



Views on mobile health apps for skin cancer screening in the general population: an in-depth qualitative exploration of perceived barriers and facilitators*

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Summary

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Conflicts of interest

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Data availability statement

The data that support the findings of this study are available on reasonable request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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Background Mobile health (mHealth) applications (apps) incorporating artificial intelligence for skin cancer screening are increasingly reimbursed by health insurers. However, an in-depth exploration of the general public's views towards these apps is lacking.

Objectives To explore the perceived barriers and facilitators towards mHealth apps for skin cancer screening among the Dutch general population.

Methods A qualitative study consisting of four focus groups with 27 participants was conducted. A two-stage purposive sampling method was used to include information-rich participants from the Dutch general population with varying experience of mHealth. A topic guide was used to structure the sessions. All focus group meetings were transcribed verbatim and analysed in thematic content analysis by two researchers using several coding phases, resulting in an overview of themes and subthemes, categorized as (sub-)barriers and (sub-)facilitators.

Results Main barriers to using mHealth apps included a perceived lack of value, perception of untrustworthiness, preference for a doctor, privacy concerns, a complex user interface, and high costs. The main factors facilitating the use of mHealth among the general population were a high perceived value, a transparent and trustworthy identity of app developers, endorsement by healthcare providers and government regulating bodies, and ease and low costs of use.

Conclusions To increase successful adoption in skin cancer screening apps, developers should create a transparent identity and build trustworthy apps. Collaboration between app developers, general practitioners and dermatologists is advocated to improve mHealth integration with skin cancer care. Special attention should be given to the development of low-cost, privacy-friendly, easy-to-use apps.

What is already known about this topic?

- Mobile health (mHealth) smartphone apps, which provide users with a risk indication of skin cancer using artificial intelligence, are increasingly reimbursed by health insurers.
- An in-depth understanding of the views of the general public towards these apps is currently lacking.
- To increase the functionality and successful adoption and integration of mHealth with skin cancer care, insight into perceived barriers and facilitators towards the use of this technology is advocated.

What does this study add?

- Our qualitative exploration shows that perceived value, trustworthiness, privacy, app design and costs act as important barriers or facilitators towards the use of mHealth apps for skin cancer screening among the Dutch general population.
- The preference for a human doctor acted as an additional important barrier towards using mHealth apps.
- Additional main facilitators were a transparent identity of the app developer, and endorsement from healthcare providers and government regulating bodies.

What are the clinical implications of this work?

- Adoption of mHealth for skin cancer can be improved by clear communication regarding the reliability of the provided screening, its associated benefits and drawbacks, and by ensuring low cost of use.
- Design and functionality can be improved by developing privacy-friendly, easy-to-use apps that are usable by all ages.
- Integration with existing healthcare systems can be improved by collaboration with and endorsement from healthcare professionals and government regulating bodies.

Skin cancer is the most common form of cancer in countries with populations of predominantly European ancestry, and known for its increasing incidence rates.^{1,2} The Netherlands ranks among the top European countries in terms of melanoma incidence.³ In addition, the incidence of keratinocyte cancer (KC), most notably basal cell carcinoma and squamous cell carcinoma, is increasing steeply in the Netherlands, resulting in over 60 000 new KC cases being diagnosed in 2017.⁴ Similarly to most other countries, Dutch healthcare providers rely on the patient's ability to detect skin cancer, as there is no population-based skin cancer screening implemented in the Netherlands. Given the rising incidence of skin cancer, new solutions are being explored to streamline skin cancer detection.

Artificial intelligence (AI) algorithms can interpret medical data without human intervention,^{5,6} and have been found to achieve levels of accuracy comparable with those of dermatologists, and even exceed them, when classifying clinical images as benign or malignant skin lesions.^{7,8} Recently, these algorithms have been implemented in consumer mobile health (mHealth) applications (apps), which allow users to instantly receive a risk assessment of a skin lesion by taking a smartphone camera photo.⁹ mHealth apps may facilitate skin cancer detection, as people in the general population can screen a skin lesion anywhere, at any time. Moreover, an easy and swift diagnostic tool may result in skin cancers such as melanoma being detected at an earlier stage with better prognosis. Additionally, countries struggling with a rising incidence of skin cancer^{1,10} and associated expenditures¹¹ may also benefit from integrating mHealth within their healthcare systems. mHealth apps can advise users to visit a doctor only in case of a suspicious skin lesion, reducing unnecessary consultations for benign skin lesions.

