A THEORY-BASED ADAPTIVE E-LEARNING PROGRAM AIMED AT INCREASING INTENTIONS TO PROVIDE BRIEF BEHAVIOR CHANGE COUNSELING: RANDOMIZED CONTROLLED TRIAL

Guillaume Fontaine[a,b] and Sylvie Cossette[a,b]

[a] Faculty of Nursing, Université de Montréal, 2375 Chemin de la Côte-Sainte-Catherine, Montréal, QC, Canada, H3T 1A8

[b] Montreal Heart Institute Research Center, 5000 Bélanger, Montréal, QC, Canada, H1T 1C8

E-mail addresses:

Guillaume Fontaine guillaume.fontaine@umontreal.ca
Sylvie Cossette sylvie.cossette.inf@umontreal.ca

Twitter handles:

Guillaume Fontaine @_GFontaine
Sylvie Cossette @sycossette

Corresponding author:

Guillaume Fontaine, RN, PhD
Université de Montréal Faculty of Nursing
Montreal Heart Institute Research Center

Acknowledgements:

We want to acknowledge the contribution of Drs. José Côté, Marie-Pierre Gagnon and Véronique Dubé for contributing to the elaboration of the study protocol. We also want to acknowledge the contribution of Mrs. Sonia Heppell, Claudie Roussy, Eva Romano, Marie-Line Brouillette, and Mélanie Charchalis to the elaboration of the content of the E_MOTIV programs.

Conflict of interest:

None declared.

Funding sources:

GF was supported by a Vanier Canada Graduate Scholarship (Canadian Institutes of Health Research; #201711CGV-396 218-255 367), a doctoral fellowship from Quebec's Healthcare Research Fund, the AstraZeneca and Dr Kathryn J Hannah scholarships from the Canadian Nurses Foundation, a doctoral scholarship from the Montreal Heart Institute Foundation, a doctoral scholarship from Quebec's Ministry of Higher Education, and multiple scholarships from the Faculty of Nursing at the Université de Montréal.

Abstract

Background: Unhealthy behaviors are significant contributors to non-communicable diseases. Nurses can help patients change unhealthy behaviors by providing brief behavior change counseling. However, training programs in brief counseling are generally not personalized, or adapted, to the barriers and theoretical determinants of its provision in clinical practice.

Objective: This study aimed to evaluate the effectiveness of the E_MOTIV$_A$ theory-based adaptive e-learning program on nurses' and nursing students' intentions to provide brief counseling for smoking, unhealthy eating habits and medication nonadherence.

Design and Methods: A randomized controlled trial was conducted with nurses and nursing students in Canada. Experimental group participants were allocated to the E_MOTIV$_A$ theory-based, adaptive e-learning program. Control group participants were allocated to the E_MOTIV$_B$ knowledge-based, standardized e-learning program. E_MOTIV$_A$ was designed to influence the constructs of the Theory of Planned Behavior (e.g., attitude, subjective norms) in relation to brief counseling. Outcomes were improvement in intention to provide brief counseling, improvement in other Theory of Planned Behavior variables, as well as cognitive load and engagement related to e-learning.

Results: A total of 102 participants were randomized to the experimental (n=51) and control (n=51) groups. End of study questionnaires were completed by 27 experimental group and 38 control group participants. Analyses indicated no significant differences between groups in the change of scores for intention to provide brief counseling. However, while not significant, the change of score was greater in the experimental group (10.22 ± 3.34 versus 9.04 ± 2.80; p = 0.787). Scores in both groups improved significantly for attitude, subjective norms, perceived behavioral control, behavioral beliefs, and control beliefs. However, there were no statistically significant differences between groups for these variables as well as for cognitive load and engagement.

Conclusions: Both e-learning programs had a similar positive effect on nurses' and nursing students' intentions to provide brief counseling and on Theory of Planned Behavior variables.

Trial Registration: ISRCTN Registry ISRCTN32603572;

http://www.isrctn.com/ISRCTN32603572.

International Registered Report Identifier (IRRID): PRR1-10.2196/18894.

Keywords: e-learning; adaptive; tailored; evidence-based practice; theory-based intervention; behavioral counseling.

Background

Cardiovascular and respiratory diseases, diabetes and neoplasia, the four main chronic noncommunicable diseases, are responsible for seven in 10 premature deaths globally (World

Health Organization, 2020). In 2015, world leaders at the United Nations agreed on an ambitious goal: to reduce the risk of premature mortality from noncommunicable diseases by one third by 2030 (United Nations, 2016). To achieve this goal, countries must tackle multiple noncommunicable diseases simultaneously and implement programs and interventions aimed at reducing the most important metabolic risk factors common to these diseases, including high blood pressure, dyslipidemia, elevated body mass index, and diabetes (Benjamin et al., 2017; Yusuf et al., 2020). These risk factors are modifiable through drug treatments and health behavior change. Health behaviors amenable to change include smoking, an unbalanced diet, physical inactivity, alcohol consumption, and medication nonadherence (Ho et al., 2009; Lemstra et al., 2018; Yusuf et al., 2020).

In the last decade, increasing attention has been paid to the role of all health professionals in helping patients initiate and maintain changes in health behaviors (Keyworth et al., 2020). Integrating opportunistic brief behavior change counseling (hereafter 'brief counseling') in the practice of all health professionals has been the focus of numerous clinical practice guidelines (Diabetes Canada Clinical Practice Guidelines Expert Committee, 2018; Rabi et al., 2020; Wharton et al., 2020; Whelton PK et al., 2017). Brief counseling is a motivational and collaborative approach mobilizing different communication techniques to explore patients' beliefs, assess their level of motivation and confidence regarding to behavior change and to elicit and support health behavior change (Patnode et al., 2017; Vallis et al., 2018). Different brief counseling approaches, based on a wide range of theoretical principles and showing different levels of complexity, can be implemented depending on the clinical context (Dragomir et al., 2018). When implemented in clinical practice, brief counseling generally lasts from 3 to 5 minutes (Aveyard et al., 2012; Aveyard et al., 2016; Rueda-Clausen et al., 2014; Vallis et al., 2018).

Nurses and nursing students working in acute care settings have a unique opportunity to support smoking cessation, healthy eating habits and adherence to medication (Fontaine, 2016; Fontaine et al., 2016; Fontaine, Cossette, Maheu-Cadotte, Mailhot, Heppell, et al., 2019; Keyworth et al., 2020; Murphy et al., 2016). Acute care nurses spend between 35% and 61% of their time at the bedside, which is more time than any other health care professional (Hurst, 2010; Westbrook et al., 2011). Hospitalization for a life-threatening health problem, such as myocardial infarction or cancer, can promote psychological and emotional receptivity conducive to change in health behavior (Berndt et al., 2013; Huntink et al., 2015; Rice et al., 2017). While brief counseling has often been implemented in primary care practice (Malan et al., 2016; Sherson et al., 2014; Sturgiss et al., 2017; Welzel et al., 2018), it is poorly integrated into the clinical practice of nurses

and nursing students in acute care settings (Duprez et al., 2020; Duprez et al., 2017, 2018). Nurses and nursing students do not have access to role models and professional training resources that would allowing them to acquire the knowledge and develop the skills to implement brief counseling (Duprez et al., 2017, 2018).

Different factors, or theoretical determinants, can influence nurses' and nursing students' intentions to provide brief counseling (Ajzen, 1991; Fishbein et Ajzen, 2010). First, a positive attitude towards brief counseling has been associated with an increase in intention to provide it, as well as its actual provision in clinical practice by nurses and nursing students (Smit et al., 2013). This attitude is influenced by underlying beliefs. For example, nurses may believe that few patients are interested in discussing health behavior change, especially in acute care, and that this change process is long and complex, leading to a lack of motivation to invest in it (Al Sayah et al., 2014; Engstrom et al., 2013; van Hooft et al., 2016). Second, subjective norms, which is perceptions of the beliefs and behaviors of the patient, the nursing team, other professionals and managers can influence nurses' and nursing students' intentions to provide, and actual provision of brief counseling (de Ruijter et al., 2018; van Hooft et al., 2016). For example, a study found that social modeling (i.e., nurses acting as role models in the environment) and team social support were correlated with implementation of several intervention strategies related to brief counseling (de Ruijter et al., 2018). Third, studies suggest that greater perceived behavioral control is linked to increased intentions to provide, and actual provision of brief counseling by nurses and nursing students in clinical practice (Duprez et al., 2017; Gotwals, 2017; Lawn et Schoo, 2010). Perceived behavioral control is linked to nurses' and nursing students' knowledge and skills in brief counseling, as well as to their perception of the barriers and enablers to the provision of brief counseling (Duprez et al., 2017; Gotwals, 2017; Lawn et Schoo, 2010). The Theory of Planned Behavior posits that these theoretical determinants (i.e., attitude, subjective norms, perceived behavioral control) are predictive of individuals' intentions to provide brief counseling, and ultimately their provision of it in clinical practice (Sinclair et al., 2019; Steinmetz et al., 2016).

