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Minimal Social Networks Effects Evident in Cancer Screening Behavior

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Abstract

Background—Social networks may influence screening behaviors. We assessed whether screening for breast, prostate, or colorectal cancer is influenced by the actual screening behaviors of siblings, friends, spouse, and coworkers.

Methods—Observational study using Framingham Heart Study data to assess screening for eligible individuals during the late 1990s. We used logistic regression to assess if the probability of screening for breast, prostate, or colorectal cancer was influenced by the proportion of siblings, friends, and coworkers who had the same screening, as well as spouse's screening for colorectal cancer, adjusting for other factors that might influence screening rates.

Results—Among 1660 women aged 41–70, 71.7% reported mammography in the past year; among 1217 men aged 51–70, 43.3% reported prostate specific antigen testing in the past year; and among 1426 men and women aged 51–80, 46.9% reported stool blood testing and/or sigmoidoscopy in the past year. An increasing proportion of sisters who had mammography in the past year was associated with mammography screening in the ego (odds ratio [OR]=1.034, 95% confidence interval [CI]=1.000–1.065 for each 10% increase). A spouse with recent screening was associated with more colorectal cancer screening (OR 1.65, 95% CI=1.39–1.98 vs. unmarried). Otherwise, screening behaviors of siblings, friends, and coworkers were not associated with screening in the ego.

Conclusion—Aside from a slight increase in breast cancer screening among women whose sisters were screened and colorectal cancer screening if spouses were screened, the screening behavior of siblings, friends, or coworkers did not influence cancer screening behaviors.

Keywords

cancer screening; mammography; prostate specific antigen; social networks

Screening for cancer has the potential to save lives by identifying cancers at earlier stages, when they may be more amenable to treatment and cure. Nevertheless, many individuals who may benefit do not undergo routine screening.[1–5] Research suggests that individuals'

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social supports, including family and friends, or their perception that screening is normative among their peers, may positively encourage screening,[6–12] and such findings have led to interventions using peers and/or other community members or worksite interventions to increase rates of screening.[13–17]

Social contacts can strongly influence a variety of behaviors, such as smoking, weight gain, and drinking.[18–20] They might also influence screening behaviors by several mechanisms. Social contacts might provide information or advice about the purpose of specific tests, the benefits of testing, or the need for evaluation of symptoms. They might also provide encouragement to someone who has avoided screening and they may provide emotional support to someone concerned about abnormal screening results. They might share their own experiences with screening, which may be more powerful at influencing behavior than sharing less direct knowledge about the tests. Finally, social contacts might assist a person in finding a doctor or getting to appointments.

Although other studies have suggested benefits of generic social support in encouraging screening behaviors, we are unaware of studies examining whether actual screening behavior of one's peers influence an individual's likelihood of cancer screening. We studied a large network of individuals to assess whether screening for breast cancer, prostate cancer, or colorectal cancer is influenced by the actual screening behaviors of one's siblings, friends, and coworkers, who may differ in their likelihood of discussing screening and their influence on the ego. We hypothesized that the screening behavior of individuals would be positively influenced by the screening behaviors of their contacts, with the effects greater for siblings and friends than coworkers. In this study, we were able to measure actual behavior of individuals' social contacts, rather than rely on an index case to inform us about the behavior of others to whom they were connected.

Methods

Data and subjects

This study used data from the Framingham Heart Study, which, in 1948, enrolled 5209 individuals in the Original cohort.[21] Children of the original cohort and their spouses were recruited in 1971 to form the Offspring cohort; this cohort included 5124 individuals.[22] In 1994, a minority oversample of 508 individuals was initiated, and in 2002, the Third-Generation cohort, consisting of 4095 children of the offspring cohort, was initiated.[23] The study protocol was approved by the institutional review boards of Harvard Medical School and the Boston University Medical Center.

