Preventive Medicine xxx (2009) xxx–xxx

Contents lists available at ScienceDirect

Preventive Medicine

journal homepage: www.elsevier.com/locate/ypmed

# Sunbed use in the Danish population in 2007: A cross-sectional study

Brian Køster *, Camilla Thorgaard, Inge Haunstrup Clemmensen, Anja Philip

*Danish Cancer Society, Department of Prevention and Documentation, Strandboulevarden 49, DK-2100, Denmark*

ARTICLE INFO

Available online xxxx

*Keywords:*
Sunbed
Sun protection
Prevention
Skin cancer

ABSTRACT

*Background.* In Denmark, the incidence of all types of skin cancer, including malignant melanoma, has been increasing since the 1960s. Exposure to ultraviolet (UV) radiation is the main preventable cause of skin cancer. We describe current sunbed use in the Danish population.

*Methods.* A population-based sample of 3437 persons aged 15–59 years completed a questionnaire that included items on artificial and natural exposure to UV. We examined relations between sunbed use, outdoor tanning, knowledge about associated health risks and demographic factors with logistic regression analysis.

*Results.* Within the past 12 months, 29% of all Danes aged 15–59 had used a sunbed, including 59% females aged 15–19, even though knowledge about the relation between exposure to UV and cancer was more frequent in this group. A larger proportion of persons aged 15–18 had first used a sunbed before the age of 14 than older groups. Single males, frequent outdoor sunbathers, persons who experienced sunburns and less educated persons were more likely to use sunbeds.

*Conclusions.* Future campaigns to reduce the Danes sunbed use should target initiation by young people and the high prevalence among them. The results suggest a legislative solution, with a minimum age of 18 years for indoor tanning.



## Introduction

The incidence of melanoma (world standardized incidence rate per 100 000) for men and women in Denmark increased from 1.4 and 1.9 in 1949–53 to 12.6 and 15.2 in 1999–2003 (Engholm et al., 2008), respectively. Apart from Australia (38.5/28.9) and New Zealand (34.8/31.4) (1998–2002) (Curado et al., 2007), the Scandinavian countries have some of the highest incidences of melanoma in the world. Non-melanoma (basal cell carcinoma and squamous cell carcinoma) is the most frequent cancer among Danes 68.9/64.3 (1999–2003) (Engholm et al., 2008).

Exposure to ultraviolet (UV) radiation is a risk factor for skin cancers of all types, including malignant melanoma. The main source of UV radiation is the sun, but artificial light from sunbeds (solariums, sunlamps) also contains UV radiation. A recent meta-analysis showed an increased risk for melanoma among persons first exposed to sunbeds before 30 years of age, with a summary relative risk estimate of 1.75 (1.35–2.26) (Green et al., 2006). In 1994, 35% of Danes reported sunbed use within the past 2 years, but by 2004 the proportion had increased to 50% (www.cancer.dk/skrunedforsolen/presserum/2007/Undersoegelser.htm).

We studied current sunbed use in a population-based sample of the Danish population ($n$=4303) collected before the start of a 10-year national sun protection campaign.

## Methods

### *Sample and questionnaire*

This study was based on a 'sun survey' conducted during 2 weeks in March 2007, with a sample of 4303 respondents aged 15+. The 75-item questionnaire included questions about exposure to artificial and natural UV, knowledge about UV exposure, skin type and sunburn. Data were collected through web and telephone interviews. A sample was drawn from a web panel of approximately 30 000 persons recruited by random-digit dialing. From the sample we collected 3500 web interviews (30% response rate). A supplementary group of respondents to match the Danish population by age, gender and region was then recruited from a list of telephone numbers provided by Statistics Denmark. Trained interviewers collected 803 telephone interviews (24% response rate, 51% not reached within 6 attempts, 17% refused, 5% wrong number and 2% not available in sampling period). We excluded age group 60+ from the analysis due to a biased distribution in this age group. The final analysis included 1955 female and 1482 male respondents aged 15–59. Skin types were determined from self-assessed tan and sunburn reactions according to Fitzpatrick (Fitzpatrick, 1988). Self-reported height and weight facilitated

* Corresponding author.
*E-mail addresses:* koester_brian@yahoo.com, brk@cancer.dk (B. Køster).

