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Screening and Intervention for Skin Cancer in the Galapagos

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Objective: This study aimed to assess the general dermatological needs and correlation of tentative skin cancer screening diagnoses with histopathological confirmation in the highly sun-exposed locals of the Galapagos Islands.

Methods: An institutional review board–approved prospective study was performed at Blanca's House, a nonprofit surgical volunteer organization, free clinics in the Galapagos. After consent, a 40-item modified SPOTme-inspired questionnaire was completed. Partial or total body skin examinations were conducted by board-certified dermatologists. Board-certified plastic and general surgeons performed excisional biopsies on suspicious lesions. Individuals younger than 18 years, and non-Spanish or non-English speakers were excluded.

Results: A total of 273 patients were included in the study, of which 202 reported skin concerns. Benign nevi (n = 76), seborrheic keratosis (n = 42), melasma (n = 19), actinic keratosis (n = 16), acne (n = 15), eczema (n = 13), fungal infections (n = 12), seborrheic dermatitis (n = 5), and psoriasis (n = 5) were most commonly identified.

Twelve patients (4.4%) had presumptive skin cancer after screening. Six of 8 biopsies confirmed cancer (group 1), 2 declined a biopsy and 2 were unresectable. Seven basal cell carcinomas and one squamous cell carcinoma were excised with clear margins. A right lower eyelid melanoma was diagnosed and subsequently treated in the United States where invasive melanoma with a Breslow thickness of 0.3 mm was found.

Compared with the noncancer group (group 2: n = 265), group 1 had significantly higher likelihood of reporting having seen a dermatologist ($P = 0.02$), taking any medications ($P = 0.0001$), having blonde or red hair ($P = 0.01$), having blue or green eyes ($P < 0.0001$), and having used indoor tanning equipment ($P < 0.0001$). Group 1 was also more likely to report 4 or more blistering sunburns ($P = 0.08$), which approached significance. When evaluated by a dermatologist, group 1 was significantly more likely to be classified as "high risk" for developing cancerous lesions ($P < 0.0001$) compared with group 2.

Conclusions: Skin concerns in the Galapagos included benign and malignant conditions. There is a need for dermatological care in this medically underserved population. This modified SPOTme-inspired skin cancer questionnaire, confirmed by histology, is a useful tool in identifying high-risk patients and detecting skin cancer in international communities that would have otherwise experienced delays in diagnosis or treatment.

Key Words: skin cancer, screening, Galapagos, access to care, melanoma, basal cell carcinoma, squamous cell carcinoma, global health

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Skin cancer is one of the most common malignancies worldwide,[1] and it is classified into melanoma and nonmelanoma skin cancers. Although the incidence varies across different geographic locations, it is on the rise.[2] Many predisposing risk factors have been identified. Some are modifiable, such as degree of sun exposure, and others such as family history are not; however, education, routine surveillance, and early detection may influence outcome.[3]

Screening initiatives have been well studied in numerous developed countries including the United States,[4] Germany,[5,6] Canada,[7] and Australia,[8] in an attempt to optimize prevention strategies, promote early intervention, and minimize disease burden. In the United States, the American Academy of Dermatology (AAD) has become the leading authority on skin cancer screening over the past 30 years. Through its SPOTme Skin Cancer Screening initiative, the AAD has organized a national program that provides an assessment of high-risk UV exposure behaviors, clinical questionnaires, and full or partial body skin examinations to aid in identifying suspicious lesions.[9] Participants are provided details about their diagnosis and given contact information to local dermatologists for follow-up.

Efforts toward skin cancer prevention and intervention in Latin America have also been reported but are limited at best. In 2006, the Brazilian Society of Dermatology determined that skin cancer was common among its citizens; however, locals did not perceive unprotected sun exposure as a risk factor.[10] Although the Society has made efforts to educate Brazilians on skin cancer prevention techniques, this strategy does not provide a mechanism for patients living with suspicious lesions to receive the intervention they need when financial resources are a barrier.