Network

We focused on the 3807 so-called "egos" in the Offspring cohort known to have participated in waves 6 and/or 7 (data collection occurred during 3-year periods centered in 1997 for wave 6 and 1999 for wave 7). The "ego" is the person whose screening behavior is being analyzed. Any persons to whom these subjects are linked (in any of the Framingham Heart Study cohorts) can serve as social contacts, referred to as "alters." Details of the ascertainment of alters are described in detail elsewhere.[18] Briefly, information was derived from archived, administrative tracking sheets used to identify people close to the study participants to facilitate follow-up. The tracking sheets provided complete information about all first-order relatives (parents, spouses, siblings, and children) and at least one "close friend" and these names were linked with the Framingham data to identify ties between egos and alters. Information on address and place of work were used to identify neighbors and coworkers. We classified alters as parents, full sisters, full brothers, friends, and coworkers. We restricted analyses to individuals and their alters who were eligible for screening based

on sex- and age-specific screening recommendations (described below). In sensitivity analyses, we repeated all analyses including a small number of half siblings, step siblings, adopted siblings, and foster siblings (5.8% of all siblings). Results were similar and are not presented. We also identified spouses for analyses of colorectal cancer screening.

Screening behaviors

Data on screening were collected in two waves: wave 6 (1995–1998) and wave 7 (1998–2001). Women were asked the year of their last mammogram, men were asked the year of their last blood test for prostate cancer, and men and women were asked the year when stool was last tested for blood and when sigmoidoscopy was last done.

We assessed screening behavior based on recommendations from national guidelines. For breast cancer screening, we assessed report of mammography within the past year for women ages 41 to 70[24, 25] (results were similar when we restricted to ages 51 to 70, because some guidelines did not recommend mammography for average risk women in their 40s before 1997[26] or later,[27, 28] and results were similar when we assessed mammography within the last 2 years). For prostate cancer screening, we assessed prostate specific antigen (PSA) testing within the past year among men aged 51–70. [25, 29] For colorectal cancer screening, we assessed receipt of stool blood testing within the past year and/or sigmoidoscopy within the past 5 years for individuals aged 51–80. Screening guidelines at the time recommended yearly stool occult blood testing or flexible sigmoidoscopy every 3 to 5 years with stool blood testing or colonoscopy;[25, 27, 30] the survey did not ask specifically about colonoscopy.

Control variables

We identified factors likely to be associated with cancer risk and/or screening behavior. Specifically, we documented each participant's sex and age and we used data from the prior survey wave (including wave 5 information for subjects whose screening behavior was ascertained in wave 6) to characterize additional participant characteristics, including self-rated health status (excellent/very good, good, fair/poor, unknown), number of years of education, marital status, number of children living (whether in the FHS or not), current employment, number of times per week of intense physical activity, current smoking status, number of alcoholic drinks per week, and presence of diabetes, cardiovascular disease, and/or pulmonary disease (asthma or chronic obstructive pulmonary disease/emphysema). We used validated data from the Framingham Study to document history of cardiovascular disease and diabetes; presence of pulmonary disease was based on the clinical impression of the Framingham Study clinic examiner. Continuous variables were not categorized.

Analyses

We evaluated testing among eligible participants for each of the waves; hence participants eligible in both waves contributed two sets of data to the analyses. We used logistic regression models to assess the proportion of siblings, friends, and coworkers who had the same type of screening test on screening for eligible egos (calculating the effect for each 10% increase in the proportion screened). We also controlled for the number of siblings, friends, and coworkers who were eligible for screening. Models for mammography were limited to female siblings, friends, and coworkers, and those for PSA testing were limited to male siblings, friends, and coworkers. Models also included all control variables described above and survey wave (wave 7 vs. 6). The colorectal cancer screening model included men and women, and we included a variable for sex and a variable reflecting marital status and if married whether spouse was screened or not screened. All models used generalized estimating equations, clustering on participants, to account for the possibility that a participant may contribute up to two dependent variable observations (one each wave in the

role of ego) or be involved in multiple observations of the predictor variable (in the role of alter).