Given the hypothesized benefits, multiple health insurers in Europe, Australia and New Zealand have already introduced a form of reimbursement for mHealth apps^{12–15} and have been included in the NHS Innovation Accelerator.¹⁶ Moreover, the COVID-19 pandemic has been further emphasizing the importance of remote care and has accelerated virtual healthcare adoption.¹⁷ Nevertheless, a systematic review underscored the need for proper validation of the accuracy of these algorithms before they should be integrated with healthcare systems.¹⁸

A critical challenge is the acceptance and actual use of these apps by the target group.¹⁹ Our latest retrospective study revealed an uptake of only 1% among a cohort of two million insured adults in the Netherlands, indicating the presence of significant barriers towards the implementation of mHealth for skin cancer screening.²⁰ Although a recent study indicated a generally positive view by the general public towards the use of AI for skin cancer screening,²¹ an in-depth qualitative exploration of their views towards mHealth applications for skin cancer screening is lacking. The aim of this study is to explore the views of the Dutch general population towards mHealth applications for skin cancer screening in terms of perceived barriers and facilitators.

Materials and methods

Study design and methodological considerations

A qualitative design was considered the most suitable for exploring the views of participants. Focus groups were chosen, as group dynamics often stimulate participants to talk about things they would not have initially thought of

themselves, leading to richer and more diverse information compared with individual interviews.^{22,23} Moreover, a focus group design previously proved to be a suitable method for exploring the implementation of mHealth in healthcare fields other than dermatology.^{24,25} The reporting of this study followed the Standards for Reporting Qualitative Research (SRQR).²⁶ The need for ethical approval was waived by the medical ethical committee of the Erasmus MC University Medical Center after review of the study design (MEC-2019-0409).

Selection of participants

A two-stage purposive sampling method^{23,27} was used for participant selection, aiming for a variable sample in terms of sex, age, and previous experience with mHealth.

For the first two focus groups the customer panel of a large Dutch health insurer (CZ, Tilburg, the Netherlands) was used to recruit participants. All CZ customer panel members received an invitation email to participate in a focus group including an information leaflet about the study. Potential participants could apply via a web form.

As the participants recruited through the CZ customer panel were aged 50 years and above, and had limited previous experience with mHealth, our focus for the additional focus groups shifted towards selecting younger participants who had more experience with mHealth apps.²⁷ Social media platforms (Facebook, LinkedIn) were used to invite additional participants. Data saturation was reached after no new concepts in terms of (sub-)barriers and (sub)facilitators were identified, which was the case after analysing four focus groups (Appendix S1; see Supporting Information).

Data collection

The four focus groups were led by an experienced moderator of focus groups (M.L.) and cochaired by at least one medical doctor (E.C.K.-N., T.E.S.). A topic guide was used to structure the discussion based on the Technology Acceptance Model and existing literature concerning mHealth adoption (Appendix S2; see Supporting Information).^{23,28,29} Relevant topics included general views towards skin cancer and apps, the role of health insurers and care providers, potential barriers, and factors facilitating the implementation of mHealth in practice. Before the focus group session's formal start, participants completed a questionnaire to collect demographic information, including mHealth experience, and provided written informed consent. The focus groups were audiotaped and transcribed verbatim in anonymized form. A €30 gift card was offered for participation.

Data analysis

A thorough thematic content analysis using elements from Grounded Theory (i.e. open and axial coding, constant comparison technique) embedded in a constructivist methodology

was performed.^{30–32} The transcripts were analysed using the qualitative data analysis software NVivo version 12 Plus (QSR International Pty Ltd, Doncaster, Vic, Australia). Several phases of coding,³² combined with the constant comparison technique, described in detail in Appendix S1, resulted in a final overview of themes and subthemes, which were categorized as (sub-)barriers and (sub)facilitators (Table 2). Descriptive analyses of demographic characteristics were performed on group level using SPSS Statistics version 15.0 (IBM SPSS Statistics, Armonk, NY, USA).

