Evaluation of a theory-driven e-learning intervention for future oral healthcare providers on secondary prevention of disordered eating behaviors

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Abstract

Oral healthcare providers have a clinical opportunity for early detection of disordered eating behaviors because they are often the first health professionals to observe overt oral and physical signs. Curricula regarding early recognition of this oral/systemic medical condition are limited in oral health educational programs. Web-based learning can supplement and reinforce traditional learning and has the potential to develop skills. The study purpose was to determine the efficacy of a theory-driven Web-based training program to increase the capacity of oral health students to perform behaviors related to the secondary prevention of disordered eating behaviors. Using the Reach, Effectiveness, Adoption, Implementation and Maintenance framework, a longitudinal group-randomized controlled trial involving 27 oral health classes from 12 oral health education programs in the United States was implemented to assess the efficacy of the Web-based training on attitudes, knowledge, self-efficacy and skills related to the secondary prevention of disordered eating behaviors. Mixed-model analysis of covariance indicated substantial improvements among students in the intervention group (effect sizes: 0.51–0.83) on all six outcomes of interest. Results suggest that the Web-based training program may increase the capacity of oral healthcare providers to deliver secondary prevention of disordered eating behaviors. Implications and value of using the Reach, Effectiveness, Adoption, Implementation and Maintenance framework are discussed.

Introduction

Disordered eating behaviors (i.e. unhealthy weight control behaviors) are significant public health issues owing to their (i) high prevalence among adolescents; (ii) association with nutritional deficiencies and mental health issues and (iii) progression to chronic physical, mental and negative psychosocial
health outcomes [1–4]. Comprising three general categories, these behaviors include: (i) unhealthy dieting, severe caloric restriction, meal supplements and skipping meals; (ii) laxative, diuretic and diet pill use/misuse and (iii) self-induced vomiting [1, 5].

Owing to evidence that suggests that (i) the severity of disordered eating behaviors increases over time, and (ii) there is progression from engaging in disordered eating behaviors to the development of a clinical eating disorder [1–3], early detection and referral to treatment are crucial. Interventions aimed at early identification of signs and symptoms of disordered eating behaviors and referral for treatment are considered secondary prevention or targeted prevention interventions [6]. Secondary prevention aims at reducing the prevalence of a specific health issue through detection in an early phase combined with referral and treatment. Comparably, targeted prevention focuses on interventions aimed at a target audience who has not yet developed the health issue, but is at high risk due to the presence of clear risk factors [6].

Dentists and dental hygienists work together as part of a team that often also includes dental assistants and laboratory technicians [7], and are both involved in oral health assessment and oral/systemic disease prevention. The dentist oversees the team and responsibilities include diagnosing oral diseases, promoting oral health and disease prevention and creating treatment plans. The responsibilities of the dental hygienist include patient screening and review of health history, assessment of oral health condition, teaching oral health strategies, removing calculus and plaque and applying preventive materials to the teeth [8]. Oral healthcare providers (i.e. dentists and dental hygienists) have a clinical opportunity for secondary/targeted prevention of oral signs of disordered eating behaviors because they are often the first health professionals to observe overt health effects [9]. Oral health issues resulting from disordered eating behaviors present themselves as signs of: (i) malnutrition [10–20], (ii) dehydration [10, 19, 21, 22] and (iii) vomiting [11, 12, 14, 17–19, 21–28]. Failure of the oral health provider to identify oral signs and oral health issues related to disordered eating behaviors may lead to irreversible damage to the oral cavity and serious systemic health consequences [29].

Although research indicates that oral healthcare providers believe they have a professional responsibility and an ethical obligation to deliver eating disorder-specific secondary/targeted prevention, the majority of oral healthcare providers do not participate in these prevention practices [30–32]. Skills cited as key to ensuring oral healthcare provider competence in providing preventive services to patients who exhibit disordered eating behaviors include: (i) differential diagnosis, (ii) patient approach and communication skills regarding sensitive topics and (iii) patient-specific oral treatment and referral [9, 33]. Nonetheless, many of these skills are not adequately covered in appropriate depth in dental and dental hygiene academic programs [34–43]. More specifically, a review of dental and dental hygiene education revealed only 75% of dental programs and 88% of dental hygiene programs included patient education regarding oral signs of disordered eating behaviors, and only 58% of dental programs and 56% of dental hygiene programs included communication skills with regard to approaching patients about this sensitive oral and systemic health issue [44]. In addition, only 6–9 min of clinical instruction and [34–40] approximately 26 min of didactic instruction were spent on oral/systemic issues regarding disordered eating behaviors [44]. Thus, there appears to be a critical need for evidence-based training programs on secondary/targeted prevention of disordered eating behaviors.

