Severe Sunburn as the Overwhelming Risk Factor for 3 Common Skin Cancers: New Prevention Strategy

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Abstract

Re-analysis of published data from two large prospective cohort studies by Wu, et al., probably provides the hitherto most unequivocal evidence that Severe Sunburn (SS) was an overwhelming risk factor (>90%) for all incidences of melanoma, Basal Cell Carcinoma (BCC) and Squamous Cell Carcinoma (SCC) in both men and women. It is found, for example, that experiencing 1-5 and ≥ 6 SSs increased one’s risk for melanoma in men by 12.7-fold and 22-fold, respectively. Since use of sunscreen during intense intermittent sun exposure can cause unintended SS, a false security phenomenon, sunscreen can be postulated as a potential major risk factor for causing skin cancers. Because chronic exposure to non-burning sunlight is protective against melanoma and can enhance immunity, this protective effect may also likely occur with less serious BCC and SCC. Therefore, regular exposure to non-burning sunlight may serve as a new strategy for skin cancer prevention and general health promotion. It is theorized that in addition to immunity enhancement, regular exposure to non-burning sunlight can result in skin tanning that will protect against sunburn and thereby protect against skin cancer. The role of erythema, a mild sunburn, in cancer incidences may be relatively limited. Since skin aging in ordinary people may be predominantly caused by the intrinsic factor, and SS is predominantly caused by intense ultraviolet (UV) B rays, the need of using broad-spectrum sunscreens or organic sunscreen ingredients for protection against UVA may need to be re-considered.
Keywords
Severe Sunburn; Ultraviolet Rays; Skin Cancers; Skin Lesions; Sunscreen; UV Index

Introduction
Exposure to ultraviolet (UV) rays from the sun or tanning devices has been commonly regarded as the major risk factor for skin cancer development [1,2]. Well-designed studies on the relative role of cumulative sun exposure and sunburn caused by acute intense UV radiation (often regarded as a skin cancer biomarker, ref. 2) in contributing to incidences of the three most common skin cancers, namely, melanoma, Basal Cell Carcinoma (BCC) and Squamous Cell Carcinoma (SCC) appear limited to date. Furthermore, there is a different degree of sunburn ranging from mild sunburn showing only skin reddening or inflammation (i. e., erythema) to Severe Sunburn (SS) with pain, swelling, peeling and/or blistering; conceivably different degrees of sunburn may have different impacts on cancer development [3]. Delineation of the above scenarios may be useful to the design of an effective strategy to prevent skin cancer. This communication reports, for the first time, quantitative data clearly demonstrating that SS is an overwhelming risk factor for all three skin cancers in the same large population in the United States and briefly discusses its potential implications in skin cancer prevention.

Relationship between the Number of Severe Sunburn and Percent Incidence of 3 Skin Cancers
The data are based on quantitative re-analysis of an extensive well-designed prospective study on the history of SS and the risk of skin cancer reported by Wu, et al., in 2016 [4]. In their study, 87,166 female nurses and 32,959 male health professionals were enrolled. The total number of SS incidences for each subject in six years prior to cancer monitoring and all the participants had blunt hair (28 years for females; 18 years for males) was obtained. Relationships between the number of SS incidences and number of cancer cases were obtained directly from their Table 2 that were then converted to percent of total case number as summarized in Table 1 and illustrated in Table 2.

<table>
<thead>
<tr>
<th>Female</th>
<th># of Severe Sunburns</th>
<th>Melanoma (%)</th>
<th>BCC (%)</th>
<th>SCC (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (never sunburned)</td>
<td>6.1</td>
<td>8.1</td>
<td>7.8</td>
<td></td>
</tr>
</tbody>
</table>

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Table 1: Relationship between the number of severe sunburns incurred and the number of female cancer cases reported in terms of percent of total cases (N = 774 for invasive melanoma, 16,092 for BCC and 1,366 for SCC) and male cancer cases reported in terms of percent of total cases (N = 391 for invasive melanoma, 5,454 for BCC and 798 for SCC) based on data reported in figure 1 of reference 4 for melanoma, BCC and SCC.

