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# Preliminary efficacy and predictors of response to a remotely-delivered symptom self-management program for persistent symptoms after concussion

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## ABSTRACT

**Background:** More than a quarter of adults with concussion endure prolonged symptoms of >3 months. We developed the Concussion Education Self-Management program to help people manage persisting symptoms. Here, we assess feasibility, preliminary efficacy, and correlates of response.

**Methods:**  $N = 80$  adults participated in the program; ages ranged from 18 to 65 years and time post-injury ranged from 6 months to 18 years. Weekly sessions, delivered remotely and in groups, comprised education and strategies for management of cognitive, emotional, and physical symptoms. Primary outcome: Confidence to self-manage symptoms. Secondary outcomes: Quality of life; mood/anxiety/stress. Predictors of response: Self-reported cognitive, emotional and physical symptoms at intake.

**Results:** Pre- to post-program improvements were observed in confidence to self-manage,  $p < 0.03$ ; quality of life,  $p < 0.001$ ; depression,  $p < 0.001$ ; anxiety,  $p < 0.001$ ; and stress,  $p < 0.001$ . Considering confidence to self-manage, those with fewer cognitive and physical symptoms benefitted more ( $p$ 's  $< 0.0005$  and  $p < 0.01$ , respectively).

**Discussion:** This program shows promise for improving self-management of prolonged symptoms. Those with high symptom burden may need extra sessions to benefit. This is a cost-effective and scalable program that can reach people regardless of geographic location or impediments to travel.

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## Introduction

Upwards of 50 million people globally sustain a concussion every year (1), and an estimated 10–40% will endure prolonged cognitive, physical, and/or emotional symptoms of varying etiology, caused directly by the concussion or indirectly (e.g., poor sleep is a primary deficit; brain fog occurs secondary to poor sleep); in addition, patients may have enduring symptoms related to the event in which the concussion was sustained and which may overlap with concussion symptoms, such as headache secondary to neck injury.

Prolonged symptoms, generally defined as symptoms that continue for three months or longer after the initial injury, can persist for years and even decades, and are associated with reduced quality of life, disability, and personal income loss (2–6). Moreover, the lack of available, evidence-based interventions for persisting symptoms of concussion has resulted in over-use of traditional health-care resources, which were not designed to manage the complex needs of this population (7). Often, such patients move from one clinician to another due to the dearth of appropriate resources. Compounding these challenges, patients may face a lack of specialized knowledge and even stigma amongst healthcare providers (8,9). Owing in part to misinformation about concussion in the public domain, many individuals facing barriers to effective symptom management become vulnerable to pursuing

treatments that are both ineffective and costly. Evidence-based, cost-effective, and scalable programs are needed that offer effective care and equitable access for the vast number of patients in need.

The complex etiology of persisting symptoms after concussion poses many challenges to treatment development. Such challenges include: (i) the nonspecific, trans-diagnostic nature of many persisting symptoms (e.g., headache, concentration problems, fatigue), (ii) interaction between symptoms that result in an amplification of symptoms, often referred to as the vicious cycle of concussion (10–12); e.g., anxiety may impede sleep quality, which compromises cognition, which further exacerbates anxiety), (iii) the impact of one cognitive impairment, particularly attentional impairment, on other cognitive functions, such as memory, (iv) the presence of pre-morbid symptoms/disorders such as depression, which clouds clinical presentation (13), (v) the tendency to overestimate pre-concussion functioning, known as the ‘good old days’ bias, which leads to an overestimation of current functioning (14), and (vi) the absence of an objective and reliable diagnostic test at this time for concussion and its persisting symptoms (e.g., neuroimaging, neuropsychological assessment or blood-based biomarkers). Taken together, these challenges preclude an understanding of the etiology of any symptom or set of symptoms (15–17).

To address the challenges of complexity of treatment and large-scale need, we developed an education and strategies

intervention, the ‘Concussion Education and Symptom Management’ (CESM) program. A symptom-based approach to treatment – without diagnostic assumptions – is currently recommended (18), and the CESM program takes such an approach. We make no attempts to discern the etiology of symptoms, as any given symptom may be primary to the brain injury, secondary to it, preexisting, or completely unrelated.

