

Malignant skin tumors in individuals with albinism in African countries as a pressing medical and social issue: current data on the prevalence, risk factors, prevention, and treatment

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Abstract

Oculocutaneous albinism (OCA), the hereditary disorder associated with the melanin synthesis impairment and manifested by hypopigmentation of the skin, eyes, and hair, is found worldwide, but is especially widely spread across the indigenous population of African countries, to the south of the Sahara. Due to melanin deficiency or complete lack of melanin in the skin of individuals with OCA, its natural protection against solar ultraviolet (UV) radiation is reduced, which makes keratinocytes particularly susceptible to mutagenic effects of chronic UV exposure and increases the risk of photodamage, precancerous lesions, and skin cancer. For many people with albinism in African countries, prevention of the solar UV radiation exposure-induced cutaneous lesions and the timely diagnosis and treatment of skin tumors are complicated by socio-economic factors. Black albinos in sub-Saharan Africa have the risk of non-melanoma skin cancer 1000 times higher, than the general population. Squamous cell carcinoma predominates in the structure of tumors, basal cell carcinoma ranks second, and the recorded cases of melanoma account for less than 1% — in contrast to the general population, where basal cell carcinoma is detected more often. In Africans with albinism, the average age of developing skin tumors is 20–30 years, which also makes them significantly different from the population of other geographic zones. The review considers the key aspects of the issue, including risk factors of malignant skin neoplasms, measures for prevention, early diagnosis, and treatment; current international epidemiological data are provided that suggest an extremely unfavorable situation concerning morbidity and mortality among this category of patients.

Keywords: oculocutaneous albinism, albinos of Africa, squamous cell carcinoma, basal cell carcinoma, melanoma, photoprotection, skin tumor prevention.

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Злокачественные опухоли кожи у лиц с альбинизмом в странах Африки как актуальная медико-социальная проблема: современные данные о распространенности, факторах риска, профилактике и лечении

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Аннотация

Глазокожный альбинизм (ГКА) — наследственное заболевание, связанное с нарушением синтеза меланина и проявляющееся гипопигментацией кожи, глаз и волос, встречается во всем мире, однако особенно широко распространено среди коренного населения стран Африки к югу от Сахары. Вследствие дефицита или полного отсутствия меланина в коже людей с ГКА снижается ее естественная защита от солнечного ультрафиолетового (УФ) излучения, что делает кератиноциты особенно восприимчивыми к мутагенному воздействию хронического УФ-облучения и повышает риск фотоповреждений, предраковых поражений и рака кожи. Для многих людей с альбинизмом в странах Африки профилактика кожных повреждений, обусловленных воздействием солнечного УФ-излучения, а также своевременная диагностика и лечение опухолей кожи осложняются социально-экономическими факторами. Риск развития немеланомного рака кожи у негроидных альбиносов в странах Африки к югу от Сахары примерно в 1 тыс. раз выше, чем в общей популяции. В структуре опухолей преобладает плоскоклеточная карцинома, на втором месте — базальноклеточная карцинома, а случаев меланомы регистрируется менее 1% — в отличие от общей популяции, где чаще встречается базалиома. Средний возраст развития опухолей кожи у африканцев с альбинизмом составляет всего 20–30 лет, что также значительно отличается от населения других географических зон. В настоящем обзоре рассматриваются ключевые аспекты данной проблемы, включая факторы риска развития злокачественных новообразований кожи, меры профилактики, ранней диагностики и лечения, а также представлены современные международные эпидемиологические данные, свидетельствующие о крайне неблагоприятной ситуации в отношении заболеваемости и смертности среди данной категории пациентов.

Ключевые слова: глазокожный альбинизм, альбиносы Африки, плоскоклеточный рак, базальноклеточный рак, меланома, фотозащита, профилактика опухолей кожи.

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Background

The term "albinism" encompasses a clinically and genetically heterogeneous group of rare hereditary disorders caused by mutations in the genes that regulate the melanin pigment biosynthesis, as well as the melanosome formation, maturation, and transport. Currently, three main nosological forms of albinism are distinguished:

- oculocutaneous albinism (OCA);
- ocular albinism;
- syndromic albinism, including, in particular, the Hermansky–Pudlak syndrome and the Chédiak–Higashi syndrome.

OCA represents the most prevalent form diagnosed in about 1 individual out of 17,000 all over the world, regardless of the gender or race [1]. The prevalence of OCA varies considerably depending on the geographic region and the population's ethnicity. Some of the highest prevalence rates of OCA have been recorded in sub-Saharan African countries (sub-Saharan Africa): between 1 case per 15,000 population and 1 case per 5000 population [2]. According to a systematic review conducted by J. Kromberg et al. (2023), the average OCA prevalence in four African countries with large population studies amounted to 1 case per 4264 population, varying between 1 case per 7900 population and 1 case per 1755 population [3]. It should be noted that some isolated ethnic populations, such as the Tonga tribe in Zimbabwe, show the increased OCA: from 1 case per 1000 population, which is four times higher than the average for Zimbabwe. The similarly high prevalence rates were reported for certain ethnic groups of three countries, such as Nigeria, Zimbabwe, and South Africa: 1:4794 (Xhosa), 1:4459 (Zulus), 1:2716 (Swazi), 1:3481 (Tswana), and 1:2041 (Southern Sotho). Furthermore, the nationwide prevalence rate of OCA, which amounted to 1:3900, was calculated for South Africa based on the studies of ethnic groups in Soweto and Johannesburg [2].

