OLSZTYN ECONOMIC JOURNAL
2019, 14(2), 223–236
ISSN 1897-2721 e-ISSN 2083-4675 DOI: 10.31648/oej.3973

ORIGINAL PAPER

Received: 23.10.2018
Revised: 15.02.2019
Published: 28.06.2019

THE CONSEQUENCES OF OZONE LAYER DEPLETION ON THE HEALTH OF POLES – A CASE STUDY OF SKIN MELANOMA

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JEL Classification: I112, I113, Q54.

K e y w o r d s: ozone layer, skin cancer, prevention.

A b s t r a c t

This article presents the results of the observation of cases of skin melanomas in Poland. Dermatologists raise the problem of increased sunlight penetration and the unreasonable use of solar radiation. This causes numerous cases of skin cancer. The aim of the article is to signal the threat posed by the depletion of the ozone layer in Poland. The article uses a research method based on an analysis of statistical data on skin cancers, supported by the available research in this area. Studies show that the incidence of skin cancer in Poland in 2007-2016 nearly doubled. Women are more prone than men to skin neoplasms. The mortality rate due to skin melanoma also increased dramatically. In the article, we point to the need of raising awareness of the hazards, and consider the coverage of treatment costs by life insurance as one of the options to protect the health of insured persons. We also raise the problem of prophylaxis on the basis of sunscreen cosmetic products.

How to cite: Wieteska, S., & Jabłońska, M. (2019). The Consequences of Ozone Layer Depletion on the Health of Poles – a Case Study of Skin Melanoma. *Olsztyn Economic Journal*, *14*(2), 223-236. https://doi.org/10.31648/oej.3973.

KONSEKWENCJE WPŁYWU ZMNIEJSZANIA SIĘ WARSTWY OZONOWEJ NA ZDROWIE POLAKÓW NA PRZYKŁADZIE ZACHOROWAŃ NA CZERNIAKA SKÓRY

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Słowa kluczowe: warstwa ozonowa, zachorowania na nowotwory skóry, prewencja.

A b s t r a k t

Przedmiotem artykułu jest obserwacja zachorowań na czerniaki skóry na terenie Polski. W opinii lekarzy dermatologów dostrzega się problem wzmożonego oddziaływania promieni słonecznych, a także nierozsądnego z nich korzystania. Skutkiem tego są liczne zachorowania na nowotwory skóry. Celem artykułu jest zasygnalizowanie zagrożenia, jakie niesie za sobą zmniejszanie się warstwy ozonowej na terenie Polski. W artykule zastosowano metodę badania polegającą na analizie danych statystycznych zachorowań na nowotwory skóry, wskazanie na dotychczasowe dostępne wyniki badań w tym zakresie. Z przeprowadzonych badań wynika, że w Polsce w latach 2007-2016 nastąpił prawie dwukrotny wzrost zachorowań na nowotwory skóry. Bardziej podatne na zachorowania są kobiety niż mężczyźni. Również radykalnie wzrasta liczba zgonów na czerniaka skóry. W artykule wskazano na konieczność podnoszenia świadomości zagrożeń oraz objęcia kosztów zachorowań przez ubezpieczenia na życie jako jedną z opcji ochrony zdrowia ubezpieczonych. Podniesiono także problem działalności prewencyjnej na gruncie produktów kosmetycznych promienioochronnych.

Introduction

Global warming is caused by several factors, including the emission of greenhouse gases to the atmosphere. A direct consequence of these phenomena is the depletion of the ozone layer. A thinner ozone layer means that UV radiation penetrates to the Earth's surface more intensively. This in turn causes numerous effects on humans, plants and animals.

The aim of this article has been to signal the risk caused by the diminishing ozone layer to people living on the territory of Poland. The hypothesis is that the depletion of the ozone layer contributes to a higher incidence of skin cancers, especially melanoma.

The research method applied in this study consists of an analysis of statistical data, where results of the most important studies on the ozone layer conducted at different research centres have been taken into consideration. The article also draws on the literature specified in the attached list of references. The article is addressed to actuarial and risk assessment departments and to persons dealing with health and personal insurance policies.

