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## Fat intake and risk of skin cancer in US adults

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### Abstract

**Background**—Fat intake has been associated with certain cancers, including colorectal, breast, and prostate cancers. However, literature on dietary fat and skin cancer has been limited.

**Methods**—We examined the association between fat intake and risk of skin cancer including cutaneous malignant melanoma, squamous cell carcinoma (SCC), and basal cell carcinoma (BCC) within two prospective studies; the Nurses' Health Study (NHS) and the Health Professionals Follow-up Study (HPFS). Dietary information on total, saturated, monounsaturated, polyunsaturated, omega-6, and omega-3 fat and cholesterol was repeatedly assessed generally every 4 years. Incident cases were identified by self-report. Diagnosis on melanoma and SCC were confirmed by pathologic records.

**Results**—A total of 794 melanoma, 2,223 SCC, and 17,556 BCC in the NHS (1984 to 2012) and 736 melanoma, 1,756 SCC, and 13,092 BCC in the HPFS (1986 to 2012) were documented. Higher polyunsaturated fat intake was associated with risk of SCC (pooled hazard ratio (HR) for highest vs. lowest quintiles, 1.16; 95% confidence interval (CI), 1.05–1.28;  $P_{\text{trend}}=0.001$ ) and BCC (pooled HR, 1.06; 95% CI, 1.01–1.11;  $P_{\text{trend}}=0.01$ ). Higher omega-6 fat intake was associated with

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### Disclaimer

The authors assume full responsibility for analyses and interpretation of these data.

risks of SCC, BCC, and melanoma. Omega-3 fat intake was associated with risk of BCC, but not with SCC or melanoma. No other fats were associated with melanoma risk. The associations were similar in women and men and by other skin cancer risk factors.

**Conclusion**—Polyunsaturated fat intake was modestly associated with skin cancer risk.

**Impact**—Further studies are needed to confirm our findings and to identify relevant biological mechanisms.

### Keywords

Fat intake; Skin cancer; Melanoma; Squamous cell cancer; Basal cell carcinoma

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## Introduction

Fat intake has been examined in many studies for its association with incident cancer such as colorectal, breast, and prostate cancers (1). A few animal studies showed that high fat intake may promote the development of ultraviolet (UV) radiation-induced skin cancer (2). In a study with hairless mice, a protective effect of saturated fat intake on UV tumorigenesis was reported compared with polyunsaturated fat (3). In other animal studies, omega-3 fat intake showed increased tumor latent period and decreased tumor multiplicity while omega-6 fat intake showed tumor promoting effects (4). On the other hand, omega-3 fat has anti-inflammatory function that may protect against ultraviolet damage (5–7) and may affect skin cancer risk.

Epidemiologic studies on overall fat intake and skin cancer risk have reported conflicting results and only a few studies used prospective studied designs (8,9). A few intervention studies found that a low-fat diet reduced the incidence of actinic keratosis, a precursor for skin cancer, (10) and non-melanoma skin cancer (NMSC) among participants with a history of NMSC (11). In a case-control study, higher fat intake showed lower risk of melanoma and basal cell carcinoma (BCC) and lower risk of squamous cell carcinoma (SCC) (12). However, in European Prospective Investigation into Cancer and Nutrition (EPIC)-Norfolk study (13), Nambour Skin Cancer Study (14,15), and Women's Health Initiative Randomized Controlled Dietary Modification Trial (16), no association between fat intake and skin cancer was found. Most of these studies were limited by small sample size ( $n < 200$ ) (8). Few studies evaluated intake of types of fat in relation to skin cancer (14,17,18). Therefore, we aimed to examine the associations between consumption of total and types of fat and risk of skin cancer with prospective data from the Nurses' Health Study (NHS, 1984–2012) and the Health Professionals Follow-up Study (HPFS, 1986–2012).

## Materials and Methods

### Study population

The NHS was initiated in 1976 with 121,700 US female registered nurses aged 30–55 years and the HPFS was initiated in 1986 with 51,529 US male health professionals aged 40–75 years. Participants of both studies completed questionnaires on their lifestyle and medical history. The participants have been followed biennially with follow-up rate of largely over

90%. The studies were approved by the institutional review boards of Brigham and Women's Hospital and Harvard School of Public Health (Boston, MA) and conducted in accordance with the Belmont Report. Participants' responses on the questionnaires were considered as written informed consent. Detailed descriptions of the two cohort studies exist elsewhere (19,20).

### **Assessment of fat intake and other dietary intake**

A validated food-frequency questionnaire (FFQ) including about 130 food items have been used for the assessment of dietary intake in the study participants (21). The first collection of dietary information with this FFQ started in 1984 in the NHS and the information was updated every four years since 1986. For HPFS, dietary information has been collected every four years since 1986. This study included the data from the FFQs administered in 1984, 1986, 1990, 1994, 1998, 2002, 2006, and 2010 for the NHS and 1986, 1990, 1994, 1998, 2002, 2006, and 2010 for the HPFS. Participants were asked how often on average they had consumed a given unit or one portion size of each food item in the FFQ during the previous year, with nine frequency responses ranging from 'never or less than once per month' to '6 or more times per day.' Nutrient intake including energy and fatty acids of participants were calculated by multiplying the consumption frequency of each food item with nutrient database prepared for specified amount of the food item. The nutrient database was based on the Harvard University Food Composition Database derived from the US Department of Agriculture (USDA) sources (22) and supplemented with information from manufacturers. Previous studies have demonstrated reasonable levels of reproducibility and validity of the FFQ for ranking individuals by consumption of nutrients and foods (23–25). The fatty acid intake measured by the FFQ has also been validated in NHS showing moderate-to-strong correlations between dietary intakes and plasma biomarkers (Spearman's partial correlation coefficients, 0.21–0.56) (26).

### **Assessment of covariates**

By sending the questionnaires to participants biennially, we collected information on anthropometric and lifestyle factors such as height, weight, physical activity and smoking status for NHS and HPFS, and menopausal status and postmenopausal hormone use for NHS. Major skin cancer related factors (27,28) were also collected, including family history of melanoma (in parents or siblings); natural hair color; number of moles on arms; skin reaction to sun exposure as a child/adolescent; number of severe or blistering sunburns; and cumulative UV flux at residence since baseline.

