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Experience of primary caregivers in utilising an mHealth application for remote dental screening in preschool children

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ABSTRACT

Objectives. This study aimed to address the acceptance of mHealth applications for a dental screening app that facilitates patient information entry and captures dental photos remotely to assist in caries diagnosis in preschool children in Australia. **Methods.** All participants were recruited through the ORIGINS Project, a community-based interventional birth cohort study in Western Australia. Forty-two primary caregivers, who were the users of a teledental screening app, were given a questionnaire with 17 questions; these were constructed based on the theme of the Technology Acceptance Model: perceived ease of use (PE), perceived usefulness (PU), behavioural intention to adopt (BI), anxiety (ANX), attitude toward a behaviour (ATB), and self-efficacy (SE). Cronbach's alpha was estimated to determine internal consistency. Path analysis was employed to quantify the relationship between each theme. **Results.** The mean values for most themes indicated high satisfaction with the intervention among caregivers (scores out of 5): PE (4.54 ± 0.55), PU (4.65 ± 0.49), BI (4.40 ± 0.65), ATB (4.23 ± 0.70), SE (4.36 ± 0.64). Results indicated high consistency in response in the PE, PU, ATB, and SE (α = 0.74–0.84) and moderate consistency was observed in ANX and BI (α = 0.50–0.62). The overall intention of using the dental screening app was significantly related to both PU and ATB ($P < 0.05$); in addition, the SE and PE also positively affected the PU. **Conclusion.** The perceived usefulness and attitude toward behaviours influenced the overall behavioural intention of the participants to use the telehealth model in dental screening. Recognising these relationships indicates community readiness for implementing the telehealth application in the dental program and enables identification of areas for improving its diffusion.

Keywords: child, delivery of health care, dental, dental caries, dental photography, smartphone, technology, telemedicine, the ORIGINS Project.

Introduction

Early childhood caries is a common chronic infectious childhood disease affecting almost half of all preschool children.[1,2] Untreated caries resulted in a significant 12% of global productivity losses attributed to dental diseases. Out of this, US$21.19 billion (11%) was due to untreated caries in permanent teeth, while US$0.90 billion (0.5%) was attributed to caries in deciduous teeth.[3] Australian toddlers have limited access to dental care, and children become eligible for free school dental service when they turn 5 years old.[4]

The recent coronavirus disease 2019 (COVID-19) pandemic has impacted the provision of non-essential health services in Australia, including oral care; for example, there were 75 000 fewer restorative services provided during restrictions from March to June 2020 than in the same period in 2019.[5] Since the pandemic, there has been a rise in the use of telehealth applications for dentistry to facilitate remote screening and diagnosis.[6,7] This is in accordance with the use of mHealth: the 'medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal

digital assistants, and other wireless devices'.[8] Teledentistry is a facet of mHealth, which facilitates dental diagnosis, treatment, management, referrals, and education via information technology; this contrasts with traditional patient–dentist interactions in a dental office setting.[9] Recent literature infers that oral health care delivered by this means can increase access to care and reduce pressure on intrinsic healthcare systems.[10–13] mHealth has been successfully implemented across a variety of medical disciplines to improve the efficiency and accessibility of services in low-resource settings.[11,14] Moreover, the accuracy and reliability of various dental mHealth applications have also been appraised in the diagnosis of dental caries, orthodontics, and oral medicine, supporting its efficacy.[15,16]

Previous studies confirm that a photographic approach is an acceptable approach to detect dental caries in children in comparison to the traditional clinical examination.[17,18] These former studies use photographs taken by clinicians themselves to determine the accuracy between photos and traditional clinical examination. However, limited studies address the usefulness of an application where photos are taken by parents or guardians of the children.[19]

Therefore, the body of literature investigating the users' (particularly parents and caregivers) experience of using technology in oral care remains limited. Previous studies lack theoretical frameworks such as the Technology Acceptance Model (TAM) or technology diffusion to explain the users' experience using technology in oral care. Therefore, this study used a modified TAM to describe primary caregivers' experience using an mHealth application designed for remote dental screening in preschool children in Australia.

