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Shift Work and Cancer Screening: Do Females Who Work Alternative Shifts Undergo Recommended Cancer Screening?

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Background *Alternative shift work is classified as a probable human carcinogen. Certain cancer screening tests reduce cancer mortality.*
Methods *The 2010 National Health Interview Survey was used to examine associations between adherence to breast, cervical, and colon cancer screening recommendations and alternative shift work among female workers.*
Results *Workers on alternative shifts, compared to workers on daytime shifts, were more likely to be non-adherent to screening recommendations for breast (34% vs. 23%) and colorectal (55% vs. 48%) cancer ($P < 0.05$). Workers on alternative shifts in two industries ("Manufacturing" and "Accommodation/Food Services") and three occupations ("Food Preparation/Serving," "Personal Care Services," and "Production") were more likely to be non-adherent to screening recommendations for at least two cancers ($P < 0.05$).*
Conclusions *The Affordable Care Act eliminates out-of-pocket screening expenses for these three cancers. Greater efforts are needed to promote this benefit, particularly among workers with demonstrated non-adherence.* Am. J. Ind. Med. 57:265–275, 2014. Published 2013. This article is a U.S. Government work and is in the public domain in the USA.

KEY WORDS: industry; occupation; shift work; cancer screening recommendations; breast cancer; cervical cancer; colorectal cancer

INTRODUCTION

Alternative shift work is relatively common. Recent population statistics estimate that 15–20% of the full-time U.S. labor force worked alternative shifts [Bureau of Labor Statistics, 2005]. Alternative shifts are any shifts outside of regular daytime working hours and include evening, night, rotating, and other unspecified schedules [Bureau of Labor Statistics, 2005; Alterman et al., 2013]. In 2007, alternative shift work (specifically shiftwork that involves circadian disruption) was classified by the International Agency for Research on Cancer (IARC) as a probable human carcinogen [International Agency for Research on Cancer, 2007]. This determination was largely based on epidemiological studies of female nurses and flight attendants who worked night shifts for many years and were found to have an elevated risk of breast cancer compared to workers employed on day shifts. Alternative shift work may contribute to cancer development through several mechanisms, including by disrupting circadian rhythm, influencing melatonin secretion/production, affecting lifestyle choices/behaviors, and influencing SES [Wang et al., 2011]. Alternative shift work (in particular night shift work) appears to be associated with increased

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smoking [Schernhammer et al., 2001; Schernhammer et al., 2003; Kolstad, 2008] and alcohol consumption [Fritschi et al., 2011] rates, poor dietary habits [Schernhammer et al., 2001; Schernhammer et al., 2003; Haus and Smolensky, 2006; Viswanathan et al., 2007; Kolstad, 2008], and low physical activity levels [Fritschi et al., 2011; Nabe-Nielsen et al., 2011], which are contributing factors for cancer development [Vucenik and Stains, 2012].

The United States Preventive Services Task Force (USPSTF) determined that screening for breast, cervical and colorectal cancers increases cancer survival through early detection and treatment [U.S. Preventive Services Task Force, 2008, 2009; Moyer and U.S. Preventive Services Task Force, 2012]. Given the potential cancer risks for workers employed on alternative shifts and the effectiveness of certain cancer screening tests, data from the 2010 National Health Interview Survey was used to assess whether employment on alternative shifts is associated with adherence to screening recommendations for breast, cervical and colorectal cancers.

MATERIALS AND METHODS

National Health Interview Survey

National Health Interview Survey (NHIS) is a cross-sectional in-person household population health survey conducted annually in the United States since 1957 by the National Center for Health Statistics (CDC). Data are collected on the civilian non-institutionalized population of the United States [Pleis et al., 2010]. The survey uses a multi-stage clustered sample design, oversampling blacks/African Americans, Hispanics, and Asians. NHIS produces nationally representative data on health related topics such as health care access and utilization, health status, and health behaviors. NHIS survey has been previously described in detail [Luckhaupt et al., 2013].

The 2010 NHIS was approved by the Research Ethics Review Board of the National Center for Health Statistics (Protocol #2009-16) and the U.S. Office of Management and Budget (Control #0920-0214). Oral consent prior to participation was sought from all 2010 NHIS respondents.

Study Populations and Adherence to Cancer Screening Recommendations

The study population was restricted to adult females who worked at any time within 12 months preceding interview, supplied work schedule information, and provided the frequency of and reason for breast, cervical, and/or colorectal cancer screening. These three cancer screening recommendations were selected for analysis because they are the only tests found by USPSTF to decrease cancer mortality. For the sake of analytic consistency across the three cancer screening recommendations, only females were included in the analyses. Females who received testing for diagnostic purposes (not screening purposes) were excluded from analyses.

