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Sun protection behaviour and skin cancer literacy among outdoor runners

Background: Outdoor runners have an increased risk of melanoma and non-melanoma skin cancer. **Objectives:** The purpose of this study was to assess skin cancer literacy and sun exposure and protection behaviour among outdoor runners during training. **Materials and methods:** A cross-sectional survey-based study was conducted. All athletes registered for four consecutive running events in Porto: the Porto Marathon (November 2014), the Fathers' Day 10-km race (March 2015), the Saint John's Day 15-km race (June 2015), and the Porto half-marathon (September 2015). Athletes were invited to answer an online survey with 23 questions on the following items: sociodemographic and constitutional factors, skin cancer literacy, and sun exposure and protection behaviour. A scoring system was devised to analyse behaviour. Multivariate analysis was performed. **Results:** The survey was completed by 2,445 runners, 2,159 of whom trained outdoors. Only 23.5% had adequate sun exposure and protection behaviour. A higher proportion of women than men had adequate behaviour (33% versus 17%; $P < 0.001$). Athletes with a university, or higher degree were more knowledgeable about skin cancer than those with a lower level of education, however, their behaviour in relation to sun exposure and protection was the same. Based on multivariate analysis, gender, skin type, marital status, and average number of hours spent training significantly affected attitude score. **Conclusions:** Investment in more targeted campaigns, aimed particularly at high-risk groups such as outdoor athletes, is essential to modify attitudes and behaviour regarding sun exposure and protection. Outdoor sports event organisers and sport associations also need to engage.

Key words: skin cancer, literacy, outdoor sports, running, sun exposure, behaviour

Ultraviolet (UV) radiation is the main environmental risk factor for melanoma and non-melanoma skin cancer (NMSC) [1]. Despite efforts to reduce skin cancer incidence and mortality through public primary and secondary skin cancer prevention campaigns, there are gaps in public awareness, knowledge, and behaviour [2, 3]. Outdoor sports such as running continue to grow in popularity and their practice is associated with healthy living habits. Nevertheless, outdoor athletes are at risk of excessive UV radiation exposure and are consequently more prone to skin cancer [4, 5]. Marathon runners have an increased risk of melanoma [6]. Immunosuppression due to overtraining and sweating (that contributes to UV radiation-induced skin damage), photosensitivity, and sunburn may play a role in this increased risk [7, 8]. Runners are usually very careful when it comes to choosing footwear and running surfaces, as they know that their choices can improve performance and minimize bone-joint and muscle injuries. Many also wear portable devices such as heart-rate monitors and fitness trackers to ensure optimal training levels. However, they often neglect skin care and sun protection [9-13].

The aim of this study was to assess sun exposure and protection behaviour and skin cancer literacy among amateur outdoor runners by means of a structured questionnaire.

Materials and methods

A descriptive cross-sectional survey-based study was performed.

All athletes registered for four consecutive races held in Porto, Portugal (the Porto Marathon [November 2014], the Fathers' Day 10-km race [March 2015], the Saint John's Day 15-km race [June 2015], and the Porto half-marathon [September 2015]) were invited to answer an online questionnaire.

The survey was a self-administered questionnaire about skin cancer knowledge and sun-related behaviour during exercise designed for outdoor runners by researchers after a review of the literature [14-17]. It consists of 23 questions on the following items:

- sociodemographic and constitutional factors: age (<25, 25-44, ≥45 years), gender, marital status, skin type, and level of education;
- skin cancer literacy: self-reported level of knowledge about skin cancer and familiarity of premalignant/malignant skin lesions (yes/no questions);
- sun exposure and protection behaviour. A scoring system was devised to analyse the following data (scores are shown in brackets): failure to use or occasional use of sunscreen during outdoor training (1) *versus* consistent use (0); application of sunscreen only on the face, on the face, ears, and neck, or on the face, ears, neck, and upper limbs (1) *versus* all exposed areas (0); application of sunscreen immediately before training (1) *versus* before and during training/30 minutes before training (0); use of sun protection factor <30 (1) *versus* ≥30 (0); use of a hat sometimes/never (1) *versus* always (0); use of a sleeveless/short-sleeved shirt (1) *versus* a long-sleeved shirt (0); use of sunglasses (0) *versus* non-use (1); history of sunburn during training in the previous two years (1) *versus* no history (0); and training between 10 a.m. and 6 p.m. (1) *versus* training before 10 a.m. or after 6 p.m. (0). It is generally recommended to avoid direct exposure from 10 a.m. to 4 p.m., although Portugal is a sunny country during spring and summer, and the ultraviolet index is moderate to high between 4 and 6 p.m. Athletes with a score of ≥5 were considered to have inadequate sun exposure and protection behaviour.

Statistical associations between categorical data were analysed using the Chi-square test of independence and the Fisher exact test. Univariate and multivariate logistic regression were used to determine the odds ratio associated with inadequate behaviour. Results were reported with a 95% confidence interval and statistical significance was set at $P < 0.05$.

Results

An email with the questionnaire was sent out to 12,559 runners, and was completed by 2,445 individuals (response rate: 19.5%). Only 19% of athletes stated that they typically trained outdoors between 10 a.m. and 6 p.m. There were no differences between this subgroup and the other athletes in terms of skin cancer literacy, skin type, or sun exposure behaviour.

Thirty percent of outdoor runners always used sunglasses when training, 17% always used a hat, 12% consistently applied sunscreen before training, and 4% used a long-sleeved shirt for protection.

The use of hats and sunglasses increased with age. Hats were always worn by 7% <25 years of age, 17% between 25-44 years, and 22% >45 years ($P < 0.001$). Sunglasses were worn by 23% <25 years of age, 29% between 25-44 years, and 38% >45 ($P < 0.001$). Sunburn during training was more common in individuals younger than 45 years (10% *versus* 6%; $P = 0.021$).

With regards to skin cancer literacy, 90% of the runners knew that melanoma was a malignant lesion but this percentage fell to 37% when asked about basal cell carcinoma.

Even fewer recognized squamous cell carcinoma and actinic keratosis as malignant (27% and 14%, respectively). A higher proportion of runners with a university, or higher degree had adequate skin cancer literacy, used sunscreen with a sun protection factor ≥30 (74% *versus* 68%; $P = 0.016$), and wore sunglasses while training (33% *versus* 27%; $P = 0.003$). However, they reported more sunburns (11% *versus* 7%; $P = 0.008$), even though there were no differences in skin type between the groups (*table 1*).

Compared with men, women were significantly more likely to train during peak exposure hours (22% *versus* 17%; $P < 0.001$) and always applied sunscreen before training (32% *versus* 7%; $P < 0.001$) (*table 2*).

Results of univariate and multivariate analysis according to behaviour score are presented in *table 3*. Factors with the greatest impact on the score were gender (male [OR: 2.85; 95% CI: 2.21-3.67]), skin type (brown skin [OR: 1.45; 95% CI: 1.17-1.81]), marital status (married or with a life partner [OR: 0.76; 95% CI: 0.59-0.97]), and average number of hours spent training (≥4 hours [OR: 0.64; 95% CI: 0.51-0.79]). There were no differences in the level of education between the groups. Considering skin cancer literacy, those who claimed to know what a basal cell carcinoma is appeared to have adequate behaviour.

Discussion

Based on a large sample of athletes who train outdoors ($n = 2,159$), more than 75% were found to have inadequate sun exposure and protection behaviour during the practice of outdoor sport. Although a relatively low response rate was observed (only 19.5% of the race participants contacted completed the survey), this is much higher than that from previous studies (4%) [18].

Training for more than four hours per week and being married or having a life partner appears to predispose to an adequate behaviour. This is possibly due to firstly a greater awareness of the risk associated with being exposed for more hours, and secondly because people generally take care of one other, drawing attention to healthy behaviour [19].

