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Evaluation of a Behavioral Self-care Intervention Administered through a Massive Open Online Course

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ABSTRACT

Background: Previous research reported the effectiveness of a curriculum-based self-care intervention for students administered in the context of a course on behavior change.

Purpose: The study evaluated the effectiveness of the self-care intervention for learners in a publicly available massive open online course (MOOC), who completed the course during the COVID-19 pandemic.

Methods: Participants were 216 learners enrolled in Coursera's Health Behavior Change – From Evidence to Action in March 2020 – January 2021. The intervention consisted of behavior change assignments designed to increase health-promoting behaviors within three domains (nutrition, physical activity, and mental health). Course assignments were to apply behavioral principles to modify health behaviors. Outcomes included measures of physical wellbeing, depression, anxiety, perceived stress, and self-efficacy.

Results: Health promotion behaviors and measures of physical and mental health showed significant improvements over the course of the semester.

Discussion: The study provides support for the effectiveness of a brief self-care intervention for learners in a publicly available MOOC.

Translation to Health Education Practice: This publicly available intervention can support learner well-being in a variety of academic programs, community, or workplace settings.

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Background

In recent years, an epidemic of mental health problems has been identified among university and professional school students.[1–4] Research in this area has identified multiple potential lifestyle or behavioral risk factors that could underly increased rates in mental illnesses, such as insufficient sleep, poor nutrition, financial strain, reductions in physical activity, and substance misuse.[5–7]

The increase in mental health needs among students reflects increasing needs in the population at large. In the United States of America, nearly one in five (51.5 million) adults live with a mental illness.[8] Nearly half (49.5%) of all adolescents aged 13–18 years suffer or have suffered from mental illness.[9] From 2000–2019, depressive disorders and self-harm ranked in the top ten causes of disability-adjusted life years.[10] Further, in 2019, 10% of the global disease burden was attributable to mental disorders.[8]

The COVID-19 pandemic has been associated with mental health challenges related to the disease and to mitigation activities, including social distancing and stay-at-home orders, increasing the global burden of mental disorders. Symptoms of anxiety and depressive disorders increased in the United States of America from April-June 2020 at a significantly higher rate than the same period in 2019.[11] Per this CDC survey, 40.9% of 5,412 adults reported at least one adverse mental health condition in 2020. This trend has been documented globally as well; a study of 1210 adults in China reported that 54.7% of respondents rated the psychological impact of COVID-19 as moderate or severe.[11] Further, the pandemic has disrupted the delivery of mental health care worldwide. The WHO reports that the pandemic has disrupted or halted mental health services in 93% of countries,[12] underscoring the need for new strategies and preventative interventions to improve mental health outcomes.

Engaging in self-care behaviors has been encouraged by the CDC and other major health agencies as a means of improving mental health outcomes, particularly for healthcare workers.[13,14] Common self-care behaviors include physical activity, consumption of fresh fruits and vegetables, and purposeful activity aimed to care for mental health (i.e., stress reduction techniques).

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Purpose

Our previous research reported the effectiveness of a curriculum-based health improvement intervention in increasing students' health behaviors and improving mental health outcomes among graduate students in the health sciences.[15–17] The current study seeks to expand on past findings by examining the effectiveness of a behavioral self-care intervention delivered in the context of a massive open online course (MOOC) during the COVID-19 pandemic. Learners enrolled in the fully remote course from March 2020 to January 2021. Participants completed a self-report questionnaire about personal health behaviors and mental health pre- and post-intervention. The primary hypothesis was the participation in health-promotion activities would result in improvements in physical and mental health.