<table>
<thead>
<tr>
<th># of Severe Sunburns</th>
<th>Melanoma (%)</th>
<th>BCC (%)</th>
<th>SCC (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (never sunburned)</td>
<td>2.8</td>
<td>6.9</td>
<td>5.3</td>
</tr>
<tr>
<td>1-5</td>
<td>35.5</td>
<td>40.8</td>
<td>40.1</td>
</tr>
<tr>
<td>6-10</td>
<td>15.9</td>
<td>15.9</td>
<td>15.3</td>
</tr>
<tr>
<td>11-15</td>
<td>13.6</td>
<td>12.2</td>
<td>12.9</td>
</tr>
<tr>
<td>≥ 16</td>
<td>32.2</td>
<td>24.2</td>
<td>26.4</td>
</tr>
</tbody>
</table>

Table 2: Illustration of remarkable similarity in the number of severe sunburns incurred and the percent of total skin cancer cases reported for melanoma, BCC and SCC in males and females in spite of dramatic differences in the total cases of 3 cancers based on data from Table 1.
Discussion

Melanoma incidences without SS were remarkably low, only 2.8% and 6.1% for men and women, respectively. BCC and SCC incidences without SS were also low ranging from 5.3% to 8.1%. The above data clearly indicate that SS was a common overwhelming (all > 90%; 97.2% for melanoma in men) risk factor in all three skin cancers in the same population. The huge impact of SS on melanoma development may be better appreciated from the following data: Experiencing 1-5 and ≥ 6 SS increased one’s risk by 12.7-fold and 22-fold for men and 5.4-fold and 10-fold for women, respectively. The above data are dramatically different (more than 27.5 times higher) from earlier reports that experiencing ≥ 5 SS increased melanoma’s risk by only 80% in men and the BCC and SCC incidences are more associated with cumulative sun exposure especially for women [1,4]. For BCC and SCC in women in the present analysis, an association with 1-5 SS would increase their chances of getting the cancer by 5.9-fold and 7.6-fold, respectively. Since the study was based on a prospective design, it eliminated problems such as recollection bias used in hitherto most reported case-control studies [1,4]. Also, all three common cancers were evaluated in the same large populations. Therefore, the data shown in Table 1 may be considered as hitherto most accurate and comprehensive study of its kind.

In this study, SS was only monitored during the six-year period of childhood and adolescence and the likeliness of SS occurring during the long (18 to 28 years) cancer monitoring was not followed [4]. It is most likely that some incidences of SS could have occurred during this period. Therefore, the number of reported zero SS in Table 1 may be significantly overestimated and the actual number of percent of cancer associated with the SS may be much higher than mentioned above. It is possible that the actual numbers for all 3 cancers in both men and women could be all 100% or near 100%. In other words, SS may be even required for all skin cancer incidences.

As shown in Table 1 and Fig. 1, in spite of their large differences in the number of the total case (e.g., 20.8 fold for women between melanoma and BCC), about 33%, 33%, and 31% of all melanoma, BCC and SCC cases were associated with 6-10 SS, respectively, and about 28%, 220% and 23% were associated with ≥ 16 SS in women, respectively. The above remarkable similarity patterns among the three totally different cancers appear very intriguing and reasons for such occurrences remain to be studied especially at the molecular level.