Ozone, the ozone layer and its properties

Ozone is an allotrope of oxygen. It is a colourless gas with a density higher than that of air. About 90% of ozone in the atmosphere is at the altitude of 10-50 km, where it forms the so-called ozone layer. Ozone is a non-flammable gas, but it has an ability to sustain a combustion processes (the same as oxygen), and it dissolves well in water. In addition, it has a characteristic smell as in the air after a storm, caused by its formation. For example, it is formed from the high temperatures of a lightning strike during thunder storms (Dobrzański & Opaliński, 2009).

The ozonosphere – 'the ozone layer, a layer of the Earth's atmosphere with an elevated content of ozone; it lies in the stratosphere at 15-50 km above the Earth's surface, reaching the maximum ozone concentration at an altitude of 20-30 km' (*Encyklopedia PWN*, online). This layer acts like a filter for the Earth, absorbing much of the solar radiation within the ultraviolet band. It plays a very important role in the atmosphere because it protects our globe from biologically harmful ultraviolet radiation, and a shortage of ozone gives rise to the formation of the so-called ozone hole.

An ozone hole is a considerable decrease in the concentration of ozone in the Earth's atmosphere (up to 90% of the average concentration) (*Encyklopedia PWN*, online).

UV radiation is ultraviolet solar radiation reaching the upper strata of the Earth's atmosphere. It is comprised of optic radiation in the range of wavelengths between 180 and 400 nm. It is divided into three bands of different wavelengths; ultraviolet A (UV-A 320-400 nm), ultraviolet B (UV-B 280-320 nm) and ultraviolet C (UV-C 180-280 nm) (Skórka, 2000, p. 7).

Freons are mainly used as a cooling factor in refrigerators and air conditioners, and (less and less often nowadays) as a carrier gas in aerosol cans.

Halons are non-flammable gases or liquids. They do not conduct electric current, do not cause corrosion, and are used for firefighting (halon extinguishers contain pressurised halons); the most popular halons are bromotrifluoromethane CF3Br – halon 1301, bromochlorodifluoromethane CF2ClBr – halon 1211, and dibromotetrafluoroethane C2F4Br2 – halon 2402. The use of halons is being reduced because it is thought that these compounds, in the same way as freons, have a damaging effect on the ozonosphere (*Encyklopedia PWN*, online).

Greenhouse gases are components of the atmosphere, originating from both natural and man-made sources, which absorb and emit radiation of specific wavelengths within the spectrum of thermal infrared radiation emitted by the Earth's surface, the atmosphere itself and clouds. The principal greenhouse gases in the Earth's atmosphere are: water vapour (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4) and ozone (O_3).

There are other greenhouse gases present in the atmosphere that are exclusively of anthropogenic sources, such as halohydrocarbons and other substances containing chlorine and bromine (Baede, 2009, p. 79).

Ozone levels have been measured for years in Poland, namely since 1963. The measurements have been taken in the near-earth atmospheric layer (Jarosławski, 1993, p. 255-259) at the Polish Academy of Sciences, specifically at the PAN Geophysical Observatory in Bielsk[1]. In 1979, the Centre of Aerology at the Institute of Meteorology and Water Management in Legionowo undertook to monitor ozone levels, too. Globally, the worst loss in the ozone layer (ca 60%), which was named the Antarctic ozone hole, was observed over the South Pole (Lityńska, 1992, p. 5).

Studies have pointed to the cyclic occurrence of ozone depletion over a one year period. The highest losses are recorded in summer, with the lowest losses occurring in autumn and winter. Also, the time of day has an effect on the amount of ozone (Tab. 1).

Table 1

Total content of ozone in the atmosphere

Years	01	02	03	04	05	06	07	08	09	10	11	12	Annual average
	in Dobson units [D]*												
	monthly average												
1970	334	442	420	417	378	373	345	328	319	305	305	320	357
1980	341	358	402	425	404	374	373	331	305	296	298	326	353
1990	314	328	350	383	368	356	–	–	320	276	296	307	330
2000	314	341	346	340	335	324	328	298	286	261	258	306	311
2010	343	377	395	396	367	346	333	316	316	300	300	338	344
2013	348	383	392	373	350	347	344	317	305	278	281	279	333

* Dobson units D = 1 millicent atmosphere, a unit corresponding to the pressure produced by the mass of ozone filling 1 cm3 under standard conditions, i.e. the pressure of 1 atmosphere and temperature of 0ºC.
Source: Polish Main Statistical Office GUS. Tab. 32(158).

