Research Article

Examining long-term motivational and behavioral outcomes of two physical activity interventions

Emily Bremer [1], Tayah M. Liska[2,5], Kelly P. Arbour-Nicitopoulos [1], Krista L. Best[3,4], Shane N. Sweet [2,5]

[1]Faculty of Kinesiology & Physical Education, University of Toronto, Toronto, ON, Canada, [2]Department of Kinesiology and Physical Education, McGill University, Montreal, QC, Canada, [3]Faculty of Medicine, Université Laval, Quebec City, QC, Canada, [4]Center for Interdisciplinary Research in Rehabilitation and Social Integration, Quebec City, QC, Canada, [5]Centre for Interdisciplinary Research in Rehabilitation of Greater Montreal, Montreal, QC, Canada

Objective: To examine possible impacts of two theory-based interventions – "Enhancing quality of life through exercise: A tele-rehabilitation approach (TEQ) and Active Living Lifestyles for individuals with SCI who use Wheelchair (ALLWheel)" – 12–18 months post-intervention on the satisfaction of psychological needs and motivation for leisure-time physical activity (LTPA), LTPA participation, and participation experience.
Design: A mixed-methods follow-up study.
Setting: Community.
Participants: Sixteen TEQ and six ALLWheel participants completed questionnaires and a semi-structured interview, 12–18 months after completing the interventions.
Intervention: TEQ intervention participants received a weekly LTPA counseling session with a trained kinesiologist through videoconferencing for 8 weeks. ALLWheel participants interacted with a peer mentor who provided LTPA counseling using smartphones for 10 weeks.
Outcome Measures: The Psychological Need Satisfaction in Exercise, and the Treatment Self-Regulation Questionnaire were used as primary outcome measures. The LTPA barrier self-efficacy scale, the Measure of Experiential Aspects of Participation, and the 7-day LTPA Questionnaire for Adults with SCI were used as secondary outcome measures. A coding framework was created and deductive thematic analyses were used to analyze the qualitative data.
Results: Medium to large effects were found for autonomous motivation (TEQ), competence (TEQ and ALLWheel), and barrier self-efficacy (TEQ and ALLWheel). LTPA remained higher for the TEQ intervention group compared to the control group at follow-up, while an increase in moderate-to-vigorous LTPA was found in ALLWheel participants.
Conclusion: Community-based tele-rehabilitation and virtual rehabilitation approaches, informed by theory, may assist adults with SCI in implementing LTPA over the long term.

Keywords: Exercise, Disability, Peers, Theory, Maintenance

Leisure-time physical activity (LTPA) is a physical activity that one chooses to do in their free time (*e.g.* exercising, wheeling for recreation), as opposed to necessary physical activities (*e.g.* occupational or housework, transportation).[1] Regular engagement in LTPA is important for a range of physical and mental health outcomes among individuals with a spinal cord injury (SCI).[2,3] Yet, LTPA participation is low among adults with SCI, with 50% of individuals reporting no engagement in LTPA.[4] Among those adults with SCI who do engage in LTPA, few are meeting the SCI-

Correspondence to: Shane N. Sweet, Department of Kinesiology and Physical Education, McGill University, 475 Pine Ave W, Montreal, QC, H2W1S4, Canada: 514-398-5184 x:00903. Email: shane.sweet@mcgill.ca

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specific physical activity fitness guidelines of a minimum of two 20-minute bouts of moderate to vigorous aerobic LTPA and two strength-training activities per week.[5,6]

Increasing attention has been directed towards designing and testing theory-informed community-based LTPA interventions to increase LTPA among adults with SCI.[7] TEQ ("Enhancing quality of life through exercise: A tele-rehabilitation approach") and ALLWheel ("Active Living Lifestyles for individuals with SCI who use Wheelchair") are two interventions grounded in self-determination theory (SDT).[8,9] According to SDT, personal growth is achieved through satisfying the three psychological needs of competence, relatedness, and autonomy while increasing autonomous motivation and reducing controlled motivation.[10,11] TEQ was an 8-week, video-based tele-rehabilitation intervention, delivered by a trained LTPA counselor, that resulted in a greater increase in LTPA behavior and autonomous motivation in the experimental versus control group.[12] SDT needs-supportive behaviours for autonomy (*e.g.* maximizing choice), competence (*e.g.* assisting with goal setting), and relatedness (*e.g.* expressing empathy) were used in the intervention.[13] ALLWheel was a 10-week, 14-session single-arm community-based smartphone intervention, delivered by peer LTPA counselors, that led to improvements in low-intensity LTPA behaviour, perceived autonomy and competence, and autonomous motivation.[13] The combination of peer interactions and the use of technology in the ALLWheel intervention delivery fostered psychosocial constructs (*e.g.* motivation, self-efficacy) to promote LTPA engagement.[9]

