Adoption of a COVID-19 Contact Tracing App Among Older Internet Users in Finland

Sakari Taipale[1,2] [0000-0001-8962-6226] and Tomi Oinas[1][0000-0003-3250-5815]

[1] University of Jyvaskyla, 40014 Jyvaskyla, Finland
[2] University of Ljubljana, 1000 Ljubljana, Slovenia
sakari.taipale@jyu.fi

Abstract. The outbreak of the COVID-19 pandemic created an unequal need for limiting physical contacts and tracing possible exposures to a novel coronavirus. Smartphone-based contact tracing applications (CTAs) were presented as a vehicle for stopping virus transmission chains and supporting the work of contact tracing teams. In this study, older adults' adoption of a CTA was studied using socioeconomic background factors, satisfaction with health, and the measure of digital activity as predictors. The data were drawn from a larger questionnaire survey targeted at older internet users. A subsample of older Finnish internet users (N = 723) was analyzed using a logistic regression model. Results showed that older internet users had widely adopted the Finnish CTA called *Koronavilkku* irrespective of demographic background factors, level of education, and self-assessed satisfaction with health. Besides high income and retirement status, digital activity measured through the breadth of mobile phone features used and the use of an online symptom checker increased the likelihood of having the CTA installed on a smartphone. The results of the study lend themselves to be used for future epidemics and other occasions that require a real-time and/or retrospective tracing of people and their physical encounters.

Keywords: Contact Tracing App, COVID-19, Internet, Older Adults, Online Symptom Checker, Smartphone

1 Introduction

The outbreak of the COVID-19 pandemic in early 2020 created an unequal need for limiting physical contacts and tracing possible exposures to a novel coronavirus all over the world [1, 2]. From very early on, the oldest people, especially those with various health conditions, were found to be at a higher risk for a serious infection [3–6]. Therefore, both recommendations for self-isolation and statutory measures to limit moving and face-to-face contact were pronouncedly targeted at older citizens. For instance, the Finnish government released the instructions in March 2020, according to which "people over the age of 70 are obliged to separate from contacts with other people where possible" [7].

Despite certain privacy concerns, smartphone-based contact tracing applications (CTAs) were presented in many countries as a vehicle for stopping virus transmission chains and supporting the work of contact tracing teams soon after the outbreak of the pandemic [8]. Voiced privacy concerns were mainly related to the various ways in which tracing apps manage, store, and transmit personal data. The “decentralized” solutions kept user data on the device itself, while “centralized” solutions transmitted data to a central repository [9]. While the former solution provoked somewhat less privacy concerns than the latter, in general CTAs were perceived as an intrusive technology that compromised the sovereignty of an individual [9].

Whereas privacy concerns may have hindered the adoption of CTAs, smartphone ownership was an absolute precondition for adoption. Hence, CTA adoption could not be taken for granted, especially among the oldest population. For example, in Finland, 75% of adults aged 65–74 and only 34% of those aged 75–89 had a smartphone equipped with a 3G or 4G connection and touchscreen for their personal use in 2020 [10]. The limited prevalence of smartphones as well as a sizable variation in digital skills and in ways of using smartphones [11, 12] may have affected older adults’ use of COVID-19 CTAs in particular ways.

This paper aims to investigate older adults’ adoption of a COVID-19 CTA in Finland using socioeconomic background factors, satisfaction with health, and measures of digital activity as key predictors. All respondents included in the sample are internet users, constituting a highly select group of older adults (aged 62–92). First, this study explores (RQ1) what socioeconomic and well-being factors are related to the use of COVID-19 CTAs. Second, it is investigated whether (RQ2a) the breadth of mobile phone features used and (RQ2b) the use of an online symptom checker—two measures of digital activity—are associated with the adoption of CTA. To obtain answers to these questions, a subsample of questionnaire survey data (N = 723) collected in November 2020 is analyzed using a logistics regression model.

The rest of the paper is organized as follows. The paper begins with a short overview of what is already known about the willingness to adopt and actual use of COVID-19 CTAs in different countries. After this, the Finnish COVID-19 CTA called *Koronavilkku* is introduced. The data, measures, and methods are presented before the results section. In the discussion and conclusions, the significance of retirement status, income, and overall digital activity for the use of CTAs is highlighted, and the implications for further research and practices are discussed.

