Prenatal Care and Pregnancy Outcome in an HMO and General Population: A Multivariate Cohort Analysis

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Abstract: We studied the use of prenatal care and pregnancy outcome in 4,148 deliveries among members of a well-established health maintenance organization (HMO) and 19,116 births among the 1973-1974 White birth cohort in the Portland, Oregon area. Mothers in the HMO were almost one year older on the average, slightly better educated, and less frequently unmarried, but had virtually identical past pregnancy histories when compared with the general population cohort.

HMO members began prenatal care one month later and had three fewer visits than the general population ($p<.01$); 78 per cent of the general population and only 64 per cent of HMO members began prenatal care in the first trimester ($p<.01$). With maternal risk held constant, low birthweight, neonatal mortality, and infant mortality were 1.5 to 5 times greater with late, less frequent prenatal care than with early, frequent care. Multivariate analysis demonstrated a positive relationship between prenatal care and birthweight. Although this relationship was independent of risk factors recorded on birth certificates, it is not necessarily a causal relationship.

Unadjusted prematurity, neonatal and infant mortality rates did not differ between the HMO and general populations. Multivariate analyses indicated that, independent of all maternal risk factors, HMO membership was associated with an increase of 30 grams in the predicted birthweight ($p<.01$), but had no effect on mortality. The data suggest that, in Portland, Oregon, pregnancy outcome for HMO members is comparable to that of the general population. (*Am J Public Health* 1981; 71:381-390.)

Prepaid group practices have existed in the United States since at least the 1930s, but within the past decade they have been rechristened "Health Maintenance Organizations" (HMOs) and have been cited as one promising solution to the challenge of providing comprehensive health care to the American public at a reasonable cost and in an acceptable setting.[1,2] Despite the assertion that HMOs achieve savings through greater use of preventive services and more judicious use of diagnostic and therapeutic services,[2,3] some groups have argued that much of the apparent cost-reduction is attributable to lower standards of care and/or to the enrollment of healthier populations whose need for medical care is less than that of the general population.[4] This debate is relevant to prenatal care and perinatal health.

Prenatal care is perhaps the prototypic form of preventive medicine and, as such, it would be expected that such care would have an important place in the services provided by HMOs. Guidelines for providing prenatal services in HMOs have been published,[5,6] yet there appears to be only one published comparative study of prenatal care and pregnancy outcome in an HMO and general population.[7,8] Based on a 100 per cent sample of Health Insurance Plan (HIP) of Greater New York births and a 10 per cent random sample of all New York City live births for the year 1955, that study demonstrated that for all ethnic groups HIP members began prenatal care earlier than the total New York City population; the differences were small when the comparison was with the population seeing private physicians. Prematurity rates, fetal death ratios, and early neonatal death rates were significantly lower for the HIP members in the years 1955-57. The study does not fully adjust for sociodemographic differences between HIP members and nonmembers. Furthermore, data drawn from the experience in New York City may be outdated and unrepresentative of current HMO performance.

If the development of Health Maintenance Organizations is to continue to receive public support and if prenatal services are to be an important part of their preventive medicine strategies, then additional data regarding the use and effectiveness of prenatal care in HMOs is needed. The following study provides a partial response to this need.

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Methods

Study Population

The data reported here are based on live birth records and infant death records registered with the Oregon State

Health Department for the 1973–74 live birth cohort. To allow analysis of neonatal and infant mortality for the specific birth cohort, infant death certificates for the years 1973 to 1975 were matched with the 1973–1974 live birth records. One hundred per cent of registered infant deaths occurring among Oregon residents born in Oregon hospitals were matched for this birth cohort.

The HMO population for this study was drawn from the Kaiser-Permanente Medical Care Program of Portland, Oregon. A comprehensive Health Maintenance Organization maintaining a multi-specialty 252-bed hospital of its own, the Plan was established in Portland in 1947 and has grown steadily to a membership of 188,184 in 1974. Prenatal and obstetrical care is provided by the Program's obstetrician-gynecologists, 14 to 17 in number during 1973 and 1974, all Diplomates of the American Board of Obstetricians and Gynecologists. Although birth records do not have any specific mention of HMO membership, Kaiser uses its own hospital for all deliveries and hospital-of-birth is noted on the birth certificate. The Kaiser hospital does provide a limited amount of fee-for-service care. Non-member births occurring in the Kaiser hospital were identified by birth certificate number and reassigned to the general population.

To improve the comparability of the general population and the HMO members, the study was limited to birth occurring to White residents of the three contiguous urban counties in which Portland, Oregon is the central city. Since race has consistently been shown to be significantly related to the use of health care services and to pregnancy outcome, inclusion of non-whites would require separate analysis by race. However, since the non-white population of Oregon is less than two per cent, analysis by race would result in extremely small numbers for many of the comparisons.

Of 65,177 births occurring in Oregon during 1973 and 1974, 24,941 occurred in the Portland three-county area. There were 1,677 non-white births that were excluded, and 97 non-member births occurring in the Kaiser hospital were re-assigned to the general population. The final study population thus selected consisted of 4,148 HMO member births and 19,116 general population births.