0091-7435/$ – see front matter © 2009 Elsevier Inc. All rights reserved.
doi:10.1016/j.ypmed.2008.12.012

**Table 1**
Distribution of answers to the question "How often did you use sunbed within the last 12 months?" in a 'sun survey' in Denmark in March 2007

| Frequency of sunbed use | *n* | % | Recent or non-recent user |
|---|---|---|---|
| More than once a week | 40 | 1 | Recent users |
| Once a week | 92 | 3 | |
| More than once a month | 157 | 5 | |
| Once a month | 254 | 7 | |
| Less than four times a year | 470 | 14 | |
| Not within the last 12 months | 1101 | 32 | Non-recent users |
| Never | 1323 | 38 | |

calculation of BMI. The group consisted of 57% females and 43% males in the age groups 15–19 (11%), 20–29 (13%), 30–39 (25%), 40–49 (25%) and 50–59 (26%) in the geographic regions Capital (40%), Zealand (11%), Northern Jutland (10%), Central Jutland (21%) and Southern Denmark (17%).

### *Statistical analyses*

Respondents were asked how often they had used a sunbed within the past 12 months. The answers were grouped into 'recent user' and 'non-recent user' (Table 1). The homogeneity of sunbed use, attitudes and demographic variables between 'non-recent users' and 'recent users' was examined. The outcome 'recent sunbed user, yes/no' was analysed by logistic regression. Factors with a statistically significant difference in distribution were included as possible explanations. Crude and adjusted odds ratios and 95% confidence intervals were calculated. For all tests, $p$ values $<0.05$ were considered statistically

**Table 2**
Logistic regression analysis of factors affecting sunbed use stratified by gender in a 'sun survey' in Denmark in March 2007

