

# Cancer Risk in Women Exposed to Diethylstilbestrol In Utero

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**Context.**—The association between in utero exposure to diethylstilbestrol (DES) and clear cell adenocarcinoma (CCA) of the vagina and cervix is well known, yet there has been no systematic study of DES-exposed daughters to determine whether they have an increased risk of other cancers. As many as 3 million women in the United States may have been exposed to DES in utero.

**Objective.**—To determine whether women exposed to DES in utero have a higher risk of cancer after an average of 16 years of follow-up.

**Design.**—A cohort study with mailed questionnaires and medical record review of reported cancer outcomes.

**Participants.**—A cohort of 4536 DES-exposed daughters (of whom 81% responded) and 1544 unexposed daughters (of whom 79% responded) who were first identified in the mid-1970s.

**Main Outcome Measures.**—Cancer incidence in DES-exposed daughters compared with population-based rates and compared with cancer incidence in unexposed daughters.

**Results.**—To date, DES-exposed daughters have not experienced an increased risk for all cancers (rate ratio, 0.96; 95% confidence interval [CI], 0.58-1.56) or for individual cancer sites, except for CCA. Three cases of vaginal CCA occurred among the exposed daughters, resulting in a standardized incidence ratio of 40.7 (95% CI, 13.1-126.2) in comparison with population-based incidence rates. The rate ratio for breast cancer was 1.18 (95% CI, 0.56-2.49); adjustment for known risk factors did not alter this result.

**Conclusions.**—Thus far, DES-exposed daughters show no increased cancer risk, except for CCA. Nevertheless, because exposed daughters included in our study were, on average, only 38 years old at last follow-up, continued surveillance is warranted to determine whether any increases in cancer risk occur during the menopausal years.

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DIETHYLSTILBESTROL (DES), a drug first synthesized in 1938,<sup>1</sup> was administered to several million pregnant

women in the United States and Europe for the prevention of spontaneous abortion and premature delivery.<sup>2</sup> In 1971, Herbst et al<sup>3</sup> reported a strong association between DES use in pregnancy and the occurrence of vaginal clear cell adenocarcinoma (CCA) in exposed female offspring. Animal models have demonstrated a range of DES effects on offspring exposed in utero, including reproductive dysfunction, immune system changes, behavioral and sexual abnormalities, and increases in various reproductive cancers in males and females. However, the applicability of these experiments to humans and the mechanism of carcinogenesis are unclear.<sup>4</sup> In the mid-1970s, several separate cohorts of DES-exposed daughters and unexposed comparison groups were followed for the

occurrence of cancer, precursor lesions, and reproductive effects,<sup>5-7</sup> but systematic follow-up of these cohorts had ceased by 1990. Concern has arisen that DES-exposed daughters may be at higher risk of breast cancer.<sup>8</sup> Exposure to high levels of endogenous estrogen in utero has been hypothesized to increase the risk of breast cancer<sup>9</sup> and DES is a potent estrogen. We conducted a study to ascertain the risk of breast and other cancers in women exposed to DES in utero by combining the previously identified cohorts, beginning follow-up in 1978 and extending it through 1994.

## METHODS

### Subjects

Three individual cohorts are included in this combined follow-up study. The largest cohort consists of 4936 women enrolled in the National Cooperative Diethylstilbestrol Adenosis (DESAD) study during the mid-1970s.<sup>5</sup> Nearly half of the exposed subjects were identified by prenatal record review at 5 centers. The remainder were referred by physicians or were self-referrals but were required to have documented exposure to DES. Women not exposed to DES in utero were selected from the same record sources as the exposed subjects or were sisters of exposed subjects. Women were followed yearly with either clinical examinations (through 1980) or mailed questionnaires (from 1984 through 1989).

The second cohort (the Dieckmann cohort) includes 644 female offspring whose mothers participated in a randomized clinical trial of the efficacy of DES during pregnancy in the early 1950s.<sup>10</sup> In 1974, attempts were made to trace all subjects in this cohort, and 83% of exposed and 77% of unexposed subjects responded to a questionnaire.<sup>11</sup> Follow-up of this cohort was episodic during the 1980s; subjects were last contacted in 1990.<sup>12</sup>

A third cohort (the Horne cohort) consists of 281 exposed daughters and 219 of their unexposed sisters whose mothers were treated with DES during preg-

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nancy by an infertility specialist in the Boston, Mass, area. The Horne cohort was assembled in the mid-1970s, and subjects were mailed yearly questionnaires through the 1980s; the data have not been analyzed previously.