The program commences with information about persisting symptoms following concussion, including education about different factors that may be contributing to persistent symptoms (e.g., whiplash injury, posttraumatic stress), information about the complex interplay between persistent symptoms, and about the ubiquitous effect of attentional dysfunction on other brain functions. Then, the program offers concrete recommendations to help address persistent cognitive, emotional, and physical symptoms. There is some evidence that early education can minimize the development of prolonged symptoms (19), and this education and strategies approach has been successful for management of nonspecific symptoms of unclear etiology in other clinical contexts such as chronic pain and cancer (20–22). The CESM is remotely deliverable and group-based to maximize scale and access; these approaches both have individual empirical support in traumatic brain injury populations (23,24), though in combination empirical data are more limited. We specifically targeted community-based adults with prolonged symptoms of concussion because of the dearth of research and care in this group.

The literature on development and evaluation of complex interventions (25) recommends a phased and iterative approach to implementation, comprising conceptual development, feasibility and piloting, and evaluation (26–28). Therefore, our key objectives were to examine feasibility indices – retention and client feedback – as well as preliminary pre- to post efficacy. We predicted greater confidence to self-manage symptoms after completion of the program (primary outcome), and improved mood, anxiety, stress, and quality of life (secondary outcomes). Importantly, to enhance our understanding of program impact, and to move toward a customized approach to treatment, we were interested in generating hypotheses regarding the correlates of response. Symptom burden following concussion has previously been associated with poorer outcomes, including more persistent symptoms (29), reduced exercise tolerance (30), and lower post-injury resilience (31). Using the number of symptoms reported at intake as a proxy for symptom burden, we explored whether this was associated with treatment response on our primary outcome measure, confidence to self-manage symptoms. Importantly, our rationale for this analysis was to examine the role of symptoms, regardless of etiology, as a predictor of response. We also explored

whether and how age, years of education, and time since injury might be associated with treatment response.

## Methods

### Participants

Participants from across Ontario with neurological disorders were referred by a medical doctor or allied health professional to our *Telerehab Centre for Acquired Brain Injury* (‘the Centre’) at KITE/Toronto Rehab for clinical services. Those with a referral diagnosis of concussion were streamed into the CESM program, prior to participation in other treatment modules offered through the Centre. General criteria for admission to the Centre were as follows (1): clinical diagnosis of an ABI as reported by the referral source (32); aged 18 years or older (2); no current psychosis or mania (3); greater than 6-months post-injury (4); fluent in English and free from communication impairments precluding group participation; and (5) basic computer literacy. Participation in the CESM program additionally required a diagnosis of concussion and persisting symptoms, as per (i) referral diagnosis; (ii) mechanism of injury compatible with concussion; (iii) presence of neurotrauma indicators (e.g., loss of consciousness, post-traumatic amnesia, acute concussion symptoms such as confusion, disorientation, headache, nausea); and (iv) injury severity indicators not beyond the mild range (i.e., post-traumatic amnesia not greater than 1 day; LOC not longer than 30 minutes). Consent to use data for research purposes was also obtained at intake. This study was approved by the University Health Network Research Ethics Board CAPCR/UHN REB #: 17–6285. All participants provided their written informed consent to participate. The authors report there are no competing interests to declare.

### Design

The study employed a single arm, pre-post intervention design to examine feasibility and preliminary efficacy, and to generate hypotheses regarding correlates of response.

### Materials

#### CESM protocol

The CESM program is a structured group psychoeducational intervention that runs once a week for six weeks. It is delivered via secure videoconferencing to individuals in their homes. Each 2-hour session comprises didactics (via PowerPoint slides) and allotted time for group discussion (see Table 1). Educational content, concepts covered, and management tools and strategies were adapted from the Ontario Neurotrauma Foundation (ONF) Guidelines for Concussion/Mild Traumatic Brain Injury and Persistent Symptoms: 3rd Edition (18), as well as Cognitive Behaviour Therapy (33), Goal Management Training (34), mindfulness (35), Acceptance and Commitment Therapy (36), and self-compassion (37). We also adapted content from our own

**Table 1.** CESM protocol.

Week	General content
1	General information about concussion; acute effects
2	Prolonged symptoms: why symptoms persist, the importance of treating symptoms, risk factors for prolonged symptoms, synergistic amplification of symptoms. Introduction to self-care/self-management, and to mindfulness principles.
3	Prolonged physical symptoms (e.g., post-traumatic headache, sleep-wake disturbances, vestibular symptoms, vision issues, deconditioning) including tools and self-management strategies (e.g., headache diary, sleep hygiene, exercise as medicine). Introduction to gratitude journaling.
4	Prolonged cognitive symptoms, including strategies for maximizing cognitive function in the context of ongoing physical and emotional symptoms (e.g., energy conservation). The causal role of reduced attentional resources for other cognitive symptoms.
5 and 6	Management of emotional symptoms, including self-care and activity planning (e.g., nourishing vs. depleting activities), concepts and tools from cognitive behavior therapy (e.g., the role of thoughts in contributing to mood; coping plans for dealing with anxiety). Introduction to acceptance and self-compassion.

