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Prophylactic Management and Public Awareness Research on the Impact of UV Radiation on Human Skin

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The sun is in everyone.
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Abstract

The role of prophylactic and social awareness of the impact of UV radiation on the skin and human body is one of the basic elements of pro-health behavior. The scope of the paper is interdisciplinary joining the fields of management and health sciences. The aim of the article is to analyze the organization, management functions and social awareness of coordinating health prophylactic of care for patients in terms of their exposure to UV radiation. The methods and materials used are a survey and questionnaire, conducted with the respondents constituting the research group, which made it possible to collect data from the subjective survey and obtain information on the applied prophylactic measures. The structure of the paper consists of posing the cognitive problems and questions, the literature review, the description of results, discussion, and conclusions.

Key words: *organization of prophylactic of UV radiation, management of prophylactic of UV radiation on the skin, impact of UV radiation on the skin, pro-health skin protection of skin.*

Introduction

The role of prophylactic and social awareness of the impact of UV radiation on the skin and human body is one of the basic elements of pro-health behavior. Skin damaged by harmful ultraviolet radiation, emitted both during exposure to solar radiation or in the solarium, as well as cancerous skin lesions resulting from this process are an increasingly common problem in patients visiting doctors of many specialties, including dermatologists, oncologists, primary healthcare doctors, aesthetic medicine specialists and cosmetologists. The creation of a competent and holistic care system for these patients seems to be a significant problem in health care. The organization and management of this process is an underestimated element of prophylactic. Effective organization and management of prophylactic contributes to the improvement of the health of the society.

The aim of the article is to analyze the organization, management functions and social awareness of coordinating health prophylactic of care for patients in terms of their exposure to UV radiation.

Research question about the usefulness of the concept of management functions for the organization of health prophylactic has been posed.

The method used is a questionnaire, conducted with the respondents constituting the research group, which made it possible to collect data from the subjective survey and obtain information on the applied prophylactic measures.

Literature review

Management functions in prophylactic

Prophylactic is an area of pro-health activity that is part of medical science, yet the organizational component seems to play a fundamental role. It seems useful to use basic management functions in the organization of care over this group of patients. Therefore, one can refer to the classics of management science. First three management functions were deve-

loped in 1909 by Henri Fayol (1841–1925) and published in "L'exposee des principles generaux d'administration" [1]. They were modified many times, although they still remain in the canon of management theory and practice [2,3,4]. They make it possible to improve the functioning of an organization by arranging the stages of its activity and are universal, regardless of the type of organization [5]. They are also included in the canon of management methodology, especially in relation to the so-called Pragmatic management methods [6]. These include planning, organizing, coordinating, leading and controlling each process [7]. The first stage is planning, which should become the starting point for the next steps. It allows to define the goals to be achieved, describe the necessary resources, both in terms of human and financial needs, and define the scope of monitoring and controlling needed during the implementation of the adopted plan. The second stage consists of organizing the process in such a way as to enable its efficient implementation through an appropriate division of tasks among individual employees, as well as the development of an appropriate organizational structure. The third stage, i.e. leadership, consists of modifying the attitudes of medical personnel by section managers in such a way that they achieve the goals. The fourth stage allows to control and check whether the goals set in the planning process have been achieved. Thanks to this last phase, it is possible to identify errors, as well as to indicate the possibilities of better performance of planned tasks in the future. It can be argued that the prevention of the impact of UV radiation on human skin should be carried out as a management process characterized by individual phases: planned organization, consistent management and conscious control [9].

The effect of ultraviolet radiation on the human body

Ultraviolet radiation, due to its biological impact, can be divided into three basic ranges of wavelengths: UVA, UVB and UVC [10]. The UVA band is in the range from 315 to 400 nm, accounts for about 95% of radiation and is the longest of the low energy wavelengths. It almost entirely penetrates the ozone layer and reaches the ground. This radiation easily penetrates

the epidermis and penetrates deeper, reaching the layers of the dermis. UVA radiation does not cause erythema, although it contributes to the formation of a tan, and its undesirable effects become visible only after many years [11]. It contributes to photoallergic reactions, is responsible for the photoaging process, facilitates the formation of freckles, discoloration and skin cancer [12]. Long-term exposure to this type of radiation may contribute to oxidative stress and increased damage to cellular structures, including DNA [13]. UVB radiation ranges from 280 to about 320 nm, has a much shorter wavelength, but greater energy compared to UVA. Most of this radiation is retained by the ozone layer, and its intensity varies depending on weather conditions, season and time of day [14]. Unlike UVA, UVB rays do not penetrate into the deeper layers of the skin, but only reach the basal layer of the epidermis. They contribute to the formation of solar erythema and even skin burns. They also have a great impact on the formation of wrinkles, accelerate photoaging and the development of skin cancer. In appropriate doses UVB radiation also has a positive effect on the human body, as it causes photoactivation of vitamin D3 in the epidermis, which is necessary for the proper functioning of the human calcium and phosphate metabolism [15]. UVC radiation is in the range of 200 to 280 nm, it has the shortest wavelength but the highest energy. Due to the wavelength range corresponding to the full absorption of biological compounds such as nucleic acids, i.e. RNA and DNA, it is deadly for all living organisms. It leads to burns and cell mutation [16]. Due to the dangerous effects of excessive exposure to ultraviolet radiation and insufficient awareness of its dangerous consequences, a UV index has been created, which has been approved by the World Health Organization, the World Meteorological Organization, the International Commission on Non-Ionizing Radiation Protection and the United Nations Environment Program. A UV index of 1 corresponds to a radiation intensity of 0.025 W m-2; when the index reaches the value of 4, the UV intensity is 0.1 W m-2. In Poland, two specialized research centers are responsible for monitoring the intensity of ultraviolet radiation. The first is the Central Geophysical Observatory of the Institute of Geophysics of the Polish Academy of

Sciences in Belsk, which has been making measurements with the use of equipment to capture the spectrum responsible for the formation of erythema on the skin since 1975. The reports show that the average level of UVB radiation increases year by year, which is caused by changes in the structure of the ozone layer in the stratosphere and a reduced concentration of atmospheric aerosols [17]. The other center belongs to the Institute of Meteorology and Water Management in Warsaw and is located in Legionowo. The measurements have been carried out here since 1993 with the use of specialized radiometers at the stations in Legionowo, Łeba and Zakopane [18]. The climate studies enable the creation and sharing of aggregate maps [19] describing the current or average UV index at a given place and time [20].

Sunbathing as an unhealthy behavior

The fashion for tanned skin was introduced to Parisian salons in the 20th century by designer Coco Chanel (1883–1971). During her fashion shows, models distinguished themselves with evenly tanned skin [21]. At that time, tanned skin was a synonym of health, good condition, beauty and high social status. In 1975, the American dermatologist Thomas B. Fitzpatrick created a six-level classification of skin phototypes, including the tendency to sunburn. Skin damaged by harmful ultraviolet radiation emitted both during exposure to sunlight and in a solarium, as well as skin changes resulting from this process, have become a common symptom found in many specialist offices. The characteristic features of UV-damaged skin are its dehydration, dryness, hyperkeratosis, roughness, irritation, numerous disorders of biochemical processes in cells and accelerated aging with its early signs. The skin exposed to cyclic radiation has the features of mature, dry and sensitive skin at the same time [22]. Ultraviolet radiation also has an extremely detrimental effect on children's health. Infants and young children have immature skin that does not yet perform all its functions. Contrary to the skin of an adult human, the epidermal layers in children are thinner, the granular layer is not coherent, but broken, the cells of the spinous layer are characterized by a smaller

number of intercellular connections, which makes them more loosely arranged. The basal layer contains a small amount of melanocytes, insufficient to impart adequate color and protect the skin from ultraviolet radiation. Children are more often exposed to high concentrated doses of solar radiation because they spend more time outdoors and do not protect their skin with creams [23]. Moreover, children's skin is able to absorb a greater dose of UV radiation in a shorter time, which accumulates throughout their lives and contributes to the development of non-melanocytic and malignant skin neoplasms, including melanoma [24]. Sunburn is damage to the skin caused by excessive exposure to harmful UVA and UVB rays. During long-term sunbathing, ultraviolet radiation with a wavelength of 250–297 nm (UVB) is absorbed by the stratum corneum and the epidermis. The first visible sign of skin damage is redness. The resulting erythema is a sign of skin warming and dilation of blood vessels in the dermis. The erythematous process can be divided into three stages: latency, build-up and recovery. The latency stage lasts from 2 to 6 hours after the end of exposure and consists in the denaturation of proteins in the cells of the spinous layer. The build-up stage becomes apparent between 6 and 24 hours after exposure to ultraviolet radiation. It is based on the production of histamine by damaged skin cells. By penetrating into the dermis, it contributes to the dilation of blood vessels and increases the permeability of capillaries. Plasma accumulates in the intercellular space, which is visible in the form of edema, and blisters filled with serum fluid appear [25]. The third stage takes place at different times and lasts from several hours to several days [26]. The amount of melanin in the skin and the tendency to burns varies depending on the latitude and race [27]. During the build-up phase, damaged cells – sunburn cells – appear in the skin. These cells are contracted, the cell nucleus is visibly reduced, while the cytoplasm stains red. Inside one can see lumpy filaments, melanin granules and lysosomes. The p53 protein responsible for identifying and destroying cells changed by ultraviolet radiation is activated. Long-term exposure may damage the p53 protein, disrupt the apoptotic cycle, uncontrolled proliferation and mutation of cells, which may contribute

to the development of melanoma [26]. Long-term and cyclical exposure of the skin to harmful solar radiation may contribute to sunburn, which, unlike erythema, is more dangerous and causes serious complications [28]. Sunburn can be classified into three basic degrees. The first degree is the most common and covers only the epidermis, the skin is red and tender in this case. Symptoms usually disappear after a few days, the damaged epidermis peels off. The second degree includes the epidermis and dermis. There is swelling, blisters filled with serous fluid, and fever. In this case, partial epidermal necrolysis may occur, and scars may remain when symptoms subside. The third degree of sunburn involves the epidermis, dermis and subcutaneous tissue. Due to the depth of damage and nerve damage, the burn leaves scars and requires long-term medical care [29]. Ultraviolet radiation is harmful to health, therefore, when exposed to it, protective clothing and sunscreen should be used. Irritated skin with visible erythema must be immediately brought to a state of homeostasis by being cooled and then should be protected with a foam or soothing cosmetics with D-panthenol [30].

Skin cancers – the result of excessive exposure to ultraviolet radiation

Skin neoplasms are an increasingly common diagnostic and therapeutic problem caused by the harmful effects of ultraviolet radiation on the integument. The group with the highest risk of developing the disease includes people working outdoors, practicing sports that require a long stay outside, and excessive sunbathing [31]. The negative effect of UV radiation on DNA consists of changes in its structure. DNA belongs to the group of subcellular molecules capable of absorbing solar photons. Hazardous genotoxic effects on cells, including acid, have been observed during excessive and long-term exposure to the sun. The deoxyribonucleic acid becomes damaged during a photochemical reaction, which results in gene mutations leading to the development of neoplasms [32]. UVA radiation (320–400 nm) penetrates the upper layers of the dermis and is hardly absorbed by DNA, therefore it contributes to its damage with reactive oxygen forms [33]. UVB radiation (280–320 nm) has the greatest

impact on the stratum corneum and hardly reaches the deeper layers of the epidermis. It has a much stronger genotoxic effect because it is directly absorbed by DNA [34]. The process of carcinogenesis is a gradual accumulation of genetic errors in previously healthy cells. It runs in three stages of initiation, promotion, and progression, during which there is an increasing genetic destabilization through increased mutations in various groups of genes [35]. In order to prevent the coding of detected mutations in genes caused by UV radiation in the body, the cell cycle is stopped and repair systems are implemented. The p53 protein, discovered in 1979 at Princeton University, plays an important role in this process. This protein consists of 393 amino acids and is encoded by the TP53 gene located on chromosome 17. During an uncontrolled, increased gene mutation with very large, unrepairable DNA defects, the p53 protein is activated, which contributes to the destruction of the cell through apoptosis [36]. Ultraviolet radiation also has a negative effect on the p53 protein itself, leading to its mutation, which contributes to uncontrolled replication of damaged DNA and cell division of damaged keratinocytes [37]. As a result, high hopes in oncological treatment are placed on the p53 protein, as restoring its suppressor function in neoplastic cells could inhibit carcinogenesis [38]. The most common skin cancers caused by exposure to harmful ultraviolet radiation are: basal cell carcinoma, squamous cell carcinoma and melanoma. Epidemiological data show that the incidence of melanoma in Poland is about 5/100,000, which means about 3,100 cases per year (about 1,400 in men and about 1,700 in women). These are the neoplasms with the greatest increase in cases. In Poland, it increased threefold in 1980–2010. Mortality rates are around 2.3/100,000 in men and 1.5/100,000 in women, which corresponds to around 1,300 deaths per year [39].

Prophylactic of the negative impact of UV radiation on the human body

Ultraviolet radiation cannot be avoided, it is just necessary to learn how to minimize its negative effects [40]. When exposed to the sun, several rules should be followed that protect the skin and support photoprotection,

minimizing the risk of negative effects of long-term exposure. One should not stay in the sun between 10 am and 3 pm because then the intensity of ultraviolet radiation is the highest [41]. The skin should be protected with light-colored, airy clothing. The head should be covered with a cap or a scarf made of light-colored material. Eyes should be protected with sunglasses with appropriate filters so as not to irritate the conjunctiva [42]. Protective preparations with properly selected UVA and UVB filters (SPF) should be applied to the skin [43]. Their action is based on the ability to absorb, reflect or scatter harmful ultraviolet rays. Filters included in cosmetics are divided into physical ones containing minerals: zinc oxide, titanium dioxide, iron oxide and chemical ones made of aromatic rings with a carboxyl group, which show isomerization properties [44]. These include: para-aminobenzoic acid, cinnamates, arobenzones (parsol), benzotriazoles (tinosorb), camphor derivatives (mexoryl) [45]. During the exhibition, one should also pay great attention to the composition of the medications (with tretinoin), dietary supplements (with St. John's wort) or the cosmetics used (antiperspirants, perfumes). Many of them contain photosensitizing substances. Each skin lesion under the influence of radiation can undergo neoplastic changes, therefore they should be closely observed and their size and color monitored in dermatoscopy [46]. In order to minimize the negative effects of long-term exposure and support skin regeneration, it should be cared for at home by using moisturizing and soothing cosmetics. The condition of damaged skin can be improved in cosmetology salons where, thanks to modern devices and professional cosmetics, its hydration, nourishment and acceleration of regeneration processes can be improved. Treatment therapy eliminates the first signs of premature aging by maintaining the hydro-lipid layer of the skin, rebuilding its structures and degrading free radicals from its surface.

Research methodology

The aim of the article is to analyze the organization, management functions and assess people's awareness of the negative effects of the emit-

ted UV radiation. The work presents one research question and one research hypothesis. The research question was: "What is the usefulness of the concept of the management function for the organization of health prophylactic?", and the hypothesis contained in the article is as follows: "Social awareness of the negative effects of ultraviolet radiation on human skin is low". The research method used is a questionnaire, which was conducted with the respondents constituting the research group, which made it possible to collect data from the subjective research and obtain information about the applied prophylactic measures.

Results and discussion

The research methodology is based on a survey conducted on a sample close to a random sample. The research consisted in answering the questions included in the survey. It involved a group of 80 people: 61 women and 19 men aged 16 to 53. Questions were asked about the frequency of exposure to the sun, observed skin changes caused by sunbathing, and above all, social awareness of the respondents in this regard was examined. When asked about how they sunbathe, the vast majority of people replied that they prefer sun exposure to the use of a solarium, 1% (1/80) of respondents chose only a solarium, 1% (1/80) of respondents tan more often in a solarium than in the sun, 83% (66/80) of respondents sunbathe only in the sun, while 11% (9/80) sunbathe more often in the sun than in a solarium. In the question checking social awareness of negative effects resulting from excessive exposure to harmful ultraviolet radiation, 95% of respondents (76/80) stated that they sunbathed with full awareness of the possible effects that threaten their health, and 4% (3/80) of respondents were not aware of the risks for their health. Upon request to determine the skin phototype according to the guidelines provided by Fitzpatrick, 9% (7/80) of respondents stated that they have phototype I, 14% (11/80) of respondents believe that they have phototype II, 53% (41/80) of respondents – phototype III, 19% (15/80) of respondents are a group with phototype IV, 4% (3/80) of respondents are classified as

phototype V, while 1% (1/80) believe that they have phototype VI. In the question describing the most common skin problems after sunbathing, 22% (18/80) of respondents experienced skin dryness, increased roughness, itching and discoloration, 35% (28/80) of respondents reported skin irritation, burning, sunburns, while 40% (32/80) of respondents did not notice any changes. When asked about the use of sunscreen cosmetics with protective filters, 66% (53/80) of respondents confirmed the use of photoprotection, 31% (25/80) of respondents said that they did not use any protective substances. When asked about the places of skin problems after exposure to the sun, 71% (57/80) of respondents stated that unwanted changes appeared on the skin that was not protected with filters, while in 20% (25/80) of respondents changes appeared despite protection with sunscreen preparations. When asked about the condition of the skin after several years of intense sunbathing, 13% (10/80) of respondents said that the skin looks worse, has premature aging symptoms, is dry and rough, 25% (20/80) of respondents noticed changes, but said that they were almost invisible, while 61% (49/80) of respondents did not find any changes.

In terms of the negative effects of the emitted ultraviolet radiation, the environmental assessment of the awareness of people who sunbathe and use solariums is present in many publications on the subject. The results obtained by other researchers are similar. In the publication "Tanning in the solarium – knowledge, attitude and habits of Poles" Katarzyna Torzewska, Jolanta Malinowska-Borowska, Agata Wypych-Ślusarska and Grzegorz Zieliński note that people using tanning beds do not follow the rules of safe tanning, although they are aware of the negative effects of UV radiation on health. The situation is worse among people who sunbathe in the sun, whose knowledge about the negative effects of tanning is lower. These researchers conclude that health campaigns are needed to promote knowledge about the negative effects of radiation [48]. In the publication by Faustyna Kuros, Karolina Pinas, Karolina Skalska and Joanna Skupień, "Awareness of young society about the impact of UV radiation and the prevention of skin aging", the vast majority of respondents

declared that they are aware of the risks associated with UV radiation, but believe that people who often tan and those using sunbeds without photoprotective preparations are not exposed to UV rays or are exposed to them in a moderate degree [49]. According to Anita Zalewska, Mirosława Cylkowska-Nowak, Poles are still inadequately protected against UV radiation, their knowledge in this area is insufficient and based on stereotypes. Men use less skin care cosmetics than women. Decisions protecting health are not always influenced by education, age, place of residence or profession [50].

Conclusions

Prevention in the field of the impact of UV radiation on human skin should be implemented as a management process characterized by various phases: planned organization, management and control. Proper coordination of organizational processes in the prevention of the impact of UV radiation on the skin allows for more effective implementation of pro-health processes.

Public awareness of the impact of ultraviolet radiation on humans is still insufficient. The research hypothesis was verified positively. Based on the survey, it was found that the level of knowledge about the positive and negative effects of ultraviolet radiation on the skin is still too low, which contributes to the lack of appropriate photoprotection, and in the future may lead to significant changes in the functioning of the body: skin burns, discoloration, faster aging. and in the most severe cases to the development of skin neoplasms. It was also noticed that despite the respondents' belief about a high level of awareness of the negative effects of radiation, their actual knowledge about the effects of tanning is low. For that reason the role of the best possible organization of health prophylactic, which can improve the health of the society, is so important here.

References

1. Rahman MH. Henry Fayol and Frederick Winslow Taylor's contribution to management thought: An overview. ABC Journal of Advanced Research 2012; 1(2): 94-103.

2. Carroll SJ, Gillen DI. Are the classical management functions useful in describing managerial work? Academy of Management Review 1987; 12(1): 38-51.

3. Marquis BL, Huston CJ, Propst J. Leadership roles and management functions in nursing: Theory and application. Journal for Nurses in Professional Development 1992; 8(6): 284-287.

4. Grunig JE. Furnishing the edifice: Ongoing research on public relations as a strategic management function. Journal of Public Relations Research 2006; 18(2): 151-176.

5. Nothhaft H. Communication management as a second-order management function: Roles and functions of the communication executive – results from a shadowing study. Journal of Communication Management 2010; 14(2): 127-140.

6. Sułkowski Ł. Paradygmaty i nurty badawcze w metodologii nauk o zarządzaniu – próba syntezy w oparciu o światową literaturę przedmiotu. Research Papers of the Wroclaw University of Economics/Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu 2014: 340.

7. Sułkowski Ł. O potrzebie rozwoju epistemologii zarządzania. Master of Business Administration 2009; 17(4): 12-19.

8. Stabryła A, ed. Podstawy organizacji i zarządzania. Podejścia i koncepcje badawcze. Kraków: Wydawnictwo UE w Krakowie; 2012.

9. Griffin RW. Podstawy zarządzania organizacjami. Warszawa: PWN; 2002, pp. 39-44, 328-359, 392-417.

10. Pościk A, Wolska A, Owczarek G. Ocena narażenia na promieniowanie nadfioletowe z zastosowaniem indywidualnych fotochromowych dozymetrów. Warszawa: CIOP PIP; 2009.

11. Pacholczyk M, Ferenc T, Czernicki J. Wpływ słonecznego promieniowania ultrafioletowego (UV) na organizm człowieka. Część I: Charakterystyka wybranych właściwości fizykochemicznych i biologicznych promieniowania UV. Acta Balneologica 2014; LVI(1)/135.

12. Narayanan DL, Saladi RN, Fox JL. Ultravioletradiation and skin cancer. Int J Dermatol 2010; 49(9): 978-986.

13. Departament Zdrowia Publicznego i Promocji Zdrowia, Główny Inspektorat Sanitarny. Informacja na temat skutków zdrowotnych wynikających z nadmiernego promieniowania ultrafioletowego (UV).

14. Węgłowska J, Milewska A. Pozytywne i negatywne skutki promieniowania słonecznego. Postępy Kosmetologii 2011; 2(2): 93-97.

15. Pacholczyk M, Ferenc T, Czernicki J. Wpływ słonecznego promieniowania ultrafioletowego (UV) na organizm człowieka Część I: Charakterystyka wybranych właściwości fizykochemicznych i biologicznych promieniowania UV. Acta Balneologica 2014; LVI(1)/135: 20-26.

16. Biszczuk-Jakubowska M. Analiza danych oraz opracowanie informacji dla odbiorców krajowych i międzynarodowych: roczny raport za rok 2018. Warszawa; czerwiec 2019.

17. Monitoring całkowitej zawartości ozonu w atmosferze oraz natężenia promieniowania UV-B na stacji Belsk w latach 2013-2016. Raport

o stanie warstwy ozonowej w 2015 roku. Warszawa: Instytut Geofizyki Polskiej Akademii; 2017.

18. Wolska A, Gałecki Ł. Narażenie zawodowe na naturalne promieniowanie nadfioletowe w Polsce – ocena szacunkowa. Bezpieczeństwo Pracy 2010; 1: 14-17.

19. Monitoring rozkładu pionowego ozonu, całkowitej zawartości ozonu nad Polską i Europą Środkową oraz promieniowania UV-B w Polsce w latach 2013-2016. Warszawa: Instytut Meteorologii i Gospodarki Wodnej Państwowy Instytut Badawczy; 2016.

20. Marciniak P. Wpływ promieniowania ultrafioletowego na skórę człowieka w badaniu świadomości społecznej oraz metody pielęgnacji skóry uszkodzonej przez nadmierną ekspozycję na ten rodzaj promieniowania. Praca magisterska. Łódź: Społeczna Akademia Nauk; 2020.

21. Możdżyńska-Nawotka M. O modach i strojach. Wrocław: Wydawnictwo Dolnośląskie; 2002, pp. 257-258.

22. Sybilski AJ. Skóra najważniejszy narząd naszego ciała. Dbajmy o nią! Pediatria. Medycyna Rodzinna 2012; 8(4): 375-379.

23. Thieden E, Philipsen P, Heydenrich J, Wulf H. UV radiationexposure-relate to age, sex, occupation ans sunbehaviorbased on time-stamped-personaldosimeterreadings. Arch Dermatol 2004; 140: 197-203.

24. Sieniawska J, Lesiak A, Segerbäck D, Young A, Woźniacka A, Narbutt J. Wakacyjna ekspozycja na słońce zwiększa stężenie witaminy D oraz dimerów tymidynowych u dzieci przebywających na obozie. Forum Dermatologicum. Via Medica 2016; 2(2): 73-80.

25. Kołodziejczak A. Kosmetologia. Warszawa: Wydawnictwo Lekarskie PZWL; 2019, p. 174.

26. Draelos ZD, Pugliese PT. Fizjologia skóry. Teoria i praktyka. Wrocław: MedPharm Polska; 2014, p. 192.

27. Ruprich M. Kolor w makijażu permanentnym. Kosmetologia Estetyczna 2015; 1(4): 51-52.

28. Draelos ZD, Pugliese PT. Fizjologia skóry. Teoria i praktyka. Wrocław: MedPharm Polska; 2014, pp. 191-193.

29. Adamski Z, Kaszuba A. Dermatologia dla kosmetologów. Poznań: Wydawnictwo Naukowe Uniwersytetu Medycznego im. Karola Marcinkowskiego w Poznaniu; 2008, p. 211.

30. Fuchs E, Moore C, Cevibkas F et al. UVB radiation generates sunburn pain and affects skin by activating epidermal TRPV4 ion channels and triggering endothelin-1 signaling. PNAS 2013; 110(34): E3225-E3234.

31. Lehmann P. Fotodermatozy. Część VI. Choroby wywołane przez czynniki środowiskowe. In: Braun-Falco O, ed. Dermatologia. Lublin: Wydawnictwo Czelej; 2017, pp. 600-601.

32. Draelos ZD, Pugliese PT. Fizjologia skóry. Teoria i praktyka. Wrocław: MedPharm Polska; 2014, pp. 337-338.

33. Ikehata H, Ono T. The mechanisms of UV mutagenesis. J Radiat Res 2011; 52(2): 115-125.

34. Brenner M, Hearing VJ. The protective role of melanin against UV damage in human skin. Photochem Photobiol 2008; 84(3): 539-549.

35. Pacholczyk M, Czernicki J, Ferenc T. Wpływ słonecznego promieniowana ultrafioletowego (UV) na powstanie raków skóry. Medycyna Pracy 2016; 67(2): 255-266.

36. Styczyński J. Genetyczne i środowiskowe uwarunkowania nowotworów. In: Drewa G, Ferenc T, eds. Genetyka medyczna. Wrocław: Elsevier Urban & Partner; 2011, pp. 581-602.

37. Zapaśnik M, Cymerys JM. Białko p53 – strażnik genomu w zakażeniu wirusowym. Postępy Biologii Komórki 2009; 36(4): 565-582.

38. Ferenc T, Pacholczyk M, Czernicki J. Wpływ słonecznego promieniowania ultrafioletowego (UV) na organizm człowieka. Część II: Mutagenne działanie promieniowania UV i naprawa uszkodzeń DNA. Acta Balneol 2014; LVI(2)/136: 82-87.

39. Sznarkowska A, Olszewski R, Zawacka-Pankau J. Farmakologiczna aktywacja supresora nowotworu, natywnego białka p53 jako obiecująca strategia zwalczania nowotworów. Postepy Hig Med Dosw 2010; 64: 396-407.

40. Rutkowski P, Wysocki PJ. Czerniaki skóry. Onkologia w Praktyce Klinicznej – Edukacja 2017; 3(6): 268-269.

41. Łastowiecka-Moras E, Bugajska J. Promieniowanie nadfioletowe-zasady zapobiegania negatywnym skutkom zdrowotnym. Bezpieczeństwo Pracy: nauka i praktyka 2008; 11: 21-23.

42. White KM, Starfelt LC, Young RM, Hawkes AL, Leske S, Hamilton K. Predicting Australian adults' sun-safe behaviour: Examining the role of personal and social norms. British Journal of Health Psychology 2014; 20(2): 396-412.

43. Young RA, Logan C, Lovato CY, Moffat B, Shoveller JA. Sun Protection as a Family Health Project in Families with Adolescents. Journal of Health Psychology 2015; 10(3): 333-344.

44. Rodrigues AM, Sniehotta FF, Birch-Machin MA, Araujo-Soares V. Aware, motivated and striving for a 'safe tan': an exploratory mixed--method study of sun-protection during holidays. Health Psychology and Behavioral Medicine 2017; 5(1): 276-298.

45. Węgłowska J, Milewska A. Pozytywne i negatywne skutki promieniowania słonecznego. Postępy Kosmetologii 2011; 2(2): 93-97.

46. Guzikowski J, Czerwińska AE, Krzyścin JW, Czerwiński MA. Controlling sunbathing safety during the summer holidays – The solar UV campaign at Baltic Sea coast in 2015. Journal of Photochemistry and Photobiology B: Biology 2017; 173: 271-281.

47. Rhein LD, Fluor JW. Starzenie skóry. Wrocław: MedPharm Polska; 2013, pp. 138-140.

48. Torzewska K, Malinowska-Borowska J, Wypych-Ślusarska A, Zieliński G. Opalanie się w solarium – wiedza, postawa i nawyki Polaków. Medycyna Środowiskowa – Environmental Medicine 2014; 17(1): 52-59.

49. Kuros F, Pinas K, Skalska K, Skupień J. Świadomość młodego społeczeństwa na temat wpływu działania promieni UV oraz profilaktyka fotostarzenia się skóry. Kosmetologia Estetyczna 2019; 4: 407-414.

50. Zalewska A, Cylkowska-Nowak M. Zdrowa skóra a słońce – próba diagnozy wiedzy oraz wybranych postaw. Nowiny Lekarskie 2012; 81(3): 214-218.