OCA type 2 (tyrosinase-positive oculocutaneous albinism), resulting from mutations in the OCA2 gene playing the key role in regulation of pH of melanosomes and eumelanin biogenesis, is the most prevalent in sub-Saharan African countries [4, 5]. According to the population genetic study, the OCA type 2 prevalence among representatives of the Vhavenda ethnic group living in the north of South Africa was 1:1970 (based on the data of birth records from local hospitals), 1:2239 (in rural villages), and 1:832 (in the Vhatavhatsindi clan) [6]. The above epidemiological data show a relative error, but suggest that OCA is a prevalent disorder among local populations of sub-Saharan African countries. For comparison, the disease prevalence in Europe (based on the data on three countries) is considerably lower: between 1 case per 15,000 population and 1 case per 10,000 population [3]. The actual values are likely to be

higher, as mild cases of the disease often go undiagnosed, and there are few large-scale population-based studies.

Patients with albinism show the total or partial melanin loss resulting from genetic defects. This results in the considerably lower natural skin protection against solar ultraviolet (UV) radiation, increasing the keratinocyte susceptibility to mutagenic effects of chronic solar UV radiation exposure and the risk of photodamage, precancerous lesions, and skin cancer [7, 8]. It is well known that the risk of photodamage is especially high in countries with intense insolation, including sub-Saharan African countries, where young people develop skin changes, and skin cancer remains one of the main causes of premature mortality among people with albinism [2, 9–11]. It is noteworthy that skin cancer in Black albinos living in Africa results from the combined interaction of biological, ecological, and socio-economic factors. The current situation raises serious concerns regarding the availability of preventive measures, early diagnosis, and timely treatment of skin cancer in this population.

The review provides the current international epidemiological data highlighting the critical situation in many African countries, where the long-term solar UV radiation exposure and socio-economic factors make skin cancer one of the leading causes of premature mortality among people with albinism. Furthermore, the key risk factors and approaches to the prevention, early diagnosis, and treatment of skin cancer in this population are analyzed.

Albinism as a medical and social problem in African countries

Clinically, patients with albinism show hypopigmentation of the skin, hair, and eyes. Ophthalmological manifestations include hypopigmentation or absence of pigment in the iris and ocular fundus, foveal hypoplasia, reduced visual acuity of varying severity, nystagmus, strabismus, photophobia, and iris transillumination [12]. However, health problems faced by people with albinism in African countries are far beyond medical manifestations of the disease and are closely intertwined with social, cultural, and economic factors. Given the high solar radiation levels characteristic of most African countries, malignant skin neoplasms are considered the leading cause of premature mortality among people with albinism. According to certain studies, up to 98% of Africans with albinism die before reaching the age of 40 due to the effects of chronic sun exposure; at least 80% of these deaths are associated with the development of skin cancer [10]. The research has shown that many Black patients with albinism in sub-Saharan Africa develop precancerous skin lesions under the age of 20, and the average life expectancy is 30 years, due to the development of the potentially fatal squamous cell carcinoma (SCC) [13, 14]. Fur-

thermore, such patients show the more aggressive course and higher recurrence rate of skin cancer compared to people with normal pigmentation [11]. High skin cancer incidence and skin cancer-related mortality in African countries are largely attributable to a number of socio-economic factors, including low awareness of people with albinism about the UV-induced skin damage prevention. The study has shown that only 10% of people with albinism in Nigeria have accurate knowledge about proper sun protection, and only 5% apply a full range of protective measures [15]. Another study has shown that in Malawi the main cause of the high incidence of non-melanoma skin cancer among people with albinism is the low level of awareness about the condition and preventive measures [16]. Furthermore, individuals with albinism often lack the financial resources both to purchase sun-protection products (such as creams, eye-wear, and clothing) and to pay for professional dermatological care. In particular, many of them cannot afford sunscreen, considering not only its cost but also additional expenses involved in traveling to a place where it is sold [17].

Compared to developed economies, education and healthcare systems in low-income African countries suffer from a lack of funding and a shortage of specialists, who address the albinism-related issues [18]. Residents of distant rural villages are in the most vulnerable: due to poverty, a lack of funding, and geographical isolation, they are deprived of access to basic medical services and sun protection products [19]. Thus, in the group of 38 children attending a rural specialized school for children with eye problems in South Africa, children often used cheap water-based creams that had no photoprotective effect as a “sunscreen” [20]. Furthermore, the late diagnosis of precancerous and malignant skin lesions, resulting both from a shortage of specialized dermatological care and patients’ failure to seek medical attention in time, plays an important role in adverse outcomes [21]. For example, in Tanzania, a delay of 14.1 months in seeking medical care was reported for people with albinism [22]. According to the available data, in Tanzania, only 42.7% of people with albinism living in temporary accommodation centers have access to medical care [23]. The early study conducted by P. Lund (2001) showed that only 23% of children with albinism living in rural settlements in Zimbabwe ever had a skin examination by a medical professional, and this often happened only during infancy [24].