**Assessment of melanoma, SCC, and BCC cases**—Participants had reported new diagnosis of melanoma, SCC, and BCC biennially since 1984 for NHS and 1986 for HPFS. Participants who reported melanoma or SCC were asked for permission to review their medical and pathological reports. These reports were reviewed by physicians to confirm the diagnoses. The proportions of reviewed cases with medical and pathological reports were 67% for melanoma and 60% for SCC in NHS, and 76% for melanoma and 71% for SCC in HPFS. Only confirmed invasive cases of melanoma and SCC were used in the current study. For BCC, self-reported cases were used. The self-reported cases of BCC demonstrated about

90% of agreement with histopathology records in the previous validation studies for both cohorts (17,29,30).

**Statistical analysis**—The participants who did not have information on fat intake were excluded in the analysis. We also excluded the participants who had baseline history of melanoma for the analysis of melanoma, SCC for the analysis of SCC, and BCC for the analysis of BCC. Since skin cancer among non-white participants was rare (28), non-white participants were excluded. At baseline, included participants were 75,311 women and 48,516 men for melanoma analysis, 75,189 women and 48,400 men for SCC analysis, and 73,564 women and 48,550 men for BCC analysis.

Person-year of follow-up was calculated from the return month of baseline questionnaire to the first diagnosis of melanoma, SCC or BCC, date of death, loss to follow-up, or the end of follow-up (June 2012 for NHS and January 2012 for HPFS), whichever came first.

We used cumulative average of fat intake during the follow-up period examined to better estimate long-term dietary intake and to minimize within-person variation. For example, intake in 1986 was used for 1986–1990 follow-up and the average of 1986 and 1990 intake was used for 1990–1994 follow-up and so on in HPFS (31). Percentages of energy contributed by each fat intake were calculated to examine the effect of each type of fat on skin cancer comparing to other energy contributing nutrients such as protein and carbohydrate. Total and each type of fat intakes were categorized into quintiles with the lowest quintile as a reference.

Cox proportional hazard models were used to estimate the age-adjusted and multivariable-adjusted hazard ratios (HRs) of fat intake on skin cancer with 95% confidence intervals (CIs). The assumption of proportion hazards was satisfied. We stratified the analysis jointly by age in months at start of follow-up and calendar year of the current questionnaire cycle to control for confounding by age or calendar year, or any possible two-way interactions between these two time scales. We adjusted for possible confounding lifestyle factors (32,33) and risk factors of skin cancer (27,28) for multivariable model 1: body mass index (<18.5, 18.5–24.9, 25–29.9, 30–34.9, 35), physical activity (metabolic-equivalents hrs/wk, quintiles), smoking status (never, past with < 10, 10–19, 20–39, 40 pack year, unknown cigarettes/d, current), personal history of non-skin cancer (yes vs. no), total energy intake (quintiles), alcohol intake (0, 0.1–4.9, 5.0–9.9, 10.0–19.9, 20.0 g/d), caffeine intake (quintiles), citrus intake (quintiles), family history of melanoma (yes vs. no), natural hair color (red, blonde, light brown, dark brown, black), number of arm moles (0, 1–2, 3–5, 6), sunburn susceptibility as a child/adolescent (no experience, no reaction/some redness, burn, painful burn/blisters), number of lifetime blistering sunburns (0, 1–2, 3–5, 6), and cumulative UV flux since baseline ( $\times 10^{-4}$  Robertson-Berger units: an estimate of amount of UV radiation reaching Earth's surface of residence within 1 year, quintiles). We also adjusted for incident SCC and BCC for the analyses of melanoma, incident melanoma and BCC for the analyses of SCC, and incident melanoma and SCC for the analyses of BCC. Menopausal status (yes vs. no) and postmenopausal hormone use (no vs. current) were additionally adjusted for in NHS. For multivariable model 2, we adjusted for the same covariates as multivariable model 1 and other types of fats simultaneously. In this model,

saturated, polyunsaturated, monounsaturated fats, and cholesterol were included in one model. For the analysis of omega-6 and omega-3 fat, the two fats were included in one model simultaneously in addition to saturated and monounsaturated fats and cholesterol. All covariates except for family history of melanoma, natural hair color, and sunburn susceptibility as a child/adolescent were updated whenever new data were available during follow-up. The Anderson–Gill data structure (34) was used for efficient management of time-varying covariates, with a new dataset created for every questionnaire cycle at which a participant was at risk and covariates set to their values at the time the questionnaire was returned.

We conducted trend tests with median values of each quintile of fat as a continuous variable. Pooled HRs were calculated with the results of separated analyses for the HPFS and the NHS using a random effects model. To examine interactions between the risk of skin cancer and sun exposure-related variables, we conducted stratified analyses by body locations of tumors, number of moles, childhood reaction to sun, and annual UV flux at residence. We also conducted stratified analyses by body mass index and diagnostic year of skin cancers. Sensitive analyses with history of physical examination and other types of skin cancer were conducted as well. Spearman correlation coefficients were calculated to examine correlations between different fats.

All statistical analyses were conducted using SAS (version 9.4; SAS Institute Inc, Cary, NC) with two-sided p values at the significance level of 0.05.

## Results

The characteristics of participants at baseline in NHS and HPFS were presented in Table 1 according to total fat intake. Participants with higher intake of total fat intake were more likely to have higher BMI, lower physical activity, lower alcohol intake, lower citrus intake and higher caffeine intake in both men and women and, more likely to be current smokers in men. The characteristics of participants at baseline in NHS and HPFS according to cholesterol, omega-6 and omega-3 fats intakes were also presented in Supplementary Table 1–3.

Because some fats may be highly correlated, we evaluated the correlation coefficients among the fats. In both women and men, we found high correlations (correlation coefficients of over 0.6) between total fat and saturated and monounsaturated fats, between saturated fat and monounsaturated fat, and between polyunsaturated fat and omega-6 fat. Cholesterol intake was not highly correlated with any other type of fat.