Theoretical framework

The theoretical underpinnings of technological acceptance in dentistry are multifaceted and are rooted in several key concepts. One such concept is the intentional or voluntary use of technology or mobile applications by patients, as described by Schmeer *et al.*[20] Additionally, attitudes towards technology, as defined by Holden and Karsh[21] as the degree to which a person holds a positive or negative perception about a certain behaviour, play a crucial role in determining behaviour. The TAM posits that an individual's beliefs about technology influence their behaviour.[21] Behavioural intention, as described by Holden and Karsh,[21] is another key concept that predicts technology usage. The relationship between attitude towards technology, behavioural intention, perceived usefulness, perceived ease of use, and anxiety, as described by Abdekhoda *et al.*[22] and Hoque and Sorwar,[23] are also important factors that influence the attitude towards technology. The present study places a particular emphasis on the external variable of self-efficacy as a focal point in this context. This study aimed to assess the acceptability of a telehealth application for dental screening for early detection and referral of early childhood caries from the perspectives of primary caregivers.

Methods and materials

Study design and setting

This study is a cross-sectional survey (2021) that was a subproject from the ORIGINS Project in Western Australia (WA),[24] a large prospective pregnancy and birth cohort study. The ORIGINS cohort is a collaboration between Telethon Kids Institute and Joondalup Health Campus, and is one of the most comprehensive studies of pregnant women and their families in Australia to date, recruiting 10 000 families over a decade from the Joondalup and Wanneroo communities of WA.[24]

Participants

This study builds upon a previous study of the teledental app.[19] Here, we explored the TAM among users of the teledental screening app, including all 42 participants who actively utilised the app. The app was designed for dental screening and tooth decay assessment of children on photographs taken by parents. Details of the teledental app, dental photography procedure, and data management system (Remote-i) have been described in the previous study.[19] Participants were recruited from the ORIGINS Project and involved parents/caregivers of children who attended the 3-year-old general assessment and dental screening.

Participants were asked to complete a questionnaire regarding using the technology for tooth decay detection straight after using the app for approximately 30 min. Participants were notified of the requirement to fill out the questionnaire immediately after using the teledental app.

Data collection and questionnaire

The questionnaire was adapted from a previously validated survey by Klingberg *et al.*[14] to explain the users' experience using the smartphone application for dental assessments.

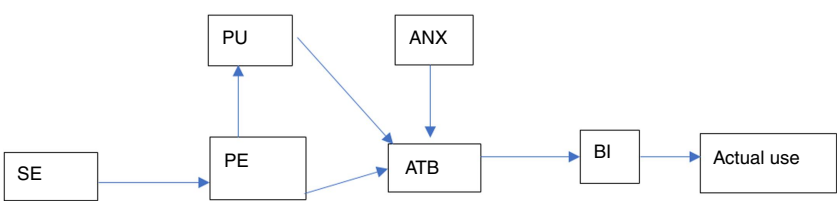

Fig. 1. The proposed TAM model (adapted from Klingberg *et al.*[14]).

The questionnaire included 17 questions measuring each of the six themes of the TAM (Fig. 1). The items of the construct were measured using a 5-point Likert scale, with answer choices ranging from (1) 'strongly disagree' to (5) 'strongly agree'. The questionnaire (Supplementary material, Table S1) was designed in RedCap and distributed online.

Demographic information, including Indigenous background, educational qualification, and post-code, were recorded. The Index of Relative Socio-economic Disadvantage (IRSD) was used as the measure of socioeconomic status (SES) based on the area of residence of the child. IRSD summarises a range of information about the economic and social conditions of people and households within an area, including measures of income, education, and occupational status and it is part of the Socio-Economic Indexes for Areas.[25]

Outcome measures

The questionnaire measured each of the six themes of the TAM. The dependent variable was behavioural intentions (BI), which defines the intention of the parents to use the app as a screening method of examination to detect dental caries. The independent variables for this study include perceived ease of use (PE), perceived usefulness (PU), anxiety (ANX), attitude towards behaviour (ATB), and self-efficacy (SE). The wording of each item reflects the theme and, thus, the overall context of the study.

