Original Research Article

DIGITAL HEALTH

DIGITAL HEALTH
Volume 10: 1–17

DOI: 10.1177/20552076241258472
journals.sagepub.com/home/dhj

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Applying an extended theoretical approach to identifying Canadian dental students' acceptance of teledentistry: A cross-sectional study

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Abstract

Objective: Teledentistry is a promising innovation for improving service quality and patient outcomes. While studies have shown the relevance of theoretical frameworks in understanding behaviour change predictors for telehealth implementation efforts, their application in dentistry is limited. This study aimed to test different theoretical approaches to identify the factors affecting dental students' behavioural intention to use teledentistry.

Methods: This cross-sectional study involved students in their final two years of undergraduate dental programmes, from three Canadian provinces (Quebec, Nova Scotia, and Saskatchewan) using an electronic self-reported questionnaire. Following descriptive analyses, we tested three theoretical models (the technology acceptance model, psychosocial model, and integrated model) using path analysis and multiple linear regression analysis. We analyzed the modifying effect of sociodemographic characteristics and prior use of teledentistry.

Results: Out of the 46 students who participated, the majority were female (53.5%) and aged over 25 years (62.8%). The three models successfully explained a substantial portion of the variance in behavioural intention to use teledentistry, ranging from 58.0% to 76.6%. Social role beliefs ($p < 0.001$) and control beliefs ($p < 0.001$) were the most significant predictors of behavioural intention to use. Prior use of teledentistry modified the association between control beliefs and behavioural intention to use teledentistry.

Conclusions: The original technology acceptance model was a good predictive model of behavioural intention to use teledentistry with perceived use as the strongest predictor. However, the integrated model performed the best in highlighting the relevance of training and education to foster teledentistry implementation in dental schools. The generalizability of the findings is constrained by the modest sample size, warranting larger studies for validation.

Keywords

Teledentistry, acceptance, intention, dental students, implementation, theoretical framework, curriculum

Submission date: 1 February 2024; Acceptance date: 13 May 2024

Introduction

Teledentistry is defined as any remote interactions involving oral healthcare providers (OHCPs), either among themselves or with other healthcare providers, patients, and/or caregivers through any form of information and communication technologies to improve patients' outcomes and to maximize the quality of care.[1–3] It includes both synchronous (e.g., live virtual consultation) and asynchronous modes (e.g., store-forward, remote patient monitoring,

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and mobile oral health).[4] Teledentistry is a viable and promising approach that is comparable to face-to-face visual examination for many aspects of the oral health treatment process.[5,6] In Canada, teledentistry has been introduced in dental practices during the coronavirus disease 2019 pandemic.[7] However, it was not introduced in the dental curriculum.

The emergent evidence suggests that teledentistry is cost-effective at the micro, meso and macro levels involving patients, OHCPs, and decision-makers.[8–11] It could help in enhancing patients' experiences of care, while also promoting high-value care.[2,12–14] From OHCPs' perspectives, teledentistry allows scheduling time-saving appointments and facilitates knowledge sharing and communication with both colleagues and patients.[15,16] It can lead to better patient management,[17,18] and increase their level of satisfaction.[3,19] Teledentistry has also demonstrated cost-effectiveness at the public health level by reducing travel costs,[19] supply expenses,[10] and delays in treatment.[9] The reduction in travel facilitated by teledentistry yields environmental benefits, contributing to a more sustainable approach to dentistry.[20,21] Dentists can use teledentistry for patient/parent education, monitoring preventive care and post-treatment follow-up, assessment of dental development, diagnosis of dental diseases, and treatment planning.[7]

Despite the potential advantages of teledentistry, its implementation remains a challenge.[13,22] These challenges include structural, organizational, and individual factors as well as challenges related to existing policies.[9,23] For instance, the most common barriers discussed are the absence of legal regulation, lack of financial compensation, insufficient training, and a general lack of familiarity with teledentistry.[24–28]

To address this concern, many authors argued the importance of exploring the cognitive mechanisms underlying behaviour change as well as the relevance of theoretical approaches to understanding and describing the determinants of those behaviours.[29] They provide target variables for future intervention studies, as well as highlight areas requiring action to improve the delivery of oral care. In a systematic review of studies about social cognitive theories and healthcare professionals' intention and behaviour, authors reported that the Theory of Planned Behaviour (TPB)[30] was the most widely used.[29] However, their results indicated that the TPB is an appropriate theory to predict behaviour, whereas Triandis' Theory of Interpersonal Behaviour (TIB)[31] was more efficient in capturing the variables underlying intention to use.

In the digital health context, the technology acceptance model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT) are among the most widely used models to predict acceptance behaviour.[32,33] According to a systematic review of theories predicting end-user acceptance of telehealth use,[34] the TAM demonstrates the highest level of variance in studies with healthcare providers,[34] with the most substantial explained variance achieving an R^2 of 0.68, in contrast to the UTAUT's R^2 of 0.59.[34]

However, studies applying these theories and models in the field of dentistry are limited. A study using the UTAUT explored factors influencing dental students' behavioural intention to use (BIU) teledentistry in Saudia Arabia.[35] Its results suggested that UTAUT could explain 60% of the BIU variance with the performance expectancy (PE) as the most significant predictor of BI, followed by effort expectancy (EE), social influence (SIn), and lastly, facilitating conditions (FCs).[35] The same constructs were found to be significant predictors of BIU in a similar study in the United States of America where the UTAUT model explained 40% of the BIU variance.[36]

Considering that healthcare providers are vital in the successful telehealth implementation and in ensuring its benefits for the target population,[37] it is critical to explore variables associated with dental students' acceptance towards the use of teledentistry. To our knowledge, no study has applied the TAM to explore Canadian dental students' acceptance of the use of teledentistry. This project offers the opportunity to address this knowledge gap and to collect preliminary data regarding factors related to dental students' acceptance of teledentistry.

Objectives

This study aimed to identify the determinants of dental students' acceptance towards the use of teledentistry in their clinical practices after their graduation using three theoretical models in dental schools of three Canadian provinces. Specifically, this study tested and compared the original TAM, a modified TAM or psychosocial model and an integrated model. In this study, we operationalized dental students' teledentistry acceptance as their BIU teledentistry.[38] Since teledentistry was not added to the dental curriculum for the dental schools included in the study, effective teledentistry usage was not assessed in this study.