Adaptive e-learning has emerged as a novel strategy that may be used to support nurses' and nursing students' practice (Fontaine et al., 2017; Fontaine, Cossette, Maheu-Cadotte, Mailhot, Deschênes, et al., 2019; Newman et al., 2016; Samulski et al., 2017; Van Es et al., 2016; Wong et Krasne, 2017). Adaptive e-learning programs collect data at different points during their use, usually through questions conceptualized by a team of experts and end users, or by computer algorithms to determine each learner's optimal learning path from multiple pathways

(Brusilovsky et Peylo, 2003; Fontaine, Cossette, Maheu-Cadotte, Mailhot, Deschênes, et al., 2019; Knutov et al., 2009). For instance, asking nurses and nursing students about whether they agree with certain beliefs with regard to brief counseling (e.g., “Brief counseling is effective in helping patients initiate health behavior change”) could orient each learner towards personalized content designed to influence this particular belief positively. Thus, adaptive e-learning mimics face-to-face learner-teacher interactions, where the teacher adapts learning content based on feedback from learners (Fontaine, Cossette, Maheu-Cadotte, Mailhot, Deschênes, et al., 2019). Designing an adaptive e-learning program based on the Theory of Planned Behavior could be an effective way to support nurses’ and nursing students’ intentions to provide brief counseling and increase their knowledge and skills to do so (Ajzen, 1991; Nilsen et Birken, 2020; St Quinton et al., 2021; Steinmetz et al., 2016; Wensing et al., 2020).

In addition, by personalizing learning content and navigation sequence to each learner, adaptive e-learning could optimize nurses’ and nursing students’ cognitive load and increase engagement related to learning (Josephsen, 2015; O’Brien, 2016; Young et al., 2014). Cognitive load broadly refers to how much the learner’s working memory is solicited during learning (Young et al., 2014). There are three types of cognitive load: 1) intrinsic load is associated with the complexity of the learning task and should be adapted to each learner; 2) extrinsic load is associated with superfluous or confusing elements during learning and should be minimized; 3) germane load is associated with the integration of the programs’ concepts by learners and should be maximized (Young et al., 2014). Engagement, which represents the level of the learner’s investment (e.g., time, energy) when interacting with an e-learning program, should be maximized (O’Brien, 2016). Thus, adaptive e-learning programs could provide tailored training and support for nurses and nursing students, while optimizing cognitive load and engagement related to learning.

In this study, we sought to evaluate an asynchronous adaptive e-learning program based on the Theory of Planned Behavior, Cognitive Load Theory and the concept of engagement (experimental group) compared to a knowledge-based and standardized e-learning program (control group) to increase nurses’ and nursing students’ intentions to provide brief counseling. Our primary hypothesis (H1) was that experimental group participants would demonstrate a greater change than control group participants in the score of intentions to provide brief counseling for smoking, unbalanced diet and medication nonadherence between baseline and follow-up. A secondary hypothesis was that experimental group participants will demonstrate greater changes in scores of attitude (H2), subjective norms (H3), perceived behavioral control

(H4), behavioral beliefs (H5), normative beliefs (H6), and control beliefs (H7) regarding brief counseling between baseline and follow-up. We also anticipated lower intrinsic and extrinsic cognitive loads (H8, H9), higher germane cognitive load (H10), and higher experiential and behavioral engagement (H11, H12) in experimental group compared to control group participants at follow-up.

Methods

Trial design

We conducted a two group, single blind, randomized controlled trial to evaluate the E_MOTIV$_A$ theory-based and adaptive e-learning program on nurses' and nursing students' intentions to provide brief counseling, compared to the E_MOTIV$_B$ knowledge-based and standardized e-learning program. The trial protocol was prospectively registered on October 14, 2019 (ISRCTN32603572) and published (Fontaine, Cossette, Gagnon, et al., 2020). The International Registered Report Identifier of this study is PRR1-10.2196/18894. This paper is reported according to the Consolidated Standards of Reporting Trials 2010 Statement (Schulz et al., 2010) as presented in ***Supplementary File 1***. All study procedures (i.e., recruitment, interventions, measures) were conducted online in April, May and June 2020 and were asynchronous, without any contact between participants and study personnel except for project presentations and standardized email reminders.

Participants

We recruited a convenience sample of nurses and nursing students enrolled in a Bachelor of Science in Nursing program at a large university in Quebec, Canada. In Quebec, Bachelor of Science in Nursing programs include both nurses and nursing students, since there are two entry-to-practice modalities: (1) a 3-year College Diploma in Nursing; after their registration as nurses, they may choose to pursue a 2-year Registered Nurse-to-Bachelor of Science degree; (2) a direct entry to nursing registration after a 3-year Bachelor of Science in Nursing degree. Thus, this study targeted both nurses during their bachelor program and direct entry nursing students (hereafter called "participants"). To be included, participants had to (1) be able to perform computer tasks (e.g., taking emails); (3) understand French. There was no exclusion criterion.

Randomization, allocation and blinding

A randomization scheme was generated offsite by the Montreal Health Innovations Coordinating Center (www.mhicc.org), and assignment was performed online following a 1:1

allocation with random block sizes (4 or 6) to minimize group imbalances. Participants were blinded to group allocation; both e-learning programs had the same appearance on the computer screen, the same branding name and the same core content in brief counseling. The difference was specific intervention components targeting theoretical variables and adaptative (vs standardized) content in the experimental group only, as described below. The study coordinator was aware of group assignment to assign each participant to the experimental or control e-learning program in the Web-based platform.

Procedures

Apart from the E_MOTIV$_A$ or E_MOTIV$_B$ programs, all study procedures were identical in both groups. After enrollment (–T2), participants completed baseline measures online (–T1) and were randomized in a 24-hour window (T0) to the E_MOTIV$_A$ or E_MOTIV$_B$ programs. Participants had up to 21 days to complete the two required training sessions (T1, T2) and potentially the optional T3 session. If participants did not want to complete the optional session T3, they completed the follow-up (T4) measures immediately after session 2 by clicking on an embedded link at the end of the session. Otherwise, participants completed follow-up measures after completing session 3. Participants had access to both e-learning programs for up to 28 days post randomization.

Interventions: E_MOTIV$_A$ and E_MOTIV$_B$ e-learning programs

Both e-learning programs are described in detail elsewhere (Fontaine, 2016, 2020; Fontaine, Cossette, Gagnon, et al., 2020) and in a paper focusing on the development of the E_MOTIV$_A$ program (Fontaine et Cossette, 2021). Thus, here we present a high-level description of both interventions.

