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Original article

"Beach Lifeguards' Sun Exposure and Sun Protection in Spain"

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ABSTRACT

Background: Sunburn is the main avoidable cause of skin cancer. Beach lifeguards spend many hours exposed to the effects of solar radiation during their work day, precisely at times of the year when levels of solar irradiation are highest. The aim of this study is to quantify the risk to beach lifeguards of sun exposure.

Methods: A descriptive cross-sectional study was carried out in the Western Costa del Sol, southern Spain, during the summer of 2018. The research subjects were recruited during a skin cancer prevention course for beach lifeguards. All participants were invited to complete a questionnaire on their habits, attitudes, and knowledge related to sun exposure. In addition, ten were specially monitored using personal dosimeters for three consecutive days, and the results were recorded in a photoprotection diary. A descriptive analysis (mean and standard deviation for the quantitative variables) was performed, and inter-group differences were evaluated using the Mann–Whitney U test.

Results: Two hundred fifteen lifeguards completed the questionnaire, and 109 met the criteria for inclusion in this analysis. The mean age was 23.8 years (SD: 5.1), 78.0% were male, 71.5% were phototype III or IV (Fitzpatrick's phototype), and 77.1% had experienced at least one painful sunburn during the previous summer. The mean daily personal ultraviolet exposure per day, the minimal erythema dose, and the standard erythema dose, in J/m^2, were 634.7 [standard deviation (SD): 356.2], 2.5 (SD: 1.4) and 6.35 (SD: 3.6), respectively.

Conclusion: Beach lifeguards receive very high doses of solar radiation during the work day and experience correspondingly high rates of sunburn. Intervention strategies to modify their sun exposure behavior and working environment are necessary to reduce the risk of skin cancer for these workers and to promote early diagnosis of the disease.

1. Introduction

Overexposure to ultraviolet (UV) radiation is the main preventable cause of skin cancer [1]. Two patterns of risky sun exposure have been recognized: the first is professional, chronic, and cumulative, with an increased risk of squamous cell carcinoma; the second is recreational, acute, and intermittent, associated with an increased risk of melanoma and basal cell carcinoma [2]. Sunburn, particularly during the first decades of life, plays a determinant role in the development of skin cancer, particularly melanoma [3]. The World Health Organization warns that sun exposure becomes risky when the UV index reaches level 3 or higher and, in such cases, recommends reducing exposure using various sun protection measures, including appropriate timing for outdoor activities, remaining in the shade, wearing protective clothing (long-sleeved shirt, long trousers, wide-brimmed cap, sunglasses), and applying broad-spectrum UV-A/UV-B and SPF15+ sun creams [4].

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Beach lifeguards spend many hours exposed to the effects of solar radiation during their work day, precisely at times of the year when levels of solar irradiation are highest. Analyzing and quantifying this aspect could be an opportunity to develop photoprotection policies to improve work conditions and behavior, especially interesting for countries that lack them like Spain [5].

The Western Costa del Sol is a coastal region in southern Spain, in the province of Malaga. It is a popular destination for domestic and foreign tourists, enjoying over 320 days of sunshine per year and where the daily mean temperature rises to 23.3 degrees in summer [6]. The incidence and the health costs of skin cancer in this area are especially high [7–9], and the health department of the regional government has launched a skin cancer prevention campaign, seeking to promote healthy photoprotection habits and to ensure early diagnosis of the disease, in different population groups [9–16]. The main aim of the present study is to quantify the risk of sun exposure by beach lifeguards and to highlight the need for greater awareness of the dangers, to design appropriate strategies for future intervention.