The study populations were restricted based on age recommendations issued by USPSTF for each of the three cancer screening tests. For the breast cancer screening analyses, the study population was restricted to females, aged 50–74 years. Adherence to breast cancer screening recommendations was defined as having had a mammogram within 2 years preceding interview. For the cervical cancer screening analyses, the study population was restricted to females, aged 21–65 years, with no history of hysterectomy. Adherence to cervical cancer screening recommendations was defined as having had a pap smear within 3 years preceding interview. Although human papillomavirus (HPV) testing was added to USPSTF cervical cancer screening recommendations in 2012, HPV testing was not used to determine adherence to cervical cancer screening because NHIS did not collect this information. For colorectal cancer screening, the study population was restricted to females, aged 50–75 years. Adherence to colorectal cancer screening could be met in one of three ways: (1) colonoscopy within 10 years preceding interview, (2) sigmoidoscopy within 5 years and fecal occult blood test within 3 years preceding interview, or (3) fecal occult blood test within 1 year preceding interview.

These three study populations were not mutually exclusive because they were drawn from the same pool of subjects. For each of the three analyses, females who had never been screened or were not screened within the USPSTF recommended time frame for that particular cancer were classified as being non-adherent to cancer screening recommendations.

Classification of Shift Work, Industry, and Occupation

Adults who were currently employed or were employed within the last 12 months at the time of the interview were asked to describe the hours they usually worked at their current job, or, if not currently employed, at the job(s) they were employed at within the past 12 months. The question stated "Which of the following best describes the hours you usually work/worked?" Response choices included: (1) regular daytime schedule, (2) regular evening shift (4 pm to midnight), (3) regular night shift (midnight to 8 am), (4) rotating shift (combination of day, evening, or night shift), and (5) some other schedule. For some analyses, the five shift work categories were dichotomized as (1) workers on regular daytime shifts (regular daytime schedule) and (2) workers on alternative shifts (all other shifts/schedules).

Each employed sample adult provided his/her industry (employer's type of business) and occupation (employee's type of work) for the main job held in the 12 months

preceding interview (i.e., most recently held job). These responses were reviewed by U.S. Census Bureau coding specialists who assigned 4-digit I&O codes based on the 2007 North American Industrial Classification System (NAICS) and 2010 Standard Occupational Classification (SOC) system. To allow for sufficient sample size for more reliable estimates, the less detailed 2-digit I&O recodes were used. The industry recodes consist of 21 simple industry categories, and 23 occupation categories.

Potential Confounders and Effect Modifiers

Behavioral and personal factors such as obesity, smoking status, alcohol consumption, race, income, education, health insurance coverage, and marital status were considered to be potential risk factors. Each of these factors has been previously linked to working alternative shifts [Gordon et al., 1986; Trinkoff and Storr, 1998; Nabe-Nielsen et al., 2011; Barbadoro et al., 2013]. Each potential risk factor was checked for confounding and interaction by examining the associations of each confounder with both adherence to cancer screening recommendations and alternative shift work. Only variables that meet the definition of a confounder and changed the risk estimate by at least 10% for the majority of the models were included in the final model. Since the study population selected for the cervical cancer screening analysis covered a wide age range (21–65 years), age was considered as a potential confounder and effect modifier for the cervical cancer analyses.

Data Analysis

Data analyses was conducted in 2012 using SAS ® 9.2 callable SUDAAN® Release 10.0.0 (Research Triangle Institute, Research Triangle Park, NC) to account for population sampling weights. The sampling stratum clusters and weights for all the analyses were provided by NHIS survey documentation. Poisson regression was used to estimate the adjusted prevalence ratios (PR) and 95% confidence intervals (CIs) for all analyses.

The chi-square test was used to assess potential confounding effects of behavioral and personal risk factors on alternative shift work and cancer screening. Variable selection for the final model was based on statistical results, prior knowledge of confounders, and pursuit of a parsimonious model that best fit all three screening tests.

The "loglink" procedure in SUDAAN® was used to calculate the PR and 95% CIs for each I&O category with sufficient sample size (i.e., no empty cells). For each I&O category, adherence to cancer screening recommendations was assessed for all workers and for workers employed on alternative shifts. In the analyses examining workers employed on alternative shifts, the comparison group consisted of all workers employed on day shifts. In the analyses examining all workers stratified by I&O categories, "Public Administration" was the comparison group for industry and "Business and Financial Operations" was the comparison group for occupation. These were selected as the comparison groups based on the following criteria: the category had more than 100 eligible individuals and had a high adherence rate for each of the three cancer screening recommendations.

Relative standard error (RSE) was calculated based on the prevalence of females who adhered to cancer screening recommendations. Risk estimates with a RSE $\geq$50% were considered too unstable to report. Statistical significance was defined as a P-value < 0.05. Correction for multiple comparisons was not done.

RESULTS

Among the 9,009 females who provided shift work information, 27.4% worked on alternative shifts (representing 8,754,136 million U.S. females who work alternative shifts). The analyses included 2,457 female workers for breast cancer screening, 6,238 for cervical cancer screening, and 2,176 for colon cancer screening. The non-adherence proportions for breast, cervical, and colon cancer screening recommendations were 26.2%, 15.6%, and 51.4%, respectively.