Experimental group: theory-based adaptive e-learning program (E_MOTIV$_A$)

Participants in the experimental group accessed the E_MOTIV$_A$ program, including content delivered through text, pictures, and short videos on smoking, unbalanced diet, and medication nonadherence. They also had access to content on the principles of the 5As brief counseling approach. The content and mode of delivery of the E_MOTIV$_A$ program were designed based on empirical literature and reviews completed by study authors (Fontaine et al., 2017; Fontaine, Cossette, Maheu-Cadotte, Mailhot, Deschênes, et al., 2019; Fontaine, Cossette, Maheu-Cadotte, Mailhot, Heppell, et al., 2019; Fontaine, 2018, 2019). Two features distinguish the E_MOTIV$_A$ program: its theory-based approach, and its adaptive component. The theory-based approach involves additional content (videos) designed to address 20 barriers to the

provision of brief counseling. The content of the E_MOTIV$_A$ program targets all five domains of the Theory of Planned Behavior: 1) attitude and behavioral beliefs; 2) subjective norms and normative beliefs; 3) perceived behavioral control and control beliefs; 4) actual behavioral control; and 5) intention to provide brief counseling. Furthermore, the E_MOTIV$_A$ intervention is adaptive; each training session includes a number of "adaptation points" consisting of questions asked to participants to adapt either the navigation sequence (the order in which the content is presented) or the content. There are two types of adaptation points can be defined as follows: (1) in navigation sequence adaptation points, the participant chooses his preferred learning path (e.g. "Which cardiovascular risk factor do you wish to see first in this training program from the options presented below?"); and (2) in content adaptation points, the participant answers a question related to the constructs of the Theory of Planned Behavior, such as attitude toward brief counseling, with a 4-point response scale (agree, slightly agree, slightly disagree, disagree). For example, for the question "Helping patients change their health behaviors, like smoking, is complex," if they answer agree, slightly agree or slightly disagree, participants are automatically sent to a video designed to modify this specific belief. If they answer disagree, they are sent to the next question or part of the program.

Control group: knowledge-based standardized e-learning program (E_MOTIV$_B$)

Control group participants accessed the E_MOTIV$_B$ intervention, which includes the same content on smoking, unbalanced diet, medication nonadherence, and the 5As approach delivered through text, pictures, and short videos. However, it was designed to target only two domains of the Theory of Planned Behavior 1) control beliefs and perceived behavioral control; and 2) actual behavioral control (e.g., knowledge, skills) in relation to brief counseling for the same three risk factors. These two constructs were chosen because increasing knowledge and skills is usually the target of training programs. Finally, the content was standardized, i.e., the learning paths were the same for all participants.

Data collection and outcomes

Data collection was conducted online using surveys and usage logs of the e-learning platforms. Participants first completed a 15-item sociodemographic questionnaire at baseline. We used the Brief Counseling Nursing Practices Questionnaire Abridged Version (BCNPQ–AV), developed by Lepage et al. (2013). The BCNPQ–AV has 7 subscales and 48 items, each with an 8-point (0-7) Likert-type response scale. The subscales, and reported Cronbach alphas [α] by Lepage et al. (2013), include the intentions to provide brief counseling (H1; [α] = 0.92), attitude toward brief counseling (H2; α = 0.81), subjective norms in relation to brief counseling (H3; α =

0.89), perceived behavioral control in relation to brief counseling (H4; α = 0.70), as well as behavioral beliefs (H5; α = 0.84), normative beliefs (H6; α = 0.84) and control beliefs (H7; α = 0.74) regarding brief counseling (Lepage et al., 2013). We used the Cognitive Load Index (CLI) to measure participants' cognitive load related to the e-learning programs at follow-up, after two training sessions (Leppink et al., 2013). The French version of the CLI (Fontaine, Cossette, Maheu-Cadotte, et al., 2020) of the CLI measures 3 types of cognitive load with 10 items, each with an 11-point (0-10) Likert-type response scale: intrinsic load (H8; α = 0.83), extrinsic load (H9; α = 0.70) and germane load (H10; α = 0.96). Mid-range intrinsic load scores, low extrinsic load scores, and high germane load scores are desired. Also at the follow-up only, we used the User Engagement Scale–Short Form (UES–SF) to measure participants' experiential engagement (H11) with the e-learning programs (O'Brien et al., 2018). The French version (Fontaine, Cossette, Maheu-Cadotte, et al., 2020) of the UES–SF measures four dimensions of experiential engagement (i.e., focused attention [α = 0.89], perceived usability [α = 0.89], esthetic appeal [α = 0.77], and reward [α = 0.83]) with 12 items, each with a 6-point (0-5) Likert-type response scale. Higher scores reflect more engagement with the e-learning program. Finally, we collected usage data (e.g., number of participants completing each training session) to measure behavioral engagement (H12) with the E_MOTIV$_A$ and E_MOTIV$_B$ programs.

Sample size

We planned to enroll at least 25 participants per group, for a total of 50 participants (75% power; 0.05 bilateral significance level). This calculation was based on the between-group comparison of the change in intentions to provide brief counseling. We estimated the standard deviation of change in intentions would be 6.5, and that a sample size of 50 would allow us to detect a difference of 5 in the change score between the two groups. Since the study was carried out in the context of university-level courses, we continued to enroll participants up to the end of the courses.

Statistical analysis

We presented continuous variables using the mean, standard deviation, median, minimum and maximum, and categorical variables using frequencies and percentages. All statistical tests performed were bilateral with a 0.05 significance level. We used the Statistical Package for the Social Sciences version 25 to produce modified intention-to-treat analyses (i.e., analysis of all randomized participant data completing the final study questionnaire, regardless of intervention entry or completion). Statistical analyses were validated by the MHICC. We analyzed the primary outcome, i.e., the change in the score of intentions to provide brief counseling (T4-−T1), using a

covariance model (ANCOVA) including the group variable and the intentions score at baseline (−T1). This model allowed comparison of the adjusted mean change in participants' intentions to provide brief counseling between groups. We verified that data met all necessary assumptions prior to conducting ANCOVAs, including homoscedasticity, homogeneity of variance, unusual points and normality. We analyzed the continuous secondary outcomes measured in terms of change between baseline and follow-up (H2 to H7) using the same covariance model as for the primary outcome. We analyzed the continuous secondary outcomes measured at follow-up (H9 to H11) using Student t tests. Finally, for the categorial secondary outcome (H12) related to participant's engagement with both e-learning programs (i.e., if a participant completed each training session or not), we conducted per protocol binomial logistic regressions.

Ethical approval and informed consent

This study has been approved by the University of Montreal Science and Health Research Ethics Board (#20-052-CERSES-D). All study participants provided an informed consent.

Results

Participant flow

Of the 204 nurses and nursing students contacted and assessed for eligibility, 102 consented to participate and completed the baseline sociodemographic and professional measures (**Error! Reference source not found.**). Two participants did not complete the baseline BCNPQ-AV. Of the 102 participants randomized to the experimental group (n=51) and control group (n=51), 24 never began the EMOTIV program (18 in the experimental group, 6 in the control group). At the follow-up, 28 days post-randomization, 27 experimental group and 38 control group participants had completed the end-of study questionnaires. Study enrollment began on April 27, 2020, and follow-up was completed on June 18, 2020.

[Figure 1]

Sample description

A majority of the sample in both groups were female, aged 24 years old or younger and were direct-entry students enrolled in the Bachelor of Science in Nursing (BSN) program (**Error! Reference source not found.**). Approximately 20% of participants were registered nurses (RNs) enrolled in a BSN program (RN-to-BS program). Very few participants had previous training in motivational interventions. The only statistically significant difference between groups at baseline

was that experimental group participants had completed fewer previous e-learning courses. There was no statistically significant difference between groups in the sample analyzed at follow-up.

[Table 1]

Observed psychometric properties of instruments

The observed psychometric qualities of the instruments are presented in ***Supplementary File 2***. The internal consistency of all subscales was adequate and similar to the original scales, except for the BCNPQ-AV perceived behavioral control subscale, the CLI extrinsic load subscale, and the UES-SF perceived usability subscale.

Description of e-learning program uptake

As presented in **Error! Reference source not found.**, session 1 was completed by 28 experimental group and 39 control group participants, session 2 by 22 experimental group and 37 control group participants and session 3 by 15 experimental group and 23 control group participants. Regarding the 13 theory-based content adaptation points within the E_MOTIV$_A$ program, collected data shows how many experimental group participants were directed to the video associated with each adaptation point. For content adaptation points #1 to #4 in session 1, which relate to behavioral beliefs and attitude towards brief counseling, the four videos were viewed respectively by 28 (100%), 6 (21%), 8 (29%) and 4 participants (14%). For content adaptation points #5 to #8 also in session 1, which relate to control beliefs and perceived behavioral control towards brief counseling, the four videos were viewed respectively by 23 (82%), 16 (57%), 12 (42%), and 14 participants (50%). For content adaptation points #9 to #12 in session 2, which relate to normative beliefs and subjective norms towards brief counseling, the four videos were viewed respectively by 0 (0%), 9 (41%), 4 (18%), and 8 participants (36%). Finally, no participant viewed to the adaptation point #13 video in session 2, related to the intention to provide brief counseling.