Methods

Participants

Participants were 216 learners enrolled in the Coursera class *Health Behavior Change: From Evidence to Action*,[18] who completed voluntary pre- and post-course surveys. The mean age was 39.0 years old (sd 14.3; range 16–75 years). The gender distribution of participants was: 78.1% female, 15.7% male, and 6.1% "prefer not to say" or missing. In terms of educational attainment, 11.1% (n = 24) had completed high school or less, 13.4% (n = 29) had completed some college, 27.3% (n = 59) had a college degree, 43.1% (n = 93) had a graduate degree, and 5.1% (n = 11) did not report/missing. Learners were geographically diverse and hailed from 45 different countries; 50.5% (n = 109) were from North America (37.0% or 80 participants resided in the United States); 14.8% (n = 32) from Europe; 14.4% (n = 31) from Asia; 10.2% (n = 22) from South America; 3.2% (n = 7) from Australia/Oceana; 2.8% (n = 6) from Africa; 4.2% (n = 9) missing. The sample was 48.1% (n = 104) Caucasian, 15.3% (n = 33) Asian, 6.0% (n = 13) Black or African American, 2.8% (n = 6) Middle Eastern or North African, 1.4% (n = 3) Native American or Alaska Native, 4.6% (n = 10) another race or mixed race; 19.4% (n = 42) of the sample reported Hispanic ethnicity. No information regarding primary/native language was collected.

Procedure

The study was granted an exemption from IRB review under federal regulation 45 CFR 46.101(b)(1) by the Human Subjects Review Board. Participation in the study was strictly voluntary; learners received no compensation or course credit in exchange for their participation. After providing informed consent, students completed an anonymous survey during the first week of the course, and again during the last week (approximately 8 weeks later, although the open nature of the course was such that learners progressed at their own pace). The mean time between the baseline and post assessments was 42.6 days. Only those participants whose pre- and post-surveys were completed at least 5 days apart were included in analysis. All learners accessed the course content through the Coursera platform; some students were enrolled to earn a certificate of completion and paid a 49 USD tuition fee; others enrolled at no cost but did not earn a certificate upon completion of the course. The number of participants in each category is not available. To progress through the course, students watched video lectures and completed assignments weekly through the 8-module course. For enrolled learners, it was only possible to complete assignments and progress to the subsequent material when the previous module had been completed. Thus the course content was accessed in an established sequence. Only those students who had completed all modules had access to the post-survey, and only those students who affirmed course completion were included in analysis (i.e., learners responded affirmatively to the question "*Have you completed Weeks 1–7 of the Coursera course: Health Behavior Change*?"). In this manner, all participants had reported accessing the full course content.

Timing of intervention

The course was launched on Coursera on March 22, 2020, shortly after many global regions had gone on lock-down or stay-at-home orders in the midst of the COVID-19 crisis. The data reported here are from learners who enrolled in the course from late March 2020 to January 2021 – i.e., during the first 10 months of the course offering.

Measures

Students completed a questionnaire battery online. No personally identifying information was collected. Questionnaire items included validated measures of mental health and key items drawn from national longitudinal health surveys (e.g.,[19–21]) The survey took approximately fifteen minutes to complete.

Nutrition

Nutritional variables were derived from large-scale epidemiologic surveys (e.g. NHANES[21]) and focused on the frequency of consuming specific types of foods over the previous week.

Physical activity

Physical activity was evaluated with the Godin Leisure Time Exercise Questionnaire (GLTEQ)[22] and with a single item to evaluate immediate retrospective activity level (number of exercise bouts in the prior 7 days). The GLTEQ measures the frequency of mild, moderate, and strenuous physical activity occurring for at least 15 minutes. A summary score is calculated by weighting each type of activity to generate a metabolic equivalent using the equation: (3 * mild bouts) + (5 * moderate bouts) + (9 * strenuous bouts). The GLTEQ is a widely-used measure of physical activity and corresponds with objective measures of physical fitness,[22] indicating it is a valid measure of physical activity.

Mental health

Mental health was assessed with the Depression Anxiety Stress Scales 21-Item version[23,24]. The DASS21 comprises three subscale scores (depression, anxiety, and stress) and is sensitive to clinical change.[24] Scores on the DASS subscales range from 0 to 42, with higher scores indicating greater distress. The DASS has demonstrated adequate reliability and validity in previous research.[24] In the current sample, the reliability (coefficient alphas) of the DASS subscales indicated strong interitem reliability for all subscales: $\alpha = .91$ for the depression subscale, $\alpha = .83$ for the anxiety subscale, and $\alpha = .87$ for the stress subscale.