Other studies have assessed the presence of public policy initiatives for primary or secondary prevention of skin cancer in various South American countries. de Vries et al[11] published a study in 2016 evaluating the burden of melanoma and the status of preventive measures in Central and South America. Panama, Chile, and Peru are a few countries that have implemented recommendations or legislation that provide education and protective measures against ultraviolet rays for citizens who work in direct sunlight.

Although the incidence rate of melanoma in Central and South America is lower compared with countries with a larger white population, such as Australia, Ecuador was found to have higher incidence rates among Latin American countries despite its high proportion of indigenous population,[11] and the reason is unknown. In addition, people from Latin America were more likely to present with advanced disease due to delay in diagnosis compared with developed countries with higher incidence.[11] de Vries et al state that it is unclear whether the low incidence rate of melanoma seen in Latin America is due to the low presentation of the disease, a lack of awareness by the general public, or the inability of regional physicians to diagnose skin cancer.

Since 2008, Stony Brook Medicine providers from Suffolk County, New York, have participated in numerous medical trips to Central and South America. Working in conjunction with Blanca's House, a nonprofit medical, dental, and surgical volunteer organization (SVO), Stony Brook physicians provide free services such as cleft lip and palate repair, general surgery, gynecological, orthopedics, ophthalmological, and dental care.[12] During SVO trips to the Galapagos, an archipelago located 621 miles off the coast of Ecuador, Stony Brook physicians witnessed first-hand the need for dermatological assessment and sought solutions to a concerning problem.

Census data state that more than 25,000 people reside on 4 of the 14 Galapagos islands.[13,14] Permanent residents experience numerous barriers to specialized health care needs including geography, topography,

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lack of availability of specialists, time, and socioeconomic challenges. For many, an appointment with a dermatologist would require traveling several days to the mainland by boat. Given the proximity of the Galapagos to the equator and the difficulty accessing specialty health care resources, an effective skin cancer screening strategy is needed. The goals of this pilot study were to identify demographics and risk factors that correlate with clinically identified cancerous skin lesions and to explore a skin cancer screening survey based on AAD's SPOTme initiative, using clinical and histology results of patients in the Galapagos while also addressing general dermatological concerns.

MATERIALS AND METHODS

An institutional review board–approved prospective study was performed at the Blanca's House free clinic on the Galapagos islands of Floreana and Santa Cruz. Inclusion criteria consisted of patients who were 18 years and older, and English or Spanish speaking. After consent, a 40-item modified SPOTme-inspired questionnaire was distributed. Surveys were available in English or Spanish and took approximately 5 to 10 minutes to complete.

The instrument was based on the SPOTme questionnaire,[9] with the incorporation of additional questions customized by Stony Brook dermatologists and plastic surgeons (Supplemental Material Document 1 http://links.lww.com/SAP/A479). It consisted of demographic information, education level, personal understanding of skin cancer prevention methods and sun-protective techniques, occupation-related solar exposure frequency, location of any skin lesions, and skin type on the basis of sun burning and tanning.

Partial or total body skin examinations were conducted by 1 of the 4 board-certified dermatologists. Any skin disease observed during the physical examination was documented, and treatment recommendations were made when applicable. Suspicious lesions were biopsied by the dermatologist or excised by a board-certified plastic or general surgeon. No additional tissue was obtained other than what was clinically indicated. All services provided by Blanca's House and Stony Brook Physicians to patients were free of charge. All tissue specimens were sent for histologic analysis. All biopsy specimens were interpreted by an Ecuadorian pathologist and subsequently independently analyzed by a board-certified dermatopathologist (D.L.). The study was conducted during a 1-week period: 2 days on Floreana Island and 3 days on Santa Cruz Island. All patients with concerning pathological findings were subsequently followed up by local Blanca's House affiliate physicians free of charge.

