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ORIGINAL ARTICLE

Changes in the Incidence of Skin Cancer Between 1978 and 2002

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Abstract

Background: Ultraviolet radiation is the main risk factor for skin cancer. Changes in lifestyle over recent decades have led to greater exposure to ultraviolet radiation; this phenomenon, coupled with aging of the population, increases the risk of developing skin cancer. Our objective was to analyze the trends in the incidence of skin cancer worldwide, in Europe, and in Spain during the period 1978 to 2002.

Material and methods: Both skin cancer incidence and trends were investigated during the period 1978 to 2002 using the publication Cancer Incidence in Five Continents.

Results: The incidence of cutaneous melanoma increased progressively throughout the period, with higher rates among women. The highest incidence was found in Australia. In Spain, the standardized rates of melanoma had tripled in both sexes by the end of the study period. The incidence of nonmelanoma skin cancer (NMSC) increased throughout the study period, with higher rates among men. The highest incidences were found in Australia, Brazil, and among the European inhabitants of Zimbabwe. Within Spain, the standardized rates of NMSC doubled or tripled in both sexes by the end of the study period.

Conclusion: The rise in the incidence of skin cancer leads us to conclude that measures of primary prevention are failing or insufficient, or that it is still too soon to evaluate their efficacy. There are certain limitations to this study, such as the fact that it was impossible to analyze the most recent period, from 2003 to 2007, and that cancer registries are not available for all populations.

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PALABRAS CLAVE

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Evolución de la incidencia del cáncer de piel en el período 1978-2002**Resumen**

Introducción: La radiación ultravioleta es el principal factor de riesgo en el desarrollo del cáncer de piel. En las últimas décadas se ha producido un cambio en los estilos de vida que conlleva mayores exposiciones a la radiación ultravioleta, lo que unido a un mayor envejecimiento de la población aumenta el riesgo de desarrollar cáncer de piel. Nuestro objetivo es analizar la tendencia temporal en la incidencia del cáncer de piel a nivel mundial, europeo y español durante el período comprendido entre 1978-2002.

Material y métodos: Se estudiaron la incidencia y la tendencia del cáncer de piel en el período 1978-2002 a través de la publicación Cancer Incidence in Five Continents.

Resultados: La incidencia del melanoma cutáneo aumentó de forma continua durante todo el período, con tasas más elevadas en mujeres. Las incidencias máximas se registraron en Australia. En España, las tasas estandarizadas de melanoma llegaron a triplicarse en ambos sexos al final del período de estudio. La incidencia del cáncer cutáneo no melanoma (CCNM) aumentó durante el período de estudio (1978-2002), con tasas más elevadas en varones. Las incidencias máximas se registraron en Australia, Brasil y en la población europea de Zimbabue. En España, las tasas estandarizadas de CCNM llegaron a duplicarse o triplicarse en ambos sexos al final del período.

Conclusiones: El aumento de la incidencia del cáncer de piel nos hace pensar que las medidas de prevención primaria están fallando, son insuficientes o que aún no ha llegado el momento de evaluar su eficacia. Como limitaciones a nuestro estudio, cabe señalar que no se ha podido analizar el período más actual 2003-2007 y el hecho de que no todas las poblaciones tienen un registro de cáncer.

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Introduction

The incidence of skin cancer continues to increase and can now be considered a worldwide epidemic.^{1,5} The term skin cancer encompasses a range of malignant tumors with very different characteristics, both in terms of their origin and risk factors, and also their prognosis. Two large groups can be considered: cutaneous melanoma and tumors that, by default, are classified as nonmelanoma skin cancer (NMSC). NMSC principally includes squamous cell carcinoma and basal cell carcinoma. NMSC is the most commonly diagnosed type of malignant tumor in white individuals.^{6,7}

Ultraviolet (UV) radiation is considered to be the main environmental factor responsible for the development of skin cancer. The type of sun exposure responsible differs according to the histologic type of the tumor. Chronic sun exposure is the main cause of squamous cell carcinoma. In contrast, basal cell carcinoma and cutaneous melanoma are due to intermittent sun exposure and a history of sunburn, especially during childhood and adolescence.⁸

