

Survival of Blacks and Whites After a Cancer Diagnosis

Peter B. Bach, MD

Deborah Schrag, MD, MPH

Otis W. Brawley, MD

Aaron Galaznik

Sofia Yakren

Colin B. Begg, PhD

IN THE UNITED STATES, 5-YEAR SURVIVAL after a cancer diagnosis is poorer for blacks than for whites— from 1992 to 1997, the figures were 52% and 63%, respectively.¹ Large, well-designed epidemiologic studies have explored possible reasons for this disparity. Differences in factors such as stage at diagnosis, socioeconomic status, and health insurance coverage, though present, do not appear to be entirely responsible.²⁻⁴ For example, the National Cancer Institute sponsored a Black-White Cancer Survival Study, which compared survival for blacks and whites with cancer of the colon, breast, uterus, and bladder. The poorer survival rates that were observed for blacks with all 4 cancer types persisted after adjustment for both clinical and socioeconomic characteristics.⁵⁻⁸ Because these factors do not appear to explain the racial difference in survival, the theory that cancers afflicting blacks may be fundamentally more aggressive due to biological or genetic differences has gained prominence.⁹⁻¹⁹

Few studies have been designed to evaluate 2 other factors, unrelated to cancer biology, which may reduce the longevity of blacks with cancer: lesser quality treatment and greater mortality due to other illnesses. Because there

For editorial comment see p 2138.

Context In recent years a theory that cancer biology is different in blacks and whites has gained prominence in reaction to epidemiologic observations that blacks have poorer survival than whites, even when diagnosed with cancer of similar severity. Yet, few studies have evaluated whether lower-quality treatment and shorter overall life expectancy due to a greater burden of other illnesses may explain the survival discrepancy.

Objective To estimate the magnitude of overall and cancer-specific survival differences between blacks and whites who receive comparable treatment for similar-stage cancer.

Data Sources We searched MEDLINE for English-language articles published from 1966 to January 2002 that reported on overall survival for black and white patients treated similarly for cancer.

Study Selection The abstracts or titles for 891 citations were independently examined by 2 authors. The full text was retrieved if the abstract mentioned both black and white patients, made some comment regarding either similarity of treatment received or presented an analysis based on the treatment received, and commented on survival. Studies were included if they included data for at least 10 black and 10 white patients; specified the cohort ascertainment method and what measures were undertaken to minimize loss to follow-up; summarized survival of both blacks and whites using actuarial measures; presented outcomes within stage, adjusted for stage, or based on cohorts with balanced stage distributions; and specified that blacks and whites in the study received similar treatment. We identified 89 unique cohorts in 54 articles that met our inclusion criteria.

Data Extraction Overall survival rates and hazard ratios (HRs) for death for blacks relative to whites were calculated. These were subsequently adjusted for rates of death due to causes other than the cancer under study to determine cancer-specific survival and cancer-specific HRs.

Data Synthesis Results represent 189877 white and 32004 black patients with 14 different cancers. Compared with whites, blacks had an overall excess risk of death (HR, 1.16; 95% confidence interval [CI], 1.12-1.20). After correction for deaths due to other causes, the cancer-specific HR was 1.07 (95% CI, 1.02-1.13). Of the 14 cancers, blacks were at a significantly higher risk of cancer-specific death only for cancer of the breast, uterus, or bladder.

Conclusions Only modest cancer-specific survival differences are evident for blacks and whites treated comparably for similar-stage cancer. Therefore, differences in cancer biology between racial groups are unlikely to be responsible for a substantial portion of the survival discrepancy. Differences in treatment, stage at presentation, and mortality from other diseases should represent the primary targets of research and interventions designed to reduce disparities in cancer outcomes.

JAMA. 2002;287:2106-2113

www.jama.com

are numerous studies documenting differences in the quality of cancer care received by blacks and whites,²⁰⁻²⁵ the thought that treatment differences may ultimately underlie the discrepancies in

Author Affiliations are listed at the end of this article.

Corresponding Author and Reprints: Peter B. Bach, MD, Health Outcomes Research Group, Department of Epidemiology and Biostatistics, Memorial Sloan-Kettering Cancer Center, 1275 York Ave, Box 221, New York, NY 10021.

survival has gained many proponents.²⁶⁻²⁸ Moreover, several studies have documented similar survival for black and white patients with cancer who have received similar treatments.²⁹⁻³³ Rates of death because of cardiovascular disease, diabetes, and other major illnesses are also greater for blacks than whites, leading some investigators to suggest that differences in population mortality should be considered.^{29,34-37}

We conducted this study to determine whether there was evidence in the literature of racial disparities in survival between blacks and whites who had received the same treatments for similar stages of cancer. We postulated that if blacks had poorer survival than whites in this context, the survival differences would be explained by the excess rates of deaths due to other causes in blacks. If not, we reasoned that the magnitude of the unexplained survival gap would constitute an estimate of that which may be attributable to differences in cancer biology.

METHODS

Study Overview

We began with a systematic review of all studies in which survival was reported for blacks and whites who had received comparable cancer treatments for similar stages of disease, with the purpose of removing treatment received and stage at diagnosis as explanatory factors. For each pair of cohorts (ie, blacks and whites within a particular study), we converted the reported survival statistics into hazards (death rates) and then calculated the ratio of the hazards for blacks relative to whites. Using the statistical tools of meta-analysis, we then combined these hazard ratios (HRs) across all studies and within predetermined categories of studies.³⁸

Next, we used life-table methods to recalculate the hazard of death for each cohort after parsing out the hazard of death due to causes other than the cancer under study. This approach allowed us to estimate the cancer-specific hazards for each cohort, while

removing the bias that results from the fact that blacks experience mortality from heart disease, diabetes, and other conditions at higher rates than whites. We then calculated the cancer-specific HRs for blacks relative to whites and generated parallel-summary statistics. Some studies reported cancer-specific death rates based on ascertained cause of death; these estimates were not incorporated in our analyses.