Patients younger than 18 years, non-English or non-Spanish speakers, and those with inability to provide consent or decision not to participate were excluded. Patients who opted not to participate in the study were still eligible to receive free skin screening and intervention services, although their data would not be included in this project's analysis.

All the data from the questionnaires and clinical data were collected, and statistical analysis was performed. Descriptive statistics were calculated for sample characteristics (eg, mean and SD for age, and frequencies and percentages for other categorical risk factors) for skin cancer. The means of ages were compared using a 2-sample *t* test, and percentages were compared using χ^2/Fisher exact tests between 2 cancer status groups.

RESULTS

Demographics and Risk Factors

Over the course of 5 days, a total 316 patients presented to Blanca's House clinic for screening, of which 273 patients were included in the study's analysis (Table 1). Fifty-one percent (n = 140) were male, and 48.7% (n = 133) were female, with a mean age of 40.9 years. The study population included a variety of ethnicities and racial backgrounds including self-identified multiracial (42.1%), Hispanic (30.5%), white/European descent (8.8%), and other (3.4%). Most participants completed at least high school level or had a higher educational degree (80.2%), and reported that they had access to health insurance (76.6%). Some also reported having been seen by a dermatologist in the past (38.8%), but only 28.9% reported having a primary care doctor. When assessing for sun exposure and other risk factors, 44.6% reported to spending more than 4 hour in the sun daily and 13.2% were found to have a positive personal or family history of skin cancer (Table 2).

TABLE 1. Demographics of Persons Screened for Skin Cancer in the Galapagos (n = 273)

Variable	n	%
Sex		
Male	140	51.3
Female	133	48.7
Age, y		
18–29	64	23.4
30–39	90	32.9
40–49	51	18.7
50–59	38	13.9
60–69	13	4.8
70–79	9	3.3
80–89	4	1.5
90+	3	1.1
Education completed		
Elementary school	17	6.2
Middle school	5	1.8
High school	89	32.6
University	130	47.6
None	5	1.8
Race		
Mixed	115	42.1
Hispanic	84	30.8
Other	10	3.7
White/European	24	8.8
Afroecuadorian	1	<1
Indigenous	2	<1
Access to care		
Have health insurance	209	76.6
Primary care doctor	79	28.9
Have seen a dermatologist	106	38.8
History of skin cancer		
Personal history	5	1.8
Family history	31	11.4

Examination Results

Of patients included in the study, 69.2% underwent full total body skin examination and 30.8% had partial examinations. After clinical examination, 12 patients were identified to have presumptive skin cancer through the screening protocol. The data were further stratified based on histology confirmation. Group 1 included patients with biopsy- and histology-confirmed skin malignancy (n = 6: 2.2%), with a mean age of 60.8 ± 23.3 years. Of the original 12 with presumptive skin cancer after screening, 2 refused the biopsy procedure, 2 had locally advanced skin cancer on examination (Fig. 1), and 2 biopsies revealed benign skin conditions (Table 3).

A combined total of 7 basal cell carcinomas (BCCs) and 1 squamous cell carcinoma (SCC) were excised, and 1 melanoma in situ lesion was biopsied (Fig. 2). All of the BCCs and SCCs were excised with clear

TABLE 2. Risk Factors Assessed for Skin Cancer (n = 273)

Risk Factors	n	%
Wear sunscreen?		
Always	94	34.4
Sometimes	89	32.6
Rarely	49	17.9
Never	38	13.9
Wear sun protective clothing?		
Always	77	28.2
Sometimes	93	34.1
Rarely	47	17.2
Never	53	19.4
Wear a hat?		
Always	147	53.8
Sometimes	66	24.2
Rarely	31	11.4
Never	27	9.9
Wear sunglasses?		
Always	112	41.0
Sometimes	49	17.9
Rarely	33	12.1
Never	78	28.6
Hours spent in the sun daily		
0–1	52	19.0
2–4	97	35.5
5–6	43	15.8
6+	78	28.8
Blistering sunburns before the age of 20 y		
0–3	166	60.8
4–6	37	13.6
7–10	13	4.7
10+	17	6.2