Regarding potential confounders, only smoking, health insurance coverage, income and education were consistently associated with both shiftwork status and cancer screening (data not shown). The final model adjusted only for health insurance coverage, as other confounders had little effect on the estimate for screening adherence when health insurance coverage was in the model. A total of 25% of workers on alternative shifts and 16% of workers on regular daytime shifts did not have health insurance. Although health insurance is a strong predictor for adherence to cancer screening, it was not found to be an effect modifier for the association between adherence to cancer screening recommendations and shiftwork status (Table I).

In the cervical cancer analysis, age had a marginally significant interaction with alternative shift work. Among workers aged 40 years or older, workers on alternative shifts were 23% more likely to be non-adherent to cervical cancer recommendations compared to workers on regular daytime shifts ($P = 0.02$). For workers younger than aged 40 years, no such difference in adherence was found among those employed on alternative shifts compared to day shifts. Education was found to modify the estimate for breast cancer screening. Among workers with at least some college education, workers on alternative shifts had lower adherence to breast cancer screening than workers on day shifts. Aside from age and education, no other variables were found to be effect modifiers.

TABLE I. Non-Adherence to Cancer Screening Recommendations Among Female Workers on Alternative Shifts by Health Insurance Status

	Health insurance					
	Yes			No		
	Non-adherent, unweighted N (%)	PR	95% CI	Non-adherent, unweighted N (%)	PR	95% CI
Breast cancer screening[a]						
Daytime shift	331 (19.6)	Ref	—	115 (57.8)	Ref	—
Alternative shift	129 (27.3)	**1.39**	**1.17–1.67**	67 (71.3)	**1.23**	**1.03–1.48**
Cervical cancer screening[b]						
Daytime shift	429 (10.8)	Ref	—	263 (33.8)	Ref	—
Alternative shift	135 (11.6)	1.07	0.88–1.30	144 (35.2)	1.04	0.87–1.25
Colorectal cancer screening[c]						
Daytime shift	671 (44.6)	Ref	—	152 (80.6)	Ref	—
Alternative shift	216 (50.4)	1.13	1.00–1.27	78 (81.1)	1.01	0.89–1.14

All estimates are weighted unless otherwise noted. Data include only U.S. working adult females who are part of the civilian non-institutionalized population. Findings in bold are statistically significant.
PR, prevalence ratio; CI, confidence interval.
[a]Mammogram screening within the last 2 years (50–74 years old).
[b]Pap smear within the last 3 years (21–65 years old).
[c]Where colonoscopy was done within the last 10 years, or sigmoidoscopy within the last 5 years and fecal occult blood test within the last 3 years, or fecal occult blood test within the past year (50–75 years old).

Adherence to Cancer Screening Recommendations by Type of Shift

Workers on alternative shifts were 35% ($P < 0.001$) more likely to be non-adherent to breast cancer screening recommendations and 10% ($P = 0.048$) more likely to be non-adherent to colorectal cancer screening recommendations (Table II). There was no difference in adherence for cervical cancer screening (Table II), apart from the age interaction described above.

Findings varied by specific types of alternative shift. For breast cancer screening recommendations, workers on any type of alternative shift had higher non-adherence than those employed on regular daytime shifts. However, these findings were statistically significant for those employed on regular evening shifts and on rotating shifts only. Similarly, for the cervical cancer screening recommendations, those employed on regular evening shifts were significantly more likely to be non-adherent compared to those employed on regular daytime shifts. For the colorectal screening recommendations, those employed on regular night and on rotating shifts were significantly more likely to be non-adherent (Table II).

Adherence to Cancer Screening Recommendations Among All Current Workers

Among workers on all shifts, the industries associated with significantly reduced adherence to screening recommendations for all three cancers were the "manufacturing" and "retail trade" industry categories, compared to workers employed in "public administration." The occupations with significantly reduced screening adherence for all three cancers were "food preparation and serving," "personal care and service," "sales and related", and "production" compared to workers employed in "business and financial operations." Furthermore, significantly lower screening adherence for two of the three cancers was found for employment in five industry categories ("agriculture, forestry, fishing, and hunting," "wholesale trade," "transportation and warehousing," "arts, entertainment, and recreation," and "accommodation and food services"), and seven occupation categories ("education, training, and library," "arts, design, entertainment, sports and media," "healthcare support," "building and grounds cleaning and maintenance," "office and administrative support," "farming, fishing and forestry," and "transportation and material moving"; Table III).

Adherence to Cancer Screening Recommendations by Industries and Occupations Among Workers Employed on Alternative Shifts

Breast cancer screening

Compared to all workers on regular daytime shifts, workers on alternative shifts in four industry categories (i.e., "manufacturing," "health care and social assistance," "arts, entertainment, and recreation," and "accommodation and food services") were significantly more likely to be non-adherent to breast cancer screening recommendations.

