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Outcomes and implications of a 12-year cross-sectional study on diagnosing and recognizing skin tumors in primary care

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Abstract

Introduction: Skin cancer, a significant global health issue, requires prompt detection and management, particularly among the elderly. Primary care physicians play a critical role in early diagnosis because they are often the first to evaluate patients with skin lesions. Accurate diagnosis by family physicians is essential for effective treatment and improved patient outcomes.
Methods: Over a 12-year period, this study analyzed 125 samples from 89 patients that presented with visible skin changes or suspicious lesions identified during routine examinations. Initial working diagnoses made by family physicians were compared to final pathohistological diagnoses (PHD).
Results: The study found a significant difference between working diagnoses and final PHDs for malignant versus benign cases, with an accuracy of 83.3% and statistical significance ($p = 0.04$). A difference of 12.9% was observed, indicating areas for improvement. The diagnostic effectiveness for premalignant versus benign cases is high (accuracy of 88.2%), but without statistical significance ($p = 0.50$), and it suggests that these differences are not clinically relevant.
Conclusions: Primary care physicians demonstrate high accuracy in identifying malignant skin conditions, which is crucial for effective skin cancer management. However, improving diagnostic accuracy, particularly to reduce the misclassification of benign conditions as malignant, remains necessary. Continued training and development are essential to further enhance diagnostic precision for all skin conditions.

Keywords: primary care physician, skin cancers, early cancer diagnosis, clinical competence

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Introduction

Skin cancer is a major global public health threat, particularly among older adults. Increasing trends have been observed in individuals over 55 years old, with the burden of skin cancers, in terms of incidence and mortality, being higher in men than in women (1). Melanoma and non-melanoma skin cancer are the most common types of cancer in white populations, with non-melanoma skin cancer being the most prevalent (2). In recent decades, there has been a global increase in the burden of non-melanoma skin cancer. Wan Hu et al. (3) reported that the age-standardized incidence rate for non-melanoma skin cancer increased from 54.08 per 100,000 in 1990 to 79.10 per 100,000 in 2019. Other indicators, such as the number of deaths, disability-adjusted life years (DALYs), age-standardized mortality rate, and age-standardized DALY rate, show a similar trend. The burden of non-melanoma skin cancer is significantly higher for men than for women (3). Although a significant proportion of melanomas can be prevented, it remains a challenging disease worldwide, occurring more often in men than in women. Compared to the incidence of melanoma in 2020, it is estimated that by 2040 the number of new cases will increase by 50% and the number of deaths by 68% (4). Most skin cancers are caused by excessive exposure to UV radiation, which is exacerbated by the depletion of the ozone layer (5). Additional risk factors include increased outdoor activities, changes in clothing style, increased longevity, genetics, and, in some cases, immune suppression (2). A recent study found that breast cancer patients have an increased risk of melanoma following treatment with radiation therapy (6).

Given these trends, the role of primary care physicians in the early detection and diagnosis of skin tumors is crucial (7). As the first point of contact for many patients, primary care physicians are in a unique position to identify suspicious skin lesions and initiate early interventions (8, 9). This study evaluates the capability of primary care physicians to diagnose skin tumors and identifies the factors that influence their diagnostic accuracy. Conducted over a 12-year period, the research involved 89 patients that first presented to a primary care physician with concerns about potential skin tumors.

This article explores the diagnostic accuracy of primary care physicians, the common types of skin tumors identified, and the challenges faced in the initial diagnosis. The implications of these findings for training and practice improvements in primary care are also discussed.

Methods

Study design and patients

The respondents were patients of an office-based family physician. The total number of patients under the physician's care cannot be precisely stated due to significant fluctuations over the 12-year follow-up period, but this number ranged from approximately 1,350 to 1,400. The study included all patients that consulted their family physician for noticeable skin changes. In addition, it included patients that did not complain of skin changes but had suspicious skin lesions noticed by the physician during a physical examination. The study excluded patients with skin changes that were

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apparently benign, such as warts, hemangiomas, fibromas, lipomas, cysts, scars, scabs, and seborrheic keratosis. It also excluded patients that consulted a family physician after previously seeing other specialists, such as dermatologists, plastic surgeons, maxillofacial surgeons, and otorhinolaryngologists.