In considering the completeness and reliability of the data thus obtained, it should be noted that under-registration of births occurring in Oregon is believed to be virtually non-existent and under-reporting of infant deaths is considered to be minimal. Oregon maintains an exchange system with adjacent states for birth and infant death records to assure completeness of the data for Oregon residents. Oregon has traditionally been among the states with the smallest number of incomplete birth certificate entries and the highest per cent of matched infant deaths and live births.[9] The reliability of birth record information was not independently evaluated. However, other studies indicate that, although some items are incomplete on certificates when compared with hospital records, those entries that are made are accurate.[10]

Variable Definitions

Sociodemographic variables, taken directly from the birth record, included maternal age, education, and marital status. Birth order was calculated from the birth record by summing all live births, including the one being recorded, and all fetal deaths. Medical-obstetric risk factors, also taken from the birth record, included characteristics of previous pregnancies and of the current pregnancy. Characteristics of previous pregnancies included delivery within one year of the present birth (determined from the birth date and date of last live birth), number of previous infant or child deaths, and number of previous fetal deaths. Characteristics of the current pregnancy included plural births, conditions during pregnancy, complications of pregnancy, labor and/or delivery, and presence of a congenital abnormality significant enough to prompt its recording on the birth record.*

For the purposes of tabular comparisons, each birth was classified according to the Institute of Medicine Risk Category[10] criteria as having No Risk, Sociodemographic Risk only, Medical-Obstetric Risk only, or Sociodemographic Risk and Medical-Obstetric Risk. A birth was considered to be at Sociodemographic Risk if it was illegitimate, the mother had eight years of education or less, the maternal age was less than 15 or greater than 39, or the maternal age-birth order combination was one of the following: 15 to 19 years and second or higher birth, 20 to 24 years and fourth or higher birth, 25 to 29 years and fifth or higher birth, 30 to 34 years and first birth or sixth or higher birth, or 35 to 39 years and first birth or fifth or higher birth. Births were judged to be at Medical-Obstetric risk if there had been a previous delivery within one year, there had been previous fetal or child deaths, the birth was plural, there was a congenital abnormality, or there were complications or conditions of pregnancy, labor or delivery. Plural births were added by the authors and not originally included in the Institute of Medicine criteria.

The month in which prenatal care began and the number of prenatal visits were also taken directly from the birth record. A single composite measure of the level of prenatal care was calculated from the month in which prenatal care began and the number of visits, adjusted for the gestational age (Table 1). This prenatal Care Index follows precisely the definitions developed by the Institute of Medicine, except that the distinction between private and non-private hospital obstetric services was dropped. The levels of care, here termed Level I, II, and III, correspond to the Institute of Medicine's Adequate, Intermediate, and Inadequate, respectively.[10] The Institute of Medicine definitions are based on recommendations of the American College of Obstetricians and Gynecologists[11] and the World Health Organization.[12]

Following generally accepted definitions, births were classified as low birthweight if the weight was 2500 grams or less; deaths were classified as being neonatal deaths if they occurred between birth and 28 days of life and as infant deaths if they occurred at any time between birth and one year of life.

*"Conditions during pregnancy" generally included chronic or acute medical or surgical conditions which do not directly involve the reproductive system and which do not occur exclusively during pregnancy. "Complications of pregnancy" are conditions which are directly related to the pregnancy.

TABLE 1—Definition of Prenatal Care Index

Prenatal Care Index	Month in Which Prenatal Care Began		Gestation (weeks)		Number of Prenatal Visits
Level I	Within First 3 months	and	13 or less	and	1 or more or not stated
			14-17	and	2 or more
			18-21	and	3 or more
			22-25	and	4 or more
			26-29	and	5 or more
			30-31	and	6 or more
			32-33	and	7 or more
			34-35	and	8 or more
			36 or more	and	9 or more
Level II	All combinations other than specified for Levels I and III.				
Level III	Seventh Month or Later, No Care	or	14-21	and	0 or not stated
			22-29	and	1 or less or not stated
			30-31	and	2 or less or not stated
			32-33	and	3 or less or not stated
			34 or more	and	4 or less or not stated

*From Kessner[10] wherein Level I care is termed "Adequate," Level III "Inadequate," and Level II "Intermediate."

Data Analysis

Comparisons of sociodemographic characteristics, medical-obstetric risk factors, use of prenatal care, and pregnancy outcome were made following standard tabular formats. The statistical significance for the frequency distributions of population characteristics were tested using the Chi-square statistic. To test the strength of the relationship between two variables, the *phi* statistic is given for symmetrical tables and for asymmetric tables Cramer's V is given. Both measures vary from 0.0 (no association) to 1.0 (one variable perfectly predicts the value of the other variable). Means are compared using the standard Student's T-test, corrected for unequal sample sizes.