Hypotheses

The hypotheses for this study include: (1) SE is positively associated with PE, (2) SE is positively associated with PU, (3) SE is positively associated with ATB, (4) PU is positively associated with BI, (5) ATB is positively associated with BI, (6) low ANX is positively associated with SE, (7) low ANX is positively associated with BI, and (8) SES is positively associated with BI.

Data analysis

The analyses were conducted using SPSS Version 27.0 (IBM Corp, NY, USA) and Stata version 16.1 (StataCorp). Cronbach's alpha was estimated to determine the internal consistency of each participant's response given in the questionnaire. The negative questions has been recoded. A correlations matrix was also constructed to determine significant correlation coefficients between each theme. Path analysis is a statistical technique theat explores the extent to which a hypothetical model agrees with existing data using cross-sectional data.[26] By applying the model, it is tested to what extent the original conceptual framework is supported by the data provided.[26] Hence, it indicated the fit of the experimental model with the theoretical model.[26] In this study, the fit indices applied included the root mean square error of approximation (RMSEA), comparative fit index (CFI), Tucker–Lewis index (TLI), standardised root mean squared residual (SRMR), and coefficient of determination (CD).

Ethics

Human research ethics approval for this study, which conforms to the Declaration of Helsinki, was obtained from the Ramsay Health ethics committee (Ref no. 2105W) with reciprocal ethical approval from the Commonwealth Scientific and Industrial Research Organisation (CSIRO) (Ref no: 2021_021_RR) and the University of Western Australia (Ref no: 2021/ET000215). Human research ethics for the ORIGINS project was granted by the Ramsay Health Care ethics committee (Ref no. 1440). All participants provided written informed consent prior to their inclusion in the study.

Results

Participants' characteristics

Table 1 presents descriptive statistics for the surveyed participants. A total of 42 participants were surveyed; around 90% of participants were from the higher SES quintile, and none identified as Aboriginal or Torres Strait Islander. In addition, most participants possessed a postgraduate qualification (29%), bachelor's degree (26%), or trade certificate (17%).

Reliability construct testing

Cronbach alpha was used to measure internal consistency reliability, and the mean scores from each theme are

Table 1. Descriptive statistics for the total population surveyed.

Characteristics	N (%)
Indigenous status	
Indigenous	0
Non-indigenous	42 (100)
IRSD	
Most disadvantage	1 (2.3)
More disadvantage	1 (2.3)
Average disadvantage	2 (4.8)
Less disadvantage	22 (52.4)
Least disadvantage	16 (38.1)
Education	
N/P	7 (16.7)
Year 12 or equivalent	5 (11.9)
Trade certificate	7 (16.7)
Bachelor's degree	11 (26.1)
Postgraduate qualification	12 (28.6)

IRSD, Index of Relative Socio-economic Disadvantage; N/P, not provided.

Table 2. Mean scores from each theme and Cronbach's alpha.

Theme (items)	Theme mean (out of 5)	Theme standard deviation	Theme minimum (out of 5)	Theme maximum (out of 5)	Cronbach's alpha
PE (1–3)	4.54	0.55	3.00	5.00	0.75
PU (4–6)	4.65	0.49	3.67	5.00	0.80
BI (7–8)	4.40	0.65	3.00	5.00	0.62
ANX (9–12)	3.33	0.57	1.50	4.75	0.50
ATB (13–14)	4.23	0.70	2.50	5.00	0.74
SE (15–17)	4.36	0.6	2.67	5.00	0.84

PE, perceived ease of use; PU, perceived usefulness; BI, behavioural intention to adopt; AT, anxiety; ATB, attitude toward a behaviour; SE, self-efficacy.

Table 3. Cross correlations matrix.