2 Previous literature on COVID-19 contact tracing apps

In less than two years from the launch of the first COVID-19 CTAs in Asian countries, such as China, South Korea, and Singapore [13], many studies have been published about citizens’ intentions and willingness to adopt these applications [1, 2, 14]. More recently, a study has also been conducted on the actual usage of CTAs [15]. So far, most of the studies have focused on entire adult populations [14–16], and some studies have addressed specific subpopulations like health care students [17]. Older adults have not yet attracted special attention in CTA studies, although they are both at a higher risk for serious COVID-19 infection and often less likely to adopt new technology than younger age groups. Despite this lack of research on older age cohorts, the earlier studies on CTAs provide much useful information about potential predictors of older adults' CTA adoption.

As regards age, a Dutch study found that the predicted adoption rate of a COVID-19 CTA was significantly lower for the oldest respondents (aged 75 or more, 45.6%) than for the youngest age bracket (aged 15–34, 79.4%) [2]. In a five-country study including respondents from France, Germany, Italy, the United Kingdom, and the United States, it was reported that the acceptability of CTAs was considerably high in all age groups, yet it slightly decreased with the increasing age of respondents [1]. Likewise, in a study from the United States, it was found that the oldest respondents were slightly less willing to adopt a CTA than younger respondents [14]. In contrast to others, a study dealing with the use of COVID-19 CTAs in Switzerland found no relationship between age and application use [15].

To date, no gender differences have been found regarding the acceptability or use of COVID-19 CTAs. Altmann et al. [1] showed that the acceptability of these apps did not vary by gender in their five-country study. Similarly, von Wyl et al. [15] reported no gender differences in Switzerland. Regarding education, prior findings have shown equally consistent results. Both a Dutch study [2] and a U.S. study [4] reported that the more educated people were, the more willing they were to adopt COVID-19 CTAs. Prior studies have paid relatively little attention to family-related factors. One of the few studies found that neither partnership status nor having children was associated with the use of COVID-19 CTAs in Switzerland [15].

Previous research has reported mixed findings regarding the predictive power of economic factors. In Switzerland, it was found that higher household income was associated with the use of COVID-19 CTAs [15], while another study from the United States detected no household income effect [14]. Due to major differences in countries' economic structures, taxation models, and welfare systems, these inconsistencies in findings are not surprising. Similarly, there are also notable differences in population density and degree of urbanization. Nevertheless, previous studies have provided only limited information about the connections between these factors and CTA use. In the United States, a study found that the urban residency of respondents was not associated with CTA use [14]. Other types of regional information were provided by a Swiss study. In Switzerland, people residing in French-speaking or Italian-speaking regions were associated with a lower CTA adoption than those living in German-speaking regions [15].

In addition to sociodemographic and economic factors, the connection between health status and CTA use has attracted some attention in previous research. In the Netherlands, a study revealed a connection between a worsened perception of general health and the preference to adopt a CTA [2]. The same study also found a positive relationship between some specific health issues, such as lung disease, kidney disease, and a compromised immune system, and the preference of having a CTA. Similarly, it was reported in a five-country study that respondents with one or more comorbidities were more likely to support the use of a CTA than those with no comorbidities [1]. In the United States, a study showed that the respondents who belonged to a high-risk group due to a certain health condition were 1.5 times likelier to adopt a CTA than the respondents without medical conditions [14]. To sum up, there is solid evidence that health conditions constituting a higher risk for infection increase the willingness to use and actual use of COVID-19 CTAs in various country contexts.

Lastly, previous studies have indicated that overall digital activity is associated with the use of COVID-19 CTAs. For example, both the higher frequency of mobile phone use [1] and internet use [15] were related to an increase in the likelihood of adopting and using CTAs. Similarly, higher internet skills were found to be associated with the willingness to install CTAs on a smartphone in the United States [14]. In contrast, the main reasons for the nonuse of COVID-19 CTAs in Switzerland were the perceived lack of usefulness (37%), not having a suitable smartphone or operating system (23%), and privacy concerns (22%) [15]. In the same study, it was concluded that the older respondents were, the more often they reported “not the right phone” as a reason for nonuse [15].

3 COVID-19 contact tracing app in Finland

In Finland, the COVID-19 CTA called *Koronavilkku* was developed by the Finnish Institute for Health and Welfare (THL). It was developed to assist in finding out if its user had been exposed to the coronavirus and should therefore self-isolate oneself and contact the health care services for a possible COVID-19 test. In the case of a positive test result, a person could share this information anonymously with those who had been in proximity with him/her. In terms of data privacy, *Koronavilkku* is based on a decentralized protocol. The app sends a randomly generated anonymous code to other apps in close proximity, and these codes are locally stored on mobile phones only.

