Recruitment in the Prostate, Lung, Colorectal, and Ovarian (PLCO) Cancer Screening Trial: the First Phase of Recruitment at Henry Ford Health System

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Abstract

Objective: **Recruitment of healthy subjects to long-term randomized controlled trials (RCTs) of cancer prevention or early detection has proven to be a difficult task. To quantify recruitment yield as well as characteristics of successfully recruited participants, we examined recruitment outcomes at 1 of the 10 centers participating in the Prostate, Lung, Colorectal and Ovarian (PLCO) Cancer Screening Trial, a National Cancer Institute–funded RCT of cancer screening modalities.**
Materials and Methods: **During the early recruitment phase of PLCO (1993-1997), data on recruitment outcome were collected at the Henry Ford Health System (HFHS) in Detroit, Michigan. In this phase, HFHS identified potential participants using patient databases. Records were used to assess recruitment success by age, sex, race, household income (using area-based U.S. Census data), and preexisting morbidity. Logistic regression was used to assess whether enrollment success differed significantly according to these factors.**
Results: **Of 74,139 persons ages 55 to 74 invited by HFHS to participate, 8,250 (11%) 'enrolled. In multivariate analyses, the odds of enrolling were modestly but significantly higher for women, Caucasians, persons in their 60's, and persons living in census blocks with higher median household income. Persons with two or more preexisting morbidities had significantly lower odds of enrolling compared to those with one or no preexisting morbidities.**
Conclusions: **These data suggest that only a small fraction of persons invited to enroll in long-term RCTs of cancer screening modalities actually do so. In this urban, Midwestern setting, certain characteristics including age, race, and income influenced recruitment success, albeit modestly.** (Cancer Epidemiol Biomarkers Prev 2008;17(4):827–33)

Introduction

Randomized controlled trials (RCT) are of paramount importance in clinical cancer research and are responsible for many of the recent advances in cancer care. Yet recruitment to RCTs can be difficult, especially in the setting of cancer prevention or early detection. These trials usually require large numbers of relatively healthy individuals; furthermore, participants are required to remain committed to the research for many years. Recruitment to early detection trials may be particularly onerous; it is likely that healthy individuals are less willing to volunteer for unnecessary medical procedures, especially those that are experimental, unpleasant, or carry the risk of adverse events.

Adding another level of difficulty to early detection RCTs is that age seems to be inversely related with willingness to participate in cancer research (1-3). Yet rates of the common cancers in the United States are highest among the elderly, and under-representation of this group may affect the generalizability, and consequently, the usefulness of study results. Older African-Americans are particularly difficult to recruit, and as such, remain greatly under-represented in cancer prevention and control studies (4-12).

Although the recruitment of a representative sample is critical, reports that address recruitment strategies and factors that affect participation in cancer prevention and control RCTs are scarce. The dearth of information may explain why study populations, especially those in early detection RCTs, continue to under-represent certain, potentially vulnerable, subpopulations (13-20). We examined aspects of recruitment, including factors that affect recruitment, within one center, the Henry Ford Health System (HFHS), of the Prostate, Lung, Colorectal and Ovarian (PLCO) Cancer Screening Trial, an ongoing RCT of screening modalities for multiple organ sites. HFHS provided a unique opportunity, as its catchment area was quite varied with regard to certain factors including race and income, and data on the base population recruited from were available.

Materials and Methods

The PLCO Cancer Screening Trial is a multicenter RCT designed to evaluate whether certain screening modalities can reduce mortality due to prostate, lung, colorectal, and ovarian cancer. The study began in 1992, recruitment was complete in 2001, and final results are expected in 2014. More than 155,000 individuals, ages 55

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Table 1. Reasons for exclusion from recruitment study population

	Number	Initial sample (%)
Initial sample	80,046	100
Excluded*	5,907	7.3
Missing mailing date	2,750	3.4
Problem with address	1,686	2.1
Not in catchment area	1,335	1.7
Other	136	0.2
Final study population	74,139	92.6

*''Missing mailing date'' includes subjects without verifiable introductory mailing due to incomplete records in tracking database; ''Problem with address'' includes P.O. box only, business address, group home, no address and unable to map; ''other'' includes duplicate records and persons ineligible for PLCO.

to 74 were enrolled, with half randomized to receive the various screening regimens [chest X-ray (lung), flexible sigmoidoscopy (colorectum), prostate-specific antigen serum level and digital rectal examination (prostate, men only), and CA-125 serum level and transvaginal ultrasound (ovary, women only)], the remaining half were advised to seek their usual medical care. Details of the study were published as a supplement to *Controlled Clinical Trials* in December 2000 (21).