Systematic Review

We found English-language studies that reported on overall survival for black and white patients treated similarly for cancer, not including studies of malignant melanoma, pediatric tumors, malignancies in persons with human immunodeficiency virus infection, or premalignant conditions such as polyps of the colon. We searched MEDLINE (1966 through the third week of January 2002) using the exploded Medical Subject Headings of the National Library of Medicine terms: *neoplasms, cross-cultural comparisons, blacks, racial stocks, negroid race, minority groups, medically underserved area, disease-free survival, survival, survival analysis, survival rate, outcome assessment (health care), outcome and process assessment (health care), follow-up studies, treatment outcome, prognosis* and the key words *neoplasms, cancer, african americans, underserved populations, survival, mortality, treatment outcome*. The abstracts (or titles for those listed prior to 1975) for these citations were then independently examined by 2 authors (P.B.B. and A.G.). The full text was retrieved if the abstract (1) mentioned both black and white patients; (2) made some comment regarding either similarity of treatment received or presented an analysis based on the treatment received; and (3) commented on survival. Agreement on these 3 criteria between the reviewers was 97%. Studies were then screened for potential overlapping cohorts. When encountered, we eliminated the smaller of the 2 overlapping cohorts; this occurred in 2 instances.³⁹⁻⁴² Studies were then included in the analysis if they (1) included data for at least 10 black and

10 white patients; (2) specified what measures were undertaken to minimize loss to follow-up; (3) specified the cohort ascertainment method; (4) summarized survival of both blacks and whites using actuarial measures (eg, median survival, 5-year survival, Kaplan-Meier plot); (5) presented outcomes either within stage, adjusted for stage, or were based on cohorts with balanced-stage distributions; and (6) specified that blacks and whites in the study received similar treatment.

Evaluation of Treatment Within Retrieved Studies

Our confidence in the extent to which treatments received by blacks and whites were comparable within each study was graded based on a hierarchy adapted from Roach and Alexander.⁴³ Grade 1 studies (the highest grade) analyzed black and white patients who were enrolled on a clinical trial or trials because participants in clinical trials are required to follow particular treatment protocols that are closely monitored. Grade 2 studies reported on the outcomes of black and white patients who had received a particular treatment (eg, all patients undergoing resection of stage I non-small cell lung cancer), allowing for within treatment group evaluation of survival. Grade 3 studies used statistical methods to control for treatment within a population of patients who received different treatments. The method could simply involve demonstration that similar proportions of blacks and whites in the study received the same treatments. Grade 4 studies presented outcomes for black and white patients in which the treatment was likely to be comparable (but was not observed to be so) because patients were all treated either within the same institution or within culturally similar institutions. Examples of the latter group include multiple sites within a single health maintenance organization or Veterans Affairs medical centers. We excluded multi-institutional studies in which such an obvious source of shared culture was not present and reports from state or multisite cancer

registries in which treatment was not directly observed.

Hazard of Death for Blacks and Whites

Two methods were required to calculate the hazard of death, each based on the assumption that survival-time distributions in the studies could be approximated by the exponential form $S(t) = e^{-\lambda t}$ (λ is the hazard; $S(t)$ is the probability of surviving beyond time t).³⁸ In circumstances where the survival curves or statistics were comparable in terms of treatments received and stage of disease, we anchored the reported actuarial survival for each group at a landmark time point—5 years unless the authors identified alternatives as more representative—and solved for λ in the preceding equation.⁴⁴ If only the median (m) was reported in these situations, the hazard was calculated using $\lambda = \log(2)/m$.

If the black and white cohorts were not comparable in terms of treatment, stage, or other relevant factors but a covariate-adjusted HR was reported, we derived the 2 hazards as follows. First, the hazard for whites was calculated using the reported actuarial estimate via the preceding equation. The hazard for blacks was then computed as the product of the covariate-adjusted HR \times the hazard for whites.

Correction of Hazards for Differences in Population Mortality

For each cohort, from the overall hazard of death we subtracted the age, sex, and race appropriate hazard of death due to population mortality to determine the cancer-specific hazard of death. We determined population mortality rates from the National Center for Health Statistics 1997 decennial life tables, from which we subtracted death rates due to the cancer under study to avoid double counting.⁴⁵ The National Center for Health Statistics tables contain population estimates of annual death hazards (presented as probabilities) by race, sex, and age. The cancer hazards in the population were gleaned from the National Cancer In-

stitute's 1994-1998 Surveillance, Epidemiology, and End Results (SEER) report, which classifies them similarly.⁴⁶ The hazard of population mortality for each racial group was taken to be the average of the hazards for each year of the study for a population matched to the race, sex distribution, and mean age of the cohort. When race-specific sex or age distributions were unavailable, we assumed that they were equal between the 2 groups.

SE of Hazard Ratios

For the majority of studies we determined the SE of the HR either based on the reported number of failures or by converting reported confidence intervals (CIs) using established methods.^{38,44,47} In 23 (26%) of the cohorts, the data needed for these calculations were unavailable; therefore, we imputed an upper bound for the SE. This upper bound was calculated based on the assumption that exactly half of the total expected deaths at the landmark time point had contributed to the statistical power of the study, thus mirroring an analysis that would have been conducted if accrual were at a constant rate and the authors had analyzed the results when the first patient accrued had been followed up to the landmark (eg, the analysis occurred 5 years after the start of a study using a 5-year landmark). In reality, the results of most of these studies were likely analyzed at some later time point (after more failures) and so most estimates were probably associated with a smaller SE. Our assumption mitigates the influence of these cohorts on our overall pooled estimates, which is appropriate given our overall objectives. It was also assumed that the correction for other causes of death did not alter the SE of the log HR, because correction for population-based rates introduces virtually no additional random error.

Combination of Study Results Through Meta-analysis

For the meta-analyses, we used random effects models; our primary analysis was across all studies and our secondary

analyses were by study grade and cancer type.⁴⁸ We assessed heterogeneity of the pooled HRs with the Q statistic.⁴⁸ We evaluated publication bias with a funnel plot and stratified and unstratified rank correlation tests.^{49,50} We conducted the meta-analyses using Stata version 7.0 (Statacorp, College Station, Tex). All P values were 2-sided and values less than .05 were considered significant.

RESULTS

Systematic Review of the Literature

Evaluation of the 891 citations yielded 157 full-text articles. A search of the reference lists of those articles yielded an additional 19 studies. From these articles, we identified 89 unique analyzable cohorts reported in 54 articles that met our inclusion criteria. In aggregate, these cohorts reported on the survival of 32 004 black patients (median, 108 patients per study) and 189 877 white patients (median, 467 patients per study) with cancer of 14 different organ sites (TABLE).