For examining patients with skin changes, the physician used naked-eye observation with a manual magnifier or a telescopic lamp that magnified the image 10 times. Although the physician had a dermatoscope in the office, it was not used during patient examinations due to a lack of certification for its use. After examining a patient with a skin lesion, the physician entered the data into a pre-prepared Excel table. Data recorded for each patient included sociodemographic information (age, sex, place of birth, and employment or pension status); the working diagnosis of the observed tumor; categorization of the tumor as benign (e.g., ganglion cyst, epidermoid cyst, melanocytic nevus, or keratoacanthoma), premalignant (e.g., cornu cutaneous or actinic keratosis), or probably malignant; localization of the tumor; and previous skin tumors with their localization. The patient's sun exposure was recorded descriptively (mild, moderate, or high), along with chronic diseases coded according to the International Statistical Classification of Diseases and Related Health Problems (ICD-10).

Patients categorized with premalignant or malignant lesions were referred for further examination and treatment by a dermatologist or, depending on the location, by a plastic surgeon, maxillofacial surgeon, or otorhinolaryngologist. Upon returning from skin tumor treatment, the treatment procedure and pathohistological analysis of the observed tumor were recorded. The pathohistological diagnosis (PHD) findings, which provide the final diagnosis, were compared with the initial categorization of the tumor by the physician.

Statistical analysis

Categorical data are represented by absolute and relative frequencies. Differences in categorical variables were tested with the chi-squared test and, if necessary, with Fisher's exact test. The concordance of the PHD findings and the referral diagnosis was tested with the McNemar–Bowker test. Sensitivity, specificity, accuracy, and AUC (area under the curve) were used in the medical predictions. The normality of the distribution of continuous variables was tested with the Shapiro–Wilk test, and due to the non-normal distribution the data were described by the median and interquartile range. All p values are two-sided. The significance level was set at alpha (α) = 0.05. The statistical program MedCalc® Statistical Software version 20.218 (MedCalc Software Ltd, Ostend, Belgium) was used for data analysis.

Results

The research was conducted from November 2012, to December 2023, on 125 samples taken from 89 patients, of whom 49 (55%) were male and 40 (45%) were female. All patients were Croatian citizens. The median age of the patients was 73 years (interquartile range 58 to 78 years), ranging from 19 to a maximum of 91 years. Most of the patients were married (70%) and retired (66%). Nineteen (21%) patients worked in open spaces, and 22 (32%) patients spent a lot of time in the sun. Earlier, skin tumors were recorded in 16 (18%) patients, of which 21/49 (43%) samples were malignant. The most common localization of previous tumors was the head (80%). After examining the observed tumor, a working diagnosis was made, and then the tumors were classified into three groups and the localization and side of the body where the tumor was located was recorded.

According to the referral diagnosis, 77 (61%) of the samples were likely to be malignant, most often localized in the head area, in 70 (56%) cases, equally on the left and right sides of the body (41% vs. 45%; Table 1).

A total of 72 PHD findings were known, of which 41 (57%) samples were malignant. Regarding the type of malignant sample, the majority (26, or 36% of cases) were basal cell carcinomas, followed by benign tumors (16, or 22%), and premalignant lesions (15, or 21%). Sixty-seven (94%) samples were surgically removed, and cryotherapy was performed in 10 (14%) patients (Table 2).