Conceptual framework

The study conceptual framework is an extended version of the TAM, a validated, robust and parsimonious model developed to predict information technology adoption in various contexts.[34,39–41] The TAM suggests that the BIU toward using new technology is an antecedent of behaviour. The BIU is determined by the attitude toward the use of the new technology, which is a function of two main variables including perceived usefulness (PU) and perceived ease of use (PEoU).[39] This model suggests that external variables, such as human and social factors, indirectly determine attitudes toward technology acceptance by influencing PU and PEoU.[40] (Figure 1) Authors proposed to extend the TAM

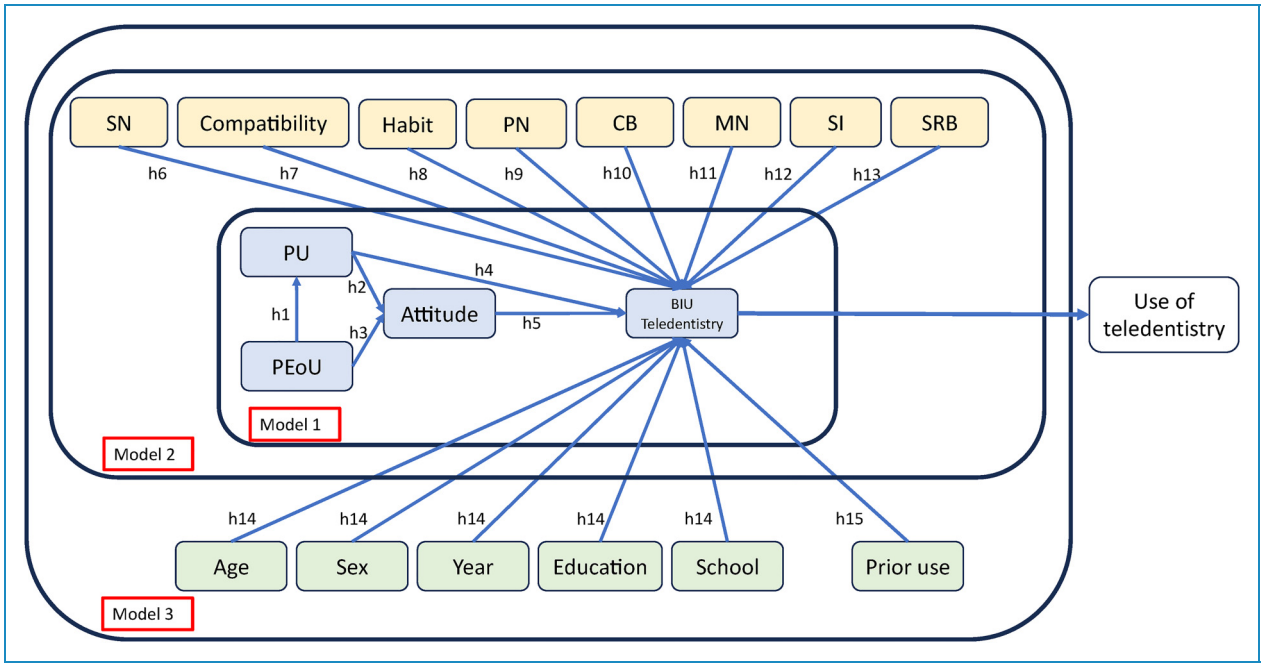

Figure 1. Theoretical models. BIU: behavioural intention to use; PU: perceived usefulness; PEoU: perceived ease of use; SN: subjective norm; PN: professional norm; CB: control beliefs; MN: moral norms; SI: self-identity; SRB: social role belief.

by introducing variables from other theoretical models as they may increase its predictive value.[42] For instance, the TAM is more powerful when it incorporates additional constructs from the TIB[34,43] or the TPB.[30,34] Control beliefs and subjective norms have been added to our model. Subjective norm from the TPB, assesses the extent to which individuals believe that people who are important to them think they should or should not perform a given behaviour.[30] Control beliefs are underlying the perceived behaviour control from TBP. They refer to perceived factors that can facilitate or impede the performance of a given behaviour.[30] We added the compatibility concept as it has been consistently recognized as a missing component of TAM.[44] Compatibility, from Roger's innovation diffusion theory, refers to the degree of congruence that an individual perceives between innovation and his or her values and beliefs, past and present experiences and needs of the potential adopter.[45]

Based on previous work in the literature,[40,46] we added other constructs from the TIB in order to address the potential influence of contextual factors on the acceptance of teledentistry. TIB has a wider scope encompassing cultural, social and norms factors that could influence the adoption of a given behaviour. These constructs include professional norms (PN), normative norms, and social role beliefs (SRBs). Role beliefs and moral norms (MN) are substantial determinants of healthcare providers' intentions.[29] According to Triandis,[31] behaviour is determined by three dimensions: Intention, FCs, and habit. Habit refers to behaviour that has become automatized.[31] The intention is formed by three factors: Attitude, normative factors, and identity beliefs. Self-identity refers to the degree of correspondence between the individual's perception of himself or herself and the characteristics that this person associates with a given behaviour. The normative factors refer to social and personal norms. The personal normative belief represents the feeling of personal obligation regarding the performance of a given behaviour. Social norms are formed by normative and role beliefs. SRB refer to the extent to which an individual thinks someone of his or her social position, gender and age should (or should not) adopt a given behaviour. Normative beliefs represent the internalization by an individual of referent people or groups' opinions about the adoption of a given behaviour. Finally, the PN has been added given it consists of the integration of an individual into the specific normative influences within their professional group.[47]

Figure 1 represents the different theoretical models tested in this study. Model 1 is the original TAM including PU, PEoU and attitude. The psychosocial Model 2 includes all other constructs such as Subjective Norms (SN), Compatibility, Habit of using technology, PN, Control Beliefs (CB), MN, Self-identity (SI), and SRB. In the last model, Model 3, sociodemographic characteristics as well as prior use of teledentistry are added.

Research hypotheses

Our hypotheses, driven from the theoretical model above, are presented in Table 1.

