Title Page

Title:

Using an electronic self-completion tool to identify patients at increased risk of melanoma in Australian primary care

Short title:

Melanoma risk in Australian primary care

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Article type : Original Research

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Abstract:

Background/Objectives

Australia has the highest incidence of melanoma in the world. Some international guidelines recommend a risk-based approach to screening for melanoma, but few suggest how to account for multiple risk factors or how to implement risk-based screening in practice.

This study investigated the acceptability and feasibility of identifying patients at increased risk of melanoma in Australian general practice using a self-completed risk assessment tool. Stratification of risk was based on the validated Williams melanoma risk prediction model.

Methods

Patients and companions aged 18 or older in Australian general practices were approached in the waiting room and invited to enter information about their melanoma risk factors into the tool using an iPad. Acceptability was measured by the proportion of people willing to participate from those invited and feasibility by the number of people able to complete the tool unaided. Risk of developing melanoma was stratified into four risk categories using the Williams model.

Results

1535 (90.4%) participants were recruited from two general practices. Only 200 participants (13%) needed assistance to complete the tool. The mean risk score for participants was 15.2 ($\pm$ SD 9.8). The

Williams model estimated between 5% and 19% of the sample were at increased risk accounting for an estimated 30% to 60% of future incident melanomas.

Conclusions

A risk stratified tool using the Williams model was acceptable and feasible for patients to self-complete in general practice clinics. This could be an effective way to identify people in primary care for implementing risk-based targeted melanoma screening and prevention.

Keywords: melanoma, primary care, risk assessment, screening

What this research adds:

- It is feasible to identify patients in Australian general practice at increased risk of melanoma using an electronic self-completion tool which incorporated a validated risk prediction model.
- Depending on risk thresholds, up to a fifth of patients identified using this tool might require screening and preventive advice.

Abbreviations:

ABS – Australian Bureau of Statistics

AUC – Area under the receiver operating curve

PPV – positive predictive value

NPV – negative predictive value

UK – United Kingdom

Introduction:

Australia has the highest incidence rates of primary cutaneous melanoma in the world; more than 15,000 new cases of melanoma are projected to be diagnosed in 2019¹. As the incidence continues to rise, new strategies are important to improve early detection and treatment outcomes². Currently, there is insufficient evidence that population screening for melanoma will reduce morbidity or mortality^{3,4}. Some international guidelines recommend a risk-based approach to melanoma screening⁴. Risk stratified screening is likely to be more cost-effective if defined using multiple risk factors instead of age alone^{5,6}. In Australia, national guidelines recommended that general practitioners identify people at increased risk of melanoma and provide them with risk-appropriate advice about prevention and early diagnosis⁷. This is currently ad-hoc and unstructured and uses single risk factors to assess risk⁸.

Risk factors for melanoma are well established and many different risk prediction models exist to identify populations at increased risk. Two systematic reviews have been recently conducted to compare existing models^{9,10}. They both demonstrated that inconsistent definitions of risk factors and risk cut-offs were used by these different models, and the area under the receiver operating curve (AUC) ranged between 0.62-0.86^{9,10}. Both reviews established that very few models have been externally validated. None of the identified externally validated models had been developed or validated in Australia, while also being suitable for patient self-completion. The Williams model which was derived from a US population, was one of very few suitable for patients to self-complete¹¹ and had a reasonable discrimination with an AUC of 0.70 (95% confidence interval 0.64-0.77)¹¹.

Usher-Smith and colleagues evaluated the Williams model, using an electronic self-completed survey, MelatoolsQ, to assess the feasibility of using this approach among the United Kingdom (UK) primary care population, and the prevalence of the at-risk population. Their study found that it was acceptable and feasible to use for self-completion in the waiting rooms of UK general practice¹².

Within the context of the Medical Research Council framework for the development and evaluation of complex interventions¹³, this study was designed to determine the feasibility of using the MelatoolsQ for Australian recruitment and to estimate prevalence of the at-risk population to inform a large potential future trial. Using a version of the MelatoolsQ modified for the Australian context, this study assessed the acceptability and feasibility of identifying patients at increased risk of melanoma in Australian primary care and estimated the prevalence of the at-risk population.