HFHS, 1 of the 10 PLCO centers, is an integrated health system based in Detroit, Michigan. Its coverage area includes the city of Detroit as well as surrounding suburban areas. PLCO recruitment at HFHS began in 1993, and >24,000 participants were eventually enrolled, making the HFHS the second largest PLCO center in terms of overall recruitment. Other accomplishments include the recruitment of >3,000 African-Americans and >3,000 persons ages 70 to 74.

During its first phase of recruitment (November 1993-January 1997), HFHS chose to identify potential participants using its administrative patient care databases, which include contact information and information on patient characteristics, as well as data on medical encounters. All persons aged 55 to 74 years old with a medical encounter during the previous 2 years were identified. Demographic information was obtained (name, address, age, sex, and race) from the health system Master Patient Index. These identified individuals were mailed a PLCO introductory letter, which advised that a telephone call would follow to provide interested persons with more information about the trial.

Eligibility verification by telephone was conducted centrally within HFHS by trained interviewing staff using a study-wide standardized questionnaire. Men and women ages 55 to 74 at the time of assessment were eligible as long as they did not meet any of the following exclusion criteria: ongoing treatment for cancer (excluding basal cell and squamous cell skin cancers); history of primary or metastatic cancer of the colon, rectum, lung, prostate, or ovary; previous surgical removal of the entire colon, one lung, entire prostate, or both ovaries (bilateral oophorectomy restriction lifted in October 1996); participation in another cancer screening trial or cancer primary prevention trial; use of finasteride or tamoxifen (females only) or raloxifene in the previous 6 months (tamoxifen/raloxifene restriction lifted in April 1999); history of colonoscopy, sigmoidoscopy, barium enema, or more than one prostate-specific antigen blood test in the previous 3 years; and persons unwilling or unable to sign the informed consent form. If a person was deemed eligible and was interested in participating, he or she was mailed an informed consent as well as another questionnaire. If both were completed and returned, he or she was enrolled and randomized. Participants invited and enrolled beyond the first phase of recruitment could not be used in these analyses as most were not members of the HFHS health maintenance organization and therefore equivalent information on demographic factors and comorbidities was not available.

For the analyses presented in this article, the outcome of recruitment was determined using PLCO records maintained at HFHS. Data on age, sex, and race were obtained from the HFHS databases used to identify potential participants. Information on morbidity, which included diagnosis codes associated with all outpatient, inpatient, and emergency department encounters for the year preceding recruitment attempt, were obtained from health system databases as well, and were categorized and summarized using the Charlson comorbidity index, a weighted sum based on the history of 19 illnesses (Appendix A; refs. 22, 23). Nonweighted counts of morbidities that comprise the Charlson index also were examined, as were individual morbidities.

Because individual income was unavailable, census block group median household income from the 1990 U.S. Census was assigned instead. Census blocks were determined by geocoding addresses obtained from the HFHS patient registration system, and that information was linked to the relevant census data to obtain estimates of median household income. Persons with insufficient or duplicate information, who resided outside the catchment area, who were randomized prior to mailings or after the first phase of recruitment, or who were determined after the fact to be ineligible for PLCO were excluded from these analyses. MapInfo (version 5) was used for geocoding, and SAS version 9.1 (SAS Institute, Inc.) was used for descriptive and statistical analyses. Logistic regression models were used to assess whether enrollment success differed significantly by factors of interest, and statistical significance of interactions of age, sex, median household income, and comorbidities with race (Caucasian versus African-American) were calculated using categorical parameterizations of those variables. Separate models were fit to calculate Caucasian-specific and African-American–specific odds ratios (OR) and 95% confidence intervals (95% CI), and a model containing both Caucasian and African-American subjects was fit to assess the statistical significance of interactions between race and other variables. Because the study did not contain a clustered data structure, and to simplify the analyses, income was treated as an individual level variable.