margins at the time of intervention. The incisional biopsy of the lower eyelid lesion diagnosed as melanoma in situ required further treatment, which was not possible in the Galapagos. Through Blanca's House and Stony Brook University Hospital, the patient was brought back to the United States for definitive treatment. The patient successfully underwent wide excision of his melanoma with 7- to 9-mm clinical margins, for a total size of 2.8 × 1.2 cm. The final pathology revealed an invasive malignant melanoma, stage pT1a, with a Breslow thickness of 0.3 mm. Clear margins were obtained. The patient required additional reconstruction of the eyelid via a Hughes tarsoconjunctival flap and a full-thickness skin graft from the left postauricular region for defect coverage (Fig. 1).

Analysis of questionnaire responses of group 1 was compared with those without skin cancer (group 2: n = 265) and demonstrated significant differences. Group 1 reported higher proportions to the following responses: "ever seen a dermatologist" (83% vs 37%, $P = 0.02$), "take any medications" (66% vs 12%, $P = 0.0001$), "blonde or red hair" (33% vs 6%, $P = 0.01$), "blue or green eyes" (66% vs 9%, $P < 0.0001$), and "use indoor tanning" (16% vs 0%, $P < 0.0001$). Group 1 was also associated with 4 or more blistering sunburns ($P = 0.08$), which approached significance. In addition, after skin examination, group 1 was more likely to be classified by a dermatologist as higher risk compared with group 2 (100% vs 1%, $P < 0.0001$).

Overall, most patients who participated in the study expressed some level of concern about an area or lesion on their skin (n = 202; 74%). When examined by a dermatologist, most of these conditions were found to be benign treatable disease. Table 4 depicts the frequency of benign diagnoses identified during the study period. Interestingly, 16 patients were identified to have precancerous actinic keratoses and were treated with either liquid nitrogen or 5-fluorouracil cream. All patients were counseled about their dermatologic conditions, and any patient with a treatable skin disease was provided with appropriate prescription medication and follow-up with local providers.

DISCUSSION

Early diagnosis of skin cancer is critical to improve prognosis, preserve quality of life, and provide optimal treatment results. Screening programs are a popular strategy to bring public awareness to insidious and devastating diseases. One of the most successful national skin cancer screening programs began as a pilot study in Germany in 2003. The SCREEN project, or the Skin Cancer Research to provide Evidence for Effectiveness in Northern Germany, was a pivotal initiative that determined population-based skin screenings can be effective at reducing the incidence rate and mortality in patients with skin cancer.[15]

During the 1-year project, more than 360,000 people, who were enrolled in statutory insurance, were screened by trained dermatologists or nondermatologist physicians. More than 3100 histopathologically confirmed skin tumors were diagnosed in the 2900 patients. Most cancers were BCC and melanoma. After the study, it was found that the incidence rate of skin cancer in the region of Northern Germany increased by 30%, presumably from increased awareness, whereas the other areas of the country remained the same.[6] Most importantly, there was a significant decrease in skin cancer–related mortality in the region 5 years