The risk of developing skin cancer increases if exposure to UV radiation is associated with the presence of other risk factors, such as fair skin type, genetic predisposition, dysplastic nevi (in the case of melanoma), actinic keratosis (for squamous cell carcinoma), and immunosuppression.^{9,10}

Cutaneous melanoma currently represents an epidemic in developed countries. Although the incidence of melanoma is far lower than that of NMSC, it is responsible for more than 90% of deaths due to skin cancer.¹ Furthermore, melanoma is one of the tumors responsible for the largest number of years of potential life lost and tends to be diagnosed

most often in young people. It is the most frequent form of cancer in white adults aged between 25 and 30 years.¹¹

In contrast, NMSC generally appears in older patients and its prognosis is good in the majority of cases. Substantial resources are still devoted to inpatient and outpatient care for these cancers, due to the large number of cases that occur, but they are curable when appropriately treated and can also be avoided through primary prevention.⁶

It is therefore important to determine the frequency of skin cancer in the population. Establishing the incidence of cancer in a given group requires a population-based cancer registry. The main objective of these registries is to determine the incidence of cancer in the corresponding population. This allows the magnitude of the problem to be ascertained, changes over time identified, and comparative studies with other populations to be performed. In addition, registries make it possible to conduct studies addressing the etiology of the cancer and the effectiveness of prevention programs.¹² As an alternative, some countries such as the USA and Australia, where skin cancer is extremely common, have carried out population-based surveys to address the incidence and prevalence of the disease.⁶

An exhaustive analysis of the incidence of skin cancer according to population-based cancer registries will allow temporal trends in the incidence of skin cancer to be determined.

The aim of this study was to analyze temporal changes in the incidence of skin cancer (NMSC and cutaneous melanoma) worldwide, in Europe, and in Spain for the period 1978-2002 based on data published by the International Agency for Research on Cancer (IARC).

Material and Methods

A temporal trend is defined as the variation in the incidence of skin cancer (increase or decrease) over a given period of time. Peak incidence is defined as the largest number of cases of skin cancer in a given population over a defined period of time compared with the incidence in other populations.

A review of the incidence of skin cancer (NMSC and cutaneous melanoma) was carried out using the information available in the following volumes of *Cancer Incidence in Five Continents* published by the IARC, an organization belonging to the World Health Organization: v (1978-1982)¹³; vi (1983-1987)¹⁴; vii (1988-1992)¹⁵; viii (1993-1997)¹⁶; and ix (1998-2002)¹⁷. This publication contains overall, age-specific, and sex-specific, truncated and cumulative standardized incidence rates for the different types of cancer in each region and provides information on population-based registries throughout the world. Each of the 9 volumes contains information relating to a 5-year period. The volumes are published with a 5-year delay, given the difficulty associated with the collection and exhaustive analysis of the data. Consequently, we were unable to analyze the period from 2003 to 2007.

Peak incidence of NMSC and melanoma worldwide, in Europe, and in Spain was analyzed by sex. The incidence of NMSC and melanoma was also analyzed according to sex in all available Spanish cancer registries. For this, we used the standardized incidence per 100 000 population, using the world standard population as reference. These rates were compared for the following 5-year periods to determine the temporal trend: 1978-1982, 1983-1987, 1988-1992, 1993-1997, and 1998-2002.

Results

Incidence and Trends in Cutaneous Melanoma for the Period 1978-2002

According to data published by the IARC in *Cancer Incidence in Five Continents*¹³⁻¹⁷ for the period 1978-2002, there has been a progressive worldwide increase in the peak incidence of cutaneous melanoma over the 25-year period. The highest rate for both sexes was obtained in the last period (1998-2002) in Queensland, Australia, with a standardized rate of 41.1 per 100 000 women and 55.8 per 100 000 men. The peak incidence according to sex was higher in men. Australia had the highest incidence of melanoma throughout the study period (Figure 1).