Low birthweight is reported as per cent of live births 2500 grams or less and neonatal and infant mortality as the number of deaths per 1,000 live births. The standard errors of these rates are estimated to be equal to the recorded rate divided by the square-root of the number of premature births or deaths upon which the rate is based.**

To assess the combined effects of maternal risk factors and health care characteristics on birthweight and infant mortality, multiple regression and logistic regression, respectively, were performed using the Statistical Analysis System software package.[13-15]

**Since multivariate analyses of the data were performed, the rather cumbersome statistical analysis needed to assess significance in a three-way table of rates was not undertaken. However, the reader may make rough comparisons of individual rates in the following way: to compare the difference between two rates the standard error of the difference is calculated by taking the geometric mean of the squares of the standard errors for the two rates. If the difference between the two rates is more than twice the standard error of the difference, then the likelihood that the two rates differ because of chance alone is less than .05. Strictly speaking, when multiple comparisons are made in this manner, the interpretation of the significance level is altered. Despite this caveat, epidemiologists often make multiple comparisons using this approach.[10]

Results

Population Characteristics and Prevalence of Risk Factors

Comparison of sociodemographic characteristics (Table 2) showed HMO members to be broadly representative of the general population. However, the HMO membership was one year older on the average, had fewer women under age 20 or older than 34, had fewer women with less than a high school education and more with a college education, and had one-half as many illegitimate births. There was no difference in birth orders.

With regard to previous pregnancy history, the two populations did not differ in any respect (Table 2). The most prevalent past event for both groups was a previous fetal death, with one in five reporting at least one fetal death. The two populations were also the same in terms of the birth number and the incidence of reported congenital abnormalities. The most common event of the current pregnancy was a complication of the pregnancy, labor or delivery, with 18.4 per cent of the general population and 17.5 per cent of the HMO members experiencing such an event.

Based on the Institute of Medicine criteria, 14.9 per cent of the HMO members and 21.4 per cent of the general population had one or more Sociodemographic Risk Factors (see Table 5 for actual numbers).

Using the Institute of Medicine criteria, 36.3 per cent of the general population and 36.6 per cent of the HMO members were at Medical-Obstetric risk because of their previous pregnancy history and/or events in the current pregnancy (Table 5).

Use of Prenatal Care

According to all of the measures used, HMO members received significantly less prenatal care than the general population (Table 3). Among HMO members, 64.6 per cent began prenatal care during the first trimester, while 78.7 per cent of the general population began within the first trimes-

TABLE 2—Characteristics of Live Births, General Population and HMO Members, Oregon, 1973–1974.

Characteristics	General Population	HMO Members	Statistics
	Per Cent	Per Cent	
SOCIODEMOGRAPHIC FACTORS			
Maternal Age			
Mean (± Std. Dev.)	24.52(±4.81)	25.22(±4.46)	$p < .001$
Maternal Education			
Elementary, None	1.9	0.9	
Some High School	15.8	11.2	
High School Graduate	45.0	44.0	$p < .001$
Some College	23.9	23.3	
College Graduate or More	13.0	20.5	Cramer's $V = .093$
Unknown	0.4	0.1	
Birth Order			
Mean (± Std. Dev.)	2.18 (±1.46)	2.21 (±1.41)	NS
Legitimacy			
In-Wedlock	90.5	95.7	$p < .001$
Out-of-Wedlock	9.5	4.3	*phi* = .071
MEDICAL-OBSTETRIC FACTORS			
Previous Pregnancy History			
Delivery within one year	2.1	2.0	NS
Previous Infant and Child Deaths	2.7	3.1	NS
Previous Fetal Deaths	18.3	18.5	NS
Current Pregnancy			
Twin or Triplet Birth	2.0	1.6	NS
Complications of Pregnancy, Labor or Delivery	18.4	17.5	NS
Conditions During Pregnancy	1.7	1.0	$p < .01$ *phi* = .019
Congenital Abnormalities	0.9	0.6	NS

TABLE 3—Use of Prenatal Care, General Populations and HMO Members, Oregon, 1973–74

	General Population	HMO Members
	Per Cent of Live Births	
Prenatal Care Index**		
Level I	72.5	46.2
Level II	18.5	42.9
Level III	5.5	6.5
Unknown	3.5	4.4
Trimester in Which Prenatal Care Began*		
First	78.7	64.6
Second	15.0	27.4
Third	4.3	4.6
None	0.9	0.1
Unknown	1.0	3.2
Number of Prenatal Visits***	11.9 (±3.7)	9.0(±2.7)

*$p < .001$, Cramer's V = .264
**$p < .001$, Cramer's V = .236
***Mean (S.D.), $p < .001$

ter. HMO members had an average of over three visits fewer than the general population.

On the basis of the Institute of Medicine guidelines, 72.5 per cent of the general population received Level I care, while only 46.2 per cent of the HMO members received such care. Figure 1 reveals that the pattern of the initiating prenatal care was similar for the two populations, except that there was a lag of approximately one month between the initiation of prenatal care by HMO members and the initiation of care by the general population.