In Poland, the highest losses in the ozone layer were recorded on 28 January 1992, at about 193 D (Dobson units) (Degórska, 1982, p. 12, 13). Unfortunately, the variability in the ozone layer's thickness for the geographical latitude at which Poland lies lacks clarification.

[1] Ozone is measured in Dobson units. Dobson unit (du) = 1 millicent atmosphere, a unit corresponding to the pressure exerted by the mass of ozone occupying 1 cm^3 under standard conditions, i.e. the pressure of 1 atmosphere and temperature of 0ºC. The name of the unit comes from the name of G.M.B. Dobson, the inventor of the spectrophotometer used for measurement of ozone (Kożuchowski, 2018).

Observations of the ozone layer in Poland (the station in Legionowo) in 1992 (Lityńska & Kois, p. 9, 10) showed that:

– there were strong fluctuations in the atmosphere at the altitude of 10-18 km, which distorted the normal course of ozone content variation. The greatest anomalies occurred on the following days: 9 January, 10 February, 5 and 9 March, and 5 and 7 August of that year; the deficit of ozone was estimated at 70-80%;

– the UV radiation intensity at the Polish latitude was 10-fold higher in summer than in winter;

– fluctuations in the ozone layer in the stratosphere at 18-30 km in height were small.

These fluctuations and anomalies can be called by convention 'ozone mini-holes'[2].

In 1979, the ozone hole covered a small area above Antarctica. Until 1992, it grew larger, and became equal to the size of the entire Antarctic (Lityńska & Latosińska, 2000, p. 109).

Causes of the depletion of the ozone layer and methods for controlling this process

The disappearance of the ozone layer increases the risk of exposing the entire biosphere to ultraviolet (UV) radiation. The negative consequences of more intensive ultraviolet (UV) radiation affect agriculture, fisheries, forestry and human health.

The ozone layer is depleted due to the use of freons[3], the emission of greenhouse gases, flights of aeroplanes, or the production of chloro derivatives of hydrocarbons.

Research concerning ozone found in the atmosphere has been conducted for many years (Dziewulska-Łosiowa, 1989). It has been hypothesised that the ozone layer is affected by: the sun's activity, dynamic processes in the atmosphere, and anthropogenic events, such as nuclear explosions, carbon dioxide generation, the application of artificial fertilizers and the production of chloro derivatives of hydrocarbons.

Scientific studies on the ozone layer have proven that the condition of this layer depends on an 11-year-long cycle in the Sun's activity. It is claimed that

[2] The ozone hole was detected around 1985. In 1987, 37 states signed the Montreal Protocol, which envisaged the reduction in freons by 50% until the year 2000. At the moment, there are 150 states which have signed the Montreal Protocol.

[3] Freons – 'saturated fluoroorganic compounds, fluoride derivatives of methane and ethane, also containing chlorine and less often bromide.'Freons are non-flammable liquids with a low boiling point and are durable molecules; despite having favourable properties, freons are now used very sparingly because once these compounds enter the ozonosphere they contribute to the expansion of the ozone hole (*Encyklopedia PWN*, online).

the durability of the ozone layer also depends on the amounts of gases emitted by a series of volcanic eruptions (Dziewulska-Łosiowa, 1989).

Forecasts on the degradation of the stratospheric ozone implicate an unfavourable future progress of these tendencies (mainly due to chlorofluorocarbons), despite the numerous measures undertaken.

On 28 September 1995, the Foundation for the Protection of the Ozone Layer was established. The foundation plays a major role in the performance of Poland's international obligations concerning environmental protection. The foundation's mission is to protect the ozone layer by organising a national network of recovery and regeneration of cooling factors (Dobrzyński, 2007, p. 9-11). In addition, proposals were submitted for the certification of refrigerating and air-conditioning appliances, and the personnel serving devices which use gases that deplete the ozone layer (Kurcz & Steindel, 2009, p. 6-9).

