

Comparative study on the effect of solar radiation on workers' skin at different altitudes

Abstract

Background: Chronic sun exposure causes significant changes in human skin that include photoaging, precancerous and cancerous lesions. The effect of sunlight exposure on outdoor workers at different altitudes has not been studied yet. For every 300 meters above sea level the ultraviolet radiation increases by 4%. Greece has a great diversity in its geography with a dominant presence of mountains and its long coastlines. A large part of the population lives and works exposed to solar radiation throughout the year, such as farmers, stock breeders, fishermen, builders and also tourism workers.

Methods: This study presents the analysis of data referred to chronic sun exposure in two different population samples of outdoor workers: one mountainous and the other coastal.

Results: Most of the workers in the total cumulative sample do not use sunscreen during their outdoor work. The surveyed outdoor workers are exposed to the sun for many hours. The effects of photo aging are obvious as expected in both groups, but the islanders' group suffered more damage than those in the mountainous area. In contrast, the presence of precancerous and cancerous lesions on the skin of both populations related to the UV radiation is almost the same.

Conclusions: Exposure to the sun's ultraviolet radiation at higher altitudes, which is stronger than exposure to sea level, does not produce significant more side effects on photoaging, precancerous and cancerous lesions.

Keywords: outdoor workers, skin cancer, photoaging, ultraviolet radiation, altitudes

Volume 4 Issue 1 - 2020

Papadopoulos Iordanis

Department of Aesthetic and Cosmetology, Alexander Technological Educational Institute of Thessaloniki, Greece

Correspondence: Papadopoulos Iordanis, Department of Aesthetic and Cosmetology, Alexander Technological Educational Institute of Thessaloniki, Greece, Email drirdanis@yahoo.gr

Received: February 21, 2020 | **Published:** February 25, 2020

Introduction

A great part of the Greek population works in the agriculture economy related to agriculture, livestock and fisheries. According to the Hellenic Statistical Authority, in 2013, the agriculture economy employed 1.218.000 people of which 939.000 were exclusively employed in this domain. A basic source of the Greek economy is tourism, especially in the summer months, with the number of workers in the sector reaching 400,000 in 2017. Therefore, it can be stated that approximately 1,600,000 Greek residents work either year-round or seasonal and especially in summer in outdoor work exposed to the sunlight radiation. The total number of sunny days in the country during a calendar year is large.

Chronic exposure to sunlight causes photoaging and cancerous lesions on the skin.¹ Photoaging occurs exclusively on sun-exposed parts of the body such as the face, neck, upper chest, and upper and lower extremities. This is a form of premature aging. A typical finding of photoaging includes radial wrinkles around the eyes, deep skin wrinkles in the back of the neck, brown spots and spider veins around the face area.²

There is also a decrease in skin elasticity, dryness and roughness. These changes in the skin are due to a decrease in collagen and elastin due to their damage by ultraviolet radiation.³ Histologically, there is a mass of amorphous elastic tissue characterized as elastosis. The blood vessels of the skin decrease and the light yellow tint of the skin appears.⁴

Actinic keratoses are likely to develop over the years in skin regions that are affected by photoaging.⁵ It has long been known that sun exposure causes actinic keratoses.^{6,7} The lesions are mainly found

on the uncovered areas of men's scalp, face, ear tips and forearms. These injuries are more common in older people. The effect of solar radiation has also been implicated in the development of actinic cheilitis, which may be the precursor to the development of squamous cell carcinoma.⁸

There are many reports and studies on the development of basal and squamous cell carcinomas as well as malignant melanomas in areas of the skin that have previously been exposed to sun without protection.⁹ Non-melanocytic cancerous tumors tend to occur more frequently in old age.¹⁰ Exposure to ultraviolet radiation is the main cause of non-melanoma skin tumors.¹¹ Type A of ultraviolet radiation may play a more active role in causing melanoma.¹²

Skin cancer depends not only on sunlight but also on other factors such as heredity and certain working conditions.¹³ It can be mentioned, for example, that professional contact to arsenic, polycyclic hydrocarbons (e.g. tar products) can cause cancer after years of contact with skin and in particular the form of squamous cell carcinoma.¹⁴ The importance of each factor in causing skin cancer is different. Heredity, the workplace environment and exposure to the sun are all highly correlated with skin cancer. The combination of working outdoors with parallel sun exposure is a major source of melanocytic and non-melanocytic skin tumors.¹⁵