Similar problems are reported in the sphere of ophthalmological care. Thus, in the same cohort of children with albinism, less than half (46%) had visited an ophthalmologist for a vision check, and only 27% had prescription glasses, and among the latter 5% believed that glasses did not improve their vision, which suggests inadequate quality or unavailability of specialized ophthalmic care and specialized vision correction aids [24]. Vision problems significantly limit the opportunities for education, employment, and social adaptation for such individuals in a number of African states [25, 26]. Due to the lack of education and social integration many patients with OCA are forced to engage in low-skilled physical labor outdoors, under direct sunlight

(trade, agriculture) [27]. The prolonged intense exposure to solar UV radiation in combination with no access to sunscreens, no regular medical check-ups and timely treatment considerably increase the risk of photo-damage, precancerous lesions and malignant neoplasms of the skin in such patients. According to the sample survey of 77 leaders and activists with albinism (unpublished report on the clinical assessment results, Standing Voice) conducted as part of the Pan-African Albinism Conference (Dar es Salaam, United Republic of Tanzania, November 19–22, 2015), 43 individuals with albinism from various African countries out of 77 had 239 precancerous lesions and three needed urgent surgery [28].

In many African countries, people with albinism often face ostracism and isolation due to widespread superstitions, myths, and prejudices linked to their appearance, which negatively affects their access to medical care, education, and employment [29–32]. Due to a lack of pigmentation, their appearance contrasts sharply with that of their dark-skinned relatives and those around them, which often leads to them being treated with prejudice. At the same time, there is a paradox involving people with albinism: they are perceived simultaneously as victims being hunted and as the culprits behind all troubles. As a result, such people are subject to discrimination both in the family and society as a whole. The study conducted in the Democratic Republic of Congo has found that 22% of people with albinism face discrimination within their families, and 66% in the wider community [17]. In Zimbabwe and some parts of Zambia, children with albinism attend comprehensive schools, where the inclusion process is fraught with difficulties due to the significant stigmatization they face from both classmates and teachers [33]. Discrimination against people with albinism in schools can lead to high levels of illiteracy, thereby limiting their employment opportunities. Along with educational problems, there are still problems regarding the interaction between healthcare professionals and people with albinism due to the lack of awareness and specialized staff training [34]. The resulting isolation of such people hinders the timely diagnosis and treatment of diseases, including skin tumors.

Moreover, there is still a problem of violence against people with albinism in many African countries. According to the summary report of the African Albinism Network (data for 2022), 707 violent incidents were recorded in 31 countries, including 241 murders (<https://africaalbinismnetwork.org/wp-content/uploads/2023/07/Attacks-of-PWAs.pdf>). In some regions, there have been reports of abductions, attacks, and murders linked to widespread superstitions regarding the alleged magical properties of body parts of people with albinism [30]. In Burundi, more than 23 people with albinism have been killed and mutilated for their bodies to be sold for use in rituals in Tanzania. Women and girls with albinism are subjected to ritual rape, as there is a widespread belief that sexual intercourse with a person with albinism brings good luck and cures diseases. As a result, women with albinism face unintended pregnancies [17]. The situation regarding violence against people with

albinism contributes to the development of psychological disorders among victims and their families, leads to social isolation, and negatively affects these individuals' access to medical care, education, and employment [23]. Taken together, cultural and socio-economic factors have a significant effect on the quality of life, social integration, and life expectancy of this population group, which allows albinism to be considered not merely as a rare genetic condition, but also as a major medical and social issue on the African continent.

Risk factors of skin cancer in individuals with albinism in African countries

It is well known that the degree of human skin pigmentation is an individual characteristic determined by many factors, such as the counts and mitotic activity of melanocytes in the basal layer of the epidermis, the melanocyte melanogenic activity, the number, size, and distribution pattern of melanosomes, the type of melanin, etc. [35]. It is melanin synthesized in the cells of the basal layer of the epidermis that plays an important role in absorbing and scattering solar UV radiation, thereby preventing damage to the cellular DNA and the development of oxidative stress [36, 37]. Due to this property, the degree of skin pigmentation determined by melanin is inversely proportional to the risk of UV-induced skin tumors, and the risk of such tumors is decreased 60-fold in people with dark skin compared to those with light skin [38, 39].

Despite the fact that OCA is not classified as the hereditary cancer predisposition syndrome, the genetically determined melanin deficiency represents a fundamental biological basis exposed to environmental factors contributing to carcinogenesis in the skin. Thus, OCA is considered to be an identified risk factor for skin cancer among the Black population of Africa [11, 22]. Among environmental factors, the leading risk factor for skin cancer is chronic exposure to solar UV radiation. Across a large part of the African continent, the UV index remains consistently high throughout the year, leading to significant cumulative exposure to solar UV radiation, starting from early childhood. Over time, the cumulative impact of solar UV radiation contributes to the progressive accumulation of DNA damage and somatic mutations in keratinocytes, accelerating the transition from actinic keratosis and other precancerous lesions to invasive skin cancer. The photocarcinogenesis molecular mechanisms are described in detail in the literature [40]. Numerous studies conducted in Tanzania, Nigeria, the Southern region, Zimbabwe, and Malawi, that were analyzed in the systematic review and meta-analysis by N. Onyishi and S. Ohayi (2022), have confirmed the exceptionally high incidence of keratinocyte (non-melanoma) skin cancer among people with albinism in sub-Saharan African countries [41].