Agenda 21, in the section entitled Conservation and Management of Resources for Development, points to the fact that air conservation, including the protection of the ozone layer, is one of the priorities. The protection of the ozone layer is an international responsibility. Numerous actions have been implemented (e.g. studies on the ozone layer, monitoring, improvement of legal regulations) in order to protect this layer (Górski, 1997, p. 79-90). The Montreal Protocol introduces the concept of 'controlled substances'. This concept embraces 'new substances, pure, mixed or isomers, in containers for transport or storage.' The Montreal Protocol, in its part regarding the ozone layer, served as the basis for developing the European Union regulations, which are binding for all EU member states.

Pursuant to Regulation (EC) no 2037/2000 of the European Parliament and of the Council of 29 June 2000, on substances that deplete the ozone layer, all member states are obliged to report to the European Commission the information about (Purski, 2007, p. 13, 14):

– the use of methyl bromide (in agriculture),
– the use of halons in critical situations (in Poland, to extinguish fires),
– replacement of halons by other substances, less harmful to the environment,
– controlling illegal trade,
– the recovery of used controlled substances.

In 2001, a law concerning the handling of ozone-depleting substances became effective (Act of 2 March 2001 on Handling Substances that Deplete the Ozone Layer; Journal of Law No 52, item 537). This law was passed in response to the obligations specified in the Vienna Convention with respect to the protection of the ozone layer, which was signed in Vienna on 22 March 1985 (Journal of Law of 1992, No 98, item 488), and in the Montreal Protocol on substances that deplete the ozone layer, signed on 16 September 1987 (Journal of Law of 1992, No 98, items 490 and 491). The Polish law regulates:

– production of ozone-depleting substances,

– trade (purchase and sale) abroad of substances that deplete the ozone layer and products that contain these substances,

– the introduction of substances that deplete the ozone layer to the domestic trade and use of such substances in business enterprises.

The attachments to the act contain a list of ozone-depleting substances. Several important decisions regarding the protection of the ozone layer were made in 2004.

1. The Polish law on substances that deplete the ozone layer was amended (Act of 20 April 2004 on Substances that Deplete the Ozone Layer; Journal of Law No 121, item 1263 as amended in 2004).

2. Guidelines for the education of personnel handling ozone-depleting substances, with templates of certificates confirming qualifications, were issued (Regulation of the Minister of Economy and Labour, of 16 August 2004, on curricula, conducting examinations and a certificate template in the field of controlled substances (Journal of Law of 2004, No 195, item 2009 as amended). The regulation specifies, *inter alia*, the curricula of introductory and supplementary courses concerning controlled substances. In the same year, another regulation concerning examination of the leakproofness of appliances containing controlled substances became effective in the same year (Regulation of the Minister of Economy and Labour of 16 August 2004 on examination of the leakproofness of appliances and installations containing controlled substances (Journal of Law of 2004, No 195, item 2008 as amended). This regulation imposes a requirement on the users to inspect the leakproofness of installations and devices by visual inspection, inspecting for signs of corrosion, detecting any leaks, checking the documents.

3. In the same year, the Regulation of the Minister concerning the register of controlled substances was passed (Regulation of the Minister of Economy and Labour of 11 August 2004 on the accounting of controlled substances (Journal of Law No 185, item 1910 as amended).

This document specifies, *inter alia*:

– how controlled substances should be registered in a ledger,

– procedures for the transmission of the data contained in ledgers of controlled substances,

– templates of the forms to register controlled substances.

In 2004, the Council of Ministers approved a strategy for the management of ozone layer depleting substances, including the strategy of withdrawing anti-asthma aerosols. The strategy also envisaged allocating about 36 million Polish zloty from the funds of the National Fund for Protection of the Environment and Water Management to financing the recovery and recycling of the above substances (*Prawna ochrona warstwy ozonowej*, 2004, p. 6).

The law that has been binding in Poland since 10 July 2015 is the Act on Substances Depleting Ozone and Some Fluorinated Greenhouse Gases,

from 15 May 2015 (Journal of Law of 2015, item 881), and after amendments the consolidated text of 6 November 2018 (Journal of Law of 2018, item 222).

A strategy was developed to phase out halons from fire-fighting devices. The strategy set out deadlines, measures, training, and restrictions on the use of halons; this is another step that allows Poland to fulfill its international obligations (Kuncerowicz-Polak & Purski, 2000, p. 3, 4).