Results

Description of participants

Participant characteristics on group level are presented in Table 1. Characteristics of individual participants can be found in Table S1 (see Supporting Information).

Views towards using mHealth apps for skin cancer screening

Six main barriers and five main facilitators for the use of mHealth for skin cancer screening were identified (Table 2). These, including the subthemes identified for the barriers and facilitators, are described below. Illustrative quotations of the results are presented in Tables 3 and 4. An overview of illustrative quotations of all (sub-)barriers and (sub)facilitators can be found in Table S2 (see Supporting Information).

Barriers to using mHealth skin cancer screening apps

Perceived lack of value of mHealth skin cancer apps The first main barrier identified to using mHealth for skin cancer screening was a perceived lack of value. This was first of all related to *limited knowledge among participants about mHealth apps for skin cancer screening*. Some participants were unaware of the functionality these apps may have to offer, and questioned the added value of these apps. Moreover, a *lack of concern regarding skin cancer* contributed to a perceived lack of mHealth apps' value. Whereas some participants had a history of skin cancer and indicated vigilance regarding suspicious skin lesions on their skin, others mentioned they had never worried about skin cancer and as such did not see the need to perform self-inspection for suspicious skin lesions. Furthermore, while participants acknowledged the usefulness of performing a skin check at home, a *lack of integration with the healthcare system* was mentioned as a sub-barrier. One still has to visit a general practitioner (GP) after a high-risk assessment instead of receiving a direct referral to a dermatologist, which was found to reduce such an app's overall value.

Perception of untrustworthiness The perception of untrustworthiness was identified as a second main barrier to mHealth for skin cancer screening, consisting of two sub-barriers: a perceived lack of screening accuracy and doubts about the app

Table 1 Participants' characteristics

	Participants, n	Median age, years (IQR)	Female	Previous experience with mHealth	History of skin cancer
Focus group 1 (CZ) ^a	5	50 (44–62)	4 (80)	0 (0)	2 (40)
Focus group 2 (CZ) ^a	6	70 (62–71)	3 (50)	2 (33)	2 (33)
Focus group 3 (Social media) ^b	8	23 (20–26)	6 (75)	6 (75)	0 (0)
Focus group 4 (Social media) ^b	8	22 (19–25)	5 (63)	3 (38)	0 (0)
Total	27	25 (21–56)	18 (68)	11 (41)	4 (15)

Values are n (%) unless otherwise stated. IQR, interquartile range; mHealth, mobile health apps (in general). ^aCustomer panel of health insurer CZ. ^bPanel recruited through social media.

Table 2 Identified main barriers to and facilitators of using mobile health (mHealth) apps for skin cancer screening, with respective sub-barriers and subfacilitators in italics

Barriers	Facilitators
Perceived lack of value of mHealth apps for skin cancer screening	Perceived high value of mHealth apps for skin cancer screening
<i>Limited knowledge about the usefulness and functionality</i>	<i>Performing a skin cancer risk assessment from home</i>
<i>Lack of concern towards skin cancer</i>	<i>Monitoring suspicious skin lesions over time</i>
<i>Lack of integration with healthcare system</i>	<i>Integration with skin cancer care</i>
Perception of untrustworthiness	Transparent and trustworthy identity of the app developer
<i>Perceived lack of accuracy</i>	Endorsement from healthcare providers (GPs, dermatologists) and government regulating bodies.
<i>Doubts about the reliability of the app developer</i>	<i>Endorsement from healthcare providers</i>
Preference for a doctor instead of an app	Government regulation
Privacy concerns	Ease of use
<i>Unsolicited personal data sharing by trackers and spyware</i>	<i>Simple user interface</i>
Complex and distracting user interface	<i>Easy to perform a risk assessment</i>
<i>Difficult in-app navigation</i>	<i>Usable by all ages</i>
<i>In-app commercial advertising</i>	<i>Added value of an app over website</i>
Perceived high costs associated with using mHealth	Low (or no) cost of use
<i>Cost in relation to GP visit</i>	<i>The possibility of reimbursement by health insurers</i>