Sex and tumor localization

Regarding the sex of the patients in the study, there were slightly more men than women. Although skin cancers, including melanomas (10, 11) and non-melanoma tumors (3), are more common in men than in women, this study found no significant difference in the incidence of skin cancers according to PHD and patient characteristics. The most common localization of tumors was the head, and the most frequent type of malignant tumor was basal cell carcinomas. Similar results were presented in a retrospective study conducted in Poland (12). Among the patients that partici-

Table 1 | Patient characteristics (n = 89).

	n (%)
Sex	
Male	49 (55)
Female	40 (45)
Working status	
Employed	23 (26)
Unemployed	7 (8)
Pensioner	59 (66)
Workplace	
Closed space	69 (78)
Open space	19 (21)
Unknown	1 (1)
Time in sun (n = 68)	
Slight	16 (24)
Moderate	30 (44)
A lot	22 (32)
Previous skin tumors	16 (18)
Previous tumor type (n = 49 samples)	
Benign	13 (27)
Premalignant	6 (12)
Malignant	21 (43)
Previous tumor localization (n = 49 samples)	
Head	39 (80)
Neck	2 (4)
Trunk	18 (37)
Hands	6 (12)
Legs	2 (4)
Left side of body	25 (51)
Right side of body	28 (57)
Working diagnosis	
Probably malignant	77 (61)
Premalignant	36 (29)
Benign	12 (10)
Localization	
Head	70 (56)
Neck	1 (1)
Trunk	24 (19)
Hands	14 (11)
Legs	17 (14)
Left side of body	51 (41)
Right side of body	56 (45)

pated in the study, slightly less than one-fifth had previous skin tumors, most of which were malignant. Earlier studies have recognized that patients with a history of basal cell carcinoma (BCC) and squamous cell carcinoma (SCC) are more prone to developing new keratinocyte carcinomas (13, 14). A meta-analysis showed that, after an initial SCC, the risk of developing another within 3 years is 18%, whereas the risk of developing a second BCC within 3 years after a BCC (or SCC) is about 44%. The risk of developing SCC in patients with a previous BCC is lower (6% within 3 years) (15). Another study conducted in Poland indicated that 9% of patients with primary non-melanoma skin cancer (NMSC) will develop a second NMSC within 2 years (12). However, this information was limited regarding the frequency and timing of these subsequent tumors, highlighting the importance of long-term follow-up for these patients (13). In the study presented here, most previous tumors were located on the head, followed by the trunk, with fewer on the neck, arms, and legs, equally distributed on both sides of the body. Similar findings were reported in a recent retrospective study, which also found the head and trunk to be the most common tumor sites (13).

The McNemar–Bowker test revealed a 12.9% difference between the working diagnosis and the final PHD (malignant vs. benign). This difference indicates that approximately 12.9% of cases had discrepancies between the initial working diagnosis and the final confirmed diagnosis, and the significant result implies that the working diagnosis often does not align with the PHD.

In cases of premalignant and benign diagnosis, the lack of statistical significance suggests that the difference between working diagnoses and PHDs may not be clinically relevant in this dataset (Table 3).

There are no significant differences in the distribution of samples according to PHD and patient characteristics (Table 4).

Table 2 | **Pathohistological findings (*n* = 72).**

	n (%)
Pathohistological findings	
Malignant	41 (57)
Benign	16 (22)
Premalignant	15 (21)
Type	
Squamous cell carcinoma	5 (7)
Basal cell carcinoma	26 (36)
Melanoma	5 (7)
Other malignant	5 (7)
Premalignant	15 (21)
Benign	16 (22)
Surgery	67 (94)
Other interventions/procedures	11 (15)
Other procedures	
Cryotherapy, n/total	10/11
Imiquimod cream, n/total	1/11

Table 3 | **Agreement of working diagnosis and pathohistological (*n* = 72).**

	n by working diagnosis			Difference	95% CI	*p** value
	Malignant	Benign	Total			
Pathohistology						
Malignant	40	1	41	12.9%	2.6%–23.3%	0.04
Benign	8	5	13			
				Value	95% CI	
			Sensitivity	83.3%	69.7%–92.5%	
			Specificity	83.3%	35.9%–99.6%	
			Area under curve	0.833	0.707–0.921	
			Accuracy	83.3	70.7%–92.1%	
	Premalignant	Benign	Total			
Pathohistology						
Premalignant	10	0	10	11.8%	3.6% to 27.1%	0.50
Benign	2	5	7			
				Value	95% CI	
			Sensitivity	83.3%	51.6%–97.9%	
			Specificity	100%	47.8%–100%	
			Area under curve	0.917	0.680–0.995	
			Accuracy	88.2%	63.6%–98.5%	

*McNemar–Bowker test.
CI = confidence interval.

