32nd IFSCC Congress
London 19–22 September 2022

Design and use of a gender-neutral, individualized wrinkle prediction model

Poster ID
383

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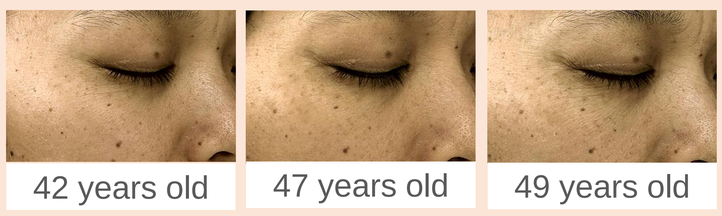
Introduction:

Background

- Wrinkles show steady progression with aging. Proactive and predictive prevention of aging phenomena is growing in importance.
- However, the progression of wrinkles and the associated risk factors of aging vary greatly from individual to individual, making it very difficult for people to prevent wrinkles.



Changes in wrinkles over seven years in the same person.

Aim of this study

We aim to develop a consumer-focused, web-based, digital tool that can predict a person's future wrinkles and estimate the factors that accelerate them.

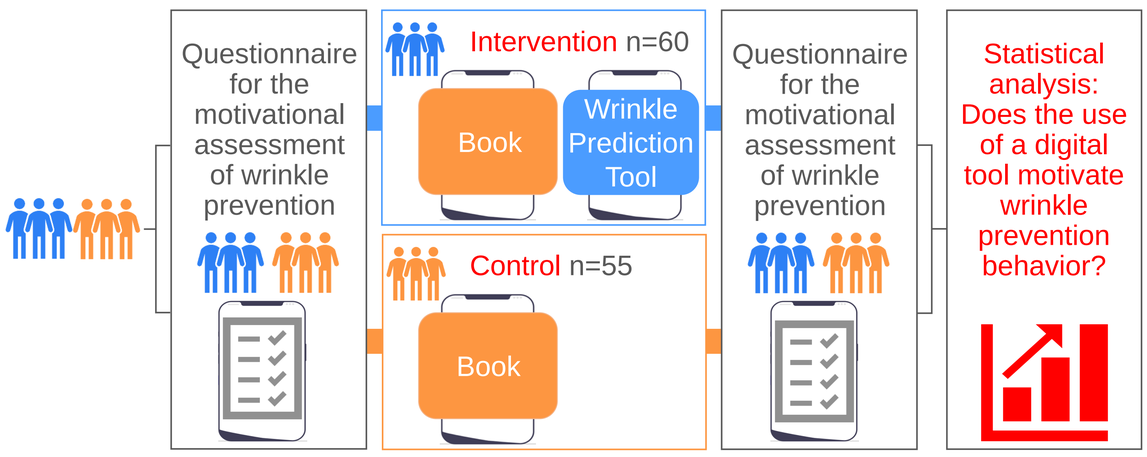
Materials & Methods:

Development of a gender-neutral wrinkle prediction model and application in a web-based, digital tool

- **Data collection** [1]
  We followed 48 women aged 22 to 60 years for 7 years from 2011 to 2017, and repeatedly obtained measurements of skin moisture content, Transepidermal water loss, sebum content, skin color (L*, a*, b*), and wrinkle grade on a scale of 0 to 7 in increments of 0.25, according to the wrinkle grade table [2].
- **Development of model for longitudinal data**
  A linear mixed-effects model was used as the prediction model, with individual differences included as random effects over time.
- **Update to gender-neutral wrinkle prediction model**
  Data were collected on 80 men aged 25 to 63 years in 2021, and the model was updated to be gender-neutral.
- **Develop of digital tool**
  The wrinkle prediction model was embedded into a web-based, digital tool.

Randomized controlled trial to test the effectiveness of the wrinkle prediction tool on wrinkle prevention behavior

- **Creation of a questionnaire**
  A total of 18 questions with response items on a 7-point Likert scale, consisting of intentions toward wrinkle prevention behaviors, confidence, perceived risk, and expectations of results was created.
- **Creation of a book of wrinkle prevention**
  A book containing non-personalized general information about wrinkle prevention was created.
- **Procedure for Randomized Controlled Trials**

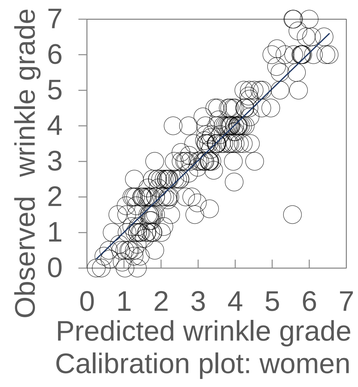


Results & Discussion:

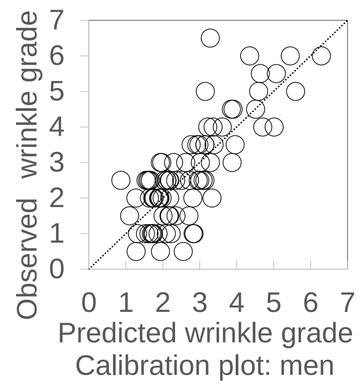
Prediction accuracy of model and step-by-step guide to using the web-based, digital tool

- The original wrinkle prediction model showed good prediction accuracy: R^2=0.88 (0.85-0.91) and RMSE=0.52 (0.38-0.66).
- The updated prediction model for male data also showed good prediction accuracy: R^2=0.63 (0.56-0.70) and RMSE=0.88 (0.86-0.90).
- A web-based, digital tool was created that predicts a person's future wrinkles based on just one facial photograph taken on their device.