Pregnancy Outcome

Unadjusted outcome measures (Table 4) show no significant differences between the HMO members and the general population with regard to mean birthweight, per cent of births premature, neonatal mortality, or post-neonatal mortality. However, comparisons by risk categories and prenatal care (Table 5) and multivariate analyses (Table 6) suggest interrelationships between maternal risk, prenatal care, plan membership, and pregnancy outcome.

Birthweight—As expected, the per cent of low birthweight deliveries varied significantly with maternal risk. For the total population, the per cent with low birthweight was

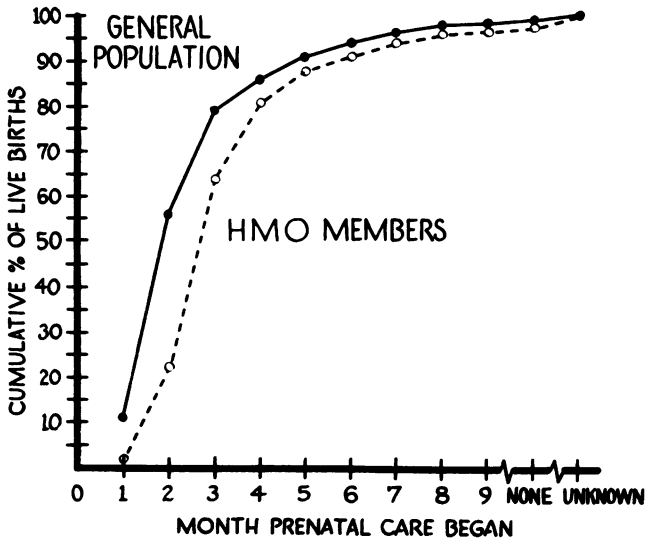

FIGURE 1—Cumulative Percent Under Prenatal Care by Month in Which Prenatal Care Began and Plan Membership

2.38 for No Risk births, 3.93 for Sociodemographic Risk only, 9.85 for Medical-Obstetric Risk only, and 12.89 for births in which both Sociodemographic and Medical-Obstetric risks were present (data not shown). Each of these rates differ significantly from the rates at each of the other three levels of risk ($p < .05$). There was a tendency for the low-risk HMO members to have a slightly less favorable outcome and for the high-risk HMO members to have a more favorable outcome than the general population. However, the only statistically significant difference between HMO members and the general population was for Medical-Obstetric Risk only ($p < .05$) (Figure 2).

For the total population, the per cent with low birthweight also increased as the level of prenatal care decreased. The per cent with low birthweight was 4.36 when mothers received Level I care, 7.25 with Level II care, and 11.27 with Level III care (data not shown). The relationship between prenatal care and low birthweight was as strong among HMO members as it was among the general population (Figure 3).

The tendency for HMO members to have higher birthweights at each level of prenatal care is significant only for Level I care ($p < .05$) (Figure 3).

To further assess the relationships among risk factors, prenatal care, and plan membership, a multiple regression was performed with birthweight as the dependent variable (Table 6). Not surprisingly the most potent influences on birthweight were the medical-obstetric factors, with plural births lowering the predicted birthweight by 750 grams, complications of pregnancy lowering it by nearly 240 grams, and the presence of congenital abnormality lowering the predicted weight by almost 180 grams.

Sociodemographic variables were less important in predicting birthweight than were medical-obstetric factors. Of special interest is the relative impact of prenatal care and the sociodemographic variables. Compared to Level II care (which is absorbed into the intercept in the regression), Level I care increased the predicted birthweight by 80 grams and Level III care reduced the birthweight by 82 grams, implying a difference of over 160 grams between Level I and Level III care. The magnitude of this difference is greater than the coefficients for any of the sociodemographic variables.

The data in Table 6 confirm the impression drawn from Table 5 that, when all risk factors and prenatal care are taken into consideration, HMO members have a slightly better pregnancy outcome than the general population: the predicted birthweight for HMO members is 29 grams higher than that of the general population ($p < .01$).

Neonatal and Infant Mortality—When compared by risk category, prenatal care index, and plan membership (Table 5), the neonatal and infant mortality rates follow the same pattern as the prematurity rates. However, the relative

TABLE 4—Unadjusted Outcome Measures, General Population and HMO Members, Oregon, 1973–74

	All Births	General Population	HMO Members
Birthweight (Grams)			
Mean (±S.E.)	3393. (±3.7)	3390. (±4.1)	3407. (±8.9)
Range	113. – 5669.	113. – 5613.	227. – 5669.
Per cent 2500 grams or under	5.56 (±.15)	5.67 (±.17)	5.09 (±.35)
Crude Mortality Rates (Deaths per 1,000 live Births)			
Neonatal Mortality Rate (±S.E.)	9.2 (±.63)	9.2 (±.69)	9.4 (±1.50)
Infant Mortality Rate (±S.E.)	13.7 (±.77)	13.9 (±.85)	12.5 (±1.73)

rarity of neonatal and infant death results in high standard errors and, consequently, greater variability in the observed rates.