Results

HFHS administrative databases produced a cohort of 80,046 persons to be invited to participate in the PLCO during the first phase of recruitment. For the purpose of these analyses, a small percentage (7%) were excluded

Table 2. Population characteristics and recruitment outcome for the first phase of recruitment at HFHS

	Invited, *n* (%)	Enrolled, *n* (%)	Yield (%)	OR (CI), unadjusted	OR (CI), adjusted*
Total	74,139 (100)	8,250 (100)	11.1		
Sex					
Male	32,851 (44)	3,151 (38)	9.6	1.00	1.00
Female	41,288 (56)	5,099 (62)	12.3	1.33 (1.28-1.39)	1.36 (1.30-1.43)
Race					
Caucasian	45,505 (61)	6,113 (74)	13.4	1.00	1.00
African-American	22,332 (30)	1,570 (19)	7.0	0.49 (0.46-0.52)	0.61 (0.57-0.65)
Other or unknown	6,302 (9)	567 (7)	9.0	0.64 (0.58-0.70)	0.68 (0.62-0.75)
Age (y)					
55-59	13,491 (18)	1,170 (14)	8.7	1.00	1.00
60-64	20,849 (28)	2,792 (34)	13.4	1.63 (1.52-1.75)	1.62 (1.51-1.74)
65-69	19,532 (26)	2,411 (29)	12.3	1.48 (1.38-1.60)	1.46 (1.36-1.57)
70-74	20,267 (27)	1,877 (23)	9.3	1.08 (0.99-1.16)	1.06 (0.98-1.14)
Median	65 years	65 years			
Household income from census block group					
<$25,000	$23,089 (31)	$1,573 (19)	6.8	1.00	1.00
$25,000-$49,999	$37,166 (50)	$4,951 (60)	13.3	2.10 (1.98-2.23)	1.70 (1.59-1.82)
≥$50,000	$13,884 (19)	$1,726 (21)	12.4	1.94 (1.81-2.09)	1.51 (1.39-1.64)
Median	$33,650	$37,308			
Morbidity †					
No morbidities	58,401 (79)	6,487 (79)	11.1	1.00	1.00
One morbidity	9,169 (12)	1,133 (14)	12.4	1.13 (1.06-1.21)	1.19 (1.11-1.28)
Two or more morbidities	6,569 (9)	630 (8)	9.6	0.85 (0.78-0.93)	0.94 (0.86-1.03)
Median	0	0			

*Adjusted for all other variables in the table.
† Includes morbidities that comprise the Charlson comorbidity index (Appendix A). The median value was calculated using the weighted Charlson score.

due to various reasons, leaving 74,139 persons eligible for inclusion (93%). Reasons for exclusion and associated measures are presented in Table 1. Most were excluded for reasons of unsuitability for these analyses and/or unsuitability for the trial, such as residing in a nursing home or outside of the HFHS catchment area, or having a P.O. Box for an address.

Table 2 displays the distribution of sex and race, as well as median values of age and household income, among those invited. More females were invited

Table 3. Recruitment success, associated adjusted ORs, and CIs for interactions with race by population characteristics for Caucasians and African-Americans

	Invited (yield)		Adjusted OR* (CI)		*P* value, interaction of race and categorical classification
	Caucasians (%)	African-Americans (%)	Caucasians	African-Americans	
Total	45,505 (13.4)	22,332 (7.0)			
Sex					
Male	20,356 (11.4)	9,655 (6.5)	1.00	1.00	
Female	25,149 (15.1)	12,677 (7.5)	1.40 (1.32-1.48)	1.17 (1.06-1.30)	0.009
Age (y)					
55-59	7,958 (10.9)	4,487 (4.9)	1.00	1.00	
60-64	12,729 (15.8)	6,493 (9.0)	1.53 (1.41-1.67)	1.96 (1.67-2.30)	
65-69	12,186 (14.6)	5,670 (7.9)	1.38 (1.27-1.51)	1.77 (1.50-2.09)	0.005
70-74	12,632 (11.4)	5,682 (5.6)	1.04 (0.95-1.14)	1.24 (1.04-1.48)	
Median among those enrolled	65 years	64 years			
Household income from census block group					
<$25,000	6,482 (9.1)	14,867 (5.8)	1.00	1.00	<0.001
$25,000-$49,999	27,151 (14.7)	6,786 (9.3)	1.73 (1.58-1.89)	1.65 (1.48-1.84)	
≥$50,000	11,872 (12.9)	679 (10.5)	1.51 (1.36-1.66)	1.92 (1.49-2.49)	
Median among those enrolled	$40,321	$22,596			
Morbidity †					
No morbidities	36,692 (13.3)	16,245 (7.0)	1.00	1.00	
One morbidity	5,404 (14.9)	3,266 (8.2)	1.17 (1.08-1.27)	1.21 (1.05-1.39)	0.244
Two or more morbidities	3,409 (12.7)	2,821 (6.0)	0.97 (0.87-1.07)	0.87 (0.73-1.03)	
Median among those enrolled	0	0			

*Adjusted for all other variables in the table.
† Includes morbidities that comprise the Charlson comorbidity index (Appendix A).