The above data suggest that we may need to focus more on avoiding SS and less on decreasing chronic or cumulative UV exposure in cancer prevention. For example, intense intermittent sun exposure at the beach and ski resort may be discouraged as this has been shown to be positively correlated with melanoma incidences due to SS [5]. Obviously, a prudent method is to have direct sun exposure in non-peak hours such as after 3 or 4 p.m. or when sun exposure is non-burning. Use of sunscreen during intermittent exposure can result in unintended sunburns due
to factors such as prolonged use and virtually unavoidable SPF-and-site-independent missing applications (even on 1% of the intended area) [3,6]. The resulting unintended or unexpected sunburn may be regarded as a false security phenomenon. Interestingly, it was reported by Petersen, et al., that “A sun holiday is a sunburn holiday” for all 25 people who used sunscreen with an SPF of 30 and developed unintended sunburn after spending one week of sunbathing at a subtropical resort [7]. Therefore, the present work also suggests sunscreen use for intense intermittent sun exposure as a potential major risk factor for skin cancer that may primarily or at least partly account for the reported exponential increase of incidences of melanoma and BCC and SCC in the United States and other countries with a temperate climate in the last two or three decades [3,6,8,9]. It is recommended that the potential unintended or unexpected risk of sunburn and skin cancer when using sunscreen for intense intermittent sun exposure be urgently conveyed to the general public as an effort to help prevent SS and skin cancer.

The present work suggests that erythema may play a less important role in cancer development than commonly assumed. Although erythema can cause damage to DNA, its visible inflammatory sign on the skin can usually disappear with minimum intervention in days [3]. Also, virtually all damaged DNAs may be completely repaired or eliminated by our body’s extremely efficient repair mechanisms in weeks or months [3,6,10]. Based on the BCC data one may estimate theoretically that only up to 22% of the total BCC cases having ≥16 SS could eventually develop melanoma reflecting the body’s super ability to defend against cancer development from damaged DNAs.

Chronic exposure to non-burning sunlight (including UVA and UVB rays) that damages DNAs and other tissue components is ironically protective against melanoma and some other non-dermatological cancers, this kind of unexpected protective phenomenon may likely also occur with the less serious BCC and SCC (confirmation needed) [3,5,6]. In other words, the observed protective phenomenon of non-burning UV radiation against melanoma may suggest that in theory, cumulative or chronic non-burning UV exposure should not be a risk factor for BCC and SCC incidences as commonly implied [1,4]. It is theorized that in addition to immunity enhancement, regular exposure to non-burning sunlight can result in skin tanning that will protect against sunburn and thereby protect against skin cancer. In view of the above and other numerous health benefits from exposure to non-burning sunlight reviewed earlier, it is suggested that regular daily exposure to non-burning sunlight should be recommended as a new important strategy to prevent skin cancer in our public health policy [3,6,11]. In reversing the traditional zero tolerance toward sunlight Australia and New Zealand, two countries with the highest incidences of melanoma, have recently encouraged their residents to go out and enjoy sunshine when the UV Index is below 3 [3,6,11].

It is possible that SS, not erythema nor non-burning chronic sun exposure, may predominantly cause precancerous skin lesions such as actinic keratosis and mole. However, one obviously needs to avoid getting erythema as much as possible in our daily lives. It is known that
numerous confounding factors can also contribute to development of skin cancers that may account for why someone may need only one SS to get a melanoma, BCC or SCC while others may need up to 16 or more SSs to develop a skin cancer (Table 1) [1,2].

Because SS is known to be predominantly caused by intense UVB radiation and chronic non-burning sun exposure may not have significant adverse effects on skin aging, the need of using organic sunscreen ingredients in our daily lives for protection against UVA may need to be re-considered, especially in view of their potential percutaneous absorption and long-term adverse effects [3,6,12-15]. It is hoped that the present work may stimulate further debate and study on the need of using broad-spectrum sunscreens in our daily lives. It may be of use to mention here that the importance of intense UVB rays and the relative insignificance of UVA rays in the etiology of melanoma in animal models have been recently reviewed [3]. Also, the dominant or prominent role of UVA rays in causing photoaging in ordinary people and in causing skin cancer seems to have been the main-stream thinking world-wide in the last two or three decades [3,15-17].

**Conflict of Interest**

There is no conflict of interest to declare.

**References**


11. Chiou WL. We may need to reconsider when to apply sunscreen in our daily life. Ann Dermatol Res. 2019;3:007-10.