A total of 794 melanoma, 2,223 SCC, and 17,556 BCC cases in the NHS (1984 to 2012) and 736 melanoma, 1,756 SCC, and 13,092 BCC cases in the HPFS (1986 to 2012) were documented during the follow-up. We found no association between either total fat or any type of fat intake and melanoma risk except for omega-6 fat (Table 2). The pooled multivariate HR for the highest quintile of total fat intake was 1.05 (confidence interval (CI), 0.88–1.25) comparing to the lowest quintile. Higher intake of omega-6 fat was associated with risk of melanoma (pooled multivariate HR, 1.20; 95% CI, 1.02–1.41;  $P_{\text{trend}}=0.03$ )

although the association was attenuated and no longer significant after adjusting for other types of fat simultaneously.

For SCC, although total fat intake was not associated with the risk, polyunsaturated fat intake was associated with SCC risk (pooled multivariate HR, 1.16; 95% CI, 1.05–1.28;  $P_{\text{trend}}=0.001$ ) (Table 3). Among types of polyunsaturated fat, higher intake of omega-6 fat was associated with SCC risk. We also found that cholesterol intake was associated with lower risk of SCC.

Intake of polyunsaturated fat was associated with higher BCC risk (pooled multivariate HR 1.06; 95% CI, 1.01–1.11;  $P_{\text{trend}}=0.01$ ) (Table 4). We found that intake of both omega-6 fat and omega-3 fat were each associated with BCC risk (pooled multivariate HR 1.08; 95% CI, 1.02–1.14;  $P_{\text{trend}}=0.01$  for omega-6 fat; pooled multivariate HR 1.09; 95% CI, 1.04–1.13;  $P_{\text{trend}}<.0001$  for omega-3 fat). Intake of monounsaturated fat was associated with lower BCC risk.

The association between fat intake and skin cancer was largely similar in men and women (Supplementary Tables 4–6). The results were also similar when other types of fats were adjusted for simultaneously. The associations between fat intake and melanoma and SCC were similar by body location of the tumor (head/neck/extremities vs. trunk) based on sun exposure pattern.

We further examined the associations between intake of trans fat and marine omega-3 fat (EPA and DHA) and risk of skin cancer. Trans fat intake was not associated with any type of skin cancer. The association between marine omega-3 fat intake (eicosapentaenoic acid + docosahexaenoic acid) and risk of skin cancer were similar to the association of total omega-3 fat intake that was associated with higher risk of BCC. Intake of individual omega-6 fat (linoleic acid and arachidonic acid) was not associated with risk of skin cancer.

When we conducted stratified analyses with sun exposure-related variables such as number of moles (with moles vs. with no mole), childhood reaction to sun (no reaction vs. burn or blister), annual UV flux at residence (below median vs. above median), the associations were similar. We found similar associations in a stratified analysis by BMI (below median vs. above median). When we evaluated the associations by year of diagnosis using approximate median year of 2004, the results were not materially different by the year.

In the analyses among participants with history of physical examination, the results remained essentially unchanged. When we excluded SCC cases in the analysis of BCC and BCC cases in the analysis of SCC, the results also remained similar.

## Discussion

Using the data from two large prospective studies of women and men in the US, we found no association of fat intake with melanoma except for omega-6 fat intake. For SCC, we found higher risk associated with higher intake of polyunsaturated fat and omega-6 fat. Higher intake of cholesterol was associated with lower risk of SCC. For BCC, we found that higher intake of polyunsaturated fat, omega-6 fat, and omega-3 fat were each associated with

higher risk. On the other hand, higher intake of monounsaturated fat was associated with lower risk of BCC.

Few studies have examined fat intake and risk of melanoma. A case-control study in Australia with 105 melanoma cases showed lower risk of melanoma with high fat intake (odds ratio (OR), 0.61; 95% CI, 0.40–0.92;  $P_{\text{trend}}=0.02$ ) (12). On the other hand, in the Women's Health Initiative randomized controlled dietary modification trial, low-fat diet intervention over 8 years of follow-up did not affect incidence of melanoma (n=114; HR, 1.04; 95% CI, 0.82–1.32) (16), which was consistent with our study of total fat intake. No previous study evaluated individual types of fat in relation to melanoma risk.

In terms of SCC, several studies evaluated the risk in relation to total fat intake. A small intervention study including 76 patients with a history of NMSC found that two years of low-fat diet reduced the incidence of actinic keratosis (10). Another intervention study of 101 participants with a history of NMSC found lower incidence of NMSC in the low-fat diet group after 2 years of intervention (11). However, other studies including case-control studies (12,18), cohort studies (14,15), and an intervention study (16) found no association between fat intake and the risk of SCC. On the other hand, Ibiebele et al. found increased risk of SCC with total fat intake in participants with a skin cancer history in an Australian cohort study (15). Only one case-control study has examined the associations of individual fatty acids with risk of SCC, which found non-significant inverse association with omega-3 fat intake (18). Our findings on polyunsaturated, omega-6 fat, and cholesterol intake are new and need to be replicated in other studies.

For BCC, EPIC-Norfolk study, a cohort study in England, found no association with total fat intake (13). A case-control study in Australia found lower risk of BCC in high fat intake group (OR, 0.60; 95% CI, 0.39–0.91;  $P_{\text{trend}}=0.02$ ) (12). Nambour Skin Cancer Study, a cohort study in Australia, found no association between risk of BCC and fat intake (15). The Nambour study, on the other hand, found lower risk of BCC in the middle tertile of omega-6 intake suggesting a U-shaped relationship with BCC (14). However, our findings were different from these studies. In a previous evaluation of HPFS with shorter follow-up (n=3,190), BCC risk was inversely associated with total fat and monounsaturated fat intakes and positively associated with omega-3 fat intake (17). After 18-years of extended follow-up, our study confirmed this association. In a pooled analysis with NHS, we additionally discovered a positive association with polyunsaturated fat and omega-6 fat.

Because fat intake is associated with BMI, some of the associations we observed might be due to the association with BMI. However, we adjusted for BMI in multivariate analysis. There was additionally no effect modification by BMI.