| Characteristic | Females | | | | Males | | | |
|---|---|---|---|---|---|---|---|---|
| | *n* | Recent sunbed user (%) | OR (95% CI)[1] | | *n* | Recent sunbed user (%) | OR (95% CI)[2] | |
| | | | Crude | Adjusted | | | Crude | Adjusted |
| Total | 1955 | 36 | | | 1482 | 18 | | |
| Age (years) | 1955 | | $p<0.001$ | $p<0.001$ | 1482 | | $p<0.001$ | $p<0.001$ |
| 15–19 | 199 | 59 | 2.5 (1.8–3.5) | 1.9 (1.0–3.6) | 165 | 42 | 2.7 (1.8–4.0) | 1.1 (0.5–2.4) |
| 20–29 | 246 | 46 | 1.5 (1.1–2.0) | 1.3 (0.9–1.8) | 198 | 40 | 2.4 (1.6–3.5) | 2.1 (1.4–3.2) |
| 30–39 | 509 | 37 | 1.0 (reference) | 1.0 (reference) | 357 | 21 | 1.0 (reference) | 1.0 (reference) |
| 40–49 | 503 | 33 | 0.8 (0.7–1.1) | 0.8 (0.6–1.0) | 362 | 17 | 0.8 (0.5–1.1) | 0.6 (0.4–1.0) |
| 50–59 | 498 | 23 | 0.5 (0.4–0.7) | 0.5 (0.4–0.7) | 400 | 9 | 0.3 (0.2–0.5) | 0.3 (0.2–0.5) |
| Has a partner | 1824 | | $p=0.563$ | | 1371 | | $p<0.001$ | $p=0.037$ |
| No | 338 | 36 | 1.1(0.8-1.4) | | 273 | 29 | 1.9 (1.4–2.6) | 1.5 (1.0–2.3) |
| Yes | 1486 | 34 | 1.0 (reference) | | 1098 | 18 | 1.0 (reference) | 1.0 (reference) |
| Body mass index | 1953 | | $p=0.008$ | | 1480 | | $p=0.002$ | |
| <18.5 | 88 | 43 | 1.3 (0.8–2.0) | | 21 | 24 | 0.9 (0.3–2.6) | |
| 18.5–25 | 1133 | 38 | 1.0 (reference) | | 739 | 25 | 1.0 (reference) | |
| 25–30 | 472 | 33 | 0.8 (0.6–1.0) | | 559 | 19 | 0.7 (0.5–0.9) | |
| >30 | 260 | 29 | 0.7 (0.5–0.9) | | 161 | 12 | 0.4 (0.2–0.7) | |
| Level of education | 1934 | | $p<0.001$ | $p<0.001$ | 1475 | | $p<0.001$ | $p<0.001$ |
| Primary school | 298 | 48 | 3.6 (2.5–5.3) | 3.3 (1.9–5.6) | 290 | 30 | 3.7 (2.3–5.9) | 3.1 (1.6–5.8) |
| Secondary school | 530 | 39 | 2.5 (1.7–3.5) | 2.5 (1.7–3.6) | 463 | 27 | 3.2 (2.1–5.0) | 3.2 (2.0–5.3) |
| Skilled/short | 867 | 33 | 1.9 (1.4–2.7) | 2.0 (1.4–2.9) | 456 | 16 | 1.6 (1.0–2.5) | 1.9 (1.1–3.2) |
| University | 239 | 21 | 1.0 (reference) | 1.0 (reference) | 266 | 11 | 1.0 (reference) | 1.0 (reference) |
| Skin type | 1942 | | $p=0.002$ | | 1456 | | $p<0.001$ | $p<0.001$ |
| I (never tan, always burn) | 285 | 29 | 0.6 (0.4–0.8) | | 140 | 16 | 0.5 (0.3–0.8) | 0.4 (0.2–0.7) |
| II (seldom tan, burn some) | 1060 | 34 | 0.7 (0.6–0.9) | | 737 | 18 | 0.6 (0.4–0.8) | 0.5 (0.4–0.8) |
| III (tan some, seldom burn) | 563 | 42 | 1.0 (reference) | | 523 | 27 | 1.0 (reference) | 1.0 (reference) |
| IV (always tan, never burn) | 34 | 38 | 0.9 (0.4–1.8) | | 56 | 34 | 1.4 (0.8–2.5) | 1.4 (0.7–3.0) |
| Outdoor sunbathing[3] | 1935 | | $p<0.001$ | $p<0.001$ | 1475 | | $p<0.001$ | $p<0.001$ |
| Never | 300 | 10 | 1.0 (reference) | 1.0 (reference) | 506 | 8 | 1.0 (reference) | 1.0 (reference) |
| Seldom | 564 | 29 | 3.6 (2.4–5.4) | 4.0 (2.5–6.4) | 467 | 21 | 3.3 (2.2–4.9) | 3.6 (2.2–5.7) |
| Once a week | 605 | 41 | 6.0 (4.0–9.0) | 6.3 (4.0–10.1) | 326 | 33 | 6.2 (4.1–9.3) | 5.9 (3.7–9.6) |
| More often | 466 | 53 | 9.8 (6.5–14.8) | 9.0 (5.6–14.5) | 176 | 41 | 8.7 (5.6–13.6) | 6.9 (4.0–11.9) |
| Sunburn[4] | 1937 | | $p<0.001$ | $p=0.047$ | 1467 | | $p<0.001$ | $p=0.030$ |
| Never | 1048 | 30 | 1.0 (reference) | 1.0 (reference) | 822 | 17 | 1.0 (reference) | 1.0 (reference) |
| 1–2 times | 769 | 42 | 1.7 (1.4–2.1) | 1.3 (1.1–1.7) | 583 | 25 | 1.6 (1.2–2.1) | 1.4 (1.0–1.9) |
| >3 times | 120 | 45 | 1.9 (1.3–2.8) | 1.1 (0.7–1.7) | 62 | 42 | 3.5 (2.0–5.9) | 2.2 (1.1–4.4) |
| Sunbeds cause cancer[5] | 1955 | | $p=0.127$ | | 1482 | | $p=0.232$ | |
| Yes | 1726 | 35 | 1.0 (reference) | | 1291 | 22 | 1.0 (reference) | |
| No | 21 | 57 | 2.5 (1.0–5.9) | | 23 | 5 | 1.9 (0.8–4.6) | |
| Do not know | 208 | 36 | 1.0 (0.8–1.4) | | 168 | 19 | 0.9 (0.6–1.3) | |
| Sunbeds cause skin changes[6] | 1955 | | $p=0.247$ | | 1482 | | $p=0.015$ | |
| Yes | 1815 | 36 | 1.0 (reference) | | 1256 | 22 | 1.0 (reference) | |
| No | 24 | 50 | 1.8 (0.8–4.1) | | 41 | 37 | 2.1 (1.1–4.0) | |
| Do not know | 116 | 32 | 0.8 (0.6–1.3) | | 185 | 16 | 0.7 (0.5–1.0) | |
| Cancer in family[7] | 1919 | | $p=0.069$ | | 1422 | | $p=0.045$ | |
| No | 1405 | 37 | 1.0 (reference) | | 1131 | 23 | 1.0 (reference) | |
| Yes | 514 | 32 | 0.8 (0.7–1.0) | | 291 | 18 | 0.7 (0.5–1.0) | |