Although training programs intended to increase awareness and recognition of signs of eating disorders have been developed for those who are best positioned to refer individuals to care [45, 46], the target audiences included school personnel, healthcare providers and public health educators. For example, McVey and colleagues implemented the Community Outreach Program for Eating Disorders [45], which provided workshops and trainings for practitioners and health educators in addition to educational materials including videos and guidebooks to elevate their knowledge of eating disorders and increase their comfort in addressing them [45].
The same authors also implemented an online curriculum to educators and health professionals working in school settings to offer universal prevention of eating disorders [46]. Accordingly, the purpose of the current study was to evaluate the efficacy of a theory-driven training program with the aim of increasing knowledge, skills, self-efficacy and access to resources that are necessary for dental and dental hygiene students to deliver secondary/targeted prevention of disordered eating behaviors.

**Methods**

**Study design**

The current study used a prospective group-randomized controlled trial involving 14 dental and 13 dental hygiene classes from six accredited dental and six accredited dental hygiene programs in the continental United States. Dental and dental hygiene classes were randomized to either the Web-based training program (intervention condition; \( n = 15 \) classes; eight dental, seven dental hygiene) or no additional training beyond what is currently delivered in their curriculum (control condition; \( n = 12 \) classes; six dental, six dental hygiene). The university’s Institutional Review Board granted approval for the study.

**Evaluation framework**

The Reach, Effectiveness, Adoption, Implementation and Maintenance (RE-AIM) evaluation framework served as the guiding framework for the evaluation. RE-AIM, which is designed to make randomized control trials more practical and generalizable, focuses on the following evaluation design elements: (i) delivery of intervention similar to how it would be implemented in real-world practice, (ii) selection of features that can be sustained after external funds are terminated and (iii) balanced attention on internal and external validity [47, 48]. The RE-AIM evaluation framework addresses these design elements through the following evaluation dimensions: (i) Reach within the selected population, (ii) efficacy/effectiveness, (iii) adoption by the targeted systems, (iv) implementation fidelity and (v) maintenance of the outcomes and/or institutionalization of the intervention.

**Participants**

Course instructors introduced the study to students in their respective courses as an optional supplement to their coursework. Students in the control classes received $5 if they completed the pretest, $15 for the posttest and an additional $5 for completing both assessments. Students in the intervention classes received $5 on completion of the pretest, $35 on completing the online program (including two quizzes and one case study), $15 for completing the posttest and an additional $5 for completing all components of the study. Before completing the pretest assessment, participants were required to register online and provide their consent to participate. Among eligible students within the 27 randomized classes (\( n = 1432 \), 41% registered to participate in the study (Fig. 1). Statistically significant differences were observed by profession. Compared with dental students, more dental hygiene students in the control condition registered to be part of the program, \( \chi^2 (1, N = 634) = 22.9, P < 0.001 \). Similarly, more dental hygiene students than dental students in the intervention condition registered to participate, \( \chi^2 (1, N = 841) = 46.2, P < 0.001 \).

**Intervention description**

**Conceptual framework**

The intervention was developed guided by extensive formative research based on a conceptual framework combining the Information Motivation Behavioral Skills [30, 32, 49–51] and Health Belief [52, 53] models (Fig. 2). The Information Motivation Behavioral Skills model conceptualizes the determinants (e.g. information, motivation and behavioral skills) of prevention behavior (e.g. secondary/targeted prevention of disordered eating behaviors) and provides a conceptual framework for promoting criterion-specific prevention behaviors among identified populations [49–51]. The Health Belief Model [52, 53] served as the framework to assess individual beliefs and moderating factors. With regard to these two models, formative research
identified several factors associated with an increased likelihood that oral healthcare providers would perform secondary prevention behaviors, including: (i) *individual beliefs* composed of perceived susceptibility of patients to disordered eating behaviors, perceived severity of eating disorders, perceived barriers to and benefits of secondary prevention and self-efficacy regarding eating disorder-specific secondary prevention behaviors; (ii) *knowledge* of eating disorders and associated oral and physical manifestations, *procedural/skill-based knowledge* regarding criterion-specific secondary prevention behavioral skills and (iii) *moderating* and *socio-demographic factors* [32].