Despite the initial promising results of community- and theory-based interventions within the disability population, in particular TEQ and ALLWheel, a critical gap remains in regard to the long-term impact of these interventions for adults with SCI.[7] Long-term follow-up is necessary to understand whether LTPA interventions can lead to sustained changes in behaviour and to identify which aspects of these interventions have the greatest impact on participant outcomes. Moreover, exploring how individuals with SCI experience LTPA participation may help understand whether community and theory-based interventions promote high quality participation among adults with disabilities. Quality participation is defined by the six experiential aspects of participation (autonomy, belongingness, challenge, engagement, mastery, and meaning) identified in a configurative review and specific for the disability population.[14,15] As such, the current mixed-methods study aimed to examine the possible impacts of TEQ and ALLWheel 12–18 months post-intervention on the satisfaction of psychological needs and motivation for LTPA, LTPA participation, and quality participation.

Methods

Design and procedure

A mixed-methods study design was employed. All TEQ and ALLWheel participants who completed measures post-intervention (defined as the end of the 8-week intervention for TEQ and end of the 10-week intervention for ALLWheel) were contacted at follow-up (defined as 12–18 months post-intervention for TEQ and ALLWheel). This timeframe was chosen to capture the effects of at least one-year post-intervention. Interested participants were invited to complete a questionnaire either online, on paper (sent via courier service), or by telephone to assess their psychological needs, motivation, and LTPA at follow-up. Each TEQ and ALLWheel intervention participant was asked if they were interested in participating in a semi-structured telephone interview to understand their experience with the respective intervention and their LTPA motivation and participation since intervention completion. All interviews were conducted over the phone (range: 22–56 min) and transcribed verbatim. Participants provided informed consent prior to their participation in the study and procedures were approved by two institutional research ethics boards [Center for Interdisciplinary Research in Rehabilitation of Greater Montreal (CRIR-1121-1015) and CIUSSS de la Capitale Nationale (RIS_EMP-2016-492)].

Participants

Individuals who completed the TEQ ($N = 22$) and ALLWheel ($N = 8$) interventions were invited and eligible to participate in this follow-up study. Control participants from TEQ only completed the survey given they were unable to provide experiences with the intervention.

Primary outcome measures

Participants from both interventions completed the Psychological Need Satisfaction in Exercise (PNSE) scale to assess participants' satisfaction of the basic psychological needs of autonomy, competence, and relatedness for LTPA.[16] Total mean scores were calculated for the 6-item subscales of autonomy, competence, and relatedness. Internal consistency was acceptable at post-intervention and follow-up with Cronbach's alphas ≥ 0.86.

The Treatment Self-Regulation Questionnaire (TSRQ) was used to assess participants' motivation for LTPA.[17] TEQ participants completed the TSRQ

at post-intervention and follow-up, while ALLWheel participants only completed it at follow-up. Mean scores were calculated for the subscales of autonomous motivation, controlled motivation, and amotivation. Internal reliability of the scale was acceptable at post-intervention for autonomous motivation (α = 0.96) but was low for controlled motivation (α = 0.65) and amotivation (α = 0.48). At follow-up, internal reliability was acceptable for autonomous (α = 0.80) and controlled (α = 0.73) motivation but was low for amotivation (α = 0.23). Data from the amotivation subscale were not analyzed given the low internal consistency results. The TSRQ has demonstrated acceptable construct validity to assess participants motivation for LTPA[17] and has been previously used to assess LTPA among adults with SCI, supporting its use in the current study.[12]

Secondary outcome measures

LTPA was assessed with the 7-day Leisure-Time Physical Activity Questionnaire for Adults with SCI (LTPAQ-SCI).[18] Participants were asked to recall the frequency (number of bouts) and duration (minutes per bout) of mild, moderate, and vigorous intensity LTPA over the past 7 days. Weekly minutes of moderate and vigorous strength training, and moderate and vigorous aerobic LTPA were summed to calculate total moderate to vigorous LTPA (referred to herein as MVPA). Similarly, weekly minutes of strength and aerobic activity at all three intensities were summed to calculate total LTPA. This questionnaire has demonstrated acceptable test-retest reliability and construct validity among adults with SCI.[19,20]

The LTPA barrier self-efficacy scale was used to assess participants' self-efficacy to overcome salient barriers to LTPA participation (*e.g.* lack of transportation).[17] Participants rated each of six barriers on a scale ranging from 0 (not confident) to 100 (completely confident) at post-intervention and follow-up. A mean score was calculated and the scale demonstrated acceptable internal consistency (αs ≥ 0.75).

