ORIGINAL REPORT

Does Teledermatology Enable Earlier Diagnosis of Cutaneous Squamous Cell Carcinoma Than Face-to-face Consultation?

Marta CEBOLLA-VERDUGO[1,3], Husein Husein EL-AHMED[2,3] and Ricardo RUIZ-VILLAVERDE[1,3]
[1]Department of Dermatology, Hospital Universitario San Cecilio, Granada, [2]Department of Dermatology, Hospital de Baza, Granadaain, and [3]Instituto de Investigación Biosanitaria de Granada, Granada, Spain

Teledermatology has become increasingly relevant for skin cancer diagnosis, particularly following the COVID-19 pandemic. This retrospective study assessed whether teledermatology enables earlier diagnosis of cutaneous squamous cell carcinoma (cSCC) compared with conventional face-to-face consultation. Clinical and histopathological data from 224 patients (101 in 2019; 123 in 2022) were analysed. Referral delays decreased from 55 to 3 days and surgical wait times from 28.7 to 12.3 days. Tumours diagnosed via teledermatology had significantly smaller minor diameters (0.56 ± 0.3 cm vs 1.09 ± 0.5 cm; $p < 0.001$). Although maximum diameter and tumour depth did not differ significantly, the smaller tumour surface area in the teledermatology group suggests diagnosis at an earlier clinical stage. In multivariate analysis, minor diameter was the strongest independent predictor of teledermatology-based diagnosis (OR = 0.01, 95% CI: 0.001–0.02). These findings suggest that teledermatology facilitates earlier diagnosis of cSCC, allowing timely treatment and potentially reducing the need for extensive surgical procedures. Teledermatology should be considered a valuable triage tool for skin cancer detection, particularly in health systems with limited access to dermatological care.

Key words: teledermatology; cutaneous squamous cell carcinoma; early diagnosis.

Submitted Jul 9, 2025. Accepted after revision Oct 20, 2025

Published Oct 30, 2025. DOI: 10.2340/actadv.v105.44362

Acta Derm Venereol 2025; 105: adv44362.

Corr: Marta Cebolla Verdugo, Department of Dermatology, Avenida del Conocimiento s/n, ES-18006 Granada, Spain. E-mail: martacevers@gmail.com

SIGNIFICANCE

Earlier diagnosis of skin cancer improves outcomes. This study shows that teledermatology helps detect squamous cell carcinoma at an earlier stage. With shorter waiting times, patients can receive faster treatment. Teledermatology also helps hospitals prioritize urgent cases and reduce unnecessary delays. These findings support the use of digital tools to improve cancer care and access to specialists.

Cutaneous squamous cell carcinoma (cSCC) represents approximately 20% of nonmelanoma skin cancers (NMSCs) and is characterized by locally aggressive behaviour with a significant risk of recurrence and metastasis (1). Despite its clinical relevance, the true incidence of cSCC is often underestimated, as it is not consistently included in national cancer registries and is frequently limited to the first tumour diagnosed in each patient (2).

Prognostic factors play a critical role in determining cSCC behaviour, allowing for the classification of high-risk tumours, which require more aggressive treatment strategies. Clinically, tumours larger than 2 cm, those located in high-risk areas such as the lip, ear, or temple, recurrent lesions, presence of neurological symptoms, and immunosuppression are considered poor prognostic indicators (3). Histopathological factors also contribute to cSCC aggressiveness, with tumours thicker than 6 mm, invasion beyond the subcutaneous fat, poor differentiation, perineural invasion affecting nerve fibres ≥ 0.1 mm, lymphovascular invasion, and aggressive histological subtypes (adenosquamous, acantholytic, desmoplastic, spindle cell) being associated with higher recurrence and metastatic potential (4).

Timely surgical intervention is crucial, as delays exceeding 18 months have been correlated with larger and more invasive tumours (5). This reinforces the need for early detection and rapid treatment, particularly given the rising incidence in several European countries and the higher risk of recurrence and poor outcomes in immunosuppressed patients (6). However, access to dermatological evaluation remains a significant barrier, particularly in regions with a shortage of dermatologists or long waiting times for specialist consultation (7). Teledermatology has emerged as a transformative tool in skin cancer screening, offering an effective means for remote lesion assessment, thereby enhancing diagnostic efficiency and access to specialized care (7). Several studies have reported high sensitivity rates (94.9%) for teledermatology-based skin cancer diagnoses, comparable to in-person assessments (7). During the COVID-19 pandemic, teledermatology played a crucial role in maintaining skin cancer screening programmes, demonstrating its functionality as a remote diagnostic tool (8).

While most teledermatology studies have focused on diagnostic concordance with in-person evaluations, few have assessed its impact on prognostic factors, including histopathological parameters. This study aims to evaluate

the impact of teledermatology on the early diagnosis of cSCC, comparing patient and tumour characteristics between cases diagnosed via traditional face-to-face consultations (2019) and teledermatology-based evaluations (2022).

METHODS

Study design and population

This retrospective observational study was conducted at Hospital San Cecilio, comparing patients diagnosed with cSCC through face-to-face consultation (2019) vs teledermatology (2022). The selection of these years is relevant, as 2019 represents the pre-pandemic period and 2022 the post-pandemic period, ensuring that observed differences are not influenced by the impact of COVID-19 on healthcare access.

Data collection and study variables

Clinical and histopathological data were collected from electronic medical records and pathology reports, including epidemiological, clinical, and histopathological variables. Epidemiological data included age (years), sex (male/female), and consultation type (teledermatology vs face-to-face). Clinical variables encompassed the initial clinical diagnosis (cSCC vs other lesions), previous history of cSCC (yes/no), immunosuppression status (yes/no), type of immunosuppression, transplanted organ (if applicable), use of antiplatelets or anticoagulants (yes/no), high-risk tumour location (yes/no), exact anatomical location, tumour recurrence (yes/no), and the need for adjuvant radiotherapy (yes/no). Histopathological parameters included tumour dimensions, specifically maximum diameter (cm), minimum diameter (cm), and depth (mm). For each lesion, both the maximum (major) and minimum (minor) diameters were recorded from the pathology report after complete excision. The "minor diameter" refers to the smallest measurable axis of the tumour in millimetres. Although AJCC staging primarily uses the maximum diameter (e.g., $\geq$2 cm or $\geq$4 cm), the minor diameter provides complementary information regarding tumour surface area and volume. Calculating tumour area as the product of both diameters (cm²) allowed us to estimate lesion extent more accurately. Tumour area was included in both univariate and multivariate analyses to evaluate its association with consultation modality. A lower minor diameter, with a comparable maximum diameter, may reflect flatter or less voluminous tumours – an indirect marker of earlier detection. Tumour invasion characteristics such as perineural invasion, lymphovascular invasion, subcutaneous fat invasion, and bone invasion were recorded (yes/no). The histological differentiation grade was classified as well, moderate, or poorly differentiated. Finally, surgical margins were assessed and categorized as clear or involved.