The *Koronavilkku* app was rolled out on August 31, 2020, and it was promoted with nationwide advertising campaigns. The app was free to download from the Google Play Store and Apple’s App Store. The oldest supported operating system for Android phones was 6.0 and for Apple iOS13.5, which was possible to install on iPhone 6s and subsequent models. The app required a Bluetooth connection to function.

When the survey data used in this study were collected in November 2021, THL reported that the *Koronavilkku* app had been downloaded over 2.5 million times in a country of 5.5 million inhabitants. According to an opinion survey commissioned by THL [18], 90% of Finns had at least heard about it in late 2020. Of the surveyed people under the age of 25, 71% had downloaded the app, while the adoption rate was the lowest among adults aged between 45 and 54.

4 Data and method

4.1 Survey data

For this study, the data were drawn from the third wave of the Aging + Communication + Technology (ACT) cross-national longitudinal survey collected in November 2020. The countries involved in the survey study were Austria, Canada, Israel, Finland, the Netherlands, Romania, and Spain. The initial target population of the survey was older internet users aged 60 or above in 2016 (Wave 1). Respondents were recruited from the respondent panels of commercial research agencies. Questionnaires were administered and filled out online in every country except Romania [19]. The third-wave data set includes 4,445 respondents in total. After completing the main survey questionnaire, a couple of additional questions concerning the use of COVID-19-related digital services were presented to Finnish respondents. These questions dealt with the use of the *Koronavilkku* CTA and the use of the *Omaolo* online service developed to facilitate self-assessment of various symptoms, including those of COVID-19, and service needs. As the COVID-19-related questions were only collected from Finland and in the latest wave of the survey, the analysis of this study was restricted to the subsample of older Finnish internet users (*N* = 723).

4.2 Measures

Descriptive statistics of the dependent and independent variables are presented in Table 1. As the dependent variable, the study used the question, "Do you have *Koronavilkku* installed on your mobile phone?" Independent variables, selected following the above-presented literature review, consisted of demographic measures (gender, age, family status, urban/rural residency, the Nomenclature of Territorial Units for Statistics (NUTS) region), socioeconomic variables (education, income, retirement status), self-assessed satisfaction with health, and two measures of digital activity—the breadth of mobile phone features used and the use of the *Omaolo* online symptom checker.

Table 1. Descriptive statistics.

Variable	*N*	%
COVID-19 contact tracing app		
No	291	40.2
Yes	432	59.8
Gender		
Female	349	48.3
Male	374	51.7
Age		
64–69	345	47.7
70–75	242	33.5
76–92	136	18.8
Family status		
No spouse, no children	121	16.9
No spouse, with children	128	17.9
Spouse, no children	258	36.0
Spouse, with children	209	29.2

Rural/urban residency		
City or suburb	326	45.5
Town	262	36.5
Countryside	129	18.0
NUTS[1] regions		
Helsinki-Uusimaa (Capital region)	193	26.7
Southern Finland	166	23.0
Western Finland	187	25.9
Northern and Eastern Finland	177	24.5
Education		
Primary	101	14.1
Secondary	326	45.7
Tertiary	287	40.2
Income		
Below average	296	46.3
Average	115	18.0
Above average	228	35.7
Retirement status		
Other	55	7.6
Retired	668	92.4
Satisfaction with health		
Low	46	6.4
Med	297	41.4
High	374	52.2
Breadth of mobile phone features used		
Narrow	238	32.9
Medium	306	42.3
Broad	179	24.8
Online symptom checker use		
No	582	82.7
Yes	122	17.3

[1] The Nomenclature of Territorial Units for Statistics (NUTS).

4.3 Statistical procedures

A binary logistic regression model was applied to find out how different background factors and the two measures of digital activity—the breadth of mobile phone features used and the use of online symptom checker—are associated with the use of the COVID-19 CTA. McFadden's Pseudo R^2 was used as a goodness-of-fit indicator.

5 Results

Table 1 shows that almost two-thirds of our respondents had the *Koronavilkku* CTA installed on their smartphone, and less than a fifth had experience in using the *Omaolo* online symptom checker at the time of the data collection in late 2020. Respondents' self-perceived health was at a good level on average. A vast majority of respondents reported their health satisfaction being either at a high or at a medium level.