The Measure of Experiential Aspects of Participation (MeEAP) was added at follow-up to assess participants' experiences with LTPA participation. The MeEAP assesses each of the six experiential aspects of participation by asking participants to respond to 12 items (2 items per experiential aspect) using a 1 (strongly disagree) to 7 (strongly agree) response scale. Only those participants who reported participating in LTPA completed the MeEAP. Each item was prefaced by the following stem: "When engaging in physical activity, I feel … ". The validity of this measure has been supported in a sample of adults with physical disabilities.[14]

Quantitative analysis

Data cleaning

Data were screened for outliers and missing values. Univariate outliers were examined by creating standardized *z*-scores, with a *z*-score of ±3.29 considered an outlier.[21] Univariate outlier scores were changed to one unit greater than the next largest score that was not an outlier.

Analyses

TEQ intervention maintenance by group (experimental vs. control)

A series of repeated measures ANOVAs were run to determine if the experimental and control groups from TEQ differed on the psychological needs, TSRQ, LTPA barrier self-efficacy, and LTPAQ-SCI from post-intervention to follow-up. Reliable change indices were also calculated for each outcome by group. Using the means and standard deviations at post-intervention and follow-up, and the Cronbach's alpha at post-intervention, reliable change indices were estimated using an excel calculator. A reliable change index (RCI) of ± 1.96 was considered a meaningful change over measurement error. Given that Cronbach's alphas cannot be calculated for the LTPAQ-SCI, greater than 20 min increase of LTPA or MVPA (one bout of LTPA as per the SCI-specific LTPA guidelines for fitness benefits[6]) was considered meaningful.

ALLWheel intervention maintenance

A series of paired samples *t*-tests were used to examine whether intervention effects were maintained on the psychological needs, LTPA barrier self-efficacy, and LTPAQ-SCI for participants in the ALLWheel intervention from post-intervention to follow-up. Reliable change indices were also calculated for each outcome, as previously described.

Intervention outcomes at follow-up (TEQ and ALLWheel)

Independent samples *t*-tests were used to examine differences in the level of quality participation in LTPA and motivation for LTPA at follow-up between participants who completed the TEQ and ALLWheel interventions.

Effect sizes for the repeated measures ANOVAs are reported as partial eta squared (η_p^2) and the values for small, medium, and large effects are 0.01, 0.06, and 0.14, respectively.[22] Effect sizes for the *t*-tests are reported as Cohen's *d* and the values for small, medium, and large effects are 0.20, 0.50, and 0.80,

respectively.[23] All quantitative analyses were performed in SPSS version 25.0.[24]

Qualitative analysis

A coding framework, based on SDT, was created to deductively analyze the responses of each interview into three pre-established categories: (1) LTPA engagement and motivation; (2) experience and perceived autonomy, competence, and relatedness support from the LTPA (peer) counselor; (3) experience of the intervention delivery with suggestions and recommendations for future interventions. A research assistant not involved with the original intervention studies conducted the interviews. The research team created interview questions based on the three categories. The research assistant was provided the pre-established questions to conduct the interviews. Co-author, TL, and a research assistant adopted Braun *et al.*'s [25] steps for thematic analysis for coding and analyzing the qualitative data: (1) familiarizing and coding; (2) theme development and refinement; and (3) writing the analysis. The researchers independently and deductively coded each transcript, following the created coding framework, using *NVivo*.[26] They compared their codes to ensure rigor of the coded data, as well as consistency in the selection and organization of codes across both coders. When differences in the coded data appeared in the cross-coding comparison, both researchers discussed the difference and rectified the discrepancy. The codes were then reviewed by co-author SS as a critical friend. All names mentioned in the results are pseudonyms.

Results

Sixteen TEQ ($n = 7$ experimental) and six ALLWheel participants completed this follow-up study, representing 73% of participants from the original sample. Participants were predominately male and between 30 and 70 years of age (see Table 1). A univariate outlier was found and modified for two participants at both time points for MVPA and LTPA and for two participants at follow-up for MVPA. All other outcome measures met the statistical assumptions for parametric analyses.