Survival of Blacks and Whites After a Cancer Diagnosis

Across the 89 cohorts (FIGURE 1), blacks who received comparable treatment for similar stage cancer were at a 16% increased risk of death relative to whites (pooled HR, 1.16; 95% CI, 1.12-1.20; $P < .001$). After correction for differences in population mortality, the hazard of death was reduced to 1.07 (95% CI, 1.02-1.13; $P = .01$). The maximum influence on either of these estimates due to any particular cohort was 0.01, which we established by repeating our analyses removing 1 cohort at a time. These 2 results were robust across study grade, without evidence of heterogeneity.

In FIGURE 2, we present the results for overall survival and cancer-specific survival for particular cancer types, juxtaposed against the estimated proportion of cancer deaths due to each type in the black population.⁹⁷ For each of the 4 most common cancers (lung, colorectal, prostate, and breast, which collectively account for roughly half of all cancer deaths), blacks

Table. Cohorts Analyzed in a Meta-analysis of Survival for Black and White Patients With Cancer, Stratified by Cancer Type and Comparability of Treatment*

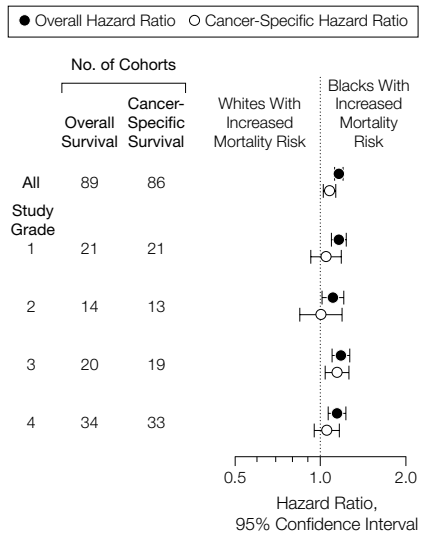
Cancer Site	Total No. of Cohorts	Study Grade							
		1		2		3		4	
		Source, y	No. of Cohorts	Source, y	No. of Cohorts	Source, y	No. of Cohorts	Source, y	No. of Cohorts
Lung	6	Akerley et al, ⁵¹ 1993	2	Bach et al, ²⁸ 1999	1	Greenwald et al, ⁵³ 1998	1	Page and Kuntz, ⁵⁴ 1980	1
		Graham et al, ⁵² 1992	1						
Colorectal	11	Dignam et al, ²⁹ 1999	5	...		Dominitz et al, ²⁷ 1998	1	Manne et al, ⁴¹ 2000	1
		Akerley et al, ⁵¹ 1993	1			Mayberry et al, ⁵⁵ 1995	1	Page and Kuntz, ⁵⁴ 1980	2
Prostate	30	Thompson et al, ⁵⁶ 2001	1	Hart et al, ⁶⁰ 1998	1	Fowler et al, ³⁹ 2000	1	Robbins et al, ⁶⁷ 1998	3
		McLeod et al, ⁵⁷ 1999	2	Kim et al, ⁶¹ 1995	2	Krongrad et al, ⁶⁵ 1996	1	Fowler and Terrell, ⁴⁰ 1996	2
		Roach et al, ⁵⁸ 1992	3	Lawton et al, ⁶² 1994	2	Optenberg et al, ⁶⁶ 1995†	3	Powell et al, ⁶⁸ 1995	1
		Crawford et al, ⁵⁹ 1990	1	Austin and Convery, ⁶³ 1993	1			Brawn et al, ⁶⁹ 1993‡	4
				Zagars et al, ⁶⁴ 1998†	1			Page and Kuntz, ⁵⁴ 1980	1
Breast	21	Dignam et al, ⁷⁰ 1997	2	Heimann et al, ⁷² 1997	1	Howard et al, ⁷⁴ 1998	1	Mancino et al, ⁷⁹ 2001	3
		Kimmick et al, ⁷¹ 1991	1	Fields et al, ⁷³ 1989	1	Franzini et al, ⁷⁵ 1997	1	Yood et al, ⁸⁰ 1999	1
						Perkins et al, ⁷⁶ 1996	1	Wojcik et al, ⁸¹ 1998	4
						Eley et al, ⁷ 1994	1	Ansell et al, ⁸² 1993	1
						Pierce et al, ⁷⁷ 1992	1	Gregorio et al, ⁸³ 1983	1
						Roetzheim et al, ⁷⁸ 2000	1		
Gastric	1		Page and Kuntz, ⁵⁴ 1980	1
Esophageal	1	...		Amendola et al, ⁸⁴ 1980	1	
Leukemia	2		Page and Kuntz, ⁵⁴ 1980	2
Multiple myeloma	2	Modiano et al, ⁸⁵ 1996	1	Savage et al, ⁸⁶ 1984	1	
Head and neck	5		Arbes et al, ⁸⁷ 1999	1	Roach et al, ⁸⁹ 1992	1
						Franco et al, ⁸⁸ 1993	3		
Uterine corpus	2		Hill et al, ⁶ 1996	1	Hicks et al, ⁹⁰ 1997	1
Central nervous system	1	Simpson et al, ⁹¹ 1996	1	
Bladder	1		Page and Kuntz, ⁵⁴ 1980	1
Uterine cervix	5	...		Grigsby et al, ⁹² 2000	2	Howell et al, ⁹³ 1999	1	Farley et al, ⁹⁴ 2001	1
								Thoms et al, ⁹⁵ 1995	1
Osteogenic sarcoma	1		Huvos et al, ⁹⁶ 1983	1
Total No. of Cohorts	89		21		14		20		34
Total No. of Black Patients	32 004		2341		2633		21 368		5662
Total No. of White Patients	189 877		17 156		15 472		129 576		27 673

*Ellipses indicate no cohorts for that study grade. Study grades are detailed in the "Methods" section.

†This cohort was excluded from analyses corrected for population mortality because population mortality accounted for the entire hazard of death.

‡One of the cohorts from this study was excluded from analyses corrected for population mortality because population mortality accounted for the entire hazard of death.