There was also a progressive increase in the peak incidence of cutaneous melanoma in Europe during the period studied (1978-2002). The highest rate for both sexes was observed in the final period (1998-2002) in Switzerland, with a standardized rate of 19.6 per 100 000 in women and 18.6 per 100 000 in men. Throughout the entire study period, the sex-specific peak incidence was higher in women. Norway and Switzerland had the highest incidences of cutaneous melanoma in Europe (Figure 2).

There was a progressive increase in the peak incidence of cutaneous melanoma in Spain over the 25-year period.

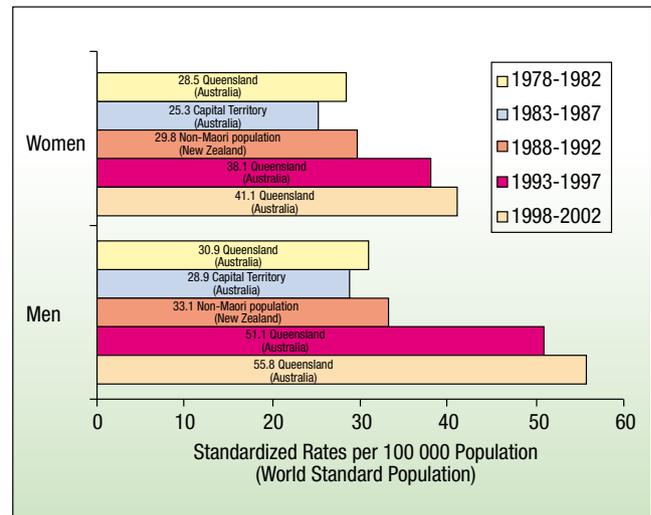


Figure 1 Worldwide peak incidences of cutaneous melanoma for the period 1978-2002.

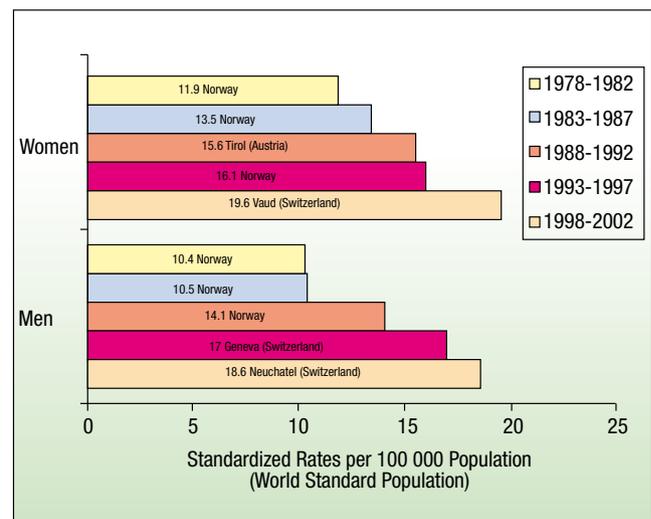


Figure 2 European peak incidences of cutaneous melanoma for the period 1978-2002.

The highest rate was observed during the last period (1998-2002), with a standardized rate of 8.7 per 100 000 for women in Tarragona and 6.6 per 100 000 for men in Navarre. The peak incidence by sex was higher in women. Among the regions of Spain, Majorca, Tarragona, Navarre, Murcia, and Girona had the highest incidences of melanoma (Figure 3).

There is an increasing number of cancer registries in Spain that collect data on the incidence of cutaneous melanoma. Individual analysis of the Spanish cancer registries showed that in each of them there was a progressive increase in the incidence of cutaneous melanoma for both sexes during the study period (1978-2002). Analysis of the longest-running registries (Zaragoza, Tarragona, and Navarre) revealed that the standardized incidences for both sexes had increased 3-fold over the period 1978-2002. The registries for

Cuenca, Albacete, and Granada were exceptions in showing a decrease in the incidence of cutaneous melanoma in women during the period 1998-2002 (Tables 1 and 2).