**Intervention components**

The Web-based intervention entitled ‘Evaluating, Assessing, and Treating Sensitive Oral Systemic Health Topics: Case Studies on Oral Manifestations of Eating Disorders’ was based on a pilot training program [31], which was further developed by a multi-disciplinary team of experts from the fields of eating disorders, dentistry, dental hygiene, curriculum development, health behavior change and public health. The expert team translated each mechanism within the conceptual model into operational intervention components. As depicted in Table I, the Web-based training program comprises three interactive intervention components. Each
component is introduced with a section overview and learning objectives. The content material is presented in various interactive forms, including text, graphics, flowcharts, tables, roll-overs (i.e. additional information can be obtained by rolling over text with the mouse), voice-overs, video examples and quizzes [31]. In addition, the interactive case studies provide problem-based learning experiences where the students make decisions, receive feedback and modify actions as needed. The intervention underwent formative evaluation and usability testing with the dental and dental hygiene faculty before the finalization for the randomized controlled trial [30–32].

The didactic component of the intervention includes ‘Eating Disorders and Oral Findings’ (Component A, Table I). This component describes the main types of eating disorders and associated behaviors, characteristics and health issues. In addition, this component displays the oral findings of disordered eating behaviors categorized as signs of malnutrition, dehydration and vomiting. Each oral finding is depicted in a ‘pop-up’ table that contains a description, a pictorial representation, common causes and questions to ask for differential diagnosis. Thorough review of this component would be expected to take students approximately 2–3 hours, followed by a 10-item quiz. The quiz is a knowledge-based assessment that was developed based on the objectives of the module. It consisted of multiple-choice questions with five to six answer choices per question. When students responded to quiz items incorrectly, they were provided with a link to relevant material within the module. It is likely that at least some of the students went directly to the quiz and reviewed relevant material only when quiz responses were incorrect.

Fig. 2. Conceptual framework model.
The behavioral skills components of the intervention include: (i) \textit{EAT} (evaluate, assess and treat) Framework and Skills (Component B, Table I), and (ii) case studies (Component C, Table I). Based on the Brief Motivational Interviewing [49, 51] conceptual framework, the EAT Framework and Skills component is the critical skill-based portion of the intervention. The \textit{EAT} Framework is divided into three steps that include: (i) Evaluating patients presenting with signs of disordered eating behaviors; (ii) Assessing patient readiness for addressing disordered eating behaviors and (iii) patient-specific Treatment strategies based on the patient’s stage of readiness [54]. This component was estimated to take 3–4 hours if the student read each section and listened to the examples demonstrating how providers can approach patients in a sensitive and effective manner. Again the EAT framework section was followed by a 10-item, knowledge-based multiple-choice quiz with five to six answer choices per question. The quiz was developed based on the objectives of the module. The quiz provided links to relevant material if students answered them incorrectly.

To address skill development and self-efficacy, four interactive case studies (Component C, Table I) were developed to meet secondary prevention behavioral skill contingencies. These interactive video case studies provide the opportunity for the learner to practice secondary prevention behaviors with four different patients (varying in age and sex) at different stages of readiness to address the underlying cause of the various oral health issues identified [55]. For the purposes of the evaluation, students were only required to complete one case study, and each case study was designed to take approximately 45–60 min if students viewed each video segment and answered all of the interspersed questions. Questions were in the same format and similarly developed as the previous quizzes,
and as with the other quizzes, students who responded incorrectly to questions were given a link to review relevant material and instructed to try again until they chose the correct response. Correct responses were required to progress through the case study.

Finally, the Resources and Referral component provides oral healthcare providers with the resources necessary for supporting secondary prevention behaviors. This section contains printer-friendly education materials for patients, parents and dental office staff. In addition, patient-specific treatment plan templates are available for printing. The Referral section contains Web links to two treatment networks that deal with disordered eating behaviors and nutrition. To find an eating disorder treatment provider and/or registered dietitian for patient referral, the oral healthcare provider enters his/her zip code to obtain a list of providers that can be printed out and provided to the patient. Students were not required to complete any quizzes after reviewing the resources, but as part of the case studies, they were required to select appropriate resources based on the patient’s symptoms and readiness to address the underlying problem.