All exposed women had documented exposure to DES during gestation. Unexposed women also had their "nonexposure" status documented by review of prenatal records (DESAD and Dieckmann cohorts) or by report of the mother (the Horne cohort). The Dieckmann and Horne cohorts were exposed to high doses of DES (median total dose, approximately 12 g), following the regimen recommended by Smith and Smith.<sup>13</sup> The doses given to the DESAD cohort were difficult to estimate because of incompleteness of data in medical charts but ranged from a median total dose of approximately 1.5 g at Baylor College of Medicine (Houston, Tex) and the Mayo Clinic (Rochester, Minn) to 4.5 g at Massachusetts General Hospital (Boston).

### Follow-up

In 1994, subjects were sent a detailed questionnaire on cancer risk factors and health history, including the occurrence of cancer. Cancers in nonrespondents were ascertained from prior records through the date of last follow-up. Identifiers of subjects known to be deceased, as well as those lost to follow-up, were linked with the National Death Index to ascertain cancers noted on death certificates.

Approvals for the study were obtained from the human investigations committees at the 5 field centers and the National Cancer Institute. Subjects indicated informed consent by filling out and returning the questionnaire and signing a medical record release form, if applicable.

Some subjects were not approached during the 1994 follow-up, either because they could not be traced or because of unwillingness to participate during previous follow-up attempts. Among women mailed a 1994 questionnaire, the response rates were 88% for both exposed and unexposed subjects. Pathology reports were sought for all cancers reported on the questionnaires, except for basal and squamous cell skin cancers. Also, slides were requested for all gynecologic malignancies for review by one pathologist (S.J.R.).

A total of 127 women reported cancers occurring after January 1, 1978. Pathology reports were not obtained for 30 reported cancers (8 because of lack of response by physicians or hospitals, 13 because of lack of consent to obtain records from the study subjects, and 9 because they were identified from follow-up prior to 1994 but could not be con-

Table 1.—Follow-up Information on Daughters Exposed or Unexposed to Diethylstilbestrol

	Exposed	Unexposed
Subjects identified, No.	4733	1660
Exclusions		
Lost to follow-up before 1/1/78	143	83
Cancer or death before 1/1/78	33	18
Missing information on year of birth	21	15
<b>Total subjects analyzed, No.</b>	<b>4536</b>	<b>1544</b>
Cohort		
National Cooperative Diethylstilbestrol Adenosis Project	3919	1017
Dieckmann	336	308
Horne	281	219
Median age at start of follow-up, y (25th percentile, 75th percentile)	24.3 (20.1, 26.6)	25.3 (21.1, 26.6)
Median No. of years followed (25th percentile, 75th percentile)	16.4 (14.6, 16.9)	16.3 (14.2, 16.7)
Responded to 1994 questionnaire, No.	3650	1202
Lost to follow-up, No.	850	331
Deceased, No.	36	11

firmed). For 17 women, the medical records obtained did not confirm cancer. The agreement between self-report and medical records was poor for cancer of the cervix (55%) and melanoma (56%). For all other cancers, confirmation rates were excellent (95% for exposed and 94% for unexposed women overall; 100% for both exposed and unexposed women for breast cancer). Therefore, except for cancer of the cervix and melanoma, reported cancers for which we were unable to obtain records are included with confirmed cancers. In the text, we report separately the results for confirmed cancers of the cervix and melanoma.

### Statistical Analysis

Person-years at risk for each subject were computed from January 1, 1978 (or date of first enrollment for the small number of respondents enrolled after this date) until the date of first cancer diagnosis, date of last known follow-up, or date of questionnaire response. Internal and external comparisons were conducted. The internal comparisons were adjusted for age and calendar year, using Poisson regression analysis.<sup>14</sup> For the analysis of total cancer incidence, we also adjusted level of education, and for breast cancer, we considered education, age at menarche, age at first live birth, oral contraceptive use, and menopausal status as potential confounders. Information on covariates was obtained primarily from the 1994 questionnaire, although we used the earliest recorded age at menarche. For nonrespondents, we ascertained information on covariates from previous follow-up data. For the internal comparisons of endometrial and ovarian cancer risk, we censored follow-up at the date of hysterectomy or date of bilateral oophorectomy, as appropriate. We also considered the gestational age of first exposure and the estimated dose of DES. For external comparisons, we used cancer incidence rates for white

women from 1978 through 1994 from the Surveillance, Epidemiology, and End Results (SEER) program.<sup>15</sup> We computed standardized incidence ratios (SIRs) and their 95% confidence intervals (CIs), assuming a Poisson distribution for the observed number of cancers.<sup>14</sup> Expected numbers of cancers were generated by applying age- and calendar year-specific incidence rates for white women to the appropriate person-years at risk. We also conducted separate analyses within each cohort and within the DESAD cohort for those identified initially by prenatal record review. An analysis of mortality from all causes was also conducted by comparing the observed number of deaths to those expected based on US mortality rates among white women and comparing all-cause mortality rates in the exposed and unexposed daughters.