2. Method

- **Design**: A descriptive cross-sectional study.
- **Participants**: Lifeguards working for two lifeguard and maritime rescue companies operating in the Western Costa del Sol (Malaga, Spain). The following inclusion criteria were applied: age at least 18 years, good understanding of Spanish, and provision of signed informed consent. Persons with no previous experience as a beach lifeguard were excluded from the analysis.
- **Procedure**:
  - **Recruitment**: Participants were recruited during a photoprotection training course for beach lifeguards held as a part of a skin cancer prevention and photoprotection campaign (details at www.disfrutadelsol.hcs.es) in collaboration with local authorities in the area during the 2018 summer season. The lifeguards were encouraged to take part in the campaign by their employers and by the municipal beach department, but participation was voluntary in all cases.
  - **Questionnaire**: In June, the 240 lifeguards enrolled in the course received an email inviting them to take part in the study. Those who agreed were asked to give their informed consent and, via an online link, to complete a questionnaire on their habits, attitudes, and knowledge related to sun exposure at the beach. This “Beach Questionnaire” had been developed by our team of researchers and validated previously [17,18], with demonstrated validity, reliability, and sensitivity to change for evaluating habits, attitudes, and understanding of exposure to sunlight. The questionnaire, to be completed unassisted, contained 49 items about demographic variables, skin colors, skin phototypes, sun exposure habits, sunburn events during the previous summer, sun protection practices, and attitudes and knowledge regarding sun exposure. The instrument has good psychometric properties (validity and reliability), and a Cronbach α coefficient >0.70 and intraclass and delta correlation >0.50 have been obtained for all items.
  - **Dosimetry**: Among the lifeguards taking part in the study, ten were selected by their coordinators to carry a personal dosimeter for three consecutive days, during their working hours between 11 a.m. and 8 p.m., in the first week of August. The members of this group were conscientious and representative of the different activities performed by lifeguards (tower, chair, roaming, attention for the disabled, health care, and coordination). The instruments used were VioSpor® blue line Type III dosimeters, manufactured by the Biosense laboratory (Bornheim, Germany) [19]. The instrument contains a photosensor based on a biological film of highly photosensitive immobilized spores. This film is covered by a filter system with optical properties that simulate the erythematous response of the human skin, in accordance with the reference spectrum of the International Commission on Illumination, and is mounted in a waterproof housing with a diameter of 32 mm. The working range used is 0.5–22.5 standard erythema dose (SED) J/m^2, and the manufacturer's specified measurement error is ±10%. The measurement obtained is expressed in sunburn threshold doses [minimal erythema dose (MED) J/m [2]; SED] and provides a spectral analysis (UV-A, UV-B, UV-C). The sensor is reliably validated and has been used in numerous studies of this type [20–29]. The sensor was placed on the participant's wrist, as recommended, and secured with Velcro [24]. The levels of environmental solar irradiation recorded in Malaga by the Spanish Meteorological Agency from April to October 2018 were also obtained. These readings were taken at the weather station in Malaga Airport (latitude: 36° 41′ 6.8872″; longitude: 4° 30′ 0.6405″, 16m altitude), located about 25km from the beach where the study was conducted.
  - **Diary**: The ten lifeguards selected to carry the personal dosimeter also completed a journal of their photoprotection practices, for each day of the measurement period. In this journal, following the procedure adopted in prior research by Gies et al. [25], the lifeguards noted (in each time section) the corresponding sun protection practices performed (e.g., staying in the shade, wearing a shirt, hat and sunglasses, and using sunscreen).
- **Statistical analysis**: A descriptive analysis was conducted using measures of centralization and dispersion (mean and standard deviation) for the quantitative variables and of frequency distribution for the qualitative ones. The differences obtained were analyzed in two groups, in accordance with greater or lesser erythematous exposure (groups I and II, respectively), determined using the Mann–Whitney U test.
- **Research ethics**: The study was approved by the Costa del Sol Hospital Research Ethics Committee and was conducted at all times in accordance with the provisions of the Helsinki Declaration and with Spanish legislation on medical confidentiality. Together with the questionnaire, the participants were sent a form on which to record their informed consent to take part in the study. All the data collected were recorded and stored anonymously, in strict accordance with applicable data protection laws and regulations (Act 41/2002 of 14 November; Act 15/1999 of 15 December; EU Regulation Data Protection, 2016/679).

3. Results

Two hundred fifteen lifeguards completed the questionnaire, and 109 met the criteria for inclusion in this analysis. 78.0% were male, and the average age of the participants was 23.8 years (SD: 5.1). Phototype III was the most common (49.5%), followed by phototypes IV (22.0%) and phototype II (21.1%). The lifeguards showed a high level of knowledge of and favorable attitudes toward sun protection. In this respect, 96.3% were aware that excessive exposure to UV light is the main cause of skin cancer, and 93.4% agreed that sunscreen creams should be used to prevent it.