Table 4 | **Distribution of samples by pathohistology and patient characteristics.**

	n (%) by pathohistology				*p*
	Malignant	Benign	Premalignant	Total	
Sex	*n* = 41	*n* = 16	*n* = 15	*n* = 72	
M	18 (64)	6 (46)	3 (27)	27 (52)	0.10*
F	10 (36)	7 (54)	8 (73)	25 (48)	
Age group (years)	*n* = 41	*n* = 16	*n* = 14	*n* = 71	
Up to 50	6 (15)	4 (25)	0	10 (14)	
51–60	6 (15)	3 (19)	0	9 (13)	
61–70	10 (24)	2 (13)	2 (14)	14 (20)	0.26†
71–80	14 (34)	5 (31)	9 (64)	28 (39)	
81+	5 (12)	2 (3)	3 (21)	10 (14)	
Workplace	*n* = 41	*n* = 16	*n* = 15	*n* = 72	
Indoor	30 (73)	13 (81)	10 (67)	53 (74)	0.66†
Outdoor	11 (27)	3 (19)	5 (33)	19 (26)	
Time in sun (*n* = 56)	*n* = 30	*n* = 12	*n* = 14	*n* = 56	
Slight	8 (27)	2 (17)	7 (50)	17 (30)	
Moderate	8 (27)	6 (50)	4 (29)	18 (32)	0.25†
A lot	14 (47)	4 (33)	3 (21)	21 (38)	

M = male, F = female.
*x^2 test; †Fisher's exact test.

Discussion

This study examined the competence and ability of primary care physicians to recognize malignant skin tumors in the patients they care for. Patients with suspicious skin lesions were examined in the family physician's office during regular working hours, without being referred for special consultations. This approach integrated the examination of patients with suspected skin tumors into the routine daily work of the family physician over the 12-year research period and beyond. This integration was challenging given the workload of family physicians, for whom time is a scarce and valuable resource with an average visit duration of 18 minutes (16). A systematic review by Irving et al. reported that a large proportion of the global population has only a few minutes with their primary care physician (17). Family physicians are under increasing time pressure to provide both preventive care and care for chronic diseases. The growing number of clinical practice guidelines for preventive and chronic care that family physicians are expected to follow significantly contributes to these time pressures (18). It is important to note that not all patients that might have had skin cancer were included in this study because many opted to see dermatologists or surgeons directly. This selection bias, along with the small sample size, limits the statistical power of the study and its ability to draw generalizable conclusions. However, by focusing on those that did visit a primary care physician first, this study provides valuable insights into the diagnostic process in a primary care setting. In this study, the average time spent examining a patient with a suspected skin tumor, including entering all data into a pre-prepared Excel table, was approximately 20 minutes. This duration could be even longer if communication with the patient was difficult during the examination. Despite these time constraints, primary care physicians were able to manage the examination and assessment of skin tumors effectively within their routine practice.

The role of a primary care physician in skin cancer detection

Primary medicine is the foundation of the healthcare system (19). It was recognized as the main part of an effective health system in the early part of the twentieth century (20). One of the benefits of primary care is early management of health problems before they become serious enough to require hospitalization or emergency services (21). Family physicians have a unique position in the healthcare system. Due to their regular contact with the population, they play a crucial role in disease prevention, including cancer, through continuous and long-term patient care (22). Most skin cancers are presented in primary medicine, and the outcome depends on early recognition and referral of the patient for further treatment. Patient safety is essential, and it is unsafe to leave the diagnosis and treatment of malignant skin disease to physicians with limited training and experience (23).