Based on other outdoor sports studies, most of the outdoor runners failed to use a sunscreen, hat, or long-sleeved shirt [20]. Less than 5% reapplied sunscreen during training. Education about the importance of reapplication is needed for long distance runs. Pocket-sized sunscreen sticks/sprays and sunscreen dispensers along the race track could encourage reapplication.

Our findings confirm previous reports that women [21] and fair-skinned individuals [18] tend to have better sun-related behaviour. Although the use of sunglasses and hats during outdoor exercise was uncommon, it improved with age. Sunburn was more common in runners with a university, or higher degree and in those younger than 45 years. This observation is consistent with the classic association between skin cancer and high socioeconomic status and sunburn at a young age [22-24].

Sunburn on the neck, scalp, and ears was more common in men in our series. Short hair and alopecia are more common in men; wearing a hat can protect exposed areas.

Table 1. Adherence to preventive measures among outdoor runners according to the level of education ($n = 2,159$).

	Education				<i>p</i> ^a
	Secondary/lower (<i>n</i> = 864; 40 %)		Third-level (<i>n</i> = 1295; 60 %)		
	<i>n</i>	%	<i>n</i>	%	
<i>Usual time for training during summer and spring</i>					
Between 10 a.m. and 6 p.m.	173	(20)	220	(17)	<0.001
<i>Average number of hours spent training outdoors per week</i>					
≥4 hours	501	(58)	569	(44)	0.028
<i>Use of sunscreen on exposed skin during outdoor training</i>					
Always use	95	(11)	181	(14)	0.058
<i>Sunscreen application site</i>					
All exposed skin	371	(43)	427	(33)	<0.001
<i>Time of sunscreen application</i>					
Immediately before training	414	(48)	686	(53)	0.029
At least 30 minutes before training	415	(48)	583	(45)	
Before and during training	35	(4)	26	(2)	
<i>Sun protection factor</i>					
≥30	587	(68)	958	(74)	0.016
<i>Use of a hat during outdoor training</i>					
Yes, always	129	(15)	233	(18)	0.051
<i>Use of a shirt during outdoor training</i>					
Yes, sleeveless or short-sleeved	812	(94)	1230	(95)	0.624
<i>Use of sunglasses during outdoor training</i>					
Yes	233	(27)	427	(33)	0.003
<i>Skin type</i>					
Light skin with freckles that burns easily and tans with difficulty	302	(35)	479	(37)	0.605
Brown skin, tans easily/black skin	562	(65)	816	(63)	
<i>History of sunburn from outdoor training within the past 2 years</i>					
Yes	60	(7)	142	(11)	0.008
<i>Well-informed about skin cancer</i>					
Yes	190	(22)	414	(32)	<0.001
<i>Do the following relate to skin cancer?</i>					
Basal cell carcinoma					
Yes	251	(29)	518	(40)	<0.001
Actinic keratosis					
Yes	104	(12)	194	(15)	0.016
Melanoma					
Yes	726	(84)	1230	(95)	<0.001
Squamous cell carcinoma					
Yes	155	(18)	388	(30)	0.001

^a Chi-square test; figures in bold indicate statistical significance ($P < 0.05$).

Basal cell carcinoma is the most common form of skin cancer [25] and almost two thirds of the study population did not know that it is a malignant condition, and knowledge on squamous cell carcinoma and actinic keratosis was even worse. Melanoma was the only cancer that the vast majority of athletes were aware of, probably reflecting the success of prevention campaigns largely focusing on melanoma. Much remains to be done to improve skin cancer literacy, which, in our study, was better in women and runners with third-level education. The incidence of skin cancer is increasing worldwide and unfamiliarity can contribute to late diagnosis, resulting in increased morbidity and mortality, as well as greater health care costs [25, 26]. Awareness must be raised not only among individual athletes, but also within

sports clubs and among trainers and sports physicians [27-29]. Event organizers should bring participants' attention to the importance of skin care and take active measures, such as scheduling events outside peak UV radiation exposure hours.