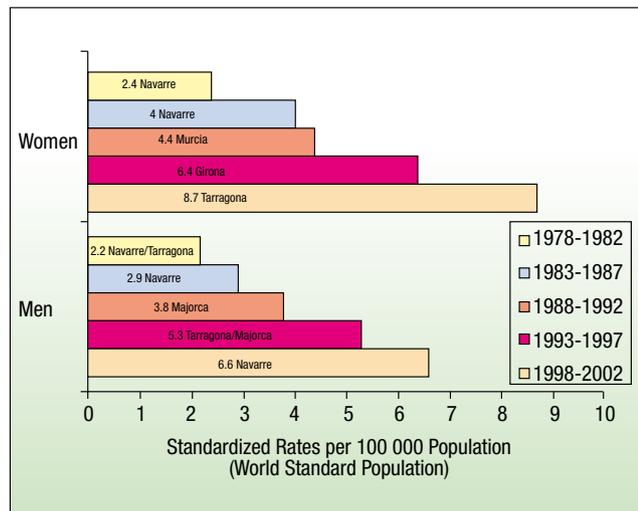


Figure 3 Spanish peak incidences of cutaneous melanoma for the period 1978-2002.

Incidence and Trends in Nonmelanoma Skin Cancer During the Period 1978-2002

There was a marked increase worldwide in the peak incidence of NMSC in women during the period 1978-2002, with rates almost doubling during that time. In contrast, the peak rates tended to stabilize in men. The highest rate for both sexes was observed for the European population of Zimbabwe during the period 1988-1992, with a standardized rate of 343 per 100 000 in women and 535.4 per 100 000 in men. The sex-specific peak incidence was higher in men. Worldwide, Australia and Brazil had the highest incidences of NMSC (Figure 4).

In Europe, there was also an increase in the peak incidence of NMSC during the 25-year period (1978-2002). This increase was more marked in women, where the peak incidence doubled. In women, the highest rate was obtained in the last period (1998-2002) in Geneva (Switzerland), with a standardized incidence of 113 per 100 000. In men, the highest rate was obtained in Ireland during the period 1993-1997, with a standardized incidence of 146.3 per 100 000. The sex-specific peak incidence was higher in men. In Europe, the highest incidences of NMSC were observed in Ireland and Switzerland (Figure 5).

In Spain, there was a substantial increase in the peak incidence of NMSC during the study period (1978-2002).

Table 1 Incidence of Cutaneous Melanoma in Women According to Spanish Cancer Registries for the Period 1978-2002

Period	1978-1982	1983-1987	1988-1992	1993-1997	1998-2002
Asturias			3.9	4.3	5.8
Cuenca				3.7	2
Canary Islands				3.6	4.8
Basque Country		3.2	4.2		6.6
Albacete			1.7	5	4.8
Zaragoza	1.4	2	3.3	3.3	4.2
Murcia		2	4.4	5.4	7
Girona				6.4	6.6
Tarragona	1.8	2.8	3.2	5.4	8.7
Granada		2.7	3.9	6.1	4.8
Navarre	2.4	4	3.6	5.8	7.5
Majorca			3.9	5.5	

Table 2 Incidence of Cutaneous Melanoma in Men According to Spanish Cancer Registries for the Period 1978-2002

Period	1978-1982	1983-1987	1988-1992	1993-1997	1998-2002
Asturias			2.1	2.9	3.4
Cuenca				3.2	3.3
Canary Islands				2.5	3.9
Basque Country		2.4	3		4.9
Albacete			2	3.2	5
Zaragoza	2.2	2.3	2.3	2.7	4
Murcia		1.5	2.8	4.1	6.5
Girona				4.1	5.2
Tarragona	1.7	2.1	3.5	5.3	6.4
Granada		2.2	3.1	4	4.3
Navarre	2.2	2.9	3.3	4.5	6.6
Majorca			3.8	5.3	