TABLE II. Distribution of Shiftwork Status and Non-Adherence With Cancer Screening Recommendations Among Female Workers, National Health Interview Survey 2010

	Non-adherent, unweighted N (%)	PR[a]	95% CI
Breast cancer screening[b] (50–74 years old)			
Regular daytime shift workers	447 (23.2)	1.00	
Regular evening shift workers	38 (46.7)	**1.81**	**1.39–2.37**
Regular night shift workers	27 (34.7)	1.28	0.94–1.74
Rotating shift workers	55 (33.2)	**1.34**	**1.06–1.68**
Some other shift workers	76 (29.9)	1.19	0.98–1.46
All alternative shift workers[c]	196 (34)	**1.35**	**1.17–1.55**
Cervical cancer screening[d] (21–65 years old)			
Regular daytime shift workers	695 (14.1)	1.00	
Regular evening shift workers	68 (21.7)	**1.32**	**1.05–1.67**
Regular night shift workers	33 (15.5)	0.90	0.65–1.25
Rotating shift workers	92 (16.7)	0.98	0.78–1.21
Some other shift workers	86 (16.1)	1.06	0.87–1.29
All alternative shift workers[c]	279 (17.3)	1.06	0.92–1.21
Colon cancer screening[e] (50–75 years old)			
Regular daytime shift workers	824 (48.2)	1.00	
Regular evening shift workers	47 (56.6)	1.13	0.90–1.41
Regular night shift workers	49 (68.8)	**1.34**	**1.13–1.58**
Rotating shift workers	93 (59.4)	**1.17**	**1.01–1.36**
Some other shift workers	105 (48.3)	0.98	0.83–1.15
All alternative shift workers[c]	294 (55.4)	**1.10**	**1.00–1.21**

All estimates are weighted unless otherwise noted. Data include only U.S. working adult females who are part of the civilian non-institutionalized population. Findings in bold are statistically significant.
PR, prevalence ratio; CI, confidence interval.
[a]Adjusted for health insurance coverage.
[b]Mammogram screening within the last 2 years.
[c]Include regular evening schedule, regular night schedule, rotating schedule, and some other schedule.
[d]Pap smear within the last 3 years.
[e]Where colonoscopy was done within the last 10 years, or sigmoidoscopy within the last 5 years and fecal occult blood test within the last 3 years, or fecal occult blood test within the past year.

Similarly, workers on alternative shifts in four occupation categories; "food preparation and serving," "office and administrative support," "production," and "personal care and service" (e.g., animal care workers, barbers, hairdressers, funeral service workers, tour guides, and flight attendants) were also significantly more likely to be non-adherent to breast cancer screening recommendations (Table IV).

Cervical cancer screening

Workers on alternative shifts in the industry categories of "wholesale trade" and "other services" (e.g., includes equipment repairing, laundry services, temporary parking services, and grant-making, and giving services) were significantly more likely to be non-adherent to the cervical cancer screening recommendations compared to all workers on regular daytime shifts. As for occupation categories, non-adherence was significantly higher for workers employed on alternatives shifts in "personal care and service," "farming, fishing and forestry," and "construction and extraction" (Table IV).

Colorectal cancer screening

Compared to all workers on regular daytime shifts, workers employed on alternative shifts in the "manufacturing" and "accommodation and food services" industry categories, and in the "transportation and material moving," "food preparation and serving," and "production" occupation categories were significantly more likely to be non-adherent to colorectal cancer screening recommendations (Table IV).

DISCUSSION

To the best of our knowledge, this is the first study to examine the association between alternative shift work and cancer screening adherence. Overall, workers on alternative

TABLE III. Non-Adherence With Cancer Screening Recommendations Among Females by Most Recently Held Industry and Occupation, All Shifts Combined, National Health Interview Survey 2010