The asynchronous teledermatology workflow was implemented through the Andalusian public digital health platform, DIRAYA®. Primary care physicians uploaded both macroscopic and dermoscopic images of suspicious lesions, which were reviewed by dermatologists within 24–48 h. Based on clinical suspicion, patients were scheduled for an in-person dermatology consultation within 1 to 3 working days. If the lesion was considered suitable for removal under local anaesthesia, it was often excised on the same day in a minor surgical theatre located within the dermatology outpatient unit. Lesions requiring general anaesthesia were referred for preoperative anaesthetic evaluation and scheduled in the main operating room (OR), typically within 2–3 weeks. Importantly, all patients included in this study underwent complete excisional biopsies; incisional biopsies (e.g., punch) were excluded.

Tumour staging and high-risk classification were performed following national clinical and histological criteria published by the Grupo Español de Dermato-Oncología y Cirugía (GEDOC) and a recent Spanish study (4), which include: tumour size (>2 cm), location in high-risk anatomical areas (e.g., lip, ear, central face), recurrence, patient immunosuppression, histological thickness (>6 mm), invasion beyond the dermis, poor differentiation (G3), perineural invasion involving nerves >0.1 mm, and presence of aggressive histological variants such as desmoplastic, acantholytic, or spindle-cell subtypes.

Time of evolution refers to the patient-reported interval between initial awareness of the lesion and the first dermatology consultation. Referral delay was defined as the time (in days) from primary care referral to the first dermatology consultation (teledermatology or in-person). Surgical waiting time was defined as the time (in days) from the dermatologist's surgical indication to the date of excision.

Statistical analysis

Continuous variables were expressed as mean ± standard deviation (SD), depending on data distribution. Categorical variables were summarized as absolute frequencies and percentages. The Shapiro–Wilk test was used to assess the normality of continuous variables. Welch's *t*-test was applied for comparisons of normally distributed continuous variables between consultation groups, whereas the Mann–Whitney *U* test was used for non-normally distributed variables. For categorical variables, Pearson's χ^2 test was performed, and when expected frequencies were <5, Fisher's exact test was applied.

A multivariate logistic regression model was conducted to adjust for potential confounders and to determine independent predictors of teledermatology-based diagnosis. The dependent variable was consultation type (teledermatology vs face-to-face), and independent

Table I. Clinical and tumour characteristics by consultation modality

Variable	Face-to-face (2019) $n=112$	Teledermatology (2022) $n=107$	p-value
Mean age (years)	79.2±10.2	79.3±10.4	0.872
Male aex (%)	65.3%	67.5%	0.846
Immunosuppression (%)	17.8%	16.3%	0.896
Previous cSCC (%)	9.9%	8.1%	0.242
Maximum tumour diameter (cm)	1.4±0.7	1.4±1.1	0.340
Minor tumour diameter (cm)	1.09±0.5	0.56±0.3	<0.001
Tumour thickness (mm)	3.7±3.1	3.3±3.0	0.259
*High-risk location (%) **	18.8%	18.7%	0.880

*High-risk locations include central face, lip, ear, genitalia, hands, and feet.
Tumour location prevalence by group:
- Face: 37.5% (2019), 39.3% (2022).
- Scalp: 11.6% (2019), 13.1% (2022).
- Neck: 4.5% (2019), 3.7% (2022).
- Trunk: 10.7% (2019), 8.4% (2022).
- Upper limbs: 16.1% (2019), 15.0% (2022).
- Lower limbs: 19.6% (2019), 20.5% (2022).

Data are presented as mean±standard deviation for continuous variables and as percentages for categorical variables. Tumour diameters are expressed in centimetres (cm), consistent with clinical staging thresholds. High-risk anatomical locations include the central face, ears, lips, genital area, hands, and feet, according to current staging criteria. Percentages for tumour location were calculated relative to the total number of tumours in each cohort ($n=112$ in 2019; $n=107$ in 2022). All tumours were histologically confirmed by complete excisional biopsy.

variables included epidemiological factors (age, sex), clinical characteristics (tumour evolution time, recurrence, anatomical location), and histopathological parameters (maximum and minor tumour diameters, tumour thickness, differentiation grade, invasion characteristics). The odds ratios (ORs) and 95% confidence intervals (CIs) were reported for each predictor. Model fit was assessed using deviance, Akaike Information Criterion (AIC), and Fisher scoring iterations. A p-value <0.05 was considered statistically significant.

All statistical analyses were performed using R software (version 4.4.3; R Foundation for Statistical Computing, Vienna, Austria). Data visualization was conducted using ggplot2 package in R for graphical representation of group differences.

This study was conducted by collecting data from medical records and pathology reports, without any interventions that could pose a risk to patients. The study was approved by the Ethics Committee of Hospital Universitario San Cecilio (DERM_HUSC_2024_002). It adhered to the ethical principles outlined in the Declaration of Helsinki.

RESULTS

Patient characteristics

A total of 224 patients diagnosed with cSCC were included in this study: 101 patients diagnosed through face-to-face consultation (2019) and 123 patients diagnosed via teledermatology (2022).

The mean age of patients was comparable between groups (79.2±10.2 vs 79.3±10.4 years; $p=0.872$), with a predominance of male patients in both cohorts (65.3% vs 67.5%; $p=0.846$). No significant differences were observed in immunosuppression status (17.8% vs 16.3%; $p=0.896$) or history of previous cSCC (9.9% vs 8.1%; $p=0.242$) (**Table I**).