Results

We identified 1660 women aged 41–70, who had 597 sisters, 175 female friends, and 174 female coworkers aged 41–70 enrolled in the Framingham Heart Study. A total of 1269 women participated in both waves of the survey, so the total number of observations was 2929 women eligible for mammography; of these 71.7% had undergone mammography in the past year. We identified 1217 men aged 51–70, who had 337 brothers, 142 male friends, and 99 male coworkers aged 51–70. A total of 804 men participated in both waves of the survey, so the total number of observations was 2021; 43.3% had undergone PSA testing in the past year. We identified 3045 men and women aged 51–80. These individuals had 1426 siblings, 364 friends, and 299 coworkers aged 51–80, and 1530 had spouses aged 51–80. A total of 2260 participated in both waves, so the total number of observations was 5305; 46.9% had undergone stool blood testing in the past year and/or flexible sigmoidoscopy in the last 5 years. Characteristics of each cohort are included in Table 1.

Table 2 demonstrates the influence of the screening behaviors of siblings, friends, and coworkers on screening behavior of the ego. For mammography screening, an increasing proportion of sisters who had undergone screening mammography in the past year was slightly associated with mammography screening in the ego (odds ratio [OR] 1.034, 95% confidence interval [CI] 1.000 to 1.065 for each 10% increase in the proportion of sisters screened). At an average rate of 71.7% of women being screened, this odds ratio corresponds to a risk ratio[31] of 1.009, suggesting a very small 0.9% increase in screening rates to 72.4% for a 10% increase in the proportion of sisters screened. Women with a greater number of sisters were less likely than women with fewer sisters to undergo mammography (OR 0.85, 95% CI 0.72 to 1.01), although this finding was of borderline statistical significance (P=.06). The proportion of female friends and female coworkers who had undergone mammography was not associated with the probability of the ego undergoing mammography screening.

The extent of PSA testing in the past year among siblings, friends, and coworkers was not associated with PSA testing among egos, nor was the number of brothers, male friends, or male coworkers.

For colorectal cancer screening with stool blood tests and/or sigmoidoscopy, individuals married to a spouse that had been screened were more likely to be screened than those who were unmarried (OR 1.65, 95% CI 1.39 to 1.98), with a risk ratio[31] of 1.296. With 42.6% of unmarried individuals screened, this corresponds to a 12.6% absolute increased risk of screening, to 55.2% for married individuals whose spouses were screened. Individuals married to a spouse who had not been screened or for whom screening status was unknown did not differ from unmarried individuals in screening. The non-overlapping confidence intervals for married patients whose spouses were or were not screened suggest that screening status of the spouse is a more important factor than marital status itself. The proportion of siblings, friends, or coworkers who had been screened was not associated with screening. Individuals with more friends were less likely to undergo colorectal cancer screening (OR 0.73, 95% CI 0.58 to 0.91 for each additional friend in the cohort).

In each model we adjusted for several control variables, some of which had significant effects. Other characteristics of the egos associated with mammography screening included older age (OR 1.02, 95% CI 1.01 to 1.04 for each year of age), being married (OR 1.63, 95% CI 1.33, 2.00), and being physically active 4 or more times per week (OR 1.05, 95% CI

1.00, 1.09). Smokers were much less likely to undergo mammography than nonsmokers (OR 0.56, 95% CI 0.44, 0.71) as were women with more comorbid illnesses (OR 0.80, 95% CI 0.65 to 0.99). Participants surveyed in the wave centered in 1999 were more likely to have mammograms than those surveyed in the wave centered in 1997 (OR 1.40, 95% CI 1.21 to 1.62).

For PSA testing, older men were more likely to be screened than younger men (OR 1.05, 95% CI 1.03 to 1.08). Married men had more PSA tests than unmarried men (OR 1.73, 95% CI 1.29, 2.31), and men with more years of education were more likely to have PSA testing (OR 1.08, 95% CI 1.04, 1.12). Smokers were less likely than nonsmokers to have PSA testing (OR 0.71, 95% CI 0.54, 0.94) as were men with more comorbid illnesses (OR 0.76, 95% CI 0.62 to 0.94). Men surveyed in wave 7 were more likely to report recent PSA testing than those surveyed in wave 6 (OR 1.59, 95% CI 1.35, 1.87), reflecting the general increase in the use of screening over this time-frame.