Appearance-based interventions could also be effective among runners, who, as well as being motivated by sport and health, are also generally concerned about fitness and appearance. Interventions highlighting the link between sun exposure and photoaging could therefore improve sun exposure and protection behaviour among athletes [15, 18]. Targeting this large high-risk population with encouragement to adopt new behaviour should not be neglected.

Table 2. Adherence to preventive measures among outdoor runners according to gender ($n = 2,159$).

	Gender				<i>P</i> ^a
	Female (<i>n</i> = 432; 20%)		Male (<i>n</i> = 1727; 80%)		
	<i>n</i>	(%)	<i>n</i>	(%)	
<i>Education</i>					
University or higher level	315	(73)	967	(56)	<0.001
<i>Usual time for training during spring and summer</i>					
Between 10 a.m. and 6 p.m.	95	(22)	294	(17)	<0.001
<i>Average number of hours spent training outdoors per week</i>					
≥4 hours	156	(36)	915	(53)	0.022
<i>Use of sunscreen on exposed skin during outdoor training</i>					
Yes, always	138	(32)	121	(7)	<0.001
<i>Sunscreen application site</i>					
All exposed skin	177	(41)	622	(36)	<0.001
<i>Time of sunscreen application</i>					
Immediately before training	177	(41)	950	(55)	<0.001
At least 30 minutes before training	246	(57)	725	(42)	
Before and during training	9	(2)	52	(3)	
<i>Sun protection factor</i>					
≥30	332	(77)	1209	(70)	0.005
<i>Use of a hat during outdoor training</i>					
Yes, always	65	(15)	293	(17)	<0.001
<i>Use of a shirt during outdoor training</i>					
Yes, sleeveless or short-sleeved	410	(95)	1623	(94)	0.882
<i>Use of sunglasses during outdoor training</i>					
Yes	138	(32)	518	(30)	0.300
<i>History of sunburn from outdoor training within the past 2 years</i>					
Yes	48	(11)	155	(9)	0.241
<i>Site of sunburn</i>					
Scalp					
Yes	4	(9)	37	(24)	0.024
Ears					
Yes	1	(2)	19	(12)	0.050 ^b
Neck					
Yes	8	(17)	80	(52)	<0.001
<i>Well-informed about skin cancer (self-assessment)</i>					
Yes	134	(31)	466	(27)	0.048
<i>Do the following relate to skin cancer?</i>					
Basal cell carcinoma					
Yes	177	(41)	587	(34)	0.014
Actinic keratosis					
Yes	65	(15)	242	(14)	0.414
Melanoma					
Yes	415	(96)	1537	(89)	<0.001
Squamous cell carcinoma					
Yes	125	(29)	432	(25)	0.106

^a Chi-square test.^b Fisher exact test; figures in bold indicate statistical significance ($P < 0.05$).

Table 3. Adequate *versus* inadequate sun exposure/protection behaviour of outdoor runners ($n = 2,159$)^a.