In our study, the positive association with intake of polyunsaturated fat, especially omega-6 fat was consistent across the three types of skin cancer. In a few animal studies, tumor promoting effects of omega-6 fat on UVR-induced carcinogenesis were found (4,35), which may support our findings. The animal studies showed that pro-inflammatory and immunosuppressive prostaglandin E synthase type 2 levels, which is associated with aggressive growth patterns of NMSC, increased linearly with the concentration of omega-6

fat intake. The studies also found tumor suppressing effects of omega-3 fat on UVR-carcinogenic expression (35), which is contrary to what we found about omega-3 fat. The investigators reported that plasma level of prostaglandin E synthase type 2 was dramatically reduced in omega-3 fat-fed animals, compared to an equivalent amount of omega-6 fat-fed animals.

The strengths of our study include large sample size, repeated dietary assessment and use of cumulative averaged dietary intake to reduce measurement error, confirmed cases of melanoma and SCC with information on body site of tumor, and extensive information on skin cancer-related covariates. We also have several study limitations. The participants of the cohorts were health professionals who were knowledgeable on healthy lifestyle and diet. This might limit the generalizability of our study results to general populations. Use of self-reported dietary assessment method may cause exposure misclassification, although this is likely to be non-differential and may attenuate the true associations even though we used a validated FFQ. Although we adjusted for some highly correlated fats simultaneously in the multivariable models, we could not completely tease out the effect of individual fats if they shared food sources. We also lacked information on some potential sources of confounding such as sun protective behaviors, particularly later in life. The self-reported BCC cases we used in this study might cause misclassification although the validity of self-reported cases of BCC was high (17,29,30). Finally, because we evaluated multiple types of fat, some of the associations we found might be due to chance and need to be confirmed in other populations.

In conclusion, there was no association between total fat intake and risk of skin cancer in the two prospective studies. However, we found that higher intake of polyunsaturated fat, especially omega-6 fat, was associated with higher risk of skin cancer. In addition, higher intake of cholesterol was associated with lower risk of SCC. Higher intake of monounsaturated fat was associated with lower risk of BCC. Because there have been few experimental and epidemiological studies of fat intake and skin cancer, our findings on certain types of fat and skin cancer need to be replicated and may motivate future studies.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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## References

1. Gerber M. Background Review Paper on Total Fat, Fatty Acid Intake and Cancers. *Ann Nutr Metab.* 2009; 55(1–3):140–61. [PubMed: 19752540]



2. Black HS. Influence of dietary factors on actinically-induced skin cancer. *Mutat Res.* 1998 Nov 9; 422(1):185–90. [PubMed: 9920444]
3. Reeve VE, Matheson M, Greenoak GE, Canfield PJ, Boehm-Wilcox C, Gallagher CH. Effect of dietary lipid on UV light carcinogenesis in the hairless mouse. *Photochem Photobiol.* 1988 Nov; 48(5):689–96. [PubMed: 3241840]
4. Black HS, Rhodes LE. Potential Benefits of Omega-3 Fatty Acids in Non-Melanoma Skin Cancer. *J Clin Med.* 2016 Feb 4.5(2)
5. Storey A, McArdle F, Friedmann PS, Jackson MJ, Rhodes LE. Eicosapentaenoic Acid and Docosahexaenoic Acid Reduce UVB- and TNF- $\alpha$ -induced IL-8 Secretion in Keratinocytes and UVB-induced IL-8 in Fibroblasts. *J Invest Dermatol.* 2005 Jan; 124(1):248–55. [PubMed: 15654981]
6. Tong LX, Young LC. Nutrition: The future of melanoma prevention? *J Am Acad Dermatol.* 2014 Jul; 71(1):151–60. [PubMed: 24656410]
7. Pilkington SM, Massey KA, Bennett SP, Al-Aasswad NM, Roshdy K, Gibbs NK, et al. Randomized controlled trial of oral omega-3 PUFA in solar-simulated radiation-induced suppression of human cutaneous immune responses. *Am J Clin Nutr.* 2013 Mar 1; 97(3):646–52. [PubMed: 23364005]
8. Bronsnick T, Murzaku EC, Rao BK. Diet in dermatology: Part I. Atopic dermatitis, acne, and nonmelanoma skin cancer. *J Am Acad Dermatol.* 2014 Dec; 71(6):1039.e1–1039.e12. [PubMed: 25454036]
9. Murzaku EC, Bronsnick T, Rao BK. Diet in dermatology: Part II. Melanoma, chronic urticaria, and psoriasis. *J Am Acad Dermatol.* 2014 Dec; 71(6):1053.e1–1053.e16. [PubMed: 25454037]
10. Black HS, Herd JA, Goldberg LH, Wolf JE, Thornby JI, Rosen T, et al. Effect of a low-fat diet on the incidence of actinic keratosis. *N Engl J Med.* 1994 May 5; 330(18):1272–5. [PubMed: 8145782]
11. Black HS, Thornby JI, Wolf JE, Goldberg LH, Herd JA, Rosen T, et al. Evidence that a low-fat diet reduces the occurrence of non-melanoma skin cancer. *Int J Cancer.* 1995 Jul 17; 62(2):165–9. [PubMed: 7622291]
12. Granger RH, Blizzard L, Fryer JL, Dwyer T. Association between dietary fat and skin cancer in an Australian population using case-control and cohort study designs. *BMC Cancer.* 2006 May 30.6:141. [PubMed: 16734890]
13. Davies TW, Treasure FP, Welch AA, Day NE. Diet and basal cell skin cancer: results from the EPIC-Norfolk cohort. *Br J Dermatol.* 2002 Jun; 146(6):1017–22. [PubMed: 12072070]
14. Wallingford SC, van As JA, Hughes MC, Ibiebele TI, Green AC, van der Pols JC. Intake of omega-3 and omega-6 fatty acids and risk of basal and squamous cell carcinomas of the skin: a longitudinal community-based study in Australian adults. *Nutr Cancer.* 2012; 64(7):982–90. [PubMed: 22974045]
15. Ibiebele TI, van der Pols JC, Hughes MC, Marks GC, Green AC. Dietary fat intake and risk of skin cancer: a prospective study in Australian adults. *Int J Cancer.* 2009 Oct 1; 125(7):1678–84. [PubMed: 19462452]
16. Gamba CS, Stefanick ML, Shikany JM, Larson J, Linos E, Sims ST, et al. Low-fat diet and skin cancer risk: the women's health initiative randomized controlled dietary modification trial. *Cancer Epidemiol Biomark Prev Publ Am Assoc Cancer Res Cosponsored Am Soc Prev Oncol.* 2013 Sep; 22(9):1509–19.
17. van Dam RM, Huang Z, Giovannucci E, Rimm EB, Hunter DJ, Colditz GA, et al. Diet and basal cell carcinoma of the skin in a prospective cohort of men. *Am J Clin Nutr.* 2000 Jan; 71(1):135–41. [PubMed: 10617958]
18. Hakim IA, Harris RB, Ritenbaugh C. Fat intake and risk of squamous cell carcinoma of the skin. *Nutr Cancer.* 2000; 36(2):155–62. [PubMed: 10890025]
19. Fung TT, Spiegelman D, Egan KM, Giovannucci E, Hunter DJ, Willett WC. Vitamin and carotenoid intake and risk of squamous cell carcinoma of the skin. *Int J Cancer.* 2003 Jan 1; 103(1):110–5. [PubMed: 12455062]
20. Li W-Q, Cho E, Weinstock MA, Mashfiq H, Qureshi AA. Epidemiological Assessments of Skin Outcomes in the Nurses' Health Studies. *Am J Public Health.* 2016 Sep; 106(9):1677–83. [PubMed: 27459457]