For stool blood testing or flexible sigmoidoscopy, older participants were more likely to report screening (OR 1.02, 95% CI 1.01 to 1.03). Participants who worked were less likely than those who did not to be screened (OR 0.85, 95% CI 0.74, 0.98), as were those who smoked (OR 0.62, 95% CI 0.51 to 0.74) and those with more comorbidities (OR 0.83, 95% CI 0.73 to 0.94). Participants surveyed in the wave centered in 1999 were more likely to undergo colon cancer screening than those surveyed in the wave centered in 1997 (OR 1.52, 95% CI 1.38, 1.67).

Discussion

We examined whether screening behavior of siblings, friends, coworkers, and spouses influenced analogous screening behaviors of individuals. We found that mammography screening increases with an increasing proportion of sisters who have had a mammogram (although women with more sisters were less likely to get mammograms, a finding of borderline statistical significance). PSA testing did not vary by the proportion of brothers, friends, or coworkers who had the test. Colorectal cancer screening was strongly associated with screening among one's spouse, but not with the proportion of friends who were screened.

Several studies suggest that support of others increases an individual's likelihood of participating in cancer screening. For example, women with higher scores on the social network index[6, 7] or who report social support from physicians, family, and friends[8] are more likely to undergo mammography and Pap smears. In addition, a study of employed women found that women who perceived that screening is normative among their peers were more likely to undergo regular mammography, although the extent of social support and the size of one's social network was not associated with screening behavior.[9] On the other hand, two studies have observed that women reporting explicit encouragement to undergo mammography by social network members were less likely to be screened,[9, 32] suggesting that the women who avoid mammography may be more likely to be offered encouragement from others. Perceived risk of cancer is also associated with mammography screening, and this perceived risk is often due to a family history of cancer.[33] In a previous study using data from the Framingham study, reporting a family history of breast cancer was strongly associated with reporting a mammogram in the last 2 years.[34]

In the current study, we were able to broaden the scope of social contacts examined (to include friends and coworkers), broaden the nature of cancers considered, and, most important, trace out direct ties between people and directly query alters about screening behavior rather than merely surveying egos about alters.

Past research suggests that friends can influence mammography behavior with direct efforts. One study randomized individuals to call or not call friends to encourage them to get a mammogram. Friends who received a call had a 15% increase in mammography compared with those who did not receive a call. This effect remained after controlling for demographic characteristics, was effective for black and white women of all ages, and was most pronounced among women with lower household incomes.[35] In addition, women reporting close friends with whom they could discuss their health were more likely to have ever had a Pap smear.[11] Programs have thus been developed that successfully use social support to improve screening for cervical cancer and breast cancer.[36]

Fewer data are available about the impact of interventions on social contacts on prostate cancer screening or colorectal cancer screening. The value of PSA testing for prostate cancer remains controversial,[37] yet research suggests that patients deciding about PSA testing value anecdotes about the decisions of friends, family, or media celebrities.[38] Thus, we had expected that the prostate screening behaviors of alters would influence those of the egos in our study. Consistent with other research,[39] we found that married men were more likely than unmarried men to undergo PSA screening. Men may be encouraged by their wives to get more routine and preventive care, or may be persuaded to get PSA testing specifically.

Colorectal cancer screening can be inconvenient and invasive, and, for colonoscopy, requires time off from work and someone to accompany the individual to the procedure. These factors may lead to negative attitudes about screening.[40] Nevertheless, support from friends and family has been associated with screening, as have positive attitudes about the screening and beliefs that it is safe.[41] We found a strong association of colorectal cancer screening among spouses of individuals who have been screened, but no associations based on the proportion of siblings, friends, or coworkers who were screened.

Overall, this work again reinforces the distinction between social support and social network effects.[42] The existence of social ties, and the willingness of others to help with health care can affect screening, as suggested by prior work. However, this is a different effect than that of the specific influence whereby an alter's actual behavior influences a similar behavior in an ego. By analogy, it is the difference between the impact on a person's happiness of having many friends versus the impact on a person's happiness of having friends who are themselves happy.[43] We found that the screening behaviors of one's contacts, at least among those contacts included in the study, had little relevance to screening behaviors. Screening behaviors may be less "contagious" because they are not easily observed (unlike smoking, alcohol, obesity, and happiness)[18–20, 43] and may not be comfortable topics to discuss. New evidence suggests that ties among friends are influenced by observable characteristics such as obesity and smoking, but not by less easily observed traits, such as blood pressure and depression score.[44]