Due to a critical deficiency of the protective pigment melanin, most people with OCA are highly susceptible to sunburn [42], especially in countries with high levels of isolation, such as those in Africa. According to data presented in a fundamental review by C. Wright et al. (2015) [2], sunburns, both with and without blistering, are common

among children with OCA in Nigeria. However, the rate of sunburns in children with OCA has not been systematically studied. In albinism, the chronic exposure to solar UV radiation triggers the cascade of severe skin lesions, from premature photoaging (dermatoheliosis) and solar elastosis to multiple actinic keratosis, which is officially classified as an obligate precancerous condition with a high risk of malignant transformation (transformation into squamous cell or basal cell carcinoma) by dermatologists [2, 43, 44]. Photoaging manifests as heavily wrinkled skin on areas of the body most often exposed to sunlight. Individuals with elastosis show the skin thickening and degeneration of the connective tissue of the dermis. Elastosis was described as a condition found in almost all children with albinism in Nigeria and Tanzania. It was particularly noticeable on the neck and the back of the hands. Furthermore, in Tanzania, all patients with OCA had chronic skin lesions by the age of 1 year, and by the age of 15–18, the majority had multiple actinic keratosis. C. Wright et al. (2015) also noted that actinic keratoses were found in 91% of patients with OCA over the age of 20 years living in rural settlements in Tanzania, and the rate reached 100% by the age of 30 years [2]. Moreover, the study conducted in Kenya that involved 151 patients with albinism revealed severe actinic lesions in 80% of patients, primarily in those aged 21–30 years [45]. It has been shown that up to 60% of cutaneous squamous cell carcinomas (SCCs) in patients with albinism develop against a background of actinic keratosis, and that histological evidence of actinic keratosis is found in 97% of SCC cases resulting from the UV-induced skin damage [46, 47]. The estimated likelihood of developing mature SCC arising from actinic keratosis associated with the UV-induced skin damage is 0.075–0.096% of cases per one lesion annually [48]. Therefore, in an individual with an average of 7.7 actinic keratoses on his/her skin, the probability of developing SCC over a 10-year period is 10.2% [49]. Other sources cite even higher figures, according to which 13–20% of people with actinic keratoses, including albinos, develop SCC within 10 years [46, 47].

The socio-economic factors described in detail above further worsen both the skin cancer incidence and the disease adverse outcomes in Africans with albinism. As a result, in many patients, the disease is diagnosed at a locally advanced stage, and the surgical resection is required that is associated with the risk of complications, probable recurrence, and the risk of metastasis (in case of SCC). The combination of a high biological predisposition, prolonged exposure to intense solar UV radiation, and significant inequality in the access to preventive measures and quality medical care makes Africans with albinism one of the populations at the highest risk of developing skin cancer globally [50].

Skin cancer epidemiology in patients with albinism in various regions of the world

The aggregate data analysis has demonstrated the extremely high prevalence of actinic keratosis (a dangerous precancerous condition) and skin cancer among individuals

with albinism all over the world [51]. According to the results of 12 independent studies, among 1747 patients the overall incidence of actinic keratosis was 38% (95% confidence interval – CI 17.7–60.3%), while the overall incidence of skin cancer reached 19% (95% CI 13.5–24.4%) [51]. SCC prevailed in the structure of malignant tumor detection – 55.4% (95% CI 36.2–73.8%), basal cell carcinoma (BCC) ranked second – 33.7% (95% CI 19.6–49.2%), and the recorded cases of melanoma accounted for less than 1% (95% CI 0.00–0.56%), in contrast to the general population, where basal cell carcinoma is more prevalent [51–53].

The prevalence of skin tumors among people with albinism depends directly on the geographical location, solar UV radiation intensity, and socio-economic factors. Global meta-analyses and large-scale epidemiological reviews, including extensive data of the Pierre Fabre Foundation demonstrate clear regional differences in the structure and prevalence of the disorder [54, 55]. As noted above, the highest prevalence of albinism is reported for equatorial and sub-Saharan Africa. Thus, according to the systematic review including the analysis of the literature published before January 1, 2022, of all the cases of skin cancer in patients with albinism analyzed worldwide, 87.3% occur on the African continent [54]. Moreover, Black individuals with albinism in sub-Saharan Africa have the risk of developing non-melanoma skin cancer (including squamous cell carcinoma) approximately 1000 times higher than the general population [11, 46]. A Tanzanian histological review of 134 biopsies from 86 patients with albinism who had been diagnosed with skin cancer reported that the youngest patient was 18 years old, and the average age of those with skin cancer was 35.5 years [22]. In general, statistical data from sub-Saharan African countries confirm that the average age at which Africans with albinism develop malignant skin tumors is only 20–30 years [56].