Scores of the BCNPQ-AV at baseline

At baseline, scores for intention to provide brief counseling were already high in both groups (***Table 2***). The three lowest scoring variables of the BCNPQ-AV across the study sample, in relation to the possible score range for each variable, were the attitude toward brief counseling (experimental group: 27.39 ± 3.34; control group: 28.44 ± 3.76; possible score range: 0–42), the perceived behavioral control toward brief counseling (experimental group: 32.27 ± 5.45; control group: 34.65 ± 5.61; possible score range 0–49) and the control beliefs with regard to brief counseling (experimental group: 25.08 ± 5.02; control group: 27.28 ± 4.78; possible score range

0–35). Thus, at baseline, these variables represented the main barriers to the behavior change of nurses and nursing students before the intervention.

Impact of the e-learning programs on outcomes

Primary outcome

In both groups, there was a statistically significant increase from baseline to follow-up on scores for intention to provide brief counseling (***Table 2***). Regarding our primary hypothesis (H1), intention-to-treat covariance analyses indicated that the adjusted score change from baseline to follow-up (T4 – –T1) in the total score of intentions was greater in the experimental group (10.22 ± 3.34) compared to the control group (9.0 ± 2.80). However, the difference between groups was not significant (p = 0.787). Thus, both groups had similar increases in scores for intentions from baseline to follow-up.

Secondary outcomes

In both groups, there were statistically significant increases from baseline to follow-up in scores for all other Theory of Planned Behavior variables (H2 to H7), except for the normative beliefs with regard to brief counseling (H6) in the experimental group. Covariance analyses indicated that both groups statistically improved similarly over time in scores for attitude (H2), subjective norms (H3), perceived behavioral control (H4), behavioral beliefs (H5) and control beliefs (H7), but the improvements were slightly higher in the experimental group (***Table 2***). Unexpectedly, there was a greater, but not statistically significant improvement in the control group compared to the experimental group for the change in normative beliefs (H6).

Regarding cognitive load scores, intrinsic load (H8), extrinsic load (H9) and germane load (H10) scores were higher at follow up in the experimental group compared to the control group, however these results were not statistically significant (***Table 3***). Regarding experiential engagement (H11), no statistically significant differences between groups were found at follow up on focused attention, perceived usability, esthetic appeal and reward scores. Finally, with regard to behavioral engagement (H12), more participants in the control group (n=44) than in the experimental group (n=32), began the e-learning program. However, there were no statistically significant differences between groups with regard to the odds of completing each session (***Table 4***).

[Table 3]

[Table 4]

Discussion

This RCT evaluated the effectiveness of the E_MOTIV$_A$ adaptive e-learning program based on the Theory of Planned Behavior, Cognitive Load Theory and engagement, versus the E_MOTIV$_B$ knowledge- and web-based standardized e-learning program, on nurses' and nursing students' intentions to provide brief counseling for smoking cessation, healthy diet and medication adherence. While participants in both groups improved significantly from baseline to follow up with regard to their intentions to provide brief counseling, indicating that both programs triggered improvements in Theory of Planned Behavior variables, there was no statistically significant difference between groups in the change in score for intentions. Therefore, findings did not support the primary hypothesis.

Both groups differed significantly from baseline to follow-up in scores for behavioral beliefs (H5) and behavioral attitude (H2), as well as control beliefs (H7) and perceived behavioral control (H4) with regard to brief counseling but no statistical differences in the change scores were observed. These results indicate that both e-learning programs influenced control beliefs and perceived behavioral control similarly, regardless of the additional content in the E_MOTIV$_A$ program targeting control beliefs, most likely by reinforcing knowledge and skills regarding brief counseling. Findings also suggest that both programs favorably influenced nurses' and nursing students' behavioral beliefs and attitudes regarding brief counseling, most likely by showcasing expert nurses interacting with patients. High change scores in both groups regarding behavioral beliefs and attitude could suggest that influencing nurses and nursing students regarding brief counseling is easier than anticipated through videos demonstrating how to provide brief counseling, and that additional theory-based content is less likely to result in a larger change in attitude scores, possibly due to a 'ceiling effect' (Ajzen, 2011; Fishbein et Ajzen, 2010). Interestingly, while both the experimental group and control group changed significantly from baseline with regard to subjective norms (H3), only the control group changed significantly from baseline regarding normative beliefs (H6). It is possible that the E_MOTIV$_A$ theory-based approach regarding normative beliefs, showcasing nurses and physicians talking about the importance of brief counseling and how to overcome barriers to it in clinical settings, had an adverse effect by drawing attention to these barriers for experimental group participants, resulting in their lower scores for control beliefs.

Our findings regarding Theory of Planned Behavior variables echo those of another recent study, which found no difference in the effect of a theory-based adaptive e-learning program versus knowledge-based e-learning program for intentions and other sociocognitive variables

related to brief counseling (Sinclair et al., 2019). It is possible that the lack of statistically significant difference between groups is attributable to too much similarity between the E_MOTIV$_A$ and E_MOTIV$_B$ e-learning programs. Indeed, the core content of both e-learning programs regarding brief counseling, including videos about behavioral risk factors, the 5As brief counseling approach, and nurse-patient interactions, was identical. This core content made up the majority of the content in both e-learning programs. The E_MOTIV$_A$ program included 3 navigation sequence adaptation points and 13 content adaptation points which, if answered favorably by participants, could allow 13 additional videos to be skipped. Thus, due to the nature of the adaptive e-learning program, exposure to experimental intervention content in the experimental group varied significantly. In a recent study where a theory-based adaptive e-learning program was evaluated, there was also moderate engagement with theory-based content in the experimental group (de Ruijter et al., 2018).

Characteristics of the study sample may have mitigated the effectiveness of the E_MOTIV$_A$ program. Indeed, the study was conducted in a university setting with only approximately 20% of participants being nurses already in practice. Nursing students have less clinical experience in the hospital environment, leading to a less consolidated professional identity and less solid conception of workplace considerations (e.g., subjective norms) that may impede the provision of brief counseling (Duprez et al., 2017, 2018). Thus, it is possible that the theory-based approach within E_MOTIV$_A$ regarding the different Theory of Planned Behavior variables was less effective than anticipated. In the study mentioned previously, an adaptive e-learning program based on similar variables as the Theory of Planned Behavior variables was effective in increasing the provision of brief counseling for smoking cessation only in a subset of nurses with above average experience (de Ruijter et al., 2018). This may suggest that beliefs susceptible to change by interacting with the intervention are more salient in experienced nurses. Replicating the study in a hospital-based setting, where the entire sample is composed of nurses in practice, may result in different findings.

Participants in both groups exhibited similar cognitive load and experiential engagement scores at follow-up. However, small, statistically non-significant differences were observed. First, extraneous cognitive load was higher in the experimental group than the control group. This difference may be attributable to the increase in interactivity related to the adaptive e-learning. Indeed, at 16 points during the E_MOTIV$_A$ program, participants were asked questions to elicit their beliefs about brief counseling and were allowed to choose their preferred learning path. Thus, these adaptation points may have somewhat increased the complexity of the learning

process, requiring participants to pause and answer questions instead of just clicking “next” as in the control intervention. However, the extraneous load score in the experimental group (1.65 ± 1.90) remains very low considering the score can range for 0 to 10 (Leppink et al., 2013; Leppink et al., 2014). Thus, it is unclear if the higher extraneous load score in the experimental group had a negative effect on study variables. Similarly, the perceived usability score was slightly lower in the experimental group. This may also be explained by the factors mentioned previously. Otherwise, the germane load scores in both groups, which represent the integration of key concepts by participants, were high and similar in both groups.

With regard to the behavioral engagement of participants, fewer participants in the experimental group (n=32) than in the control group (n=44) logged into the e-learning platform and began the first training session. This difference is difficult to explain since 1) there was an equal number of participants randomized in the experimental group and control group; 2) there were no imbalances between groups with regard to baseline characteristics; 3) participants were blinded to group allocation; 4) both e-learning programs had the same appearance and branding; and 5) study procedures prior to the beginning of training sessions were identical in both groups. Thus, we believe this difference in the initiation of training sessions is attributable to chance. There were no statistically significant differences with regard to the number of participants completing session 1, 2 and 3 in both groups.