Table 4. Morbidity and recruitment outcome (selected conditions)

Illness	Invited, *n* (%)	Enrolled, *n* (%)	Yield (%)	OR (CI), unadjusted	OR (CI), adjusted*
Diabetes					
No	68,170 (92)	7,585 (92)	11.1	1.00	1.00
Yes	5,969 (8)	665 (8)	11.1	1.00 (0.92-1.09)	1.21 (1.10-1.33)
Chronic pulmonary disease					
No	70,345 (95)	7,836 (95)	11.1	1.00	1.00
Yes	3,794 (5)	414 (5)	10.9	0.98 (0.88-1.09)	1.06 (0.95-1.19)
Cancer (non-PLCO site) †					
No	71,659 (97)	7,983 (97)	11.1	1.00	1.00
Yes	2,480 (3)	267 (3)	10.8	0.96 (0.85-1.10)	1.00 (0.85-1.16)
Cerebrovascular disease (including stroke)					
No	72,309 (98)	8,039 (97)	11.1	1.00	1.00
Yes	1,830 (2)	211 (3)	11.5	1.04 (0.90-1.21)	1.30 (1.11-1.52)
Peripheral vascular disease					
No	72,689 (98)	8,067 (98)	11.1	1.00	1.00
Yes	1,450 (2)	183 (2)	12.6	1.16 (0.99-1.35)	1.32 (1.12-1.56)
Congestive heart failure					
No	72,312 (98)	8,115 (98)	11.2	1.00	1.00
Yes	1,827 (2)	135 (2)	7.4	0.63 (0.53-0.75)	0.81 (0.67-0.98)
Connective tissue disease					
No	73,162 (99)	8,106 (98)	11.1	1.00	1.00
Yes	977 (1)	144 (2)	14.7	1.39 (1.16-1.66)	1.32 (1.10-1.58)
Myocardial infarction					
No	73,242 (99)	8,180 (99)	11.2	1.00	1.00
Yes	897 (1)	70 (1)	7.8	0.67 (0.53-0.86)	0.85 (0.66-1.09)
Moderate or severe renal disease					
No	73,333 (99)	8,205 (99)	11.2	1.00	1.00
Yes	806 (1)	45 (1)	5.6	0.47 (0.35-0.64)	0.64 (0.46-0.87)

*Adjusted for sex, race, age, household income, and Charlson score.
† Non-PLCO cancers only as a history of PLCO organ cancers was a basis for exclusion from the study.

compared with males (56% versus 44%, respectively). Sixty-one percent of the invited population was Caucasian, whereas 30% was African-American. The distribution of sex and race were very similar to that of the patient population served by HFHS (data not shown). Median age was 65 years old, and median household income from the census block group was $33,650, with nearly a third of the study population having census block group incomes of <$25,000. The median Charlson score was 0, indicating the absence of all listed diagnoses in the year prior to recruitment attempt, whereas nearly 9% of the invited population had two or more of the morbidities that are included in the index.

Data concerning recruitment success, including ORs adjusted for factors under investigation, are also found in Table 2. A greater percentage of invited females were successfully recruited (12.3% for females versus 9.6% for males; adjusted OR, 1.36, 95% CI, 1.30-1.43). Among racial groups, more invited Caucasians enrolled (13.4%) as compared with African-Americans (7.0%; OR, 0.61; 95% CI, 0.57-0.65) or persons who reported other races or did not report their race (9.0%; OR, 0.68; 95% CI, 0.62-0.75). Examination of recruitment success for categories of age showed decreased recruitment among the youngest and oldest strata. Persons who resided in areas with median household income >$25,000 had greater odds of being recruited ($25,000 and $49,999—13.3%; OR, 1.70; 95% CI, 1.59-1.82; $50,000 or more—12.4%; OR, 1.51; 95% CI, 1.39-1.64), as compared with persons who resided in areas with a median household income <$25,000 (6.8%). Differences in recruitment success by number of Charlson Index morbidities were not great, although the comparison of one morbidity with none was statistically significant (12.4% versus 11.1%; OR, 1.19; 95% CI, 1.11-1.28).