Balanced exposure to sunlight is essential. Careful sun exposure should be required to activate vitamin D metabolism.¹⁶ The UV index of sunlight plays an important role in the severity of the effects of the sun on the skin. This is an international measurement of the risk of solar radiation. The lower the index, the lower the risk of sun damage. The UV radiation index is calculated using the radiation

propagation model in combination with the position of the sun at any time, the vertical ozone column, the suspended particles and the soil reflectivity.¹⁷ Under clear sky, the observed increase in radiation relative to the altitude is $8\% \pm 2\%$ per 1000m. For every 300meters above sea level, the ultraviolet radiation increases by 4%.¹⁸

Other factors that influence the intensity of solar radiation are the time of year, the time of day exposure and the geographical location of the region relative to Equator. Apparently summer is considered more dangerous than other seasons due to the intensity of the sun rays because of better weather conditions. Clouds and rainfall are less during this time of the year. Also, noon hours are the most dangerous. The geographical location is extremely important because the closer to Equator, the higher the risk of UV radiation. Reflection surfaces are also very important as this percentage can reach 90% depending on the material. Sand, snow and water are considered to have a high reflectivity.¹⁹

The relationship between chronic exposure to sunlight and the harmful effects on human skin has already been documented. The documentation lies in the reduced presence of the harmful effects of the sun on indoor workers compared to those working outdoors.²⁰ Also a lot of studies have been carried out on the negative effects of the sun in different countries of different continents with high sunshine throughout the year. The parameters relating to the UV index and the time of year have already been substantiated as to their importance for the effect of the sun on human skin.²¹ So far there are no studies referring to the severity of the exposure to the sun's UV rays in relation to the altitude of the exposure.

Materials and methods

This study was conducted from September 2018 to February 2019 and consisted of a sample of 200 men working outdoors: half of them lived and worked in mountainous villages in Northern Greece, and

the remaining half lived and worked in Greek islands. The altitude difference in the collection of mountain population data ranges from 320 to 687 meters. On the contrary, those on the islands were working near to the sea area. The participants were all men because manual and outdoor work was performed mainly by them. The sample age ranged from 40 to 70 years old. Patients were screened voluntarily, either clinically or by the use of telemedicine via internet access. Prior to their examination, they were given a questionnaire to anonymously indicate their age, type of occupation, hours exposed to the sun, and whether they use sunscreen. They were also asked if they visit a dermatologist on an annual basis.

Written informed consent was obtained from all participants prior to their enrollment in the study. People younger than 40 years old and those who did not complete the questionnaire were excluded, because chronic skin side effects due to sun exposure appear usually after the age of 40 years. Those who did not send a photo of the affected areas or those who were not clinically examined were also excluded.

Photoaging lesions as well as actinic keratoses and malignant tumors of the skin were recorded. The work was conducted in accordance with the COPE of Ethics of the World Medical Association for studies involving humans and it was approved by the Board of Aesthetics and Cosmetology of the Alexandrian Technological Institute of Thessaloniki. Statistical analysis was performed using SPSS 2.0 software, with descriptive statistics (frequencies, Crosstabulation).

Results

Most of the people examined in the islands deal with the tourism industry during the summer, which is the island's main financial source. These activities involve serving tourists on the beaches and in restaurants, as well as the construction work related to the maintenance and erection of new tourist accommodation. Only 20% of the island's men are engaged in fishing. (Figure 1)