Intervention outcomes

TEQ intervention maintenance by group (experimental vs. control)

The experimental group had greater autonomous motivation ($\eta_p^2 = 0.47$), LTPA barrier self-efficacy ($\eta_p^2 = 0.52$), and total LTPA ($\eta_p^2 = 0.48$) than the control group (all P values <0.01), irrespective of time effects (see Table 2). RCI values confirm these ANOVA findings as the change in psychological needs, motivational regulations, and LTPA barrier self-efficacy were not considered reliable beyond measurement error (all values <1.96). A time by group interaction effect was present for total LTPA ($P < .05$, $\eta_p^2 = 0.31$), with a larger decline in the experimental group. However, the experimental group still reported more total LTPA than the control group ($d = 0.74$) at follow-up. The number of participants demonstrating a reliable change in total LTPA from post-intervention to follow-up by TEQ intervention group is reported in Table 3. The breakdown of data for TEQ participants' engagement in strength training and aerobic activity is provided in the supplemental tables.

Table 1 Participant demographics' data.

Characteristics	TEQ	ALLWheel
Age (y)	50.7 (SD = 13.2)	49.2 (SD = 15.0)
Sex (Female/Male)	4/12	4/2
Years since injury	13.94 (SD = 11.44)	–
Years being a wheelchair user	–	12.41 (SD = 12.50)
Mobility	*n* = 9 (manual wheelchair) *n* = 3 (power wheelchair/scooter). *n* = 3 (manual wheelchair and power wheelchair/scooter) *n* = 1 (cane)	*n* = 6 (all manual wheelchair users).
Disability Type		
SCI	*n = 16 (all paraplegia)*	*n* = 3 (*n* = 2 paraplegia, *n* = 1 quadriplegia)
MS		*n* = 1
Spina Bifida		*n* = 2

ALLWheel intervention maintenance

Moderate-to-large effects were found from post-intervention to follow-up for the psychological need of competence, LTPA barrier self-efficacy, and total MVPA (see Table 4). The RCI values for the change in psychological needs were below 1.96, indicating that the individual change was not reliable over measurement error. Reliable change was found in LTPA barrier self-efficacy: three ALLWheel participants (50%) improved their barrier self-efficacy from post-intervention to follow-up and the remaining three participants (50%) had no change. The number of participants demonstrating a reliable change in LTPA from post-intervention to follow-up in the ALLWheel intervention is reported in Table 4. The breakdown of data for

Table 2 Maintenance effects of psychological needs, motivational regulations, barrier self-efficacy, and physical activity from post-intervention to follow-up of TEQ by group.

		Post-intervention		Follow-up		Time Effect Size (η_p^2)	Group Effect Size (η_p^2)	Time*Group Effect Size (η_p^2)
	Outcome	Experimental Mean (SD)	Control Mean (SD)	Experimental Mean (SD)	Control Mean (SD)			
Psychological	Competence	4.9 (1.0)	4.0 (0.6)	5.4 (1.0)	5.1 (0.6)	.66***	.13	.21
Needs	Autonomy	5.1 (1.0)	4.8 (1.1)	4.8 (1.0)	4.3 (0.9)	.10	.08	.01
	Relatedness	4.1 (1.5)	4.2 (1.1)	4.2 (1.2)	4.4 (1.0)	.01	.01	.002
Motivational	Autonomous	6.7 (0.2)	5.1 (1.3)	6.2 (0.7)	5.1 (0.8)	.10	.47**	.12
Regulations	Controlled	2.9 (0.9)	2.8 (0.9)	1.4 (0.6)	0.7 (0.6)	.79***	.12	.06
Self-efficacy	Barrier Self-efficacy	5.5 (1.0)	3.6 (1.0)	5.7 (1.1)	3.7 (1.3)	.04	.52**	.001
Physical	Total MVPA	198.5 (157.6)	61.7 (88.9)	135.2 (102.3)	69.0 (113.0)	.10	.20	.15
Activity$^+$	Total LTPA	656.7 (246.9)	185.6 (180.5)	305.0 (184.6)	149.4 (233.5)	.41*	.48**	.31*

*P < .05, **P < .01, ***P < .001;$^+$Data available for $N = 15$ ($n = 6$ experimental) participants.

Table 3 Number of participants demonstrating a reliable change in physical activity by intervention (TEQ/ALLWheel) and group (experimental/control).