Table 1. Hypotheses.

h1	Perceived ease of use will be positively associated with dental students' perceived usefulness of teledentistry.
h2	Perceived usefulness will be positively associated with dental students' attitude to use teledentistry.
h3	Perceived ease of use will be positively associated with dental students' attitude to use teledentistry.
h4	Perceived usefulness will be positively associated with dental students' behavioural intention to use teledentistry.
h5	Attitude will be positively associated with dental students' behavioural intention to use teledentistry.
h6	Subjective norms will be positively associated with dental students' behavioural intention to use teledentistry.
h7	Compatibility will be positively associated with dental students' behavioural intention to use teledentistry.
h8	Habit of using technology will be positively associated with dental students' behavioural intention to use teledentistry.
h9	Professional norms will be positively associated with dental students' behavioural intention to use teledentistry.
h10	Control beliefs will be positively associated with dental students' behavioural intention to use teledentistry.
h11	Moral norms will be positively associated with dental students' behavioural intention to use teledentistry.
h12	Self-identity will be positively associated with dental students' behavioural intention to use teledentistry.
h13	Social role beliefs will be positively associated with dental students' behavioural intention to use teledentistry.
h14	There are no significant associations between sociodemographic variables and dental students' behavioural intention to use teledentistry.
h15	There is no significant association between prior use of teledentistry and dental students' behavioural intention to use teledentistry.

Research questions

Based on the conceptual models, this study aimed to answer the following questions:

1. To what extent do the predictors of original TAM influence dental students' BIU teledentistry?
2. Which psychosocial factors from the modified TAM significantly explain dental students' BIU teledentistry?
3. Do sociodemographic and professional factors (e.g., age, gender, work experience) influence dental students' BIU teledentistry?

Methods

Design

This study is a component of a quantitative, descriptive, cross-sectional study[48] conducted from October 2022 to July 2023 after obtaining ethical approval from McGill University Institutional Review Board (IRB), eRAP/Info-Ed File Number: 22-03-052. This approval was recognized by other dental schools' IRBs. This cross-sectional study aimed at the dental students' perspectives on the integration of teledentistry into the dental curriculum. We have followed the Checklist for Reporting Results of Internet E-Surveys (CHERRIES)[49] (Supplementary File 1).

Setting and participants

The study included a convenient sample of students enrolled in the last two years of undergraduate dental programmes (DMD/DDS) in five dental schools in Canada. Dental programmes in Canada span 4–5 years. The initial 2–3 years emphasize foundational science and skills in a simulated setting (pre-clinical). The latter years transition to supervised patient treatment (clinical). Admission necessitates a bachelor's degree (or final year enrolment) with a minimum 3–4 years of full-time university studies. However, dental schools in three provinces, Quebec, Saskatchewan, and Nova Scotia, collaborated with this study. The Université de Montréal (in Quebec) is a five-year programme with about 85 students per year while dental programme at the University of Saskatchewan, Laval University (in Quebec), McGill University (in Quebec) and Dalhousie University (in Nova Scotia) are 4 years long enrolling about 25, 50, 40, and 50 students per year,

respectively. Due to the exploratory nature of the study, no formal sample size calculation was undertaken.

Inclusion and exclusion criteria

The inclusion criteria included dental students from their third year onwards, who were invited to participate in the survey voluntarily. The sole exclusion criterion was prior participation in the survey's pilot phase.

Data collection

We adapted a bilingual (English and French) online self-administered close-ended questionnaire, originally developed in a previous study.[50] The questionnaire was tailored for use in a dental education setting following suggestions from dentists and dental faculty members. We then pilot-tested the questionnaire with a small sample of three students from McGill University's Faculty of Dental Medicine and Oral Health Sciences to assess its face and content validity. Based on their feedback, the clearance and relevance were satisfactory, and the length was long which was shortened accordingly. The final questionnaire (Supplementary File 2) had five sections with closed questions regarding (i) perceptions about teledentistry; (ii) current practices using teledentistry; (iii) acceptance of teledentistry; (iv) educational training opportunities at the dental school; and (v) sociodemographic information including age, gender, year in dental programme, highest education level before dental school, prior use of teledentistry, and questions related to Equity, Diversity, and Inclusion, such as minority, disability, and indigenous status.. The questions constructing acceptance of teledentistry were rated on a 7-point Likert scale, with response options ranging from "strongly disagree" (1) to "strongly agree" (7). The number of items per construct was variable between 2–5 items. In this study, we focused on parts ii, iii, and v.

Participants were invited using an email containing all relevant study information (e.g., research rationale, objectives) along with a link to the survey. The first page of the survey contained a consent declaration with the contact information of the principal investigator should they require more information. This email invitation was sent to all students in their last two years of undergraduate DMD/DDS studies through the offices of the research vice-dean or academic affairs vice-dean of each dental school. A statement declared that the participation was voluntary and that there were no direct benefits for completion. After reading the information sheet, respondents were presented with a question with two options: "I agree to participate" and "I do not agree to participate." Their response to this question determined consent.

The electronic questionnaire was posted on a secured website, Lime Survey, to ensure that personal or identifying information could not be collected or traced. Participants were asked to provide their consent before completing the questionnaire. No incentives were provided to respondents in this study. To increase the response rate, three reminder emails were sent 1, 3, and 5 weeks after the first email.[51] To avoid duplicate submissions from the same person, access was limited to one entry per IP address. However, individuals were able to reopen the questionnaire multiple times using the same IP address after initiating it, allowing them to complete the survey. Participants were given the choice to review their responses and skip questions as desired.

Data analysis

Firstly, we conducted a descriptive analysis of sociodemographic, professional characteristics and theoretical constructs. The computation of each construct involved calculating the mean of the summation of the corresponding items. The reliability of the questionnaire or the internal consistency of the constructs was measured using the Cronbach alpha coefficient.[52] Constructs with a Cronbach alpha less than 0.6 or lack of consistency were removed from the analysis as recommended by Sharma.[53]

Subsequently, we assessed the magnitude and significance of associations between theoretical variables and intention to use teledentistry by calculating Pearson correlation coefficients.[54] The univariable association between sociodemographic variables and prior use of teledentistry with BIU was explored using linear regression. Prior to model construction, we assessed multicollinearity among the predictors and considered Variance Inflation Factors exceeding 5.0 as indicative of high multicollinearity, in line with established guidelines.[55] Our examination confirmed satisfactory results. To construct our models, we employed path analysis with parameter estimation to evaluate both the direct and indirect effects of components within the original TAM model. Following this, we investigated constructs from the TAM model that exhibited significant direct effects, along with constructs from psychosocial Model 2, for potential direct effects by conducting multivariate linear regression using the maximum likelihood method for parameter estimation. We adopted the backward stepwise regression method with an elimination threshold of $p \geq 0.05$ to construct a model with optimal fit to the data. In this model, all associations between these constructs and BIU were hypothesized as direct.