Health hazards due to the depletion of the ozone layer

Solar radiation, especially UV-β, affects the human skin, inducing its greater pigmentation. Among the diseases caused by UV rays, there are: solar urticaria, malignant melanoma (neoplasm), dermatomyositis, and other ailments effected by drugs which elevate the sensitivity to UV radiation. UV radiation affects the blood system in humans (Latanowicz & Latosińska, 2000, p. 99-102).

It has also been found that UV rays activate certain infectious diseases, e.g. caused by herpes or human papilloma virus, resulting in a more severe course of the illness.

Solar radiation causes damage to the immune system, especially to the skin, accelerating its ageing. Excessive exposure of the human body to solar rays, especially UV radiation, may lead to malignant skin cancers[4].

It is believed that the UV type ß radiation, that is rays within the wavelength range of 290-320 nm, play a major role in the aetiology of skin cancer.

The literature distinguishes the following types of skin cancer (Ciszewska, 2000, p. 65-68):

– basal cell carcinoma (BCC),

– squamous cell carcinoma (SCC). BCC is more frequent than SCC,

– non-melanoma skin cancer (NMSC). The incidence of NMSC varies and ranges between: $0.5 \cdot 10^{-5}$ in Spain, $213.2 \cdot 10^{-5}$ in Australia and $0.2 \cdot 10^{-5}$ in Slovenia. In Poland, between 1988-97, the incidence was from $9.5 \cdot 10^{-5}$ to $11.1 \cdot 10^{-5}$ among men, and from $6.5 \cdot 10^{-5}$ to $7.9 \cdot 10^{-5}$ among women.

Malignant melanoma (melanoma malignum MM) originates mainly from melanocytes localised within the basal layer of the epithelium.

Studies suggest various classifications of MM. Moreover, the incidence of MM in different states and among different human races varies (Bień, 2005, p. 113-120). Factors which favour its development are (Pastuszka, 2010, p. 58-62):

– exposure to sunlight,

– occurrence of melanoma in the family (genetic factors),

[4] The impact of ozone degradation on the increasing incidence of skin cancer is difficult to assess because of a great number of factors involved (e.g. human behaviour patterns, environmental factors) that can occur simultaneously. Mathematical models have been used as well (Kaczmarek *et al*., 1998, p. 313-323).

– immunological disorders,
– presence of viruses,
– influence of hormones.

The incidence of melanoma cases in Poland can be seen in Table 2.

Table 2

Cases of melanoma in Poland in 2007–2014

Specification / Year	Total	Men	Women	Total number of deaths
2007	8,871	4,210	4,661	47*
2011	10,965	5,229	5,736	86
2012	11,853	5,625	6,228	145
2013	12,598	5,987	6,611	171
2014	14,081	6,675	7,406	·

* 2006 r.
· no data
Source: the Statistical Yearbook by the Polish Central Statistical Office (GUS). Table. Incidence of malignant neoplasms.

These data indicate that there was a dynamic growth in 2007-2014 in the rate of skin melanoma, by about 58.7%. The number of deaths due to this cancer increased as well. Notably, women suffer from melanoma more often than men.

Dependencies between skin cancer cases, gender and age are presented in Table 3.

Table 3

Cases of melanoma and other skin cancers

Age	Men					Women				
	2007	2011	2012	2013	2014	2007	2011	2012	2013	2014
0–9	-	-	-	-	1	-	1	-	1	1
10–19	5	5	8	3	10	8	3	13	7	5
20–29	37	53	63	52	66	58	90	86	111	106
30–39	117	128	140	183	166	145	194	231	232	232
40–49	332	277	322	339	364	389	421	410	375	413
50–59	735	864	913	954	948	758	943	958	1,003	1,031
60–69	1,049	1,261	1,338	1,408	1,614	956	1,150	1,245	1,336	1,452
70–79	1,329	1,720	1,818	1,886	2,059	1,482	1,661	1,841	1,976	2,205
80 years and more	606	921	1,023	1,162	1,447	865	1,273	1,444	1,570	1,961

Source: the author, based on the Demographic Yearbook by the Polish Central Statistical Office (GUS) for the years 2008–2014.