	Group	Experimental			Control		
Intervention	Outcome	No Change (*n*)	Decreased (*n*)	Improved (*n*)	No Change (n)	Decreased (n)	Improved (n)
TEQ	Total MVPA	*1*	*4*	*1*	*5*	*1*	*3*
	Total LTPA	*0*	*5*	*1*	*1*	*4*	*4*
ALLWheel	Total MVPA	*3*	*0*	*3*			
	Total LTPA	*0*	*3*	*3*			

ALLWheel participants' engagement in strength training and aerobic activity is provided in the supplemental tables.

Intervention outcomes at follow-up

There was a large effect between the two interventions on controlled motivation, with participants in ALLWheel reporting higher controlled motivation ($d = 1.39$, P < 05). Ratings of experiential aspects of participation in LTPA were generally high in both interventions with a large effect on the meaning aspect of participation, favoring the TEQ intervention (Table 5).

During the qualitative interview, four of the ten participants, two from TEQ and two from ALLWheel, reported that they maintained their LTPA at follow-up. Those who did maintain their LTPA reported increased enjoyment and competence to engage in LTPA ($n = 4$), along with increased autonomous motivation ($n = 3$), and the ability to draw on previous physical activity knowledge, learnt prior to and during the intervention, to support their LTPA ($n = 2$). In contrast, six participants who reported that their LTPA was not maintained at follow-up spoke about decreased motivation and competence to engage in LTPA ($n = 5$), and frustration due to limited access to facilities ($n = 3$). Supportive quotes for participants LTPA engagement and motivation at follow-up are presented in Table 6.

Table 4 Maintenance of psychological need satisfaction, barrier self-efficacy, and physical activity from post-intervention to follow-up in the ALLWheel intervention.

	Outcome	Post-intervention Mean (SD)	Follow-up Mean (SD)	Effect Size (Cohen's *d*)
Psychological needs	Competence	4.4 (0.9)	5.5 (0.5)	0.99
	Autonomy	5.2 (1.0)	4.6 (0.9)	0.43
	Relatedness	4.8 (1.0)	4.8 (0.6)	0.06
Self-efficacy	Barrier Self-efficacy	3.5 (1.2)	4.8 (1.2)	0.63
Physical activity	Total MVPA	4.2 (8.0)	46.8 (54.8)	0.77
	Total LTPA	167.3 (161.2)	88.3 (75.1)	0.39

Table 5 Experiential aspects of participation in exercise and motivational regulations at follow-up by intervention.

	Outcome	Cronbach's alpha	TEQ Mean (SD)	ALLWheel Mean (SD)	Effect Size (Cohen's *d*)
MEAP – Exercise^{+}	Autonomy	.53	6.3 (1.0)	6.7 (0.5)	0.49
	Belonging	.89	5.9 (1.5)	6.5 (0.4)	0.53
	Challenge	.47	5.4 (1.3)	6.1 (1.2)	0.56
	Engagement	.70	6.1 (1.6)	6.0 (1.0)	0.07
	Mastery	.68	6.3 (1.2)	6.3 (1.0)	0
	Meaning	.62	5.1 (0.9)	3.9 (1.0)	1.27
Motivational Regulations	Autonomous	–	6.2 (0.7)	5.6 (1.2)	0.63
	Controlled	–	1.4 (0.6)	2.3 (0.7)*	1.39

*Significantly different from TEQ at $P < .05$; $^{+}$Data available for $N = 13$ ($n = 7$ from TEQ) participants.

Intervention components

Ten participants ($n = 5$ from TEQ) described their LTPA engagement and motivation at the time of follow-up, as well as strategies and interpersonal behaviours used by the LTPA counselors that aligned with SDT. Specifically, participants' perceived autonomy, competence, and relatedness support, and provided suggestions for future LTPA interventions.

Autonomy support

All ten participants reported that their LTPA counselor supported their autonomy during their counseling sessions. Participants predominantly reported that LTPA counselors engaged in a dialogue that allowed for reciprocation of ideas and for participants to choose how to resume or increase their LTPA participation, and the types of LTPA they want to engage in. For example, "[Kate, TEQ LTPA counsellor] had given some ideas, maybe places to look. Encouraged me to look online and I did do things like that. Looked up wheelchair yoga, things like that that maybe I would've thought of it" (TEQ 27). Participants also expressed that their LTPA counselor listened attentively during each session, recognized their individual preferences, and tailored their LTPA plans to meet their specific needs, as one participant noted that "it was a team effort" (Qc02).