**Intervention delivery**

Strongly encouraged by the American Dental Education Association [56], e-learning, the use of electronic media for teaching and learning [57], presents an opportunity for supplementing and reinforcing traditional oral health curricula by developing knowledge, skills and self-efficacy. Advantages of e-learning over traditional classroom-based instruction include: (i) flexible learning, (ii) change in focus from instructor-centered learning to learner-centered learning, (iii) delivery of educational opportunities to remote areas, (iv) increased student enrollment, (v) anytime and anywhere learning, (vi) self-directed learning, (vii) learning at one’s own pace and h) reduced costs of course delivery [58–61]. A meta-analysis assessing evidence of effectiveness of e-learning in health professions education revealed large pooled effect sizes when comparing e-learning interventions with no intervention and similar pooled effect sizes with traditional forms of instruction [62]. Thus, findings from the meta-analysis supported previous studies in concluding that e-learning interventions are neither superior to nor inferior to traditional instructional methods in the health professions [62].

Various strategies for incorporating e-learning into existing curricula include: (i) using the Internet to deliver parts or entire courses online; (ii) provision of interactive learning experiences where students manage cases, make decisions and receive feedback on actions through online cases and (iii) development of e-learning opportunities that enrich coursework with additional experiences [58, 63]. The current intervention was developed to supplement existing course-work with interactive cases serving as supplemental learning experiences.

**Measures**

A 52-item Likert-type questionnaire based on the conceptual framework described previously was used to assess the following contingencies with regard to secondary prevention of disordered eating behaviors: (i) information including general knowledge and procedural knowledge; (ii) motivation including role beliefs, perceived threat to the patient and benefits/barriers and (iii) behavioral skill including self-efficacy. All items were reviewed for content validity and accuracy by an interdisciplinary team of experts, most of whom were involved in developing the educational program. Scores from measures of motivation and self-efficacy were included in a confirmatory factor analysis model using Mplus statistical software and using weighted least squares (WLSMV) estimation. Fit indices suggest that the hypothesized measurement model demonstrated relatively good fit (CFI = 0.974; RMSEA = 0.043). Factor loadings for all items were >0.53, with most in the range of 0.7 to 0.9. These results provide evidence of construct validity.

**General knowledge**

Assessment of knowledge of eating disorders and oral findings included a composite score of seven multiple-choice questions. Correct responses were
coded with a 1 and incorrect responses were coded with a 0. Responses were summed and ranged from 0 to 7. A representative sample of questions included the following (correct responses in parentheses): (i) oral findings associated with disordered eating behaviors can be categorized as signs of… (dehydration, vomiting and malnutrition), and (ii) angular cheilitis is an extra-oral finding that can be associated with the following disordered eating behavior(s)… (severe food restriction).

Procedural knowledge
Assessment of behavioral skill included skills-based knowledge regarding how to (i) evaluate for signs of disordered eating behaviors, (ii) communicate findings, (iii) assess patient readiness to address the underlying cause and (iv) treat patients with disordered eating behaviors. This score consisted of a 10-item composite that demonstrated an adequate 1-month test–retest correlation coefficient of $r = 0.49$ based on scores from participants in the control condition. Correct responses were coded with a 1 and incorrect responses were coded with a 0. Responses were summed and ranged from 0 to 10. A sample of questions included the following (correct responses in parentheses): (i) which of the following would be best when evaluating a patient who exhibits oral signs of disordered eating behaviors (rule out the most common and/or least sensitive of the possible underlying causes first), and (ii) to provide the most effective care, a patient treatment plan should… (be tailored based on a patient’s stage of readiness to address the underlying problem).

Role beliefs
Professional and legal role beliefs were assessed with eight items rated on a 4-point Likert-type scale ranging from ‘strongly disagree’ (0) to ‘strongly agree’ (3). This scale demonstrated good internal consistency reliability ($\alpha = 0.87$) based on scores from all participants who completed the pretest. Representative questions included the following: (i) dental professionals have a professional responsibility to communicate with patients about how certain oral findings can be associated with disordered eating behaviors once other possible etiologies have been ruled out, and (ii) liability in identifying patients with eating disorders is an important issue in dentistry. Scores were averaged to create a scale measure ranging from 0 to 3, with higher scores indicating a stronger belief that oral health providers (OHPs) have a professional and legal responsibility to perform behaviors related to secondary prevention of disordered eating behaviors.

Perceived threat to patient health
In accordance with the Health Belief Model, two subscales (i.e. perceived susceptibility and perceived severity) were combined to create a measure of perceived threat to patient health. The perceived susceptibility subscale was composed of nine items asking to what extent the student agrees that various individuals, who do not fit the stereotype (i.e. young, thin and female), could present with oral signs of disordered eating behaviors ($\alpha = 0.91$). Examples included ‘a female who is average weight for her height’, ‘a 10-year old girl’ and ‘an athletic male’. These items were rated on a 4-point Likert-type scale ranging from ‘strongly disagree’ (0) to ‘strongly agree’ (3). Scores were averaged to create a final scale ranging from 0 to 3, with higher scores indicating a higher level of perceived susceptibility among a broader range of individuals who are all potentially at risk for disordered eating behaviors.