	Sun exposure/protection behaviour									
	Adequate (<5) ($n = 507$; 23,5%)		Inadequate (>5) ($n = 1649$; 76,5%)		P^b	OR (1)		95% CI		
	n	(%)	n	(%)						
Sex										
Female	165	(33)	272	(17)	<0.001 ^b	1.000	–		1.00	–
Male	340	(67)	1370	(83)		2.444	1.94	3.067	2.850	2.22 3.67
Age (years)										
<25	25	(5)	98	(6)	0.666	1.000	–		1.00	–
25-44	384	(76)	1226	(75)		0.814	0.52	1.282	0.692	0.41 1.16
>45	96	(19)	317	(19)		0.842	0.51	1.382	0.761	0.43 1.35
Marital status										
Married/life partner	320	(63)	1010	(62)	0.453	0.924	0.75	1.136	0.758	0.59 0.96
Education										
University or higher level	305	(60)	976	(59)	0.702	0.961	0.78	1.178	1.163	0.92 1.47
Skin type										
Light skin with freckles that burns easily and tans with difficulty	215	(42)	560	(34)	0.001	1.000	–		1.00	–
Brown skin, tans easily/ black skin	292	(58)	1089	(66)		1.432	1.17	1.755	1.452	1.17 1.81
Average number of hours spent training outdoors per week										
≥4 hours	275	(54)	798	(48)	0.021	0.791	0.65	0.966	0.641	0.51 0.79
Well-informed about skin cancer (self-assessment)										
Yes	156	(31)	448	(27)	<0.001	1.000	–		1.00	–
No	33	(7)	214	(13)		2.258	1.50	3.400	1.809	1.14 2.88
Reasonably	315	(63)	980	(60)		1.083	0.87	1.353	0.982	0.77 1.25
Are the following related to skin cancer? (Yes)										
Angioma	98	(20)	292	(19)	0.609	0.935	0.72	1.208	0.906	0.69 1.19
Fibropapilloma	49	(10)	152	(10)	0.932	0.985	0.70	1.384	1.244	0.84 1.84
Basal cell carcinoma	211	(44)	501	(33)	<0.001	0.634	0.51	0.782	0.750	0.57 0.99
Actinic keratosis	84	(17)	193	(13)	0.009	0.692	0.52	0.915	0.801	0.57 1.13
Melanoma	434	(90)	1369	(91)	0.839	1.037	0.73	1.466	1.201	0.83 1.74
Seborrheic keratosis	63	(13)	182	(12)	0.537	0.908	0.67	1.234	1.181	0.81 1.73
Nevi	50	(10)	100	(7)	0.006	0.610	0.43	0.872	0.738	0.49 1.12
Squamous cell carcinoma	155	(32)	353	(23)	<0.001	0.641	0.51	0.802	0.823	0.61 1.12

$R^2 = 0.06$ (Hosmer and Lemeshow), 0.06 (Cox and Snell), 0.09 (Nagel Kerke); Model χ^2 (17) = 122.43, $P < 0.001$; OR (1): univariate odds ratio; OR (2): odds ratio adjusted to all variables presented in this table; 95% CI: 95% confidence interval.

^a Scoring system was devised to analyse failure to use or occasional use of sunscreen during outdoor training (1) versus consistent use (0); application of sunscreen only on the face, on the face, ears, and neck, or on the face, ears, neck, and upper limbs (1) versus all exposed areas (0); application of sunscreen immediately before training (1) versus before and during training/30 minutes before training (0); use of sun protection factor < 30 (1) versus ≥ 30 (0); use of a hat sometimes/never (1) versus always (0); use of a sleeveless/short-sleeved shirt (1) versus a long-sleeved shirt (0); use of sunglasses (0) versus non-use (1); a history of sunburn during training within the previous two years (1) versus no history (0); and training between 10 a.m. and 6 p.m. (1) versus training before 10 a.m. or after 6 a.m. (0). The maximum score was 9. Runners were considered to have inadequate sun exposure and protection behaviour when they scored ≥ 5.

^b Chi-square test.

Despite the large sample of outdoor athletes included, this study has some limitations, including the cross-sectional design and the reliance on a self-assessment method. A low response rate might have been due to failure to read emails or emails being treated as spam, or alternatively, to a lack of time and/or a worrying lack of interest in skin cancer and protection.

Outdoor runners are a high-risk group for skin cancer and a considerable proportion of runners do not follow primary preventive recommendations. Since skin cancer is an increasing public health problem, directing primary and secondary prevention campaigns to risk groups such as outdoor athletes, adapting language, and creating best-practice resources could improve awareness and protection

behaviour. Larger studies designed to modify behaviour and improve literacy are needed. ■

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