ORIGINAL ARTICLES

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Dosimeters: measuring occupational UV exposure's involvement in skin cancer development

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Abstract: *Introduction: Solar exposure is a major causative factor for multiple skin pathologies. Even though UV radiation is the most important factor implicated in skin cancer pathogenesis, still, few European countries recognize UV occupational-induced skin cancer as an occupational disease, Romania not being part of this category. The objectives of this study were to evaluate the UV exposure doses in agriculture and construction workers and to establish efficient protective measures.*

Materials and methods: In our Department, a prospective, observational, analytical study was conducted, including six outdoor workers (in construction and agriculture), over a period of three summer months (July, August, September). Subjects were asked to wear personal dosimeters and the following parameters were analyzed: profession, duration of exposure, UV exposure doses, skin aspect, preexisting preventive measures.

Results: The wearing of dosimeters was well tolerated by all subjects, without any interference with daily professional activities. Daily UV radiation doses ranged from 1.79 SED (tractor driver) to 19 SED (agriculture worker). Maximum UVR doses were recorded between 10:00 am and 4 pm. Clinical examination was made after measurements, with no detectable skin changes.

Conclusion: Even though workers in agriculture and construction in Romania are exposed to significant UV doses, with 40% more than the general population, these professions are not recognized as high-risk professions for developing skin tumors. More prospective and retrospective studies are necessary for more significant statistical results and for demonstrating the necessity of introducing primary, secondary and tertiary preventive measures.

Keywords: *ultraviolet radiation, occupational exposure, skin cancer*

INTRODUCTION

Solar exposure is a major causative factor for multiple skin pathologies. Most frequently it is the case of cutaneous tumors, both precancerous and malignant lesions (actinic keratoses, basal cell carcinomas, squamous cell carcinomas and melanomas). [1]

There are numerous professions that imply working

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outdoors, from which we concentrated our study on agriculture and construction workers. Occupational ultraviolet (UV) exposure can be measured with UV dosimeters.

Personal UV dosimeters are electronic devices that are able to record data that permits analysis of UV exposure dose on working days. Modern dosimeters are small in size, therefore easy to wear at the workplace, permitting personal UV measurements. Even more so, multiple dosimeters can be used, recording data from different parts of the body. They are relatively new devices used more and more frequently in UV exposure-related studies. [2-5]

Ultraviolet radiations represent segments of the electromagnetic specter and are classified in UVC (100-290 nm), UVB (290-320 nm) and UVA (320-400 nm).

UV radiation is very important in dermatological practice, being able to determine both exacerbations and remissions of different skin disorders and of course playing a major role in skin cancer development. [6]

Even though UV radiation is the most important factor implicated in skin cancer pathogenesis and World Health Organization introduced UV radiation on the carcinogens agents list of group I, still, few European countries recognize UV occupational-induced skin cancer as an occupational disease, Romania not being part of this category. [7]

The lack of studies in this area in Romania suggests the fact that more analysis should be made for a better understanding of this aspect in our country.

Objectives: to evaluate UV exposure doses in agriculture and construction workers and to establish efficient prevention and protection measures.

MATERIALS AND METHODS

In our Department, a prospective, observational, analytical study was conducted, including six outdoor workers (in construction and agriculture), over a period of three summer months (July, August, September).

Subjects were selected based on their profession. Our study took place in Bordusani, Ialomita, Romania, with the geographical coordinates 44°28′21″N 27°53′59″E for the agriculture outdoor workers and in Bucharest, Romania, with the geographical coordinates 44°25′57″N 26°06′1 for the construction workers.

Subjects were asked to record in personal diaries information regarding: profession, location, date, start time and end time of their schedule, lunch breaks and weather conditions.

The following parameters were analyzed: profession, duration of exposure, UV exposure doses, skin aspect, preexisting preventive measures.

For the agriculture workers, we've selected irrigation system manufacturer, tractor driver and beans manufactures and for the construction site we've selected road workers.

Subjects were asked to wear personal dosimeters for several working days. Sun exposed areas involved the face, neck, forearms and dorsum of hands, the rest of the areas were covered by equipment.

Clinical examination was performed before and after measurements to detect any skin changes.

The personal dosimeter used in this study was X-2012-10 Personal UV Irradiance Dosimeter from Gigahertz-Optik and a "Velcro" fastening system was used to attach it on the subject's forearm.

Data was processed using Microsoft Office Excel 2013.

RESULTS

The wearing of dosimeters was well tolerated by all subjects, without any interference with daily professional activities.

Daily UV radiation doses ranged from 1.79 SED (tractor driver) to 19 SED (agriculture worker).

Maximum UVR doses were recorded between 10:00 am and 4 pm. Apart from standard equipment, no protective measures were applied.

Clinical examination was made after measurements, with no detectable skin changes.

DISCUSSION

Sunlight is composed of a continuous spectrum of electromagnetic radiation divided into three major groups: ultraviolet, visible and infrared. [8] Ultraviolet radiation is a major causative factor in skin cancer development. [9]

Even though UVA has less energy than UVB and penetrates deeper, into the dermis, UVB radiation is most implicated in carcinogenesis. UVA is responsible for carcinogenesis through immunosuppression: it determines production of reactive oxygen species that cause damage in the deoxyribonucleic acid, therefore gene mutations and damage in the epidermal keratinocytes and dermal connective tissue.

Examples of gene mutations include PTCH and p53 tumor suppression gene in basal cell carcinomas, activated mitogenic ras pathway and p53 in squamous cell carcinomas and ras pathway, inactive p16 and p53 in melanomas. [10]

Also, the duration and intensity of UV exposure are factors implicated in skin cancer development. For example, cumulative, long-term UV exposure is related to chronic actinic skin damage, therefore implicated in the appearance of actinic keratoses and squamous cell carcinomas, since intermittent, high intensity UV exposure especially at young ages would most likely cause basal cell carcinomas and melanomas. [11]

For measuring UV exposure doses on an outdoor worker, irradiance should be determined - the flux of radiant energy per unit (W/m2). But this applies only for one moment in time, so for a larger period (e.g. one working day) the term "exposure dose" (J/m2) is used. [12] For this, a standardized unit – SED – Standard Erythema Dose is applied, where 1 SED is equivalent with 100J/m2. [13]

The annual exposure dose for the general population in Germany is 130 SED. [14] Considering our results, with a daily UV exposure dose of 19 SED (15% daily of the annual exposure dose), we have to acknowledge the fact that both agriculture and construction professions in Romania are professions with high-risk of developing solar exposure related pathologies.

Even more so, by German standards, if the outdoor worker was exposed to a cumulative UVR dose with 40% higher than the general population, than the nonmelanoma skin cancer is considered to be of "occupational origin". [14]

Therefore these professions should be placed in the occupational skin diseases category.

It is very important to take into consideration that different parts of the body absorb different UV doses depending on body geometry, therefore involve different risks. Multiple personal dosimeters should be used, calculating UV doses on different body sites. [16]

Horizontal body locations seem to receive 2x - 2,5x more UV that the vertical ones. [17]

Also, UV exposure dose depends on the reflection of UV radiation on surrounding structures. For example, UV reflection for construction workers surrounded by metallic structures is different to that of fishermen that are surrounded by water. This is a significant additional benefit of personal dosimeters, being able to record UV doses from different parts of the body and not taking into consideration only the direct, vertical radiation.

For example, even if an outdoor worker has correct equipment, with a broad-brimmed hat, UV reflection from surrounding structures could still reach him. Therefore additional protective measures should be implemented, such as protective sun creams. Also, personal dosimeters, being able to measure UV radiation received by the subject, these measurements could be compared with those stated by meteorological departments. [18]

Even more so, occupational exposure to UV radiation can determine specific features of the tumors involved. For example, basal cell carcinoma appears more frequently in the "mask area" of the face in occupational exposed workers and also histopathologically appears to be more aggressive in evolution. [19]

All of this important features reinforce the necessity of implementing strict preventive and protective measures for outdoor workers, including protective sun creams (SPF 30 or more), special sun protective equipment (long pants and long sleeves, broad-brimmed hats or helmets, sunglasses), multiple breaks in indoor areas and rotating shifts. [15] Also, considering the fact that the maximum UVR dose was detected between 10 am and 4 pm, outdoor workers should avoid working outside in this timeframe.

Even if by the end of our study no pathological skin changes were expected, we have to keep in mind that most UV skin related pathologies depend on a cumulative UVR dose with long term exposure. More interventional and observational studies are necessary for a better understanding of UVR effects on outdoor workers in Romania.

CONCLUSION

Even though workers in agriculture and construction in Romania are exposed to significant UV doses, with 40% more than the general population, these professions are not recognized as high-risk professions for developing nonmelanoma skin cancer or melanomas. More prospective and retrospective studies are necessary for more significant statistical results and for demonstrating the necessity of introducing primary, secondary and tertiary preventive measures.

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