All results concerning the research questions are presented in Table 2. Regarding RQ1, the analysis revealed no associations between basic demographic measures (gender, age, family status, urban/rural residency, NUTS region) and COVID-19 CTA use. Similarly, education and self-reported health satisfaction turned out to be insignificant predictors. On the contrary, employment status and self-reported income (relative to a national average) were strongly associated with the adoption of the *Koronavilkku* CTA. More precisely, the retired respondents had the CTA downloaded on their phones more likely than the nonretired (i.e., the employed, unemployed, volunteer workers). Respondents with an average or above-average income had, in turn, the app more commonly installed on their phones than those who reported having an income lower than a national average.

In response to RQ2a, it was found that the breadth of mobile phone features used was strongly associated with the adoption of the *Koronavilkku* CTA among the studied population. The wider the array of mobile phone features used, the higher the likelihood of having the CTA installed on the phone. Regarding RQ2b, the results showed that the use of the *Omaolo* online symptom checker was associated with the use of the CTA. Respondents who had used the online symptom checker were 2.8 times likelier to have the *Koronavilkku* CTA installed on their mobile phone than those with no experience in using it.

Table 2. Predictors of COVID-19 tracing app use (binary logistic regression).

Variable	Odds ratio	SE	*t*-value	*p*-value
Gender (ref. female)	1			
Male	1.004	.204	0.02	.984
Age group (ref. 64–69)	1			
70–75	.835	.184	−0.82	.412
76–92	.703	.177	−1.40	.162
Family status (ref. no spouse, no children)	1			
No spouse, with children	.968	.299	−0.10	.916
Spouse, no children	1.124	.309	0.42	.671
Spouse, with children	1.211	.345	0.67	.502
Education (ref. primary level)	1			

Secondary	.615	.175	–1.70	.088
Tertiary	.642	.201	–1.42	.157
Satisfaction with health: (ref. low)				
Med	.741	.288	–0.77	.439
High	.933	.367	–0.18	.859
Monthly personal income (ref. below average)	1			
Average	1.944	.509	2.54	.011
Above average	2.278	.561	3.34	.001
Rural/urban residency (ref. city or suburb)	1			
Town	1.144	.247	0.62	.534
Countryside	.773	.206	–0.97	.333
NUTS (ref. Helsinki-Uusimaa (capital region))	1			
Southern Finland	.898	.245	–0.39	.695
Western Finland	1.214	.319	0.74	.460
Northern and Eastern Finland	1.498	.403	1.50	.133
Retirement status (ref. other)	1			
Retired	2.958	1.022	3.14	.002
Breadth of mobile phone features used (ref. narrow)	1			
Medium	2.603	.542	4.59	<.001
Broad	5.271	1.398	6.27	<.001
Online symptom checker use (ref. no)	1			
Yes	2.752	.745	3.74	<.001
Constant	.235	.142	–2.39	.017
McFadden's Pseudo R^2	0.132			
N	614			

6 Discussion and conclusions

The results of the study show that older internet users had widely adopted the COVID-19 tracing app irrespective of demographic background factors, level of education, and self-reported satisfaction with health. These results align well with previous studies that have found no gender effects [1, 15] or variation in the adoption of CTAs according to family status or marital status [15]. However, the results depart from the earlier findings regarding age and education. Unlike previous studies [1, 2], this study did not support the negative association between the use of COVID-19 CTAs and age. Similarly, this study did not find evidence for a connection between education and the adoption of CTA [cf. 2, 14]. These less anticipated findings may be interpreted as acknowledging the characteristics of the target population. Older internet users are more likely to be highly educated and experienced users of CTAs than their agemates not using the internet and thus not included in our data.

Strong associations between socioeconomic factors and the adoption of COVID-19 CTAs were found in the analysis. First, retired respondents were significantly more likely to use the CTA than other respondents who were mostly full-time or part-time workers. Since virtually all the respondents had reached their minimum retirement age, it can be presumed that employed respondents comprise a relatively healthy subgroup of individuals. In fact, it is unlikely that the employed respondents would have serious health conditions as they have continued to work beyond the age of 64. For the same reason, they may not consider themselves at an equivalent risk of getting a serious infection compared with their retired agemates and had therefore not installed a COVID-19 CTA on their phones.