Figure 1. Meta-analysis of the Hazard Ratio (HR) of Survival for Blacks Relative to Whites

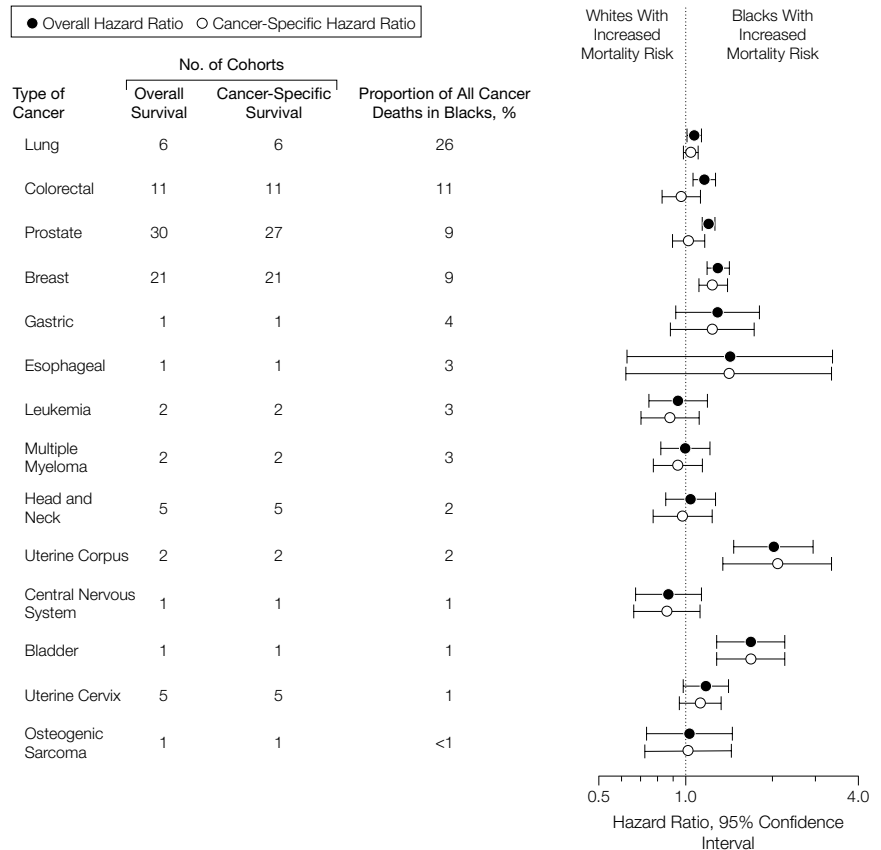


The overall excess mortality was statistically significant ($P < .05$) for all cohorts combined and study grades 1, 3, and 4; excess mortality after correction for population mortality was statistically significant ($P < .05$) for all cohorts combined and study grade 3. The pooled overall HR is 1.16 (95% confidence interval [CI], 1.12-1.20; $P < .001$). The pooled cancer-specific HR is 1.07 (95% CI, 1.02-1.13; $P = .01$).

were at a significantly excess risk of death overall. However, after correction for population mortality, there was no statistical evidence of excess cancer-specific mortality in blacks with the first 3 cancer types; the excess mortality in blacks with breast cancer was only moderately reduced (HR, 1.22; 95% CI, 1.10-1.37; $P < .001$).

For each of the remaining cancer sites, the results are based on either single studies or aggregation of very few studies. For the majority, cancer-specific mortality appeared similar for the 2 racial groups. The exceptions were the doubling of risk for blacks with cancer of the uterine corpus (HR, 2.08; 95% CI, 1.34-3.21; $P = .001$) and the 70% increased risk of mortality for blacks with cancer of the bladder (HR, 1.68; 95% CI, 1.28-2.21; $P < .001$). The pooled cancer-specific HR for all cancers other than breast, uterine, and bladder was 1.02 (95% CI, 0.97-1.06; $P = .49$), without evidence of heterogeneity (Q , 8.21; $P = .61$).

Figure 2. Meta-analysis of the Hazard Ratio (HR) of Survival for Blacks Relative to Whites for Particular Cancer Types



The overall excess mortality was statistically significant ($P < .05$) for lung, colorectal, prostate, breast, uterine corpus, and bladder cancers; excess mortality after correction for population mortality was statistically significant ($P < .05$) for breast, uterine corpus, and bladder cancers. Numbers do not sum to 100 because all cancers are not represented.

Tests for Publication Bias

We found no evidence of publication bias. We graphed the overall log HR for each cohort against its SE to form a funnel plot (FIGURE 3). In this figure, there is no systematic drift in the reported HR in relation to the SE of the study, constituting evidence against the hypothesis of publication bias. Statistical tests for detecting publication bias were also negative overall ($P = .45$), stratified by grade of study ($P = .79$), and stratified into studies of breast, uterine, or bladder cancer compared with other cancers ($P = .40$).

COMMENT

Disparities in treatment, rates of death due to other causes, and biological be-

havior of the cancer itself might each account for discrepancies in survival between blacks and whites with similar-stage cancer. We identified studies relevant to the bulk of cancer types and found that across these studies blacks were at a 16% increased risk of death. We then corrected this estimate for differences in underlying death rates and found that the pooled estimate of excess cancer-specific mortality for blacks was only 7%.

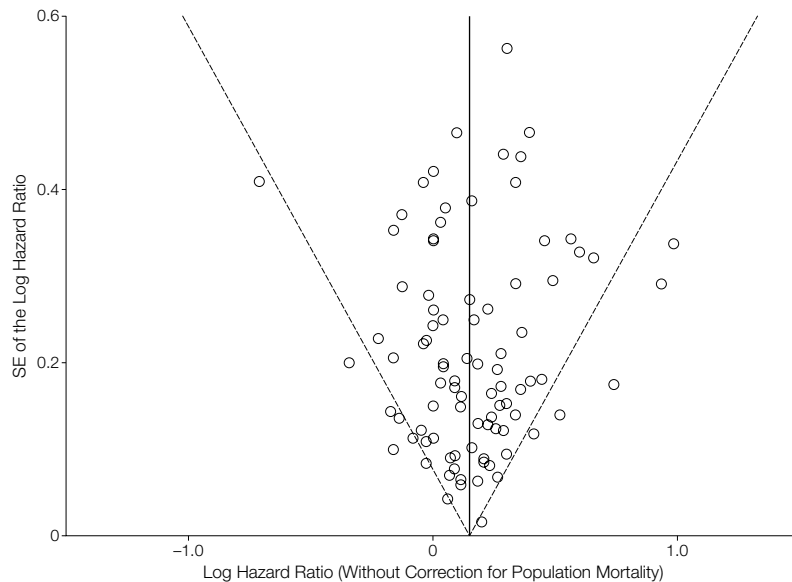
The excess cancer-specific mortality that was observed appeared to be due to a modest increase in risk of death for blacks with breast cancer (9% of cancer deaths in blacks), a doubling of risk for blacks with uterine cancer (2%), and a 70% increase in risk for blacks with

bladder cancer (1%). In contrast, there were no appreciable differences in cancer-specific survival in lung cancer (26%), colorectal cancer (11%), prostate cancer (9%), and 8 other cancers assessed in this study.