Our findings should be interpreted in light of some limitations. First, information on screening was only collected in two waves of the Framingham Study, both during the late 1990s. Thus, we cannot be certain that the findings are relevant to current screening behaviors; screening rates for colorectal cancer have increased since this time,[45] although our study period corresponded with the peaking of mammography rates, which declined in the early 2000s.[46] Second, our study focused on a single community that was lacking in racial and ethnic diversity, so the generalizability of our findings to other populations requires further study. Rates of prostate cancer screening in our cohort were lower than those of colorectal cancer screening, which has not been observed nationally.[47] Third, we could only assess screening behaviors among alters who were included in the Framingham cohorts and of ages that would make them eligible for screening themselves, and our cohort of egos had relatively few alters in the study, limiting our power to observe effects.

Moreover, if an individual had many friends but few were in the Framingham cohorts, then our study would likely underestimate the effects of the other friends' behaviors. Fourth, the survey question about stool blood testing did not distinguish in-office or at-home testing. Finally, self-report of screening may overestimate use.[48]

In conclusion, mammography receipt among sisters and colorectal screening among spouses slightly influenced personal screening behaviors, but otherwise screening behaviors of siblings, friends, and coworkers were not associated with increased rates of cancer-specific screening. These observations suggest that while many health behaviors may spread across social ties, not all health behaviors necessarily do. Some behaviors may be intrinsically more "contagious", just like some fashions are easier to adopt and some germs are more contagious than others.

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Table 1

Characteristics of the study cohorts

	Breast cancer screening cohort*	Prostate cancer screening cohort†	Colorectal cancer screening cohort‡
Mean (SD) age	57.2 (7.3)	59.8 (5.5)	62.3 (7.6)
Mean (SD) number of years of education	13.9 (2.2)	14.6 (2.8)	14.0 (2.5)
Married (%)	72.1	85.1	75.9
Spouses screened among married (%)			
Unmarried	-	-	24.3
Married, spouses screened	-	-	24.1
Married, spouses not screened	-	-	27.5
Married, unknown if spouses screened	-	-	24.1
Sex			
Female	-	-	54.0
Male	-	-	46.0
Mean (SD) number of children	2.6 (1.6)	2.8 (1.6)	2.9 (1.6)
Mean (SD) number of times per week intense physical activity	2.2 (2.1)	2.8 (2.7)	2.4 (2.4)
Currently working (%)	61.7	64.7	51.8
Mean (SD) number of drinks per week	3.6 (5.4)	7.6 (10.0)	5.2 (7.9)
Current smoker (%)	16.5	18.3	15.4
Self reported health (%)			
Excellent/very good	43.4	43.9	39.9
Good	49.9	47.9	51.2
Fair/poor	6.0	7.3	7.7
Unknown	0.7	0.9	1.1
Number of comorbidities (%)¶			
0	83.9	76.6	78.1
1	15.1	20.2	19.3
2 or 3	1.0	3.2	2.6
Survey wave (%)			
Wave 6	51.2	50.1	47.7
Wave 7	48.8	49.9	52.3
Mean (SD) number of eligible siblings in cohort Ω	0.4 (.7) (range 0–4)	0.3 (0.6) (range 0–3)	0.7 (1.0) (range 0–5)
Mean (SD) number of friends in cohort	0.1 (0.3) (range 0–2)	0.1 (0.3) (range 0–1)	0.1 (0.3) (range 0–2)
Mean (SD) number of coworkers in cohort	0.2 (0.9) (range 0–10)	0.1 (0.5) (range 0–7)	0.2 (0.9) (range 0–10)
% reporting screening in past year	71.7	43.3	46.9

*Based on 2929 observations for 1660 women.

†Based on 2021 observations for 1217 men.

‡Based on 5305 observations for 3045 men and women.

¶Considering heart disease, diabetes, and chronic obstructive pulmonary disease

ΩSiblings included sisters for breast cancer screening cohort, brothers for prostate cancer screening cohort, and sisters and brothers for colorectal cancer screening cohort who met screening criteria.