Perceived stress

The Perceived Stress Scale – 10 item version[25,26] is a reliable and valid measure of psychological stress. Its psychometric properties have been established for use with large-scale community samples.[27] Scores range from 0 to 40, with higher scores indicating greater perceived stress. In the current sample, coefficient alpha was $\alpha = .87$.

Self-efficacy

Self-efficacy, or one's perceived ability to overcome adversity or challenging situations, was measured with the 10-item General Self-Efficacy Scale.[28] Scores on this measure can range from 10 to 40, with higher scores indicating a greater degree of self-efficacy. The Self-Efficacy Scale has demonstrated good psychometric properties in previous research. In the current sample, the measure demonstrated high interitem reliability, with $\alpha = .92$.

Health perception was evaluated using three items from the National Health and Nutrition Examination Survey.[21] Key items were: "Would you say that in general your health is – ? (poor to excellent)"; "Compared to a year ago, how has your health changed? (Much worse to Much better)"; and "Compared to others your same age and sex, how would you rate your overall health? (Much worse than average to Much better than average)."

Post-treatment behavioral adherence measure

In the post-course survey, key questions evaluated adherence to the individually-chosen behavioral goals: "Considering each of the behavior change goals, on approximately what percentage of days did you achieve your goal? (Consider the entire class period when estimating): Nutrition, Physical Activity, and Mental Health"

Anonymous data collection

All data were collected anonymously via an online self-report questionnaire. The questionnaire link was posted as an optional course reading, and embedded in the assignments distributed to all learners. To allow for matching of data at baseline and post, each student completed identifying yet impersonal questions – i.e., provided mother's birthdate, favorite movie). No information was gathered that could allow for identification of any participant.

Course description and content

The educational setting was a large massive open online course (MOOC) offered through Coursera. The course was delivered fully online; students were required to log on to the course website to access the content, and to watch prerecorded video lectures. The video lectures were delivered in 4 to 8 minute segments and were followed by online discussion prompts. Course content and assignments have been described in detail elsewhere[15–17] and are available online through Coursera[18] with free registration. An outline of the lecture content and corresponding weekly assignments appears in Table 1. In brief, the course taught the fundamentals of behavioral theory as it applies to health promotion and clinical and public health interventions. The course involved three distinct modules, focusing on nutrition, physical activity, and mental health. Within each module, learners established individual health behavior change goals and completed assignments to attain these goals on a daily basis. Example daily goals were: consume two liters of water, consume two servings of fresh fruit, consume breakfast (nutrition); walk 10,000 steps per day, do 10 minutes of yoga (physical activity); gratitude journaling, meditation (mental health). Critically, learners chose their own goals within each module and were encouraged to employ behavioral strategies, including self-monitoring, and to post on the course discussion boards to encourage social support. Weekly lecture content was evaluated via quizzing; enrolled students could progress to the next module once they had demonstrated competency by passing the module quiz.

Table 1. Health behavior change: from evidence to action course outline.