More surprisingly, the study found that the respondents with a below-than-average income were less likely to use the COVID-19 CTA than the respondents with higher incomes. Although this finding is in line with some previous findings [15], it can be considered at least partly counterintuitive as the CTA is completely free to download. A possible explanation for this finding lies in mobile phones and their operating systems. Without further evidence, it can only be hypothesized that the respondents with a low income may have possessed older phone models that cannot run the *Koronavilkku* CTA requiring a Bluetooth connection and a relatively new version of iOS or Android operating system.

Based on the results of this study, the subjective measure of health satisfaction is not associated with the adoption of the COVID-19 CTA among the studied population of older Finnish internet users. This finding complements the previous knowledge, according to which both specific heath conditions constituting a high risk for a severe infection and self-perceived general health [1, 2, 14] are positively associated with CTA use. This divergent finding indicates that subjective measures of health satisfaction do not inevitably correlate with diagnosed health conditions and may not similarly increase people's awareness of risks related to COVID-19 infection.

Lastly, RQ2a and RQ2b dealt with the associations between two measures of digital activity—the breadth of mobile phone features used and the use of the *Omaolo* online symptom checker—and the adoption of the *Koronavilkku* CTA. Both measures were strongly and positively associated with having the CTA installed on a mobile phone. In this respect, the results are consistent with the previous studies that applied other measures of digital activity, such as the frequency of mobile phone use [1] and of internet use [15]. Regarding the online symptom checker, it is worth mentioning that it was developed before the COVID-19 pandemic to self-check the symptoms of other common health conditions. Hence, some respondents may have been familiar with and even used it before the pandemic. Prior knowledge of e-health applications like *Omaolo* may have lowered the threshold for adopting the *Koronavilkku* app. To conclude, the results of the study imply that apart from higher income and retirement status, digital activity in general increases the likelihood of CTA adoption among older internet users.

7 Limitation and future research

This study has certain limitations that arise from its sample and measures. As the survey was originally developed to study older people's media use, the sample was only indicative of older internet users. Additional measures on COVID-19 CTA use and online checker use were only added to the Finnish version of the questionnaire. Hence, it was not possible to make country comparisons. The data set also included some obvious limitations regarding potential independent variables. It did not involve measures of digital skills or detailed information about respondents' personal techno-biography, which could have served as good predictors of CTA adoption. Similarly, the data did not contain information about respondents' diagnosed health conditions, which have been successfully applied as independent variables in some prior studies [2]. Moreover, it is likely that older adults' social connectedness and lifestyles are related to their perceived need for and willingness to adopt a CTA. If a person's lifestyle is home-centered and in-person encounters with others are rare, the need for a CTA is certainly perceived as relatively small. These types of measures would be important to include in future models to also cover motivational factors behind the adoption of CTAs.

As new pandemics may break out at any time, it is crucial to understand what factors influence their adoption rates. The effectiveness of CTAs is largely dependent on the overall adoption rate, which should be as high as possible. Although the effectiveness of CTAs in breaking and tracking infection chains has been questioned, a recent systematic review shows that CTAs can be a valuable addition to the work of manual tracing teams [20]. The results of this and similar studies also lend themselves to other possible applications of CTAs on occasions where real-time and/or retrospective tracing of people and their physical encounters are required. In the future, portable CTAs may turn out to be useful in other types of emergencies, such as natural disasters or bioterrorism. It is hence important to pay attention to their acceptability and reliability in the future.

Acknowledgments

This study was funded by the Strategic Research Council at the Academy of Finland (grants 327145 and 327149 for the DigiIN project) and the Academy of Finland for the Centre of Excellence in Research on Ageing and Care (grants 312367 and 336671).

References

1. Altmann, S., Milsom, L., Zillessen, H., Blasone, R., Gerdon, F., Bach, R., Kreuter, F., Nosenzo, D., Toussaert, S., Abeler, J.: Acceptability of app-based contact tracing for COVID-19: cross-country survey study. JMIR mHealth and uHealth **8**(8), e19857 (2020).
2. Jonker, M., de Bekker-Grob, E., Veldwijk, J., Goossens, L., Bour, S., Rutten-Van Mölken, M.: COVID-19 contact tracing apps: predicted uptake in the Netherlands based on a discrete choice experiment. JMIR mHealth and uHealth **8**(10), e20741 (2020).