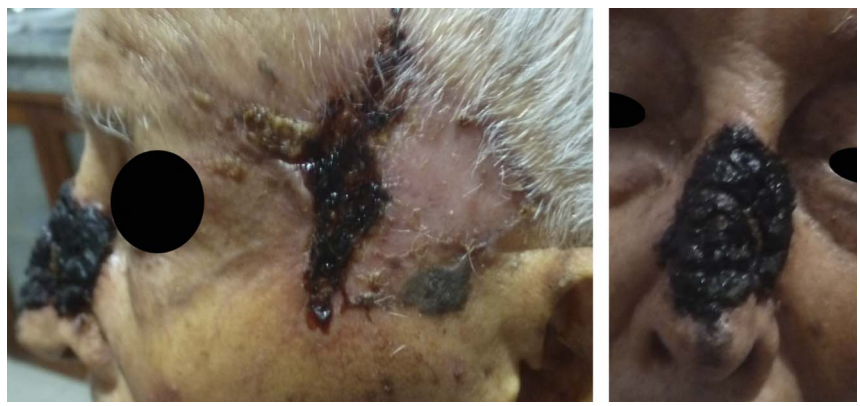

FIGURE 1. A 94-year-old man with multiple lesions too advanced for any treatments available at Blanca's House clinics. No biopsy obtained. full color online

TABLE 3. Cases and History From Patients Who Had Biopsies for Suspicious Lesions

Case	Description
1	44-year-old Hispanic man with no history of skin cancer. The patient reports the lesion first appeared to be the size of a period at age 18 y and continued to grow over time on his left lower eyelid. He never pursued medical treatment. Presumptive diagnosis of melanoma was confirmed with histology, stage 1a. The patient required further treatment at Stony Brook University Hospital and had a successful complete resection.
2	62-year-old European woman with no history of skin cancer reporting her thigh was concerning to her. Presumptive diagnosis of BCC on her left thigh confirmed with histology. Lesion was completely excised.
3	24-year-old European woman with no history of skin cancer reporting having more than 10 blistering sunburns before the age of 20 years. Lesion located on right side of her upper chest. Histology revealed BCC, which was completely excised.
4	71-year-old white man with 2 BCC lesions, one on his lower right eyelid and the other on the left side of his nose, in addition to an SCC in situ on his left upper arm. Confirmed with histology, all lesions completely excised.
5	88-year-old Hispanic man presented with an ulcerated lesion of middle left forehead. Pathology revealed confirmation of suspected BCC with clear margins.
6	76-year-old Hispanic man with no history of skin cancer presented with 2 BCC lesions on the right side of his neck and his left upper arm. Histology confirmed BCC, both of which were completely excised requiring no further intervention.
7	35-year-old Hispanic woman with pigmented lesion on upper left back. Lesion biopsied to rule out melanoma. Histology revealed compound nevus needing no further excision.
8	51-year-old Hispanic man with pigmented lesion in the left ear. Presumptive diagnosis was melanoma; however, histology results demonstrated seborrheic keratosis as the final diagnosis with no further treatment needed.

later. Ultimately, the federal joint committee, the national decision making body that determines benefit package of the statutory health insurance influencing 70 million Germans, used the protocol as a template for instituting a permanent national screening initiative in 2008.[6,15]

Studies have shown that the AAD SPOTme Program may have potentially identified skin cancers that would have otherwise gone undetected or experienced a delay in diagnosis in the United States.[16,17] In 2019, Beaulieu published a cross-sectional analysis of SPOTme skin cancer screenings indicating that the program has the potential to identify and target patients at high risk.[17] The questionnaire also demonstrated ability to identify common positive associations in patients suspected to have BCC and SCC such as advanced age, history of melanoma, specific skin phototype, 3 or more blistering sunburns before the age of 20 years, lack of insurance, or never visited a dermatologist.[17] Unlike the German SCREEN-based program, patients without insurance can undergo skin cancer screening through SPOTme's free