Competence support

Participants spoke highly of the general and practical support they received from their LTPA counselor. They acknowledged the usefulness of the LTPA counselors' assistance in building action plans that aligned with their preferred LTPA. The tools and information provided by the LTPA counselor during the interventions were still used to help maintain participants' LTPA 1-year later: "I have continued to use the [web]site Sam [peer LTPA counsellor] gave me. I visit it regularly. I find it interesting and I am happy to have it" (Qc01). Participants also remembered the LTPA counselors' consistency of reviewing behavioural goals and action plans. Reviewing the goals and plans helped participants create more realistic outcomes or expectations: "If I found it too difficult to train for an hour, he would tell me to at least do 30 … he would offer me solutions" (Qc04).

Relatedness support

Participants also spoke about the friendly and welcoming environment their LTPA counselor created by acting in warm and caring ways and using open-ended questions to create meaningful, individualized dialogue during each counseling session, "I found it positive, I can't say the opposite. She was a great conversationalist" (TEQ 100); "The focus wasn't the activity, but more so the human aspect" (Qc01). Participants whose LTPA counselor was also a wheelchair user reported that the commonality and understanding of using a wheelchair when exercising was highly encouraging; "No, I felt ok with them being in wheelchairs as well. I think we were able to better understand each other. But he didn't have a disability from birth, I did, he had an accident. That was maybe the only difference" (Qc03).

Experienced limitations with the interventions

Some participants acknowledged their satisfaction when interacting with their LTPA counselor was less than anticipated. They felt the conversation with their LTPA counselor was at times generic and topics of conversation became repetitive. Participants also mentioned that it was difficult when the intervention concluded because the established relationship abruptly ended, leaving them susceptible to returning to previous habits. Participants expressed that on-going guidance to support LTPA maintenance would be very helpful: "I think the most important thing is to have these kinds of follow-ups so that they could remind you to do your exercises. This would motivate you" (TEQ 6). Supportive quotes for participants' experience with

Table 6 Supportive quotes of intervention outcomes at follow-up of participants LTPA engagement and motivation, and experience of intervention delivery.

Theme	Sub-theme	Example Quotes*
LTPA engagement maintained at follow-up ($n = 4$)	Increased competence ($n = 4$)	"When I start to have shoulder pain, I lower the (number) of exercises. I learned that with the program, and with my motivation from 'Adapt your life.' I learned that I have to listen to my body, to my pains" (Qc01). "I knew I could start doing it again because I already succeeded before" (Qc04). "But I was able to paint that front entranceway as high as I could reach with my hands and my husband is going to have to take care of the rest because I can't do everything. But that would not have ever been possible before I did this program. So, the stamina was there to do the basecoat and the treating and then two days went by, maybe a week went by, I looked at it, tried to figure out (…) So all that to say that that's an incredible thing. To be able to be part of redecorating my home and doing what I did before it's so empowering and it's nice. Every time I come into my house, I look at what I did, and it reinforces all that positive energy" (TEQ #27).
	Increased autonomous motivation ($n = 3$)	"I am still motivated, and I continue to do my exercises, and I try to keep my manual wheelchair as long as I can" (Qc01). "By the end of the 10 weeks, it became a habit to roll two times a day. I just continued" (Qc02). "I do need their help to install the wheel, however. This dependence is difficult, but it's my routine. However, I don't need their motivation. I usually play music when I'm training" (Qc04).
	Previous LTPA knowledge use ($n = 2$)	"Because I've done a lot of that in the past, like I said, a lot of training and a lot of coaching, I was able to say, 'Okay. This is your first stage, this is your second stage, this is your third stage.' I'm able to break the task down to achieve goals further on into the future because I'm able to break it down into stages. Okay, well, you can do your three miles, yet, you have to walk around the block first. Someone who doesn't have that experience or knowledge, I don't know how they would react after that. But for me, this is how it worked" (TEQ #27).
LTPA engagement not maintained at follow-up ($n = 6$)	Decreased autonomous motivation to engage in LTPA ($n = 5$)	"Job-related is just basically how busy we've been. It's interfered with a lot of stuff. And then from there also some health-related issues got in the way. That's one of the more difficult things to deal with. Quality of life and taking care of yourself is one of the most important parts, but it's kind of hard to do when you're already dealing with other health issues" (TEQ #8).
	Decreased competence to engage in LTPA	"It's the fear that is there. I developed fears. I was never sacred in my life. If someone's able to do something, it is me. I'm not crazier than the next person, I am capable. I do things very well. But now, today, I live with fears. I've never had to deal with that before in my life. It becomes a challenge managing all of this" (Qc01).
	Increased frustration, decreased relatedness, due to limited access to facilities ($n = 3$)	"It discouraged me when the physio let me go here at the Rehabilitation Center of Saint-Hubert. They decided: 'Well, [sir], we were unable to attain the objectives of walking as far as you are concerned. So, we must stop here, because us, the physios, we're there to get you back on your feet, but you will be staying in the wheelchair for a long time since your spinal cord injury is so deep,'" (Mtl101). "When I leave the house, it's only to use adapted transportation. Since I cannot perform much and the revenues at my age decrease drastically (which is what allows me to go to the center and move around), I don't have the will to just move around. I must have a goal at the time, there must be a reason for me to go. But just to move around, it takes too much effort and costs too much. With the laziness, it's a few years since I stopped doing the groceries myself. Now, with getting groceries delivered to us through internet, we don't have to exhaust ourselves and it costs less than adapted transport" (TEQ #100)?