Descriptive and univariate analysis

The mean maximum tumour diameter did not differ significantly between groups (1.4±0.7 cm vs 1.4±1.1 cm; $p=0.340$). Similarly, tumour thickness was comparable (3.7±3.1 mm vs 3.3±3.0 mm; $p=0.259$). However, minor tumour diameter was significantly smaller in the teledermatology group (0.56±0.3 cm vs 1.09±0.5 cm; $p<0.001$). No significant differences were observed in high-risk tumour location (18.8% vs 18.7%; $p=0.880$) or recurrence rate (7.9% vs 9.1%; $p=0.617$. Similarly, Pearson's χ^2 test with Yates' continuity correction showed that the variable "time of evolution" did not reach statistical significance ($p=1.000$). In addition, the bivariate analysis of tumour surface area (product of maximum × minor diameter) showed that lesions diagnosed via teledermatology had a smaller mean surface area compared with those diagnosed through face-to-face consultation (mean±SD: 1.53±X cm² vs 1.92±X cm²; $p=0.051$).

In the conventional face-to-face consultation pathway, the average delay from primary care referral to dermatology consultation was 55 days in 2019, whereas with teledermatology in 2022, the delay was significantly reduced to 3 days for in-person evaluation.

Additionally, the mean waiting time for surgical intervention for cSCC in our healthcare area was 28.7 days in 2019 and 12.3 days in 2022, primarily due to scheduling delays associated with cases requiring general anaesthesia (see Fig. 5).

Table II summarizes the main tumour characteristics, while **Fig. 1** visually represents the differences between groups according to continuous variables. **Fig. 2** provides a visual representation of the distribution of these categorical variables between the 2 consultation groups.

Multivariate analysis

To account for potential confounders, a multivariate logistic regression model was performed, adjusting

Table II. Multivariate logistic regression model for teledermatology-based diagnosis

Variable	Estimate	Std. error	z-value	*p*-value	Significance
Intercept	1.41003	0.69065	2.042	0.0412	$p<0.05$
Tumour thickness 1	−0.07602	0.35502	−214	0.8304	
Tumour thickness 2	−0.02685	0.40583	−66	0.9473	
Major × minor diameter	0.92629	0.25258	3.667	0.0002	$p<0.001$
Maximum diameter (cm)	0.72768	0.43624	1.668	0.0953	$p<0.1$
Minor diameter (cm)	−4.31751	0.65685	−6.573	<0.001	$p<0.001$
Evolution time	0.06071	0.39389	154	0.8775	
Face vs other location	0.09132	0.42629	214	0.8304	
High-risk location	−0.33632	0.43706	−0.77	0.4416	
Differentiation grade	0.08744	0.25113	348	0.7277	
Lymphovascular invasion	15.8568	849.62821	19	0.9851	

Adjusted logistic regression model evaluating independent predictors of teledermatology-based diagnosis. Minor tumour diameter remained a significant predictor ($p<0.001$), suggesting that smaller tumours were more likely to be detected remotely. Other histopathological features, including tumour thickness and differentiation grade, were not significantly associated with the consultation method. Odds ratios (ORs) and 95% confidence intervals (CIs) are reported for each variable.
– Null deviance: 306.77 (df = 222).
– Residual deviance: 224.59 (df = 212).
– AIC: 246.59.
– Observations removed due to missingness: 1.
– Fisher Scoring iterations: 14.

for tumour dimensions, tumour thickness, differentiation grade, and invasion characteristics. Minor tumour *diameter remained a strong independent predictor of teledermatology-based diagnosis (estimate = –4.31751,* $p<0.001$), confirming that smaller tumours were more likely to be detected remotely. Additionally, the product of maximum and minor diameters was also significant (estimate = 0.92629, $p=0.0002$), reinforcing the impact of tumour size on consultation modality. This multivariate finding is consistent with the bivariate analysis, which also demonstrated a smaller surface area in the teledermatology group.

Table III presents the full logistic regression model, including the adjusted odds ratios (OR) and confidence intervals (CI) for each predictor.

The adjusted model confirmed that minor tumour diameter was the strongest predictor of teledermatology diagnosis (OR = 0.01, 95% CI: 0.001–0.02, $p<0.001$). Other histopathological characteristics, including tumour thickness, differentiation grade, and high-risk location, did not show significant associations ($p>0.05$ for all comparisons).

Fig. 3 provides a visual representation of the logistic regression coefficients, and **Fig. 4** illustrates the adjusted odds ratios for each variable included in the model.

DISCUSSION

Our study provides valuable insights into the role of teledermatology in the early detection of cSCC, comparing its performance with traditional face-to-face consultation. The findings reinforce the feasibility of remote assessment while highlighting critical aspects that warrant further investigation regarding its impact on clinical decision-making and long-term outcomes.

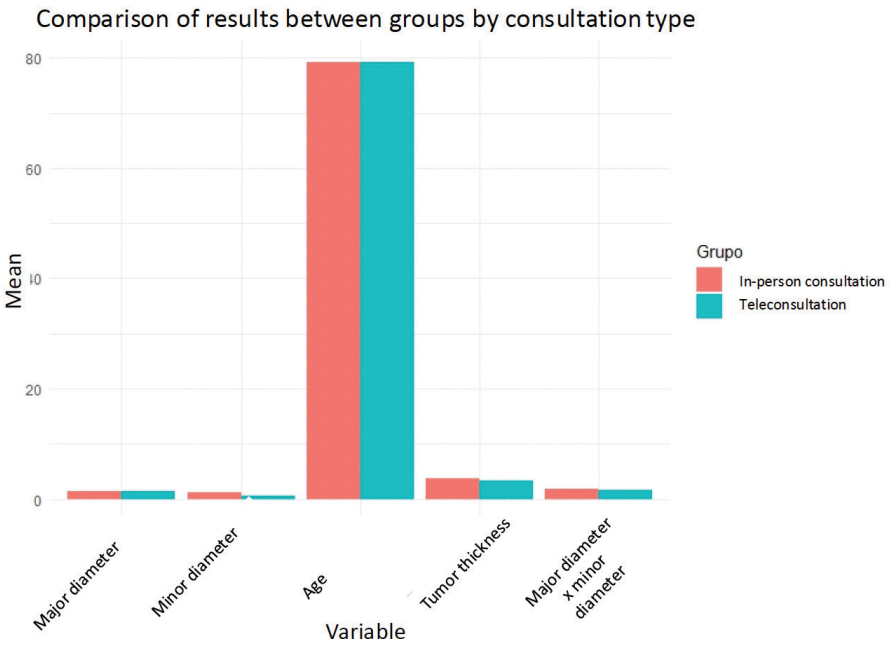

Fig. 1. Comparison of mean tumour size parameters between face-to-face and teledermatology groups. Bar plot illustrating the comparison of maximum diameter, minor diameter, and tumour thickness between face-to-face and teledermatology-based diagnoses. Minor tumour diameter was significantly smaller in the teledermatology group ($p<0.001$), whereas no significant differences were observed for other tumour size parameters.