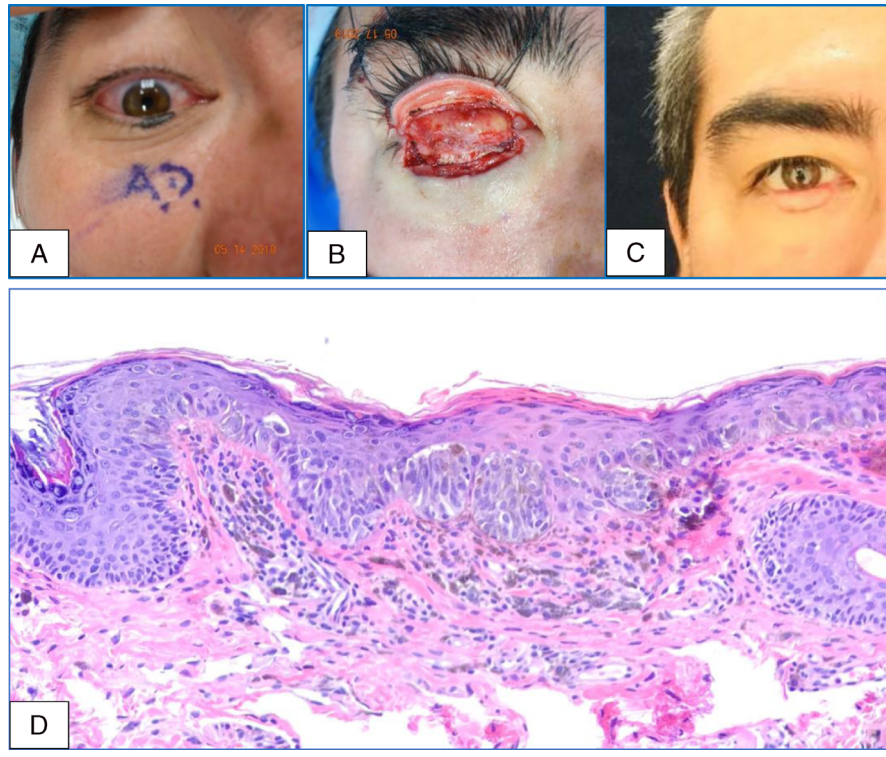

FIGURE 2. Patient and histology confirming diagnosis of malignant melanoma. A, Lesion preoperatively. B, Intraoperative image during reconstruction with Hughes tarsoconjunctival flap. C, The patient at 2 months status after division and inset of flap. D, Histology: marked uneven distribution of abnormal melanocytes in solitary units and in nests within the epidermis. Histiocytes with engulfed melanin pigment are present within the subcutis and fibroconnective tissue. full color online

TABLE 4. Frequency of Other Skin Conditions

Documented Findings	Cases (n)
Benign nevi	76
Seborrheic keratosis	42
Melasma	19
Actinic keratosis	16
Acne	15
Eczema	13
Fungal infection	12
Hyperpigmentation	8
Congenital nevus	7
Idiopathic guttate hypomelanosis	7
Seborrheic dermatitis	5
Psoriasis	5
Wart (flat or plantar)	5
Cyst	5
Folliculitis	4
Atypical nevus	4
Rosacea	3
Contact dermatitis	3
Scabies	3
Vitiligo	3
Dyshidrotic eczema	2
Atrophoderma vermiculatum	1
Cutaneous mastocytosis	1
Acral nevus	1

evaluation. This is significant considering that the analysis of SPOTme program 30-year history by Okhovat et al[16] demonstrated that lack of insurance was most commonly reported among 12% of patients diagnosed as having melanoma.

Although the SPOTme program is an impactful tool, limitations remain. The SPOTme program lacks the ability to confirm whether patients followed recommendations or met with a dermatologist, or whether the preliminary diagnosis correlated with findings on the histological level.[16,17] The only known study to correlate SPOTme screened patients with histological confirmation of melanoma was published in 1996 by Koh et al.[18] In this preliminary study, Koh et al collected completed SPOTme reports from the AAD between 1992 and 1994 and contacted 95% of patients who were suspected to have melanoma to determine whether the patient had followed up with a dermatologist after initial screen. Pathology reports from the physicians were obtained of the presumptive lesion, and the positive predictive value of a clinical diagnosis of melanoma was found to be 17%, thus determining that the patient questionnaire with visual examination was a reliable screening tool for skin cancer. A noted limitation of the study by Koh et al was that the strict inclusion criterion of verified clinical diagnosis of melanoma was applied. Other more prevalent skin cancers such as BCC and/or SCC were not investigated.[18] Our study presents the first time that histopathologic confirmation was carried out on a SPOTme-based questionnaire during initial screening.