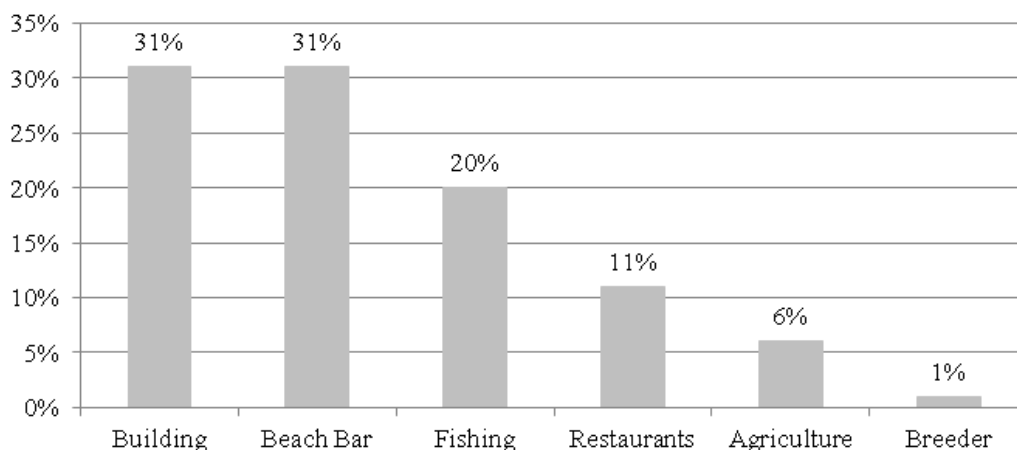


Figure 1 The jobs of the men in the Greek islands.

The majority of men who are working in the countryside of the northern cities are mainly engaged in agricultural work. After all, agricultural products are the main source of revenue for the specific region. (Figure 2) Therefore due to the different geographical location of the two areas under consideration, the occupation of each of its residents is different.

In the question related to the use of sunscreen during their work, 67% of sample of the Greek islands answered that they do not use it at all, while only 33% of them apply sunscreen. In the same question, 76% of the residents of the northern cities answered that they do not use sunscreen, compared to 24% who use it. (Figure 3) Virtually more than two out of three workers in the total cumulative sample do not use sunscreen during their outdoor work.

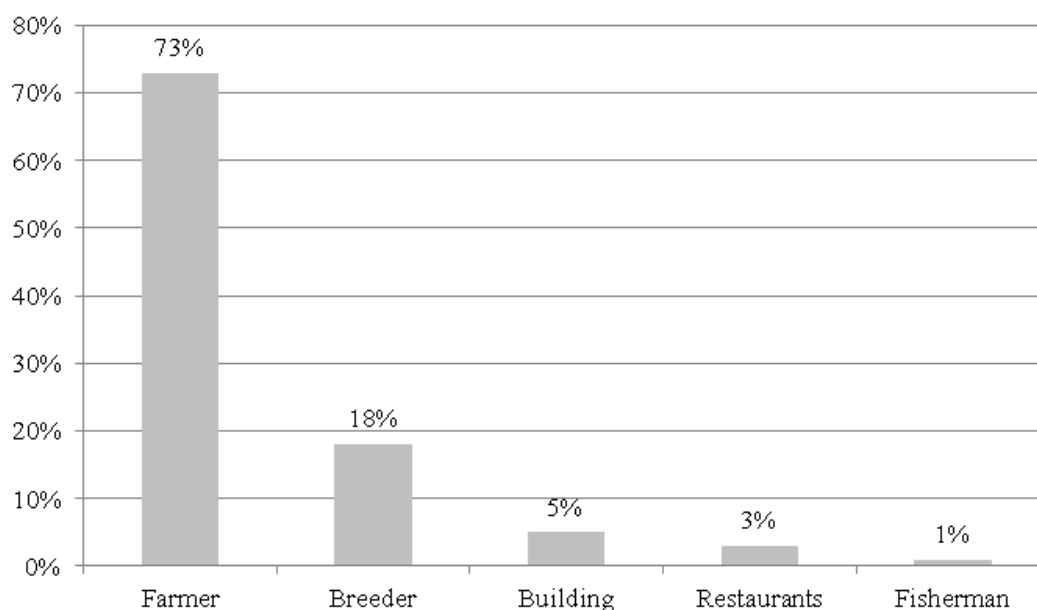


Figure 2 The jobs of the men in the mountainous areas.