Study limitations

This study has two main limitations. First, there was a significant number of participants who did not complete the interventions and outcome measures in both study groups. This may be explained by several factors. It is important to mention that the current study was conducted in the context of two university courses, but that the e-learning program was not mandatory or planned, nor integrated into the curriculum. The participation was voluntary and there were no incentives to participate. Furthermore, the study was conducted in April, May and June 2020 at the height of the first wave of the COVID-19 pandemic in Canada. Thus, during this timeframe, a significant proportion of nurses and nursing students were solicited to help in the health care system. We noticed that several participants were not able to continue to participate in the study due to the public health context. Second, the study coordinator was not blinded to group assignment, as he needed to assign participants to each e-learning program and create log-in credentials for each participant. Despite these limitations, strengths of the study include the fact that the interventions were asynchronous and automated (i.e., computer-based), all study measures were online, and all study procedures were standardized between groups, including

reminders. Thus, we believe the risk of bias regarding deviations from intended interventions is low.

Conclusion

Nurses and nursing students play a critical role in supporting patient health behavior change in acute care settings. However, there are few resources, professional development opportunities, and role models to strengthen their capacity in providing brief counseling for smoking cessation, healthy eating habits and medication adherence. This study demonstrated that a theory-based adaptive e-learning program (E_MOTIV$_A$) and a knowledge-based standardized e-learning program (E_MOTIV$_B$) had similar positive effects in increasing nurses' and nursing students' intentions to provide brief counseling. This suggests that engagement with intervention content generated an effect on behavioral predictors in both groups. Additional studies are warranted to evaluate the theory-based adaptive e-learning program in a sample of nurses in practice to investigate (1) if the effect on behavioral predictors differs based on study population; (2) the effect of the intervention on higher-level outcomes, such as clinical behavior and patient outcomes. Indeed, only intentions and the different sociocognitive determinants that influence nurses' and nursing students' intentions to provide brief counseling were measured in this study. Thus, to investigate whether the increase in intentions to provide brief counseling in both groups would translate in actual increases in provision of brief counseling, a study integrating measures of self-reported or actual clinical practice and patient outcomes would be relevant. Furthermore, evaluating the cost-effectiveness of interventions was not an objective of this study, but it would be important to evaluate if the additional resources involved in the development of an adaptive e-learning are cost-effective compared to a standardized, traditional e-learning program.

References

Ajzen, I. (1991). The Theory of Planned Behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179-211.

Ajzen, I. (2011). Behavioral interventions: Design and evaluation guided by the theory of planned behavior. Dans M. Mark, S. Donaldson et B. Campbell (dir.), *Social psychology for program and policy evaluation* (p. 74-100). Guilford.

Al Sayah, F., Williams, B., Pederson, J. L., Majumdar, S. R. et Johnson, J. A. (2014). Health literacy and nurses' communication with type 2 diabetes patients in primary care settings. *Nursing Research, 63*(6), 408-417. https://doi.org/10.1097/NNR.0000000000000055

Aveyard, P., Begh, R., Parsons, A. et West, R. (2012). Brief opportunistic smoking cessation interventions: a systematic review and meta-analysis to compare advice to quit and offer

of assistance. *Addiction, 107*(6), 1066-1073. https://doi.org/10.1111/j.1360-0443.2011.03770.x

Aveyard, P., Lewis, A., Tearne, S., Hood, K., Christian-Brown, A., Adab, P., Begh, R., Jolly, K., Daley, A., Farley, A. et Lycett, D. (2016). Screening and brief intervention for obesity in primary care: A parallel, two-arm, randomised trial. *The Lancet, 388*(10059), 2492-2500. https://doi.org/10.1016/S0140-6736(16)31893-1

Benjamin, E. J., Blaha, M. J., Chiuve, S. E., Cushman, M., Das, S. R., Deo, R., de Ferranti, S. D., Floyd, J., Fornage, M., Gillespie, C., Isasi, C. R., Jiménez, M. C., Jordan, L. C., Judd, S. E., Lackland, D., Lichtman, J. H., Lisabeth, L., Liu, S., Longenecker, C. T., Mackey, R. H., Matsushita, K., Mozaffarian, D., Mussolino, M. E., Nasir, K., Neumar, R. W., Palaniappan, L., Pandey, D. K., Thiagarajan, R. R., Reeves, M. J., Ritchey, M., Rodriguez, C. J., Roth, G. A., Rosamond, W. D., Sasson, C., Towfighi, A., Tsao, C. W., Turner, M. B., Virani, S. S., Voeks, J. H., Willey, J. Z., Wilkins, J. T., Wu, J. H. Y., Alger, H. M., Wong, S. S. et Muntner, P. (2017). Heart disease and stroke statistics—2017 update: a report from the American Heart Association. *Circulation, 135*, e146-e603. https://doi.org/10.1161/CIR.0000000000000485

Berndt, N. C., Bolman, C., de Vries, H., Segaar, D., van Boven, I. et Lechner, L. (2013). Smoking cessation treatment practices: Recommendations for improved adoption on cardiology wards. *Journal of Cardiovascular Nursing, 28*(1), 35-47. https://doi.org/10.1097/JCN.0b013e318231f424

Brusilovsky, P. et Peylo, C. (2003). Adaptive and Intelligent Web-based Educational Systems. *International Journal of Artificial Intelligence in Education, 13*, 159-172.

de Ruijter, D., Candel, M., Smit, E. S., de Vries, H. et Hoving, C. (2018). The Effectiveness of a Computer-Tailored E-Learning Program for Practice Nurses to Improve Their Adherence to Smoking Cessation Counseling Guidelines: Randomized Controlled Trial. *Journal of medical Internet research, 20*(5), e193. https://doi.org/10.2196/jmir.9276

Diabetes Canada Clinical Practice Guidelines Expert Committee. (2018). Diabetes Canada 2018 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada. *Canadian Journal of Diabetes, 42*, S1-S325.

Dragomir, A. I., Julien, C. A., Bacon, S. L., Boucher, V. G. et Lavoie, K. L. (2018). Training Physicians in Behavioural Change Counseling: A Systematic Review. *Patient Education and Counseling*. https://doi.org/10.1016/j.pec.2018.08.025

Duprez, V., Beeckman, D., Van Hecke, A. et Verhaeghe, S. (2020). Nurses' perceptions of success in self-management support: An exploratory qualitative study. *Research in Nursing & Health, 43*(3), 274-283. https://doi.org/10.1002/nur.22018

Duprez, V., Beeckman, D., Verhaeghe, S. et Van Hecke, A. (2017). Self-management support by final year nursing students: A correlational study of performance and person-related associated factors. *International Journal of Nursing Studies, 74*, 120-127. https://doi.org/10.1016/j.ijnurstu.2017.06.010

Duprez, V., Beeckman, D., Verhaeghe, S. et Van Hecke, A. (2018). Are person-related and socio-structural factors associated with nurses' self-management support behavior? A

correlational study. *Patient Education and Counseling, 101*(2), 276-284. https://doi.org/10.1016/j.pec.2017.08.011

Engstrom, M., Skytt, B., Ernesater, A., Flackman, B. et Mamhidir, A. G. (2013, Nov). District nurses' self-reported clinical activities, beliefs about and attitudes towards obesity management. *Appl Nurs Res, 26*(4), 198-203. https://doi.org/10.1016/j.apnr.2013.06.009

Fishbein, M. et Ajzen, I. (2010). *Predicting and Changing Behavior: The Reasoned Action Approach*. Psychology Press.

Fontaine, G. (2016). *Évaluation de la plateforme de formation en ligne MOTIV@ CŒUR sur les interventions motivationnelles brèves auprès d'infirmières en soins aigus cardiovasculaires* [Université de Montréal]. http://hdl.handle.net/1866/16290

Fontaine, G. (2020). *Développement et évaluation d'un programme de formation numérique adaptatif sur le counseling bref en changement de comportement lié à la santé* [Université de Montréal].

Fontaine, G. et Cossette, S. (2021). Development and Design of a Theory-Based Adaptive E-Learning Program to Support the Provision of Brief Behavior Change Counseling [Manuscript submitted].