These findings should be considered in the context of the data on which they are based. Our search did not yield information on all types of cancer nor did our rules for categorizing treatment ensure that the cohorts received care of similar quality. In determining cancer severity, cancer stage either within strata or based on covariate adjustment was available in all studies but further detail on clinically important prognostic factors was absent. We also lacked information on either the mode of cancer detection (eg, screen detected vs symptom detected) or the types of staging evaluations undergone by these cohorts. In general, disparities between blacks and whites in these latter parameters tend to increase the survival of whites relative to blacks—the first through lead time and length time biases,⁹⁸ the second through stage migration.⁹⁹ Conceivably, the survival differences that were observed between blacks and whites with breast cancer (Figure 2), for example, reflected the impact of cancer being detected more often through screening mammography in whites (and thus earlier in its natural history) than in blacks.¹⁰⁰⁻¹⁰²

There are quantitative limitations as well. We modelled survival using mathematical models that likely do not mirror the observed relations precisely. We corrected for population mortality based on rates of death matched for age, sex, and race from the National Center for Health Statistics and the National Cancer Institute's 1994-1998 Surveillance, Epidemiology, and End Results; in fact, in these cohorts the actual rates of death due to other causes may be different. In studies set in relatively homogenous populations such as Veterans Affairs medical centers, the rates for blacks and whites may be more similar than they are in the United States as a whole. A parallel concern is that

Figure 3. Assessed Publication Bias



The solid line represents the pooled estimate for the uncorrected log of the hazard ratio of 0.15; the dashed lines represent 95% confidence intervals around that estimate given the SE of the study.

particular groups of patients with cancer, such as those with lung cancer, have a greater comorbid disease burden than the average population. Although this phenomenon will increase rates of death due to causes other than cancer, it may attenuate the differences in underlying death rates between blacks and whites.¹⁰³

Our methods, therefore, may have introduced measurement inaccuracies such that our reported CIs and accompanying *P* values do not capture the full degree of statistical uncertainty. The finding that differences in rates of death due to other causes reduced the HR for blacks relative to whites from 1.16 to 1.07 and eliminated the excess risk of mortality for blacks with colorectal, lung, and prostate cancer should be viewed in this context.

Finally, whether differences in death rates due to causes other than cancer constitute evidence of biological differences between blacks and whites was not addressed in this study. The death rates that were used in our calculations were derived from population statistics, which reflect the aggregate

impact of differences in prevalence, severity, access to care, and, if present, biological differences. That there has been abundant documentation of disparities in care between blacks and whites for conditions such as heart disease and end-stage renal disease provides evidence that differences in treatment may be at least partially responsible for these disparities as well.¹⁰⁴ Similarly, this study focuses on subjects with a cancer diagnosis and therefore provides no insight into the extent to which biological differences may play a role in explaining racial differences in incidence rates, such as are seen in prostate cancer, gastric cancer, and uterine cancer.

Many researchers and physicians have concluded that poorer survival of blacks relative to whites after a cancer diagnosis reflects fundamental differences in the biology of the host or the attendant cancer or both. We did not observe the impact of these putative biological differences consistently in cohorts of comparably treated black and white patients with cancer of similar stage once we took into account differences in un-

derlying death rates. We cannot be sure if our findings in breast cancer, uterine cancer, and bladder cancer constitute exceptions to this conclusion or reflect residual differences in treatment and disease severity that could not be identified through our study.

These findings suggest that if biological differences do exist, they are responsible for at most a very small fraction of all cancer deaths. Therefore, biological differences between blacks and whites cannot explain a meaningful share of the racial disparity in cancer survival observed in the United States. Numerous studies have demonstrated that blacks are less likely to receive optimal care for cancer than whites and are also more likely to be diagnosed initially at an advanced stage of disease. Finding workable remedies for these latter inequalities, as well as addressing the control of comorbid diseases, are important public health goals and should be an objective of future research.

Author Affiliations: Health Outcomes Research Group, Department of Epidemiology and Biostatistics (Drs Bach, Schrag, and Begg and Ms Yakren) and Department of Medicine (Drs Bach and Schrag), Memorial Sloan-Kettering Cancer Center, and Weill Medical College of Cornell University (Mr Galaznik), New York, NY; and Winship Cancer Institute, Emory University, Atlanta, Ga (Dr Brawley).

Author Contributions: Study concept and design: Bach, Schrag, Brawley, Begg.

Acquisition of data: Bach, Galaznik, Yakren.

Analysis and interpretation of data: Bach, Schrag, Galaznik, Yakren, Begg.

Drafting of the manuscript: Bach, Schrag, Galaznik, Begg.

Critical revision of the manuscript for important intellectual content: Bach, Schrag, Brawley, Yakren, Begg.

Statistical expertise: Bach, Schrag, Begg.

Obtained funding: Bach.

Administrative, technical, or material support: Bach, Brawley, Galaznik, Yakren, Begg.

Study supervision: Begg.

Funding/Support: This study was supported by a grant from the National Center on Minority Health and Health Disparities at the National Institutes of Health. Dr Brawley is a scholar of the Georgia Cancer Coalition.

Acknowledgment: We are grateful to Ramsey Tate for her dedicated research assistance and Douglas C. McCrory, MD, MHS, for his methodologic insights.