3. Bidzan-Bluma, I., Bidzan, M., Jurek, P., Bidzan, L., Knietzsch, J., Stueck, M., Bidzan, M.: A Polish and German population study of quality of life, well-being, and life satisfaction in older adults during the COVID-19 pandemic. Frontiers in Psychiatry **11**, 585813 (2020).
4. Campos-Castillo, C.: Gender divides in engagement with COVID-19 information on the internet among US older adults. The Journals of Gerontology: Series B **76**(3), e104–e110 (2021).
5. Zhou, F., Yu, T., Du, R., Fan, G., Liu, Y., Liu, Z., Xiang, J., Wang, J. Song, B., Gu, X., Guan, L., Wei, Y., Li, H., Wu, Z., Xu, J., Tu., S., Zhang, Y., Chen, H., Cao, B.: Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. The Lancet **395**(10229), 1054–1062 (2020).
6. Xie, B., Charness, N., Fingerman, K., Kaye, J., Kim, M.T., Khurshid, A.: When going digital becomes a necessity: ensuring older adults' needs for information, services, and social inclusion during COVID-19. Journal of Aging & Social Policy **32**(4–5), 460–470 (2020).
7. STM. Uusi koronavirus—COVID-19 Toimintaohjeita yli 70-vuotiaille. https://aineistopankki.thl.fi/l/wFdKSXz2Jdg7 (last accessed January 4, 2022).
8. Abeler, J., Bäcker, M., Buermeyer, U., Zillessen, H.: COVID-19 contact tracing and data protection can go together. JMIR mHealth and uHealth **8**(4), e19359 (2020).
9. Savona, M.: The saga of the COVID-19 contact tracing apps: lessons for data governance. SPRU Working Paper Series SWPS 2020–10 (June), University of Sussex. https://www.sussex.ac.uk/webteam/gateway/file.php?name=2020-10-swps-savona.pdf&site=25 (last accessed January 4, 2022).
10. Official Statistics of Finland. Use of information and communications technology by individuals. https://www.stat.fi/til/sutivi/2020/sutivi_2020_2020-11-10_tau_013_fi (last accessed January 4, 2022).
11. Hänninen, R., Pajula, L., Korpela, V., Taipale, S.: Individual and shared digital repertoires—older adults managing digital services. Information, Communication & Society 1–16 (2021).
12. Hänninen, R., Taipale, S., Luostari, R.: Exploring heterogeneous ICT use among older adults: the warm experts' perspective. New Media & Society **23**(6), 1584–1601 (2021).
13. Du, L., Raposo, V.L., Wang, M.: COVID-19 contact tracing apps: a technologic Tower of Babel and the gap for international pandemic control. JMIR mHealth and uHealth **8**(11), e23194 (2020).
14. Hargittai, E., Redmiles, E.M., Vitak, J., Zimmer, M.: Americans' willingness to adopt a COVID-19 tracking app. First Monday **25**(11), (2020).
15. von Wyl, V., Höglinger, M., Sieber, C., Kaufmann, M., Moser, A., Serra-Burriel, M., Ballouz, T., Menges, D., Frei, A., Puhan, M.A.: Drivers of acceptance of COVID-19 proximity tracing apps in Switzerland: panel survey analysis. JMIR Public Health and Surveillance **7**(1), e25701 (2021).
16. Lin, J., Carter, L., Liu, D.: Privacy concerns and digital government: exploring citizen willingness to adopt the COVIDSafe app. European Journal of Information Systems 1–14. (2021).
17. Montagni, I., Roussel, N., Thiébaut, R., Tzourio, C.: Health care students' knowledge of and attitudes, beliefs, and practices toward the French COVID-19 app: cross-sectional questionnaire study. Journal of Medical Internet Research **23**(3), e26399 (2021).
18. THL. Koronavilkku has been downloaded more than 2.5 million times—widespread use increases the app's effectiveness. https://thl.fi/en/web/thlfi-en/-/koronavilkku-has-been-downloaded-more-than-2.5-million-times-widespread-use-increases-the-app-s-effectiveness (last accessed January 4, 2022).
19. Ivan, L., , Schiau, I.: Older audiences and digital media: focus on Romania. Management Dynamics in the Knowledge Economy **6**(3), 423–447 (2018).

20. Jenniskens, K., Bootsma, M.C., Damen, J.A., Oerbekke, M.S., Vernooij, R.W., Spijker, R., Moons, K.G.M., Kretzschmar, M.E., Hooft, L.: Effectiveness of contact tracing apps for SARS-CoV-2: a rapid systematic review. BMJ Open **11**(7), e050519 (2021).