For the total population, neonatal and infant mortality rates were, respectively, 2.4 and 5.4 for No Risk births, 3.9 and 12.9 for Sociodemographic Risk only, 20.1 and 24.6 for Medical-Obstetric risk only, and 22.5 and 29.6 for births having both risks (data not shown). The neonatal and infant mortality rates for all risk categories were, respectively, 6.8 and 10.0 when Level I care was obtained, 18.3 and 19.4 when Level II care was obtained, and 22.1 and 31.2 when Level III care was obtained (data not shown).

Comparison of the HMO and general population indicates that for all births in each group the neonatal and infant mortality rates do not differ significantly (Table 4). When compared by risk category (Table 5), the HMO population is found to have a slightly poorer outcome in the low risk groups and consistently more favorable outcome in the high risk groups. This is true for both neonatal mortality and infant mortality.

To further investigate the relationship between plan membership and mortality, multivariate logistic regression was performed in which the dependent variable was infant mortality. The regression indicated that plan membership was not a significant independent predictor of infant mortality (Table 6). It would appear that the lower mortality rates for HMO members in certain risk categories reflects the small, but favorable relationship between plan membership and birthweight, rather than an independent effect of plan membership on infant mortality.

The multiple regression presented in Table 6 explains less than ten per cent of the variance in birthweight (R-square of 0.095). This low R-square reflects the fact that many factors influencing neonatal and infant health are either unknown or—as with factors such as cigarette smoking, alcohol consumption, dietary habits, and maternal occupation—are not reflected in birth records. In multiple regression analyses with similar data in which the emphasis was on assessing the impact of prenatal care, Kessner found comparably low R-squares.[10] Although low R-square mean that the regression is likely to be a poor predictor of individual outcome, they do not limit the value of the regression in assessing the relative impact and significance of available independent variables on outcome for the total population.

TABLE 5—Number of Live Births, Per Cent Low Birthweight, Neonatal Deaths, and Infant Deaths by Risk Category and Prenatal Care Index, General Population and HMO Members, Oregon, 1973–1974

Risk Category and Prenatal Care Index	Number of Live Births		Per Cent of Live Births Less than 2501 Grams (±S.E.)		Neonatal Deaths per 1000 Live Births (±S.E.)		Infant Deaths Per 1000 Live Births (±S.E.)	
	General Population	HMO Members	General Population	HMO Members	General Population	HMO Members	General Population	HMO Members
All Risk Categories	19,116	4,148	5.67 (.17)	5.09 (.35)	9.2 (.69)	9.4 (1.51)	13.9 (0.8)	12.5 (1.7)
Level I	13,865	1,918	4.55 (.18)	3.02 (.40)	6.9 (.70)	6.3 (1.8)	10.2 (2.4)	8.3 (2.1)
Level II	3,529	1,778	7.65 (.47)	6.47 (.60)	18.3 (1.86)	11.8 (2.56)	21.2 (2.4)	15.7[a] (3.0)
Level III	1,045	269	11.78 (1.06)	9.29[a] (1.86)	24.9 (4.88)	11.2[a] (6.47)	34.5 (5.7)	18.6[a] (8.3)
Unknown	677	183						
No Risk	10,137	2,350	2.24 (.15)	2.98 (.36)	2.1 (0.4)	3.8 (1.3)	5.4 (.7)	5.1 (1.5)
Level I	7,930	1,107	1.94 (.16)	1.17 (.33)	1.7 (0.4)	0.9 (0.9)	4.3 (.7)	0.9 (0.9)
Level II	1,501	1,007	3.26 (.47)	4.27 (.65)	3.3 (1.5)	5.0 (2.2)	10.0 (2.6)	6.9 (2.6)
Level III	372	136	4.30[a] (1.07)	5.88[a] (2.08)	5.4[a] (3.8)	0.0[a] —	16.1[a] (6.6)	7.3[a] (7.3)
Unknown	334	100						
Sociodemographic Risk Only	2,036	281	3.58 (.42)	6.41 (1.51)	2.5 (1.1)	14.2 (7.1)	10.8 (2.3)	28.5 (10.1)
Level I	974	88	2.36 (.49)	6.82[b] (2.78)	3.1 (1.8)	22.7[b] (16.1)	10.3 (3.2)	34.1[b](19.7)
Level II	738	141	4.06 (.74)	5.67[a] (2.01)	0.0 —	7.1[a] (7.1)	9.4 (3.6)	21.3[a](12.3)
Level III	244	38	6.15[a] (1.59)	10.53[b] (5.26)	4.1[a] (4.1)	26.3[b] (26.3)	12.3[a] (7.1)	52.6[b] (37.2)
Unknown	80	14						
Medical-Obstetric Risk Only	4,885	1,178	10.48 (.46)	7.22 (.78)	21.1 (2.1)	16.1 (3.7)	25 8 (2.3)	19.5 (4.1)
Level I	3,818	594	8.96 (.48)	4.88 (.91)	16.2 (2.1)	11.8 (4.5)	19.4 (2.3)	15.1 (5.0)
Level II	682	472	13.93 (1.43)	9.11[a] (1.39)	32.2 (6.9)	23.3[a] (7.0)	39.6 (7.6)	27.5[a] (7.6)
Level III	199	63	21.61[a] (3.30)	12.70[b] (4.49)	75.4[a] (19.5)	15.9[b] (15.9)	85.4[a] (20.7)	15.9[b] (15.9)
Unknown	186	49						
Sociodemographic Risk and Medical-Obstetric Risk	2,058	339	13.17 (.80)	11.21 (1.82)	22.8 (3.3)	20.6 (7.8)	30.6 (3.9)	26.5 (8.8)
Level I	1,143	129	9.80 (.92)	7.75[a] (2.45)	14.9 (3.6)	15.5[a] (11.0)	21.0 (4.3)	23.3[a] (13.4)
Level II	608	158	15.79 (1.61)	13.29[a] (2.90)	31.2 (7.2)	25.3[a] (12.7)	42.8 (8.4)	31.6[a] (14.1)
Level III	230	32	21.40[a] (3.06)	15.62[b] (6.99)	34.8[a] (12.3)	31.2[b] (31.2)	43.5 [a](13.7)	31.2[b] (31.2)
Unknown	77	20						