Methods:

Study population and data collection

Ethical approval for this study was gained from the University of Melbourne Human Research Ethics Committee (1545602.2). Participants were recruited from two large general practices in outer metropolitan Melbourne between February 2016 and August 2017. Participants and companions aged ≥ 18 years were approached in general practice waiting rooms by trained researchers at different times of the day and different days of the week. Posters were also placed in the waiting room to advertise the study. Those willing to take part were invited to complete an electronic assessment tool using iPads. Researchers recorded if participants required assistance to complete the survey. Reasons for not wishing to participate were recorded.

Australian MelatoolsQ tool

The iPad administered the melanoma risk assessment tool (MelatoolsQ). MelatoolsQ consisted of two sections to collect the risk variables as defined by the Williams risk prediction model, and additional demographic variables. The demographic section included questions on ethnic background, education level, employment status, and living status. The questions in the tool were phrased as originally reported in the Williams model and included: sex, age, natural hair colour at the age of 15 years, number of raised moles on both arms, density of freckles on both arms before the age of 20 years, number of severe sunburns up to the age of 18 years and prior non-melanoma skin cancer (basal cell carcinoma and squamous cell carcinoma)¹¹. Participants were also asked whether they had had a melanoma. Photographic images were included of raised moles and freckles alongside those questions to assist completion by each participant independently.

Statistical methods

The risk score for each participant was calculated using the points scoring system developed by Williams et al and patients were categorised using four risk score cut offs based on their risk¹¹. The scoring system ranged between 0 and 67, the higher the risk score the greater the risk (table 1). We calculated the proportion of participants who would be identified as at increased risk using each of the four risk score cut-offs used by Williams et al.¹¹: 25, 28, 30, 34. We repeated this, weighted to the age and sex distribution of the Australian population using the Australian Bureau of Statistics (ABS) 2016 Census data¹⁴, to obtain estimates of the proportion of the Australian population who would be classified as at increased risk. To estimate the positive predictive value (PPV) and negative predictive value (NPV) for each cut-off we assumed that the Williams model¹¹ would perform equally in the Australian population as in the published validation study. We used the sensitivity and specificity reported by Williams et al. for each of the four risk score cut-offs¹¹ and the published national data for the 2015 age standardised melanoma incidence¹⁵ to estimate 5-year PPVs and NPVs. We computed the mean risk score and standard deviation for the entire sample and compared the mean risk to the UK data from Usher-Smith et al.¹² using a two-sample t test with equal variances. Using the Socio-economic indexes for areas (SEIFA) from the ABS 2011 Census¹⁶, participants' postcodes were stratified into low, moderate and high socio-economic status. All analyses were performed using Stata version 13¹⁷.

Results:

Participant recruitment (Figure 1)

1,960 people were consecutively approached and invited into the study. 132 were ineligible (6.7%) either due to poor English (n=86) or being too unwell (n=46) and 152 people (7.8%) declined to participate. 1,651 participants were recruited (90.4%) and 1,535 participants completed the risk assessment tool (91.7%). 139 people agreed to take part but were called into their appointment before completing the tool (figure 1). We excluded 41 (2.1%) participants who had a history of melanoma as they are already defined as high risk for melanoma, leaving 1,493 participants in the final analyses.

Participants (table 2)

Our study participants were slightly younger (65% under age 44 compared to 51%) and contained proportionately fewer males (40.7% male compared to 49.2%) when compared with the Australian population¹⁴, the latter reflecting the primary care consulting population. This study had a broad range of ethnicities, however the majority reported to be Anglo-Australian (32%).

Acceptability and feasibility

Only 200 participants (13%) required assistance to complete the survey. Of these, 104 (52%) required assistance counting their moles on their arms, 76 (38%) were not confident using the iPad and 20 (10%) could not read the survey as they did not have their reading glasses with them.

Distribution of melanoma risk factors and scores

The prevalence of the melanoma risk factors for the sample is presented in Table 3. As expected, due to the large proportion of people born in South East Asia and the Mediterranean countries, a low proportion of our study sample had red hair at the age of 15 (2.8%) or had had a prior non-melanoma skin cancer (5.7%).