The perceived severity subscale consisted of five items rated on the same Likert-type scale as the susceptibility items. Examples include ‘Disordered eating behaviors can cause life-threatening health problems’ and ‘Disordered eating behaviors can cause significant and extensive damage to the teeth and/or oral cavity’. Scores were averaged to create a final subscale score ranging from 0 to 3, with higher scores indicating higher perceived severity. Finally, to create the overall threat score, the susceptibility and severity scores were averaged.

Benefits/barriers
An overall cost–benefit score was created using the barrier and benefits subscales. Both of these subscales consisted of five items rated on the same
Likert-type rating scale as the previous measures. Examples from the barriers subscale include ‘I am concerned that I may misdiagnose a patient with signs of disordered eating behaviors’ and ‘I do NOT have resources needed to make appropriate referrals for patients with signs of disordered eating behaviors’. Examples from the benefits subscale include ‘Addressing disordered eating behaviors with patients will show patients that I care about their oral and overall health’ and ‘Communicating with patients about the link between eating behaviors and oral health will lead to improved oral health’. The overall benefit–barrier score was created by subtracting the barriers from the benefits, for a possible range of −3 to +3.

Self-efficacy
Perceived self-efficacy was assessed with seven items rated on a 4-point Likert-type scale, ranging from ‘not at all confident’ (0) to ‘very confident’ (3). A sample of representative behaviors included the following: (i) recognizing oral findings associated with disordered eating behaviors, (ii) approaching a patient who presents with oral signs associated with disordered eating behaviors, (iii) prescribing patient-specific home-dental care instructions for patients with oral signs associated with disordered eating behaviors and (iv) assessing patient readiness to determine and/or address the underlying cause of the oral finding(s). Scores were averaged to create a scale measure ranging from 0 to 3, with higher scores indicating higher self-efficacy. The measure showed good internal consistency (α = 0.91) and 1-month test–retest stability in the control condition (r = 0.66).

Socio-demographic factors
Sex, race/ethnicity, age, training program (e.g. dental or dental hygiene student), year in academic training, clinical experience and knowing someone with an eating disorder were included on the pre-assessment.

Procedures
After providing consent, participants in both conditions were asked to complete an online baseline assessment. Participants in the intervention condition were then required to go through the intervention on their own and complete two quizzes and at least one interactive case study during a 3-week period. After the 3-week period, intervention and control participants were asked to complete the follow-up assessment to receive stipends. Although the collected data were not sensitive or personal, assurance was given to participants that their responses would not be disclosed and would not affect their grade in the class.

Data analyses
All models within this cluster-randomized trial accounted for the dependence of individuals nested within classrooms. Before testing the general efficacy of the Web-based training program, equivalency of the control and intervention groups was conducted for each demographic variable as well as for baseline outcome scores because non-equivalent groups is the rule rather than the exception in group-randomized trials [64]. Also, to bolster confidence in the external validity of the study, students who completed the educational training program were compared with non-completers on each of the demographic variables and baseline outcome scores with completion status as the predictor. For all models, continuous dependent measures were tested using restricted maximum likelihood estimators using SAS PROC MIXED and discrete dependent measures estimated with SAS PROC GLIMMIX specifying the appropriate link function.

To test the general efficacy of the Web-based training program, a mixed-model analysis of covariance (ANCOVA) was used. Six models were run, one for each outcome. Each mixed-model ANCOVA tested for condition effects at posttest while treating the respective pretest score as a covariate. The model specifies two variance components, one for classrooms and one for students. In the following equation: \( Y_{ik} = \beta_0 + \beta_0C_k + \beta_1T_{ik} + \tau_{ik} + \mu_{ik} \), where \( Y_{ik} \) represents an outcome score for member i, \( C_k \) = 1 for intervention classrooms and 0 for control classrooms.
Each observation is predicted by a grand mean ($\beta_{00}$), the effect of the condition ($\beta_{01}$), a covariate ($\beta_{10}$), a classroom variance ($u_{0k}$) and an individual error term ($r_{ik}$). The terms $u_{0k}$ and $r_{ik}$ represent random effects. A test of the condition term ($\beta_{01}$) reveals the effect of the intervention.