[a]Based on 101–500 live births.
[b]Based on less than 101 live births.

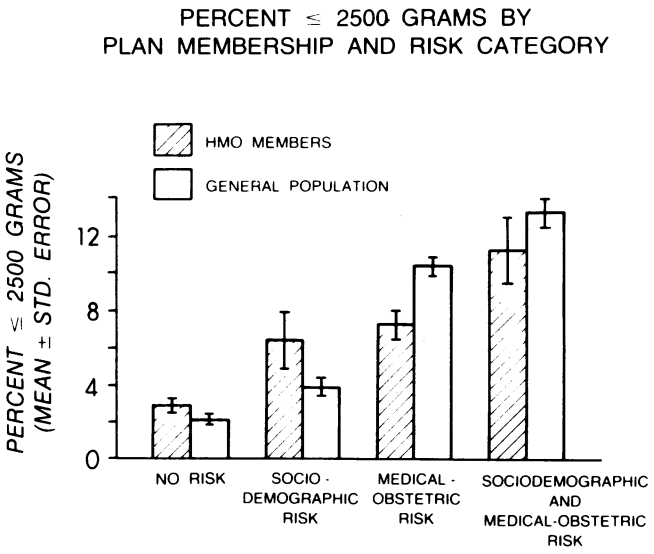

FIGURE 2—Per Cent 2500 Grams or Less by Plan Membership and Risk Category

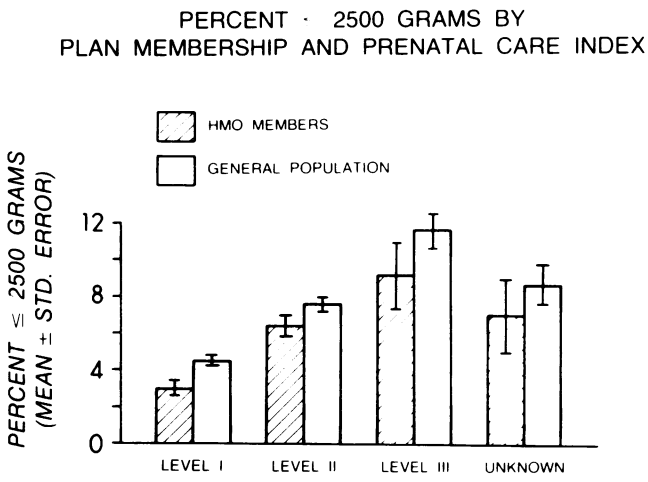

FIGURE 3—Per Cent 2500 Grams or Less by Plan Membership and Prenatal Care Index

TABLE 6—Multiple Regression with Birthweight and Logistic Regression with Infant Mortality as Dependent Variables, General Population and HMO Members, Oregon, 1973–1974.

Independent Variables	Birthweight (grams)[c]		Infant Mortality[d]	
	Unstandardized Coefficient	Significance (p less than:)	Unstandardized Coefficient	Significance (p less than:)
Plan Membership				
HMO member[b]	28.5	.01	.0889	.63
Prenatal Care				
Level I[a]	78.8	.01	.6994	.01
Level III[a]	−81.4	.01	−.3404	.10
Sociodemographic				
Maternal Age (years)	3.9	.55	.0448	.66
Maternal Age-Squared (years²)	−0.1	.23	−.0010	.62
Birth Order	50.5	.01	.1036	.16
Education				
Some High School[b]	45.2	.13	−.0089	.98
High School Graduate[b]	90.7	.01	−.0489	.91
Some College[b]	130.1	.01	.4507	.32
College Graduate[b]	154.5	.01	.5421	.26
Illegitimate[b]	−48.9	.01	−.2563	.20
Medical-Obstetric				
Previous Pregnancies				
Previous child deaths	−131.0	.01	−.5275	.01
Previous fetal deaths	−72.8	.01	−.1403	.23
Live birth within 1 year[b]	−172.8	.01	−1.2709	.01
Current Pregnancy				
Plural birth	−749.8	.01	−.6634	.01
Congenital abnormality[b]	−179.2	.01	-4.826×10^9	.01
Complications of pregnancy[b]	−237.1	.01	−1.4532	.01
Complications of labor or delivery[b]	−139.7	.01	−1.1206	.01
Conditions during pregnancy[b]	−51.8	.08	−.8890	.01

[a]Coded such that LEVEL II care is included in the interceptor alpha. Coefficients for Level I and Level III care thus represent the impacts of these levels compared with Level II care.