About sun exposure and sun protection practices during the previous summer, 55.0% spent more than three hours a day and 72.5% more than one hour during the midday period. 77.1% had suffered at least one painful sunburn. Among the protection practices used, the use of sunglasses was most commonly mentioned (79.8%), followed by the use of SPF15+ creams (72.5%). Wearing a long-sleeved shirt and long trousers was least common (2.8%) (Table 1).

The distribution of sun protection practices during the current summer varied during the day. The most constant was the use of a T-shirt (100%), followed by sunglasses (69.0%), staying in the shade (49.0%), wearing a cap (45.2%) and, finally, using sunscreen (29.1%). Although 55.2% of the participants applied sunscreen between 11.00 a.m. and 12.00 p.m., only 30.1% reapplied it between 1 and 2 p.m. and this value fell to 20.7% doing so between 3 and 4 p.m (Table 2).

With regard to the results of the personal dosimetry carried out on the monitoring group, the average values of accumulated sun exposure on the three days of measurement were 1,904.1 J/m^2 (SD: 1,068.5), 7.6 MED (SD: 4.3), and 19.05 SED (SD: 10.7). Wherefore, the average cumulative sun exposure values for one day were 634.7 J/m^2 (SD: 356.2), 2.5 MED (SD: 1.4), and 6.35 SED (SD: 3.6) (Table 3).

There were differences in sun exposure between lifeguards, resulting in a low-exposure and high-exposure group (the former, mainly coordinators and those attentive to persons with reduced mobility, and the latter, those working in surveillance towers and/or roaming). The accumulated daily erythema dose for the workers in the low-exposure group (group I) was 310.3 ± 13.0 J/m^2, in contrast to 1.2 ± 0.1 MED, 3.1 ± 0.1 SED for phototype II, whereas those in the high-exposure group (group II) recorded 859.1 ± 148.7 J/m^2, versus 3.8 ± 0.6 MED and 9.6 ± 1.5 SED. The differences were statistically significant (Table 4).

Table 5 shows the maximum ultraviolet index (UVI) values recorded on the 15th of each month during the period April–October in the province of Malaga, together with the potential daily accumulated erythema dose for a working day between 11.00 and 20.00 hours. The maximum UVI value was 9.9 and was obtained in June.

Table 6 shows the duration of solar exposure needed to reach the MED for a person with phototype II, in the different time bands. Thus, in June, at 2 p.m. the MED is a mere 17 minutes for a person with skin phototype II.

Table 1
Habits related to sun exposure during the previous summer

	n (109)	%
Sun exposure habits		
How many days were you exposed to the sun?		
≤30 days	64	59.8
>30 days	43	40.2
How long each day?		
≤3 hours	49	45.0
>3 hours	60	55.0
How long between 12 and 4 p.m.?		
<1 hour	30	27.5
≥1 hour	79	72.5
How often did your skin burn (become red and painful)?		
None	25	22.9
≥1	84	77.1
Sun protection practices		
Use a sunshade		
Never/hardly ever/sometimes	42	38.5
Usually/always	67	61.5
Wear sunglasses		
Never/hardly ever/sometimes	22	20.2
Usually/always	87	79.8
Wear a hat or cap		
Never/hardly ever/sometimes	73	67.0
Usually/always	36	33.0
Wear a long-sleeved shirt and long trousers		
Never/hardly ever/sometimes	105	97.2
Usually/always	3	2.8
Avoid peak-sun exposure (12 to 5 p.m.)		
Never/hardly ever/sometimes	91	83.5
Usually/always	18	16.5
Use SPF15+ sunscreen		
Never/hardly ever/sometimes	30	27.5
Usually/always	79	72.5

4. Discussion

This paper presents the results of the first study, to our knowledge, conducted to obtain both sun exposure and sun protection data of beach lifeguards. These results clearly show that lifeguards working in a country receiving as much sun as Spain are exposed to an extremely high risk of skin cancer. Our findings highlight the need to apply effective measures to address this risk and provide useful information for the design of such strategies.