GP, general practitioner.

developer's reliability. First of all, a *perceived lack of accuracy* was related to a general lack of confidence in mHealth apps to detect skin cancer. The screening accuracy of mHealth apps was questioned as they are based on an image rather than an in-person assessment by a doctor, which was considered a limited source of information on which to base an assessment. Secondly, the perceived lack of confidence was related to a lack of information provided by mHealth developers about screening accuracy. For example, the accuracy of an app in comparison with that of GPs and dermatologists was unclear to participants. When asked about the minimum required level of screening accuracy of such apps, some participants insisted that apps should work flawlessly; others mentioned that they would accept less than 100% accuracy from an app. The absence of an evaluation of the screening accuracy by an independent party (i.e. an academic institution or regulating body) contributed to perceptions that an app was unreliable. Insufficient accuracy in detecting skin cancer was considered a

potential health risk for app users, as an incorrect risk advisory may evoke a false sense of reassurance and potentially cause delay in skin cancer treatment. Furthermore, it was mentioned that mHealth apps incorrectly classifying benign skin lesions as skin cancer would cause unnecessary worry and concerns among users. *Doubts about the app developer's reliability* was identified as a second subtheme in the perception of untrustworthiness of an mHealth app for skin cancer screening. Participants expressed their concerns towards mHealth apps, which are developed for commercial purposes. Moreover, claims about the safety and trustworthiness coming from mHealth app developers with a commercial motive were considered unreliable.

Preference for a human doctor instead of an algorithm The preference for visiting a GP or dermatologist for a suspicious skin lesion rather than using an app to perform a risk assessment was identified as a third barrier. While some participants stated

Table 3 Illustrative participant quotations on barriers to using mobile health (mHealth) apps for skin cancer screening

Barrier	Participant quotation
Perceived lack of value of mHealth apps for skin cancer screening	'I don't have an app, because I don't see the need for it anyway.' Participant Focus Group 2
Perception of untrustworthiness	'Yeah, sort of, I'd do a little research myself into how well that algorithm would work, but it sounds like an algorithm that says whether a picture is good or not. That sounds a bit like it's doubtful whether it works at all.' Participant Focus Group 4
Preference for a doctor instead of an app	'It's not a resistance to an app. It's not. But it's me as a person who'd rather have someone live in front of me. [...] That just seems a lot more truthful and believable as you have someone to talk to.' Participant Focus Group 2
Privacy concerns	'It's more about what you look for, because when you download an app like that, it's really quite personal data that you send. Sometimes you take a photo and so on, you just don't want it to be linked to you, in general. So, in that respect, I really wouldn't want to create an account.' Participant Focus Group 4
Complex and distracting user interface	'I have no idea. I just couldn't figure it out. So I thought it was very user-unfriendly.' Participant Focus Group 2
Perceived high costs associated with using mHealth	'... [I]f you go to the doctor it's free and if you have an app, so yes less reliable in your opinion and then you have to pay, and if you go to the doctor it is included in your health insurance. That's weird, isn't it?' Participant Focus Group 2

that they would use an app for a skin cancer risk assessment, others appeared to prefer an assessment from a physical doctor. The assessment of a doctor was considered more believable than the assessment from an algorithm. Additionally, the possibility of communicating verbally and discussing the possibility of treatment was a reason to prefer a doctor consultation. Furthermore, participants explained that person-specific disease information related to prognosis (e.g. tumour staging) should only be communicated by doctors rather than an app. Lastly, participants mentioned that even if an app were integrated within healthcare systems, patients should always maintain the choice to visit a doctor instead of using an app compulsorily.