Additionally, we evaluated the potential for sociodemographic variables and prior teledentistry experience to modify the effects in a final model. An interaction effect was identified between past teledentistry experience and CB. This interaction, along with sociodemographic variables with a significant association with BIU in univariable analysis, was added to the final model using the backward stepwise method. Finally, we have conducted a

discriminant analysis (each item of the finally included constructs) to identify the main targets of action using a distinct linear regression analysis. Furthermore, we investigated the influence and potential effect modification of sociodemographic variables, as well as the impact of past teledentistry experience, similar to the description provided above. The dataset contained a few missing values for demographic information. To address this issue, we employed multiple imputation by chained equations to handle missing data.[56] All statistical analyses were carried out using STATA 18.0 (College Station, TX, USA), and statistical significance was established at a p-value threshold of < 0.05. The final models presented in this article include only those predictors of BIU that were statistically significant ($p < 0.05$).

Results

Response rate

Of a total of approximately 585 students in the five dental schools of Quebec, Saskatchewan, and Nova Scotia, 88 students opened the link (view rate = 15.0%). Out of the 88 students, 46 tried to complete the questionnaire (participation rate = 52.3%), and 43 completed the questionnaire in full (completion rate = 93.5%). The 46 questionnaires had enough data to be included for analysis. On average, students spent 13.3 ± 2.8 min to complete the questionnaire.

Sociodemographic description

Table 2 demonstrates the sociodemographic characteristics of the sample.. The majority (62.8%) of participants were above 25 years of age with 5 (11.6%) students aged 30–39 years. More than half of the participants were female (53.5%). Twenty-seven (62.8%) of the participants had a bachelor's degree and an equal number and proportion were in the third year of their dental studies. Nearly one in five participants said they were from a visible minority (18.6%). Almost three-fourths (73.9%) of the participants reported no prior experience of using teledentistry.

Variables measured and psychometric properties

The mean and standard deviation of each construct and the corresponding items are shown in Table 3. Except for the Habit of using technology (Cronbach's alpha = 0.58), Cronbach's alpha values for other constructs were shown to be satisfactory (0.70–0.97).

As shown in Table 4, all theoretical constructs had a statistically significant positive correlation with BIU.

Table 5 shows the results of the univariable analysis of the association between BIU and sociodemographic variables and prior experience using teledentistry. Compared to the youngest age group, students aged 30 and above were significantly more likely to have the intention to use teledentistry in the future ($p = 0.024$). However, students with prior use of teledentistry were less likely to have the intention to use it after graduation ($p = 0.006$).

Model 1 – Original TAM

The results of the path analysis showed that PU from the original TAM model was the only component with a statistically significant positive and direct effect on BIU (beta = 0.6, p-value < 0.001). Therefore, it was considered the unique determinant of BIU in Model 1, explaining 58.0% of the variance in BIU. Also, the results supported three other hypotheses: h1: PEoU is positively associated with PU (beta = 0.8, p-value < 0.001), h2: PU is positively associated with Attitude (beta = 0.5, p-value < 0.001), and h3: PEoU is positively associated Attitude (beta = 0.3, p-value = 0.011). The direct effect of Attitude on BIU was positive (beta = 0.3) but not statistically significant (p-value = 0.152). Figure 2 illustrates the theoretical framework with coefficients corresponding to each direct effect in the model.

Model 2 – Psychosocial model

In this model, all other theoretical constructs were added to Model 1 (with PU as the sole predictor with a significant direct effect on BIU) using multivariable linear regression to check for the direct effects on BIU. Given the low Cronbach's alpha (0.58) for Habit, it was not added to the model. After removing insignificant variables (backward stepwise regression), SRB (beta = 0.4, p-value < 0.001) and CB (beta = 0.5, p-value < 0.001) remained significant. This model explains 71.5% of the variance in BIU.

Model 3 – Integrated model

After checking for interactions between each of the determinants in Model 2 and age, gender, education, school, current programme year, and prior use of teledentistry (PUT), the latest showed an interaction with CB. In Model 3A, sociodemographic variables with a significant association with BIU in univariable analysis (age) and the interaction of PUT and CB were added to Model 2. Like Model 2, we used multivariable linear regression (backward stepwise regression). Except for SRB (beta = 0.4, p-value = 0.001) and the interaction between CB and PUT (beta = 0.8, p-value = 0.014), none of the sociodemographic variables remained significant. This model explains 76.6% of the variance in BIU.

The results of exploring the association between CB and BIU in each of the two categories of dental students, with and without prior experience of using teledentistry, showed that in the former group, this association was negative (beta = -0.2), though not statistically significant

Table 2. Sociodemographic characteristics of the participants.

Characteristics	Frequency (*n*)	Proportion (%)
Age group (n = 43)		
<25 years	16	37.2
25–29 years	22	51.2
30–39 years	5	11.6
Gender (n = 43)		
Male	19	44.2
Female	23	53.5
Prefer not to answer	1	2.3
Undergraduate dental programme (year) (n = 43)		
Third	27	62.8
Fourth	15	34.9
Fifth	1	2.3
Level of education (n = 43)		
CEGEP/college or lower	8	18.6
Bachelor's degree	27	62.8
Master's degree	8	18.6
Person from visible minority (n = 43)		
Yes	8	18.6
No	32	74.4
Prefer not to answer	3	7
Person living with disability (n = 43)		
Yes	0	0
No	43	100
Person living from indigenous communities (n = 43)		
Yes	0	0
No	43	100
Prior use of teledentistry (n = 46)		
Yes	12	26.1
No	34	73.9

Table 3. Theoretical constructs items and psychometric properties of the measures.