REFERENCES

- Ries LAG, Eisner MP, Kosary CL, et al. *SEER Cancer Statistics Review, 1973-1998*. Bethesda, Md: National Cancer Institute, National Institutes of Health; 2001.
- Marcella S, Miller JE. Racial differences in colorectal cancer mortality: the importance of stage and socioeconomic status. *J Clin Epidemiol*. 2001;54:359-366.
- Ragland KE, Selvin S, Merrill DW. Black-white differences in stage-specific cancer survival: analysis of seven selected sites. *Am J Epidemiol*. 1991;133:672-682.
- Steinhorn SC, Myers MH, Hankey BF, Pelham VF. Factors associated with survival differences between black women and white women with cancer of the uterine corpus. *Am J Epidemiol*. 1986;124:85-93.
- Howard J, Hankey BF, Greenberg RS, et al. A collaborative study of differences in the survival rates of black patients and white patients with cancer. *Cancer*. 1992;69:2349-2360.
- Hill HA, Eley JW, Harlan LC, et al. Racial differences in endometrial cancer survival: the black/white cancer survival study. *Obstet Gynecol*. 1996;88:919-926.
- Eley JW, Hill HA, Chen VW, et al. Racial differences in survival from breast cancer: results of the National Cancer Institute Black/White Cancer Survival Study. *JAMA*. 1994;272:947-954.
- Breen N, Wesley MN, Merrill RM, Johnson K. The relationship of socio-economic status and access to minimum expected therapy among female breast cancer patients in the National Cancer Institute Black-White Cancer Survival Study. *Ethn Dis*. 1999;9:111-125.
- Chen VW, Correa P, Kurman RJ, et al. Histological characteristics of breast carcinoma in blacks and whites. *Cancer Epidemiol Biomarkers Prev*. 1994;3:127-135.
- Evans LA. Black and white differences: narrowing the gap in cancer medicine. *In Vivo*. 1992;6:429-434.
- Pettaway CA. Racial differences in the androgen/androgen receptor pathway in prostate cancer. *J Natl Med Assoc*. 1999;91:653-660.
- Carethers JM. Racial and ethnic factors in the genetic pathogenesis of colorectal cancer. *J Assoc Acad Minor Phys*. 1999;10:59-67.
- Newman L. Prostate cancer develops differently in black men and may be more deadly [DNA sciences Web site]. November 16, 2000. Available at: <http://65.161.124.110/newsArticles/newsArchiveArticle.jsp?link=/newsArticles/newsArticle-ProstateCancerDevelopsDifferentlyinBlackMenandMayBeMoreDeadly.html&site=dna>. Accessibility verified March 22, 2002.
- Jetter A. Breast cancer in blacks spurs hunt for answers. *New York Times*. February 22, 2000;sect F:7.
- Freeman HP. The meaning of race in science: considerations for cancer research. *Cancer*. 1998;82:219-225.
- Freedman LS, Simon R, Foulkes MA, et al. Inclusion of women and minorities in clinical trials and the NIH Revitalization Act of 1993: the perspective of NIH clinical trials. *Control Clin Trials*. 1995;16:277-285.
- Evaluation of priority setting and programs of research on ethnic minority and medically underserved populations at the National Institutes of Health. In: Haynes MA, Smedley BD, eds. *The Unequal Burden of Cancer: An Assessment of NIH Research and Programs for Ethnic Minorities and the Medically Underserved*. Washington, DC: National Academy Press; 1999:154-186.
- Aging, Race, and Ethnicity in Prostate Cancer*. Bethesda, Md: US Dept of Health and Human Services, National Institute on Aging; 2001. RFA publication AG-02-003.
- Manley C. Unique study aims at why blacks get, die from cancer more often [EurekAlert Web site]. October 17, 2001. Available at: http://www.eurekalert.org/pub_releases/2001-10/vumc-usa101601.php. Accessibility verified March 20, 2002.
- Shavers VL, Brown ML. Racial and ethnic disparities in the receipt of cancer treatment. *J Natl Cancer Inst*. 2002;94:334-357.
- Muss HB, Hunter CP, Wesley M, et al. Treatment plans for black and white women with stage II node-positive breast cancer. *Cancer*. 1992;70:2460-2467.
- Smith TJ, Penberthy L, Desch CE, et al. Differences in initial treatment patterns and outcomes of lung cancer in the elderly. *Lung Cancer*. 1995;13:235-252.
- Diehr P, Yergan J, Chu J, et al. Treatment modality and quality differences for black and white breast-cancer patients treated in community hospitals. *Med Care*. 1989;27:942-958.
- Lee JA, Gehlbach S, Hosmer D, Reti M, Baker CS. Medicare treatment differences for blacks and whites. *Med Care*. 1997;35:1173-1189.
- Klabunde CN, Potosky AL, Harlan LC, Kramer BS. Trends and black/white differences in treatment for nonmetastatic prostate cancer. *Med Care*. 1998;36:1337-1348.
- Brawley OW, Freeman HP. Race and outcomes: is this the end of the beginning for minority health research? *J Natl Cancer Inst*. 1999;91:1908-1909.
- Dominitz JA, Samsa GP, Landsman P, Provenzale D. Race, treatment, and survival among colorectal carcinoma patients in an equal-access medical system. *Cancer*. 1998;82:2312-2320.
- Bach PB, Cramer LD, Warren JL, Begg CB. Racial differences in the treatment of early-stage lung cancer. *N Engl J Med*. 1999;341:1198-1205.
- Dignam JJ, Colangelo L, Tian W, et al. Outcomes among African-Americans and Caucasians in colon cancer adjuvant therapy trials: findings from the National Surgical Adjuvant Breast and Bowel Project. *J Natl Cancer Inst*. 1999;91:1933-1940.
- Roach M. Is race an independent prognostic factor for survival from prostate cancer? *J Natl Med Assoc*. 1998;90:5713-5719.
- Roach M, Cirrincione C, Budman D, et al. Race and survival from breast cancer: based on Cancer and Leukemia Group B trial 8541. *Cancer J Sci Am*. 1997;3:107-112.
- Cella DF, Orav EJ, Kornblith AB, et al. Socioeconomic status and cancer survival. *J Clin Oncol*. 1991;9:1500-1509.
- Morgan MA, Behbakht K, Benjamin I, et al. Racial differences in survival from gynecologic cancer. *Obstet Gynecol*. 1996;88:914-918.
- Hodgson DC, Fuchs CS, Ayanian JZ. Impact of patient and provider characteristics on the treatment and outcomes of colorectal cancer. *J Natl Cancer Inst*. 2001;93:501-515.
- West DW, Satariano WA, Ragland DR, Hiatt RA. Comorbidity and breast cancer survival: a comparison between black and white women. *Ann Epidemiol*. 1996;6:413-419.
- Sutherland CM, Mather FJ. Long-term survival and prognostic factors in breast cancer patients with localized (no skin, muscle, or chest wall attachment) disease with and without positive lymph nodes. *Cancer*. 1986;57:622-629.
- Satariano WA, Ragland DR. The effect of comorbidity on 3-year survival of women with primary breast cancer. *Ann Intern Med*. 1994;120:104-110.
- Collett D. *Modelling Survival Data in Medical Research*. Boca Raton, Fla: CRC Press; 1994:1.
- Fowler JE Jr, Bigler SA, Bowman G, Kilambi NK. Race and cause specific survival with prostate cancer: influence of clinical stage, Gleason score, age and treatment. *J Urol*. 2000;163:137-142.
- Fowler JE Jr, Terrell F. Survival in blacks and whites after treatment for localized prostate cancer. *J Urol*. 1996;156:133-136.
- Manne U, Weiss HL, Grizzle WE. Racial differences in the prognostic usefulness of MUC1 and MUC2 in colorectal adenocarcinomas. *Clin Cancer Res*. 2000;6:4017-4025.
- Manne U, Weiss HL, Grizzle WE. Bcl-2 expression is associated with improved prognosis in patients with distal colorectal adenocarcinomas. *Int J Cancer*. 2000;89:423-430.
- Roach M, Alexander M. The prognostic significance of race and survival from breast cancer: a model for assessing the reliability of reported survival differences. *J Natl Med Assoc*. 1995;87:214-219.
- Parmar MKB, Torri V, Stewart L. Extracting sum-