Continued

Table 6 ***Continued***

Theme	Sub-theme	Example Quotes*
Suggestions for future directions:	Having on-going follow-ups	"Without anyone on top of you, you end up letting go. This is why I think it would be better to do it on a 6 month to a year basis, depending on what people need. The follow ups shouldn't necessarily only be about the exercises, but some people might need them for motivation or support. And this could maybe be done in bunches. There may not be enough resources to cater to everyone individually, but you could have one consultant for a few people at the same time. The calls don't have to be 1 hour, they could just be 10 minutes. If you're talking and you realize thing are going well, you can end it there and continue" (TEQ #6). "They could suggest different things to put an emphasis on. If you have any problems, these follow ups would allow you to discuss them with a consultant and find a solution" (TEQ #6).
	Having a counselor or professional accessible to answer questions	"I think as long as possible. I think it would be good to have these check ins, it could even be on demand, to answer questions that you might have or even have an online consultation" (TEQ #6). "I think I would place a greater emphasis on questions and answers. For example, being able to ask a physiotherapist or and occupational therapist questions. Being able to have the answers to your question. It not always easy to immediately understand how to do an exercise. It's one thing observing someone else doing it and another doing it yourself. You can't do things any way. You risk injuring yourself" (TEQ #6). "I don't know whether it's part of the program to have specialized people that could be on hand, like someone who's maybe a kinesiologist or maybe someone – a psychology student or someone that could be also part of that program. If there was an element that I would need that [Kate] could say, 'Well, I can't really answer that question but I could maybe have this person call you and maybe they might be able to respond to your question.' It'd be having specialized people that would not be part of the program – well, would be part of the program but would not affect, I guess, the statistics that you would be taking. It'd be sort of in the side. I don't know if that would be helpful. Or maybe partnering with maybe a rehabilitation center or someone who's already doing that sort of thing that they could say, 'We have some participants that from time to time might need some guidance or some whatever, some intervention. Would you be prepared to partner with us? And we can send you the names or they can call you and set up appointments or something like that'" (TEQ #27)?

*The quotes presented in the table are additional, supportive quotes of participants LTPA engagement and motivation, and experience of intervention delivery. All supporting quotes for autonomy, competence, and relatedness support are found in-text.

the intervention and suggestions for future interventions are presented in Table 6.

Discussion

The results of this study provide insight into the long-term effects of two community-based LTPA interventions, guided in their development by principles of SDT, for adults with SCI. In regard to maintenance of LTPA from post-intervention to follow-up, our findings were mixed. For instance, the TEQ intervention group decreased their LTPA from post-intervention to follow-up, but still reported higher LTPA at follow-up than the control group. Further, while the ALLWheel intervention did not include a control group, half of the participants in the intervention increased their LTPA from post-intervention to follow-up. Taken together, the interventions may have provided participants with strategies to continue engaging in LTPA than if they hadn't received the intervention.

Maintenance of LTPA may be partially attributed to participants' motivational regulations and competence/self-efficacy. TEQ intervention participants maintained a higher score on autonomous motivation at post-intervention and follow-up, while TEQ and ALLWheel participants found large effects on competence and self-efficacy. These findings align with the results of a recent meta-analysis which indicates that SDT-based health interventions lead to small effects in competence and autonomous motivation at follow-up.[10] As a result, current LTPA interventions among adults with SCI should incorporate strategies to foster a need-based supportive environment.