Theoretical construct		*Mean ± SD*	*Cronbach's alpha*
BIU: An individual's motivation for performing a given behaviour.		5.3 ± 1.3	0.76
BIU1	I have the intention to use teledentistry routinely with my patients.	4.9 ± 1.5	
BIU2	I have the intention to use teledentistry when necessary to provide oral healthcare to my patients.	5.7 ± 1.5	
Attitude: An individual's evaluative judgement of the target behaviour on some dimensions (e.g., good/bad, harmful/beneficial, pleasant/unpleasant).		5.3 ± 1.1	0.77
Attitude 1	I think it is a good idea to use teledentistry.	5.5 ± 1.3	
Attitude 2	The use of teledentistry is beneficial for the delivery of oral care of patients.	5.7 ± 1.1	
Attitude 3	It is a trend to use teledentistry to the delivery of oral care.	4.5 ± 1.5	
PU: The degree to which an individual believes that the use of a given technology or innovation improves the execution of a task and, consequently, performance within their organization.		5.4 ± 1.2	0.93
PU1	The use of teledentistry could help me to provide oral healthcare to patients more rapidly.	5.2 ± 1.4	
PU2	The use of teledentistry would improve the access of my patients.	6.0 ± 1.1	
PU3	Teledentistry would help me get the most out of my time to monitor my patients.	5.0 ± 1.6	
PU4	Teledentistry would enhance my effectiveness in providing oral healthcare to my patients.	5.0 ± 1.5	
PU5	I would find teledentistry useful for the patients' care.	5.5 ± 1.4	

(p-value = 0.552). Interestingly, there was a positive and statistically significant association (beta = 0.6, p-value < 0.001) between CB and BIU among dental students with no PUT.

To gain a more comprehensive insight into the influence of individual items within each construct in Model 3B, we conducted parallel analyses of those in this model, focusing on the respective items within CB and SRB. Items CB1 (beta = 0.2, p-value = 0.005), SRB1 (beta = 0.3, p-value < 0.001), and the interaction between CB2 and PUT (beta = 0.6, p-value = 0.002) remained significant. This model explains 82.0% of the variance in BIU.

There was a statistically significant positive association (beta = 0.4, p-value < 0.001) between CB2 and BIU among students without PUT. However, this association was negative and insignificant among dental students with PUT (beta = −0.2, p-value = 0.379).

Table 6 summarizes the determinants of dental students' intention to use teledentistry in each model and the corresponding values of variance explained (R^2), Bayesian information criterion, and Akaike information criterion. As shown in Table 6, Model 3B explains the highest proportion of the variance in BIU with an R^2 of 82.0%.

Discussion

The purpose of this study was to identify determinants of dental students' acceptance towards the use of teledentistry in their clinical practices after graduation using various theoretical models. We tested the original TAM and a modified model that integrated various psychosocial constructs. We also tested the impact of sociodemographic characteristics as well as PUT. Model 1 (original TAM) rejected hypothese h5, and Model 2 (psychosocial model) rejected hypotheses h6, h7, h9, h11, and h12.

In this study, female students' participation (n = 23) outnumbered their male counterparts (n = 19), which is consistent with the prevailing trend in healthcare and dentistry.[57] The univariable analysis showed that compared to the youngest age group, students aged 30 and above were

Table 3. Continued.

Theoretical construct		Mean ±SD	Cronbach's alpha
Compatibility: The degree of correspondence between innovation and existing values, past experiences and needs of potential adopters.		4.8 ± 1.6	0.83
Compatibility1	The use of teledentistry would be compatible with my work habits.	5.1 ± 1.6	
Compatibility2	The use of teledentistry would fit well with the way I like to provide oral healthcare.	4.5 ± 1.9	
PEU: The degree to which a person believes that using a new technology does not require significant physical and mental efforts.		5.3 ± 1.1	0.80
PEU1	I think that I could easily learn how to use teledentistry.	5.9 ± 0.9	
PEU2	I think it would be easy to perform the tasks necessary for the patients' outcomes using teledentistry.	4.5 ± 1.8	
PEU3	I think I will find it easy to acquire the necessary skills to use teledentistry.	5.8 ± 1.1	
PEU4	I think that the teledentistry will be easy to use.	4.9 ± 1.7	
Habit of using technology: The level of routinization of behaviour, i.e., the frequency of its occurrence.		5.5 ± 1.1	0.58
Habit1	I feel comfortable with information and communication technologies.	5.3 ± 1.3	
Habit2	I often use computing tools in my work.	5.7 ± 1.4	
SN: The extent to which an individual believes that people who are important to him/her will approve his/her adoption of a particular behaviour.		5.0 ± 1.0	0.70
SN1	Most of my future patients will welcome my use of teledentistry.	4.9 ± 1.5	
SN2	Most of my future colleagues will welcome my use of teledentistry.	4.9 ± 1.4	
SN3	Other health professionals (nurses, other specialists, etc.) would welcome my use of teledentistry.	5.2 ± 0.9	

significantly more likely to have the intention to use teledentistry in the future. Additionally, the findings revealed a limited exposure of dental students to the use of teledentistry, reflecting a situation similar in medical schools where students have few opportunities to engage with telehealth.[58]

Our study revealed a high intention to use dentistry (Mean ± SD = 5.3 ± 1.3), which was higher than Sharka et al.[35] in Saudi Arabia (Mean ± SD = 4.0 ± 0.8) and Alabdullah et al.[36] in the United States (Mean ± SD = 2.9 ± 1.0). This inconsistency might be attributed to differences in the elements that formed the intention to use construction. Alabdullah et al.[36] specifically asked about the intention to use within the next six months, while our focus was on students' intent to incorporate teledentistry into their practice post-graduation. Notably, as teledentistry is not currently integrated into curriculums, students may face barriers in applying it while are still in school.

The results from this study affirm the robustness and the restricted suitability of TAM in examining the intention to use teledentistry with an R^2 of 58.0%. In the original TAM model, our results showed that PU was the only predictor of the BIU. This result corroborates other findings in the literature[59,60] meaning that dental students are likely to accept a new technology in their practices such as teledentistry if they feel its utility and that it can help them to improve their dental services. A systematic review also supports this result, highlighting PU as the primary significant predictor across most included studies.[34] The utility of

Table 3. Continued.