After weighting to the Australian age and gender distributions, using the four different potential cut-offs from the Williams model, we estimated the proportion of the sample who would be at increased risk of melanoma and the associated proportion of incidence melanoma cases for each estimated threshold. 19.8% of the sample were classified at increased risk if the threshold was 25, accounting for 60% of future incident melanomas. 13.5% were classified as at increased risk if the threshold was 28, accounting for 50% of future incident melanomas. 9.8% would be classified as at increased risk if the risk threshold was 30, accounting for 42% of future incident melanomas. Lastly, 5.3% were classified at increased risk if the risk threshold was 34, accounting for 30% of incident melanomas (figure 2).

Comparison to the UK study

The mean risk score for all 1,493 participants was 15.2 ($\pm$ SD 9.8); this was significantly lower than the UK score (17.1, $\pm$ SD 8.5) [difference in mean scores between UK and Melbourne 1.9 (95% Confidence interval (CI) 1.4-2.4), $p < 0.001$]. Comparing the risk score cut-offs with the UK study data, the values were generally similar (Figure 2), however a slightly greater proportion of the population would be classified as increased risk at all thresholds in Australia after adjusting for age and sex (table 4). Estimated PPVs and NPVs are also given for each risk score cut-off for this study population and the UK population, based on the relative risk, sensitivity and specificity reported by Williams et al.¹¹ The PPVs for this study population is higher than the UK due to the higher prevalence of melanoma in the Australian population.

Discussion:

Summary of main findings

Using an electronic tool which implements the Williams melanoma risk model¹¹ to identify patients at increased risk in Australian primary care waiting rooms is acceptable and feasible. This was evidenced by the high response rate and low number of patients needing assistance to complete the survey. These findings support the implementation of a real-time risk stratification tools for use by patients in primary care to allow tailored screening and prevention of melanoma.

Strengths and limitations

A strength of this study is the simple survey design and data collection method. The MelatoolsQ software used in this study had a user-friendly design and provided enough information for most participants to complete the questions unaided. We included photos as examples to assist participants with counting their moles and determining their freckle density on their arms. These photos, along with the detailed explanation for each question, enabled participants to easily self-complete the survey. A minor limitation of this study was not assessing participants ease of completion while using the tool. This would have strengthened our feasibility data. However, this may not be completely indicative of acceptability. In a previous study by Harty and colleagues 84% of participants claimed a colorectal cancer risk prediction tool easy to use but 41% of participants required assistance to complete the questions¹⁸. With almost 90% of the participants not needing assistance and the high recruitment rate in our study, this provides essential feasibility data for future trials aiming to recruit patients in primary care who are at increased risk of melanoma.

The sample demographics differed from the Australian population by gender and age, the demographics were applicable to the general practice population that we were testing the tool for. Our study population was relatively ethnically diverse, and this in turn potentially would lower the mean risk scores compared to the UK findings, where the population was predominately white/British (91%)¹². However, the ethnic diversity we recorded is representative of the current Australia population as reported by the Australian Bureau of Statistics¹⁴. Our ethnically diverse sample had over 50% with dark hair and a lower proportion with fair skin compared to the UK study¹⁹.

Despite the large sample size and high recruitment rate, a limitation of this study is only sampling patients from two general practices in Melbourne. Compared to the Usher-Smith et al. study¹² which recruited from more than 20 general practices in three different regions throughout the UK (England, Scotland and Wales), our study sample size is relatively small. We accounted for this by adjusting for age and sex of the Australian population but are limited by the uncertainty of the estimates of prevalence for the other risk factors in the tool.

Context with other literature

Past research on risk models for melanoma demonstrated a large variety of risk factors, measured in a multitude of ways^{9,10}. Family history has been shown to be a strong indicator of risk, however it was not selected for inclusion in the Williams model¹¹. Including family history could potentially increase the AUC, however this would make it more challenging and potentially unreliable to self-complete on an iPad without assistance. A new risk model developed by Vuong et al.²⁰ with a similar AUC to the Williams model has been developed since the data collection of this study. It includes family history and has been validated in an Australian population. We expect our findings would be generalisable, in terms of feasibility and acceptability, if a tool implemented this model and is likely to perform better in an Australian population than the Williams model.