[b]Coded and entered as "dummy" variables (1 = characteristic present, 0 = characteristic absent).

[c]Calculated from standard multiple regression. Intercept = 3957.7, R^2 = 0.095, F = 122.81. P values tested by F test.

[d]Calculated by multivariate logistic regression. Alpha = 4.5655, F = 38.890. P values tested by asymptotic t-test.

Discussion

To summarize the above results, there was a tendency for HMO mothers to be slightly older, slightly better educated, and less frequently unmarried than mothers in the general population. Contrary to the assertions of some critics, however, these differences were small and contributed only slightly to the favorable outcome among HMO member births. Within risk categories, HMO members tended to have equal or slightly better outcomes on all measures, particularly among the high risk pregnancies. There was a small but significant positive effect of HMO membership on birthweight and this was independent of all sociodemographic, medical-obstetric, and prenatal care factors. No independent effect on neonatal or infant mortality was noted. The apparent beneficial effect of HMO membership was small and not consistent for all measures; however, the critical issue from the viewpoint of health services planning and health care policy is that the effect of HMO membership in the community studied is not a negative one, even within comparable risk groups.

The overall outcome was equivalent for HMO members despite their having received significantly less prenatal care. HMO members began prenatal care an average of one month later and had an average of three fewer prenatal visits than women in the general population. In reviewing the usual pattern for the initiation of prenatal care in the HMO, it became apparent that there is a potential lag in the system. Women who call to make an appointment to begin care with an obstetrician and who are certain that they are pregnant may wait as long as six weeks for the first visit. This may explain a significant part of the observed difference.

Some authors have been critical of previous studies associating prenatal care with the improved outcome, arguing that the improved outcome was related to the type of woman who sought early care, rather than to the care itself.[16-17] The present study adjusts for those sociodemographic factors available for analysis and still finds a strong relationship between prenatal care and pregnancy outcome. The magnitude of the impact of prenatal care is greatest for women at medical-obstetric risk, for whom health care would be expected to have the greatest impact. These findings are in agreement with other studies in which independent, favorable effects of prenatal care were observed after sociodemographic differences were well-controlled.[18-20] Despite the consistency of these epidemiological studies, they do not constitute proof of a causal relationship between prenatal care and pregnancy outcome. None of these studies controlled for cigarette smoking, alcohol consumption, dietary habits, maternal occupation, attitude toward pregnancy, emotional factors, and other factors which may be independently associated with both care-seeking behavior and pregnancy outcome.

Although several maternal and child health programs have shown improved outcome after their initiation,[21-26] few studies have related the specific content and timing of prenatal care to improvement in perinatal morbidity or mortality. In one program designed to provide intensified prenatal care to high-risk mothers, previously undetected illnesses were found in one-third of the patients and improved outcome was associated with the increased care.[21-22] In a comprehensive review of studies published between 1930 and 1977, Hemminiki and Starfield found data supporting a beneficial effect of specific prenatal intervention in 0 of 15 studies of prophylactic iron and vitamins, one of two studies on diet education, and no convincing evidence from the one controlled study of smoking education.[27] Nevertheless, accumulating evidence regarding the effects of nutrition,[28-29] smoking,[30] and alcohol consumption[31] during pregnancy suggests a possible role for health behavior change which may be largely unrealized at present.

Thus, there is much yet to be learned regarding the nature and impact of prenatal care. HMO populations—in which financial barriers to care are minimal—present important opportunities to further assess the effects of prenatal care and to conduct intervention studies aimed at improving perinatal and maternal health. Areas for continued efforts include, among others, the effectiveness of proposed high-risk screening instruments in altering prenatal management and influencing pregnancy outcome,[32-34] the completeness with which treatable medical conditions are uncovered during prenatal examinations, and the extent to which behavioral interventions can alter diet, smoking, alcohol consumption, and other such factors.

A second area for discussion concerns the contrast between the results from the 1973-1974 Oregon birth cohort and those from the late 1950's comparison of the Health Insurance Plan (HIP) of Greater New York with the New York City private and total obstetric populations.[7-8] In the use of prenatal care, the relationship between the HMO and the total population was reversed in the two studies: HIP had nearly 70 per cent of its White members enrolled for prenatal care within the first trimester in contrast to 61 per cent of the total NYC White population. The HMO in this study had only 65 per cent starting prenatal care within the first trimester, while in the general population over 75 per cent began within the first trimester.