Table 3 displays recruitment success and associated adjusted ORs separately for Caucasians and African-Americans, the predominant racial groups invited and recruited at HFHS for PLCO. *P* values for the interaction of race with categorical classification of the variables of interest are included as well. Relative patterns of enrollment within sex, age, and presence of comorbidities were similar for the two races, although the magnitude of ORs for sex and age (but not the presence of comorbidities) did differ significantly by race. For income, the participation had a somewhat different pattern, and the *P* value for interaction by race was statistically significant ($P < 0.001$). African-Americans in the middle ($25,000-$50,000) and highest (at least $50,000) income category had an OR of enrollment of 1.65 (95% CI, 1.48-1.84) and 1.92 (95% CI, 1.49-2.49), respectively, whereas the comparable estimates for Caucasians were 1.73 (95% CI, 1.58-1.89) and 1.51 (95% CI, 1.36-1.66), respectively, so that for African-Americans, participation increased by income; but for Caucasians, participation declined for the highest income group. Among both races, however, persons outside of the lowest income category had significantly higher odds of participating as compared with those in the lowest income category (<$25,000).

Table 4 indicates, as would be expected in a population of this age and medical encounter history, that diabetes and chronic pulmonary disease were relatively common, affecting 8% and 5% of the population, respectively. History of a non-PLCO cancer (solid tumor sites), cerebrovascular disease, congestive heart failure, and peripheral vascular disease were

recorded for a smaller yet nontrivial portion of the invited population. Connective tissue disease, myocardial infarction, and renal disease were noted less often. Other illnesses (including ulcer, dementia, hematologic malignancies, liver disease, and AIDS) were rare in the study population (data not shown). Recruitment success was significantly associated with a number of morbidities: diabetes, cerebrovascular disease, peripheral vascular disease, or connective tissue disease were positively associated, whereas congestive heart failure or renal disease was inversely associated with success.

Discussion

In this analysis of nearly 75,000 persons residing in the Detroit area, we observed that certain characteristics were significantly associated with willingness to enroll in the PLCO Cancer Screening Trial. The odds of enrolling were modestly increased for women, Caucasians, persons in their 60's, persons with one morbidity, and those who resided in areas with a higher median household income. We also observed that for some of these characteristics, in particular, age, sex, and income, the magnitude of the willingness to participate varied by race (Caucasian versus African-American). Our findings support the idea that certain population subgroups are under-represented in medical research, and suggest that special recruitment efforts may be necessary to ensure that early detection study populations properly represent the population as a whole.

The strengths of our study include a large sample size and the ability to assess important demographic and medical characteristics for all potential participants, even those who refused participation. The fact that the population of the Detroit metropolitan area and the HFHS patient population were heterogeneous was another advantage, as it afforded us the ability to assess the effect of race and income. Unfortunately, we were unable to entirely eliminate from our analyses persons who were truly ineligible for PLCO; therefore, our yields cannot be viewed as estimates of willingness to participate among those who truly could have enrolled had they been interested. We view this as a minor limitation, however, as the quantity that our data can measure, the yield among persons invited to participate, was more typical of the situation faced by clinical trialists during enrollment.

We could not assess predictors of enrollment for all PLCO sites; recruitment methods varied by center, and detailed information on persons at other sites who were invited but chose not to participate was usually not collected or maintained (3). If such information had been available, our analyses might have revealed regional differences in predictors of enrollment. Without evidence of homogeneity in predictors, we are limited in our ability to generalize our results to other early detection RCTs.

Much has been written about the difficulties in recruiting cancer patients to treatment trials, and data are available to provide evidence that certain subgroups, in particular older persons, non-Caucasians, and persons of lower socioeconomic status, are under-represented in these research endeavors (1, 2, 24). Less has been written about recruitment to cancer prevention and control trials, although the limited data suggests that certain subgroups are either under-represented or are likely to be under-represented (16, 17, 25, 26). Our report of recruitment success by participant characteristics in a large cancer screening trial seems to be the first of its kind, although Ford et al. reported on the effectiveness of two strategies to recruit African-American men to the PLCO at the HFHS center (16). To the best of our knowledge, analyses of recruitment success by age, sex, morbidity, economic status, and other factors are yet to be published for other early detection RCTs.