The importance of skin cancer detection in primary medicine is twofold. First, more patients contact primary care physicians than dermatologists, and most patients referred to dermatologists are referred by primary care physicians. Second, early detection, diagnosis, and treatment are key to successful treatment (24). The primary care physician as the first line in detecting skin tumors should be aware of skin lesions with malignant characteristics. In case of uncertainty about the diagnosis of skin cancer, the patient should be referred to a dermatologist. False alarms are possible, but it is better than overlooking a melanoma patient (25). Any suspected melanoma and SCC should be urgently referred to a specialist for histological diagnosis and treatment. Suspected BCC should be routinely referred to specialist care unless it is of worrisome size or location, when it should also be given priority referral (8).

Training and expertise

The burden on primary care physicians to manage suspicious skin lesions is increasing, leading to higher healthcare costs. Primary care physicians must be trained in diagnosing suspected skin lesions (26). Understanding the similarities and differences between skin cancer and skin lesions that resemble cancer allows primary care physicians to diagnose most cases through inspection and palpation (27). With appropriate education, primary care physicians can detect and record all types of skin cancers earlier and more accurately. In addition, skin cancer prevention can be achieved by educating the population, in which family physicians play a crucial role (28). Non-dermatologists, including primary care physicians, are an essential part of the national skin cancer screening program (29). Primary care physicians should educate patients about risk factors for skin cancer and include skin examinations for premalignant and malignant lesions as part of routine check-ups (21). Patients that are knowledgeable about skin cancer risk factors are more likely to opt for clinical screening and draw malignant lesions to the physician's attention (30).

Barriers to family physicians recognizing and diagnosing premalignant and malignant skin tumors

Recognition and diagnosis of premalignant and malignant skin tumors by family physicians is variable. Skin cancer control practices are performed less frequently than other preventive practices, with one of the most important barriers being the lack of training to perform these practices (31). A study conducted in France among family physicians showed that prevention and screening for skin cancer are infrequent, and fewer patients were examined by family physicians. According to the authors, one reason is the perceived insufficient qualifications for examining suspicious skin lesions, leading to three times more frequent referrals to specialists for consultations aimed at skin cancer than for other consultations (32). Research conducted in the United Kingdom among foundation trainees on skin cancer assessment and referral for surgical treatment and reconstruction was not satisfactory. Foundation trainees were not reliable at performing complete skin examinations or formulating diagnoses of pigmented skin lesions. This is concerning given that most will enter general practice, where exposure to skin tumors will be common (33). A study conducted in the United States among middle-aged and older white adults found low rates of skin examinations reported in the year preceding the study. Risk groups for which skin examination rates need to be increased include men, the elderly, and those with a lower level of education (34). Educational training programs for primary care physicians on skin cancer could reduce mortality and morbidity from skin cancer, especially in populations with insufficient access to dermatologists, such as rural, underserved, and uninsured populations (9). One study of family physicians in the United States found that, although physicians are confident in evaluating skin lesions and believe skin cancer screening should be the standard of care, insufficient time makes skin cancer screening difficult. They also reported a need for tar-

geted education about skin lesions in family medicine residency training programs (35). Another study conducted in the United States reported that a higher density of primary care physicians might be associated with increased diagnosis of early-stage melanoma without a corresponding reduction in late-stage melanoma and melanoma-related mortality (36).

Diagnosing skin cancer can be challenging because common non-malignant skin lesions, such as seborrheic keratoses, share features with less common skin cancers (8). Even experts in pigmented lesion clinics can sometimes miss a diagnosis of malignant melanoma (37). Another important obstacle is the insufficient use of dermoscopy. Although dermoscopy can help primary care physicians in the assessment and triage of skin lesions, it is used by only a small number of them. According to primary care physicians, regardless of whether they use dermoscopy, the main barrier to its wider use is insufficient training in dermoscopy and dermatology in general (38).