Statistical power analyses for the nested design need to account for the non-independence of observations based on the intra-class correlation (ICC). The power estimates that follow rely on Murray’s (1998) discussion of power estimation for a mixed-model ANCOVA. Because we do not have an estimate of the ICC associated with classes, our power calculations are based on an ICC ranging from 0.05 to 0.15. With 15 classes per condition, accounting for 15% attrition of students at posttest (average class size = 25.5) and the ICC, two-tailed alpha of 0.01 (to adjust for multiple tests), covariate $r = 0.40$, we have sufficient power (>0.80) to detect small-to-medium effect sizes. Based on the average effect size of $d = 0.97$ from the pilot evaluation, we expect to

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<th>Intervention</th>
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<td>54</td>
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<td>4 or more</td>
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<td>Have had clinical experience (% yes)</td>
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<td>67</td>
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<td>42</td>
<td>161</td>
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<tr>
<td>Known a person with an eating disorder (% yes)</td>
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<td>75</td>
<td>234</td>
<td>67</td>
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*All tests of significance accounted for the clustered nature of the data.
**Tests of significance were not performed given that no participants in the control group reported being Native Hawaiian/Pacific Islander.
have sufficient power to detect significant differences between condition.

Finally, several socio-demographic variables (i.e. program of study, previous clinical experience, a previous course on eating disorders and oral findings or know someone with an eating disorder) hypothesized to moderate the main effects of the intervention were added to the mixed-model ANCOVA as well as the interaction term of the socio-demographic variable with study condition (i.e. intervention or control). A significant interaction term would indicate differential efficacy of the program. A partial point-biserial correlation coefficient, $r$, computed as square root of the $t$-value squared divided by the $t$-value squared plus degrees of freedom [65], was used to compare effects across measures with the convention small ($r = 0.14$), medium ($r = 0.36$) and large ($r = 0.51$). To protect against type-I errors, a false discovery rate correction was made for all tests of main effects and moderation [66]; adjusted $P$-values are reported.

## Results

### Intervention REACH

Among the 608 registered participants who completed the baseline survey, no statistically significant differences (at $P < 0.05$) were observed between intervention ($n = 349$) and control ($n = 259$) groups with regard to demographic variables (Table II) or baseline measures of the study outcomes. These results suggest that randomization produced essentially equivalent groups.

Participants who completed all assessments (completers; $n = 501$) were compared with those who did not (non-completers; $n = 107$) on study condition, demographic characteristics and all baseline measures of the study outcomes. Attrition was not observed to be related to study condition or demographic characteristics (all $P > 0.05$). However, attrition was related to perceived threat ($t[580] = 1.97, P = 0.05$; completer mean $= 2.24$ [SD = 0.48], non-completer mean $= 2.12$ [SD = 0.56]) as well as to self-efficacy ($t[580] = 3.03, P = 0.003$; completer mean $= 1.77$ [SD = 0.61], non-completer mean $= 1.92$ [SD = 0.67]).

### Intervention EFFICACY

Descriptive statistics for main study outcomes assessing program effectiveness by condition are presented in Table III. Table III also depicts the effect of the intervention on each of the six main outcomes of interest. The coefficient estimates for study condition indicate that post-assessment scores