Table 4 Illustrative participant quotations on facilitators of using mobile health (mHealth) apps for skin cancer screening

Facilitator	Participant quotation
Perceived high value of mHealth apps for skin cancer screening	'I always feel a little burden to go to the GP, with the idea that it is actually not necessary to go to the GP.' Participant Focus Group 4
Transparent and trustworthy identity of the app developer	'Is there a team behind this or is it clear that an algorithm determines what's going on? Or does it involve a real doctor or whatever?' Participant Focus Group 1
Endorsement by healthcare providers (GPs, dermatologists) and government regulating bodies	'... [I]f you would also give it approval because of a ministry or because of a legal regulation or something like that, this guarantee should be legal. The responsibility lies with the government with regard to its quality.' Participant Focus Group 2
Ease of use	'User-friendliness is an important precondition if you want to entice people to use it.' Participant Focus Group 2
Low (or no) cost of use	'If my insurance company says I can use that app for free, I'm quite willing to try it.' Participant Focus Group 2

GP, general practitioner.

Privacy concerns Participants expressed concerns about the sharing of personal data with mHealth apps for skin cancer screening. While some participants considered an image of a skin lesion to be nonintrusive personal data, others saw this as a reason not to use an app. Participants reported preferably wanting to fill in as few personal details as possible. The fear of unsolicited data sharing by trackers and spyware was a reason to refrain from using mHealth. The need to create an account and fill out personal details and requests for permission (e.g. to access GPS location) and install cookies was considered a reason to remove the app directly after installation.

Complex and distracting user interface A complex user interface, referring to the inability to quickly navigate to and perform essential tasks, such as the camera function to perform a risk assessment, was identified as a fifth barrier. A lengthy tutorial and the need to perform multiple clicks through the app menu were considered factors contributing to a complex user interface. Moreover, concerns were expressed about the ability to properly use the camera function to make a high-quality photo for a risk assessment, particularly by older people. Participants explained that it might be challenging to take photos of skin lesions located on certain parts of the body (e.g. the face) and worried that the inability to make a high-quality photo may

lead to an incorrect assessment by the algorithm. Concerning the user interface, participants viewed *commercial in-app advertising* during the use of an app as rather distracting.

Costs associated with using mHealth Costs associated with using mHealth apps were identified as a sixth barrier. Consulting a GP in the Netherlands does not involve any costs for the patient, as the health insurer fully reimburses a visit's costs. Therefore, participants indicated they would be reluctant to pay for an mHealth app that provides a similar service.

Facilitators of mHealth use

Perceived high value of mHealth apps for skin cancer screening A perceived high value of mHealth apps was identified as a first facilitator of using mHealth apps for skin cancer screening. Perceptions of high value were related to the ability to perform a skin cancer risk assessment from home, the ability to monitor skin lesions over time, and the possibility of integration with dermatology-related care. First and foremost, participants were generally positive about the idea of *receiving instant risk advice for a suspicious skin lesion at home from an app*. Participants expressed their difficulty in judging for themselves whether a doctor visit was necessary or not. As a result, the main benefit mentioned from using an app for a skin lesion risk assessment was the avoidance of unnecessary doctor consultations. However, participants mentioned two preconditions regarding the risk assessment provided by an app. Firstly, they indicated that an app should only provide a risk indication but not a diagnosis. Secondly, while an app may provide an advisory suggesting a doctor visit, the advisory should not be binding and should not take away users' freedom to see a doctor. Beside the possibility of instantly screening a skin lesion and receiving a risk indication of skin cancer, participants were positive about the possibility of *monitoring skin lesions over time*. Moreover, a functionality that sends users a reminder to rephotograph a skin lesion to judge whether it is progressing into malignancy was evaluated as useful. Furthermore, *integration of mHealth apps with GP and dermatological care* increased the value of such apps to users. Multiple possibilities for integration were stated. Firstly, participants would have liked the option to directly visit a dermatologist after receiving a high-risk rating from an mHealth app, without first having to visit the GP. Secondly, the possibility that an app could provide advice about whether or not to contact a doctor during treatment of skin cancer was thought to be useful. Thirdly, the availability of tailored information related to a photographed skin lesion or skin cancer follow-up care in an app was considered valuable.

Transparent and trustworthy identity of app developer A transparent and trustworthy identity of the app developer was a second main identified facilitator of using mHealth apps. Participants stressed that they wanted to know the identity and background of the (clinical) team that develops the app as this influences its perceived trustworthiness. Additionally, insight into who performs the assessment (i.e. an algorithm or a

teledermatologist) was also considered essential. Participants mentioned that an app ideally should be developed by healthcare providers, a hospital, or a health institution associated with the government instead of a commercial company. App store ratings were named as a factor that could indicate whether an app is trustworthy.