	Breast cancer screening[a]			Cervical cancer screening[b]			Colorectal cancer screening[c]		
		Multivariate[d]			Multivariate[d]			Multivariate[d]	
	Non-adherent, unweighted N (%)	PR[e]	95% CI	Non-adherent, unweighted N (%)	PR[e]	95% CI	Non-adherent, unweighted N (%)	PR[e]	95% CI
Industries									
Agriculture, forestry, fishing, and hunting	14 (40)	**1.83**	**1.04–3.22**	16 (16)	1.31	0.71–2.45	22 (64)	**1.62**	**1.19–2.21**
Mining	1 (26)	1.23[f]	0.46–3.26	1 (8)	--	--	2 (46)	1.16[f]	0.54–2.50
Utilities	2 (14)	--	--	2 (11)	--	--	4 (30)	0.77[f]	0.32–1.88
Construction	18 (28)	1.31	0.82–2.10	**21 (21)**	**1.74**	**1.03–2.94**	30 (51)	1.29	0.91–1.81
Manufacturing	147 (36)	**1.67**	**1.28–2.18**	**108 (19)**	**1.59**	**1.09–2.32**	207 (54)	**1.37**	**1.14–1.66**
Wholesale trade	20 (28)	1.30	0.82–2.04	**25 (21)**	**1.70**	**1.04–2.79**	32 (56)	**1.41**	**1.04–1.93**
Retail trade	144 (30)	**1.38**	**1.05–1.83**	171 (18)	**1.47**	**1.04–2.07**	218 (55)	**1.40**	**1.16–1.69**
Transportation and warehousing	39 (32)	**1.46**	**1.00–2.13**	26 (13)	1.02	0.63–1.61	53 (51)	**1.31**	**1.00–1.71**
Information	35 (33)	**1.53**	**1.02–2.28**	25 (13)	1.10	0.67–1.80	32 (33)	0.85	0.60–1.21
Finance and insurance	36 (19)	0.87	0.60–1.26	47 (13)	1.04	0.65–1.65	71 (45)	1.15	0.91–1.44
Real estate and rental and leasing	24 (26)	1.18	0.81–1.73	15 (14)	1.17	0.69–2.00	37 (43)	1.09	0.83–1.44
Professional, scientific, and technical	51 (29)	1.33	0.95–1.87	62 (14)	1.13	0.76–1.69	74 (46)	1.18	0.92–1.50
Management of companies and enterprises	1 (17)	--	--	0 (0)	—	—	2 (37)	--	--
Administrative and support and waste management and remediation services	44 (26)	1.20	0.84–1.71	62 (15)	1.26	0.85–1.86	68 (45)	1.16	0.93–1.45
Education services	110 (19)	0.90	0.66–1.22	120 (14)	1.11	0.76–1.63	185 (35)	0.90	0.73–1.12
Health care and social assistance	254 (27)	1.27	0.98–1.64	247 (14)	1.16	0.84–1.61	380 (45)	1.16	0.96–1.39
Arts, entertainment, and recreation	29 (35)	**1.60**	**1.09–2.35**	28 (16)	1.34	0.84–2.15	48 (54)	**1.38**	**1.07–1.76**
Accommodation and food services	85 (34)	**1.57**	**1.16–2.21**	**145 (18)**	1.43	0.97–2.12	121 (58)	**1.49**	**1.20–1.84**
Other services	76 (28)	1.31	0.95–1.79	103 (19)	**1.52**	**1.04–2.22**	111 (45)	1.14	0.91–1.42
Public administration[e]	56 (22)	1.00	—	39 (12)	1.00	—	98 (39)	1.00	—
Occupations									
Management	55 (19)	1.40	0.87–2.25	59 (13)	1.42	0.91–2.20	91 (39)	0.99	0.75–1.31
Business and financial operations[e]	28 (14)	1.00	—	37 (9)	1.00	—	61 (40)	1.00	—
Computer and mathematical	7 (19)	1.37[f]	0.61–3.06	12 (10)	1.09[f]	0.54–2.20	15 (40)	1.01	0.65–1.57
Architecture and engineering	5 (27)	1.99[f]	0.88–4.50	9 (15)	1.62[f]	0.75–3.48	10 (65)	**1.64**	**1.07–2.52**
Life, physical, and social science	4 (11)	0.81[f]	0.27–2.48	11 (13)	1.47[f]	0.64–3.37	18 (50)	1.26	0.84–1.90
Community and social services	23 (24)	**1.73**	**1.00–2.97**	20 (11)	1.21	0.68–2.18	34 (39)	0.97	0.70–1.34
Sales and related	6 (20)	1.46[f]	0.60–3.55	12 (14)	1.50[f]	0.75–3.01	16 (41)	1.03	0.64–1.65
Education, training, and library	79 (23)	**1.66**	**1.06–2.58**	92 (14)	**1.53**	**1.02–2.29**	110 (34)	0.85	0.65–1.12
Arts, design, entertainment, sports, and media	23 (31)	**2.30**	**1.35–3.91**	23 (17)	**1.84**	**1.08–3.12**	29 (41)	1.03	0.69–1.53
Healthcare practitioners and technical	80 (30)	**2.17**	**1.39–3.39**	63 (12)	1.34	0.88–2.05	120 (45)	1.14	0.87–1.48