Even 12–18 months after the completion of the interventions, participants recalled autonomy, competence, and relatedness supportive behaviours used by their LTPA counselors. These results shed light on which interpersonal behaviours may need to be present in interventions to help foster longer-term LTPA participation. For instance, actively listening, tailoring, and involving participants in the decision-making were recalled as important autonomy support behaviours, while being caring and empathic were elaborated as important relatedness support behaviours. Interestingly, participants also discussed the importance of goals and action plans and the review of those goals and plans to help them feel competent to engage in LTPA.[26] In line with SDT, these supportive behaviours are likely a key reason for the higher reported levels of autonomous motivation and competence at follow-up, which would ultimately result in continued LTPA participation. Unfortunately, our study was not powered to run a multiple mediation analysis to determine the relationship between the basic psychological needs, motivation, and LTPA participation. Future studies should examine these mediational pathways to confirm if the satisfaction of psychological needs leads to increased motivation and LTPA, and associated health benefits, among adults with SCI.

Participants provided suggestions for future LTPA counseling programs to maintain contact with their LTPA counselor. Emphasis was placed on the use of similar technology provided during the interventions to periodically check in with the counselor, providing LTPA action/coping plans upon completion of the intervention, and making available a point of contact to receive feedback and continued guidance for LTPA. These recommendations suggest integrating booster sessions upon the completion of a LTPA counseling intervention. Booster sessions can serve as a useful, cost-effective alternative to extending the overall length of an intervention, and have a positive impact on LTPA maintenance among clinical and non-clinical populations.[27] Moreover, previous research has demonstrated that post-rehabilitation booster sessions can result in changes in planning and self-efficacy to facilitate LTPA behaviour.[28] Thus, periodically engaging with a LTPA counselor after the completion of the intervention to receive on-going feedback could increase LTPA maintenance, as well as maintain participants' sense of autonomy, competence, and relatedness towards their continued LTPA engagement. Future LTPA counseling interventions should consider the use of booster sessions to foster continued LTPA participation.

In addition to simply providing booster sessions, it may be important to consider who delivers the intervention and booster sessions. TEQ and ALLWheel varied in their intervention delivery: TEQ used an LTPA counselor who was a kinesiologist, trained in behavior change and motivational principles, and had extensive knowledge of SCI, while ALLWheel used a peer LTPA counselor who had lived experience as a wheelchair user and who was trained in applying behavior change techniques. Despite the differences in the LTPA counselor's backgrounds, there were few differences in intervention outcomes suggesting that both peers and non-peers may be equally effective. While peers are a potentially overlooked mechanism for LTPA service provision,[28] their inclusion in LTPA interventions may not always be feasible due to the availability of peer LTPA counselors, particularly among disability populations such as SCI. However, we recommend that future interventions ensure that LTPA counselors, including peers, be trained in person-centered approaches, such as SDT, and behavior change strategies to facilitate on-going participation in LTPA.

Limitations

Eight participants (27%) from the original samples did not participate in this follow-up study, limiting our complete understanding of the impact of the TEQ and ALLWheel interventions on participant's psychological needs and motivation towards LTPA. It is possible that participants who agreed to participate in the follow-up were also more motivated to participate in LTPA than participants who did not agree to participate in the follow-up. LTPA behavior was measured by self-report, which may have led to over- or under-reporting of LTPA minutes. However, the general direction of change in LTPA in ALLWheel and relative levels compared to the control group in TEQ provide preliminary support of the potential long-term impact of these interventions. We recognize the small sample size of both interventions does not allow us to make generalizable conclusions. However, these study results help to provide a needed preliminary look at LTPA participation post-intervention among adults with SCI and thus may provide the impetus for future research. Given the novelty and exploratory nature of this study, multiple analyses were conducted which may increase the chance of finding significance. For this reason, we also presented effect sizes to provide another metric for data interpretation and look at long-term LTPA participation. Although amotivation was not analyzed due to low reliability, these low reliability scores and floor effects are commonly reported for amotivation scores in the TSRQ.[17,29] These scores should be expected as only participants who were motivated to participate in LTPA were eligible for the two interventions understudy. More research may be needed to recruit and promote LTPA among individuals who would report higher amotivation scores.

Conclusion

Findings from this study suggest that community-based tele-rehabilitation and virtual rehabilitation approaches, informed by SDT, may assist adults with SCI to implement LTPA with long-term impacts. More research can build on this study to develop a more comprehensive understanding of the ideal theoretical and motivational factors to support long-term LTPA participation among adults with SCI.

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ORCID

Emily Bremer http://orcid.org/0000-0003-1488-1032
Kelly P. Arbour-Nicitopoulos http://orcid.org/0000-0003-1011-3669
Shane N. Sweet http://orcid.org/0000-0002-6172-3769

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