Theoretical construct		Mean ±SD	Cronbach's alpha
PN: The integration by the self of the specific normative pressures of one's professional group.		4.9 ± 1.3	
PN1	It would be a matter of professional responsibility for me to use teledentistry to provide oral healthcare to my patients.	4.30 ± 1.5	0.87
PN2	It is fine for a dentist to use teledentistry in his/her practice to provide oral healthcare to my patients.	5.11 ± 1.6	
PN3	It is appropriate for a dentist in a solo practice to use teledentistry in his/her regular practice to provide oral healthcare to his/her patients.	5.04 ± 1.6	
PN4	It is appropriate for a dentist in a group practice to use teledentistry in his/her regular practice to provide oral healthcare to his/her patients.	5.06 ± 1.5	
CB: Factors that positively or negatively influence the adoption of a behaviour.		5.6 ± 1.1	0.79
CB1	I will use teledentistry if I receive adequate training.	5.7 ± 1.7	
CB2	I will use teledentistry if I receive a technical assistance.	5.7 ± 1.5	
CB3	I will use teledentistry if my time is reimbursed.	5.3 ± 1.5	
CB4	I will use teledentistry if I have all necessary infrastructures.	5.7 ± 1.3	
SI: The degree of congruence between the individual's perceptions of himself/herself and the characteristics he or she associates with the realization of the behaviour.		5.6 ± 1.3	0.97
SI1	A dentist using teledentistry to provide oral healthcare is a person who is empathetic.	5.6 ± 1.2	
SI2	A dentist using teledentistry to provide oral healthcare is a person who cares about the patients' overall health and well-being.	5.7 ± 1.4	
SI3	A dentist using teledentistry to provide oral healthcare is a person who demonstrates professionalism.	5.4 ± 1.4	
SI4	A dentist using teledentistry to provide oral healthcare is a person who cares about the oral health of his or her patients.	5.7 ± 1.4	

telehealth largely revolves around its ability to streamline care processes, particularly in diagnosing and monitoring disease parameters.[61] PU is influenced by PEoU, as dental students will find easy-to-use teledentistry more useful. From UTAUT, PE corresponds to PU in TAM, whereas EE corresponds to PEoU in TAM.[32,62] Our results confirm the findings in the dental literature that PU is the strongest predictor of BIU teledentistry.[35,36]

While some studies identify PEoU[40] and attitude[63] as significant predictors of intention to use teledentistry, in the original TAM,[39] PEoU does not directly impact BIU. Instead, it influences PU and attitude toward technology use, indirectly affecting the BIU technology. Both associations were significant in our study. Contrary to previous studies,[63,64] attitude was not a direct predictor of BIU in our findings, confirming studies that deleted the attitudinal construct from TAM.[14,44] This underscores the need for curricula to emphasize the documented advantages of integrating this innovative technology, and how it could improve their dental practices for themselves and their patients.

The inclusion of additional psychosocial constructs enhanced the predictive value of the model on BIU ($R^2 =$ 71.5%). In addition, the integration of prior teledentistry

Table 3. Continued.

Theoretical construct		Mean ±SD	Cronbach's alpha
MN An individual's assessment of the fit between his or her values/principles and the adoption of a behaviour.		4.6 ± 1.3	0.8
MN1	My personal values would lead me to use teledentistry to provide oral healthcare to my patients.	5.2 ± 1.5	
MN2	It is morally unacceptable for me NOT to use teledentistry to provide oral healthcare to my patients.	3.4 ± 1.6	
MN3	The use of teledentistry to provide oral healthcare to my patients aligns with my principles.	5.2 ± 1.5	
SRB: An individual's evaluation of what a person in a similar social position, age, gender, etc. (in a reference group) should or should not do to adopt the targeted behaviour.		4.6 ± 1.6	0.86
SRB1	I consider it normal for a dentist in my area to use teledentistry to provide oral healthcare to the patients.	4.3 ± 1.8	
SRB2	I consider that a dentist of my age should use teledentistry to provide oral healthcare to the patients.	5.1 ± 1.6	
SRB3	As a healthcare professional, it is expected that a dentist would use teledentistry to provide oral healthcare to his/her patients.	4.4 ± 1.7	

BIU: behavioural intention to use; PU: perceived usefulness; PEU: perceived ease of use; SN: subjective norm; PN: professional norm; CB: control belief; SI: self-identity; MN: moral norm; SRB: social role belief.

use proves most effective ($R^2 = 76.6\%$). Previous research similarly demonstrated that supplementing the original TAM model with other theoretical variables increased the variance explained in BIU.[16,46]

After incorporating all other constructs in Model 2, CB and SRB persisted as significant predictors of BIU, corroborating the impact of SNs as one of the major predictors of acceptance.[31,34] CB is a trigger of perceived behavioural control, which is a strong predictor of BIU in Ajzen's TPB.[30] This indicates that students contemplate the use of teledentistry if it is supported by training, infrastructure, technical assistance and SNs. In studies using UTAUT, this supportive context, referred to as FCs, promotes acceptance. Aligning with these findings, Asua et al.[61] also underscored FC as the most influential predictor of healthcare professionals' intent to adopt a telemonitoring system. Therefore, it is crucial to prioritize and plan implementations that facilitate the adoption of teledentistry.

SRB emerged as the second most influential determinant of BIU. This suggests that the decisions of dental students are notably influenced by what Triandis called the "collective self"[31] related to peers, particularly those of similar age or those from the same geographical region. A systematic review focusing on factors influencing healthcare professionals' behaviours, grounded in social cognitive theories, revealed that assessments of role beliefs were as one of the five categories of variables that significantly contributed to predicting intention.[29] This aligns with the idea that what dental students perceive as their roles and expectations within their social and professional peer group significantly influence their decision-making. This finding supports the impact of cultural context on the development of normative cognitions, the formation of salient beliefs[65] and for the adoption of a given innovation.[31]

The results of this study indicate that compatibility, PNs, SI and MNs are not the predictors of BIU teledentistry. This finding may suggest that while dental students recognize that teledentistry can be useful for their practices, they perceive it as less compatible with the way their dental practices. Habit also did not appear as a strong predictor of dental students' future use of teledentistry. In this study, several dental students have declared not to have prior experience with teledentistry. This lack of association reinforces Triandis' TIB that habit is a moderator of the relation between intention and behaviour.[31]

Regarding the impact of sociodemographic characteristics and PUT, we found that no sociodemographic characteristic remained a significant predictor of BIU in the final model. Most of the previous studies did not assess the direct[58,64] or potential moderation effect[35,36] of sociodemographic characteristics. Gagnon et al.[47] did not find any

Table 4. Correlation (*r* (95% CI)) matrix/ univariable associations between theoretical constructs and the intention to use teledentistry.