2-session Concussion Education and Support Workshop, a psychoeducational workshop for individuals with persistent symptoms after concussion, offered to the general public twice a year for 6 years with support from the Canadian Concussion Centre.

Development of the CESM program has been iterative, involving a synthesis of the most up-to-date evidence and expert opinion on the assessment and management of prolonged concussion symptoms in adults. Investigators in the current study were also involved in the development of the ONF Guidelines, above. The CESM was developed by content experts with five or more years of direct clinical experience working with people with persisting symptoms after concussion. The program continues to be revised and refined periodically based on participant feedback, and to incorporate emerging evidence and new developments.

### Outcome measures

All outcome measures were completed online, prior to beginning the program and immediately after completion. Primary and secondary outcome measures are described in Table 2. All outcomes were client-reported outcome surveys. Three of the four outcomes are published measures with demonstrated psychometric properties (38, 44–46). The fourth measure (the CESM Feedback Questionnaire) was developed to collect feedback about the intervention to guide future revisions.

Variables for symptom burden as a predictor of response to the program were generated post-hoc, using the emotional, cognitive, and physical complaints reported by clients during the intake process in response to questions about symptoms and difficulties that had emerged since their concussion.

Operationally, within each of the three categories above (i.e., emotional, cognitive, physical), we grouped similar

**Table 2.** Outcome measures.

Scale	Domain and description
<b>Primary outcome</b>	
Perceived Medical Condition Self-Management Scale (38; PMCSMS)	Confidence to self-manage symptoms is an important construct in the maintenance of self-care behaviors and for patient satisfaction (38). The PMCSMS is a reliable and valid way of measuring perceived competence for self-management behaviors in patients with chronic disease (39–41). Eight items are scored on a 6-point Likert scale (strongly disagree to strongly agree), assessing confidence to self-manage (e.g., It is difficult for me to find effective solutions for problems that occur in managing my medical condition; I am generally able to accomplish my goals with respect to managing my medical condition).
<b>Secondary outcomes</b>	
Depression, Anxiety, and Stress Scale (39; DASS-21)	A widely used self-report measure indexing symptoms of stress, anxiety and depression over the previous week, with separate sub-scales for each plus a total score. The DASS-21 has previously been shown to be valid as a screening tool for anxiety and mood disorders in TBI samples (42,43). The questionnaire is designed to measure the severity of a range of symptoms common to depression, anxiety, and stress. In completing the DASS-21, the individual is required to indicate the presence of a symptom over the previous week. Each item is scored from 0 (did not apply to me at all over the last week) to 3 (applied to me very much or most of the time over the past week).
Quality of Life Enjoyment and Satisfaction Questionnaire (40, 41; Q-LES-Q)	Quality of life; participants are asked to rate their satisfaction over the prior week (on a 6-point Likert scale ranging from very poor to very good) with a number of different life domains (e.g., physical health, mood, work, social relationships, family relationships, living/housing situation, etc.)
CESM Feedback Questionnaire	Participants rated seven statements according to the scale: agree/neutral/disagree: 1) The program met my expectations; 2) I am glad that I participated in this program; 3) The content of the program met my needs; 4) The content of the program was relevant and appropriate; 5) The information presented was clear and understandable; 6) The length of the program was just right; 7) The length of the program was too long. Participants also had the opportunity to answer the following, open-ended questions: 1) Have you noticed any overall benefits or improvements as a result of your participation in the Concussion Education and Symptom Management Module? 2) Is there anything you would have liked to hear more about, or is there anything we didn't discuss that you feel would be helpful for future sessions? 3) Is there anything else you can think of that would help us improve future Concussion Education and Symptom Management groups? Participants also had the opportunity to answer the following, open-ended questions: 1) Have you noticed any overall benefits or improvements as a result of your participation in the Concussion Education and Symptom Management Module? 2) Is there anything you would have liked to hear more about, or is there anything we didn't discuss that you feel would be helpful for future sessions? 3) Is there anything else you can think of that would help us improve future Concussion Education and Symptom Management groups?