	PE	PU	ANX	ATB	SE	BI	SES
PE	1.0000						
PU	0.5771*	1.0000					
ANX	0.2625	0.3698*	1.0000				
ATB	0.2677	0.5441*	0.4240*	1.0000			
SE	0.5867*	0.5888*	0.2655	0.4260*	1.0000		
BI	0.2240	0.5538*	0.2973	0.6400*	0.2792	1.0000	
SES	0.0924	0.1832	0.1669	−0.1506	0.0343	−0.1588	1.0000

PE, perceived ease of use; PU, perceived usefulness; BI, behavioural intention to adopt; AT, anxiety; ATB, attitude toward a behaviour; SE, self-efficacy; SES, socioeconomic status.
*$P < 0.05$.

demonstrated in Table 2. Consistent results were found in the PE ($\alpha = 0.75$), PU ($\alpha = 0.80$), ATB ($\alpha = 0.74$), and SE ($\alpha = 0.84$). However, moderately consistent responses were observed in BI ($\alpha = 0.62$) and ANX ($\alpha = 0.50$). For the majority of themes, the mean values were approximately 4.00 out of 5: PE (4.54 ± 0.55), PU (4.65 ± 0.49), BI (4.40 ± 0.65), ATB (4.23 ± 0.70), and SE (4.36 ± 0.64). ANX received the lowest mean score of 3.33 out of 5.

Correlations matrix

Table 3 presents the cross-correlation matrix for assessing discriminant validity. The results confirm the discriminant validity of all constructs in the study, as indicated by the diagonal elements being larger than the corresponding entries in the columns and rows.[27]

Path analysis

As shown in Fig. 2 and Table 4, there was a direct effect of PE on SE, PU on SE, ATB on PU, and BI on both PU and ATB. Furthermore, there were indirect effects of PU, BI, and ATB on SE, and BI on both SE and ANX. In addition, there was a total effect of PE on SE, PU on both SE and PE, ATB on SE, PU, and ANX, and BI on SE, PU, and ATB.

Fig. 2 graphically displays the estimated parameters for the final model. The path model reveals significant direct effects from SE to PE ($B = 0.5$) and PE to PU ($B = 0.31$), resulting in an increase in both domains. The path from PU also led to a statistically significant increase in ATB ($B = 0.53$) and BI ($B = 0.39$). Furthermore, the ATB led to an increase in BI ($B = 0.45$). ANX did not statistically impact either BI or SE directly. In terms of indirect effects, an increase in PU increased the SE ($B = 0.16$), and ATB increased the SE ($B = 0.24$). BI increased the SE ($B = 0.35$) but decreased the ANX ($B = -0.24$).

Therefore, this study supported the following hypotheses, where direct and total effect were significant: SE was positively associated with PE; SE was positively associated with PU; PU was positively associated with BI; ATB was positively associated with BI.

The final model fit

According to the literature[28] and Table 5, the final model demonstrated an acceptable fit with an RMSEA < 1.0,