Week	Module	Lecture topic(s)	Assignments
1	Introduction	Define concept of health; Social and behavioral factors of health; Leading causes of death; Health beliefs model; Behaviorism; Behavior change strategies: prompting, stimulus control, reinforcement; Boosting behavioral compliance	Baseline assessment; Discussion prompt (post on Coursera discussion board) to describe personal experiences with behavior change
2	Nutrition	Nutrition and chronic disease; Health impacts of junk food consumption; Interventions for improving dietary choices; Nutrition intervention research studies	Discussion prompt: Selection of nutrition goal and behavior change strategy
3	Nutrition	Obesity epidemic; Overview of nutrition interventions (large-scale RCTs); Food marketing; Health halos; Optimal defaults in reducing obesity; Environmental restructuring	Discussion prompt: Evaluation of behavior change attempt/summary of nutrition goal and behavior change strategy
4	Physical Activity	Defining physical activity (PA); Measuring PA; Health benefits of PA; Physical inactivity	Discussion prompt: Selection of PA goal and behavior change strategy
5	Physical Activity	Factors contributing to regular PA; PA in older adults; PA interventions; Social interventions; National PA plan; Challenges to PA promotion; Physical inactivity as a target for intervention	Discussion prompt: Evaluation of behavior change attempt/summary of PA goal and behavior change strategy
6	Mental Health	Define mental health; Impact and epidemiology of mental disorders; Public health model of mental health and risk factors; Prevention vs. treatment of mental disorders; Depression; Effective treatment and CBT	Discussion prompt: Selection of mental wellness goal and behavior change strategy
7	Mental Health	Define positive affect; Impact of humor; Anxiety disorders; Stress and health; Stress reduction interventions	Discussion prompt: Evaluation of behavior change attempt/summary of mental health goal and behavior change strategy
8	Conclusion	Overview of research process; Presentation of results; Intervention effects on nutrition, physical activity, and mental health behaviors and on physical health outcomes; Summary: self-care interventions to promote physical and mental health	Post assessment; Discussion prompt: Behavior change summary

Curriculum

The course content aligned with the health behavior change modules and has been described in previous reports.[15–17] The introductory week taught the fundamentals of behavior change, as applied to health behaviors. Behavior modification techniques (e.g., reinforcement, prompting, response cost) were described, and clinical and public health interventions utilizing each technique were reviewed. Following the foundational unit on behavior change techniques, the course covered three modules: nutrition, physical activity, and mental health. Lecture content addressed key epidemiologic issues within each topic, research findings on relevant clinical behavior change interventions, and public health prevention strategies and programs.

Behavior change interventions

Each student established personal behavior change goals within the three course units of nutrition, physical activity, and mental wellness. The pacing of the goals was sequential, with the nutrition goal setting occurring during week 2 of the course, physical activity occurring during week 4, and mental health during week 6. Using a variety of specialized strategies informed by behavioral theory (e.g., reinforcement, response cost, negative reinforcement), students chose contingencies for the completion of their targeted behavior. Learners were encouraged to attempt to achieve the behavior change goals for the duration of the course, but there was no accountability or recording of whether learners achieved these goals, except for during the post-treatment assessment.

Statistical analysis

Data were downloaded directly from the survey collection service (Qualtrics.com) and analyzed with SPSS. Missing data and invalid responses were excluded from analysis. Learners who completed the pre- and post-surveys within the same 5-day window were excluded from analysis. Dependent t-tests were conducted to evaluate change in continuous measures. Chi-square test for independence evaluated change in categorical outcomes. Correlation (Pearson's r) was used to test associations among health behaviors and mental health outcomes. Alpha of .05 was used to determine statistical significance.

Results

Behavioral adherence

Learners reported achieving their behavioral goals for the majority of the 8-module course. The mean adherence was 76.3% of days for nutrition (range 5–100), 79.7% for

physical activity (range 0–100), and 74.6% for mental wellness behaviors (range 3–100). Examined in terms of an adherence threshold (i.e., participant reported meeting goals on at least 50% of days), 88% of the participants met their nutrition goals, 89% met their physical activity goals, and 85% met their mental wellness goals on at least half the days.

Primary outcomes

The primary outcomes were perceived stress, DASS depression, DASS anxiety, and DASS stress scores, and frequency of depressed and anxious days. Our previous work has found associations between engagement in health promoting activities and improved mental health. Thus we reported the outcomes in the nutrition and physical activity domains as well. Table 2 reports descriptive statistics for behavioral outcomes, mental health measures, and general health measures.

Significant improvements were observed for behavioral outcomes. Learners reported significant increases in fruit, vegetable, and whole grain intake, and significant reductions in sweet and fast food intake. Learners also reported significant increases in physical activity, assessed both in terms of METs[22] and in terms of number of vigorous bouts of exercise in the past week.