The pattern of the skin cancer prevalence among patients with albinism also shows significant geographical variation. BCC predominates in Europe and America [54], while on the African continent SCC is the most prevalent type, and melanoma is extremely rare. In particular, squamous cell carcinoma accounts for 75–88% of all malignant skin neoplasms in people with albinism, while basal cell carcinoma accounts for only 9–23% cases, and melanoma only 1.3–3% of cases [57]. However, some studies note that BCC occurs more frequently than SCC in African albinos, which is consistent with the pattern observed among individuals of European descent [58, 59]. Furthermore, in certain populations and when active screening is conducted, the ratio of squamous cell carcinoma to basal cell carcinoma may be close to equal [9]. A clear topical link has been established between the development of cutaneous squamous cell carcinoma and sun exposure in Africans with albinism [22].

In the study by P. Kassang et al. (2025) focused on the analysis of 1143 cases of skin cancer in 850 patients with albinism, nearly 90% of whom lived in Africa, the highest incidence of this carcinoma type was reported for areas with maximum exposure to solar radiation: 81.4% of cases occurred on the head, and 11.2% on the trunk [54]. Most fre-

quently affected are areas of the body exposed to the sun: the face, scalp, ears, neck, shoulders, and the back of the hands. In these areas, the cumulative dose of solar UV radiation contributes to the progressive accumulation of genetic mutations in keratinocytes [22, 50]. Compared with patients of European descent, SCC demonstrates more aggressive biological behavior, characterized by the increased local invasiveness, high risk of local recurrence, and the pronounced trend of metastasis to regional lymph nodes in Africans with albinism (particularly in sub-Saharan African countries) [60]. Furthermore, multiple squamous cell carcinoma forms are common in this group of patients [61]. Such an aggressive disease course results from not only constant exposure to solar UV radiation, but also late diagnosis and limited access to specialized care and surgical treatment. As a result, in many regions of Africa, only advanced stage tumors are diagnosed, when these have spread significantly into the soft tissues and, in severe cases, have invaded the underlying bone. All these factors contribute significantly to the high mortality rate observed in numerous African clinical trials [22, 50].

BCC is the second most common malignant skin tumor in people with OCA in sub-Saharan Africa [41]. As is the case with squamous cell carcinoma, the BCC development is closely linked to cumulative solar UV radiation exposure. Tumors develop primarily in the skin areas that are constantly exposed to sunlight, including the face, ears, and neck. Clinically, BCC typically manifests as a slowly enlarging, translucent papule. Neoplasms may be pigmented, ulcerated, or exhibit both of these features, depending on the histological subtype. When untreated, some tumors progress to an infiltrative-ulcerative form, historically known as a "rodent ulcer." Despite its extremely low metastatic potential, BCC can be locally invasive, with the ability to gradually penetrate the dermis, subcutaneous tissue, and cartilage, and, in advanced cases, the face bones. In patients of African descent with BCC, this destructive process is often exacerbated by delayed diagnosis, inadequate use of sunscreens, and limited access to specialized dermatological and surgical care; as a result, tumors can reach a large size and require radical treatment.

The most common BCC subtypes are nodular, superficial, and infiltrative ones. The infiltrative subtype is characterized by a more aggressive growth pattern, an increased tendency for deep tissue penetration, and a high risk of local recurrence following surgical excision. The prognosis is generally favorable, provided there is early diagnosis and complete excision of the tumor, with no tumor cells found at the surgical site margins. Nevertheless, despite its low metastatic potential, BCC remains a significant cause of esthetic defects and functional impairment in individuals with OCA living in sub-Saharan Africa [8, 22, 50, 62].

Cutaneous melanoma is reported only in sporadic cases or small case series and accounts for a negligible proportion of all skin cancer cases in individuals with OCA in sub-Saharan Africa [22, 41]. Despite the fact, that the melanin deficiency significantly increases the keratinocytes' vulnerability to the solar UV radiation-induced carcinogenesis, it

also can alter the biology of melanocytes in a way that reduces the incidence of melanoma. However, molecular mechanisms underlying the development of melanoma in individuals with albinism are poorly understood – largely because the available data are limited to individual case reports and small retrospective studies [8]. In clinical practice, melanoma in people with albinism often differs from typical pigmented melanoma, manifesting as hypopigmented or entirely amelanotic neoplasms. The lack of characteristic pigmentation can complicate both timely clinical recognition and dermatoscopic diagnosis, increasing the risk of misinterpreting the neoplasm as a keratinocytic carcinoma, a chronic ulcer, or other benign or malignant dermatological condition [63].

In other geographical regions where a high UV index is also observed, such as Brazil, the high incidence of skin neoplasms is also reported in albinos, resulting from a combination of two factors: high insolation levels and reduced genetic population diversity due to isolation and consanguineous marriages [64]. In the studied population in São Paulo, Brazil, high prevalence of actinic lesions was reported in 2010–2017: sunburns (72%), actinic keratosis (45%), elastosis (57%), lentigo (25%), and skin cancer (26%) [65]. The disease onset occurred at early age, specifically actinic keratosis at the age of 21 years, solar elastosis at the age of 6 years, and skin cancer at the age of 23 years, which corresponds to the values recorded in African countries. It should be noted that the prevalence of skin cancer in this population (26%) was similar to the prevalence among patients with albinism in Tanzania (25%), South Africa (23%) and was significantly higher, than in Europe, specifically 4.6% in France and 0.5% in Italy [65].