In underserved areas, teledermatology has been shown to be a useful way to provide diagnosis of skin conditions.[19,20] However, geographic barriers to care still remain when further treatment is required. Our project reflects some of the best aspects of previous skin cancer screening studies. Using a well-known survey instrument, establishing a temporary interventional clinic, and verifying clinical suspicions with histopathological analysis, we provide a protocol on how to conduct a free skin cancer screening initiative in an underserved region. In addition, we were able to incorporate immediate skin examinations, biopsy, and excisional procedures all within the same initial visit minimizing loss to follow-up. This was significant because many patients in group 1 reported to have been seen by a dermatologist ($P = 0.02$) and yet were still living with their cancerous lesion when they presented for the screening. This can imply that barriers exist between diagnosis and treatment of a skin malignancy.

Histopathologic analysis confirmed that the modified SPOTme survey aided in identifying high-risk patients when evaluated by a dermatologist ($P < 0.0001$). Our results also demonstrated that patient education on skin protection strategies and self-skin check techniques were found to be a vital need in this population, as 44.6% of patients reported spending more than 4 hours in the sun per day. For this reason, patient education and community lectures on solar skin protection, how to properly conduct a self-skin examination, and how to identify concerning features of a nevus were given. Another unique aspect of this project is that patients automatically are connected with a local provider affiliated with Blanca's House, where they will continue to receive free follow-up.

It is also important to note that many patients came to the free clinic with various skin complaints; as a result, treatment was extended to address these needs. Any future skin cancer screening SVO initiative should expect to provide care for benign skin pathologies as well. Lastly, collaborating with local physicians and support staff is paramount in ensuring that any beneficial impact patients receive continues uninterrupted after the SVO trip has concluded. Working with local physicians during screening initiatives will enable community providers to learn from dermatologists and gain additional skills useful in diagnosing skin cancers.

We recognize that given the small sample size nature of this pilot study, the data may not be an accurate representation of the incidence or prevalence of skin cancer in the Galapagos. Although this study has limitations, it provides a template and practical insight for performing a larger-scale screening. Results from this pilot study may also be useful in the development of future studies aimed at determining the prevalence of skin cancer and understanding the risk factors that may predispose these patients to skin cancer in this region.

The value and impact of short-term SVO trips should constantly be assessed to minimize potential harms and maximize benefits for the underserved patients receiving care. Although there are no formal guidelines, it is the responsibility of the organization and physicians participating in SVO to perform a comprehensive assessment of the host country, local government laws and legislation, proper training and preparation of volunteers, and a plan for continued sustainability once the international volunteers have left.[21] Any future studies or initiatives implementing a protocol to conduct skin cancer screening and treatment for international communities will require a context and needs assessment throughout the planning process.[22]

We were able to adapt a well-known frequently used questionnaire tool and make it applicable to an international community; hence, this modified skin cancer survey may be useful for future goodwill medical volunteer trips aimed at providing dermatological services in underserved vulnerable communities. Future studies should focus on the ability of local physicians to implement this screening tool to identify patients who are at most risk, as this may potentially conserve health care resources. This study can also serve as the prototype for implementing screening initiatives where interventions are provided, offering immediate benefit to patients.

CONCLUSIONS

Skin cancer screening, particularly in regions where access to care is limited, should aim to incorporate immediate intervention, as socioeconomic and geographical barriers can be a challenge in seeking follow-up. When conducting a skin cancer screening, benign dermatological conditions may also need to be addressed. By verifying tentative clinical diagnosis with histopathology, we explored the utility of a modified SPOTme questionnaire in identifying patients with skin malignancy.

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