From baseline to post-intervention, there were significant improvements in all mental health outcomes, with learners reporting lower levels of stress, anxiety, and depression following the intervention.

Physical health

Learners also reported significant improvements in health perception: compared to baseline, learners reported being in better overall health, reported that their health had improved, and believed themselves to be in better health as compared to others of the same sex and age.

Self-efficacy

Self-efficacy significantly increased following the intervention. Self-efficacy scores were significantly correlated with behavioral goal attainment: $r(184) = .16$, $p = .02$ for nutrition daily goal attainment, $r(183) = .28$, $p < .001$ for physical activity, and $r(184) = .31$, $p < .001$ for mental health behaviors. At post-intervention, self-efficacy was positively associated with self-reported health, $r(188) = .42$, $p < .001$, with perceived improvement from one year prior, $r(188) = .20$, $p = .005$, and with relative health in comparison to others, $r(188) = .45$, $p < .001$. Self-efficacy was inversely associated with mental health outcomes, such that as self-efficacy increased, the scores on DASS Depression ($r(181) = -.52$, $p < .001$), DASS Stress ($r(183) = -.39$, $p < .001$), and DASS Anxiety ($r(182) = -.38$, $p < .001$) decreased.

Discussion

The current study tested the effectiveness of a curriculum-based health improvement intervention for learners enrolled in a massive open online course on behavior change. Previous research reported the effectiveness of this intervention in increasing students' health behaviors and in improving mental health outcomes in the campus-based version of the course.[15–17] The current study sought to extend the previous work by examining the effectiveness of the intervention in a publicly available course, and among learners of a variety of ages, backgrounds, and nationalities.

Results of the current study paralleled those reported previously of the intervention that was delivered to graduate students enrolled in a competitive degree

Table 2. Behavioral outcomes, mental health measures, and general health measures.

	Baseline		Post			
	M	SD	M	SD	t	p
Nutrition (servings per week)						
Vegetable	13.1	(8.6)	14.2	(8.5)	2.25	.013
Fruit	9.7	(7.5)	11.0	(8.0)	2.49	.007
Sweets or fast foods	4.4	(5.3)	3.2	(3.3)	−4.00	.001
Whole grains	1.8	(1.8)	2.0	(1.9)	1.90	.030
Physical Activity						
Vigorous activity bouts (past week)	3.5	(2.1)	3.9	(2.0)	2.80	.003
Godin (METs)	49.0	(29.3)	53.4	*(26.3)*	2.55	.006
Mental Health						
Perceived Stress Scale	16.7	(6.4)	15.4	(6.6)	−3.75	<.001
DASS Stress	11.5	(8.2)	10.7	(8.7)	−1.78	.039
DASS Anxiety	6.0	(6.5)	5.0	(6.4)	−2.94	.002
DASS Depression	8.2	(8.1)	7.3	(8.3)	−1.98	.025
Self-Efficacy	30.8	(5.2)	31.4	(5.2)	1.92	.029
Perceived Health Status						
General health perception (1 = poor; 5 = excellent)	3.5	(0.9)	3.6	(0.8)	3.23	.001
Change in general health (1 = much worse; 5 = much better)	3.6	(1.0)	3.7	(0.9)	2.71	.004
Compared to others same age and sex (1 = much worse; 5 = much better)	3.7	(1.0)	3.8	(0.9)	2.79	.003

df range 168–188; missing values were excluded from analysis.

program at a U.S. university. The primary finding is that teaching behavioral strategies through self-focused behavioral goals is effective in improving mental and physical health outcomes. Notably, engagement in health promoting behaviors was inversely associated with all post-intervention mental health outcomes, such that engagement in self-care behavior throughout the semester was associated with lower levels of psychological stress, depression, and anxiety.

In terms of specific observed improvements: students reported increased fruit, vegetable, and whole grain intake, and decreased intake of sweets and fast foods. Each of these dietary targets was mentioned in the curriculum for the nutrition module. It should be noted that these values are estimates provided retrospectively via self-report and cannot be validated.