- mary statistics to perform meta-analyses of the published literature for survival endpoints. *Stat Med*. 1998; 17:2815-2834.
45. Armstrong RJ. *US Decennial Life Tables for 1989-1991*. Hyattsville, Md: US Dept of Health and Human Services, National Center for Health Statistics; 1997:13.
 46. Ries LAG, Eisner MP, Kosary CL, et al. *SEER Cancer Statistics Review, 1973-1997*. Bethesda, Md: National Cancer Institute, National Institutes of Health; 2000.
 47. Tudur C, Williamson PR, Khan S, Best LY. The value of the aggregate data approach in meta-analysis with time-to-event outcomes. *J R Stat Soc*. 2001;164: 357-370.
 48. DerSimonian R, Laird N. Meta-analysis in clinical trials. *Control Clin Trials*. 1986;7:177-188.
 49. Light RJ, Pillemer DB. *Summing Up: The Science of Reviewing Research*. Cambridge, Mass: Harvard University Press; 1984.
 50. Begg CB, Mazumdar M. Operating characteristics of a rank correlation test for publication bias. *Biometrics*. 1994;50:1088-1101.
 51. Akerley WL 3rd, Moritz TE, Ryan LS, et al. Racial comparison of outcomes of male Department of Veterans Affairs patients with lung and colon cancer. *Arch Intern Med*. 1993;153:1681-1688.
 52. Graham MV, Geitz LM, Byhardt R, et al. Comparison of prognostic factors and survival among black patients and white patients treated with irradiation for non-small-cell lung cancer. *J Natl Cancer Inst*. 1992; 84:1731-1735.
 53. Greenwald HP, Polissar NL, Borgatta EF, et al. Social factors, treatment, and survival in early-stage non-small cell lung cancer. *Am J Public Health*. 1998;88: 1681-1684.
 54. Page WF, Kuntz AJ. Racial and socioeconomic factors in cancer survival. *Cancer*. 1980;45:1029-1040.
 55. Mayberry RM, Coates RJ, Hill HA, et al. Determinants of black/white differences in colon cancer survival. *J Natl Cancer Inst*. 1995;87:1686-1693.
 56. Thompson I, Tangen C, Tolcher A, et al. Association of African-American ethnic background with survival in men with metastatic prostate cancer. *J Natl Cancer Inst*. 2001;93:219-225.
 57. McLeod DG, Schellhammer PF, Vogelzang NJ, et al. Exploratory analysis on the effect of race on clinical outcome in patients with advanced prostate cancer receiving bicalutamide or flutamide, each in combination with LHRH analogues. *Prostate*. 1999;40: 218-224.
 58. Roach M, Krall J, Keller JW, et al. The prognostic significance of race and survival from prostate cancer based on patients irradiated on Radiation Therapy Oncology Group protocols (1976-1985). *Int J Radiat Oncol Biol Phys*. 1992;24:441-449.
 59. Crawford ED, Blumenstein BA, Goodman PJ, et al. Leuprolide with and without flutamide in advanced prostate cancer. *Cancer*. 1990;66:1039-1044.
 60. Hart KB, Porter AT, Shamsa F, et al. The influence of race on the efficacy of curative radiation therapy for carcinoma of the prostate. *Semin Urol Oncol*. 1998;16:227-231.
 61. Kim JA, Kuban DA, el-Mahdi AM, Schellhammer PF. Carcinoma of the prostate: race as a prognostic indicator in definitive radiation therapy. *Radiology*. 1995;194:545-549.
 62. Lawton CA, Cantrell JE, Derus SW, et al. Prostate cancer: are racial differences in clinical stage and survival explained by differences in symptoms? *Radiology*. 1994;192:37-40.
 63. Austin JP, Convery K. Age-race interaction in prostatic adenocarcinoma treated with external beam irradiation. *Am J Clin Oncol*. 1993;16:140-145.
 64. Zagars GK, Pollack A, Pettaway CA. Prostate cancer in African-American men: outcome following radiation therapy with or without adjuvant androgen ablation. *Int J Radiat Oncol Biol Phys*. 1998;42:517-523.
 65. Krongrad A, Lai H, Lamm SH, Lai S. Mortality in prostate cancer. *J Urol*. 1996;156:1084-1091.
 66. Optenberg SA, Thompson IM, Friedrichs P, et al. Race, treatment, and long-term survival from prostate cancer in an equal-access medical care delivery system. *JAMA*. 1995;274:1599-1605.
 67. Robbins AS, Whittemore AS, Van Den Eeden SK. Race, prostate cancer survival, and membership in a large health maintenance organization. *J Natl Cancer Inst*. 1998;90:986-990.
 68. Powell JJ, Schwartz K, Hussain M. Removal of the financial barrier to health care: does it impact on prostate cancer at presentation and survival? *Urology*. 1995; 46:825-830.
 69. Brawn PN, Johnson EH, Kuhl DL, et al. Stage at presentation and survival of white and black patients with prostate carcinoma. *Cancer*. 1993;71:2569-2573.
 70. Dignam JJ, Redmond CK, Fisher B, et al. Prognosis among African-American women and white women with lymph node negative breast carcinoma: findings from two randomized clinical trials of the National Surgical Adjuvant Breast and Bowel Project (NSABP). *Cancer*. 1997;80:80-90.
 71. Kimmick G, Muss HB, Case LD, Stanley V. A comparison of treatment outcomes for black patients and white patients with metastatic breast cancer. *Cancer*. 1991;67:2850-2854.
 72. Heimann R, Ferguson D, Powers C, et al. Race and clinical outcome in breast cancer in a series with long-term follow-up evaluation. *J Clin Oncol*. 1997; 15:2329-2337.
 73. Fields JN, Kuske RR, Perez CA, et al. Prognostic factors in inflammatory breast cancer: univariate and multivariate analysis. *Cancer*. 1989;63:1225-1232.