These data prove that women contract skin cancers more often than man. The persons at the highest risk are above 50 years of age.

Uncontrolled exposure of the human body to the sun's rays can cause solar urticaria (Peyron *et al*., 1999, p. 347-350). Another common health problem is uveitis. The eye lens absorbing large amounts of UV rays can become turbid. This is a problem commonly observed on snowy mountain slopes.

An index of natural UV radiation serving as a measure of the negative influence on the human skin has been developed[5]. Thus, the higher the UV index, the higher the risk of acquiring a skin disease.

A wide-scale investigation into the effects of UV rays on the human skin has implicated a number of factors responsible for skin cancers. The problem appears all across Europe (Kaczmarek *et al*., 1998, p. 313-348), and the differentiating factors are the patient's age, sex, geographical location, season of the year, and others.

A study conducted on 251 patients in the Oncological Centre of Warmia and Mazury in Olsztyn revealed that (Kuciel-Lisieska *et al*., 2011, p. 344-348):

– melanoma is most often localised in the area of the upper limbs, head and neck,

– melanoma of the digestive system was diagnosed in 8 patients,

– the localisation of melanoma depends on the patient's age and sex, but not on his or her place of residence,

– among the analysed group, about 34.7% of the patients were in stage IV of the cancer.

This last finding indicates that the general population are largely unaware of the risk, hence about 25% of MM are localised on the head and the neck.

UV radiation has an additional, adverse consequence on (Latanowicz, & Latosińska, 2012, p. 205-215):

– blood (UV radiation inhibits the activity of Langerhaus cells, which may lead to the development of a skin neoplasm);

– damage to eyes (the intensity of radiation depends on the angle at which the sunrays fall). The following eye structures are at the highest risk: conjunctiva, cornea, lens, retina;

– infectious diseases, by activating such viruses as HIV-1, AIDS;

[5] The UV index is an international measure of the intensity of the Sun's ultraviolet radiation on a given day and in a given site. It allows us to compare the consequences of the harmful impact of UV radiation on the skin, and to this end a weighted function is applied which is derived from the so called McKinlay – Diffey spectrum. It is assumed in this function that radiation of the wavelength 290 nm is three-fold more harmful than that of the wavelength 350 nm and five-fold worse than that of the wavelength 400 nm. These units can be referred to as statistical weights. All weighted results are added up or integrated, which leads to the calculation of the UV index value. However, this is not the final result as that must be corrected considering the cloud cover and radiation angle.

– inanimate matter, e.g. a negative effect on medications (photodegradation affects liquid and solid substances, e.g. tablets). In addition, UV rays cause isomerisation in fatty acids.

Studies on the effect of UV radiation on the human skin have shown that some of these rays are deflected (Cader *et al.*, 1995, p. 33-38). The ability of the human skin to deflect UV rays grows as the wavelength decreases.

Some researchers claim that the depletion of the ozone layer by 2% over the past 20 years has led to an increase in the amount of UVB rays reaching the Earth, which in turn contributed to an increase in the incidence of skin cancer cases (Ciszewska, 2000, p. 65-68).

Data collated in Table 2 indicate that a further increase in the incidence of skin diseases, including melanoma, can continue until the year 2020.

Health insurance and prevention aspects

A nearly double rise in the rate of skin diseases among men and women (Tab. 2) implicates a serious threat to the health of the Polish population. A higher incidence of illnesses entails an increase in the treatment costs, which are borne by the population. Noteworthy is the fact that this health-risk situation is complicated by the long latent phase of skin cancer (5–6 years), which has a significant influence on the number of cases detected in Poland. This is known in the insurance business as a trigger, i.e. we do not know when we will become ill, when the illness will manifest itself, when we should present at the doctor's, how long it needs to be treated and, consequently, what costs it will incur. In the light of the above remark (and earlier considerations), skin cancer cases show the characteristics of randomness conditioned by excessive exposure to UV radiation, regardless of the spatial location. It should also be mentioned that skin neoplasms require expensive and specialist treatment. Hence, to relieve, at least in part, the costs of such therapy an insurance method can be suggested where these costs are spread over a larger population via an established insurance contribution fund. The data (Tab. 2) show that the frequency of skin cancer is around $4.85 \cdot 10^{-4}$. This would translate to a small contribution per capita, and therefore increasing insurance contributions may be possible, for instance as one of the options in life insurance policies.