The personal dosimetry values obtained show that lifeguards receive very high levels of solar irradiation during their workday, especially those on surveillance towers or roaming. These doses can exceed 900 J/m^2 per day (i.e., nine times the SED or three times the MED for persons with skin phototype II). Such doses are also nine times greater than the threshold recommended by the International Commission on Non-Ionizing Radiation Protection, of 100–130 J/m^2 effective UV dose over an eight-hour period, for sensitive,

Table 2
Time distribution of sun protection practices while working

Time	Shade		Headwear		Sunglasses		T-shirt		Suncream	
	n	%	N	%	n	%	n	%	n	%
11:00–12:00	10	34.5	17	58.6	21	72.4	29	100.0	16	55.2
12:00–13:00	11	37.9	21	72.4	21	72.4	29	100.0	11	37.9
13:00–14:00	24	82.8	7	24.1	17	58.6	29	100.0	9	31.0
14:00–15:00	20	69.0	10	34.5	15	51.7	29	100.0	7	24.1
15:00–16:00	19	65.5	7	24.1	20	69.0	29	100.0	6	20.7
16:00–17:00	8	27.6	16	55.2	22	75.9	29	100.0	11	37.9
17:00–18:00	15	51.7	14	48.3	21	72.4	29	100.0	6	20.7
18:00–19:00	10	34.5	16	55.2	21	72.4	29	100.0	6	20.7
19:00–20:00	11	37.9	10	34.5	22	75.9	29	100.0	4	13.8
Overall	128	49.0	118	45.2	180	69.0	261	100.0	76	29.1

Table 3
Personal UV dosimetry results

Test	Protocol	Accumulated 3-day dose			Accumulated 1-day dose		
		J/m^2	MED	SED	J/m^2	MED	SED
2279	1	2512	10	25.1	837.3	3.3	8.4
2244	2	3406	13.6	34.1	1135.3	4.5	11.4
2265	3	2529	10.1	25.3	843.0	3.4	8.4
2157	4	959	3.8	9.6	319.7	1.3	3.2
2262	5	974	3.9	9.7	324.7	1.3	3.2
2236	6	2620	10.5	26.2	873.3	3.5	8.7
2206	7	877	3.5	8.8	292.3	1.2	2.9
2223	8	3320	13.3	33.2	1106.7	4.4	11.1
2253	9	935	3.7	9.4	311.7	1.2	3.1
2212	10	909	3.6	9.1	303.0	1.2	3.0
Mean		1904.1	7.6	19.05	634.7	2.5	6.4
Standard deviation		1068.5	4.3	10.7	356.2	1.4	3.6

* Viospor® Blueline tYpe III dosimeter, Biosense.
MED, minimal erythema dose; SD, standard deviation; SED, standard erythema dose; UV, ultraviolet.

unprotected skin [26,27]. This value is also five times greater than the SED, representing a major risk of skin cancer for persons with skin phototype III, if their skin has not previously tanned [28].

Our results are consistent with those obtained in similar studies carried out in Spain in areas of seaside tourism and in other environments of outdoor work and sports [29–31]. These findings are also consistent with the environmental radiometry measurements recorded in the Costa del Sol area during the study period and with those reported in previous years for the province of Malaga [32]. In August, the maximum midday UVI value is greater than 8, and, therefore, the potential accumulated erythema dose is more than 17 times the MED during the work day. However, the maximum UVI values were obtained in June, with values close to 10. During this month, a lifeguard with skin phototype II could receive a cumulative dose of 20 times the MED during a work day, and unprotected skin would be sunburnt in just 17 minutes.

Table 4
Personal daily UV dosimetry, by groups

Groups	Accumulated 1-day dose		
	J/M^2	MED	SED
Group 1 (MED <3) N = 5			
Mean	310.3	1.2	3.1
SD	13.0	0.1	0.1
Group 2 (MED≥3) N = 5			
Mean	959.1	3.8	9.6
SD	148.7	0.6	1.5
p	**<0.001**	**<0.001**	**<0.001**

*Group 1: coordinator, assistance to disabled, and healthcare.
MED, minimal erythema dose; SD, standard deviation; SED, standard erythema dose; UV, ultraviolet.
Group 2: chair, tower, and roaming.