### RESULTS

A total of 4536 DES-exposed daughters (contributing 68 110 person-years) and 1544 nonexposed women (contributing 22 599 person-years) were included in the analysis (Table 1). A total of 3650 questionnaires from exposed daughters and 1202 questionnaires from unexposed daughters were completed for an overall follow-up rate of 81% and 79%, respectively. There were few demographic differences between DES-exposed and nonexposed subjects (Table 2). Women exposed to DES had a slightly higher educational level than unexposed women. Age at menarche occurred slightly earlier in the exposed women, but menopausal status was similar. Exposed women were somewhat more likely to be nulliparous, to have fewer live births, and to have a later age at first live birth.

The incidence rate of all cancer (excluding cervix and melanoma) among exposed women was similar to SEER population incidence rates and to the rate in unexposed women (Table 3). When we limited

Table 2.—Characteristics of Daughters Exposed or Unexposed to Diethylstilbestrol\*

Characteristic	Exposed, No. (%)	Unexposed, No. (%)
<b>Year of birth</b>		
<1950	659 (14.5)	272 (17.6)
1950-1954	1941 (42.8)	708 (45.9)
1955-1959	1154 (25.4)	357 (23.1)
≥1960	782 (17.2)	207 (13.4)
<b>Race</b>		
White	4327 (95.4)	1398 (90.5)
Nonwhite	93 (2.1)	36 (2.3)
Missing	116 (2.6)	110 (7.1)
<b>Education</b>		
≤High school	462 (10.2)	232 (15.0)
Some college	823 (18.1)	259 (16.8)
4-Year college	1335 (29.4)	394 (25.5)
Graduate school	1024 (22.6)	314 (20.3)
Missing	892 (19.7)	345 (22.3)
<b>Age at menarche, y†</b>		
≤11	690 (15.2)	208 (13.5)
12-13	2695 (59.4)	844 (54.7)
≥14	1033 (22.8)	379 (24.5)
Missing	118 (2.6)	113 (7.3)
<b>Age at first live birth, y‡</b>		
≤24	694 (28.4)	329 (36.9)
25-29	915 (37.5)	295 (33.1)
≥30	834 (34.1)	268 (30.0)
<b>Parity</b>		
Nulliparous	1460 (32.2)	419 (27.1)
1	675 (14.9)	179 (11.6)
2	1030 (22.7)	388 (25.1)
≥3	474 (10.4)	213 (13.8)
Missing	897 (19.8)	345 (22.3)
<b>Age at menopause, y</b>		
Premenopausal	3085 (68.0)	1013 (65.6)
<40	337 (7.4)	89 (5.8)
40-44	151 (3.3)	49 (3.2)
≥45	36 (0.8)	28 (1.8)
Missing	927 (20.4)	365 (23.6)
Hysterectomy	387 (8.5)	122 (7.9)
Bilateral oophorectomy	157 (3.5)	59 (3.8)
Ever used hormone replacement therapy	328 (7.2)	114 (7.4)
Ever used oral contraceptives	3266 (72.0)	1093 (70.8)
Family history of breast cancer	298 (6.6)	106 (6.9)
Family history of ovarian cancer	51 (1.1)	10 (0.6)

\*Data from current 1994 questionnaire and previous follow-ups.

†Data for age at menarche taken from earliest records available.

‡Percentages calculated based on subjects with known ages at live birth; 866 subjects with unknown age at first live birth and 1879 nulliparous subjects excluded from denominator.

the analysis to the 80 cancers confirmed by pathology reports, there was also no increased risk among the exposed subjects compared with SEER rates (SIR, 0.87; 95% CI, 0.67-1.11) or compared with unexposed women (RR, 1.20; 95% CI, 0.71-2.03). The incidence of breast cancer in DES-exposed daughters was not elevated in comparison to the incidence in the general population or to the rate in unexposed daughters (Table 3). The results were similar when we included 9 additional breast tumors that were in situ (SIR, 1.22; 95% CI, 0.87-1.71; RR, 0.99; 95% CI, 0.52-1.88).