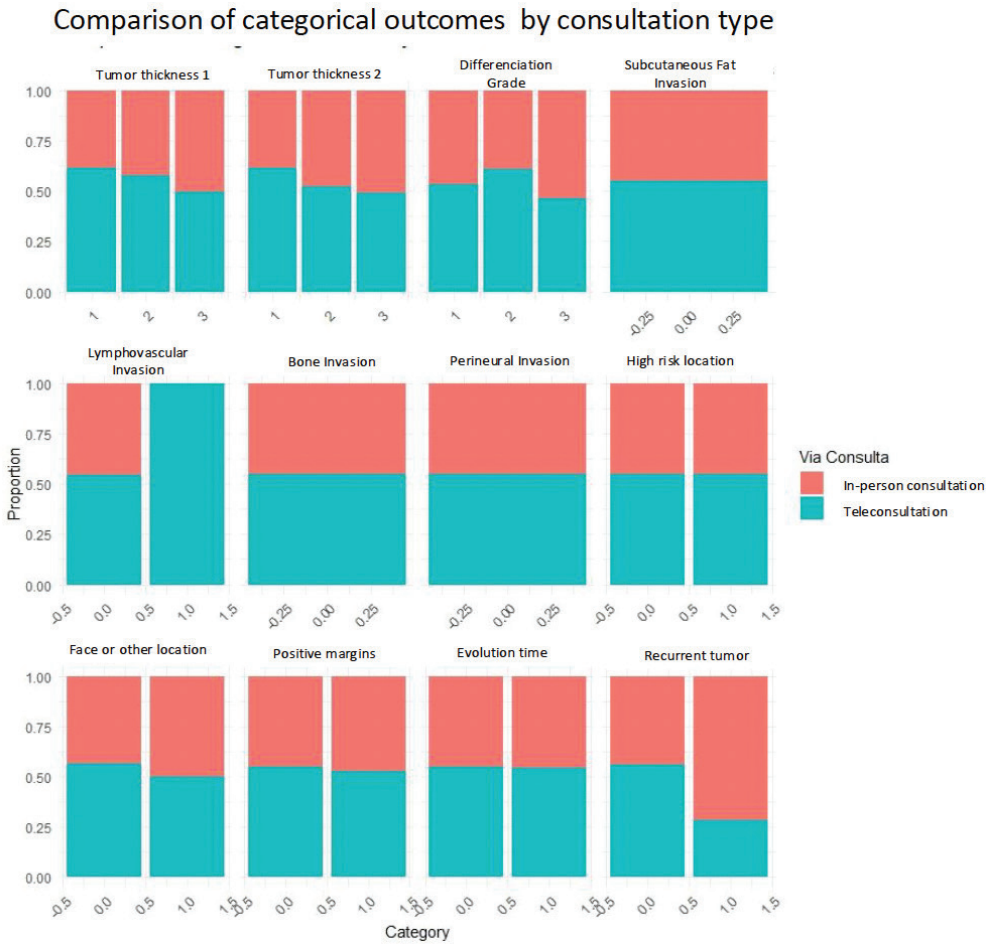

Fig. 2. Distribution of categorical tumour characteristics by consultation type. Stacked bar chart showing the distribution of histopathological variables, including tumour classification, tumour differentiation grade, and high-risk location, across consultation modalities. No significant differences were observed between face-to-face and teledermatology groups ($p > 0.05$ for all comparisons), suggesting comparable tumour characteristics between the 2 modalities.

The implementation of asynchronous teledermatology significantly improved access times in our healthcare area. The average delay from primary care referral to dermatology consultation was reduced from 55 days in 2019 to only 3 days in 2022. Likewise, the waiting time for surgical excision of cSCC decreased from 28.7 to 12.3 days. These differences were influenced by logistical factors: while many lesions in the teledermatology group were excised under local anaesthesia during the same outpatient visit, cases requiring general anaesthesia faced inherent delays due to preoperative evaluation and limited operating room availability. These systemic factors help contextualize the differences observed between groups.

One of the most notable findings was the significantly smaller mean tumour area in the teledermatology group. The teledermatology group exhibited a significantly smaller minor diameter, despite similar maximum diameters. Although staging is based solely on maximum diameter, a smaller minor axis reflects a lower surface extension. This suggests that remote evaluation may facilitate earlier detection, potentially allowing for less invasive surgical interventions and improved patient outcomes (9). Given that early excision is associated with lower morbidity (10), these results underscore the potential of teledermatology as a tool for timely cSCC management. This suggests that teledermatology not only facilitates the early recognition of cSCC but may also reduce the need for more aggressive surgical interventions, such as wide excisions requiring general anaesthesia or adjuvant radiotherapy.

However, the absence of significant differences in maximum tumour diameter or depth raises important questions. While tumour area was reduced, the lack of variation in depth suggests that teledermatology may be particularly effective at identifying smaller lesions in terms of surface extension rather than vertical invasion. This may be related to the heterogeneous biological behaviour of cSCC, where some tumours exhibit rapid horizontal growth regardless of depth, while others remain indolent for extended periods. Additionally, patient delay in presentation may not always correspond to tumour growth rate, as lesions in low-visibility areas may go unnoticed for longer and, conversely, lesions in visible