Primary care physicians' proficiency in diagnosing skin cancer

In this study, the McNemar–Bowker test revealed a 12.9% discrepancy between the working diagnosis and the final PHD for malignant versus benign cases. This discrepancy indicates that approximately 12.9% of cases had mismatches between the initial working diagnosis and the final confirmed diagnosis. The statistical significance (p = 0.04) suggests that the working diagnosis often does not fully align with the PHD. For premalignant versus benign cases, the lack of statistical significance (p = 0.50) suggests that the differences between the working diagnoses and PHDs may not be clinically relevant. This is reflected in the strong diagnostic performance for malignant cases, for which the working diagnosis showed an accuracy of 83.3% and a significant result (p = 0.04). However, the 12.9% discrepancy indicates that there is still room for improvement. In contrast, the diagnostic performance for premalignant versus benign cases was excellent, but the lack of significant difference implies that any diagnostic discrepancies are not as impactful in this dataset. The process of qualifying each tumor as possibly malignant relied heavily on the existing knowledge and experience of the physician, combined with a very detailed clinical examination. Given that the study lasted 12 years, the skill of the physicians in evaluating skin tumors as likely malignant steadily increased over time. This long duration allowed for ongoing learning and refinement of diagnostic techniques, which may have contributed to the improvements observed in diagnostic accuracy.

Brochez et al. noted that the proportion of pigmented lesions correctly identified is proportional to their frequency in everyday practice (39). Similarly, research from Spain indicated that primary care physicians were more effective at ruling out certain skin conditions than at making accurate clinical diagnoses, suggesting a need for further improvement in their knowledge and skills, particularly for skin cancers (40). A cross-sectional study in Turkey found that family physicians were better at distinguishing between benign and malignant lesions than between malignant and premalignant lesions (41). In contrast, a study in the Netherlands highlighted that family physicians had high diagnostic accuracy for malignant skin tumors, with a sensitivity of 74.3% and a specificity of 97.3%, and could effectively exclude malignancies (42). An Australian study showed that general practitioners detected 73.9% of melanomas, and their diagnostic accuracy compared favorably with both dermatologists and other general practitioners (43). Furthermore, research in Australia indicated that skin cancer clinic physicians and general practitioners both demonstrated high sensitivity (0.94 vs. 0.91) in diagnosing and treating skin cancers, although clinic physicians showed higher sensitivity for BCC and melanoma (44). Finally, a study on the early detection of melanoma in specialized skin cancer clinics within primary care in Australia found that physicians detected 83% of in situ melanomas and 73% of thin invasive melanomas, but only 48% of thicker invasive melanomas (≥ 0.8 mm). These findings suggest a high level of diagnostic capability in detecting early-stage melanomas but highlight challenges in identifying more advanced cases (45).

The results of this study highlight the proficiency of primary care physicians in diagnosing malignant skin tumors. The high accuracy and statistical significance for malignant cases demonstrate their strong diagnostic capabilities. However, the 12.9% discrepancy in diagnoses emphasizes the need for improvement, particularly in minimizing the misclassification of benign conditions as malignant. Misclassifying malignant conditions as benign can be particularly concerning because it might delay necessary treatments. This outcome suggests that primary care physicians, possibly fearing the consequences of missing a malignant tumor, may have characterized some benign tumors as malignant. For example, seborrheic keratosis, a common benign tumor often affecting the elderly (46), can mimic malignancy, especially in its pigmented and inflamed forms. This type of seborrheic keratosis can be confused with melanoma, basal cell carcinoma, or pigmented actinic keratosis (47), and atypical malignant melanomas can resemble seborrheic keratosis, adding to diagnostic challenges (48, 49).

Given these complexities, this study indicates there is significant room for improvement. This cautious approach underscores the importance of continuous training and support for primary care physicians in dermatological diagnostics to improve accuracy across all types of skin conditions. Primary care physicians may benefit from additional training or tools to better distinguish between benign and malignant lesions, as well as between malignant and premalignant conditions (33, 50). Addressing these needs will help in providing even more effective and reliable care in skin cancer detection and management.

Conclusions

Primary care physicians demonstrate high diagnostic accuracy for both malignant and premalignant skin conditions. Despite this, there is a notable discrepancy in the diagnosis of malignant lesions, indicating a need for further improvement. The performance in distinguishing premalignant from benign lesions is strong, although not statistically significant. Continued efforts to refine diagnostic precision are recommended to enhance overall accuracy and patient care.

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