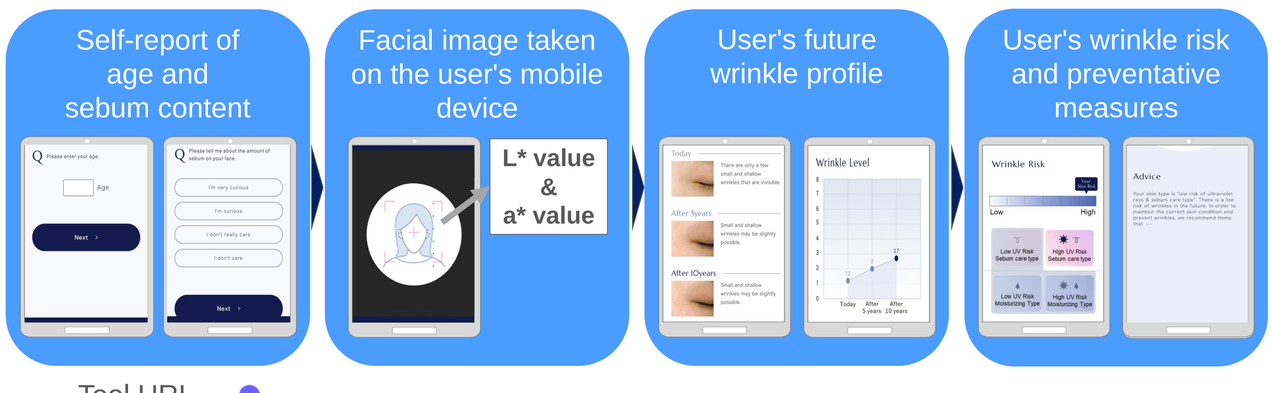
$$
\begin{aligned}
&Wrinkle\ grade_i \\
&= 0.1469 \times age \\
&+ 0.7540 \times ln(sebum) \\
&+ 0.3270 \times skin\ color\ a^* \\
&+ 0.1654 \times mean[skin\ color\ L^*] \\
&- 0.1044 \times [ln(sebum) \times skin\ color a^*] \\
&-15.90 + b_{0,i}\ \ b_{0,i} \sim N(0, 0.4847)
\end{aligned}
$$



Calibration plot: women



Calibration plot: men



Tool URL

- To protect a user's personal information, the captured facial image is deleted immediately after creating the information.
- No app download is required as it is a web app.
- Localization possible through the translation function of the device.

Users can easily find the best preventive cosmetic strategies for themselves.

Randomized controlled trial to test the effectiveness of the wrinkle prediction tool on wrinkle prevention behavior

- The digital tool significantly improved user's self-efficacy in assessing their own wrinkles and continuing wrinkle prevention behaviors.

Item	Group	Score value	
		Before	After
I can confidently assess the state of my own wrinkles.*	Intervention	3.80(3.46-4.14)	4.53(4.21-4.86)
	Control	4.35(3.89-4.80)	4.60(4.19-5.01)
I can continue to engage in wrinkle prevention actions even if I don't immediately feel the effects of my actions.**	Intervention	4.60(4.30-4.90)	5.18(4.89-5.47)
	Control	4.98(4.59-5.38)	5.04(4.65-5.42)

Data are presented as means (95% confidence interval) *p < .05, **p < .01

The digital tool is effective in motivating consumers to engage in wrinkle prevention behavior.

Conclusions:

- We developed an accurate wrinkle prediction model and embedded this into a web-based, digital tool that helps users to assess wrinkle progression and take preventative measures through image analysis technology.
- A randomized controlled trial using the developed web-based, digital tool showed it significantly increases the user's self-efficacy in assessing wrinkles and forming preventive habits.

This study opens the door to a future in which people do not have to worry about wrinkles.

References:

[1] Nakamura, R., Uehara, S., Suematsu, K., Ishitsuka, Y., & Noma, H. (2021). Prediction of future wrinkles for middle - aged women: A 7 - year longitudinal study on the progression of wrinkles in Japanese women. Skin Research and Technology, 27(5), 854-862.
[2] (2007) Guideline for evaluation of anti-wrinkle products. Journal of Japanese Cosmetic Science Society, 31, 411-431.