Fontaine, G., Cossette, S., Gagnon, M.-P., Dubé, V. et Côté, J. (2020). Effectiveness of a Theory- and Web-Based Adaptive Implementation Intervention on Nurses' and Nursing Students' Intentions to Provide Brief Counseling: Protocol for a Randomized Controlled Trial. *JMIR Research Protocols, 9*(7), e18894. https://doi.org/http://doi.org/10.2196/18894

Fontaine, G., Cossette, S., Heppell, S., Boyer, L., Mailhot, T., Simard, M. J. et Tanguay, J. F. (2016, 18 Aug). Evaluation of a Web-Based E-Learning Platform for Brief Motivational Interviewing by Nurses in Cardiovascular Care: A Pilot Study. *Journal of medical Internet research, 18*(8), e224. https://doi.org/10.2196/jmir.6298

Fontaine, G., Cossette, S., Maheu-Cadotte, M.-A., Mailhot, T., Deschênes, M.-F. et Mathieu-Dupuis, G. (2017). Effectiveness of adaptive e-learning environments on knowledge, competence, and behavior in health professionals and students: Protocol for a systematic review and meta-analysis. *JMIR Research Protocols, 6*(7), e128. https://doi.org/http://doi.org/10.2196/resprot.8085

Fontaine, G., Cossette, S., Maheu-Cadotte, M.-A., Mailhot, T., Deschênes, M.-F., Mathieu-Dupuis, G., Côté, J., Gagnon, M.-P. et Dubé, V. (2019). Efficacy of adaptive e-learning for health professionals and students: A systematic review and meta-analysis. *BMJ Open, 9*, e025252. https://doi.org/10.1136/bmjopen-2018-025252

Fontaine, G., Cossette, S., Maheu-Cadotte, M.-A., Mailhot, T., Heppell, S., Roussy, C., Côté, J., Gagnon, M.-P. et Dubé, V. (2019). Behavior change counseling training programs for nurses and nursing students: A systematic descriptive review. *Nurse Education Today, 82*, 37-50. https://doi.org/http://doi.org/10.1016/j.nedt.2019.08.007

Fontaine, G., Cossette, S., Maheu-Cadotte, M.-A., Mailhot, T., Lavoie, P., Gagnon, M.-P., Dubé, V. et Côté, J. (2020). Traduction, adaptation et évaluation psychométrique préliminaire d'une mesure d'engagement et d'une mesure de charge cognitive en contexte

d'apprentissage numérique. *Pédagogie Médicale, 20*(2), 79-90. https://doi.org/http://doi.org/10.1051/pmed/2020009

Fontaine, G., Cossette, S., Heppell, S., Roussy, C., Maheu-Cadotte, M. A., & Mailhot, T. (2018). Training nurses in health behaviour change counseling: A narrative review of current approaches. *Canadian Journal of Cardiology, 34*(10), S200. https://doi.org/https://doi.org/10.1016/j.cjca.2018.07.426

Fontaine, G., Cossette, S., Maheu-Cadotte, M. A., Heppell, S., Roussy, C., Mailhot, T., Côté, J., Gagnon, M.-P. & Dube, V. (2019). Theoretical foundations, structure, content, and modes of delivery of behavior change counseling training programs for nurses. Dans *Annals of Behavioral Medicine* (vol. 53, p. S311-S311). Oxford Univ Press Inc. https://doi.org/http://doi.org/10.1093/abm/kaz007

Gotwals, B. (2017, Feb). Self-Efficacy and Nutrition Education: A Study of the Effect of an Intervention with Faith Community Nurses. *J Relig Health, 57*(1), 333-348. https://doi.org/10.1007/s10943-017-0465-2

Ho, P. M., Bryson, C. L. et Rumsfeld, J. S. (2009, Jun 16). Medication adherence: its importance in cardiovascular outcomes [Research Support, U.S. Gov't, Non-P.H.S.

Review]. *Circulation, 119*(23), 3028-3035. https://doi.org/10.1161/CIRCULATIONAHA.108.768986

Huntink, E., Wensing, M., Klomp, M. A. et van Lieshout, J. (2015). Perceived determinants of cardiovascular risk management in primary care: disconnections between patient behaviours, practice organisation and healthcare system. *BMC Fam Pract, 16*, 179. https://doi.org/10.1186/s12875-015-0390-y

Hurst, K. (2010). How much time do nurses spend at the bedside? *Nursing Standard, 24*(52), 14-14. https://doi.org/10.7748/ns.24.52.14.s20

Josephsen, J. (2015). Cognitive Load Theory and Nursing Simulation: An Integrative Review. *Clinical Simulation in Nursing, 11*(5), 259-267. https://doi.org/10.1016/j.ecns.2015.02.004

Keyworth, C., Epton, T., Goldthorpe, J., Calam, R. et Armitage, C. J. (2020). Delivering Opportunistic Behavior Change Interventions: a Systematic Review of Systematic Reviews. *Prevention Science, 21*(3), 319-331. https://doi.org/10.1007/s11121-020-01087-6

Knutov, E., De Bra, P. et Pechenizkiy, M. (2009). AH 12 years later: A comprehensive survey of adaptive hypermedia methods and techniques. *New Review of Hypermedia and Multimedia, 15*(1), 5-38. https://doi.org/10.1080/13614560902801608

Lawn, S. et Schoo, A. (2010). Supporting self-management of chronic health conditions: Common approaches. *Patient Education and Counseling, 80*(2), 205-211. https://doi.org/10.1016/j.pec.2009.10.006

Lemstra, M., Nwankwo, C., Bird, Y. et Moraros, J. (2018). Primary nonadherence to chronic disease medications: a meta-analysis. *Patient Preference and Adherence, 12*, 721-731. https://doi.org/10.2147/PPA.S161151

668 Lepage, M., Champagne, F. et Renaud, L. (2013). Un outil pour évaluer les pratiques cliniques
669 des infirmières auprès des patients fumeurs en cessation tabagique à l'hôpital. *Recherche*
670 *en Soins Infirmiers,* (112), 35-45. https://doi.org/10.3917/rsi.112.0036

671 Leppink, J., Paas, F., Van der Vleuten, C. P., Van Gog, T. et Van Merriënboer, J. J. (2013).
672 Development of an instrument for measuring different types of cognitive load. *Behavior*
673 *Research Methods, 45*(4), 1058-1072. https://doi.org/10.3758/s13428-013-0334-1

674 Leppink, J., Paas, F., Van Gog, T., van Der Vleuten, C. P. et Van Merrienboer, J. J. (2014). Effects
675 of pairs of problems and examples on task performance and different types of cognitive
676 load. *Learning and Instruction, 30*, 32-42.
677 https://doi.org/10.1016/j.learninstruc.2013.12.001

678 Malan, Z., Mash, B. et Everett-Murphy, K. (2016, Jan). Evaluation of a training programme for
679 primary care providers to offer brief behaviour change counselling on risk factors for non-
680 communicable diseases in South Africa. *Patient Educ Couns, 99*(1), 125-131.
681 https://doi.org/10.1016/j.pec.2015.08.008

682 Murphy, K. M., Mash, R. et Malan, Z. (2016). The case for behavioural change counselling for the
683 prevention of NCDs and improvement of self- management of chronic conditions. *South*
684 *African Family Practice, 58*(6), 249-252. https://doi.org/10.1080/20786190.2016.1187885

685 Newman, A., Bryant, G., Fleming, B. et Sarkisian, L. (2016). *Learning to adapt 2.0: The evolution*
686 *of adaptive learning in higher education*.

687 Nilsen, P. et Birken, S. A. (2020). *Handbook on Implementation Science*. Edward Elgar
688 Publishing.

689 O'Brien, H. L. (2016). Theoretical perspectives on user engagement. Dans *Why Engagement*
690 *Matters: Cross-Disciplinary Perspectives and Innovations on User Engagement with*
691 *Digital Media* (p. 1-26). Springer.