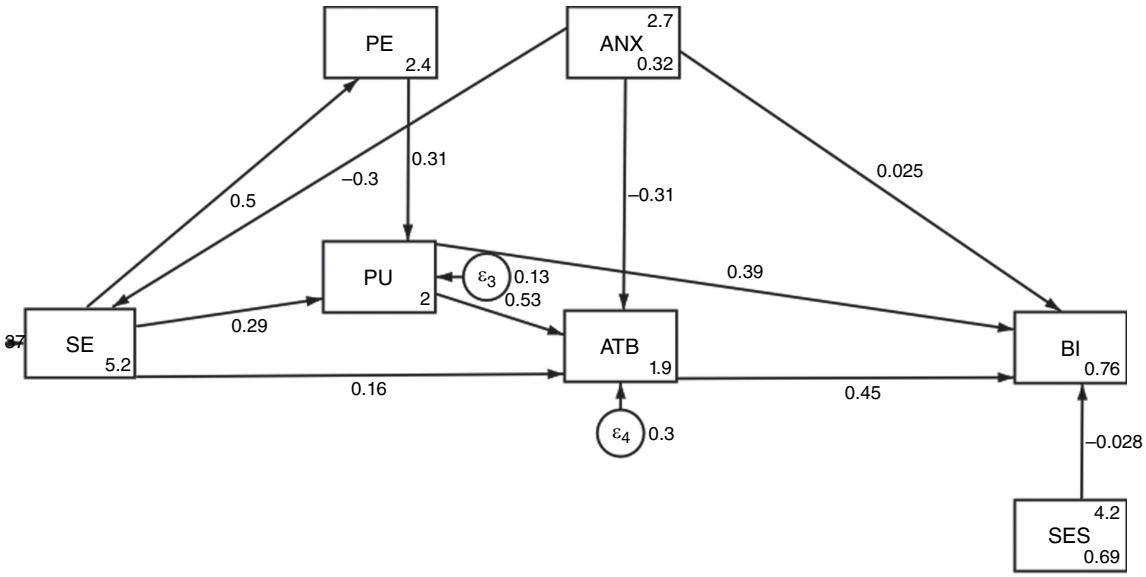

Fig. 2. Experimental framework. All significant values indicate standardised coefficients.

SRMR < 0.05, CFI > 0.9, TLI > 0.9, and CD close to 1. These results indicate that the final model provided an overall acceptable fit for the observed data.

Discussion

Principal findings

The responses acquired from the questionnaire broadly show positive user acceptance of teledental screening during the COVID-19 pandemic, with Cronbach's alpha value supporting the authenticity of the results. Out of the eight hypotheses proposed in the model, four statistically significant relationships based on total and direct effects were observed. Users' behaviours were significantly influenced by their attitude (ATB) and perceived benefit of the system (PU). Perceived ability to use telehealth applications for dentistry technology systems (SE) significantly affected the perceived usefulness (PU) and perceived easiness of the systems (PE). In addition, results showed a positive effect of ease of use on perceived usefulness.

The positive relationship between SE and PE is supported by Zhang *et al.*,[29] who used a larger sample size of 650 participants of potential users of an mHealth service. Thus, it may be inferred that having the necessary skills to use technology may influence how a user perceives their own ability to use the app itself in the first place. Some factors that may improve the SE to increase the PE may include non-judgemental feedback or reassurance to patients while they use the app.[30] One study describes that perceived usefulness is insignificant towards the use intention.[31] However, other recent studies, such as Qi *et al.*,[32] Rajeh *et al.*,[33] and Chung *et al.*,[34] including the findings of this study, suggest otherwise. These support the hypothesis that PU is positively associated with BI.

Moreover, it was found that ATB is positively associated with BI. Despite limited studies to support this significant relationship, Gallos *et al.*[35] emphasise this relationship in their study and, thus, the importance of mHealth technologies to improve outcomes in public health.[35] The hypothesis that SES may be related to BI was rejected by the findings in this study. Garey *et al.*[36] reports SES as a potential moderating factor that determines the overall BI for an mHealth application. The study's teledental app was provided free of charge to users, eliminating any financial barriers. This enables patients from various socioeconomic backgrounds to use the app, potentially removing SES as a factor influencing the BI.[37]

Strength and limitation

This was the first TAM analysis of telehealth applications for dental screening with primary caregivers, and revealed a readiness to use this technology. Limitations include a small sample size of 42 participants and a cross-sectional design. The app was used on-site for a short duration, suggesting a need for further research with longer user engagement.

Implications and future study

The COVID-19 pandemic has posed challenges to healthcare continuity but has also opened doors to explore accessible and cost-effective healthcare options.[38] Telehealth applications for dental screening offer a convenient alternative to traditional face-to-face dental examinations, addressing the restrictions imposed by COVID-19, and alleviating the burden on public health care.[8] Moreover, it provides caregivers

Table 4. Decomposition of effects into direct, indirect, and total effects between SE, ANX, PE, PU, ATB, BI, and SES.