Because no other data on recruitment success by participant characteristics in early detection RCTs are available, we chose to compare our findings to those from cancer treatment trials and community-based screening programs. Our results are quite similar to those for treatment trials. Reports of recruitment success in National Cancer Institute–sponsored trials indicated that African-Americans, Hispanic persons, and persons residing in geographic areas with lower socioeconomic levels were less likely to enroll; in addition, a study of persons with small cell lung cancer indicated that persons with comorbidities were less likely to enroll as well (1, 2, 27).

However, one summary analysis of the aforementioned National Cancer Institute–sponsored trials suggested that males were more likely to enroll in treatment trials of lung and colorectal cancer, whereas another suggested no strong sex difference in recruitment to treatment trials for non–sex-specific cancers (1, 2). For the most part, our observations did not agree with those from studies of screening utilization. A number of studies have indicated that African-American women are less likely to use mammography, although data from the National Health Interview Study indicate no difference (28). In contrast with our findings, Heflin et al. observed an increased use of mammography with morbidity unrelated to mobility, whereas Hawley et al. observed colorectal screening to be positively associated with age and not related to sex (29, 30). Age seems to be inversely related to cervical cancer screening, although the relationship of mammography utilization and age has been observed to be nonlinear (31).

Our data suggest that personal characteristics have an effect on participation in cancer research, and our findings concur with much of the available literature on recruitment to cancer RCTs. Rates of enrollment may be higher for women due to health awareness or availability of time, although recent NIH directives to increase participation in clinical trials may be responsible as well (14). The underlying reason for lower participation among minority populations is not known, but it is probable that mistrust of medical research explains much of the hesitation, especially for African-Americans (6, 10, 11, 32). For minority populations with high percentages of recent immigrants, English language difficulties and lack of familiarity with the U.S. medical system may be to blame. Older age and chronic illness may reflect an inability or lack of desire to travel to the screening clinic. Residence in an area of higher economic status may reflect education about medical research or an ability to make time for participation. Of course, the five factors we examined may in part be surrogates for other factors that affect participation, including eligibility

criteria. An example is bilateral oophorectomy, which initially excluded women from PLCO. Published data on hysterectomy consistently show a higher rate among African-American women (33). It is unknown whether rates of bilateral oophorectomy are elevated as well, but if they are, this in part could explain why a lower percentage of African-American women enrolled in the trial. Because we are unable to eliminate persons who were invited to enroll but did not due to ineligibility, we cannot stringently address this hypothesis.

Our analyses covered trial recruitment which occurred >10 years ago, so it is reasonable to wonder if our findings are relevant to current cancer screening trials in the field or those to be undertaken in the future. The terrorist attacks of 2001 have made persons less trusting of unsolicited invitations, and may mean that our recruitment yields are overestimates of what would be observed today if the same activity was undertaken. Furthermore, our data were collected prior to the mandated implementation of the Health Insurance Portability and Accountability Act Privacy Rule in April 2003, and new or additional consent language may be a deterrent against participation, once again suggesting that our yields may be better than what would be observed today. Then again, the higher costs of health care may result in persons, especially those at lower incomes, to seek out opportunities for free screening exams or contact with the medical system, thus resulting in higher yield than we saw in the 1990s.

Study populations need to accurately represent target populations in terms of any characteristic that could potentially influence, either directly or indirectly, the study's outcome. When subgroups are either omitted or represented disproportionately, the usefulness of study results is jeopardized, and questions remain as to whom the results apply. The need for generalizable results in cancer screening trials is strong, as definitive RCTs are expensive, take many years to complete, and are unlikely to be repeated. Our findings provide a starting point for research in recruitment to cancer screening trials, and will hopefully spark additional research in this important area.

Appendix A. Weights for specific illnesses included in the Charlson comorbidity index

Condition	Condition weight
Myocardial infarction, congestive heart failure, peripheral vascular disease, cerebrovascular disease, dementia, chronic pulmonary disease, connective tissue disease, ulcer disease, mild liver disease, diabetes	1
Hemiplegia, moderate or severe renal disease, diabetes with end organ damage, any tumor, leukemia, lymphoma	2
Moderate or severe liver disease	3
Metastatic solid tumor, AIDS	6

Total comorbidity score is a summation of individual condition weights.

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