### Table III. Descriptive statistics for study outcomes and condition effects of the online educational intervention

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Pretest</th>
<th>Posttest</th>
<th>Condition effect ($\beta_{01}$)</th>
<th>Coefficient</th>
<th>SE</th>
<th>$t$-value</th>
<th>$P$-value</th>
<th>$r^b$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Role beliefsc</td>
<td>Control: 2.27 (0.50) Intervention: 2.18 (0.50)</td>
<td>Control: 2.28 (0.49) Intervention: 2.35 (0.48)</td>
<td>Coefficient: 0.01</td>
<td>SE: 0.04</td>
<td>$t$-value: 2.94</td>
<td>$P$-value: 0.035</td>
<td>$r$: 0.51</td>
<td></td>
</tr>
<tr>
<td>Benefits/barriersd</td>
<td>Control: 0.66 (0.76) Intervention: 0.46 (0.73)</td>
<td>Control: 0.64 (0.72) Intervention: 1.16 (0.80)</td>
<td>Coefficient: 0.59</td>
<td>SE: 0.10</td>
<td>$t$-value: 6.21</td>
<td>$P$-value: 0.003</td>
<td>$r$: 0.78</td>
<td></td>
</tr>
<tr>
<td>Perceived threatc</td>
<td>Control: 2.22 (0.40) Intervention: 2.22 (0.36)</td>
<td>Control: 2.32 (0.39) Intervention: 2.42 (0.39)</td>
<td>Coefficient: 0.11</td>
<td>SE: 0.04</td>
<td>$t$-value: 3.13</td>
<td>$P$-value: 0.026</td>
<td>$r$: 0.53</td>
<td></td>
</tr>
<tr>
<td>Self-efficacyc</td>
<td>Control: 1.85 (0.65) Intervention: 1.71 (0.60)</td>
<td>Control: 1.90 (0.62) Intervention: 2.23 (0.47)</td>
<td>Coefficient: 0.37</td>
<td>SE: 0.06</td>
<td>$t$-value: 6.57</td>
<td>$P$-value: 0.002</td>
<td>$r$: 0.80</td>
<td></td>
</tr>
<tr>
<td>Knowledge of eating disorders and oral findings</td>
<td>Control: 3.59 (0.95) Intervention: 3.55 (0.88)</td>
<td>Control: 3.90 (0.88) Intervention: 4.50 (1.18)</td>
<td>Coefficient: 0.59</td>
<td>SE: 0.12</td>
<td>$t$-value: 5.13</td>
<td>$P$-value: 0.001</td>
<td>$r$: 0.72</td>
<td></td>
</tr>
<tr>
<td>Procedural knowledgef</td>
<td>Control: 4.00 (1.46) Intervention: 4.15 (1.49)</td>
<td>Control: 5.00 (1.48) Intervention: 6.41 (1.95)</td>
<td>Coefficient: 1.47</td>
<td>SE: 0.19</td>
<td>$t$-value: 7.58</td>
<td>$P$-value: &lt;0.001</td>
<td>$r$: 0.83</td>
<td></td>
</tr>
</tbody>
</table>

All tests of condition effects were computed with 25 degrees of freedom. $^a$Benjamini–Hochberg adjusted $P$-values. $^b$r is a measure of effect size with 0.14 = small effect, 0.36 = medium effect and 0.51 = large effect [65]. $^c$Possible scale measures range from 0 to 3. $^d$Scale measure has a potential range of −3 to +3. $^e$Scale ranges from 0 to 7. $^f$Scale ranges from 0 to 10.
for each of the six study outcomes were significantly greater for the intervention group than for the control group. Effect sizes for all outcomes of interest were large ranging from $r = 0.51$ to $0.83$. No significant moderating effects were observed.

**Intervention ADOPTION, IMPLEMENTATION AND INSTITUTIONALIZATION**

Findings pertaining to Adoption, Implementation and Institutionalization have been reported elsewhere [32, 55]. However, these insights are important for overall program evaluation and are useful in the interpretation of findings pertaining to intervention reach and efficacy. Thus, several of the relevant themes will be related to reach and efficacy findings in the discussion.

**Discussion**

Oral healthcare providers have a clinical opportunity for secondary/targeted prevention of disordered eating behaviors because they are often the first health professionals to observe signs of malnutrition, dehydration and vomiting. This prospective group-randomized controlled trial measured the efficacy of a theory-based e-learning intervention that was designed to improve attitudes, knowledge, skills and self-efficacy associated with secondary/targeted prevention of disordered eating behaviors. Results from the current study indicate strong support for the efficacy of this intervention at changing key theory-based contingencies, with improvements occurring among intervention group participants on all six outcomes of interest. Moreover, based on the lack of statistically significant interactions, the effect of the intervention appeared to be consistent among both dental and dental hygiene students. The effect was also independent of whether students had previous clinical experience, a previous course on eating disorders and oral findings or knew someone with an eating disorder.

Most randomized controlled trials focus solely on efficacy. However, intervention efficacy should be interpreted within the context of program, reach and adoption to inform translation and subsequent institutionalization in real-world settings. With regard to program reach, despite monetary incentives, many eligible students chose not to participate in the study and therefore we cannot conclude that this program would influence or be equally successful among all dental and dental hygiene students. External validity is further limited, given the baseline differences found between those students who registered to take part in the intervention but chose not to complete it and those who completed the program. Although there is no way to know for certain why individuals who failed to complete the program reported higher baseline self-efficacy, perhaps their confidence led them to believe that additional training was unnecessary. Nevertheless, because there were no differences between completers and non-completers in terms of general knowledge and skills-based (procedural) knowledge, it appears that non-completers were no more competent than completers at baseline to provide secondary prevention for patients who present with signs of disordered eating behaviors. Another implication of this finding is that although self-efficacy may be necessary, it cannot be used as a proxy for competency. Non-completers were also less likely to perceive disordered eating as a health threat compared with those who completed the training. Given how perceived threat was operationalized, this indicates that students who perceive disordered eating behaviors to be applicable to their patients, in addition to perceiving that disordered eating behaviors have serious oral and physical health consequences, were more likely to complete the training. This is not surprising because perceived threat is often a necessary precursor for behavior change. Nevertheless, current findings do have implications in terms of the potential reach that this type of online educational training program may have. If the program is optional, as was the case for this study, reach may be limited, unless a way can be devised to increase the perceived threat to a level sufficient to motivate the participant to complete the program.

