CHAPTER 4

SOLAR ULTRAVIOLET IRRADIANCE AND CANCER INCIDENCE AND MORTALITY

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Abstract: The solar ultraviolet-B (UVB)/vitamin D/cancer hypothesis was proposed by the brothers Cedric and Frank Garland in 1980. In 2002, the list was increased to 15 types of cancer using data in the 1999 version of the atlas of cancer mortality rates in the United States. Ecological studies of cancer incidence and/or mortality rates with respect to indices of solar UVB doses have also been reported for Australia, China, France, Japan, and Spain with largely similar findings. In addition, several studies using nonmelanoma skin cancer as the index of solar UVB dose have found reduced internal cancer incidence and/or mortality rates, especially in sunny countries. A study of cancer incidence with respect to 54 categories of occupation in five Nordic countries, using lip cancer less lung cancer as the UVB index, found this index inversely correlated with 14 types of internal cancers for males and four for females. Observational studies with respect to UVB doses and serum 25-hydroxyvitamin D [25(OH)D] concentrations also support the hypothesis. Hill’s criteria for causality in a biological system to assess whether solar UVB and vitamin D can be considered causal in reducing risk of cancer. The primary criteria for this analysis include strength of association, consistent findings in different populations, biological gradient, plausibility (e.g., mechanisms), and experimental verification (e.g., randomized controlled trials). The totality of evidence is judged to satisfy the criteria very well for breast and colorectal cancer, and moderately well for several other types of cancer.

INTRODUCTION

The first paper positing a link between sunlight and reduced risk of cancer was published in 1937.1 Persons in the US Navy with greater “skin irritation” (actinic keratosis and skin cancer) had lower risk of internal cancers. A second paper appeared
then reported that residents of sunnier states had lower cancer risk. The hypothesis that provided a good explanation for these findings was the ultraviolet-B (UVB)/vitamin D/cancer hypothesis proposed by the brothers Cedric and Frank Garland after seeing the atlas of colon cancer mortality rates in the United States. Since then ecological and observational studies have provided evidence that solar UVB and vitamin D reduce the risk of 15–20 types of cancer.

This chapter reviews the support for the UVB/vitamin D/cancer hypothesis and discusses the whether the hypothesis satisfies the criteria for causality laid out by A Bradford Hill.

SOLAR UVB OF GEOGRAPHIC LOCATION AS THE INDEX OF VITAMIN D PRODUCTION: SINGLE-COUNTRY STUDIES

The solar UVB/vitamin D/cancer hypothesis was proposed in 1980 by Cedric and Frank Garland, then associated with the Johns Hopkins School of Public Health. They heard a lecture on the geographic variation of cancer mortality rates in the United States that was based on the Atlas of Cancer Mortality for US Counties: 1950–1969. Maps had age-adjusted mortality rates for various cancers displayed in color for five categories:

- significantly high, in highest decile;
- significantly high, not in highest decile;
- in highest decile, not significant;
- not significantly different from the United States; and
- significantly lower than the United States.

For most of the cancers, the color for “not significantly different from the US” dominated the atlas. However, for large-intestine-except-rectum cancer for males, Arizona, southern California and New Mexico were colored “significantly lower than the US,” as were parts of the southern states east of the Mississippi River, whereas the northeast had the highest rates. They knew that it was sunny in the southwest and hypothesized that since the most important physiological effect of solar radiation was the production of vitamin D, vitamin D concentrations must be higher in the southwest. Vitamin D, they posited, reduced the risk of cancer mortality. They did an ecologic study of colon cancer mortality rates for 17 metropolitan and 32 nonmetropolitan states with respect to annual hours of solar radiation on the basis of cancer data in Lilienfeld et al. Their work was slowly extended over the next two decades. They showed that dietary vitamin D and calcium were inversely correlated with colorectal cancer and that serum 25-hydroxyvitamin D [25(OH)D] concentrations were inversely correlated with colon cancer. They also extended their ecologic studies to include breast and ovarian cancer.

Their seminal paper on vitamin D and colon cancer was republished in the International Journal of Epidemiology along with their commentary and the commentaries by others on the progress and status of the understanding of the roles of UVB and vitamin D in cancer risk reduction.

Other ecological studies also reported inverse correlations between indices of and solar UVB doses and cancer incidence rates. A study in Japan reported that pancreatic cancer mortality rates increased with increasing latitude but vitamin D was not mentioned. Schwartz and coworkers added prostate cancer to the list of vitamin D-sensitive cancers in the 1990s as well. Hartgke et al. added non-Hodgkin’s lymphoma (NHL) to the list.