The relative risk (RR) for invasive cervical cancer among the exposed daughters compared with the unexposed daughters was below 1 (RR, 0.67; 95% CI, 0.12-3.67). This estimate was based on 6 cases confirmed by pathology

report; of them, 4 were squamous cell carcinoma, and 2 were adenocarcinomas of the endocervix, endometrioid cell type. There was also no increase in risk when the rates in the exposed daughters were compared with general population rates.

The SIR for CCA was approximately 40 times that expected from SEER incidence rates, based on 3 cases of vaginal CCA in the exposed group, diagnosed during routine examinations during the DESAD project. Five cases of ovarian cancer occurred among the exposed women, including 1 endometrioid ovarian tumor, 3 borderline serous tumors, and 1 malignant ovarian germ cell tumor (an immature teratoma), and 1 reported case (pathology report not obtained) in the unexposed women. The rate in exposed women was not significantly elevated in comparison to either SEER incidence or the unexposed group.

Five cases of Hodgkin disease were found among the exposed daughters and none in the unexposed group; the rate was not significantly elevated compared with the general population. There was no increased risk of melanoma in the exposed daughters, either in comparison to the general population (SIR, 0.49; 95% CI, 0.18-1.31) or compared with the unexposed daughters (RR, 1.38; 95% CI, 0.15-12.34) based on 4 confirmed cases in the exposed group and 1 in the unexposed group.

The results for all cancers combined or for breast cancer were similar among the original individual cohorts (Table 4). Likewise, an analysis restricted to DESAD subjects identified by prenatal record review showed similar results for all cancers and breast cancer. However, all 3 cases of CCA occurred in the physician and self-referral groups. More of the subjects in the physician and self-referral groups had adenosis and other vaginal epithelial changes during the initial phase of the DESAD project than the group identified by prenatal record review.<sup>5</sup>

There were no major differences in the results for all cancers combined (excluding cervix and melanoma) among women younger than 40 years and aged 40 years and older (Table 4). The higher risk for breast cancer in the exposed group than in the unexposed group among women who were aged 40 years and older appeared to be due to a lower than expected rate of breast cancer in unexposed women. The rate of breast cancer in exposed women aged 40 years and older was not elevated in comparison to the general population of women aged 40 years and older (SIR, 0.83; 95% CI, 0.51-1.35). There was no evidence for different effects by follow-up time (data not shown). Only 1 cancer was diagnosed

within 1 year of entry, 7 occurred between 1 and 4 years, and 75 cancers occurred at least 5 years after the date of entry.

Adjustment for level of education did not alter the risk estimate for all cancers combined (RR, 0.96; 95% CI, 0.59-1.57) or for breast cancer (RR, 1.17; 95% CI, 0.55-2.47). Simultaneous adjustment for age at first live birth, ages at menarche and menopause, ever use of oral contraceptives, education, and cohort also did not affect the risk estimate for breast cancer (RR, 1.24; 95% CI, 0.55-2.78). We examined gestational age at first exposure to DES (available for 69% of exposed subjects); none of the risk estimates for breast cancer was significantly different from 1, nor was there any discernible pattern according to timing of exposure (data not shown). Also, there was no pattern of increasing risk with increasing estimated doses of DES (data not shown); however, information on dose was missing for 34% of the exposed subjects and was likely underreported for the subjects who had some dose information recorded in their medical charts.

To assess whether loss to follow-up may have biased the results, we performed the same analyses extending follow-up through December 31, 1994, for all nonrespondents. The SIR for all cancers combined was reduced (SIR, 0.91; 95% CI, 0.69-1.16); as expected, this pattern of slightly lower SIRs held for individual cancer sites also. The rate ratios based on the comparison of exposed and unexposed daughters remained virtually unchanged using this approach.

An analysis of mortality rates in the cohort found no excess mortality in the exposed group compared with the unexposed group from all causes combined (RR, 1.11; 95% CI, 0.59-2.07). The standardized mortality ratios for both the exposed and unexposed groups compared with population mortality rates were below 1.