	BIU	Attitude	Habit	PU	PEoU	Compatibility	SN	PN	CB	SI	MN	SRB
BIU												
Attitude	0.7* (0.5 to 0.8)											
Habit	0.3* (0.04 to 0.6)	0.4** (0.1 to 0.6)										
PU	0.8**** (0.6 to 0.9)	0.8**** (0.7 to 0.9)	0.5***** (0.2 to 0.7)									
PEoU	0.6*** (0.3 to 0.7)	0.7**** (0.5 to 0.8)	0.6**** (0.3 to 0.7)	0.7**** (0.5 to 0.8)								
Compatibility	0.7**** (0.5 to o.8)	0.8**** (0.6 to 0.9)	0.6***** (0.3 to 0.7)	0.8**** (0.6 to 0.9)	0.8**** (0.6 to 0.9)							
SN	0.7**** (0.5 to 0.8)	0.6**** (0.4 to 0.8)	0.5*** (0.3 to 0.7)	0.7**** (0.6 to 0.9)	0.7**** (0.5 to 0.8)	0.7**** (0.5 to 0.8)						
PN	0.8**** (0.7 to 0.9)	0.8**** (0.7 to 0.9)	0.5*** (0.2 to 0.7)	0.9**** (0.8 to 0.9)	0.7**** (0.5 to 0.8)	0.9****	0.8**** (0.6 to 0.9)					
CB	0.8**** (0.6 to 0.9)	0.8**** (0.7 to 0.9)	0.4** (0.1 to 0.6)	0.8**** (0.7 to 0.9)	0.6**** (0.4 to 0.7)	0.8**** (0.6 to 0.9)	0.7**** (0.5 to 0.8)	0.8**** (0.7 to 0.9)				
SI	0.6**** (0.4 to 0.8)	0.6**** (0.3 to 0.7)	0.6**** (0.3 to 0.7)	0.7**** (0.5 to 0.8)	0.5*** (0.3 to 0.7)	0.6**** (0.4 to 0.8)	0.6**** (0.4 to 0.8)	0.7**** (0.60.8)	0.6**** (0.4 to 0.8)			
MN	0.8**** (0.7 to 0.9)	0.8**** (0.7 to 0.8)	0.4** (0.2 to 0.6)	0.8**** (0.7 to 0.9)	0.6**** (0.4 to 0.8)	0.9**** (0.7 to 0.9)	0.6**** (0.4 to 0.8)	0.9**** (0.8 to 0.9)	0.8**** (0.6 to 0.9)	0.7**** (0.5 to 0.8)		
SRB	0.8**** (0.7 to 0.9)	0.7**** (0.5 to 0.8)	0.4** (0.2 to 0.6)	0.8**** (0.6 to 0.9)	0.6**** (0.3 to 0.7)	0.8**** (0.7 to 0.9)	0.7**** (0.6 to 0.9)	0.8**** (0.7 to 0.9)	0.7**** (0.5 to 0.8)	0.6**** (0.4 to 0.8)	0.9**** (0.7 to 0.9)	

BIU: behavioural intention to use; PU: perceived usefulness; PEoU: perceived ease of use; SN: subjective norm; PN: professional norm; CB: control belief; SI: self-identity; MN: moral norm; SRB: social role belief.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, **** $p < 0.0001$.

Table 5. Univariable associations of the intention to use teledentistry with sociodemographic characteristics and prior use of teledentistry.

Variables	Coefficient (95% CI)	*p*-value
Gender		
Male	Reference	
Female	−0.2 (−1.0 to 0.6)	0.570
Age group		
<25 years	Reference	
25–29 years	−0.2 (−1.0 to 0.7)	0.656
30 years and above	0.7 (0.1 to 1.3)	0.024
Undergraduate dental programme year		
Third year	Reference	
Fourth and fifth year	0.3 (−0.5 to 1.1)	0.432
Level of education		
CEGEP/college or lower	Reference	
Bachelor's degree	0.0 (−1.1 to 1.2)	0.940
Master's degree	0.4 (−0.8 to 1.7)	0.497
Prior use of teledentistry		
No	Reference	
Yes	−0.9 (−1.5 to 0.0)	0.006

significant correlation between age or gender and intention to use telehealth among physicians.

An interesting result of this study was that PUT had an unadjusted negative association with BIU. This result can be attributed to an insufficient understanding or knowledge regarding teledentistry usage. Given that all participants were students and teledentistry has yet to be formally integrated into dental curricula in Canada, it is conceivable that they have a weak awareness of its functionalities and advantages. When examining the impact of prior usage in Model 3 (adjusted), it emerged as an effect modifier factor. The observed interaction between PUT and CB, indicating a lack of significant association between CB and the intention to use teledentistry among individuals with prior experience, contrasts with a positive and significant association among those without prior exposure. Individuals with prior experience tend to have established routines and, consequently, might require fewer facilitating conditions for acceptance. Conversely, those without prior experience might inherently perceive a greater need and benefit from such supportive conditions to use teledentistry.

Implications for dental education and practice

Understanding the future dentists' perspectives and their needs towards the use of teledentistry offers relevant information to guide decision-makers in dental schools. The relevance of teledentistry education and training and the potential to integrate teledentistry into the dental curricula is discussed in the literature.[66–68] Dental schools are essential environments for dentists to gain fundamental knowledge and practical experience to effectively practice teledentistry.[69] It is recognized that healthcare professionals use the knowledge and skills acquired during their education and training, and they are usually less aware of innovations that become available after they complete their training.[70,71] Therefore, exposure to teledentistry during their training is an opportunity to equip students with the tools to respond to patients' needs, to ensure they are ready to use technological innovations in an efficient way and with the core competencies and concepts required to provide remote oral health care. Furthermore, experiences during education are key in influencing careers.[72] As with any innovation, contextual, structural and individual factors are important ingredients in its successful implementation.[73]

Strengths and limitations

To our knowledge, this is the first study using TAM and an integrated theoretical framework to identify predictors of dental students' BIU to use teledentistry. The results from the tested models carry significant implications for education and decision-makers, offering valuable insights for integrating teledentistry into dental curricula and to understand specific areas to concentrate on for improving acceptance of teledentistry. This study can be a guide for future studies with larger samples for a better understanding of the trends.