Only participants who began the program in 2020 (and ongoing) completed the PMCSMS. Completion of home practice recommendations was not formally assessed.

symptoms together into symptom clusters/areas (e.g., complaints of poor focus, problems concentrating, and having to re-read information would be grouped together into one symptom cluster representing poor focus/concentration). Then, we counted the different symptom clusters within each category (i.e., emotional, cognitive, and physical) to index symptom burden within that category. The cognitive category comprised nine symptom clusters: attentional concerns (e.g., distractibility, poor concentration, and forgetfulness), slowed thinking, difficulty with mental effort, issues with verbal expression (e.g., word-finding), issues with comprehension, visuospatial difficulties, difficulty learning new information, poor memory, and executive dysfunction (e.g., difficulties with decision-making, planning and organization, problem-solving, concept formation). The physical category comprised 11 symptom clusters: headache, body pain, nausea, dizziness, photophobia, phonophobia, screen sensitivity, sleep disruption, difficulties with balance, fatigue/low energy, and visual changes (e.g., blurred vision). Finally, the emotional category included four symptom clusters consistent with depression, anxiety, posttraumatic stress disorder, and/or generalized emotional lability/emotion dysregulation.

We then divided participants into low and high symptom burden groups within each category using the median split. For the cognitive category, those in the low symptom burden group ( $n = 39$ ) had complaints in three or fewer areas while those in the high symptom burden group ( $n = 40$ ) had complaints in four or more areas. Within the physical category, those in the low symptom burden group ( $n = 25$ ) had three or fewer areas of complaints while those in the high symptom burden group ( $n = 54$ ) had four or more areas of complaint. Within the emotional category, those in the low symptom burden group ( $n = 43$ ) had complaints in two or fewer areas while those in the high symptom burden group ( $n = 36$ ) had complaints in three or four areas.

### Statistical analyses

For preliminary efficacy, we used linear mixed effects models (R; version 4.0.3) to examine pre- to post-treatment change on primary and secondary outcome measures. We also ran a sensitivity analysis using one of the secondary outcome

measures, including only those with clinical elevations in the mild range or higher on scales of depression, anxiety, and stress.

To ascertain control variables for the above models, we correlated age, education, and time post-injury with the change scores for the dependent variables of interest.

To examine symptom burden as a correlate of treatment response on our primary outcome measure, we re-ran the linear mixed effects models with cognitive/emotional/physical symptom burden group included as a factor (low vs high).

## Results

Data were collected from November 2019 until the end of January 2022 when the database was closed for analysis.

### Feasibility

One hundred and thirty-eight individuals were offered and accepted a spot in one of the 16 CESM groups that ran between November of 2019 and January of 2022. Retention was high, only eight individuals dropped from their group, and two of those went on to complete the program with a subsequent group. One individual accepted a spot in two other groups after not attending the sessions with his first group, but did not attend those groups either. Four individuals accepted spots in groups, but did not attend any of the sessions and could not be contacted.

Eighty individuals completed the program, consented to the use of their data for research purposes, and had complete pre- and post-intervention data on at least one of the outcome measures. Demographic and clinical information for this sample is provided in Table 3.

Regarding findings from the CESM Feedback survey: for 79% of participants, the program met their expectations; 93% were glad to have participated, and 83% agreed that the program met their needs. The content was also well received, with 93% finding the content relevant and appropriate, and 96% finding the presented information clear and understandable. Feedback regarding the overall (i.e., 6-week) program length was variable, with 63% agreeing that the length was 'just right,' 20% endorsing the statement that it was too long.

**Table 3.** Demographic and clinical information.

Demographics	<i>N</i> = 80
Age (years) M(SD)	41.9 (12.0)
Education (years) M(SD)	15.3 (1.7)
Time post-injury (months) M(SD)	30.7 (33.8)
Single vs. multiple concussions (based on self-report only)	51:29
Areas of cognitive difficulty reported at intake M(range)	4 (0–9)
Physical symptoms reported at intake M(range)	5 (0–11)
Areas of emotional difficulty described at intake M(range)	2 (0–4)
Index injury type:	
MVA	36
Bicycle accident	4
Fall	21
Sports-related	6
Assault	2
Other blows to head	11