692 O'Brien, H. L., Cairns, P. et Hall, M. (2018). A practical approach to measuring user engagement
693 with the refined user engagement scale (UES) and new UES short form. *International*
694 *Journal of Human-Computer Studies, 112*, 28-39.
695 https://doi.org/10.1016/j.ijhcs.2018.01.004

696 Patnode, C. D., Evans, C. V., Senger, C. A., Redmond, N. et Lin, J. S. (2017). Behavioral
697 Counseling to Promote a Healthful Diet and Physical Activity for Cardiovascular Disease
698 Prevention in Adults Without Known Cardiovascular Disease Risk Factors: Updated
699 Systematic Review for the U.S. Preventive Services Task Force. *JAMA, 318*(2), 175-193.
700 https://doi.org/10.1001/jama.2017.3303

701 Rabi, D. M., McBrien, K. A., Sapir-Pichhadze, R., Nakhla, M., Ahmed, S. B., Dumanski, S. M., ...
702 et Zarnke, K. B. (2020). Hypertension Canada's 2020 comprehensive guidelines for the
703 prevention, diagnosis, risk assessment, and treatment of hypertension in adults and
704 children. *Canadian Journal of Cardiology, 36*(5), 596-624.
705 https://doi.org/10.1016/j.cjca.2020.02.086

706 Rice, V. H., Heath, L., Livingstone-Banks, J. et Hartmann-Boyce, J. (2017). Nursing interventions
707 for smoking cessation. *Cochrane Database of Systematic Reviews,* (12), Art. No.:
708 CD001188. https://doi.org/10.1002/14651858.CD001188.pub5

709 Rueda-Clausen, C. F., Benterud, E., Bond, T., Olszowka, R., Vallis, M. T. et Sharma, A. M. (2014).
710 Effect of implementing the 5 A s of O besity M anagement framework on provider–patient
711 interactions in primary care. *Clinical Obesity, 4*(1), 39-44.
712 https://doi.org/10.1111/cob.12038

713 Samulski, T. D., Taylor, L. A., La, T., Mehr, C. R., McGrath, C. M. et Wu, R. I. (2017). The utility
714 of adaptive eLearning in cervical cytopathology education. *Cancer Cytopathology*, 1-7.
715 https://doi.org/10.1002/cncy.21942

716 Schulz, K. F., Altman, D. G., Moher, D. et Group, C. (2010). CONSORT 2010 statement: Updated
717 guidelines for reporting parallel group randomised trials. *Trials, 11*(1), 32.
718 https://doi.org/https://doi.org/10.1186/1745-6215-11-32

719 Sherson, E. A., Yakes Jimenez, E. et Katalanos, N. (2014). A review of the use of the 5 A's model
720 for weight loss counselling: Differences between physician practice and patient demand.
721 *Family Practice, 31*(4), 389-398. https://doi.org/10.1093/fampra/cmu020

722 Sinclair, P. M., Kable, A., Levett-Jones, T., Holder, C. et Oldmeadow, C. J. (2019). The CKD-
723 DETECT study: An RCT aimed at improving intention to initiate a kidney health check in
724 Australian practice nurses. *Journal of Clinical Nursing, 28*(15-16), 2745-2759.
725 https://doi.org/10.1111/jocn.14882

726 Smit, E. S., de Vries, H. et Hoving, C. (2013). Determinants of practice nurses' intention to
727 implement a new smoking cessation intervention: The importance of attitude and
728 innovation characteristics. *Journal of Advanced Nursing, 69*(12), 2665-2674.
729 https://doi.org/10.1111/jan.12153

730 St Quinton, T., Morris, B. et Trafimow, D. (2021). Untangling the Theory of Planned Behavior's
731 auxiliary assumptions and theoretical assumptions: Implications for predictive and
732 intervention studies. *New Ideas in Psychology, 60*, 100818.
733 https://doi.org/10.1016/j.newideapsych.2020.100818

734 Steinmetz, H., Knappstein, M., Ajzen, I., Schmidt, P. et Kabst, R. (2016). How effective are
735 behavior change interventions based on the Theory of Planned Behavior? *Zeitschrift für*
736 *Psychologie, 224*(3), 216–233. https://doi.org/10.1027/2151-2604/a000255

737 Sturgiss, E., Haesler, E., Elmitt, N., Van Weel, C. et Douglas, K. (2017). Increasing general
738 practitioners' confidence and self-efficacy in managing obesity: A mixed methods study.
739 *BMJ Open, 7*(1), e014314. https://doi.org/10.1136/bmjopen-2016-014314

740 United Nations. (2016). *Transforming our world: the 2030 agenda for sustainable development*.
741 https://sdgs.un.org/sites/default/files/publications/21252030%20Agenda%20for%20Sust
742 ainable%20Development%20web.pdf

743 Vallis, M., Lee-Baggley, D., Sampalli, T., Ryer, A., Ryan-Carson, S., Kumanan, K. et Edwards, L.
744 (2018). Equipping providers with principles, knowledge and skills to successfully integrate

behaviour change counselling into practice: A primary healthcare framework. *Public Health, 154*, 70-78. https://doi.org/10.1016/j.puhe.2017.10.022

Van Es, S. L., Kumar, R. K., Pryor, W. M., Salisbury, E. L. et Velan, G. M. (2016, Jan 08). Cytopathology whole slide images and adaptive tutorials for senior medical students: a randomized crossover trial. *Diagn Pathol, 11*, 1. https://doi.org/10.1186/s13000-016-0452-z

van Hooft, S. M., Dwarswaard, J., Bal, R., Strating, M. M. et van Staa, A. (2016). What factors influence nurses' behavior in supporting patient self-management? An explorative questionnaire study. *International Journal of Nursing Studies, 63*, 65-72. https://doi.org/10.1016/j.ijnurstu.2016.08.017

Welzel, F. D., Stein, J., Pabst, A., Luppa, M., Kersting, A., Blüher, M., Luck-Sikorski, C., König, H. H. et Riedel-Heller, S. G. (2018). Five A's counseling in weight management of obese patients in primary care: A cluster-randomized controlled trial (INTERACT). *BMC Fam Pract, 19*(1), 97. https://doi.org/10.1186/s12875-018-0785-7

Wensing, M., Fluit, C., Grimshaw, J. et Grol, R. (2020). Educational Implementation Strategies. Dans M. Wensing, R. Grol et J. Grimshaw (dir.), *Improving Patient Care: The Implementation of Change in Health Care* (3e éd., p. 221-233).

Westbrook, J. I., Duffield, C., Li, L. et Creswick, N. J. (2011). How much time do nurses have for patients? A longitudinal study quantifying hospital nurses' patterns of task time distribution and interactions with health professionals. *BMC Health Services Research, 11*(1), 319. https://doi.org/10.1186/1472-6963-11-319

Wharton, S., Lau, D. C., Vallis, M., Sharma, A. M., Biertho, L., Campbell-Scherer, D., Adamo, K., Alberga, A., Bell, R., Boulé, N. et Boyling, E. (2020). Obesity in adults: A clinical practice guideline. *CMAJ, 192*(31), e875-e891. https://doi.org/10.1503/cmaj.191707

Whelton PK, Carey RM, Aronow WS, Casey DE Jr, Collins KJ, D., ennison Himmelfarb C, DePalma SM, Gidding S, Jamerson KA, Jones DW, MacLaughlin EJ, Muntner P, Ovbiagele B, Smith SC Jr, Spencer CC, Stafford RS, Taler SJ, Thomas RJ, Williams KA Sr, Williamson JD et Jr., W. J. (2017). 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *Hypertension, 70*(6). https://doi.org/10.1161/HYP.0000000000000065

Wong, M. S. et Krasne, S. (2017). Use of a Perceptual Adaptive Learning Module Results in Improved Accuracy and Fluency of Fetal Heart Rate Categorization by Medical Students. *American Journal of Obstetrics & Gynecology, 216*(1), S491-S492. https://doi.org/10.1016/j.ajog.2016.11.768

World Health Organization. (2020). *Noncommunicable diseases: Progress monitor 2020*.

783 Young, J. Q., van Merrienboer, J., Durning, S. et ten Cate, O. (2014). Cognitive Load Theory:
784 Implications for medical education. *Medical Teacher, 36*(5), 371-384.
785 https://doi.org/10.3109/0142159X.2014.889290

786 Yusuf, S., Joseph, P., Rangarajan, S., Islam, S., Mente, A., Hystad, P., Brauer, M., Kutty, V. R.,
787 Gupta, R., Wielgosz, A. et Al Habib, K. F. (2020). Modifiable risk factors, cardiovascular
788 disease, and mortality in 155 722 individuals from 21 high-income, middle-income, and
789 low-income countries (PURE): A prospective cohort study. *The Lancet, 395*(10226), 795-
790 808. https://doi.org/10.1016/S0140-6736(19)32008-2

791

Table 1. – Sociodemographic and professional characteristics of participants at baseline.