21. Willett WC, Sampson L, Stampfer MJ, Rosner B, Bain C, Witschi J, et al. Reproducibility and validity of a semiquantitative food frequency questionnaire. *Am J Epidemiol.* 1985 Jul; 122(1):51–65. [PubMed: 4014201]
22. Composition of Foods Raw, Processed, Prepared. Beltsville, Maryland 20705: US Department of Agriculture Agricultural Research Service. USDA National Nutrient Database for Standard Reference;
23. Feskanich D, Rimm EB, Giovannucci EL, Colditz GA, Stampfer MJ, Litin LB, et al. Reproducibility and validity of food intake measurements from a semiquantitative food frequency questionnaire. *J Am Diet Assoc.* 1993 Jul; 93(7):790–6. [PubMed: 8320406]
24. Rimm EB, Giovannucci EL, Stampfer MJ, Colditz GA, Litin LB, Willett WC. Reproducibility and validity of an expanded self-administered semiquantitative food frequency questionnaire among male health professionals. *Am J Epidemiol.* 1992 May 15; 135(10):1114–1126. 1136. [PubMed: 1632423]
25. Yuan C, Spiegelman D, Rimm EB, Rosner BA, Stampfer MJ, Barnett JB, et al. Relative Validity of Nutrient Intakes Assessed by Questionnaire, 24-Hour Recalls, and Diet Records Compared With Urinary Recovery and Plasma Concentration Biomarkers: Findings for Women. *Am J Epidemiol.* 2017 Oct 4.
26. Sun Q, Ma J, Campos H, Hankinson SE, Hu FB. Comparison between plasma and erythrocyte fatty acid content as biomarkers of fatty acid intake in US women. *Am J Clin Nutr.* 2007 Jul; 86(1):74–81. [PubMed: 17616765]
27. Cho E, Rosner BA, Feskanich D, Colditz GA. Risk factors and individual probabilities of melanoma for whites. *J Clin Oncol Off J Am Soc Clin Oncol.* 2005 Apr 20; 23(12):2669–75.
28. Wu S, Han J, Li W-Q, Li T, Qureshi AA. Basal-cell carcinoma incidence and associated risk factors in U.S. women and men. *Am J Epidemiol.* 2013 Sep 15; 178(6):890–7. [PubMed: 23828250]
29. Colditz GA, Martin P, Stampfer MJ, Willett WC, Sampson L, Rosner B, et al. Validation of questionnaire information on risk factors and disease outcomes in a prospective cohort study of women. *Am J Epidemiol.* 1986 May; 123(5):894–900. [PubMed: 3962971]
30. Hunter DJ, Colditz GA, Stampfer MJ, Rosner B, Willett WC, Speizer FE. Risk factors for basal cell carcinoma in a prospective cohort of women. *Ann Epidemiol.* 1990 Oct; 1(1):13–23. [PubMed: 1669486]
31. Hu FB, Stampfer MJ, Rimm E, Ascherio A, Rosner BA, Spiegelman D, et al. Dietary fat and coronary heart disease: a comparison of approaches for adjusting for total energy intake and modeling repeated dietary measurements. *Am J Epidemiol.* 1999 Mar 15; 149(6):531–40. [PubMed: 10084242]
32. Song F, Qureshi AA, Gao X, Li T, Han J. Smoking and risk of skin cancer: a prospective analysis and a meta-analysis. *Int J Epidemiol.* 2012 Dec; 41(6):1694–705. [PubMed: 23064412]
33. Pothiwala S, Qureshi AA, Li Y, Han J. Obesity and the incidence of skin cancer in US Caucasians. *Cancer Causes Control CCC.* 2012 May; 23(5):717–26. [PubMed: 22450736]
34. Therneau, TM. Modeling survival data: extending the Cox model. New York: Springer; 2000.
35. Black HS, Rhodes LE. The potential of omega-3 fatty acids in the prevention of non-melanoma skin cancer. *Cancer Detect Prev.* 2006; 30(3):224–32. [PubMed: 16872755]

**Table 1**  
Baseline characteristics of study participants according to quintile of total fat intake in the Nurses' Health Study and Health Professionals Follow-up Study.

