours of birth actually dropped. This finding, however, is also compatible with improvements in management of high-risk infants which could shift deaths to a later time.

Changes in medical practices and technology, such as increasing use of cesarean sections and greater success in treating women with fertility problems, may be an additional explanation for increases in LBW rates. This explanation is consistent with results in this study, since LBW rates remained higher in 1977 than in 1972 even when standardization on the distribution of the maternal variables was performed. Just as important, however, are the implications of the findings for health services delivery. The general decline in neonatal mortality rates for infants weighing 1,001 to 2,500 grams is probably attributable to the proliferation of neonatal intensive care units in Baltimore. Prenatal and intrapartum services, on the other hand, may require some modification because of the changing mix of women bearing children. The needs of the unmarried woman as well as the impact of a prior induced abortion on births to women who already are at higher risk for having a low birth weight infant (for example, the young, poorly educated, and nonwhite) must be considered in the delivery of these services.

In light of the results of this study, it seems reasonable to reexamine the premise that continued fertility declines should necessarily reduce the levels of poor pregnancy outcomes in a population. Indeed, in Baltimore City, the shifting composition of the childbearing population associated with changing marital fertility and possible abortion practices suggests that women delivering a birth during the mid-1970s may be bringing a different configuration of problems to childbearing than their counterparts of a previous decade.

References

1. Morris, N. M., Udry, J. R., and Chase, C. L.: Shifting age-parity distribution of births and the decrease in infant mortality. Am J Public Health 65: 359–362, April 1975.

2. Wright, N. H.: Family planning and infant mortality rate decline in the United States. Am J Epidemiol 101: 182–187, March 1975.

3. National Center for Health Statistics: Teenage childbearing: United States, 1966–1975. Monthly Vital Stat Rep vol. 26, No. 5, Supp., Sept. 8, 1977.

4. National Center for Health Statistics: Advance report, final natality statistics, 1975, 1976, 1977. Monthly Vital Stat Rep vol. 25, No. 10, Dec. 30, 1976, for 1975; vol 26, No. 12, Mar. 29, 1978, for 1976; and vol. 27, No. 11, Feb. 5, 1979, for 1977.

5. Weinstock, E., et al.: Abortion needs and services in the United States, 1974–1975. Fam Plann Perspect 8: 58–69, March/April 1976.

6. Tietze, C.: Legal abortions in the United States: rates and ratios by race and age, 1972–1974. Fam Plann Perspect 9: 12–15, January/February 1977.

7. National Center for Health Statistics: Trends and differentials in births to unmarried women: United States, 1970–1976. Vital Health Stat [21] No. 36, May 1980.

8. National Center for Health Statistics: Vital statistics of the United States. Natality, vol. 1, for 1972, 1973, 1974, 1975, 1976. U.S. Government Printing Office, Washington, D.C., 1976, 1977, 1978, 1978, 1979, respectively.

9. Lee, K. S., et al.: Neonatal mortality: an analysis of the recent improvement in the United States. Am J Public Health 70: 15–22, January 1980.

10. Kleinman, J. C., et al.: A comparison of 1960 and 1973–74 early neonatal mortality in selected states. Am J Epidemiol 108: 454–469, December 1978.