It is known that there are insurance products providing clients with a long-term (sometimes indefinite) cover. The insurance company should specify very precisely, in the general terms of life insurance policies, the scope of their responsibilities, according to their risk assessment and other parameters of a given policy.

Both the literature connected with insurance and the insurance products use the term 'severe illnesses', which most often refers to malignant neoplasms (Kolbarczyk, 2015, p. 47, 48). This term also covers melanoma.

As these are serious illnesses, it becomes necessary to undertake certain prophylactic measures, besides insurance.

Since the late 20th century, great progress has been achieved in the protection from UV radiation with photostable filters and broad-band UV filters (Osterwalder *et al.*, 2014, p. 42-46). Such cosmetic products are now widely available. The various labels they are given have encouraged efforts undertaken to coordinate the labeling.

Other recommended measures are:

– to raise the awareness of the general public about the risk of skin cancer, to make dermocosmetics protecting the skin from UV radiation more popular, and especially to recommend using cosmetics that contain anti-radiation substances;

– to search for ways to prevent these diseases;

– to develop early warning systems against the risk of developing a skin cancer.

The sunscreen attribute of cosmetics declared by their producers, in line with the European regulations and the Polish law, requires them to document this property based on reliable and repeatable determination methods. Attention is drawn to the Sun Protection Factor (SPF), which defines the effectiveness of sunscreen cosmetics and enables consumers to choose the most suitable product. The SPF informs 'how much longer the exposure to the sun (after applying the cosmetic) becomes, and after what length of time the skin erythyma is comparable to the one observed on the skin not protected with this cosmetic'.

It is also worth considering a solution where the National Health Fund (the NFZ in Poland) would co-finance contributions paid to private insurance policies. It is also necessary to monitor the quality of life of patients who have recovered from melanoma.

It is necessary to implement prophylactic measures, which should involve all people over 60 years of age (Tab. 3). As skin cancers are difficult to treat, we cannot exclude a possibility of setting up regional centers for therapy of skin neoplasms, which would coordinate the procedures in cases of such diseases, should their prevalence increase.

Conclusions

This brief analysis of the depletion of the ozone layer confirms that this problem also affects Poland's territory. Causes of the loss of ozone in the atmosphere are numerous. The conclusions arising from the above considerations are as follows:

– as the ozone layer undergoes depletion, the incidence of skin cancers increases;

– an increase in the cases of melanoma will entail an increase in the costs of treatment;

– it is necessary to provide an insurance cover for this neoplasm in health and life insurance policies.

The limited length of this article prevented an exhaustive presentation of this problem. Instead, it was only possible to highlight the main issues. Further studies are needed to examine the costs of treatment in the case of skin cancer, so as to determine a potential rise in health policy contributions.

Translated by Jolanta Idźkowska
Proofreading by Michael Thoene

References

Bień, S. (2005). Czerniak złośliwy w obrębie głowy i szyi. *Otolaryngologia*, *4*, 113-120.

Cader, A., Matusiak M., Janowski, J., Kajdos, Z. & Kaczmarek, J. (1995). Ocena współczynnika odbicia promieniowania ultrafioletowego dla skóry ludzkiej. *Medycyna Pracy*, *1*, 33-38.

Ciszewska, M. (2000). Środowiskowe uwarunkowania raka skóry. *Medycyna Środowiskowa*, *3*, 65-68.

Degórska, M., & Rojewska-Więch, B. (1982). Dziura ozonowa – zagrożenie czy przestroga? *Przyroda Polska*, *6*, 12-13.

Dobrzyński M. (2007). Fundacja Ochrony Warstwy Ozonowej PROZON. *Chłodnictwo*, *1-2*, 9-11.

Dziewulska-Łosiowa, A. (1989). *Ozon w atmosferze*. Warszawa: PWN.

Górski, M. (1997). Prawo międzynarodowe a ochrona warstwy ozonowej. *Studia Prawno-Ekonomiczne*, *LV*, 79-90.