Table 5
Daily ultraviolet index (UVI) and potential accumulated minimal erythema dose (MED), by phototype*

Month	Maximum UVI	MED, phototype II	MED, phototype III	MED, phototype IV
April	7.6	15.5	11.1	8.6
May	9.3	18.9	13.5	10.5
June	9.9	20.2	14.4	11.2
July	9.8	19.9	14.2	11.0
August	8.7	17.8	12.7	9.9
September	7.5	15.3	10.9	8.5
October	4.4	8.9	6.3	4.9

MED, minimal erythema dose; UVI, ultraviolet index.
* Assuming direct exposure throughout the workday (11.00 a.m.–8.00 p.m.).

Table 6
Minutes' exposure required for skin phototype II to receive an erythema dose

Time	Sun exposure for skin phototype II to receive an erythema dose (minutes)						
Time	April	May	June	July	August	September	October
11 a.m.	48	39	37	37	42	49	84
12 p.m.	31	26	24	24	27	32	54
1 p.m.	24	20	19	19	21	25	42
2 p.m.	22	18	17	17	19	22	38
3 p.m.	23	19	18	18	20	23	40
4 p.m.	28	23	21	22	24	28	49
5 p.m.	40	33	31	31	35	41	70
6 p.m.	71	59	55	56	62	72	124
7 p.m.	173	143	134	136	152	176	303
8 p.m.	720	593	555	563	630	732	1,260

The study results show that beach lifeguards take few effective measures to prevent sunburn. Thus, the most common practice was to wear sunglasses (over two thirds of respondents did so), followed by the use of SPF15+ sun creams. However, the latter measure was not applied consistently during the workday, and application rates fell to below 30% in the afternoon. Other measures, more effective and longer-lasting, such as wearing a long-sleeved shirt and long trousers, were followed by less than 5% of the lifeguards in our study. These findings are similar to those described by other researchers in relation to the sun protection habits of beach lifeguards in the USA. As in our case, previous studies have observed high rates of sunburn in summer among this occupational group [25,33]. As sunburn in early life is the main risk factor for skin cancer, lifeguards are at a professional risk of developing this disease, particularly in the forms of basal cell carcinoma and malignant melanoma [3]. Therefore, it is essential for these young workers to adopt stringent measures of sun protection while they are working, to examine their skin regularly and to learn to recognize the early signs of sun damage.

Interestingly, most of the lifeguards in our study group were well aware of the factors involved and presented attitudes favorable to photoprotection. Therefore, in designing future preventive interventions targeting these workers, it will be necessary to go beyond educational strategies focused on individuals. Political and structural measures of photoprotection are also needed, similar to those applied elsewhere with good results [34,35].

According to the labor regulations in Spain, it is the company that hires the lifeguards (and subsidiarily the Town Hall) that must be responsible for providing adequate training in matters to occupational safety, including sun protection measures, and for providing effective and sufficient protection elements to guarantee safe working activity. In addition, the worker must, obligatorily, pay attention to the protection measures against labor risks (in this case the sun). Better awareness of the risks of excessive sun exposure, and appropriate photoprotection measures (clothing, hat, shaded rescue stations, photoprotection creams) could reduce the increased risk in this highly exposed population.

Our study presents several limitations, related to its epidemiological design, to the geographic environment considered (restricted to a single territorial area), to the study method used (unsupervised responses to health questionnaires and forms), and

to possible errors in the measurement of solar irradiance due to potential failures in the use of the personal dosimeters.

In conclusion, beach lifeguards constitute an occupational group at high risk of skin cancer, because of the high frequency of sunburn experienced, the large amounts of solar radiation received, and the poor sun protection practices employed. For this reason, future interventions addressing their behaviour in this respect and the work environment are needed to reduce the risk of skin cancer among these young workers.

Author contributions

MTM and NBS conceived the ideas; MTM, NBS, MCAL, CGH, JAA, and MVGA collected the data; JAA and FRR analyzed the data; and MTM led the writing.

Conflicts of interst

All authors have no conflicts of interest to declare.

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