11. Shapiro, S., et al.: Relevance of correlates of infant deaths for significant morbidity at 1 year of age. Am J Obstet Gynecol 136: 363–373, February 1980.
12. Kitchen, W. H., et al.: A longitudinal study of very low-birthweight infants: results of controlled trial of intensive care and incidence of handicaps. Develop Med Child Neurol 21: 582–589, October 1979.
13. Chase, H. C.: Time trends in low birth weight in the United States. *In* The epidemiology of prematurity, edited by D. M. Reed and F. J. Stanley. Urban and Schwarzenberg, Baltimore, 1977, pp. 17–37.
14. Chase, H. C.: Trends in prematurity, United States, 1950–1967. Am J Public Health 60: 1967–1983, October 1970.
15. Menken, J. A.: Teenage childbearing: its medical aspects and implications for the U.S. population. *In* U.S. Commission on Population and the American future. Edited by C. F. Westoff and R. Parke, Jr. U.S. Government Printing Office, Washington, D.C., 1972, vol. 1, pp. 331–353.
16. Selvin S. and Garfinkel, J.: Relationship between parental age and birth order with the percentage of low birth weight infants. Hum Biol 44: 501–510, February 1972.
17. Hardy, J. B., and Mellits, D. E.: Relationship of low birth weight to maternal characteristics of age, parity, education and body size. *In* The epidemiology of prematurity, edited by D. M. Reed and F. J. Stanley. Urban and Schwarzenberg, Baltimore, 1977, pp. 105–125.
18. Rosenwaike, I.: The influence of socio-economic status on incidence of low birth weight. HSMHA Health Rep 86: 641–649, July 1971.
19. Bakketeig, L. S.: The risk of repeated preterm or low birth weight delivery *In* The epidemiology of prematurity, edited by D. M. Reed and F. J. Stanley, Urban and Schwarzenberg, Baltimore, 1977, pp. 231–241.
20. Billewicz, W. Z.: Some implications of self-selection for pregnancy. Brit J Prevent Social Med 27: 49–52, February 1973.
21. Schlessinger, E. R., Mazumder, S. M., and Logrillo, V. M.: Long-term trends in perinatal deaths among offspring of mothers with previous child losses. Am J Epidemiol 96: 255–262, September 1972.
22. Snedecor, G. W., and Cochran, W. G.: Statistical methods. Iowa State University Press, Ames, 1972, pp. 240–248.
23. Fleiss, J. L.: Statistical methods for rates and proportions. John Wiley and Sons, New York, 1981, pp. 92–102, 244.
24. National Center for Health Statistics: Comparability of reporting between the birth certificate and the national natality survey. Vital and Health Statistics Series 2, No. 83, April 1980.
25. Harlap, S., and Davies, A. M.: Late sequelae of induced abortion: complications and outcome of pregnancy and labor. Am J Epidemiol 102: 217–224, September 1975.
26. Richardson, J. A., and Dixon, G.: Effects of legal termination on subsequent pregnancy. Brit Med J No. 6021: 1303–1304, May 29, 1976.
27. WHO Task Force on Sequelae of Abortion: Gestation, birth weight and spontaneous abortion in pregnancy after induced abortion. Lancet No. 8108: 142–145, Jan. 20, 1979.
28. Daling, J. R., and Emanuel, I.: Induced abortion and subsequent outcome of pregnancy in a series of American women. N Engl J Med 297: 1241–1245, Dec. 8, 1977.
29. Hogue, C. J., et al.: The interactive effects of induced abortion, interpregnancy interval and contraceptive use on subsequent pregnancy outcome. Am J Epidemiol 107: 15–26, January 1978.
30. Maine, D.: Does induced abortion affect later pregnancies? Fam Plann Perspect 11: 98–101, March/April 1979.
31. Oppel, W. C.: Pregnancy wastage and induced abortion. Final report, grant No. MCIR–240268–05–0, Maternal and Child Health Research, Office of Maternal and Child Health, Health Services Administration, Rockville, Md., 1979.
32. Roht, L. H., et al.: The association of multiple induced abortion with subsequent prematurity and spontaneous abortion. Acta Obst Gynaec Jap 23: 140–145, April 1976.

SYNOPSIS

STROBINO, DONNA M. (Johns Hopkins University School of Hygiene and Public Health): *Trends in low birth weight infants and changes in Baltimore's childbearing population, 1972–77. Public Health Reports, Vol. 97, May–June 1982, pp. 273–282.*

Linked birth and death records provided the population for a study of trends in low birth weight (LBW) rates in Baltimore between 1972 and 1977 and of the effect of changes in the characteristics of the childbearing population on these trends. The impact of shifts in the birth weight distribution on neonatal mortality rates was also investigated. Trends were analyzed for unstandardized LBW rates as well as for rates standardized on the distributions of maternal age, education, gravidity, prior pregnancy losses, and marital status.

Between 1972 and 1977, the 1,500 and 2,000 gm rates rose significantly by approximately 1 infant per 1,000 live births per year among whites and 2 infants per 1,000 live births among nonwhites. Despite declines in rates for most weights, the effect of these increases was a rise in neonatal mortality rates for both races, but especially for nonwhites.

The population of women delivering in Baltimore in 1977 became slightly older, slightly more educated, and of higher gravidity than in 1972, but these changes had little impact on yearly fluctuations in LBW rates. In contrast, increases in births to unmarried women and to women with at least one prior pregnancy loss were related to rising LBW rates. For both races, standardization on marital status and prior pregnancy losses diminishes the increase in the LBW rate over the study period, especially when standardization is performed simultaneously for both variables. These findings hold within maternal age, education, and gravidity groups. However, the LBW rates for nonwhite teenage mothers and for nonwhite women with 12 years or less education increased significantly over the study period, regardless of standardization.