**Table 4.** Change on clinical outcome variables in full sample and enriched sample with clinical elevations on DASS21.

	Mean at PRE $\pm$ SD	Mean at POST $\pm$ SD	Change from PRE-POST	Standard error	Degrees of freedom	t-value	p-value
PMCSMS	26.09 $\pm$ 7.68	27.86 $\pm$ 7.61	1.78	0.79	57	2.24	0.03
Q-LES-Q	0.46 $\pm$ 0.16	0.51 $\pm$ 0.15	0.06	0.01	78	4.49	<0.001
<b>Full Sample</b>							
DASS-21 Depression	9.10 $\pm$ 5.48	7.35 $\pm$ 5.24	-1.75	0.47	79	-3.70	<0.001
DASS-21 Anxiety	6.88 $\pm$ 4.76	6.16 $\pm$ 4.67	-0.71	0.37	79	-1.92	0.06
DASS-21 Stress	11.35 $\pm$ 5.08	9.84 $\pm$ 5.27	-1.51	0.41	79	-3.68	<0.001
DASS-21 Total	27.33 $\pm$ 13.45	23.35 $\pm$ 13.32	-3.98	1.03	79	-3.86	<0.001
<b>Enriched Sample</b>							
DASS-21 Depression	11.08 $\pm$ 4.53	8.74 $\pm$ 4.94	-2.34	0.57	61	-4.13	<0.001
DASS-21 Anxiety	9.18 $\pm$ 3.89	7.60 $\pm$ 4.61	-1.58	0.43	54	-3.69	<0.001
DASS-21 Stress	13.76 $\pm$ 3.63	11.53 $\pm$ 4.85	-2.22	0.48	57	-4.61	<0.001

DASS-21 = Depression, Anxiety, and Stress Scale-21; Depression, Anxiety and Stress refer to sub-scale scores on DASS-21. PMCSMS = Perceived Medical Condition Self-Management Scale. Q-LES-Q = Quality of Life Enjoyment and Satisfaction Questionnaire.

**Table 5.** Change in confidence to self-manage by symptom burden.

	Change from PRE-POST	Standard error	Degrees of freedom	t-value	p-value
PMCSMS					
Main effect: time (pre-post)	9.98	2.35	56	4.25	0.0001
Main effect: group (low vs. high cognitive symptom burden)	2.53	2.01	56	1.26	0.21
Time by Group Interaction	-5.29	1.44	56	-3.67	0.0005
Main effect: time (pre-post)	8.86	2.86	56	3.10	0.003
Main effect: group (low vs. high physical symptom burden)	0.21	2.16	56	0.10	0.92
Time by Group Interaction	-4.19	1.63	56	-2.57	0.01
Main effect: time (pre-post)	3.80	2.57	56	1.48	0.14
Main effect: group (low vs. high emotional symptom burden)	-2.13	1.99	56	-1.07	0.29
Time by Group Interaction	-1.32	1.59	56	-0.83	0.41

PMCSMS = Perceived Medical Condition Self-Management Scale.

### Preliminary efficacy

**Control variables for models.** Table 4 shows that there was no significant correlation between age, education, or time from index injury with pre-post change scores on any of the primary or secondary outcomes.

**Efficacy.** Findings from the linear mixed effects model are shown in Table 4. The analyses showed significant increases on the Perceived Medical Condition Self-Management Scale (PMCSMS), our primary outcome measure, from pre- to post-intervention. There were also significant increases on secondary outcome measures: the Quality of Life Enjoyment and Satisfaction Questionnaire (Q-LES-Q) and the Depression, Anxiety, and Stress Scale (DASS-21) (Table 4). For the DASS-21 sub-scales, when examining the entire sample, there were significant decreases in depression and stress and marginally significant decreases in anxiety from pre- to post-intervention. Notably, when using an enriched sample constrained to individuals within the clinical range on the DASS-21 at baseline (i.e., rating mild or higher on the subscale of interest), change from pre- to post-treatment was significant across all three subscales.

### Symptom burden as correlate of response to treatment

The linear mixed-effect models for our primary outcome measure, PMCSMS, showed a significant interaction between time (pre-post) and *cognitive* symptom burden group (Table 5); specifically, individuals with fewer cognitive symptoms at intake showed greater gains in confidence to self-manage after the program. The same interaction was observed for *physical* symptom burden (Table 5). In

contrast, individuals with higher cognitive and/or physical symptom burden showed little to no change in confidence to self-manage after the program. There was no significant effect of *emotion* symptom burden on confidence to self-manage. Those with both low and high emotional burden at intake showed some gains from pre to post; however, the effect did not reach statistical significance ( $p = 0.14$ ) (Table 5).

### Discussion

In response to gaps in clinical care for individuals struggling with persistent symptoms following concussion, we developed and preliminarily evaluated a novel education intervention and found promising early results. With regards to feasibility, both retention and adherence (as measured by completion of outcome measures) were high and clients had positive comments on their experience.