## COMMENT

This study found no overall increase in cancer incidence among a cohort of over 4500 women who had documented exposure to DES in utero and were followed for an average of 16 years beginning in 1978. Despite the solid linkage of in utero exposure to DES to risks of CCA of the vagina and cervix in case-control studies,<sup>3,16</sup> this is the first cohort study to document the relationship and thus the first with direct data on the absolute risks involved. There were 3 cases of vaginal CCA diagnosed by routine colposcopy and biopsy during the DESAD project, whereas none was expected. All

Table 3.—Cancer Risk in Daughters Exposed or Unexposed to Diethylstilbestrol, Compared With SEER Incidence Rates, and Relative Risk of Cancer, Comparing Exposed With Unexposed Daughters\*

Cancer Site	Exposed (n=4536)†			Unexposed (n = 1544)§			Rate Ratio (95% CI)
	Observed	Expected	SIR (95% CI)‡	Observed	Expected	SIR (95% CI)‡	
All cancer¶	61	56.7	1.08 (0.82-1.38)	22	20.6	1.07 (0.67-1.62)	0.96 (0.58-1.56)
Breast	29	24.3	1.19 (0.83-1.72)	9	9.2	0.98 (0.51-1.88)	1.18 (0.56-2.49)
Clear cell adenocarcinoma	3	0.07	40.7 (13.1-126.2)	0	0.02	0 (0-149.8)	∞ (0.08-∞)
Ovary	5	4.1	1.21 (0.50-2.90)	1	1.5	0.69 (0.10-4.87)	1.54 (0.18-13.22)
Endometrium, uterus or not otherwise specified	3	2.4	1.26 (0.41-3.92)	3	0.9	3.29 (1.06-10.19)	0.34 (0.07-1.69)
Thyroid	4	6.2	0.64 (0.24-1.71)	0	2.1	0 (0-1.43)	∞ (0.15-∞)
Digestive system	2	3.7	0.54 (0.14-2.17)	2	1.4	1.44 (0.36-5.77)	0.35 (0.05-2.46)
Lung	1	2.2	0.46 (0.06-3.26)	1	0.9	1.15 (0.16-8.14)	0.29 (0.02-4.67)
Brain	3	2.0	1.48 (0.48-4.58)	0	0.7	0 (0-4.28)	∞ (0.10-∞)
Leukemia/lymphoma	9	6.7	1.34 (0.70-2.58)	3	2.3	1.33 (0.43-4.12)	0.86 (0.23-3.21)
Hodgkin	5	2.7	1.84 (0.77-4.42)	0	0.8	0 (0-3.75)	∞ (0.18-∞)
Leukemia	2	1.6	1.22 (0.30-4.88)	2	0.6	3.44 (0.86-13.74)	0.33 (0.04-2.45)

\*SEER indicates Surveillance, Epidemiology, and End Results; CI, confidence interval.

†68 110 Person-years.

‡Standardized incidence ratio (SIR) using age and calendar-year SEER rates to obtain expected values.

§22 599 Person-years.

||Age-adjusted rate ratio, comparing exposed with unexposed daughters.

¶All cancers excluding cancer of the cervix and melanoma.

3 cases occurred among the 29 111 person-years accumulated by the cohort up through 29 years of age. There were no cases in the 38 999 person-years accumulated after 30 years of age. If we apply this rate of 1 per 10 000 cases per year to the 15-year time span when the vast majority of cases are diagnosed (from age 15 through 29 years), then our estimate of the cumulative incidence rate becomes 1.5 per 1000 exposed women. This is at the upper end of the range of 1 per 1000 to 1 per 10 000 estimated in 1979 and remarkably close to the rate of 1 per 1000 through 34 years of age estimated from population data in 1987.<sup>17</sup> Thus, DES exposure leads to a large relative increase in the risk of CCA, but it affects only a small proportion of all exposed women. The lack of any cases in the cohort thus far older than 30 years is encouraging. However, several cases of primary CCA in exposed women in their 40s have been reported recently to the Registry for Research on Hormonal Transplacental Carcinogenesis (Arthur L. Herbst, MD, oral communication, November 10, 1997), and there is major interest in evaluating risk when the cohort reaches their 50s and 60s, when CCA is most common in unexposed women.

The effect of DES exposure on male offspring is still unknown. Animal studies have suggested an increased risk of testicular cancer and several case-control studies have attempted to assess this association, but results have been inconsistent.<sup>18</sup> Diethylstilbestrol has been associated with a small increase in breast cancer risk in mothers exposed during pregnancy,<sup>19-23</sup> although the studies are not entirely consistent.<sup>7,24</sup> Because of the multiple lines of evidence linking estrogen to breast cancer risk, perhaps the most attention and concern

Table 4.—Cancer Risk in Daughters Exposed to Diethylstilbestrol by Original Cohort and by Time Since Exposure\*