Using the Williams model¹¹ we demonstrated that with a low risk score cut-off of 25, 20% of the population would be categorised as increased risk which would capture nearly 60% of melanomas. This could underpin a program of targeted prevention and surveillance delivered principally in primary care. The Williams model could be used to further stratify this at risk population to tailor frequency of clinical skin examination or use of novel technologies to support self-skin monitoring²¹ and primary preventive behaviours.

Moloney and colleagues²² demonstrated the effectiveness of risk stratifying the population and focusing on a high-risk population to facilitate early diagnosis. Along with the two cost effectiveness studies (Watts et al. 2017⁵ and Wilson et al. 2018⁶) which demonstrated the possibility of saving costs by stratifying risk. These studies show the need for further country-specific health-economic modelling of different risk stratified melanoma screening programs.

Implications and conclusions

This study provides useful information for planning research into future screening and educational programs for melanoma detection in Australia. A recent cost-effectiveness study modelling a risk-stratified population screening in a UK population using the Williams model showed that such an approach would be effective and enrolling only high-risk participants would be most cost-effective⁵. In Australia, there are high rates of skin cancer screening occurring with little consideration to a person's melanoma risk. Further country specific-modelling as well as clinical implementation research is required to determine the feasibility of implementing a risk-stratified approach to targeted surveillance.

This study reported the use of a self-completed, electronic survey to identify patients in Australian general practice at increased risk of melanoma. This study shows it would be potentially feasible to implement this in an Australian general practice setting to support real-time risk stratification and better target melanoma screening and prevention.

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Tables:

Table 1. Risk factors and risk score calculation from the Williams melanoma risk model (range 0-67)¹¹

Risk Factor	Point score
	N (%)
Gender	
Male	7
Female	0
Age (Years)	
< 44	0
45-54	5
55-64	8
≥ 65	11
Natural hair colour at the age 15 years	
Dark brown/black	0
Light Brown	4
Blonde	5
Red	8
Number of severe sunburns aged 2-18 years	
None	0
1-4	1
5-9	4
10 or more	7
Prior non-melanoma skin cancer	
No	0

Yes	13
Number of raised moles	
None	0
1	3
2	5
3 or more	11
Density of freckles on arms before age 20 years	
None	0
A few	4
Several	6
A lot	10
Total score:	67

Table 2. Sociodemographic characteristics of participants

Characteristic	Participants n (%) n=1,535
Gender	
Male	625 (40.7)
Female	910 (59.3)
Age (Years)	
18-34	677 (44.1)
35-44	320 (20.9)
45-54	249 (16.2)
55-64	178 (11.6)
65-74	75 (4.9)
>75	36 (2.3)
Ethnic background	
Australian	182 (11.9)
British	308 (20.1)
Western European	242 (15.8)
Eastern European	144 (9.4)
African	34 (2.2)

Asian	170 (11.1)
South East Asian	52 (3.4)
Middle Eastern	71 (4.6)
Maori	25 (1.6)
ASSI/ATSI*	13 (0.8)
Mixed Ethnicity	258 (16.8)
Other	36 (2.3)
Education	
Year 10	196 (12.8)
Year 11	141 (9.2)
Year 12	420 (27.3)
Trade	216 (14.1)
Bachelor degree	324 (21.1)
Post-graduate qualification	238 (15.5)
Employment status	
Retired	132 (8.6)
Unemployed, seeking	49 (3.2)
Unemployed, unable	20 (1.3)
Student	76 (5.0)
Working part-time	180 (11.7)
Working full-time	613 (39.9)
Home-carer/maker	409 (26.6)
Permanently sick/disabled	56 (3.7)
Living alone	
No	1386 (90.3)
Yes	149 (9.7)
SEIFA status (VIC tertiles)**	
Lowest SES (0-40%)	325 (21.2)
Mid-range SES (41-80%)	745 (48.5)
Higher SES (81-100%)	465 (30.3)
Past history melanoma	
No	1493 (97.3)

