



Prospective study of ultraviolet radiation exposure and risk of breast cancer in the United States



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ABSTRACT

Although there are few environmental risk factors for breast cancer, some epidemiologic studies found that exposure to solar UV radiation (UVR) may lower risk. Prior epidemiologic studies are limited by narrow ambient UVR ranges and lack lifetime exposure assessment. To address these issues, we studied a cohort with residences representing a wide range of ambient UVR. Using the nationwide U.S. Radiologic Technologists study (USRT), we examined the association between breast cancer risk and UVR based on ambient UVR, time outdoors, a combined variable of ambient UVR and time outdoors (combined UVR), and sun susceptibility factors. Participants reported location of residence and hours spent outdoors during five age periods. Ambient UVR was derived by linking satellite-based annual UVR estimates to self-reported residences. Lifetime values were calculated by averaging these measures accounting for years spent in that location. We examined the risk of breast cancer among 36,725 participants ($n=716$ cases) from baseline questionnaire completion (2003–2005) through 2012–2013 using Cox proportional hazards models. Breast cancer risk was unrelated to ambient UVR (HR for lifetime 5th vs 1st quintile = 1.22, 95% CI: 0.95–1.56, p -trend = 0.36), time outdoors (HR for lifetime 5th vs 1st quintile = 0.87, 95% confidence interval (CI): 0.68–1.10, p -trend = 0.46), or combined UVR (HR lifetime 5th vs 1st quintile = 0.85, 95% CI: 0.67–1.08, p -trend = 0.46). Breast cancer risk was not associated with skin complexion, eye or hair color, or sunburn history. This study does not support the hypothesis that UVR exposure lowers breast cancer risk.

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1. Introduction

With the exception of skin cancer, breast cancer is the most common malignancy among women in the United States (American Cancer Society, 2015). The strongest and most consistently identified individual risk factors include age, reproduction-related factors (e.g., parity, age at menarche, age at first childbirth, exogenous hormone use), family history of breast cancer, and lifestyle factors such as alcohol consumption, anthropometry, and physical activity (Claus et al., 1991; Kelsey, 1979). Ecological studies have found decreasing breast cancer incidence with increasing proximity to the Equator (Gorham et al., 1990; Mandal et al., 2009; Mohr et al., 2008). Since latitude is an influential determinant of cutaneous vitamin D production, these ecologic findings supported the hypothesis that exposure to vitamin D reduces breast cancer risk. However, other epidemiological

studies of circulating vitamin D and breast cancer risk have been inconsistent and preliminary results from a recent large pooled analysis suggest no association with breast cancer risk (Visvanathan et al., 2015).

Several studies have directly examined the relationship between personal UV radiation (UVR) exposure and breast cancer incidence. However, findings have been inconsistent, supporting either a reduced risk (Anderson et al., 2011; Engel et al., 2014; Engel et al., 2011; John et al., 1999, 2007; Yang et al., 2011) or no association (Edvardsen et al., 2011; Fuhrman et al., 2013; Kuper et al., 2009; Lin et al., 2012; Millen et al., 2009). UVR exposure has been estimated in prior studies using a variety of metrics, most commonly either ambient UVR or time outdoors. Many studies reporting an association between UVR and breast cancer have used time outdoors as the metric of UVR exposure, (Engel et al., 2014; John et al., 1999; Millen et al., 2009; Yang et al., 2011) and some evaluated ambient UVR exposure (Anderson et al., 2011; P. Engel et al., 2011; John et al., 1999; Millen et al., 2009). Overall, few studies investigating relationships between UVR-related factors and risk of breast cancer have been prospective (Edvardsen et al., 2011; Engel et al., 2014; Engel et al., 2011; John et al., 1999; Kuper

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Table 1
Summary of prior studies on UVR exposure and breast cancer risk.

First author, year	Study type/study population	No. cases/ non-cases	Location	UVR measures	Summary of results
Zamoiski, 2016 (current study)	USRT Cohort	716/36,009	United States	Ambient UVR Time outdoors Combined	Null for all
Engel et al., 2014	Agricultural Health Study cohort	578/30,443	Iowa and North Carolina	Time outdoors	Decreased risk for time outdoors (in women with no family history of breast cancer)
Lin et al., 2012	NIH-AARP cohort	8681/442,253	United States (CA, FL, LA, NJ, NC, PA, GA, MI)	Ambient UVR	Null for ambient UVR.
Edvardsen et al., 2011	Population-based cohort	948/40,863	Norway	Time outdoors (sunny vacations, solarium use) Ambient UVR Sunburn history	Null for all.
Engel et al., 2011	Population-based cohort	2871/64,850	France	Ambient UVR	Decreased risk for highest ambient UVR (in postmenopausal women).
Yang et al., 2011	Population-based cohort	1053/48,208	Sweden	Time outdoors (sunny vacations, solarium use) Sun sensitivity factors Sunburn history	Decreased risk for time outdoors. Null for sun sensitivity factors. Null for sunburn history.
Kuper et al., 2009	Population-based cohort	840 / 41,049	Sweden	Time outdoors (sunny vacations, solarium use) Sun sensitivity factors Sunburn history	Null for all.
Millen et al., 2009	WHIOS Cohort	2535/69,127	United States (23 states + DC)	Time outdoors Ambient UVR	Decreased risk for time outdoors. Null for ambient UVR.
John et al., 1999	NHANES I Cohort	190/4819	United States	Time outdoors Ambient UVR Skin pigmentation	Decreased risk for time outdoors. Null for ambient UVR. Null for skin pigmentation.
Anderson et al., 2011	Case-control	3101/3471	Ontario, Canada	Time outdoors Ambient UVR	Decreased risk for time outdoors. Null for ambient UVR.
John et al., 2007	Case-control	1788/2129	San Francisco Bay Area	Time outdoors Skin complexion and pigmentation	Null for time outdoors. Decreased risk for increasing pigmentation (in women with light complexion).

et al., 2009; Millen et al., 2009; Yang et al., 2011), and few of these included a wide range of ambient UVR exposures over the course of a lifetime (Table 1) (Anderson et al., 2011; Kuper et al., 2009; Millen et al., 2009; Yang et al., 2011).

The objective of this study is to assess the relationship between ambient UVR, time spent outdoors, sun sensitivity factors, and subsequent risk of first primary breast cancer using data from the United States Radiologic Technologists (USRT) study. This is the first study to prospectively examine multiple UV radiation-related factors in a large nationwide cohort, which has collected information on personal sun sensitivity characteristics, sun exposure over the lifetime, and detailed lifestyle factors in a population from all 50 states exposed to a wide range of ambient UVR.

2. Methods

2.1. Overview

The United States Radiologic Technologists (USRT) study is a prospective occupational cohort composed of radiologic technologists who were certified by the American Registry of Radiologic

Technologists for at least two years between 1926 and 1982. Detailed descriptions of this cohort have been previously published (Boice et al., 1992; Doody et al., 1998). Briefly, participants were mailed self-administered questionnaires during the following four time periods: 1983–1989, 1994–1998, 2003–2005, and 2012–2013. Informed consent was obtained to collect medical records. The USRT study has been annually approved by human subjects review boards at the University of Minnesota (Minneapolis, MN) and the National Cancer Institute (Bethesda, MD).

2.2. Study population

The study population included female participants who completed the third (2003–2005) and fourth (2012–2013) questionnaires, and reported no history of cancer (other than non-melanoma skin cancer [NMSC]) at the time of the third questionnaire (N=36,725). Follow-up continued from completion of the third questionnaire until the earlier of first primary cancer diagnosis (excluding NMSC) or completion of the fourth questionnaire.

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