Cohort	All Cancer†		Breast Cancer	
	Cases, No.	Rate Ratio‡ (95% CI)	Cases, No.	Rate Ratio‡ (95% CI)
DESAD	67	1.17 (0.63-2.13)	32	1.33 (0.55-3.25)
Record review subjects	36	0.94 (0.47-1.89)	19	1.24 (0.48-3.28)
Dieckmann	13	0.57 (0.19-1.73)	6	0.91 (0.18-4.49)
Home	3	1.14 (0.10-12.66)	0	...
Attained age, y (time since exposure)				
<40	54	0.79 (0.43-1.46)	20	0.66 (0.26-1.68)
≥40	29	1.22 (0.52-2.87)	18	3.17 (0.73-13.83)

\*CI indicates confidence interval; DESAD, National Cooperative Diethylstilbestrol Adenosis Project.

†Excludes cancer of the cervix and melanoma.

‡Age-adjusted rate ratio, comparing exposed with unexposed daughters.

among those exposed to DES is focused on breast cancer. Indeed, several investigators have hypothesized that breast cancer risk in general may be associated with in utero exposure to elevated estrogen levels,<sup>9,25-27</sup> and some associations have been reported for variables that may reflect endogenous in utero estrogen levels, such as maternal age, twin status, and preeclampsia during the index pregnancy. If the hypothesized relationship is due to estrogenicity itself, rather than to the chemical structure of the estrogen, then perhaps the best test of this hypothesis would be among women exposed in utero to the extraordinarily high levels achieved during DES treatment. Among the entire cohort, we found no evidence of an increased risk of breast cancer in women exposed to DES in utero. However, among women who were aged 40 years and older, there was a suggestion of a higher risk in the DES-exposed daughters compared with the unexposed daughters, but this result was not statistically significant and appeared to be due to a lower-than-ex-

pected rate of breast cancer among unexposed women in this age group.

Previous analysis of data from the DESAD study found no statistically significant difference in the prevalence of squamous cell lesions of the cervix in the DESAD cohort at their initial screening examination<sup>28</sup> but noted a 2-fold excess in the incidence of squamous cervical intraepithelial neoplasia (CIN) among exposed daughters at subsequent examinations.<sup>29</sup> The absence of an increased risk of invasive cervical cancer even in the presence of excess risks of CIN might not be surprising, since exposed daughters undergo frequent screening, with precursor lesions likely treated aggressively. An important limitation of our study is the absence of pathology reports for many of the cervical lesions reported on the questionnaires, due either to lack of response by hospital pathology departments or to subjects' lack of consent for retrieval of medical records. The pathology reports obtained showed poor agreement between the questionnaire and the pathologist's diagnosis. However, even when we

included those reported cases of cervical cancer for which we did not obtain pathology reports, the risk in exposed women was not significantly elevated, either compared with SEER rates or with unexposed daughters. The important remaining question is DES exposure in relation to risk of CIN subsequent to the last report from the DESAD project in 1984<sup>29</sup>; we are currently collecting data to address this risk.

While the size of this group, the documentation of exposure, and the extent of data collection all make this a uniquely valuable cohort, it also has its limitations. For purposes of this analysis, follow-up began in 1978 shortly after assembly of the component cohorts and when the median age of the subjects was 24 years. Thus, there was no opportunity to assess the risks of childhood malignancies. We were also able to achieve complete follow-up on only 80% of the eligible study population. However, losses to follow-up were similar for exposed and nonexposed subjects. Also, when we extended the follow-up for lost subjects to the date of study completion, we found similar results to those that

used individual dates of last follow-up. The major limitation, however, relates to the relatively young age of cohort members, leading to a limited expected number of specific cancers. For example, our study has limited power (63%) to detect an RR of 2 for breast cancer, although it has high power (97%) to identify an RR of 3 ( $\alpha = .05$ , 1-sided test). Thus, while no statistically significant excess was noted for any site except CCA, the wide CIs indicate that we cannot rule out potentially important increases in risk for any site. With respect to breast cancer, the observations to date relate to cancers occurring at a young age. Any influence of DES on breast cancer may only become discernible among those cases that occur in the more usual age range of the disease.

This cohort study is the first to examine systematically the risk of all forms of cancer in a large group of DES-exposed daughters. The results should reassure the DES-exposed population, since they confirm previous estimates that CCA is an uncommon occurrence and they also reveal no major excesses in risk of other types of cancer. Since the majority of women in-

cluded in our study are currently younger than 50 years, it will be important to continue follow-up of the cohort to monitor cancer risk as the cohort ages.

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