Jarosławski, J. (1993). Pomiary zawartości ozonu w przyziemnej warstwie atmosfery w Bielsku. *Przegląd Geofizyczny*, *3-4*, 255-259.

Kaczmarek, J., Jankowski, J., & Cader, A. (1998). Wzrost zachorowań na schorzenia skóry uwarunkowane oddziaływaniem promieniowania ultrafioletowego. Prognoza dla Polski. *Medycyna Pracy*, *4*, 313-323.

Kolbarczyk, W.P. (2000). Poważne choroby. *Miesięcznik Ubezpieczeniowy*, styczeń, 47-48.

Kuncerowicz-Polak, B., & Purski, R. (2000). Wycofanie halonów a ochrona przeciwpożarowa. *Przegląd Pożarniczy*, *10*, 3-4.

Kurcz, L., & Steindel, M. (2009). Fluorowane gazy cieplarniane i substancje zubożające warstwę ozonową. Certyfikacja, ocena kompetencji i szkolenia. Część I. Certyfikacja personelu i przedsiębiorstw. *Chłodnictwo*, *1-2*, 6-9.

Kuciel-Lisieska, G., Godlewski, J., Lisiecka-Tyszko, S., Lachowski, A., & Kaczmarska, G. (2011). Analiza danych epidemiologicznych chorych na czerniaka leczonych w latach 1996-2007 w Warmińsko Mazurskim Centrum Onkologii w Olsztynie. *Nowotwory. Journal of Onkology*, *4*, 344-348.

Latanowicz, L., & Latosińska J.N. (2000). *Promieniowanie ultrafioletowe a środowisko*. Zielona Góra: Wyższa Szkoła Pedagogiczna im. T. Kotarbińskiego, p. 99-102.

Latanowicz, L., & Latosińska, J.N. (2012). *Promieniowanie UV w środowisku*. Warszawa: Wydawnictwo Naukowe PWN, p. 205-215.

Lityńska, Z. (1992). Problem zaniku warstwy ozonowej. *Gazeta Obserwatora IMGW*, *1-3*, 5.

Pastuszka, M. (2010). Zwiększone ryzyko wystąpienia pierwotnych nowotworów złośliwych (skóry i narządów wewnętrznych) u pacjentów z czerniakiem lub rakiem skóry w wywiadzie. *Dermatologia Praktyczna*, *3*, 58-62.

Peyron, J.L., Raison-Payron, N., Meynadier, I., Moyal, D., Rougier, A., & Hourseau, C. (1999). Zapobieganie pokrzywce świetlnej przy pomocy ekranów słonecznych o szerokim spektrum

i określenie wskaźnika protekcji pokrzywki świetlnej (Solar Urticaria Protection Factor – SUPF). *Postępy Dermatologii*, *XVI*, 347-350.

Prawna ochrona warstwy ozonowej. (2004). *Gazeta Obserwatora IMGW*, *4*, 6.

Purski, R. (2005). Diabeł a dziura ozonowa. *Gazeta Obserwatora IMGW*, *6*, 4-6.

Purski, R. (2007). Ochrona warstwy ozonowej. *Środowisko*, *11*, 13, 14.

Stan warstwy ozonowej nad Polską. (1993). *Gazeta Obserwatora IMGW*, *2-3*, 9, 10.

Encyklopedia PWN. Retrieved from https://encyklopedia.pwn.pl/szukaj/ozonosfera.html.

Rozporządzenie Ministra Gospodarki i Pracy z 16 sierpnia 2004 r. w sprawie programów kursów, przeprowadzania egzaminów oraz wzoru świadectwa kwalifikacji w zakresie substancji kontrolowanych. DzU z 2004 r., nr 195, poz. 2009 ze zm.

Rozporządzenie Ministra Gospodarki i Pracy z 16 sierpnia 2004 r. w sprawie kontroli szczelności urządzeń i instalacji zawierających substancje kontrolowane. DzU z 2004 r., nr 195, poz. 2008 ze zm.

Ustawa z 2 marca 2001 r. o postępowaniu z substancjami zubożającymi warstwę ozonową. DzU nr 52, poz. 537.

Ustawa z 20 kwietnia 2004 r. o substancjach zubożających warstwę ozonową. DzU nr 121, poz. 1263 ze zm.