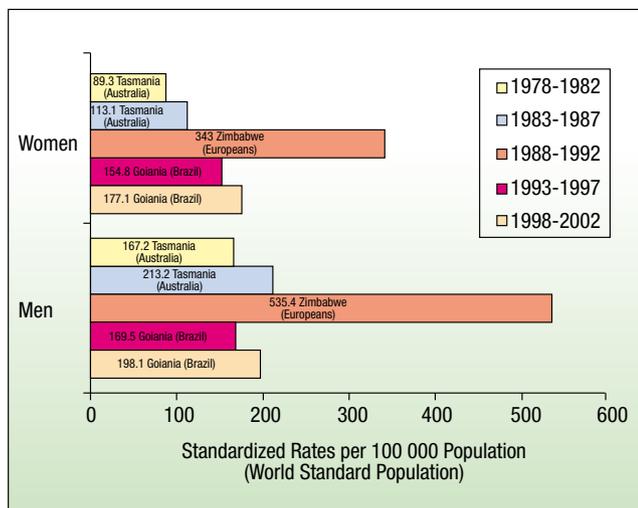


Figure 4 Worldwide peak incidences of nonmelanoma skin cancer for the period 1978-2002.

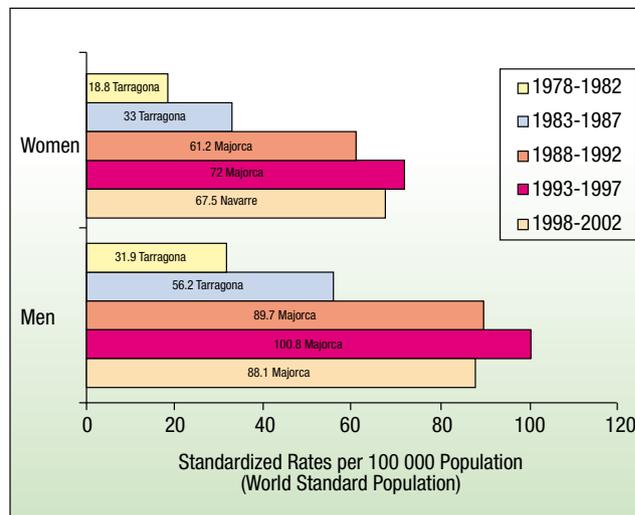


Figure 6 Spanish peak incidences of nonmelanoma skin cancer for the period 1978-2002.

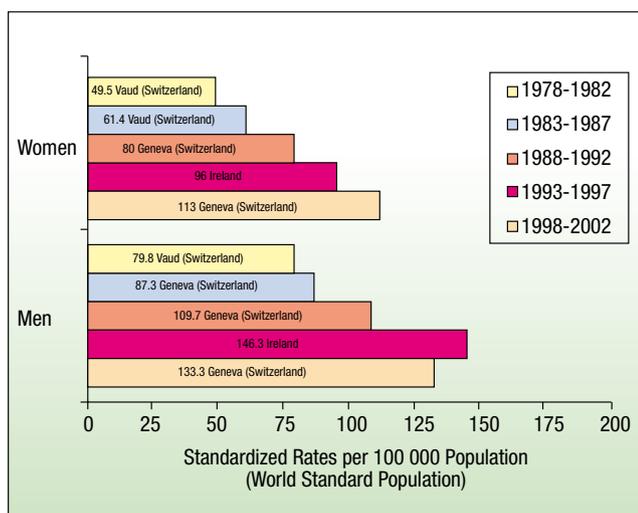


Figure 5 European peak incidences of nonmelanoma skin cancer for the period 1978-2002.

The rate tripled in women over this period. The highest rate for both sexes was observed in Majorca for the period 1993-1997, with a standardized incidence of 72 per 100 000 in women and 100.8 per 100 000 in men. The sex-specific peak incidence was higher in men. The highest regional incidences of NMSC in Spain were obtained in Majorca, Tarragona, and Navarre (Figure 6).

An increasing number of Spanish cancer registries collect data on the incidence of NMSC. Individual analysis of the registries revealed a progressive increase in the incidence of NMSC for both sexes during the study period (1978-2002), with the exception of the registries for Cuenca and Girona, where there was a reduction in the incidence of NMSC in men during the last period studied (1998-2002). Analysis of the standardized incidences for the longest-running registries (Zaragoza, Tarragona, and Navarre) revealed that

the rates had doubled or tripled in both sexes over the period 1978-2002 (Tables 3 and 4).