In temperate latitudes (European and American countries), skin cancer prevalence rates differ significantly from those in equatorial regions. In these countries, skin cancer in people with albinism is diagnosed at a much later age (usually over 40–50 years). Due to a more temperate climate, higher levels of awareness, the availability of high-quality sun protection products, early dermatoscopic diagnosis, and the timely removal of precancerous lesions, the overall incidence of advanced and invasive skin cancer among European and American patients with albinism is significantly lower compared to regions in sub-Saharan Africa (Europe – 2.2%, America – 6.6%) [54, 66].

The contribution of Asian countries to global statistics on the incidence of skin cancer among albinos is relatively small [54]. Nevertheless, the pattern of morbidity in this region has its own specifics. The study showed that, for example, Japanese patients with OCA exhibit a tendency toward a higher incidence of malignant melanoma compared to patients of African or European descent, among whom non-melanoma skin cancers prevail [67]. The annual incidence of melanoma in the Japanese patient population is estimated at approximately 1 per 16,000 population, whereas in the general population it is estimated at 1 per 100,000 population [67, 68]. This phenomenon may be attributed to the unique genetic landscape of this population and a critical deficiency of melanin, occurring against a backdrop of high

UV radiation. In the study by K. Okamura and T. Suzuki (2020), demographic and genetic data of Japanese patients with OCA and their families were presented [69]. The analysis showed that OCA types 4 (25.3%) and 1 (20.0%) were the most prevalent in this cohort.

In general, the prevalence of skin tumors among Asians with albinism is poorly understood. In developed economies of Asia (Japan, Singapore, South Korea), the high availability of quality sun protection products, early diagnosis, and public awareness make it possible to detect precancerous conditions at an early stage, preventing these from progressing into an invasive state. In the less developed regions of Asia, logistical difficulties and the lack of unified cancer registries make it challenging to accurately track such patients [70].

Thus, on our planet, there is variation in the epidemiological spread of albinism among individuals of different races and across different geographic regions. In sub-Saharan Africa, the prevalence of albinism is extremely high (1:5000 to 1:1000); squamous cell carcinoma predominates among skin tumors (accounting for about 57–75%), which typically occurs on exposed areas of the body and is characterized by a rather aggressive clinical course, a recurrence, and early metastasis. The risk of developing squamous cell skin cancer here is 1,000 times higher than in the general population. Without sunscreens, up to 98% of patients die from metastatic skin cancer by the age of 30–40. There is an acute shortage of specialized dermatological care and sun protection products [2, 8, 54].

In Latin America and the Caribbean, the prevalence of albinism in the population is at an average level: about 1:10 000. The most common skin tumor variants are basal cell and squamous cell carcinoma. High rates of precancerous skin lesions, such as sunburns, elastosis, and actinic keratosis (observed in 43–57% of young patients), are also recorded here, as is the early onset (often before the age of 30) of squamous cell carcinoma, which occurs more frequently in rural areas and along the coast [8, 71–73].

In Asia, the prevalence of albinism depends on the region. Thus, this phenomenon is rare in Japan and China (up to 1:20 000), where a highly characteristic skin tumor is amelanotic melanoma, which is notable for its extremely malignant course. The melanoma epidemiology specifics in Japan is the high share of acral and mucosal forms, a distinct mutational profile, and a predominance of type 4 ALM compared to the Caucasian population. The 5-year survival for each disease stage shows a trend similar to that reported for representatives of the Caucasian race. In India, on the contrary, it is rather high: between 1:23,568 and 1:13,500. The extremely high prevalence of albinism is reported in Pakistan (Bhatti tribe): about 1:20. In general, the prevalence of skin tumors among Asians with albinism is poorly understood [67, 69, 74–77].

Treatment and prevention of skin tumors in individuals with OCA in African countries

In African countries, treatment of skin tumors in individuals with HIV/AIDS follows the same oncological principles

as it does for the general population; however, it presents specific challenges due to the multifocal nature of the lesions, late diagnosis, and limited healthcare resources. Optimal patient management requires a multidisciplinary approach involving dermatologists, plastic surgeons, surgical oncologists, pathologists, radiation oncologists, and chemotherapists. Furthermore, achieving local disease control, preserving functional capabilities, and reducing the likelihood of recurrence remain the key objectives [8, 22].

Surgical excision is the treatment of choice for most types of non-melanoma skin cancer. Radical tumor resection represents a standard treatment method for both SCC and BCC, leading to a cure in the majority of patients with the detected early-stage neoplasms. However, in African patients with skin cancer, the disease is often diagnosed at an advanced stage, frequently necessitating extensive resections that involve the ears, nose, eyelids, lips, or scalp. In such cases, restoring function and achieving an acceptable esthetic outcome often require complex reconstructive procedures using local or regional flaps, or split-thickness skin grafts. Patients with squamous cell carcinoma are recommended a thorough clinical and radiographic assessment of the regional lymph nodes, since the involvement of those in the neoplastic process is one of the most significant adverse prognostic factors [22, 50, 78]. Radiation therapy is an important treatment modality for patients with locally advanced tumors that are not amenable to radical surgical removal. However, access to radiotherapy remains extremely limited in many African countries [24].