Effect	Structure		Coefficient	*P*-value	95% confidence interval	
					Lower	Upper
Direct effects	SE	ANX	−0.30	0.074	−0.62	0.03
	PE	SE	0.50	<0.001*	0.29	0.71
	PU	SE	0.29	0.008*	0.07	0.50
		PE	0.31	0.014*	0.06	0.57
	ATB	SE	0.16	0.346	−0.17	0.48
		PU	0.53	0.020*	0.08	0.98
		ANX	−0.31	0.059	−0.62	0.01
	BI	PU	0.39	0.033*	0.03	0.75
		ATB	0.445	0.001*	0.20	0.71
		ANX	0.03	0.860	−0.26	0.31
		SES	−0.03	0.754	−0.20	0.15
Indirect effect	PE	ANX	−0.15	0.095	−0.32	0.03
	PU	SE	0.16	0.030*	0.02	0.30
		ANX	−0.13	0.0095*	−0.29	0.02
	ATB	SE	0.24	0.037	0.01	0.46
		PE	0.17	0.092	−0.03	0.36
		ANX	−0.12	0.139	−0.27	0.04
	BI	SE	0.35	0.002*	0.13	0.57
		PE	0.20	0.050	−0.00	0.40
		PU	0.24	0.053	−0.00	0.48
		ANX	−0.24	0.021*	−0.45	−0.04
Total effect	SE	ANX	−0.30	0.074	−0.62	0.03
	PE	SE	0.50	<0.001*	0.29	0.71
		ANX	−0.15	0.095	−0.32	0.03
	PU	SE	0.44	<0.001*	0.26	0.63
		PE	0.31	0.014*	0.06	0.57
		ANX	−0.13	0.095	−0.29	0.02
	ATB	SE	0.39	0.008*	0.10	0.68
		PE	0.17	0.092	−0.03	0.36
		PU	0.53	0.020*	0.08	0.98
		ANX	−0.42	0.013*	−0.75	−0.90
	BI	SE	0.35	0.002*	0.13	0.57
		PE	0.20	0.050	−0.00	0.40
		PU	0.63	0.001*	0.25	1.01
		ATB	0.45	0.001*	0.20	0.71
		ANX	−0.22	0.179	−0.53	0.10
		SES	−0.03	0.754	−0.20	0.15

PE, perceived ease of use; PU, perceived usefulness; BI, behavioural intention to adopt; AT, anxiety; ATB, attitude toward a behaviour; SE, self-efficacy.
*$P < 0.05$.

Table 5. Fit indices for path model for BI.

Population error			Baseline comparison		Size of residuals	
RMSEA	90% CI (lower bound, upper bound)	Pclose	CFI	TLI	SRMR	CD
0.04	(0.000–0.185)	0.454	0.991	0.980	0.077	0.151

with a stress-free and convenient means to maintain their child's dental care at home.[39]

The acceptance of the technology for this telehealth application for a dental screening model will help developers improve its user interface and application capabilities, thus allowing a sustainable model. The findings of this study indicate the need for policymakers and healthcare organisations to develop strategic plans that prioritise the crucial factors involved in the adoption of teledentistry services, particularly from the patient's perspective. These plans should aim to facilitate the widespread use of teledentistry services and ensure their successful implementation, ultimately enhancing dental healthcare accessibility and quality for children.

The use of mHealth technologies in dentistry in a local setting is relatively new, despite its prominent use in other medical disciplines.[40] Therefore, it is not easy to compare and support the hypotheses tested using current literature when there is little relevance to its use in dentistry. This study offered some insight into users' experience of technology. Further studies in the use of mHealth technology would further contribute to knowledge in this modern field.

Conclusion

The perceived usefulness and attitude toward behaviours affected the overall behavioural intention of participants towards using the telehealth model in dental screening. Self-efficacy also positively affected perceived usefulness. Self-efficacy can lead to maximising the benefits of the dental screening app.

Supplementary material

Supplementary material is available online.

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