Despite differences in the populations and their use of prenatal care, pregnancy outcome tended to be equivalent or more favorable among HMO members in both the HIP study and the present study. Compared to the present study, the positive effect of plan membership was stronger and more consistent for all outcome measures in the HIP study. In neither study could effective HMO performance be explained by the composition of the HMO population. As in the present study, early initiation of prenatal care was associated with better pregnancy outcome in both the HMO and the general population.

From the available data it is not possible to determine whether the differences in prenatal care utilization and outcome between the Oregon study and the NYC study reflect the time interval between the studies (almost 20 years), differences in the Oregon and NYC populations, differences in HMO operation, or reporting differences.

A final point of discussion concerns the possibility of reporting bias in this study. An independent assessment of the completeness and accuracy of the birth records was not performed by the authors. Recent reports have highlighted problems of omission and inaccuracy in vital statistical

data.[36-39] Although the Oregon birth records had less missing data than were reported in these studies, the possibility of reporting bias nevertheless exists. Unfortunately, Oregon does not code specific complications in the computerized birth record; such information would allow easy comparison of the HMO and general populations. For the greatest observed difference—prenatal care utilization—it might be expected that, since all their medical records are in one system, HMO members would have more complete reporting of prenatal care. In light of the observed results, this would be a conservative bias. However, the data here reflect only the care recorded on the birth record. Generally, this includes only designated prenatal visits. Important additional contacts, including telephone calls and referrals to subspecialists, are not generally included on the birth record. Data from the Kaiser Foundation Health Plan in Portland indicates that over 25 per cent of patient contacts are by telephone. However, for pregnancy-related contacts, there is only one telephone call for every eight physician office visits.[35]*** Since similar data do not exist for the general population, it is not possible to estimate the impact of telephone contacts on the observed differences in utilization. However, even if differences in telephone utilization exist, the significance of these differences would be difficult to interpret, since an important aspect of routine prenatal care is screening for asymptomatic conditions, something which can best be done in person.

Thus, there clearly are caveats which must accompany the use of vital statistics data to assess pregnancy outcome in an HMO. Vital statistics provide information which is locally-based, comprehensive, and not prohibitively expensive to collect or analyze. If such data are to be used to assess health interventions such as the regionalization of prenatal care, to evaluate new health care organizations such as HMOs, to monitor individual hospital performance, or to study other pressing questions, it is imperative that collection and coding be closely monitored.

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'The Sanitation Revolution'

"The world would be a saner place if, at this moment, its chief worries were the functioning of a new urban water and sanitation system in this city or the spread of rural water supplies in that country. Amid today's political and ideological upheavals, how many people remember that, in many Third World countries, between three and four out of every five children die before they reach the end of childhood, and that a prime cause of this mortality is polluted water?

"Nor is this the only risk. So long as parents experience the death of their first children, they continue to bring more into the world–not out of folly or ignorance, but to maintain the family work force and against old age. By a paradox, proved not only in the industrialized world but also in many parts of the Third World, when primary health care, the start of education, clean water, and hope and work are introduced, the birth-rate begins to stabilize. And with this change begins to fade the nightmare of a world which can no longer, without repeated famine, carry its population.

"These perceptions of life and death make, so far, very little impression among the rich–the rich North, the rich minorities in the South. The figures tell the tale. For military spending, the world is approaching US $500,000 million a year. Even the most ambitious schemes for clean water and sanitation approach that figure only over a whole decade of work and involvement. Yet the deaths from contamination and pollution go on and the risks grow.

"We must therefore be grateful for the fact that at least a first small step has been taken by the world community to redress such insane priorities. The United Nations General Assembly has voted to make the 1980s the International Drinking Water and Sanitation Decade. Most governments will respond. Most agencies will reconsider their priorities. A practical start will be made, and it is at least permissible to hope that the effects of the sanitation revolution, in saving life, in giving a sense of being cared for, in easing the unending grind of water collection, will help to produce more stable, more contented and more peaceful people. . . .

". . . Third World countries today have one advantage to set against the world's appallingly unequal distribution of resources. This advantage is, by a paradox, the mistakes which the wealthy countries have already made and which can now be avoided. Two of these should be underlined. Twenty years of aid have shown that sanitary improvements without basic education, training of maintenance staff and full community participation lead nowhere. Secondly, there is a whole range of new technologies available; thus, dung and excreta need no longer be wasted but can be put into biogas plants which will yield usable fuel and manure. Urban sewage or night-soil, once any pathogens are destroyed, can be safely used on allotments, farmlands and fishtanks where valuable nutrients can all return indispensable riches to the land and water. This is being practised in countries as far apart as France and Taiwan. It is the sort of saving which could not only cut sanitation costs but also stop the steady depletion of the soil. . . ."

IN: Ward B: The sanitation revolution. World Health WHO, August-September 1980, p. 9. [About the author: Dame Barbara Ward–Baroness Jackson of Lodsworth–recently retired as President of the International Institute for Environment and Development (IIED).]