Odds ratios (ORs) and 95% confidence intervals (CI). *P*-values are test for variation between factor levels.
[1] Female model adjusted for age, level of education, sunbathing and sunburn.
[2] Male model additionally adjusted for skin type and civil status.
[3] Recall last summer. On a day off, when the sun was shining, how often did you sunbathe, i.e. spent time in the sun to tan?
[4] How many times have you had a sunburn within the past 12 months?
[5] Do you think that sunbeds cause cancer of the skin?
[6] Do you think that sunbeds cause skin changes, e.g. wrinkles, leathery skin?
[7] Have any of your relatives ever been diagnosed with cancer?

Please cite this article as: Køster, B., et al., Sunbed use in the Danish population in 2007: A cross-sectional study, Prev. Med. (2009), doi:10.1016/j.ypmed.2008.12.012

**Table 3**
Distribution (%) of present age sunbed users (15–39) by age of first sunbed use (age of first use ≤18) in a 'sun survey' in Denmark in March 2007

| Proportion of sunbed users % | Female | | | Male | | |
|---|---|---|---|---|---|---|
| | Present age 15–19 | Present age 20–29 | Present age 30–39 | Present age 15–19 | Present age 20–29 | Present age 30–39 |
| Age at first use | $n=139$ | $n=195$ | $n=334$ | $n=73$ | $n=107$ | $n=133$ |
| <14 | 48 | 19 | 16 | 22 | 17 | 8 |
| 14–15 | 47 | 42 | 43 | 49 | 32 | 42 |
| 16–18 | 5 | 39 | 31 | 29 | 51 | 50 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 |

significant. The procedure logistic in SAS version 9.1 (SAS Institute, Cary, NC, USA) was used for the analyses.

## Results

### *Sunbed use*

Table 2 shows the distribution of factors for recent sunbed use, stratified by gender. The proportion of sunbed users decreased with age. More single males used sunbeds than those with a partner, and male sunbed use increased with skin type, whereas female sunbed use was not influenced by having a partner or by their skin type. There were more sunbed users among persons with lower levels of education, among highly frequent outdoor sunbathers, and among persons who experienced sunburn. Body mass index and knowledge about sunbeds and cancer were not significant factors in our adjusted model. In a logistic regression model of sunbed use by gender, age, skin type, level of education, cancer in the family, sunburn and outdoor sunbathing behaviour, the crude and adjusted odds ratios for women relative to men were 2.0 (1.7–2.3) and 1.7 (1.4–2.1); ($p<0.001$).

### *Age at start of sunbed use*

Table 3 shows that younger sunbed users reported having started using sunbeds earlier than older groups (age of first use≤18), and females started using sunbeds earlier than males. Twice as many women as men reported having used sunbeds before the age of 14.

### *Knowledge about the relation between skin changes or cancer and sunbeds*

The survey showed that 17% more females aged 15–19 than males knew that sunbeds cause changes to the skin (88% vs. 71%). Generally, both males and females knew that sunbeds can cause skin cancer, but this knowledge decreased with age: 15–19 (93%), 20–29 (93%), 30–39 (89%), 40–49 (86%) and 50–59 (84%). The proportion who answers "Do not know" increases with age. In all age groups about 2% thinks that there is no relation between skin cancer and sunbeds.