	Quintile of Total fat intake (% of energy intake)				
	Q1	Q2	Q3	Q4	Q5
<b>NHS (women, 1984)</b>					
Total fat intake (% of energy intake), mean (SD)	26.6 (3.0)	31.8 (0.9)	34.7 (0.8)	37.6 (0.9)	42.6 (3.1)
Number of participants	15,079	15,020	15,092	15,057	15,063
Age, years, mean (SD)	51.8 (7.1)	50.7 (7.2)	50.1 (7.2)	49.7 (7.1)	49.4 (7.1)
Family history of melanoma, %	2.5	2.6	2.5	2.6	2.6
Red/blonde hair, %	15.8	15.7	15.6	15.7	15.8
Painful burn/blisters reaction as a child/adolescent, %	34.7	33.9	35.1	34.6	33.8
6+ of Blistering sunburns, %	6.6	7.0	7.7	7.4	8.0
6+ of moles, %	4.1	4.8	4.8	4.6	4.8
Body mass index (kg/m <sup>2</sup> ), mean (SD)	24.3 (4.3)	24.7 (4.4)	25.1 (4.7)	25.3 (4.9)	25.8 (5.2)
Physical activity level (MET hrs/wk), mean (SD)	17.6 (25.6)	15.2 (21.3)	13.6 (19.4)	12.4 (18.3)	11.7 (18.8)
Alcohol intake (g/d), mean (SD)	10.4 (16.0)	7.8 (11.7)	6.5 (9.9)	5.6 (8.6)	4.3 (7.3)
Smoking, %	24.2	22.6	22.6	24.6	28.8
Menopause status, %	59.1	58.1	57.8	58.3	58.2
Postmenopausal hormones use in postmenopausal women, %	24.5	23.9	23.3	23.1	23.0
Total citrus intake (serving/d), mean (SD)	1.1 (0.9)	1.0 (0.8)	0.9 (0.7)	0.8 (0.6)	0.6 (0.6)
Caffeine intake (mg/d), mean (SD)	281.4 (221.7)	303.7 (224.0)	322.4 (229.5)	342.2 (236.4)	366.4 (248.7)
Total energy intake (kcal/d), mean (SD)	1675.8 (517.3)	1746.3 (519.5)	1775.7 (526.4)	1782.7 (534.4)	1745.3 (546.3)
<b>HPFS (men, 1986)</b>					
Total fat intake (% of energy intake), mean (SD)	23.0 (3.3)	28.9 (1.1)	32.2 (0.9)	35.3 (1.0)	40.6 (3.3)
Number of participants	9,703	9,703	9,704	9,703	9,703
Age, years, mean (SD)	55.4 (10.0)	54.6 (10.0)	54.0 (9.8)	53.5 (9.7)	53.9 (9.5)
Family history of melanoma, %	2.7	2.8	3.3	3.1	3.4
Red/blonde hair, %	13.3	13.6	14.0	14.5	14.4
Painful burn/blisters reaction as a child/adolescent, %	54.1	55.1	54.9	55.7	54.7
6+ of Blistering sunburns, %	12.6	13.7	13.9	13.7	14.7

	Quintile of Total fat intake (% of energy intake)				
	Q1	Q2	Q3	Q4	Q5
6+ of moles, %	5.1	5.4	5.6	5.2	5.6
Body mass index (kg/m <sup>2</sup> ), mean (SD)	24.3 (4.7)	24.7 (5.0)	25.0 (5.0)	25.2 (5.2)	25.5 (5.2)
Physical activity level (MET hrs/wk), mean (SD)	27.2 (34.8)	22.6 (32.1)	20.3 (28.1)	18.6 (27.8)	16.1 (21.8)
Alcohol intake (g/d), mean (SD)	15.9 (21.4)	13.7 (17.4)	12.0 (15.0)	10.2 (13.5)	7.8 (10.9)
Current smoking, %	6.6	8.5	9.8	10.9	14.1
Total citrus intake (serving/d), mean (SD)	1.3 (1.2)	1.1 (0.9)	0.9 (0.8)	0.8 (0.7)	0.7 (0.6)
Caffeine intake (mg/d), mean (SD)	173.6 (201.3)	210.6 (212.8)	227.6 (220.5)	248.4 (232.9)	281.1 (250.7)
Total energy intake (kcal/d), mean (SD)	1884.1 (591.3)	1938.1 (580.7)	2007.1 (603.0)	2052.7 (629.2)	2068.6 (660.7)

Values are means (Standard Deviation, SD) or percentages and are standardized to the age distribution of the study population except for age and number of participants.

NHS, Nurses' Health Study; HPFS, Health Professionals Follow-up Study; MET, metabolic-equivalents

Table 2

Pooled multivariable hazard ratios and 95% confidence intervals of melanoma by fat intake in the Nurses' Health Study and Health Professionals Follow-up Study.