Table 2

Factors associated with recommended screening in egos

	Odds Ratios (95% Confidence Intervals*)		
Alters Use of Screening	**Mammogram in past year**	**PSA in past year**	**Stool card in past year and/or flex sig in past 5 years**
Siblings Ω			
10% increase in proportion of siblings with test	1.034 (1.000 to 1.065)†	1.005 (0.969 to 1.042)	1.009 (0.992 to 1.027)
Number of siblings	0.85 (0.72 to 1.01)‡	0.87 (0.72 to 1.07)	0.95 (0.89 to 1.02)
Friends			
10% increase in proportion of friends with test	1.012 (0.958 to 1.070)	1.021 (0.970 to 1.074)	1.017 (0.986 to 1.049)
Number of friends	0.96 (0.57 to 1.64)	1.08 (0.73 to 1.59)	0.73 (0.58 to 0.91)†
Coworkers			
10% increase in proportion of coworkers with test	0.987 (0.941 to 1.037)	0.947 (0.803 to 1.021)	1.023 (0.984 to 1.064)
Number of coworkers	0.96 (0.86 to 1.07)	1.11 (0.89 to 1.38)	0.97 (0.89 to 1.05)
Spouse screened among married (%)			
Unmarried	-	-	1.0
Married, spouse screened	-	-	1.66 (1.39 to 1.98)†
Married, spouse not screened	-	-	1.06 (0.89 to 1.27)
Married, unknown if spouse screened	-	-	1.07 (0.89 to 1.27)
Age	1.02 (1.01 to 1.04)†	1.05 (1.03 to 1.08)†	1.02 (1.01 to 1.03)†
Married	1.63 (1.33 to 2.00)†	1.73 (1.29 to 2.31)†	-
Sex			
Male	-	-	1.0
Female	-	-	1.00 (0.87 to 1.15)
Years of education	0.99 (0.94 to 1.03)	1.08 (1.04 to 1.12)†	1.06 (1.03 to 1.09)†
# of children	0.99 (0.92 to 1.05)	0.95 (0.89 to 1.02)	1.00 (0.96 to 1.04)
Currently working	0.90 (0.73 to 1.10)	0.90 (0.71 to 1.14)	0.85 (0.74 to 0.98)†
Physical activity	1.05 (1.00 to 1.09)†	1.00 (0.96 to 1.04)	1.00 (0.98 to 1.02)
# drinks/week	1.00 (0.98 to 1.02)	1.00 (0.99 to 1.01)	1.00 (1.00 to 1.01)
Smokes	0.56 (0.44 to 0.71)†	0.71 (0.54 to 0.94)†	0.62 (0.51 to 0.74)†
Self reported health status			
Very good/excellent	1.0	1.0	1.0
Good	1.01 (0.84 to 1.21)	0.95 (0.78 to 1.15)	0.97 (0.86 to 1.09)
Fair/poor	1.09 (0.74 to 1.61)	0.85 (0.56 to 1.27)	1.04 (0.82 to 1.32)
Unknown	0.37 (0.15 to 0.95)†	0.64 (0.21 to 1.94)	0.37 (0.20 to 0.69)†
Number of comorbid illnesses¶	0.80 (0.65 to 0.99)†	0.76 (0.62 to 0.94)	0.83 (0.73 to 0.94)
Survey wave			
Wave 6	1.0	1.0	1.0
Wave 7	1.40 (1.21 to 1.62)	1.59 (1.35 to 1.87)	1.52 (1.38 to 1.67)

[*] Using generalized estimating equations to account for clustering within participants because some participants had data from both waves 6 & 7 and/or functioned (multiple times) as alters. Adjusted for participant age, level of education, marital status, number of children, employment status, level of physical activity, smoking status, self-reported health status, coronary heart disease, diabetes, chronic obstructive pulmonary disease, and survey wave.

Only female siblings, friends, and coworkers were included in mammography analyses, only male siblings in PSA analysis.

PSA=prostate specific antigen

[†] $P<.05$

[‡] $P<.10$

[¶] Considering heart disease, diabetes, and chronic obstructive pulmonary disease

[Ω] Siblings included sisters for mammography analysis, brothers for PSA analysis, and sisters and brothers for colorectal screening analysis who met screening criteria.