## Discussion

The survey showed that use of sunbeds is very prevalent in Denmark, especially in younger age groups. Among 15–19-year-olds, 51% (59% females, 42% males) had used a sunbed within the past 12 months, even though this group knew more about the effects of UV radiation on the skin than the rest of the population. A similar result was found in Australia (Dixon et al., 1999). Our survey showed a higher prevalence of sunbed use than other surveys (reviewed by Gallagher et al. (Gallagher et al., 2005)). For example, Demko et al. found a prevalence of 28% among females aged 13–19 in the United States (Demko et al., 2003). Females knew more about the effects of UV radiation than males, but females used sunbeds more often. In contrast to other studies (Rhainds et al., 1999), we found that the level of education influenced sunbed use in our population, with a larger proportion of sunbed users among less educated persons.

The questionnaire used is a revised version of those used in previous studies of Danish sun behaviour (www.cancer.dk/skruned-forsolen/presserum/2007/Undersoegelser.htm), with new questions added and some adjusted to make it comparable to international questionnaires. Direct comparison with previous questionnaires on Danish sunbed use between 1994 and 2004 was not possible as the intervals of use were different. Skin type was self assessed, and males considered themselves better tanners than females, with 39% vs. 31% reporting skin types III and IV. A larger fraction (15%) of the participants in the survey than in the Danish population (6%) had a university degree; however, this would influence the prevalence of sunbed use in our survey negatively. The low response rate in the telephone interviews was due to a large percentage of not reached. The response rate was acceptable for a web panel (Dobrow et al., 2008). Selection bias could be caused by peoples own sunbathing or sunbed activity though e.g. sunbed users could be less (or more) likely to participate in the survey.

## Conclusion

This study shows a high prevalence of recent sunbed users in the Danish population. Young people use sunbeds frequently, even though they are more aware of the associated health risks. Our results suggest that future sun behaviour campaigns should target sunbed use by younger age groups, even down to the age of 10, in order to prevent early first visits and to limit use. The results suggest that a legal restriction on sunbed use by young people (<18) would be a necessary step for preventing skin cancer (Autier and Boyle, 2008).

### Conflict of interest statement

The authors declare that there are no conflicts of interest.

## Acknowledgments

The survey was funded by Trygfonden. The data were collected by Epinion.

## References

Autier, P., Boyle, P., 2008. Artificial ultraviolet sources and skin cancers: rationale for restricting access to sunbed use before 18 years of age. Nat. Clin. Pract. Onkol. 5, 178–179.
Curado M.P., Edwards B., Shin H.R., et al., 2007. Cancer Incidence in Five Continents, Vol. IX. IARC Scientific Publications No. 160, Lyon, IARC.
Demko, C.A., Borawski, E.A., Debanne, S.M., Cooper, K.D., Stange, K.C., 2003. Use of indoor tanning facilities by white adolescents in the United States. Arch. Pediatr. Adolesc. Med. 157, 854–860.
Dixon, H., Borland, R., Hill, D., 1999. Sun protection and sunburn in primary school children: the influence of age, gender, and coloring. Prev. Med. 28, 119–130.
Dobrow, M.J., Orchard, M.C., Golden, B., et al., 2008. Response audit of an internet survey of health care providers and administrators: implications for determination of response rates. J. Med. Internet. Res. 10, e30.
Engholm G., Ferlay J., Christensen N., et al., 2008. NORDCAN: Cancer Incidence, Mortality and Prevalence in the Nordic Countries, Version 3.2. Association of Nordic Cancer Registries. Danish Cancer Society (http://www.ancr.nu).
Fitzpatrick, T.B., 1988. The validity and practicality of sun-reactive skin types I through VI. Arch. Dermatol. 124, 869.
Gallagher, R.P., Spinelli, J.J., Lee, T.K., 2005. Tanning beds, sunlamps, and risk of cutaneous malignant melanoma. Cancer Epidemiol. Biomarkers. Prev. 14, 562–566.
Green, A., et al., 2006. The association of use of sunbeds with cutaneous malignant melanoma and other skin cancers: A systematic review. Int. J. Cancer 120, 1116–1122.
Rhainds, M., De Guire, L., Claveau, J., 1999. A population-based survey on the use of artificial tanning devices in the Province of Quebec, Canada. J. Am. Acad. Dermatol. 40, 572–576.