Based on intervention findings pertaining to the REACH dimension, it may be that unless dental and dental hygiene faculty adopt this training program
and integrate it into the existing dental and dental hygiene curricula (i.e. institutionalization), it will have a limited impact. An ongoing challenge in health professions education is finding strategies to introduce information and interactive learning experiences into an already crowded curriculum with limited faculty resources. An advantage of this type of e-training intervention is that it can be used as a resource or tool to supplement existing oral health curricula as well as for other health professions that require both didactic and skill-based training. With this in mind, we assessed the likelihood that instructors would adopt and integrate the intervention into existing programs of study. Based on semi-structured interviews implemented with instructors of classes assigned to the intervention group, it appears that faculty instructors believe in the added value of the online training program and would be willing to adopt and integrate it within the existing curricula. However, not all instructors perceived the usefulness of the entire training program for one particular course. Many instructors indicated that they would likely assign certain portions of the training program to specific courses. In other words, they would spread out sections of the intervention throughout the current 2–4-year dental hygiene or dental curricula. These types of alterations to intervention implementation could have a positive or negative impact on outcomes. Thus it will be critical for future studies to monitor how the program is actually implemented in addition to program outcomes.

Implementation of secondary prevention of eating disorders during dental visits has implications for both successful eating disorder treatment and long-term oral health. Although there are many issues that need to be addressed, there are two major problems regarding the treatment of eating disorders. Although the negative health outcomes associated with eating disorders have been well-documented [29, 67–69], just 1 of 10 individuals with disordered eating behavior receives treatment [70]. Moreover, the cost of treatment is extremely high [71]. One way to improve the problems associated with treatment is early identification of the disorder [71] as it increases the likelihood of recovery [29]. As OHPs are often the first providers to observe signs of disordered behaviors, it is crucial that they engage in secondary prevention. Furthermore, increasing the likelihood of successful treatment of the eating disorder, secondary prevention behavior will also improve the patients’ long-term oral health. By addressing the underlying cause of the oral manifestation rather than just treating the oral signs associated with disordered eating behaviors will result in a positive impact on the physical, mental and oral health of the patient, a responsibility of both dentists and dental hygienists [7, 8].

The implementation of this Web-based training program transcends both public health and health education. The Healthy People 2020 oral health objective ‘Increase the proportion of adults who receive preventive interventions in dental offices’ [72] supports the need for educational and skill-building training for oral health providers with regard to oral/systemic health issues like eating disorders. The EAT training also specifically addresses a second Health People 2020 objective ‘Reduce the proportion of adolescents who engage in disordered eating behaviors in an attempt to control weight’ [72]. Thus, this program has the potential for a significant impact on public health, as it takes a multidisciplinary approach to increase secondary prevention behaviors among dentists and dental hygienists to ultimately reduce the prevalence and severe health consequences of eating disorders.

Despite certain limitations, this study illustrates how triangulating RE-AIM dimensions can add to the interpretation of efficacy outcomes in randomized controlled trials. Results from the current study suggest that the theory-driven e-learning intervention can prepare future oral healthcare providers to deliver secondary/targeted prevention of disordered eating behaviors. Although the audience for the intervention was oral health students, the Web-based training program could be adapted into a Web-based continuing education program for practicing dentists and dental hygienists, thereby expanding reach and maximizing potential impact. Nevertheless, future studies assessing the public health impact of the intervention need to include
multiple levels (e.g. provider, patient and parent of patient) and multiple time points to determine whether the intervention leads to an increase in the number of persons with disordered eating behaviors who (i) receive appropriate oral healthcare, (ii) are referred for behavioral treatment and/or nutritional counseling and (iii) follow through with referrals and patient-specific treatment plans.

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Conflict of interest statement

None declared.

References