Discussion

The incidence of cutaneous melanoma and NMSC has increased continuously during the period 1978-2002, with higher rates for melanoma in women and for NMSC in men. In Spain, the standardized rates for the longest-running registries showed that incidences had doubled or tripled in both sexes and for both types of cancer over this period. The highest rate for both sexes was obtained in the European population of Zimbabwe for the period 1988-1992, with rates for women that were 80 times higher than in the African population. This reveals the very high risk of developing NMSC seen in individuals with fair skin types compared with others in the same population who have a similar level of sun exposure but darker skin pigmentation.

The incidence of NMSC is estimated to be 18 to 20 times higher than that of cutaneous melanoma. The ratio of standardized incidences for basal cell carcinoma to squamous cell carcinoma is approximately 4 to 1.¹ The cumulative lifetime risk of developing basal cell carcinoma is calculated at 28% to 33%, while that of squamous cell carcinoma is between 7% and 11%.¹⁸

The incidence of NMSC in white individuals has risen alarmingly since 1960, at a rate of 3% to 8% per year in Europe, the USA, Canada, and Australia.¹⁹ This increase could be linked to greater exposure to UV radiation, an increase in the number of people who engage in outdoor activities, changes in clothing preferences, increased life expectancy, the use of sunbeds, and the thinning of the ozone layer.⁶ The increase in the incidence of NMSC may also be due to greater ease of recording cases in the cancer registries, thanks to the availability of electronic pathology data.²⁰ Nevertheless, there are still few worldwide cancer registries that systematically record full epidemiologic data on NMSC.^{1,4,21} In the United

Table 3 Incidence of Nonmelanoma Skin Cancer in Women According to Spanish Cancer Registries During the Period 1978-2002

Period	1978-1982	1983-1987	1988-1992	1993-1997	1998-2002
Asturias			0.3	6.4	
Cuenca				0.4	0.7
Canary Islands				0.7	0.8
Basque Country		0.2	0.3		0.9
Albacete			1.1	0.3	1.6
Zaragoza	14.8	12.6	12.1	22.5	30.2
Murcia		17.5	34.1	8.4	31.5
Girona				45.6	45.2
Tarragona	18.8	33	40.1	42.4	52.1
Granada		20	26.2	48.8	61.8
Navarre	14.9	21.8	31.8	52.5	67.5
Majorca			61.2	72	

Table 4 Incidence of Nonmelanoma Skin Cancer in Men According to the Spanish Cancer Registries During the Period 1978-2002

Period	1978-1982	1983-1987	1988-1992	1993-1997	1998-2002
Asturias			0.4	9.9	
Cuenca				0.7	0.6
Canary Islands				0.6	0.7
Basque Country		0.4	0.6		1
Albacete			0.6	0.8	1.8
Zaragoza	31.3	26	25.3	39.8	48.6
Murcia		34	58.4	20	51
Girona				67.4	64.5
Tarragona	31.9	56.2	62.8	67.3	79.4
Granada		39.9	45.3	68.2	79.7
Navarre	30.7	42	51.5	70.4	88.1
Majorca			89.7	100.8	

Kingdom, the true incidence of NMSC is estimated to be 30% higher than the rate obtained from cancer registries.⁴ In Germany, the incidence of basal cell carcinoma is estimated to be 30% higher than that contained in the cancer registries, while in the case of squamous cell carcinoma it would be 5% to 17% higher.²²

Comprehensive systematic recording of data on NMSC is difficult for a number of reasons. In most cases, these tumors have an indolent clinical course and as a result a large number of patients do not consult a doctor. Death due to NMSC is infrequent, making it difficult to estimate the incidence of the tumor based on associated mortality. These tumors tend not to require hospital treatment, and on many occasions the treatment used does not allow subsequent histologic confirmation.²⁰ There are often differences in the methods used for recording data, even between registries in the same country.²¹ Furthermore, some registries do not record incident cases of basal cell carcinoma,^{16,21} only considering cases of squamous cell carcinoma as NMSC.