	Q1	Q2	Q3	Q4	Q5	P trend
<b>Total fat</b>						
HR1 <sup>a</sup> (95% CI)	1.00 (referent)	1.04 (0.83, 1.30)	0.99 (0.84, 1.16)	1.00 (0.73, 1.38)	1.05 (0.88, 1.25)	0.80
<b>Saturated fat</b>						
HR1 <sup>a</sup> (95% CI)	1.00 (referent)	1.01 (0.81, 1.27)	1.02 (0.82, 1.28)	0.94 (0.79, 1.11)	0.96 (0.80, 1.14)	0.36
HR2 <sup>b</sup> (95% CI)	1.00 (referent)	0.98 (0.76, 1.25)	0.97 (0.78, 1.22)	0.87 (0.69, 1.08)	0.88 (0.68, 1.12)	0.13
<b>Monounsaturated fat</b>						
HR1 <sup>a</sup> (95% CI)	1.00 (referent)	1.02 (0.87, 1.19)	0.95 (0.81, 1.12)	1.07 (0.84, 1.35)	1.02 (0.86, 1.21)	0.81
HR2 <sup>b</sup> (95% CI)	1.00 (referent)	0.99 (0.83, 1.18)	0.91 (0.74, 1.13)	1.04 (0.82, 1.31)	0.98 (0.75, 1.28)	0.92
<b>Cholesterol</b>						
HR1 <sup>a</sup> (95% CI)	1.00 (referent)	1.00 (0.85, 1.17)	1.05 (0.89, 1.23)	1.18 (1.00, 1.38)	1.03 (0.87, 1.22)	0.30
HR2 <sup>b</sup> (95% CI)	1.00 (referent)	1.02 (0.86, 1.20)	1.09 (0.92, 1.28)	1.23 (1.04, 1.46)	1.09 (0.90, 1.31)	0.13
<b>Polyunsaturated fat</b>						
HR1 <sup>a</sup> (95% CI)	1.00 (referent)	1.08 (0.76, 1.53)	1.11 (0.91, 1.35)	1.17 (1.00, 1.38)	1.15 (0.95, 1.40)	0.05
HR2 <sup>b</sup> (95% CI)	1.00 (referent)	1.09 (0.74, 1.59)	1.12 (0.88, 1.42)	1.19 (0.99, 1.42)	1.17 (0.94, 1.45)	0.08
<b>Omega-6 fat</b>						
HR1 <sup>a</sup> (95% CI)	1.00 (referent)	1.04 (0.74, 1.47)	1.09 (0.92, 1.30)	1.08 (0.79, 1.47)	1.20 (1.02, 1.41)	0.03
HR2 <sup>b</sup> (95% CI)	1.00 (referent)	1.04 (0.71, 1.54)	1.10 (0.85, 1.41)	1.07 (0.69, 1.63)	1.18 (0.95, 1.46)	0.18
<b>Omega-3 fat</b>						
HR1 <sup>a</sup> (95% CI)	1.00 (referent)	1.05 (0.88, 1.26)	0.99 (0.84, 1.18)	1.17 (0.99, 1.37)	1.16 (0.99, 1.37)	0.03
HR2 <sup>b</sup> (95% CI)	1.00 (referent)	1.03 (0.87, 1.22)	0.96 (0.80, 1.14)	1.10 (0.92, 1.32)	1.06 (0.87, 1.28)	0.54

HRs, hazard ratios; Cis, confidence intervals; NHS, Nurses' Health Study; HPFS, Health Professionals Follow-up Study

The multivariate-adjusted hazard ratios from each cohort were pooled using random effects model.

<sup>a</sup>Multivariable model 1 was jointly stratified by age in months and calendar year of the questionnaire cycle and adjusted for family history of melanoma, natural hair color, number of arm moles, sunburn susceptibility as a child/adolescent, number of lifetime blistering sunburns, cumulative UV flux since baseline, body mass index, physical activity, smoking status, incident SCC, incident BCC, personal history of non-skin cancer, intakes of total energy, alcohol, caffeine and citrus fruits. Among women analyses were additionally adjusted for menopausal status and postmenopausal hormone use.

Multivariable model 2 was adjusted for the same covariates as multivariable model 1 and for other fats in quintiles simultaneously. Saturated, polyunsaturated, and monounsaturated fats and cholesterol were adjusted for each other. Omega-6 fat and omega-3 fat were adjusted for each other, as well as adjustment for saturated, monounsaturated fats, and for cholesterol.

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**Table 3**  
Pooled multivariable hazard ratios and 95% confidence intervals of squamous cell carcinoma by fat intake in the Nurses' Health Study and Health Professionals Follow-up Study.

	Q1	Q2	Q3	Q4	Q5	P trend
<b>Total fat</b>						
HR1 <sup>a</sup> (95% CI)	1.00 (referent)	0.92 (0.83, 1.03)	1.07 (0.94, 1.21)	1.02 (0.92, 1.13)	1.03 (0.92, 1.15)	0.20
<b>Saturated fat</b>						
HR1 <sup>a</sup> (95% CI)	1.00 (referent)	1.07 (0.97, 1.17)	1.04 (0.94, 1.15)	1.07 (0.96, 1.19)	0.98 (0.88, 1.09)	0.99
HR2 <sup>b</sup> (95% CI)	1.00 (referent)	1.13 (1.01, 1.25)	1.13 (1.00, 1.27)	1.18 (1.03, 1.34)	1.11 (0.96, 1.30)	0.11
<b>Monounsaturated fat</b>						
HR1 <sup>a</sup> (95% CI)	1.00 (referent)	0.96 (0.87, 1.07)	1.01 (0.92, 1.12)	0.97 (0.88, 1.08)	1.02 (0.92, 1.13)	0.63
HR2 <sup>b</sup> (95% CI)	1.00 (referent)	0.90 (0.80, 1.02)	0.92 (0.81, 1.04)	0.87 (0.75, 1.00)	0.91 (0.77, 1.07)	0.37
<b>Cholesterol</b>						
HR1 <sup>a</sup> (95% CI)	1.00 (referent)	0.96 (0.88, 1.06)	0.93 (0.85, 1.03)	0.96 (0.87, 1.05)	0.82 (0.73, 0.93)	0.002
HR2 <sup>b</sup> (95% CI)	1.00 (referent)	0.94 (0.86, 1.04)	0.91 (0.83, 1.01)	0.92 (0.83, 1.03)	0.80 (0.67, 0.94)	0.001
<b>Polyunsaturated fat</b>						
HR1 <sup>a</sup> (95% CI)	1.00 (referent)	1.04 (0.94, 1.15)	1.08 (0.97, 1.19)	1.09 (0.99, 1.21)	1.16 (1.05, 1.28)	0.001
HR2 <sup>b</sup> (95% CI)	1.00 (referent)	1.06 (0.96, 1.18)	1.11 (1.00, 1.24)	1.13 (1.01, 1.27)	1.20 (1.07, 1.36)	0.001
<b>Omega-6 fat</b>						
HR1 <sup>a</sup> (95% CI)	1.00 (referent)	1.02 (0.88, 1.17)	1.08 (0.97, 1.19)	1.11 (1.00, 1.23)	1.18 (1.06, 1.30)	0.0001
HR2 <sup>b</sup> (95% CI)	1.00 (referent)	1.04 (0.89, 1.21)	1.11 (1.00, 1.25)	1.16 (1.03, 1.31)	1.23 (1.08, 1.41)	0.0005
<b>Omega-3 fat</b>						
HR1 <sup>a</sup> (95% CI)	1.00 (referent)	0.99 (0.90, 1.10)	1.04 (0.94, 1.15)	1.02 (0.93, 1.13)	1.04 (0.94, 1.15)	0.36
HR2 <sup>b</sup> (95% CI)	1.00 (referent)	0.98 (0.88, 1.08)	1.01 (0.91, 1.12)	0.98 (0.88, 1.09)	0.97 (0.87, 1.10)	0.78

HRs, hazard ratios; Cis, confidence intervals; NHS, Nurses' Health Study; HPFS, Health Professionals Follow-up Study

The multivariate-adjusted hazard ratios from each cohort were pooled using random effects model.