 74. Howard DL, Penchansky R, Brown MB. Disaggregating the effects of race on breast cancer survival. *Fam Med*. 1998;30:228-235.
 75. Franzini L, Williams AF, Franklin J, et al. Effects of race and socioeconomic status on survival of 1,332 black, Hispanic, and white women with breast cancer. *Ann Surg Oncol*. 1997;4:111-118.
 76. Perkins P, Cooksley CD, Cox JD. Breast cancer: is ethnicity an independent prognostic factor for survival? *Cancer*. 1996;78:1241-1247.
 77. Pierce L, Fowle B, Solin LJ, et al. Conservative surgery and radiation therapy in black women with early stage breast cancer. *Cancer*. 1992;69:2831-2841.
 78. Roetzheim RG, Gonzalez EC, Ferrante JM, et al. Effects of health insurance and race on breast carcinoma treatments and outcomes. *Cancer*. 2000;89: 2202-2213.
 79. Mancino AT, Rubio IT, Henry-Tillman R, et al. Racial differences in breast cancer survival: the effect of residual disease. *J Surg Res*. 2001;100:161-165.
 80. Yood MU, Johnson CC, Blount A, et al. Race and differences in breast cancer survival in a managed care population. *J Natl Cancer Inst*. 1999;91:1487-1491.
 81. Wojcik BE, Spinks MK, Optenberg SA. Breast carcinoma survival analysis for African American and white women in an equal-access health care system. *Cancer*. 1998;82:1310-1318.
 82. Ansell D, Whitman S, Lipton R, Cooper R. Race, income, and survival from breast cancer at two public hospitals. *Cancer*. 1993;72:2974-2978.
 83. Gregorio DI, Cummings KM, Michalek A. Delay, stage of disease, and survival among white and black women with breast cancer. *Am J Public Health*. 1983; 73:590-593.
 84. Amendola B, Hazra TA, Belgrad R, King ER. Radiation therapy for esophageal cancer: the Medical College of Virginia experience. *South Med J*. 1980;73: 1481-1483.
 85. Modiano MR, Villar-Werster P, Crowley J, Salmon SE. Evaluation of race as a prognostic factor in multiple myeloma. *J Clin Oncol*. 1996;14:974-977.
 86. Savage D, Lindenbaum J, Van Ryzin J, et al. Race, poverty, and survival in multiple myeloma. *Cancer*. 1984;54:3085-3094.
 87. Arbes SJ, Olshan AF, Caplan DJ, et al. Factors contributing to the poorer survival of black Americans diagnosed with oral cancer (United States). *Cancer Causes Control*. 1999;10:513-523.
 88. Franco EL, Dib LL, Pinto DS, et al. Race and gender influences on the survival of patients with mouth cancer. *J Clin Epidemiol*. 1993;46:37-46.
 89. Roach M, Alexander M, Coleman JL. The prognostic significance of race and survival from laryngeal carcinoma. *J Natl Med Assoc*. 1992;84:668-674.
 90. Hicks ML, Kim W, Abrams J, et al. Racial differences in surgically staged patients with endometrial cancer. *J Natl Med Assoc*. 1997;89:134-140.
 91. Simpson JR, Scott CB, Rotman M, et al. Race and prognosis of brain tumor patients entering multicenter clinical trials. *Am J Clin Oncol*. 1996;19:114-120.
 92. Grigsby PW, Hall-Daniels L, Baker S, Perez CA. Comparison of clinical outcome in black and white women treated with radiotherapy for cervical carcinoma. *Gynecol Oncol*. 2000;79:357-361.
 93. Howell EA, Chen YT, Concato J. Differences in cervical cancer mortality among black and white women. *Obstet Gynecol*. 1999;94:509-515.
 94. Farley JH, Hines JF, Taylor RR, et al. Equal care ensures equal survival for African-American women with cervical carcinoma. *Cancer*. 2001;91:869-873.
 95. Thoms WW, Unger ER, Johnson PR, et al. Cervical cancer survival in a high risk urban population. *Cancer*. 1995;76:2518-2523.
 96. Huvos AG, Butler A, Bretsky SS. Osteogenic sarcoma in the American black. *Cancer*. 1983;52:1959-1965.
 97. Hoyert DL, Arias E, Smith BL, et al. *Deaths: Final Data for 1999: National Vital Statistics Report, 49(8)*. Hyattsville, Md: National Center for Health Statistics; 2001.
 98. Shwartz M. Estimates of lead time and length bias in a breast cancer screening program. *Cancer*. 1980; 46:844-851.
 99. Feinstein AR, Sosin DM, Wells CK. The Will Rogers phenomenon: stage migration and new diagnostic techniques as a source of misleading statistics for survival in cancer. *N Engl J Med*. 1985;312:1604-1608.
 100. Hunter CP, Redmond CK, Chen VW, et al. Breast cancer: factors associated with stage at diagnosis in black and white women. *J Natl Cancer Inst*. 1993;85: 1129-1137.
 101. Moody-Ayers SY, Wells CK, Feinstein AR. Benign tumors and early detection in mammography-screened patients of a natural cohort with breast cancer. *Arch Intern Med*. 2000;160:1109-1115.
 102. Breen N, Wagener DK, Brown ML, et al. Progress in cancer screening over a decade: results of cancer screening from the 1987, 1992, and 1998 National Health Interview Surveys. *J Natl Cancer Inst*. 2001; 93:1704-1713.
 103. Brown BW, Brauner C, Minnotte MC. Noncancer deaths in white adult cancer patients. *J Natl Cancer Inst*. 1993;85:979-987.
 104. Smedley BD, Stith AY, Nelson AR, eds, for the Committee on Understanding and Eliminating Racial and Ethnic Disparities in Health Care, Board on Health Sciences Policy. *Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care*. Washington, DC: National Academy Press; 2002.