Recent advances in oncology have significantly expanded the range of therapeutic options for advanced skin cancer forms. Patients with metastatic or unresectable locally advanced SCC, who are not candidates for surgery or radiation therapy, may benefit from systemic therapy. It includes both traditional chemotherapy and, which crucially important, immune checkpoint inhibitors targeting the programmed cell death protein 1, PD-1 (for example, cemiplimab and pembrolizumab). The use of these drugs has made it possible to significantly improve objective response rates, progression-free survival, and overall survival. The use of Hedgehog signaling pathway inhibitors (including vismodegib and sonidegib) is a standard systemic therapy method for patients with locally advanced or metastatic BCC, while immunotherapy may be considered in certain patients with the disease that resistant to the Hedgehog pathway inhibition or other standard therapeutic methods [79–81].

Despite such significant therapeutic advances, access to modern cancer treatments remains limited across much of Africa. The high cost of new anticancer drugs, limited access to specialized oncology centers, the absence of pathology and molecular diagnostic services, and difficulties in developing interdisciplinary treatment plans for cancer represent significant obstacles to the implementation of modern treatment strategies. Thus, surgery remains the cornerstone of treatment for skin neoplasms in routine clinical practice in most African countries. Such a situation suggests that the skin cancer treatment outcome improvement depends not only on advances in therapeutic methods, but

also on strengthening preventive programs, promoting early diagnosis, expanding access to specialized medical care, and bolstering local healthcare systems, i.e. the measures that are likely to prove more effective and sustainable than relying solely on advanced cancer treatment methods [60]. Thus, in African countries, skin tumor prevention should be central for management of patients with OCA, ensuring the most effective strategy for reducing morbidity, mortality, and the need for major surgical interventions. In contrast to many other malignant neoplasms, the main risk factor for skin tumors in this group of patients is a modifiable environmental factor, i.e. solar UV radiation, which allows for primary prevention due to consistent and effective use of sun protection products [60, 82].

Photoprotection should begin in early childhood and include the daily use of a broad-spectrum sunscreen with a sun protection factor (SPF) of 50 or higher. The use of sunscreen should be combined with additional protective measures, such as wearing wide-brimmed hats, long-sleeved clothing made of thick fabric, and sunglasses with UV protection. Furthermore, one should avoid staying in direct sunlight during hours of peak solar activity. Consistent adherence to these measures can significantly reduce the risk of developing precancerous lesions and skin cancer among Africans with OCA [8, 22].

In African countries, people with albinism face not only an exceptionally high risk of malignant skin tumors but also profound social vulnerability, which negatively affects their quality of life. In recent years, albinism is increasingly recognized not only as a rare hereditary condition but also as an issue that requires targeted public health and human rights protection strategies by international organizations, human rights groups (for example, Amnesty International [89]) and UN agencies, including the World Health Organization and the Human Rights Council [90, 91] in these countries. Today, there are a number of international organizations and support programs for people with albinism that aim to protect their rights, provide access to sun protection products and medical care, and combat discrimination:

- Global Albinism Alliance – an international network spanning more than 80 countries [83];
- IARC Albinism Research Network – another international network focused primarily on Africa [86];
- Under the Same Sun – operates primarily in Tanzania and African countries [84];
- Standing Voice – in Tanzania and Malawi [85].

In particular, global initiatives are represented by the independent UN expert's mandate on the rights of people with albinism [87]. The International Albinism Awareness Day is celebrated on June, 13 all over the world [88].

Comprehensive strategies are needed that combine sustainable prevention programs, access to sun protection products, health education, regular dermatological check-ups, rehabilitation for individuals with impaired vision, educational support, and measures to prevent discrimination, violence, and social isolation to solve the problem of malignant skin tumors as a priority public health task in these

countries. Awareness-raising campaigns are also necessary to improve the understanding of albinism and to counter harmful misconceptions that persist in some communities [60, 82, 92].

Health education is a key component of prevention that represents one of the most sustainable long-term measures in African countries. In many rural communities, limited use of sun protection products reflects not only financial constraints but also a lack of awareness among patients with OCA regarding the importance of using such products. In some communities, sun protection products are still perceived primarily as a cosmetic item rather than as a necessary preventive measure for people with albinism. Moreover, even when sunscreens are available, the use of those is often irregular and limited to periods of intense sun exposure, rather than being a lifelong daily habit. Therefore, educational initiatives should involve people with albinism, their families, teachers, healthcare professionals, and community leaders, in order to emphasize the role of photoprotection as a fundamental component of skin cancer prevention [3, 82]. Educational programs for children and adolescents with albinism, implemented in schools, can help foster early sun-protection habits and reduce the stigmatization associated with this condition.

At the same time, improving the ability of primary care physicians to detect precancerous lesions and early-stage skin cancer is crucial for the timely referral of patients to specialists and the treatment provision. Regular dermatological monitoring, which includes at least annual skin examinations and more frequent check-ups for individuals at particularly high risk, contributes to the early detection of actinic keratosis and skin cancer. At this stage, treatment is generally less invasive and leads to more favorable outcomes [22, 50].