With regard to efficacy, there were robust pre- to post-treatment improvements on our primary outcome, measuring confidence to self-manage symptoms, as well as on secondary outcomes measuring quality of life and mood/anxiety/stress, particularly for the enriched sample that excluded patients with minimal pre-treatment mood, anxiety, and stress symptoms. Notably, there were no significant relationships between change following treatment and age, education, or time-post injury, indicating that benefits may be generalizable to participants of all ages, time post-injury, and education level. Lastly, lower pre-morbid symptom burden in cognitive and physical domains was associated with greater gains in confidence to self-manage symptoms after the intervention; in contrast,

those with high cognitive and physical symptom burden did not benefit at all. These preliminary findings are in line with other data on education and self-management programs following concussion (47,48).

High retention and adherence at this early stage of development, combined with evidence of robust improvements in the primary target – self-management of symptoms – supports the continued development of this education program. The lack of impact of age, education, and time-post injury on the outcomes is especially encouraging, considering this sample was a heterogeneous group drawn from community referrals; it suggests people stand to benefit regardless of demographics or how long they have been struggling with persistent symptoms.

The differential response to CESM based on self-reported cognitive and physical symptom burden at the beginning of the program is not surprising considering previous research that associates higher symptom burden with poorer outcomes (e.g., more persistent symptoms, reduced exercise tolerance, lower resilience; 30–32).

First, these individuals may have had more difficulty engaging with or recalling the intervention content because of direct cognitive issues (e.g., attention and memory difficulties). Second, for at least some individuals, indirect interference related to their symptoms was also likely a factor (e.g., heightened somatic focus and/or distress about perceived cognitive issues and physical symptoms interfering with attention, retention, and engagement). With regard to a more customized treatment approach, the findings suggest that more treatment (more sessions; a second round of treatment) might improve outcomes in those with elevated cognitive symptoms.

Third, it is also important to consider that the CESM program itself places more emphasis and provides more strategies to self-manage cognitive and emotional symptoms. Physical symptoms are discussed (e.g., headache, light sensitivity and visual issues, dizziness) and some management recommendations are provided (e.g., headache diary, sleep logging), but treatment of these symptoms requires the involvement of other healthcare professionals (e.g., a neurologist or psychiatrist to prescribe medication or a physiotherapist) or they might require a separate program (e.g., cognitive behavior therapy for insomnia). As such, it certainly stands to reason that individuals for whom physical symptoms were a primary concern would get less out of the program. A relevant customization, however, would be treatment of these physical symptoms before or concurrent with the CESM.

Lastly, resilience, as well as motivation and other personality characteristics, would be expected to influence to the extent to which clients are able to benefit from the program. Further research is needed to better understand all the various factors that contribute to or detract from gains following a program like CESM in order to support the most individualized approach to care as possible.

## Limitations

These preliminary efficacy analyses were carried out using a clinical sample without a control group. The single-arm design's internal validity may have thereby been threatened

by history and by expectation effects, in particular. The external validity, or generalizability of the treatment effects may have been affected by social contact, amongst other factors. Further, the study would have been strengthened with a prospective sample of concussion patients that have enduring symptoms. In addition, exposure to prior treatment was not explored and is another limitation. Thus, these findings should be interpreted conservatively due to the many factors that may have confounded outcomes. Regardless, these are important first steps in the staged development of an intervention (26–28).

Our early findings also indicate that clients with extensive cognitive and physical symptoms and/or those who are more somatically focused may benefit less from this type of program. Further research is needed to ascertain whether this is an inherent limitation of this type of program, or whether customizations of the protocol, in content and approach, could improve response.

Despite the limitations, these findings help to establish effect sizes for an experimental design. Future directions for the current program include a randomized controlled trial with an active control arm, such as a facilitated support group, and follow-up assessment to examine retention of benefits. Future directions should also include examination of the hypotheses generated by our exploratory analyses regarding predictors of treatment response, namely symptom burden and demographic variables (i.e., age, education, and time since injury).

## Conclusions

People with persisting symptoms following concussion place a substantial burden on traditional healthcare systems and have to navigate misinformation and promises of 'magic-bullet' treatments, often with high financial cost. The CESM program is a promising educational intervention that is scalable and cost-effective, and our preliminary findings offer promise that adults of wide-ranging demographic backgrounds and time post-injury may benefit. Exploratory findings on correlates of treatment response raise customization possibilities. The remotely delivered format helps to reduce inequities of access to care, and additionally allows for safe treatment in the context of infection risk. Finally, the protocol has been manualized to facilitate broad uptake.

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