Yes	42 (2.7)
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*ASSI/ATSI: Australian South Sea Islanders/ Aboriginal and Torres Strait Islander

** SEIFA: Socio-Economic Indexes for Areas, Victorian tertiles

Table 3. Risk factor profile of participants, comparing Australian and UK data¹²

Risk Factor	Australian Data	UK Data
	N (%)	N (%)
Gender		
Male	625 (40.7)	2691 (35.6)
Female	910 (59.3)	4875 (64.4)
Age (Years)		
< 44	997 (65.0)	3026 (40.0)
45-54	249 (16.2)	1260 (16.7)
55-64	178 (11.6)	1200 (15.9)
≥ 65	111 (7.2)	2080 (27.5)
Natural hair colour at the age 15 years		
Dark brown/black	854 (55.6)	2908 (38.4)
Light Brown	460 (30.0)	3038 (40.2)
Blonde	178 (11.6)	1254 (16.6)
Red	43 (2.8)	366 (4.8)
Number of severe sunburns aged 2-18 years		
None	543 (35.4)	3701 (48.9)
1-4	702 (45.9)	3196 (42.2)
5-9	156 (10.1)	412 (5.4)
10 or more	132 (8.6)	257 (3.4)
Prior non-melanoma skin cancer		
No	1448 (94.3)	7383 (97.6)
Yes	87 (5.7)	183 (2.4)
Number of raised moles		
None	951 (61.9)	4972 (65.7)
1	231 (15.1)	1060 (14.0)
2	137 (8.9)	637 (8.4)
3 or more	216 (14.1)	897 (11.9)
Density of freckles on arms before age 20 years		

None	561 (36.6)	3091 (40.9)
A few	593 (38.6)	2582 (34.1)
Several	195 (12.7)	938 (12.4)
A lot	186 (12.1)	955 (12.6)
Mean score (±SD)	15.2 (9.8)	17.1 (8.5)

Table 4. The population above various risk score cut offs of the Williams model melanoma risk score¹¹ along with estimated positive predictive values (PPVs) and negative predictive values (NPVs)

Region	Risk score cut-off	Sample above cut-off (%)	Practice/ General Population above cut-off*	Sensitivity (%)	Specificity (%)	5-Year PPV (%)**	5-Year NPV (%)***
Australia	25	16.9	19.8	61	80	7.9	99.9
	28	11.4	13.5	50	85	8.5	99.9
	30	8.0	9.8	42	90	10.8	99.9
	34	4.2	5.3	29	95	14.8	99.9
UK	25	17.9	19.4	61	80	4.0	99.9
	28	11.0	11.8	50	85	4.3	99.9
	30	8.0	8.6	42	90	5.5	99.9
	34	3.3	3.9	29	95	7.5	99.9

* For Australian data, weighted for the Australian population age and sex and for the UK data weighted for the practice registered population

** Estimated 5-year PPV the estimated proportion of the population considered higher risk who would be diagnosed with melanoma in the next 5 years, assuming the same performance of the Williams model as reported in Williams et al 2011¹¹ and a prevalence of newly diagnosed cases of 259 per 100,000 for Australia (the 2016 age-standardised incidence rate for melanoma in Australia from data from the AIHW Australian Cancer Database 2016 multiplied by 5), 130.5 per 100,000 for UK (the 2016 age-standardised incidence rate for melanoma from the Office for National Statistics UK 2017 multiplied by 5).

*** Estimated 5-year PPV the estimated proportion of the population considered higher risk who would be diagnosed with melanoma in the next 5 years, assuming the same performance of the Williams model as reported in Williams et al 2011¹¹ and the same prevalence as the PPV above for both Australia and the UK.

Figures legends:

Figure 1. Recruitment flow chart

Figure 2. Distribution of risk scores for the Australian population and the UK population from Usher-Smith et al.¹². Vertical lines represent the four different risk score cut-offs (25, 28, 30 and 34) of the Williams model¹¹ with the percentage of the population above the cut-off.

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