In Europe, many registries only record the first NMSC in an individual, in accordance with the recommendations of

the IARC and the European Network of Cancer Registries. Consequently, if a person has more than one NMSC (simultaneous or synchronous) it is recorded as a single case. It has been estimated that 25% of patients diagnosed with basal cell carcinoma and 14% of those diagnosed with squamous cell carcinoma present a new basal cell carcinoma or squamous cell carcinoma, respectively, in the following 5 years.²² Similarly, cancer registries also fail to record recurrent NMSC, despite the elevated tendency to recur years after initial diagnosis, especially in the case of basal cell carcinoma.²³

The incidence of melanoma in white individuals increased by around 3% to 7% annually in the second half of the 20th century.²⁴ This increased incidence is due in part to a higher frequency of early diagnosis.²⁵

The progressive increase in life expectancy also contributes to the increased incidence of melanoma and the finding that melanoma is increasingly common in patients of more advanced age.²⁶ The melanomas diagnosed in older patients are often deeper, and therefore have a worse prognosis,^{25,26} making it necessary to increase screening and early diagnosis in patients over 60 years of age.²⁷

Although all cancer registries systematically record comprehensive data on melanoma, some authors have suggested that the incidence remains underestimated.²⁸ This is due in part to the fact that not all pathology laboratories report cases of melanoma to the registries, especially when diagnosis occurs at early stages. Nevertheless, the marked increase in the incidence of melanoma is also observed in countries where cancer registries receive complete histologic data, such as in Switzerland, the Netherlands, Scotland, and Finland, indicating that improvements in registries are insufficient to explain the increased incidence of melanoma.⁷

Mortality due to melanoma has continued to increase in white individuals worldwide in recent years.¹ Melanoma has one of the highest annual increases in mortality of any tumor, only surpassed by non-Hodgkin lymphoma and lung cancer in women and by testicular cancer in men.²⁷ However, recent studies indicate that mortality due to melanoma is beginning to stabilize or decline slightly in a number of countries.^{2,25,29} A possible explanation for this trend is the improvement in early diagnosis, which leads to a higher proportion of tumors with a shallower Breslow depth at diagnosis and, therefore, a better prognosis.^{25,30}

In Spain, recent decades have also seen an increase in mortality due to melanoma in both sexes. This continued up until 1994, when the rate began to stabilize or even decline in men but continued to rise in women.²⁷ These observations may be explained by changes in lifestyle and exposure to the sun in Spain.

Our study is limited by the failure to analyze data for the period 2003-2007, due to the delay in publication of data on the incidence of skin cancer by the IARC. In addition, not all populations have a cancer registry. However, the registry sample used by the IARC offers an adequate representation of skin cancer epidemiology.

The incidence of skin cancer (NMSC and melanoma) is predicted to continue increasing in white individuals. This trend will continue for at least the next 2 or 3 decades, and the incidence of these tumors is expected to almost double in that time period.² Despite the public apparently being increasingly aware that UV radiation is the principal modifiable environmental risk factor for skin cancer, an ever greater preoccupation with physical appearance (sunbeds, beach holidays, etc) appears to take priority over primary prevention measures.²⁶

Given the trend in the incidence of skin cancer in recent years, its certain increase in the future, and the growing life expectancy of the population, there will need to be increased investment in healthcare resources (both human and material) to satisfy the demand that will be generated by these tumors. A clear picture of trends in the incidence of skin cancer will help to facilitate the development of health care services and primary and secondary prevention campaigns. Consequently, it is essential that skin cancer receives the same attention as other tumors in the cancer registries.

Although the continued increase in the incidence of skin cancer suggests that primary prevention measures are failing or inadequate, it may still be too early to assess the effectiveness of primary prevention, since at least 20 years must pass from their implementation until an

analysis of their effects on incidence becomes possible. The same is not true of secondary prevention, the results of which directly affect mortality and can be assessed in the short term. The slight decline or stabilization of mortality associated with melanoma indicates that secondary prevention is effective.

Conflicts of Interest

The authors declare no conflicts of interest.

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