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Can peer-tutored psychological flexibility training facilitate physical activity among adults with overweight?

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ABSTRACT

Objective: An increase in psychological flexibility has been found to be associated with health behavior changes. Peer-led interventions have been advantageous in improving physical activity among individuals at health risk. This study aimed to discover whether an ACT-based peer-tutored online intervention can increase self-reported physical activity participation and psychological flexibility among adults with overweight.

Design: The study was a non-randomized longitudinal intervention study. The intervention participants ($N = 177$) were primary health care clients with overweight. They participated in a 24-month program provided by health services, including three online modules of ACT of six week each, and tutoring by trained peers via five group meetings and four phone calls.

Main outcome measures and results: Physical activity participation was measured with Kasari's FIT index concerning the frequency, intensity and time of the physical activity. Psychological flexibility was measured with AAQ-II, and thought suppression, as a dimension of psychological flexibility, with WBSI. Measures were taken at baseline, and at 6, 12, and 24 months. The statistical analysis was conducted with Mplus to identify latent groups with similar change patterns of physical activity, and to examine differences between the profiles. Two change profiles for physical activity participation were found: Low and High. At baseline in High profile group, physical activity and psychological flexibility were higher and thought suppression was lower than they were in Low profile group, as was expressing other psychological symptoms measured by DASS. During the intervention, physical activity increased significantly only within Low profile (within Cohen's $d = .48$). