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ULTRAVIOLET RADIATION – LEVEL OF KNOWLEDGE AND HEALTH PROTECTION OF COLLEGE STUDENTS IN SLOVAKIA. AN EDUCATIONAL-QUESTIONNAIRE STUDY

It is generally acknowledged that there is a correlation between the incidence of ultraviolet burden diseases and overexposure of the body to ultraviolet radiation (UVR). The main goals of our study were to determine the level of knowledge of college students in regard to the effects of UVR, to educate them about it, and finally to urge them to improve their personal protection against the harmful effects of UVR. We performed an educational-questionnaire study of UVR in 2003, 2005, and 2008 years. Responses of 841 students from Jessenius Faculty of Medicine in Martin (JFM), University of Zilina, and St. Elizabeth College of Health and Social Work (SEC) in Bratislava showed a higher level of knowledge in students at JFM and Univ. of Zilina following their education, as compared to those students from SEC. There was little difference in responses to questions related to the protection against UVR. A lower level of knowledge in all groups of students was shown in 2005. Nevertheless, all respondents significantly increased their level of protection against UVR during the years of the study and the number of those visiting solaria decreased. A weak relationship between the knowledge of students and their protection skills against UVR was found, indicating that a complex reason might be involved. This study highlights the importance of providing education that is systematic and long-term to university students in Slovakia (future doctors, bioengineers and nurses). Moreover, this study brings new insights on the surveillance and protection against the harmful effects of UVR to prospective patients.

Key words: Ultraviolet Radiation, Knowledge of College Students, Sunburn, Public Health Protection, Sunbeds, Questionnaire

1. Introduction

The damage to the human body by ultraviolet radiation (UVR) is a serious medical threat. UVR as a kind of non-ionizing radiation is essential for health, but excessive exposure poses health risks that may result in diseases, such as a malignant cutaneous melanoma, squamous and basal cell carcinomas, sunburn, solar keratoses, cortical cataract, pterygium, ocular melanoma, carcinoma of the cornea and conjunctiva, a reactivation of herpes labialis, suppression of the immune system, a premature skin aging, etc. [1], [2], [3]. In this respect, the higher intensities of mostly UVR-B radiation reaching the Earth surface due to the reduced concentration of an atmospheric ozone layer represents an important hazard to human health. The effective reduction of the stratospheric ozone concentration (below 220 Dobson units) was found in the Antarctica nearly 30 years ago [4]. Increased levels of UVR-B reaches its maximum between September and December [5]. Physical characteristics of UVR as well as the intensity of solar radiation are determined by the position of the Sun, by latitude, by specific conditions of the atmosphere and the Earth surface, time of exposure, meteorological conditions, and some additional environmental factors [6], [1]. The strict implementation of the Montreal Protocol on Substances that Deplete the Ozone Layer [7] needs to continue in order for

the UV- protective ozone layer to eventually recover. The prevention of serious UVR-related diseases would not be possible without the complex study of UVR, which will enable a clearer understanding of its effects on the human body [8], [9]. Evidence suggests that repeated sunburns in particular during childhood and adolescence are linked to serious skin cancers (invasive melanomas and non-melanomas) in children [10] and in relatively young people aged under 55 [2], [11]. Some of these diseases seem to be related to hereditary factors, the sensitivity of particular skin (photo)type, colour of hair, the number of pigment naevi, life style, health habits, quality of environment, protection skills, and some other factors. In Slovakia for example, in the years of 2006, 2007, and 2008, the incidence (a number of new cases/year/10000 citizens) of malignant melanoma and other invasive skin cancers was 51.4, 54.8, and 54.5, respectively [12], [13], [14].

Without proper education that will increase individual awareness and teach effective personal protection, a substantial reduction of health damage to the population due to the UVR overexposure is impossible. Some regulations such as control and even bans on the use of solaria by children and teenagers were adopted. However, national surveys in Europe have indicated that 9–16% of people still use tanning appliances but that usage among teenagers can

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reach 30% or more [15], [16], [17], [18]. A reduction of the use of solaria in 2004 (18%) as compared to 2001 (27%), however, was also documented [19].

The goal of our study was to use an educational-questionnaire method in order to provide a systematic educational program and then to make an assessment of the level of student knowledge regarding the physical and biological effects of UVR on humans. We also evaluated their behavioral skills related to protection against UVR. As a consequence to the UVR educational program, we expected students to be more knowledgeable and to show more skill in protecting their health and to reduce attendance to the solaria.

2. Material and methods

Our study was performed in the years of 2003, 2005, 2008 at three Slovakian universities: at the Jessenius Faculty of Medicine, Comenius University (JFM) in Martin, at the University of Zilina (in a program of biomedical engineering), and at the St. Elizabeth College of Health and Social Work (SEC) in Bratislava. The point was to educate the college students, and then determine their knowledge and personal skills in protecting themselves against harmful effects of UVR. A total number of 841 college students (Tab. 1) were involved. The average age of our respondents was 22 years. The study included 701 (83.3 %) females and 140 (16.7 %) males. The ratio of females to males in the individual years of 2003, 2005, and 2008 were: 275 (88 %) and 36 (12 %), 311 (85 %) and 56 (15 %), 115 (71%) and 48 (29 %), respectively.

The counts of university students involved in the study Table 1.

| University | Students in the year | | | | | | Together | |
|-----------------|----------------------|-------------|------------|-------------|------------|-------------|------------|------------|
| | 2003 | | 2005 | | 2008 | | | |
| | # | % | # | % | # | % | # | % |
| JFM Martin | 311 | 37.0 | 287 | 34.1 | 116 | 13.8 | 714 | 84.9 |
| Univ. of Zilina | 0 | 0 | 28 | 3.3 | 47 | 5.6 | 75 | 8.9 |
| SEC Bratislava | 0 | 0 | 52 | 6.2 | 0 | 0 | 52 | 6.2 |
| Together | 311 | 37.0 | 367 | 43.6 | 163 | 19.4 | 841 | 100 |

Students freely answered an anonymous questionnaire containing both epistemic and informative parts. The epistemic part consisted of 24 questions with an option to answer “yes” or “no”. These questions referred to the physical properties and biological effects of UVR, as well as to the protection available against health damage caused by UVR (Tab. 2). The questions were based on the standard medical textbook of Hrazdira [20]. At JFM in Martin and University of Zilina, our specific UVR education was fully covered by mandatory lectures of medical biophysics (the lectures were basically identical in the years 2003, 2005, and 2008) provided by ourselves. In addition to the medical textbook, students from 2005 at the above mentioned three universities could use additional literature [21]. The students at SEC in Bratislava obtained the com-

parable lectures and literature. Respondents were notified about the topics of the questionnaire. Students of JFM and University of Zilina obtained the questionnaire four weeks following the last lecture of our specific UVR subject. The informative part of the questionnaire dealt with, among other things, the skin type of students, the possibility of sunburn(s) during either the childhood, pubescence, or adolescence, their attendance to solaria, and the character of protection they used against UVR (behavior during tanning, number of visits, a quality of their sunscreens, sunglasses, dress, hats, etc.).

Respondents returned 92.3% of the questionnaires, 96% in 2003, 94% in 2005, and 87% in 2008. The data was processed by the PC program ORIGIN 5 Professional and GraphPad InStat. Success rates (percentages) were calculated for each answer (number of correct answers/number of students). The mean values \pm SE of the success rate were then calculated by averaging all the 24 questions. Repeated measures ANOVA (GraphPad InStat) with Student-Newman-Keuls post tests were used to test the statistical significance of differences. The informative part of the questionnaire was processed by analyzing the contingency tables using chi-square and Fisher's tests. Linear regression for trends of increases or decreases in the years 2003, 2005, and 2008 was also accomplished. The level of statistical significance was set at $p < 0.05$.

3. Results

In 2003, the respondents (311 students of JFM) reached a 87.4 \pm 2.1% success rate (in average 21.0 out of 24 answers were correct). In 2005 (Tab. 3), 367 students of all three universities (see Tab. 1) reached a 78.2 \pm 3.2% success rate (18.8 correct out of 24 answers). The lowest success rate reached were students from SEC in Bratislava, a program which did not cover our specific UVR subject (Tab. 3). The differences among universities were much less obvious in regard to questions N° 19 to 24 (related to the protection against UVR) while our students answered differently in questions N° 1 to 18 (associated with theoretical knowledge about UVR; Tab. 3). In 2008, a total of 163 respondents (students of JFM and University of Zilina) answered 88.0 \pm 1.7% correctly (21.1 correct out of all 24 answers). The comparison of success rates among related years showed a lower level of student knowledge in 2005 (Tab. 4). This finding was also confirmed by the comparison of the students (JFM and University of Zilina) that were educated in our specific program (Fig. 4) and by a separated analysis of questions N° 1 to 18 (theoretical knowledge). No significant difference in the success rate among the years was found for questions N° 19 to 24 (protection against UVR; Tab. 4)

The queries of the informative part of the questionnaire revealed an increased number of students who did not attend solaria in the successive years of 2003, 2005, and 2008 (61 %, 70 %, and 87 %, respectively; Fig. 1; correlation coefficient 0.998, $p = 0.039$). The number of those only seldom attending the solaria gradually decreased in the years of 2003, 2005, 2008 (36 %, 25 %, 12 %, respectively; Fig. 1; correlation coefficient 0.998, $p = 0.043$). In our study, only females reported to visit the solaria.

The list of questions under the epistemic part of our questionnaire with correct answer within parenthesis. (Y), correct statement; (N), incorrect statement

Table 2.

| | |
|-----|--|
| 1) | UVR is electromagnetic waving with the wavelength of 100 to 400 nm (Y) |
| 2) | UVR is ionizing radiation (N) |
| 3) | UVR is non-ionizing radiation (Y) |
| 4) | UVR is component of solar radiation (Y) |
| 5) | An artificial source of UVR is light bulb and neon lamps (N) |
| 6) | UVR is produced by mercury lamps (Y) |
| 7) | There is only one type of UVR (N) |
| 8) | There are two types of UVR (N) |
| 9) | The wavelength of UVR is important and this determines its biological effects (Y) |
| 10) | Biological effects of UVR depend on its intensity, the duration of exposure, the atmospheric ozone concentration. (Y) |
| 11) | Ozone layer enhances effects of UVR (N) |
| 12) | The reduction in ozone layer (ozone hole) can contribute to the induction of skin cancer (Y) |
| 13) | Exposure by UV induces tan of skin by melanin production within the melanocytes (Y) |
| 14) | UVR predominantly induces heating in the skin (N) |
| 15) | The pigmentation usually follows the erythema (Y) |
| 16) | Overexposure by UVR during the tanning usually does not induce any damage (N) |
| 17) | Acute effect of overexposure by UVR is solar dermatitis (skin inflammation) (Y) |
| 18) | Chronic exposure by UVR causes early ageing of skin and increases a possibility of skin cancer (Y) |
| 19) | A protective factor of sunscreens expresses the number - how many fold longer time can one stay under the sun without any risk of skin damage (Y) |
| 20) | The lower protective factor of sunscreens, the better protection of the skin (N) |
| 21) | Using the sunscreen with higher protective number, the erythema and pigmentation happen later (Y) |
| 22) | To protect body against UVR one can reduce the exposure to solar radiation between 10 a.m. and 2 p.m. (in the middle Europe) (Y) |
| 23) | To protect body against UVR one can use sunscreens with low protective factor enriched with vitamins (N) |
| 24) | To improve the protection of humans against UVR it is strictly recommended to stop the tanning of newborns and nurslings, as well as the humans treated with antibiotics, sulfonamides, etc. (Y) |

The level of students knowledge relative to UVR at 3 universities in 2005.

Table 3.

| University | Correct answers out of 24 | Success rate [%] mean ± SE | Questions N° 1 to 18 | | Questions N° 19 to 24 | |
|-----------------|---------------------------|----------------------------|---------------------------|----------------------------|--------------------------|----------------------------|
| | | | Correct answers out of 18 | Success rate [%] mean ± SE | Correct answers out of 6 | Success rate [%] mean ± SE |
| Univ. of Zilina | 21.8 | 90.9 ± 2.4 | 16.0 | 88.9 ± 3.0 | 5.8 | 97.0 ± 2.3 |
| JFM Martin | 19.0 | 79.3 ± 3.2 ** | 13.8 | 76.5 ± 3.9 ** | 5.3 | 87.7 ± 4.1 |
| SEC Bratislava | 16.5 | 68.9 ± 5.4 *** ++ | 11.6 | 64.6 ± 6.8 *** + | 4.9 | 81.7 ± 5.2 * |
| Together | 18.8 | 78.2 ± 3.2 | 13.6 | 75.8 ± 4.0 | 5.1 | 85.5 ± 3.7 |

*, **, ***, $p < 0.05$, $p < 0.01$, $p < 0.001$ comparing with University of Zilina; +, ++, $p < 0.05$, $p < 0.01$ comparing with JFM Martin.

Similar to previous findings, the number of students that did not use any protection against UVR have decreased during the course of our study in 2003, 2005, and 2008 (12 %, 4 %, and 2.5 %, respectively; Fig. 2). The numbers of respondents that used sunscreens, hats and clothes were higher in 2008 comparing with 2003 and 2005 (Fig. 2). Among our respondents - females used mostly sunscreens as UVR protection (about 1.5 fold more than males). Males preferred sunglasses (about 1.2 fold more of them) and hats

with clothes (about 2.2 fold more of them). On the other hand, the number of males that did not use any protection against UVR was about six times more than in females.

We found no significant differences in percentages of respondents visiting (avoiding) solarium, and in the percentages of those using (not using any) protection against UVR among the students at three universities passing our study in 2005.

The comparison of level of students knowledge in years 2003, 2005 and 2008. Table 4.

| Year | All students | | Students of JFM and Univ. of Zilina | |
|--------------------|---------------------------|----------------------------|-------------------------------------|----------------------------|
| | Correct answers out of 24 | Success rate mean ± SE [%] | Correct answers out of 24 | Success rate mean ± SE [%] |
| 2003 | 21.0 | 87.4 ± 2.1 | 21.0 | 87.4 ± 2.1 |
| 2005 | 18.8 | 78.2 ± 3.2 *** | 19.3 | 80.4 ± 3.1 ** |
| 2008 | 21.1 | 88.0 ± 1.7 +++ | 21.1 | 88.0 ± 1.7 ++ |
| Questions 1 to 18 | Correct answers out of 18 | Success rate mean ± SE [%] | Correct answers out of 18 | Success rate mean ± SE [%] |
| | 2003 | 15.6 | 86.6 ± 2.5 | 15.6 |
| 2005 | 13.6 | 75.8 ± 4.0 *** | 14.0 | 77.6 ± 3.7 ** |
| 2008 | 15.6 | 86.6 ± 2.0 ++ | 15.6 | 86.6 ± 2.0 ++ |
| Questions 19 to 24 | Correct answers out of 6 | Success rate mean ± SE [%] | Correct answers out of 6 | Success rate mean ± SE [%] |
| | 2003 | 5.4 | 90.0 ± 4.2 | 5.4 |
| 2005 | 5.1 | 85.5 ± 3.7 | 5.3 | 88.6 ± 3.9 |
| 2008 | 5.5 | 92.2 ± 2.7 | 5.5 | 92.2 ± 2.7 |

, *, $p < 0.01, p < 0.001$ comparing with 2003; +, ++, $p < 0.01, p < 0.001$ comparing with 2005

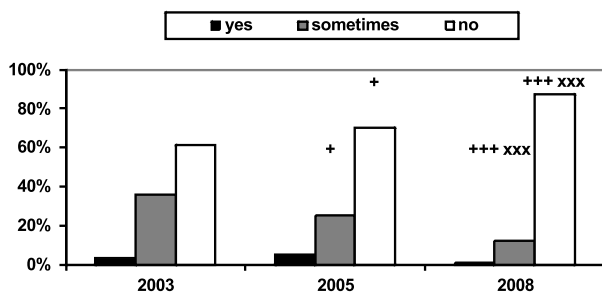


Fig. 1. Percentages of university students attending solaria in years 2003, 2005, and 2008. +, +, $p < 0.05, p < 0.001$ comparing with 2003; xxx, $p < 0.001$ comparing with 2005

Among our respondents, 586 of 841 students (69.7%) knew their skin type, 213 of them (25.3%) did not know their skin type, and 42 students (5.0%) were not familiar with the term “(photo) type of skin”. 108 students reported never to have been sunburnt (12.8%), and 439 respondents (52.2%) reported having been sunburnt during their childhood. The rest of the participants – 294 students (35.0%) reported solar skin trauma mostly in adulthood.

4. Discussion

UVR exposes everyone to both positive (Vitamin A production, an increase of immunity, behavioral aspects) and negative impacts

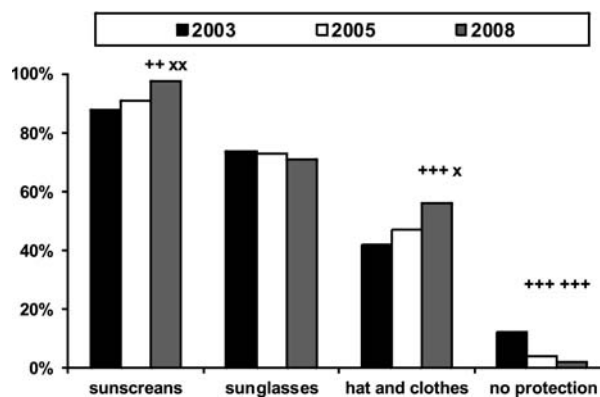


Fig. 2. Protection against UVR used by students in years 2003, 2005, and 2008.

+, +, $p < 0.01, p < 0.001$ comparing with 2003; x, xx, $p < 0.05, p < 0.01$ comparing with 2005

(disorders of skin, eye, immunity, etc.). Thus, overexposure to natural solar radiation and/or to artificial UV radiation produced by industry or solarium is potentially risky for individuals and thus for public health [22], [23], [24], [25], [26], [27]. Our assessment of three groups of the Slovak college students (future medical doctors, bio-engineers and nurses) was the first attempt to enhance the level of their knowledge, to raise protection against the harmful effects of UVR, to decrease the visits to solarium, and to provide relevant information that they will pass on to their prospective patients.

The students of JFM and University of Zilina were educated by our lectures on the specific UVR subject (textbooks and Internet were also available). Students responded to our questionnaire four weeks (self-education period) following the last lecture. However, students from SEC did not take part in our lectures and thus their knowledge on the topic was proved significantly lower. This confirmed that regular education significantly contributed to a higher level of knowledge obtained by our students (Tab. 3). All respondents showed appropriate knowledge about protection against UVR, including the safe time for natural tanning, protective factor of sunscreens, etc. However, questions related to behavioral skills to UVR among particular respondents from the three universities were much less in proportion to the whole set of questions (Tab. 3). Following this, no differences in the level of protection used against UVR among the students of all three faculties were found. In comparing the years 2003, 2005, and 2008, a significantly lower level of knowledge of our respondents was proved in 2005. The analysis of only JFM and Univ. of Zilina students confirmed this finding (Tab. 4). We attempted to separate groups of students (medical program, nursing program, biomedical engineering program, etc.) in order to determine if some of these student groups contributed to the result. However, similar trends were shown between all respondents and all student subgroups (JFM and Univ. of Zilina) that have been educated in our UVR program (Tab. 4). Thus, an objective reason for the lower level of student knowledge in 2005 remains unknown. We propose multiple reasons for the 2005 result, some of which may be due to the differences and vari-

ability of a high school education, access to public information and/or public education about UVR specifically, and a variable degree of interest that may exist between people in protecting their own health. The low level of knowledge found in the 2005 group urged us to modify the content of the specific UVR subject. We prepared handouts for students on the topic and gave them more time to both gather information and for discussion in order to make our educational method more effective. This arrangement could have contributed to the significant improvement of knowledge of the respondents in 2008 (Tab. 4).

Our findings revealed that there was a very weak correlation between the students' knowledge and the protection against the negative effects of UVR (e.g. lower or equal knowledge found in questions N0 19-24 and the increased protection in 2005 comparing with 2003; similarly, the equal knowledge but increased protection in 2008 in comparison with 2003). However, in our previous study [28], in 168 inhabitants in the areas of Ružomberok and Liptovský Mikuláš who did not receive specific UVR education, more than 16% of inhabitants did not use any kind of UV protection (it was approx. 6.4 fold more than it was found out in our students in 2008). Also the level of general (i.e. elementary, high school or university) education may greatly affect the quality of UV protection used. In this respect our former study [29] concerning UV protection proved that medical staff in hospitals protected themselves in 95% of cases, and the medical doctors in 100% of the cases. Along with this, the present study also confirmed the higher level of knowledge and responsibility by students having high school and university education.

It was interesting to find that few of our respondents regularly visited solaria (in 2008 only 1%, compared to 5% in 2005) and also the number of all students attending the solaria seldom have also decreased during the years of our assessment. This is the most promising trend because in some European countries (particularly Northern Europe) there is still reported a high prevalence of those taking artificial sunbath in solaria [11], [16], [17], [18], [30]. Nonetheless, there is still an increase in the number of solaria per year. For example, in 2008 and 2009, the total number of licensed solaria in Slovakia was 761 and 823, respectively (personal information from Slovak Ministry of Health). It is recommended that solaria be registered, solaria staff provided with professional education, that a systematic control of solaria operation be put in place, and visitors be given instruction that must include information about protection (particularly wearing sunglasses). Tanning per se always implies damage to cellular DNA in the skin with unpredictable long-term consequences. As a precaution, it would be prudent to reduce yearly doses as much as possible. Some epidemiological studies indicate an increased risk of malignant melanoma if a person has more than 10 sessions in a solarium per year e.g. [15].

It is necessary to know skin type in order to make correct calculations regarding reasonable durations of UVR exposure. In the present study, almost 30% of our respondents did not know their skin type nor did they know that there are various skin types to be

considered. Thus, to prevent damage due to UVR exposure, it is essential that students of elementary and high schools, if not the whole population, should be educated on this point.

The present study also showed that males preferred protection through sunglasses and clothes whereas females preferred sunscreens. This is congruent with similar studies performed in Europe [31] and in the USA [32]. It was perturbing to find that almost 52% of our respondents suffered from sunburns in their childhood. This fact clearly indicates a low level of public knowledge about UVR and/or ineffective protections used against UVR for the citizens of Slovakia mostly in the period of 1980–1990. Our study also emphasizes the need for education and the formation of new habits in protecting children and youngsters. Such habits need to be taught, encouraged and strengthened also in their parents, teachers, medical staff, public health professionals and other representatives. Our results support the findings that there must be more knowledge about UVR and an adjustment made to the “outdoor – indoor” exposure to UVR in children [23], [33], [34], in adolescents [35], [36] and in college undergraduates [37]. Only a systematic and long term educational program, along with comprehensive protection policies, will reduce the burdens of diseases resulting from excessive exposure to UVR. Our future studies will continue to target children in elementary schools, as well as young people (15–24 years) of both genders, as they are relatively more careless about exposure to the sun and UVR from solaria.

5. Conclusions

This comprehensive study stressed the importance of a long term and systematic approach to education of college students in Slovakia (future doctors, bioengineers, and nurses) in the specific field of UVR, and the importance in improving the protection mechanisms against the harmful effects of UVR. Our study proved an increased level of protection by university students during the six years of their systematic education. However, the quality of their personal protection does not correlate with the level of their knowledge, which was obtained during their education. It is very probable that UVR will significantly affect the health of the general population in the coming years. Therefore, we propose developing and establishing a reactional approach to UVR exposure. This reactional approach would include a systematic educational program for the general public, including children, young people, undergraduates, their teachers, etc., which will result in improved habits of protection against UVR exposure, along with producing health care professionals who are more aware of UVR, its dangers, and who will encourage prevention.

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