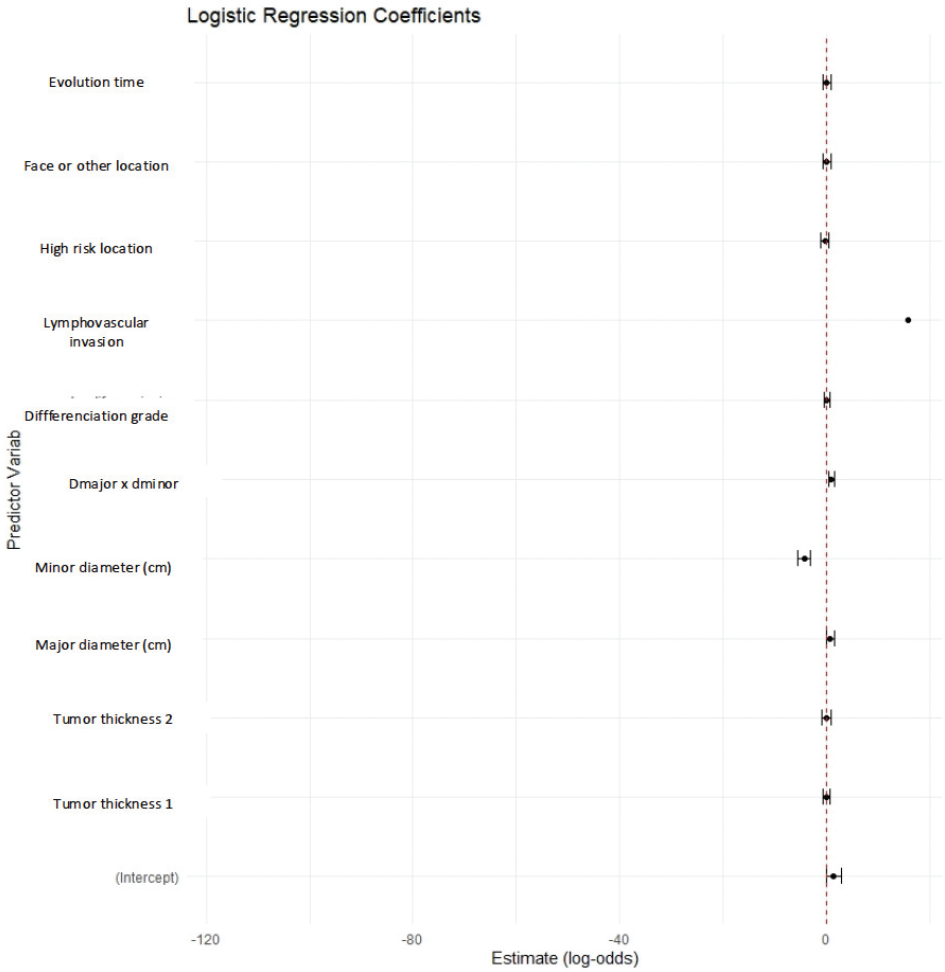

Fig. 3. Logistic regression coefficients with 95% confidence intervals. Forest plot representing the estimated coefficients from the multivariate logistic regression model. Minor tumour diameter showed a strong negative association with teledermatology-based diagnosis ($p < 0.001$), reinforcing that smaller tumours were more likely to be detected remotely. The interaction term (maximum × minor diameter) was also significant ($p = 0.0002$), while other histopathological characteristics did not reach statistical significance.

or symptomatic areas may prompt earlier consultation even when larger. Moreover, access to teledermatology platforms may have favoured the inclusion of patients with better digital literacy or healthcare access, potentially introducing a selection bias. This highlights the need for further refinement in remote assessment protocols to ensure the accurate identification of subtle prognostic features, such as perineural invasion or tumour differentiation, which are crucial for risk stratification (4). Moreover, certain clinical features suggestive of high-risk cSCC – such as ulceration, rapid growth, or local infiltration (4) – can be identified clinically or dermoscopically and may inform early prioritization even before histological confirmation. These observations align with the findings of Díaz-Calvillo et al. (14) who, in a national post-pandemic study, reported an increased proportion of high-risk cSCCs despite stable histologic parameters such as tumour depth and perineural invasion. This supports the notion that clinical delays may impact tumour burden primarily at the surface level, without necessarily altering vertical invasion or histopathologic aggressiveness.

Most studies evaluating teledermatology have focused on diagnostic concordance between remote and in-person assessments, rather than prognostic implications. To our knowledge, there is limited evidence assessing histopathological parameters to determine whether tumours diagnosed via teledermatology differ in prognosis compared with those detected through face-to-face consultation. A study by Ferrándiz et al. (11), evaluating melanoma prognosis, found that tumours diagnosed via teleconsultation had significantly lower tumour thickness and a higher proportion of favourable-stage melanomas than those diagnosed through traditional referral pathways (11). In our study, although the tumour thickness was also lower in the teleconsultation group, the result did not reach statistical significance. This lack of significance may be attributed to the sample size, suggesting that a larger cohort could potentially confirm this trend. Whether a similar trend exists for cSCC remains unclear, underscoring the need for further studies assessing long-term oncological outcomes in teledermatology-diagnosed cases. However, our literature search did not identify