Healthcare support	65 (32)	**2.36**	**1.50–3.72**	60 (16)	**1.78**	**1.15–2.76**	91 (49)	1.23	0.94–1.60
Protective service	16 (38)	**2.82**	**1.57–5.08**	9 (14)	1.60[f]	0.75–3.41	18 (45)	1.13	0.74–1.73
Food preparation and serving related	84 (34)	**2.50**	**1.59–3.93**	113 (18)	**1.99**	**1.32–3.01**	117 (55)	**1.39**	**1.06–1.80**
Building and grounds cleaning and maintenance	63 (28)	**2.04**	**1.28–3.24**	89 (19)	**2.15**	**1.44–3.21**	98 (45)	1.14	0.87–1.49
Personal care and service	79 (34)	**2.48**	**1.58–3.90**	100 (19)	**2.13**	**1.43–3.16**	112 (53)	**1.32**	**1.01–1.73**
Sales and related	121 (28)	**2.02**	**1.31–3.12**	169 (18)	**2.05**	**1.40–2.98**	213 (58)	**1.46**	**1.14–1.87**
Office and administrative support	249 (26)	**1.93**	**1.29–2.90**	211 (14)	**1.53**	**1.07–2.21**	383 (44)	1.10	0.87–1.40
Farming, fishing, and forestry	6 (26)	1.91[f]	0.78–4.67	14 (18)	**2.00**	**1.02–3.89**	14 (63)	**1.59**	**1.07–2.37**
Construction and extraction	5 (26)	1.91[f]	0.84–4.34	10 (27)	**2.98**[f]	**1.38–6.45**	8 (49)	1.23[f]	0.64–2.39
Installation, maintenance, and repair	7 (53)	**3.89**	**1.99–7.63**	3 (16)	- -	- -	5 (39)	0.98[f]	0.48–2.00
Production	133 (37)	**2.75**	**1.80–4.20**	99 (22)	**2.40**	**1.62–3.57**	169 (55)	**1.37**	**1.07–1.76**
Transportation and material moving	47 (37)	**2.69**	**1.69–4.28**	48 (24)	**2.66**	**1.67–4.24**	62 (50)	1.24	0.92–1.68

All estimates are weighted unless otherwise noted. Data include only U.S. working adult females who are part of the civilian non-institutionalized population. Findings in bold are statistically significant. (—) cells = estimate could not be computed; (- -) cells = relative standard error is ≥50%.
PR, prevalence ratio; CI, confidence interval.
[a]Mammogram screening within the last 2 years (50–74 years old).
[b]Pap smear within the last 3 years (21–65 years old).
[c]Where colonoscopy was done within the last 10 years, or sigmoidoscopy within the last 5 years and fecal occult blood test within the last 3 years, or fecal occult blood test within the past year (50–75 years old).
[d]Adjusted for insurance coverage.
[e]Comparison group for the analyses involving industry was "Public Administration" and the comparison group for the analyses involving occupation was "Business and Financial Operations."
[f]Relative standard error between 30% and 50%.

shifts were less likely to adhere to breast and colorectal cancer screening recommendations compared to workers on regular daytime shifts. Workers on alternative shifts in the industry categories of "manufacturing" and "accommodation and food services" showed significantly lower adherence to both breast and colon cancer screening recommendations. Workers on alternative shifts in the occupation categories of "food preparation and serving" and "production" also showed significantly lower adherence to cancer screening recommendations for these two cancers.

Previous research [Rosa and Colligan, 1997; Hsia et al., 2000] suggests several possible reasons for why alternative shift work reduces adherence to cancer screening recommendations. First, health promotion activities at work are more frequent during daytime hours. Hence working alternative hours may reduce workers' access to these health promotion opportunities. Moreover, blue collar workers were more likely to view working alternative shifts as a barrier to participating in health promotion activities [Alexy, 1990]. Second, because workers on alternative shifts are more likely to lack health insurance, they may have reduced access to cancer screening services. Health insurance coverage was included in the models and thus was accounted for in our findings. However, the comprehensiveness of the health insurance policies held by the survey participants was not determined. Workers employed on alternative shifts may be less likely to have cancer screening coverage included in their health insurance policies [Hsia et al., 2000]. Finally, others have suggested that working alternative shifts may make regular social contact with family and friends difficult, resulting in social isolation [Rosa and Colligan, 1997]. As such, these workers may be deprived of the social support systems that encourage preventive health behaviors, such as cancer screening.

Although there were no differences in adherence for cervical cancer screening in the overall group, decreased adherence to cervical cancer screening recommendations was found among alternative shift workers aged 40 years or more. Also, among females with at least some college education, we found that those employed on alternative shifts were less likely to be adherent to breast cancer screening recommendations compared to similarly educated females employed on day shifts. It is possible that the shift work differential in health insurance coverage, access to health promotion, and social isolation might be greater in older and more educated females.

This study did not correct for multiple comparison because these analyses were based on surveillance data. The main purpose of surveillance is to generate new hypotheses. While some of the associations observed may be due to chance, presenting findings with no adjustments may assist other researchers. In addition, although

TABLE IV. Female Workers on Alternative Shifts and Non-Adherence With Cancer Screening Recommendations by Most Recently Held Industry and Occupation, National Health Interview Survey 2010