Characteristics	All randomized participants (*N*=102)	Control group (CG)		Experimental group (EG)		P value between CG and EG at randomization	P value between CG and EG at analysis
		Randomized (N=51)	*Analyzed (N=38)*	*Randomized (N=51)*	*Analyzed (N=27)*		
	Mean ± SD / *n* (%)	Mean ± SD / *n* (%)	Mean ± SD / *n* (%)	Mean ± SD / *n* (%)	Mean ± SD / *n* (%)		
Sex						0.538 [a]	0.940 [a]
Female	87 (86) [b]	45 (88)	34 (90)	42 (84) [c]	24 (89)		
Male	14 (14) [b]	6 (12)	4 (10)	8 (16) [c]	3 (11)		
Age						0.181 [a]	0.722 [a]
≤24 years old	60 (59) [b]	27 (53)	18 (47)	33 (66) [c]	14 (52)		
≥25 years old	41 (41) [b]	24 (47)	20 (53)	17 (34) [c]	13 (48)		
Language(s) usually spoken						0.563 [a]	0.849 [a]
French	89 (88) [b]	44 (86)	33 (87)	45 (90) [c]	23 (85)		
Other	12 (12) [b]	7 (14)	5 (13)	5 (10) [c]	4 (15)		
Background						0.767 [a]	0.468 [a]
Non-nurses enrolled in Bachelor of Science in Nursing program	80 (79) [b]	41 (80)	31 (82)	39 (78) [c]	20 (74)		
Nurses enrolled in Bachelor of Science in Nursing program	21 (21) [b]	10 (20)	7 (18)	11 (22) [c]	7 (26)		

Experience in e-learning: Number of e-learning courses completed	3.30 ± 6.07 [d]	3.72 ± 4.39 [e]	3.71 ± 4.81 [f]	2.89 ± 7.38 [g]	3.88 ± 9.88 [h]	0.015 [i]	0.175 [i]
Any previous training in motivational interventions	3 (3) [b]	2 (4)	2 (5)	1 (2) [c]	1 (4)	0.570 [a]	0.768 [a]

a. Pearson Chi-square test; b. n=101; c. n=50; d. n=93; e. n=46; f. n=34; g. n=47; h. n=25; i. Mann-Whitney test.

Table 2. – Analysis of covariance for change in scores of Theory of Planned Behavior variables in relation to brief behavior change counseling.

			Control group	Experimental group	P value (difference between groups)
H1 — Total score of intentions	**Baseline**	Mean ± SD*	82.42 ± 18.68 [a]	82.55 ± 15.97 [b]	
	Follow-up	Mean ± SD	90.84 ± 19.44 [c]	92.33 ± 14.03 [d]	
	Nominal change	Adjusted mean ± SE*	9.04 ± 2.80 [e]	10.22 ± 3.34 [f]	0.79
		P value, FU versus baseline*	0.002	0.003	
H2 — Attitude toward brief counseling	**Baseline**	Mean ± SD	28.44 ± 3.76 [a]	27.39 ± 3.34 [b]	
	Follow-up	Mean ± SD	30.47 ± 3.55 [c]	30.33 ± 3.66 [d]	
	Nominal change	Adjusted mean ± SE	2.29 ± 0.49 [e]	2.43 ± 0.58 [f]	0.86
		P value, FU versus baseline	<0.0001	<0.0001	
H3 — Subjective norms toward brief counseling	**Baseline**	Mean ± SD	22.52 ± 3.59 [a]	20.71 ± 3.52 [b]	
	Follow-up	Mean ± SD	23.61 ± 3.43 [c]	22.82 ± 3.55 [d]	
	Nominal change	Adjusted mean ± SE	1.73 ± 0.44 [e]	1.84 ± 0.52 [f]	0.87
		P value, FU versus baseline	0.0002	0.0008	
H4 — Perceived behavioral control toward brief counseling	**Baseline**	Mean ± SD	34.65 ± 5.61 [b]	32.27 ± 5.45 [b]	
	Follow-up	Mean ± SD	37.82 ± 4.71 [c]	37.15 ± 4.49 [d]	
	Nominal change	Adjusted mean ± SE	4.00 ± 0.66 [g]	4.73 ± 0.78 [f]	0.48
		P value, FU versus baseline	<0.0001	<0.0001	
H5 — Behavioral beliefs with regard to brief counseling	**Baseline**	Mean ± SD	29.34 ± 5.30 [a]	28.82 ± 5.19 [b]	
	Follow-up	Mean ± SD	30.37 ± 4.68 [c]	31.00 ± 3.42 [d]	
	Nominal change	Adjusted mean ± SE	1.57 ± 0.69 [e]	2.12 ± 0.82 [f]	0.61
		P value, FU versus baseline	0.0263	0.0123	
	Baseline	Mean ± SD	35.14 ± 7.00 [a]	34.12 ± 5.03 [b]	

H6 — Normative beliefs with regard to brief counseling	**Follow-up**	Mean ± SD	38.21 ± 3.60 [c]	36.19 ± 6.15 [d]	
	Nominal change	Adjusted mean ± SE	2.87 ± 0.71 [e]	0.84 ± 0.85 [f]	0.07
		P value, FU versus baseline	0.0002	0.3247	
H7 — Control beliefs with regard to brief counseling	**Baseline**	Mean ± SD	27.28 ± 4.78 [a]	25.08 ± 5.02 [b]	
	Follow-up	Mean ± SD	28.92 ± 4.43 [c]	28.30 ± 5.24 [d]	
	Nominal change	Adjusted mean ± SE	2.19 ± 0.75 [e]	2.27 ± 0.90 [f]	0.95
		P value, FU versus baseline	0.0052	0.0146	

*Adjusted mean = adjusted for scores of intentions at baseline. SD = standard deviation. SE = standard error. FU = follow-up.

a. N=50; b. N=49; c. N=38; d. N=27; e. N=37; f. N=26; g. N=36.

Table 3. – Scores at Follow-Up for the Cognitive Load Index and the User Engagement Scale – Short Form at Follow-Up (T4).

Subscales	**Control group (*n*=36)** Mean ± SD	**Experimental group (*n*=24)** Mean ± SD	**T test**	**P value**
Cognitive Load Index				
Intrinsic Load [a]	2.35 ± 2.05	2.38 ± 1.80	0.05	0.96
Extraneous Load [a]	0.98 ± 1.17	1.65 ± 1.90	1.70	0.10
Germane Load [a]	8.40 ± 1.25	8.52 ± 1.33	0.35	0.73
User Engagement Scale - Short Form				
Focused Attention [b]	3.39 ± 0.67	3.38 ± 0.60	–0.08	0.40
Perceived Usability [b]	4.72 ± 0.37	4.51 ± 0.61	–1.66	0.10
Esthetic Appeal [b]	4.35 ± 0.49	4.40 ± 0.45	0.41	0.69
Reward [b]	4.42 ± 0.54	4.32 ± 0.54	–0.68	0.50

a. Scores presented as means ± SD. Range from 0 (not at all the case) to 10 (completely the case).
b. Scores presented as means ± SD. Range from 1 (strongly disagree) to 5 (strongly agree).

Table 4. – Binomial logistic regression results regarding the odds of completing training sessions 1, 2 and 3 depending on group (experimental group = 1; control group = 0).

Variable	Control group N (%)	Experimental group N (%)	B	Standard error	Wald	df	P value	Odds ratio	95 % Confidence interval for odds ratio
Completed session 1 [a]	39 (89)	28 (88)	–0.11	0.72	0.02	1	0.88	0.90	0.22 – 3.65
Completed session 2 [a]	37 (84)	22 (69)	–0.88	0.56	2.44	1	0.12	0.42	0.14 – 1.25
Completed session 3 [a]	23 (52)	15 (47)	–0.34	0.47	0.54	1	0.46	0.71	0.28 – 1.77

a. The data presented for each training session are relative to the number of participants who logged in the E_MOTIV program in each group: 44 in control group, 32 in experimental group.