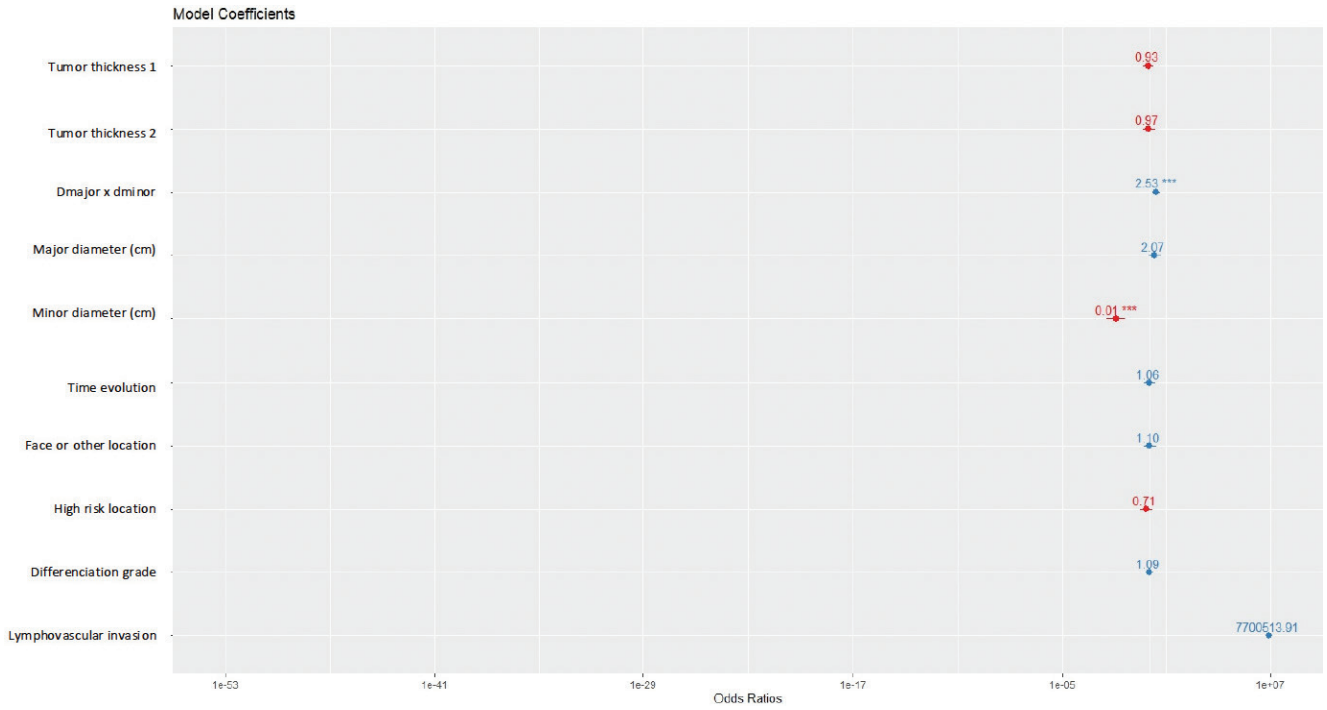

Fig. 4. Adjusted odds ratios (ORs) for independent predictors of teledermatology diagnosis. Forest plot displaying the adjusted ORs with 95% confidence intervals for variables included in the logistic regression model. Minor tumour diameter remained the most significant predictor (OR = 0.01, 95% CI: 0.001–0.02, $p < 0.001$), confirming that teledermatology is associated with the diagnosis of smaller tumours. No significant associations were found for tumour thickness, tumour differentiation, or high-risk location.

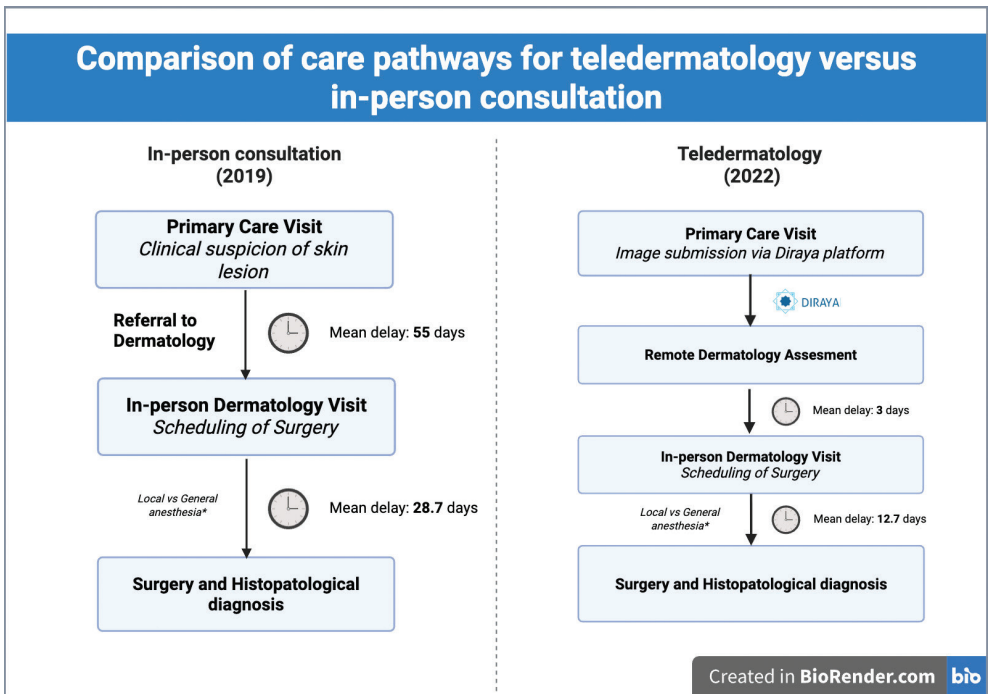

Fig. 5. Comparison of clinical pathways for cutaneous squamous cell carcinoma (cSCC) management via conventional in-person consultation (2019) vs asynchronous teledermatology (2022). In the conventional pathway, patients were referred from primary care and typically waited 55 days for an in-person dermatology visit, followed by a mean delay of 28.7 days until surgical excision.* In the teledermatology model, macroscopic and dermoscopic images were submitted via the Andalusian digital health platform (Diraya), with remote dermatologist evaluation completed within 24–48 h. Patients were triaged for in-person consultation (mean delay: 3 days), and if suitable, excision was frequently performed the same day in a minor surgical setting (mean delay to surgery: 12.7 days)*. *In both care models, surgical planning depended on clinical factors such as anaesthesia requirements and reconstructive complexity. Excision under local anaesthesia was performed in an outpatient minor surgery room while patients requiring general anaesthesia or complex reconstructions (e.g., skin flaps or grafts) were referred to the main operating theatre after pre-anaesthetic evaluation and scheduling.

similar studies assessing prognostic differences in cSCC, highlighting the need for further research to determine whether teledermatology influences histopathological characteristics and long-term oncological outcomes in this tumour type.

Interestingly, despite differences in tumour area, the proportion of high-risk tumous (defined by location, perineural invasion, or poor differentiation) remained comparable between groups. This suggests that teledermatology not only facilitates early detection but also enables accurate identification of cases requiring prompt surgical intervention. The similarity in treatment approaches – particularly the consistent use of primary excision – supports the reliability of remote assessment in guiding therapeutic decisions.

These findings align with previous research indicating that teledermatology can enhance triage efficiency without compromising diagnostic accuracy (7, 12, 13). By optimizing patient selection for in-person evaluation, teledermatology may help streamline dermatological care, particularly in high-demand settings or regions with limited specialist availability.

Consistent with existing literature, our results reaffirm that teledermatology serves as an effective strategy for improving access to dermatological care. This is especially relevant in the context of healthcare resource optimization, where remote consultations can alleviate the burden on in-person clinics while maintaining diagnostic integrity (7, 12).

The role of teledermatology was particularly highlighted during the COVID-19 pandemic, and its continued integration into routine dermatological practice could enhance care delivery beyond crisis scenarios (8). A critical difference between the 2019 and 2022 periods lies in the clinical pathway for lesion detection. In 2019, most cSCCs were identified incidentally during routine in-person follow-up visits, often without specific concern from the patient. In contrast, in 2022, asynchronous teledermatology enabled patients to initiate dermatological evaluation more proactively after self-identifying suspicious lesions. Moreover, following the COVID-19 pandemic, oncological care pathways were prioritized and triage protocols were established to fast-track cases suspected of malignancy.