	Breast cancer screening[a]			Cervical cancer screening[b]			Colorectal cancer screening[c]		
		Multivariate[d]			Multivariate[d]			Multivariate[d]	
	Non-adherent, unweighted N (%)	PR[e]	95% CI	Non-adherent, unweighted N (%)	PR[e]	95% CI	Non-adherent, unweighted N (%)	PR[e]	95% CI
All regular day shift[e]	447 (24)	1.00	—	695 (15)	1.00	—	824 (49)	1.00	—
Industries									
Agriculture, forestry, fishing, and hunting	5 (35)	1.47[f]	0.70–3.09	4 (23)	1.59[f]	0.80–3.18	7 (70)	**1.45**	**1.00–2.09**
Mining	0 (0)	—	—	0 (0)	—	—	0 (0)	—	—
Utilities	0 (0)	—	—	0 (0)	—	—	0 (0)	—	—
Construction	1 (28)	1.20[f]	0.47–3.05	2 (13)	--	--	1 (100)	—	—
Manufacturing	12 (41)	**1.75**	**1.20–2.55**	9 (14)	0.93	0.51–1.67	20 (80)	**1.65**	**1.36–1.99**
Wholesale trade	1 (40)	--	--	4 (36)	**2.43**[f]	**1.12–5.28**	1 (100)	—	—
Retail trade	35 (28)	1.18	0.91–1.53	53 (17)	1.17	0.88–1.55	63 (56)	1.16	0.97–1.38
Transportation and warehousing	7 (28)	1.19[f]	0.62–2.27	1 (1)	--	--	15 (55)	1.13	0.78–1.64
Information	5 (34)	1.42[f]	0.75–2.70	3 (9)	--	--	4 (37)	0.76[f]	0.33–1.73
Finance and insurance	4 (43)	1.80[f]	0.89–3.63	3 (14)	--	--	1 (22)	--	--
Real estate and rental and leasing	8 (27)	1.13	0.69–1.86	2 (7)	--	--	11 (38)	0.77	0.47–1.27
Professional, scientific, and technical	2 (12)	--	--	10 (12)	0.83[f]	0.44–1.57	5 (57)	1.18[f]	0.64–2.19
Management of companies and enterprises	0 (0)	—	—	0 (0)	—	—	0 (0)	—	—
Administrative and support and waste management and remediation services	8 (33)	1.40[f]	0.75–2.62	21 (17)	1.17	0.79–1.75	12 (50)	1.02	0.67–1.56
Education services	7 (19)	0.81[f]	0.38–1.72	15 (16)	1.07	0.67–1.70	10 (30)	0.61	0.36–1.02
Health care and social assistance	47 (32)	**1.35**	**1.04–1.76**	58 (15)	1.02	0.77–1.35	70 (51)	1.06	0.88–1.26
Arts, entertainment, and recreation	11 (52)	**2.18**	**1.41–3.38**	9 (15)	1.03[f]	0.56–1.91	14 (55)	1.13	0.77–1.67
Accommodation and food services	17 (47)	**1.98**	**1.44–2.73**	45 (15)	1.00	0.76–1.32	23 (69)	**1.41**	**1.12–1.78**
Other services	17 (34)	1.42	0.92–2.20	24 (23)	**1.58**	**1.08–2.31**	17 (47)	0.96	0.66–1.41
Public administration	5 (22)	0.95[f]	0.42–2.15	10 (20)	1.34	0.77–2.33	12 (56)	1.15	0.80–1.66
Occupations									
Management	9 (23)	0.97[f]	0.51–1.85	15 (17)	1.18	0.76–1.84	15 (57)	1.18	0.86–1.61
Business and financial operations	3 (35)	1.48[f]	0.57–3.81	5 (18)	1.21[f]	0.56–2.62	7 (100)	—	—
Computer and mathematical	0 (0)	—	—	2 (18)	—	—	1 (100)	—	—
Architecture and engineering	0 (0)	—	—	0 (0)	—	—	0 (0)	—	—
Life, physical, and social science	1 (42)	—	—	2 (33)	—	—	0 (0)	—	—
Community and social services	5 (35)	1.49[f]	0.77–2.86	6 (14)	0.95[f]	0.45–2.02	2 (20)	—	—
Sales and related	0 (0)	—	—	2 (69)	v	--	0 (0)	—	—
Education, training, and library	7 (24)	1.00[f]	0.47–2.11	10 (14)	0.96	0.55–1.68	6 (26)	0.53[f]	0.23–1.18