Despite these strengths, the findings of this study should be considered in light of its limitations. Firstly, the use of a small sample size may reduce the study's statistical power and its ability to detect smaller and potentially significant effects. Additionally, the relatively low response rate might introduce non-response bias. A possible explanation for the relatively low participation rate could be the length of the survey. From our records, students took on average 13.3 ± 2.8 min to fill out the survey and there were some attempts to open the survey but with no response. In addition, the voluntary participation could induce a desirability bias. However, the response rate in our study is almost similar to other studies about students' intention to use

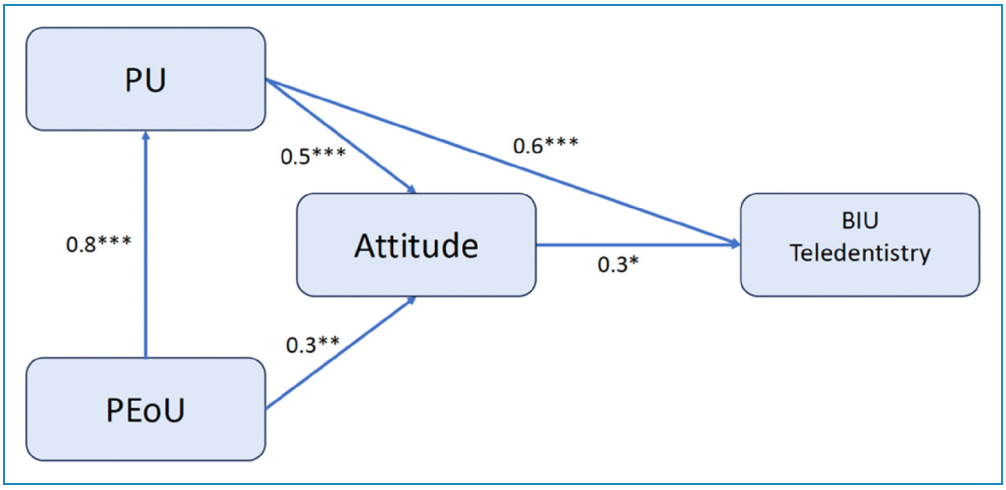

Figure 2. Model 1. * $p > 0.05$, ** $p < 0.05$, *** $p < 0.001$.

Table 6. Summary of models.

	Effect type	Coefficient (95% CI)	*P*-value	Percentage of variance explained (%) (R^2)	BIC	AIC
Model 1				58.0	122.0	118.4
PU	Direct	0.6 (0.3 to 1.0)	<0.001			
	Indirect	0.1 (−0.6 to 0.3)	0.168			
	Total	0.8 (0.6 to 0.1)	<0.001			
PEoU	Indirect/total	0.7 (0.4 to 0.9)	<0.001			
Attitude	Direct/total	0.3 (−0.1 to 0.6)	0.152			
Model 2				71.5	106.9	101.4
SRB	Direct/total	0.4 (0.2 to 0.6)	<0.001			
CB	Direct/total	0.5 (0.3 to 0.8)	<0.001			
Model 3A				76.6	103.3	94.1
SRB	Direct/total	0.4 (0.2 to 0.5)	0.001			
CB#PUT	Direct/total	0.8 (0.2 to 1.5)	0.014			
Model 3B				82.0	93.9	82.9
SRB1	Direct/total	0.3 (0.1 to 0.4)	<0.001			
CB1	Direct/total	0.2 (0.1 to 0.4)	0.005			
CB2#PUT	Direct/total	0.6 (0.2 to 0.9)	0.002			

PU: perceived usefulness; PEoU: perceived ease of use; SRB: social role beliefs; CB: control beliefs; PUT: prior use of teledentistry; #: interaction; BIC: Bayesian information criterion; AIC: Akaike information criterion.

telehealth.[58] Furthermore, data collection was province-based rather than school-specific. Considering Quebec hosts three dental schools, it's uncertain whether all three collaborated, which could influence the calculated response rate. Depending on whether one, two, or all three schools distributed the invitation links to their students, the actual response rate might be higher than what we calculated. Another limitation pertained to the study's focus on only three Canadian provinces, which restricts the generalizability of the findings to a broader context. Dental students from other regions with potentially different healthcare systems and educational backgrounds may have distinct perspectives on teledentistry. These results are representative of the study's participants and cannot be generalized to all dental students in Canada.

Future directions

While our study has predominantly focused on dental students' perspectives and the educational framework necessary to support teledentistry, the experiences of the patients as end-users are equally crucial. Understanding patient experiences with teledentistry services provides valuable insights into potential implementation challenges and opportunities that might not be readily evident from a provider-centric viewpoint. Recent research has begun to uncover these dimensions by exploring predictors of teledentistry acceptance among end-users.[74,75] These findings indicate that successfully integrating teledentistry into dental curricula should encompass a holistic approach to better prepare future dentists to meet their patients' needs and adapt to evolving healthcare delivery models.

Conclusions

Our results have highlighted that PU, social role and control beliefs are the main predictors of dental' students' intention to use teledentistry after their graduation. These findings could inform decision-makers who want to design and implement teledentistry in the dental curriculum and to promote its use among future dentists. Formal training and technical assistance would increase dental students' acceptance with the adoption of teledentistry. However, further studies are needed to confirm the value of these models. These should be validated with larger samples and with the participation of students from other dental schools as well as students at pre-clinical levels.

Acknowledgements: The authors would like to thank Dr Ajinkya, a non-thesis master student for his contribution in the development of the survey using Lime survey. In addition, we would like to thank summer students for their involvement in the first phases of this project (Bushra K. and Annie W.). We would like to recognize the contribution of the biostatistician Pierre R. We are grateful to the dental students who have participated in this project.

Contribution: PKT conceptualized and led the development of the study, drafting both the proposal and the initial manuscript. PKT and YM conducted the data analysis, while PM, RD, and EE contributed significantly to data collection. All authors thoroughly reviewed and approved the final version of the manuscript.

Declaration of conflicting interests: The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical approval: This study received approval from the McGill University IRB (eRAP/Info-Ed File Number: 22-03-052).

Funding: The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: The principal investigator has received a start-up of the Faculty of Dental Medicine and Oral Health Sciences from McGill University.

Guarantor: PKT.

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Supplemental material: Supplemental material for this article is available online.

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