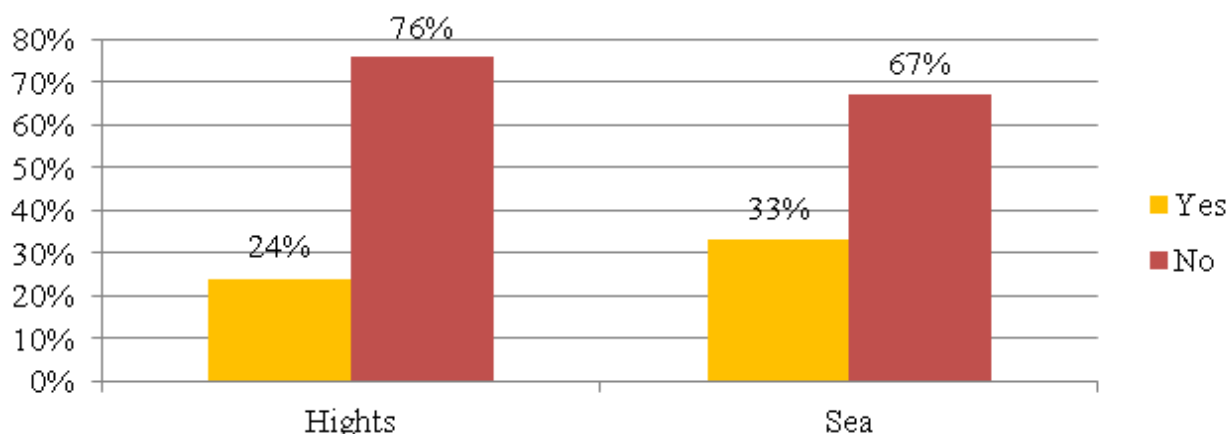


Figure 3 The use of sunscreen.

When they were asked about the number of hours they work under the sun, 52% of the islanders answered that they worked less than eight hours a day and 48% more than eight hours a day. Correspondingly, 42% of the outside workers of northern cities responded that they worked less than eight hours a day while 58% more than eight hours a day. In summary, most outdoor workers are exposed to the sun more than eight hours a day.

The clinical findings regarding photoaging related to the presence of radial wrinkles around the eyes. The presence of these wrinkles in coastal workers reached 89% while the corresponding percentage of mountain workers reached 76% (Figure 4).

The presence of skin deep grooves in the neck with the image of the crease wrinkles was 85% in island workers and 38% in mountain workers (Figure 5). There is a clear predominance of the presence of wrinkles in the skin on the island's outdoor workers over those who work in the mountainous countryside. The percentage of presence of

brown spots is 52% among the island workers while the corresponding percentage of mountain workers is 25% (Figure 6). The incidence of brown spots in uncovered and sun-exposed parts of the body is greater for workers in the coastal zone than for those working in the highlands.

There were two cases of actinic keratoses, one case of basal cell carcinoma and one case of squamous cell carcinoma among the people worked in islands. All of the lesions above were located in the face area. In the sample of workers in the mountainous region there were two cases of actinic keratoses and one case of basal cell carcinoma. Therefore skin cancer incidence is marginally higher among island workers than mountain workers. All lesions were located in the patient's facial area except from the squamous cell carcinoma that manifested in the right forearm. Regarding to the annual dermatological checkup, 61% of coastal workers reported that they do not visit a dermatologist regularly, while the corresponding percentage of mountain workers to this question reaches 72%.

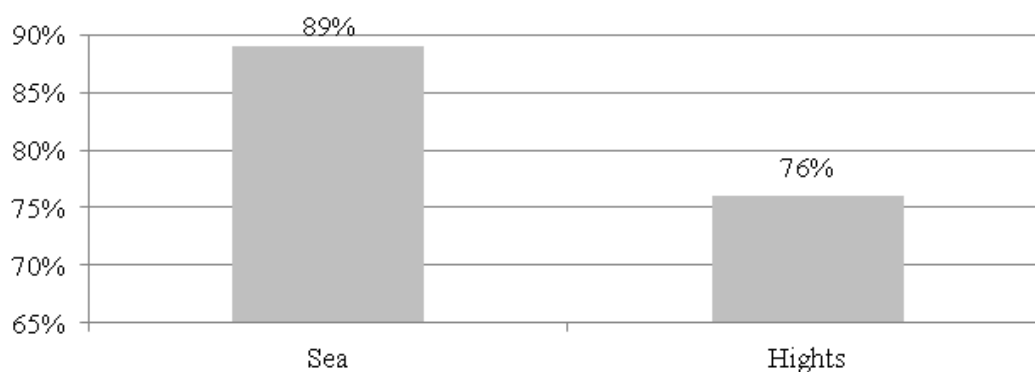


Figure 4 Wrinkles around the eyes.