<sup>a</sup>Multivariable model 1 was jointly stratified by age in months and calendar year of the questionnaire cycle and adjusted for family history of melanoma, natural hair color, number of arm moles, sunburn susceptibility as a child/adolescent, number of lifetime blistering sunburns, cumulative UV flux since baseline, body mass index, smoking status, incident melanoma, incident BCC, personal history of non-skin cancer, intakes of total energy, alcohol, caffeine and citrus fruits. Among women analyses were additionally adjusted for menopausal status and postmenopausal hormone use.

Multivariable model 2 was adjusted for the same covariates as multivariable model 1 and for other fats in quintiles simultaneously. Saturated, polyunsaturated, and monounsaturated fats and cholesterol were adjusted for each other. Omega-6 fat and omega-3 fat were adjusted for each other, as well as adjustment for saturated, monounsaturated fats, and for cholesterol.

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**Table 4**

Pooled multivariable hazard ratios and 95% confidence intervals of basal cell carcinoma by fat intake in the Nurses' Health Study and Health Professionals Follow-up Study.

	Q1	Q2	Q3	Q4	Q5	P trend
<b>Total fat</b>						
HR1 <sup>a</sup> (95% CI)	1.00 (referent)	0.99 (0.96, 1.03)	0.96 (0.89, 1.03)	0.97 (0.89, 1.05)	0.94 (0.86, 1.03)	0.20
<b>Saturated fat</b>						
HR1 <sup>a</sup> (95% CI)	1.00 (referent)	1.01 (0.97, 1.04)	0.98 (0.95, 1.02)	0.96 (0.93, 1.00)	0.90 (0.79, 1.01)	0.04
HR2 <sup>b</sup> (95% CI)	1.00 (referent)	1.01 (0.97, 1.06)	0.99 (0.95, 1.04)	0.98 (0.93, 1.03)	0.92 (0.79, 1.08)	0.29
<b>Monounsaturated fat</b>						
HR1 <sup>a</sup> (95% CI)	1.00 (referent)	0.96 (0.93, 1.00)	0.98 (0.92, 1.06)	0.95 (0.89, 1.02)	0.92 (0.87, 0.98)	0.02
HR2 <sup>b</sup> (95% CI)	1.00 (referent)	0.94 (0.89, 0.99)	0.96 (0.88, 1.03)	0.93 (0.89, 0.98)	0.90 (0.85, 0.96)	0.002
<b>Cholesterol</b>						
HR1 <sup>a</sup> (95% CI)	1.00 (referent)	1.04 (0.99, 1.10)	1.00 (0.97, 1.04)	1.02 (0.98, 1.06)	0.97 (0.93, 1.01)	0.03
HR2 <sup>b</sup> (95% CI)	1.00 (referent)	1.06 (0.99, 1.13)	1.03 (0.99, 1.06)	1.06 (0.97, 1.16)	1.02 (0.96, 1.10)	0.65
<b>Polyunsaturated fat</b>						
HR1 <sup>a</sup> (95% CI)	1.00 (referent)	1.00 (0.96, 1.03)	1.03 (0.99, 1.07)	1.04 (1.01, 1.08)	1.06 (1.01, 1.11)	0.01
HR2 <sup>b</sup> (95% CI)	1.00 (referent)	1.01 (0.97, 1.05)	1.05 (1.00, 1.10)	1.08 (1.04, 1.12)	1.11 (1.06, 1.16)	0.0002
<b>Omega-6 fat</b>						
HR1 <sup>a</sup> (95% CI)	1.00 (referent)	1.03 (0.99, 1.07)	1.03 (1.00, 1.07)	1.03 (1.00, 1.07)	1.08 (1.02, 1.14)	0.01
HR2 <sup>b</sup> (95% CI)	1.00 (referent)	1.03 (1.00, 1.07)	1.04 (1.00, 1.08)	1.05 (1.00, 1.09)	1.11 (1.05, 1.16)	0.0003
<b>Omega-3 fat</b>						
HR1 <sup>a</sup> (95% CI)	1.00 (referent)	1.02 (0.97, 1.08)	1.04 (1.00, 1.08)	1.08 (1.04, 1.12)	1.09 (1.04, 1.13)	<.0001
HR2 <sup>b</sup> (95% CI)	1.00 (referent)	1.01 (0.95, 1.07)	1.02 (0.98, 1.06)	1.04 (1.00, 1.09)	1.04 (0.98, 1.09)	0.07

HRs, hazard ratios; Cis, confidence intervals; NHS, Nurses' Health Study; HPFS, Health Professionals Follow-up Study

The multivariate-adjusted hazard ratios from each cohort were pooled using random effects model.

<sup>a</sup>Multivariable model 1 was jointly stratified by age in months and calendar year of the questionnaire cycle and adjusted for family history of melanoma, natural hair color, number of arm moles, sunburn susceptibility as a child/adolescent, number of lifetime blistering sunburns, cumulative UV flux since baseline, body mass index, physical activity, smoking status, incident melanoma, incident SCC, personal history of non-skin cancer, intakes of total energy, alcohol, caffeine and citrus fruits. Among women analyses were additionally adjusted for menopausal status and postmenopausal hormone use.

Multivariable model 2 was adjusted for the same covariates as multivariable model 1 and for other fats in quintiles simultaneously. Saturated, polyunsaturated, and monounsaturated fats and cholesterol were adjusted for each other. Omega-6 fat and omega-3 fat were adjusted for each other, as well as adjustment for saturated, monounsaturated fats, and for cholesterol.

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