Arts, design, entertainment, sports, and media	9 (35)	1.47	0.82–2.62	8 (18)	1.23[f]	0.65–2.35	8 (36)	0.75[f]	0.39–1.45
Healthcare practitioners and technical	17 (33)	1.39	0.91–2.11	16 (10)	0.67	0.40–1.14	29 (54)	1.11	0.85–1.46
Healthcare support	10 (27)	1.12	0.71–1.78	17 (16)	1.12	0.68–1.85	16 (48)	0.98	0.71–1.36
Protective service	2 (35)	--	--	3 (31)	--	--	5 (74)	1.52	0.90–2.60
Food preparation and serving related	15 (41)	**1.72**	**1.15–2.55**	38 (15)	0.99	0.73–1.35	23 (64)	**1.31**	**1.06–1.63**
Building and grounds cleaning and maintenance	7 (17)	0.73[f]	0.35–1.53	17 (16)	1.09	0.72–1.64	16 (48)	0.99	0.66–1.49
Personal care and service	19 (34)	**1.43**	**1.01–2.03**	32 (23)	**1.57**	**1.15–2.13**	23 (55)	1.13	0.84–1.52
Sales and related	32 (28)	1.16	0.87–1.56	43 (16)	1.07	0.79–1.43	53 (51)	1.05	0.86–1.28
Office and administrative support	27 (38)	**1.62**	**1.18–2.23**	27 (11)	0.72	0.49–1.05	40 (56)	1.16	0.91–1.47
Farming, fishing and forestry	1 (60)	--	--	3 (29)	**2.00**	**1.16–3.47**	1 (54)	--	--
Construction and extraction	0 (0)	—	—	2 (88)	**5.98**[f]	**2.56–14.00**	1 (100)	—	—
Installation, maintenance, and repair	0 (0)	—	—	0 (0)	—	—	0 (0)	—	—
Production	17 (40)	**1.71**	**1.25–2.34**	16 (19)	1.32	0.82–2.13	20 (63)	**1.30**	**1.00–1.68**
Transportation and material moving	9 (31)	1.29	0.77–2.18	8 (12)	0.83[f]	0.40–1.73	18 (66)	**1.35**	**1.02–1.80**

All estimates are weighted unless otherwise noted. Data include only U.S. working adult females who are part of the civilian non-institutionalized population. Findings in bold are statistically significant. (—) cells = estimate could not be computed; (--) cells = relative standard error is ≥50%.

PR, prevalence ratio; CI, confidence interval.

[a]Mammogram screening within the last 2 years (50–74 years old).

[b]Pap smear within the last 3 years (21–65 years old).

[c]Where colonoscopy was done within the last 10 years, or sigmoidoscopy within the last 5 years and fecal occult blood test within the last 3 years, or fecal occult blood test within the past year (50–75 years old).

[d]Adjusted for insurance coverage.

[e]Comparison group was all workers employed on regular daytime shifts.

[f]Relative standard error between 30% and 50%.

correcting for multiple comparisons will reduce type I error (i.e., rejecting a true null hypothesis) it will increase type 2 error (i.e., failing to reject a false null hypothesis) [Rothman, 1990].

Limitations

This study has several limitations. First, this study is based on cross-sectional data, making it impossible to determine the direction of the association between alternative shift work and adherence to cancer screening (e.g., those prone to non-adherence to cancer screening may be more likely to work alternative shifts). Second, small sample size limited analyses by I&O categories and by specific type of alternative shift work. This was especially true for the construction, mining, and management industries. Third, USPSTF general cancer screening recommendations were used to restrict the age ranges of study populations and to identify testing frequencies required to meet the adherence definition. Thus, results are not generalizable to females with a family history of cancer or with an elevated risk of cancer who may require screening at an earlier age or with increased frequency. Fourth, this study is limited by the information collected by NHIS. NHIS did not collect data concerning HPV testing, duration of shiftwork, or lifetime history of work pattern. Similarly, the question on shiftwork was only asked if an individual was employed at any time within the last 12 months. Hence, this study was not able to include those not employed in the 12 months preceding interview (e.g., the unemployed, retired, and homemakers). Finally, cancer screening is self-reported and not independently verified.

One strength of this study is that NHIS is a large population-based survey whose findings are representative of the U.S. working population. Another strength is that NHIS collects data on a wide variety of health and socio-demographic variables which permitted us to assess potentially important confounders.

Recommendations

Among other things, the Affordable Care Act was designed to increase the population's access to cancer screening [U.S. Departmant of Health and Human Services, 2012]. It will eliminate out-of-pocket expenses for breast, cervical, and colorectal cancer screening, because all new private insurance policies must cover their full cost. Enhanced marketing to inform the public that this screening is effective and involves no out-of-pocket expenses may increase overall adherence to cancer screening recommendations.

Another way to reduce screening barriers is to increase workers' access to preventive health care opportunities outside of regular daytime working hours (e.g., scheduling mammography screening vans to be present at workplaces during alternative work shifts). Study findings suggest that outreach to the industries of "manufacturing" and "accommodation and food services," and occupations of "food preparation and serving," "personal care and service," and "production," may be most beneficial because of the low adherence to cancer screening recommendations among their workers on alternative shifts. Additional research is also needed to enhance the fundamental understanding of how working alternative shifts affects adherence to cancer screening recommendations.

CONCLUSIONS

Alternative shift work appears to adversely influence adherence to cancer screening recommendations, especially for breast and colorectal cancer. In particular, workers employed on alternate shifts in "manufacturing" and "accommodation and food services" industries and "food preparation and serving," "personal care and service," and "production" occupations had consistently lower adherence to cancer screening recommendations. Employers and workers should be educated both about the importance of cancer screening, and about how the Affordable Care Act can eliminate out-of-pocket expenses for breast, cervical and colorectal cancer screening. Finally, workers on alternative shifts should have comparable access to preventive health care opportunities, including the availability of screening mammograms at the workplace, as workers on regular daytime shifts.

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