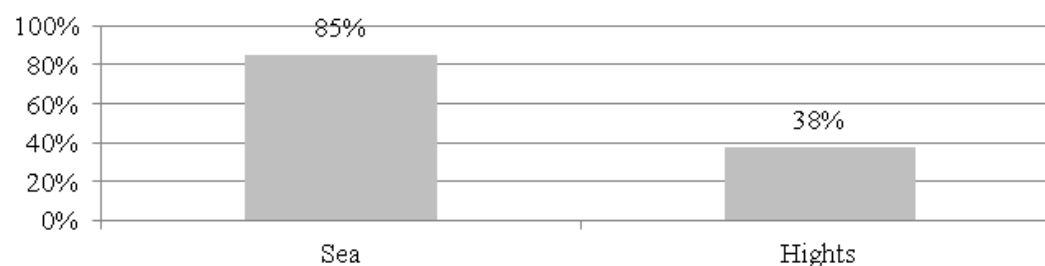


Figure 5 Deep wrinkles in the neck.

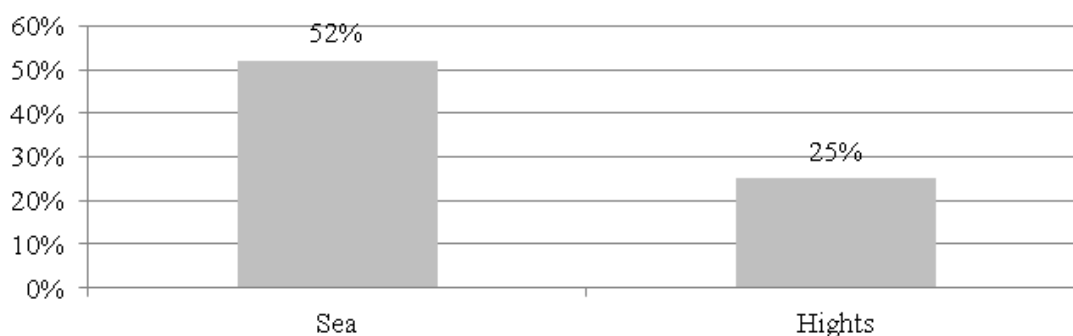


Figure 6 Brown spots.

Conclusion

The present comparative study investigated the effects of ultraviolet radiation on outdoor workers that they worked at different altitudes. A characteristic similarity of the two groups is their common attitude towards the sun. Both populations largely do not make frequent use of sunscreen products.

Another similarity is the degree of their annual visits to a dermatologist, which is low for both groups. Both groups worked under the sun without protection for a long time daily. This common behavior may be justified by the low educational and living standards of these people who, despite having access to information through new technology, continue to ignore the harmful conditions of their working environment regarding the sun.

The effects of photoaging are obvious as expected in both groups examined, but the islanders' group suffered more damage than those in the mountainous area. Although workers in the mountainous areas due to altitude difference are more likely to receive UV radiation than coastal workers, they are less likely to experience photoaging. A reason for that is probably the UV index which in the case of the

islands of south Greece is higher especially in the summer months due to its geographical location.²²

In contrast, the presence of pre-cancerous and cancerous lesions on the skin of both populations related to UV radiation is almost the same and lower compared to the presence of photoaging lesions. Exposure to the solar ultraviolet radiation at higher altitudes, although more intense, does not produce more effects on photoaging and cancerous lesions compared to sun exposure at sea level.

Discussion

Greece is small in geographical size but it has differences in altitude as it is largely surrounded by the sea and has large mountain ranges in which a significant part of its population lives and works. The altitude and other factors are taken into account when calculating the UV index.

During summer the UV index is almost the same throughout Greece due to the small geographical size of the country. Also in summer there are very good weather conditions in both the island and the mainland. During the summer there are no significant variations in the weather on both the coast and the mountains.

Since the increase in altitude is accompanied by an increase in exposure to ultraviolet radiation, one would expect that skin damage due to photoaging and precancerous and cancerous lesions would be the same in the two populations or slightly more pronounced in the highlands because of altitude.

Indeed, pre-cancerous and cancerous lesions are almost the same in both populations. However, the effects of photoaging not only do not predominate in the mountain population, which due to altitude is exposed to more UV radiation, but they occur more strongly in the coastal population.