These systemic changes are supported by national data. A study by Díaz-Calvillo et al. (14) found a significant increase in the proportion of high-risk cSCCs diagnosed after the pandemic onset compared with pre-pandemic cases (46.2% vs 35.3%, $p=0.011$), suggesting that delays in consultation may have resulted in more advanced tumours at the time of diagnosis. Similarly, a meta-analysis by the same author (15) reported that, during the early months of the pandemic, melanoma surgeries declined by nearly 30% and keratinocyte carcinoma surgeries by over 50% (20). In the long term, while surgical volumes partially recovered, post-pandemic skin cancers exhibited worse prognostic features, such as increased ulceration rates in melanoma and greater tumour thickness in keratinocyte carcinomas (20). Similarly, Tejera-Vaquerizo et al. (16) documented a 44% decrease in cSCC surgeries during the Spanish lockdown (March–June 2020), along with a marked rise in advanced-stage tumours (stage III: 29.6% in 2020 vs 16.7% in 2019, $p<0.001$). These findings highlight how healthcare access disruptions may worsen tumour staging even when histological aggressiveness remains stable.

Our data suggest that the structured integration of teledermatology during the post-pandemic period may have mitigated these risks. By enabling early triage and expedited excision of clinically suspicious lesions, the teledermatology model helped maintain a stable proportion of high-risk tumours despite system-wide pressures. Notably, while prior national studies have documented the negative oncological impact of the pandemic, the protective role of teledermatology remains underexplored, underscoring the relevance of our findings.

Beyond its clinical implications, teledermatology may also provide substantial economic benefits. Although our study did not specifically assess healthcare costs, previous research has demonstrated that teleconsultation can significantly reduce overall expenditures. In our cohort, a significant proportion of patients in the teledermatology group underwent same-day excision under local anaesthesia in an outpatient setting, avoiding referral to general anaesthesia and main operating theatre. According to the *Orden de 24 de mayo de 2024* del Sistema Sanitario Público de Andalucía (BOJA no. 106) (17), the cost of a dermatology consultation is €123.45, and outpatient excision under local anaesthesia is €278.31, compared with €545.00 for procedures requiring general anaesthesia, plus €65.80 for pre-anaesthetic evaluation. Based on these values, we estimate a cost saving of over €14,000 per 100 patients managed via teledermatology. Earlier diagnosis may lead to less expensive treatment strategies, decreasing the need for complex surgical reconstructions and adjuvant therapies.

Given the rapid advancements in digital imaging and telecommunication technologies, the expanding role of teledermatology warrants further exploration. Future innovations, such as high-resolution dermoscopic imaging and artificial intelligence-assisted diagnostics (18–20), may further enhance the precision of remote assessments, reducing the risk of misclassification and improving early detection rates.

Study limitations

Several limitations should be acknowledged. The retrospective design of the study introduces potential biases, including variability in the documentation of clinical parameters and differences in healthcare practices between the 2 time periods analysed (2019 vs 2022).

Additionally, while the study highlights significant findings regarding tumour area, a prospective design incorporating standardized diagnostic protocols across both modalities would provide stronger evidence regarding the true impact of teledermatology on cSCC prognosis.

Moreover, the study did not assess long-term outcomes, such as recurrence rates or disease-specific survival. Future research should focus on evaluating whether earlier detection via teledermatology translates into improved oncological outcomes over time. Future research should aim to determine whether earlier detection via teledermatology leads to improved recurrence-free survival and overall survival rates.

Additionally, the variable "time of evolution" – defined as the interval from patient-reported lesion onset to the first dermatology consultation – was derived from retrospective clinical interviews and often imprecisely reported (e.g., "months" or "years"). This imprecision introduces a potential information bias and limits the reliability of this metric for temporal comparisons. We therefore consider this variable exploratory and interpret the results with caution.

Future implications

The implementation of standardized asynchronous teledermatology protocols should be prioritized before exploring more advanced technological solutions. Key steps include improving the quality and consistency of image acquisition, establishing unified referral and triage criteria, and ensuring proper training of both dermatologists and primary care professionals.

Moreover, cost-effectiveness analyses based on real-world data are essential to assess the economic viability of teledermatology integration in routine workflows. Our preliminary findings, supported by the official BOJA tariffs (17), suggest substantial savings when low-complexity surgeries are performed under local anaesthesia outside the main operating room.

Only after consolidating these foundational aspects should the integration of artificial intelligence be considered. Future research should evaluate how AI-assisted lesion analysis might enhance diagnostic accuracy and risk stratification. Finally, long-term studies are needed to assess the impact of teledermatology on recurrence rates, tumour staging, and patient survival in cSCC.

Conclusion

Teledermatology could facilitate earlier diagnosis of cSCC, as suggested by a smaller tumour surface area at the time of diagnosis compared with face-to-face consultations. However, no significant differences were observed in tumour thickness or other high-risk histopathological features, suggesting that while teledermatology may facilitate earlier detection, it does not appear to influence tumour aggressiveness at the time of surgical excision. These findings support the role of teledermatology in improving initial cSCC screening and triage, particularly in settings with limited access to dermatological care. Further studies are warranted to assess its long-term impact on clinical outcomes and disease progression.

ACKNOWLEDGMENTS

The authors would like to express their gratitude to the dermatology and pathology departments of Hospital San Cecilio for their collaboration in data collection and analysis. Special thanks are offered to the teledermatology unit for facilitating patient referrals and digital image processing.

Data availability statement: The datasets used and analysed during this study are not publicly available due to patient confidentiality but can be obtained from the corresponding author upon reasonable request.

Ethics declarations and trial registry information: This study was conducted by collecting data from medical records and pathology reports, without any interventions that could pose a risk to patients. The study was approved by the Ethics Committee of Hospital Universitario San Cecilio (DERM_HUSC_2024_002), and adhered to the ethical principles outlined in the Declaration of Helsinki.

The authors have no conflicts of interest to declare.