Endorsement by healthcare providers (general practitioners, dermatologists) and government regulating bodies Endorsement of mHealth apps for skin cancer screening by healthcare providers and government regulating bodies was identified as a third facilitator of using mHealth in the general population. The *endorsement of healthcare providers* was considered to increase an mHealth app's trustworthiness, especially if the app is endorsed by an independent group of experts from multiple academic institutions. In addition to endorsement from an expert group, a GP or dermatologist who recommended the app during a consultation was considered an encouraging reason for adoption. Besides endorsement from healthcare providers, *government regulation of mHealth apps* was regarded as essential to ensure an app's quality and safety, and was thus perceived as a facilitator. They considered assurance of the quality of mHealth apps to be a matter of government regulation.

Ease of use The ease of use of an mHealth app for skin cancer screening was identified as a fourth facilitator, consisting of four subthemes. Firstly, participants mentioned that to facilitate use, the app should have a *simple user interface*, and focus on the core feature of taking a photo using the smartphone camera and providing advice on whether a doctor visit is necessary. Secondly, *the process of performing a risk assessment should ideally be easy*, without requiring users to provide additional information or create an account. Thirdly, through a simple user interface and assessment functionality, *the app should be usable by all ages, regardless of technological savvy*. Last, participants emphasized the *superiority of mHealth apps in terms of usability and portability over alternatives*, such as a website or brochure providing information on skin cancer.

Low or no cost of use Low, or no cost for the use of a mHealth app was identified as a fifth facilitator. While there was no consensus among participants about how low the costs ideally should be, they indicated that low or no costs would significantly increase their drive to adopt a mHealth app. *Reimbursement by one's health insurer* was identified as a solution to overcome the resistance of paying for an mHealth app.

Discussion

This in-depth qualitative study aimed to explore the Dutch general population's views towards mHealth apps for skin cancer screening. It revealed multiple barriers and facilitators related to using these apps as perceived by the general population.

Consistent with previous studies focusing on mHealth in general, a lack of perceived usefulness and trustworthiness,

concerns over privacy and perceived high costs appeared to be important barriers to adoption.^{25,33,34} However, we also identified new (sub-)barriers that seem to be unique to skin cancer, in which a perceived lack of screening accuracy is most prominent.^{18,35} The expectations regarding the required minimal levels of accuracy seem to vary, ranging from GP-level skin cancer detection accuracy up to flawless screening capabilities.

With regard to facilitators, the general population appeared to value the benefits of mHealth apps in relation to skin cancer screening, such as the opportunity to perform a risk assessment at home and to self-monitor skin lesions in a standardized manner over time. They agreed that mHealth apps may lower the threshold at which patients seek care for a suspicious skin lesion, which may especially be important in rural areas. Simultaneously, these functionalities may reduce unnecessary consultations as they can advise users only to visit a doctor in case of a suspicious skin lesion.⁹

In line with existing literature, we also identified the endorsement of healthcare providers and government regulating bodies, the ease of use of an app, and low user costs as facilitators of use.^{25,33,34} Low costs were reported to facilitate the adoption of mHealth if proportionate to a doctor visit or reimbursed by a healthcare insurer. As such, the minimal accepted amount paid for use may differ between healthcare systems, depending on the direct and indirect cost of a doctor visit. Whereas health insurers' willingness to reimburse mHealth largely depends on reducing direct medical costs (e.g. reducing the number of unnecessary visits, early diagnosis of malignant lesions to avoid expensive surgical and/or oncological treatment), our results emphasize that from a societal perspective, the potential savings of indirect medical costs (e.g. travel expenses and loss of work-related productivity) should also be taken into account when assessing the cost effectiveness of mHealth.