Perhaps the altitude may not be so significant as a causing parameter for the damage of human skin from UV radiation.^{23,24}

Conflicts of interest

The author declare that there is no conflicts of interests.

Acknowledgments

None.

Funding

None.

References

- Hudson L, Rashdan E, Bonn CA, et al. Individual and combined effects of the infrared, visible, and ultraviolet light components of solar radiation on damage biomarkers in human skin cells. *FASEB J*. 2020.
- The Canadian Dermatology Association information home page. *topic photoaging*. 2018.
- Battie C, Jitsukawa S, Bernerd F, et al. New insights in photoaging, UVA induced damage and skin types. *Exp Dermatol*. 2014;1:7–12.
- Fisher GJ, Kang S, Varani J, et al. Mechanisms of photoaging and chronological skin aging. *Arch Dermatol*. 2002;138(11):1462–1470.
- Sjerobabski Masnec I, Poduje S. Photoaging. *Coll Antropol*. 2008;2:177–180.
- Filosa A, Filosa G. Actinic keratosis and squamous cell carcinoma: clinical and pathological features. *G Ital Dermatol Venereol*. 2015;150(4):379–384.
- Freeman RG. Carcinogenic effect of solar radiation and prevention measures. *Cancer*. 1968;21(6):1114–1120.
- Mello FW, Melo G, Modolo F, et al. Actinic cheilitis and lip squamous cell carcinoma: Literature review and new data from Brazil. *J Clin Exp Dent*. 2019;11(1):e62–e69.
- Armstrong B, Kricger A. The epidemiology of UV induced skin Cancer. *Journal of Photochemistry and Photobiology B*. 2001;63(1–3):8–18.
- Papadopoulos I. Comparative study of dermatological diseases of the elderly in relation to the rest population. *Clinical, Cosmetic and Investigational Dermatology*. 2020;13:173–178.
- International Agency for Research on Cancer (IARC). Radiation Volume 100 D. A review of human carcinogens. *IARC*. 2018.
- Lyon, Monographs on the Evaluation of Carcinogenic Risks to Humans. *International Agency for Research on Cancer*. 1988.
- Wang SQ, Setlow R, Berwick M, et al. Ultraviolet A and melanoma: a review. *J Am Acad Dermatol*. 2001;44(5):837–846.
- PDQ Cancer Genetics Editorial Board. Genetics of Skin Cancer (PDQ®): Health Professional Version. 2020.
- PDQ Cancer Information Summaries. Bethesda (MD): *National Cancer Institute (US)*. 2002–2020.
- Gawkrodger DJ. Occupational skin cancers. *Occup Med*. 2004;54(7):458–463.
- Cherry NM, Meyer JD, Adisesh A, et al. Surveillance of occupational skin disease: EPIDERM and OPRA. *Br J Dermatol*. 2000;142(6):1128–1134.
- Hoel D, Berwick M, De Gruijl F, et al. The risks and benefits of sun exposure 2016. *Dermatoendocrinol*. 2016;8(1):e1248325.
- Watson M, Holman D, Maguire–Eisen M, Ultraviolet Radiation Exposure and Its Impact on Skin Cancer Risk. *Semin Oncol Nurs*. 2016;32(3):241–254.
- Blumthaler M, Ambach W, Ellinger R. Increase in solar UV radiation with altitude. *Journal of photochemistry and photobiology B*. 1997;39:130–134.
- Volkovova K, Bilanicova D, Bartonova A, et al. Associations between environmental factors and incidence of cutaneous melanoma. Review. *Environ Health*. 2012;11(Suppl 1):S12.
- Grandahl K, Ibler KS, Laier GH, et al. Skin cancer risk perception and sun protection behavior at work, at leisure, and on sun holidays: a survey for Danish outdoor and indoor workers. *Environ Health Prev Med*. 2018;23(1):47.
- Young C. Solar ultraviolet radiation and skin cancer. *Occupational Medicine*. 2009;59(2):82–88.
- Xiang F, Lucas R, Hales S, et al. Incidence of nonmelanoma skin cancer in relation to ambient UV radiation in white populations, 1978–2012 empirical relationships. *JAMA Dermatol*. 2014;150(10):1063–1071.