Future work should test the effectiveness of this intervention in comparison to a control group of learners enrolled in other MOOCs. It is possible that students who self-selected into a course on behavior change were uniquely motivated to engage with the course material and to complete the behavioral goal-setting. In the current study mental health improvements were associated with self-efficacy, which was further associated with the degree of goal attainment. Larger longitudinal studies are needed to examine mechanisms of improvement in mental health outcomes.

It is worth noting that the improvements reported here occurred in the context of the COVID-19 pandemic. Multiple reports of clinically significant mental distress have been reported in the wake of the COVID-19 crisis[11,29] yet learners enrolled in this self-care course experienced improvements in mental health outcomes. Thus we cautiously suggest that this brief self-care course was effective in preventing the decline in mental health that has been observed in a variety of settings and populations during the pandemic. Additional research employing a control group of community participants is necessary to further examine these effects.

Strengths of this study include the use of psychometrically validated and clinically sensitive measures of psychological distress and multiple measures of nutrition and physical activity. Furthermore, this study included measurement of self-efficacy, which is thought to mediate health behavior change. Indeed, in the current study self-efficacy at post-intervention was positively associated with self-reported health, and was inversely associated with all measures of psychological distress.

In summary, the current study supports the generalizability of our previous work citing the effectiveness of a curriculum-based intervention in improving health for graduate students. Thus, the current study supports the effectiveness of this intervention for use in community and workplace settings. The results suggest that behavioral self-care interventions presented through a cost-effective health promotion course can mitigate risks to psychological wellbeing.

Translation to Health Education Practice

The intervention described and reported here has the potential to be successful in other academic programs or within workplace contexts. The adoption of a MOOC platform expands on previous work showing the positive effects of health behavior education and behavioral theory in formal classroom settings, inviting further development of similar educational resources for various other communities.

A critical didactic component is the identification of empirically-supported behavioral techniques, often used in clinical health psychology practice. Learners are specifically taught elements of behavioral theory, such as reinforcement, the Premack Principle, response cost, and the use of prompts. Learners therefore established their own behavioral contingencies and were encouraged to experiment with multiple strategies to facilitate behavior change.

With the radical changes brought about by the COVID-19 pandemic with respect to distance learning platforms, and increased acceptance of those platforms, the curriculum and intervention described here may be an appropriate intervention for preventing declines in mental health outcomes.

Planning, implementing, and evaluating health education/promotion

Health Educators and Certified Health Education Specialists can use the methods and results of this study in designing and implementing similar interventions, or in applying the same intervention, in their respective populations of interest. A number of CHES/NCHEC responsibilities, competencies, and sub-competencies were applied in the administration of this curriculum and study. Regarding the assessment of health education needs, special attention was paid to methods of collection of health-related data, particularly the choice of survey-based DASS/PSS/Self-Efficacy scales to assess mental health outcomes. Health education strategies were further planned following input from participants in similar past studies.[15–17] Specific objectives related to helping learners identify realistic/attainable health behavior goals were identified. Further, the didactic material and assignments provided experiential exercises designed to teach a variety of empirically-supported behavioral techniques; this "learning by doing" of behavioral theory was instrumental to the sustainability of health-promoting behaviors. The open-source nature of

this curriculum, further, invites the adaptation of these materials or the development of similar curricula and interventions for target communities by other health educators. As of the time of this publication, the Coursera lecture content for this course has been translated/subtitled into several languages (Arabic, German, Portuguese, Vietnamese, Italian, Chinese, Turkish, Spanish, French, Russian, and Korean) thus expanding its accessibility. In developing curricula and interventions, Health Educators may also access the lecture videos at no charge through Coursera.org. Readings, assignments, and assessment tools are available from the senior author (M.W.) upon request.

Disclosure statement

Dr. White received royalties based on revenue sharing generated by Yale digital courses on Coursera.

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