Under the current Medical Device Directive (MDD) of the European Union, mHealth apps for skin cancer screening can register as a class I CE-marked medical device. However, concerns have been raised about this classification, as there is no mandatory inspection by an independent notified body coupled to this classification.¹⁸ In contrast to Europe, the US Food and Drug Administration has not approved any deep learning algorithms for skin cancer detection for consumer use. The Medical Device Regulation (MDR), set to replace the MDD in May 2021, may result in a new classification of mHealth apps as class II or III, instead of class I.³⁶ We expect the MDR to act as a facilitator towards the use of mHealth apps, as their adequate certification and regulation for skin cancer screening can increase the perception of trustworthiness of these apps.

Based on our findings, we make the following recommendations. (i) We recommend that mHealth app developers collaborate with, and seek endorsement from GPs and dermatologists, and their national societies. This will increase the adoption of mHealth among the general population and facilitate the integration of mHealth apps with skin cancer management. (ii) Furthermore, we recommend improving

mHealth integration with healthcare systems in several ways. Firstly, patients should be offered the possibility of being referred directly to a dermatologist based on an app's assessment in countries with a closed healthcare system. Secondly, healthcare providers could offer the possibility of monitoring skin cancer lesions during and after skin cancer treatment. Thirdly, a high-risk rating by an mHealth app could be used as a triage system for dermatology outpatient clinics to select patients who need to be seen swiftly. Fourthly, ideally, the images and ratings from mHealth apps should be connected to patients' electronic healthcare records. Fifthly, mHealth could be promoted on existing eHealth webpages (e.g. NHS Health A-to-Z) that laypersons check when deciding if a doctor's visit is necessary. (iii) We encourage developers to build apps that provide a reliable risk indication for skin lesions, and use clear communication regarding their identity and the benefits and drawbacks of the technology. Moreover, an app's screening accuracy should be communicated to potential users, preferably in comprehensible plain language. (iv) In addition to mHealth's need to implement low-cost, privacy-friendly, easy-to-use apps, we encourage robust scientific evaluation in real-world settings.

In terms of limitations, firstly, our qualitative study focused on perceived barriers to and facilitators of mHealth for skin cancer screening, which depended on participants' perception of the situation. Although perceptions are of great importance as a starting point, they may not fully reflect the range of barriers and facilitators associated with the actual use of mHealth. Secondly, the characteristics such as age varied between the selected participants and did not allow subgroup analyses. Thirdly, the sample of study participants consisted of a customer panel from a Dutch health insurer, which was skewed in terms of age and previous experience. While we aimed to compensate for the skewed sample by performing additional sampling through social media, there needs to be some caution in extrapolating the findings to the entire Dutch population.

A strength of this study is that we explored both barriers and facilitators in relation to mHealth. Several of the identified facilitators (e.g. perceived high value, trustworthy identity of the developer, low costs of use) can potentially resolve the perceived barriers. However, our study also showed that some facilitators, such as endorsement by healthcare providers and government regulating bodies, do not logically follow from identified barriers. Similarly, the identified barriers of the preference for a doctor instead of an app and privacy concerns about mHealth apps could not be countered by the identified facilitators. Another strength of the study is that we could obtain a variable sample of participants in terms of relevant characteristics, such as age and previous experience with mHealth. The coding in multiple phases, the constant comparison technique,²⁷ and discussions of the identified results in a multidisciplinary group of researchers further contributed to the robustness and validity of our results.

Differences in perceived barriers and facilitators between specific age groups could be explored in future research, as

previous work shows that young people are more likely to use mHealth.³⁷ Moreover, ethnographic research and other forms of qualitative observation may provide additional insights into understanding the use of mHealth apps for skin cancer screening. Furthermore, we recommend future research to explore the views of GPs and dermatologists towards mHealth apps for skin cancer screening.

In conclusion, as AI development in mHealth apps for skin cancer screening progresses rapidly, it is vital to consider the public's perspective on this innovative technology. The results of this study may be useful for app developers and healthcare professionals as they seek to improve acceptance and integration of mHealth in skin cancer care.

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's website:

Appendix S1 Detailed description of the data analysis process.

Appendix S2 Focus group schedule and topic guide.

Table S1 Individual characteristics of focus group participants.

Table S2 Complete overview of illustrative quotes for (sub-)barriers and (sub)facilitators.