REFERENCES

1. Stratigos AJ, Garbe C, Dessinioti C, Lebbe C, van Akkooi A, Bataille V, et al. European consensus-based interdisciplinary guideline for invasive cutaneous squamous cell carcinoma: Part 2. Treatment-update 2023. Eur J Cancer 2023; 193: 113252. https://doi.org/10.1016/j.ejca.2023.113252
2. Lomas A, Leonardi-Bee J, Bath-Hextall F. A systematic review of worldwide incidence of nonmelanoma skin cancer. Br J Dermatol 2012; 166: 1069–1080. https://doi.org/10.1111/j.1365-2133.2012.10830.x
3. Tejera-Vaquerizo A, Descalzo-Gallego MA, Otero-Rivas MM, Posada-García C, Rodríguez-Pazos L, Pastushenko I, et al. Skin cancer incidence and mortality in Spain: a systematic review and meta-analysis. Actas Dermosifiliogr 2016; 107: 318–328. https://doi.org/10.1016/j.ad.2015.12.008
4. Cañueto J, Tejera-Vaquerizo A, Redondo P, Botella-Estrada R, Puig S, Sanmartin O. A review of terms used to define cutaneous squamous cell carcinoma with a poor prognosis. Actas Dermosifiliogr (Engl ed.) 2020; 111: 281–290. https://doi.org/10.1016/j.ad.2019.06.005
5. Renzi C, Mastroeni S, Mannooranparampil TJ, Passarelli F, Caggiati A, Potenza C, et al. Delay in diagnosis and treatment of squamous cell carcinoma of the skin. Acta Derm Venereol 2010; 90: 595–601. https://doi.org/10.2340/00015555-0966
6. Gjersvik P, Falk RS, Roscher I, Rizvi SMH, Mjøen G, Gude E, et al. Rates of second tumor, metastasis, and death from cutaneous squamous cell carcinoma in patients with and without transplant-associated immunosuppression. JAMA Dermatol 2023; 159: 923–929. https://doi.org/10.1001/jamadermatol.2023.2029
7. Chuchu N, Dinnes J, Takwoingi Y, Matin RN, Bayliss SE, Davenport C, et al. Teledermatology for diagnosing skin cancer in adults. Cochrane Database Syst Rev 2018; 12: CD013193. https://doi.org/10.1002/14651858.CD013193
8. Jobbágy A, Kiss N, Meznerics FA, Farkas K, Plázár D, Bozsányi S, et al. Emergency use and efficacy of an asynchronous teledermatology system as a novel tool for early diagnosis of skin cancer during the first wave of COVID-19 pandemic. Int J Environ Res Public Health 2022; 19: 2699. https://doi.org/10.3390/ijerph19052699

9. Juhasz MLW, Rosenthal AH, Nguyen TA, Gharavi NM. Clinical versus histologic margins for cutaneous squamous cell carcinoma: comparing outcomes for high-risk tumors treated with Mohs micrographic surgery. Dermatol Surg 2024; 50: 1000. https://doi.org/10.1097/DSS.0000000000004278
10. Roccuzzo G, Orlando G, Rumore MR, Morrone A, Fruttero E, Caliendo V, et al. Predictors of recurrence and progression in poorly differentiated cutaneous squamous cell carcinomas: insights from a real-life experience. Dermatology 2023; 240: 329–336. https://doi.org/10.1159/000535040
11. Ferrándiz L, Ruiz-de-Casas A, Martin-Gutierrez FJ, Peral-Rubio F, Mendez-Abad C, Rios-Martin JJ, et al. Effect of teledermatology on the prognosis of patients with cutaneous melanoma. Arch Dermatol 2012; 148: 1025–1028. https://doi.org/10.1001/archdermatol.2012.778
12. Finnane A, Dallest K, Janda M, Soyer HP. Teledermatology for the diagnosis and management of skin cancer: a systematic review. JAMA Dermatol 2017; 153: 319–327. https://doi.org/10.1001/jamadermatol.2016.4361
13. Shapiro M, James WD, Kessler R, Lazorik FC, Katz KA, Tam J, et al. Comparison of skin biopsy triage decisions in 49 patients with pigmented lesions and skin neoplasms: store-and-forward teledermatology vs face-to-face dermatology. Arch Dermatol 2004; 140: 525–528. https://doi.org/10.1001/archderm.140.5.525
14. Díaz-Calvillo P, Sánchez-Díaz M, Rodríguez-Pozo JÁ, Martínez-Ruiz V, Martínez-López A, Arias-Santiago S. Impact of COVID-19 pandemic on cutaneous squamous cell carcinoma: a single-centre study of epidemiologic, clinic and histopathological factors. Actas Dermosifiliogr 2024; 115: T224–T230. https://doi.org/10.1016/j.ad.2023.10.003
15. Díaz-Calvillo P, Muñoz-Barba D, Ureña-Paniego C, Maul LV, Cerminara S, Kostner L, et al. Effects of COVID-19 pandemic on the diagnosis of melanoma and keratinocyte carcinomas: a systematic review and meta-analysis. Acta Derm Venereol 2024; 104: adv19460. https://doi.org/10.2340/actadv.v104.19460
16. Tejera-Vaquerizo A, Paradela S, Toll A, Santos-Juanes J, Jaka A, López A, et al. Effects of COVID-19 lockdown on tumour burden of melanoma and cutaneous squamous cell carcinoma. Acta Derm Venereol 2021; 101: adv00525. https://doi.org/10.2340/00015555-3890
17. Servicio Andaluz de Salud. Orden de 24 de mayo de 2024, por la que se establece el importe de los servicios, actividades y bienes de naturaleza sanitaria, prestados en centros sanitarios del Sistema Sanitario Público de Andalucía, que deben ser retribuidos mediante precios públicos por los terceros obligados legalmente al pago. Boletín Oficial de la Junta de Andalucía (BOJA) nº 106, 3 de junio de 2024. Available from: https://juntadeandalucia.es/boja
18. Lee C, Witkowski A, Żychowska M, Ludzik J. The role of mobile teledermoscopy in skin cancer triage and management during the COVID-19 pandemic. Indian J Dermatol Venereol Leprol 2023; 89: 347–352. https://doi.org/10.25259/IJDVL_118_2022
19. Frow H, Brown A, Waqas M, Skittrall Z, Charman C. BT41 Piloting a hospital-based tele-dermatology and artificial intelligence service for urgent suspected skin cancer alongside an established community-based teledermatology advice and guidance service. Br J Dermatol 2024; 191: i207–i208. https://doi.org/10.1093/bjd/ljae090.438
20. Marsden H, Kemos P, Venzi M, Noy M, Maheswaran S, Francis N, et al. Accuracy of an artificial intelligence as a medical device as part of a UK-based skin cancer teledermatology service. Front Med 2024; 11: 1302363. https://doi.org/10.3389/fmed.2024.1302363