The effectiveness of comprehensive prevention programs has been demonstrated by initiatives implemented at the local community level in Tanzania and South Africa [3, 50]. Despite the fact that these programs were usually implemented on a limited geographical scale, these demonstrate that relatively simple and cost-effective strategies can significantly improve the quality of life of people with albinism.

Thus, based on available data, prevention of skin tumors in individuals with OCA should be considered a public health priority in African countries. National strategies should facilitate access to high-SPF sunscreens, support programs for their free or subsidized distribution, and prioritize sustainable educational initiatives focused on lifelong photoprotection. Combined with regular dermatological check-ups, early detection programs, and strengthening of primary healthcare systems, these measures have the potential to significantly reduce the burden of malignant skin tumors in this particularly vulnerable population group [3, 8, 22, 50, 82].

Unresolved issues and prospects for further research

Malignant neoplasms of the skin in individuals with albinism remain a serious and poorly understood issue, particularly in regions with intense solar UV radiation; these represent one of the most severe complications and are a

primary cause of premature death. Despite the clear role of poor photoprotection, many issues regarding epidemiology, early diagnosis, prevention, and optimal treatment remain unresolved.

The lack of reliable epidemiological data is one of the main limitations of the available evidence base. Most published studies are retrospective case series or regional studies. The literature review by P. Kassang et al. (2025) emphasizes the need for longitudinal studies, standardization of diagnostic criteria, and collection of detailed data at the level of individual patients [54].

An additional complication arises from the insufficient knowledge about the differences between the albinism genetic types. Albinism is a genetically heterogeneous disorder; however, the impact of specific subtypes and genetic variants on the likelihood of developing various forms of skin cancer is poorly understood. For example, the increased risk of BCC has been reported for OCA types 1 and 2, while that for OCA type 4 has not been quantified [93]. A promising avenue for further research is the integration of genetic, clinical, and epidemiological data to identify groups at particularly high risk [51].

Early diagnosis of neoplasms still represents a distinct challenge. Tumors and precancerous lesions may have an atypical or subtle appearance on the severely hypopigmented skin. The presence of a large number of actinic lesions further complicates the differentiation of skin lesions. Thus, a standard visual examination does not always ensure the timely detection of abnormalities. That is why it is important to determine the extent to which the use of supplementary dermatoscopy improves diagnostic accuracy, and to develop monitoring algorithms considering specific skin characteristics associated with albinism, as indicated in contemporary reviews [66]. Directly related to this is the issue of the lack of standardized screening protocols. Today, there is insufficient data to determine the optimal age to begin the follow-up, the frequency of examinations, indications for biopsy, and the most effective screening methods. Developing accessible early-diagnosis programs is especially important for countries with high levels of solar UV radiation and limited healthcare resources [11, 51].

The issue of the photoprophylaxis accessibility and effectiveness is of no less importance. The World Health Organization identifies the accessibility of sunscreens for the prevention of skin tumors in people with albinism as a significant public health issue in several regions, where financial, social, and infrastructural barriers continue to hinder the regular use of those [86].

Finally, it should be noted that there is a lack of long-term data on treatment outcomes. The research focused on the recurrence, metastasis, survival, and quality of life after treatment is necessary. This is particularly relevant for squamous cell carcinoma, which is the most common type of malignant skin tumor in people with albinism in African countries [54]. The limited availability of such data currently makes it impossible to reliably compare different treatment strategies and to identify the factors associated with adverse outcomes.

Thus, further research should be focused on not only understanding biological mechanisms underlying the skin malignant tumor development in people with albinism, but also constructing a complex prevention model including the genetic risk stratification, regular screening, access to sun protection products, early treatment, and the removal of social barriers. Large-scale, multicenter, prospective studies aimed at establishing international patient registries, standardizing the classification of precancerous and malignant lesions, and investigating the molecular mechanisms of the solar UV radiation-induced carcinogenesis in various forms of albinism hold great promise. Furthermore, it is necessary to evaluate the effectiveness of implementing regular dermatological screening programs, teledermatology, digital dermatoscopy, and other tumor early detection methods. The study of social determinants of health, such as the cost of sun protection products, access to specialized medical care, the consequences of vision impairment, stigmatization, and the level of patient awareness, is of particular importance, since factors can influence both the risk of delayed diagnosis and treatment outcomes [94, 95]. Such a comprehensive approach can significantly reduce the disease incidence, disability, and premature mortality from skin cancer and melanoma among people with albinism in African countries.

Conclusion

Available data indicate that skin cancer is one of the primary preventable causes of morbidity and mortality among people with OCA in many African countries (particularly, in sub-Saharan African countries). Cutaneous SCC represent the histological type predominant in this population that typically develops at a significantly earlier age compared to the general population; this reflects the cumulative impact of factors such as impaired melanin-mediated photoprotection of the skin and life-long exposure to solar UV radiation, which trigger a progressive accumulation of cellular damage and, consequently, the development of malignant skin neoplasms. Furthermore, the delayed diagnosis and limited access to specialized dermatological and oncological care remain the key factors contributing to the significant burden of skin cancer in this highly vulnerable population group. In this regard, the review considered the key risk factors, approaches to the prevention, early diagnosis, and treatment of skin tumors in people with OCA living in African countries.

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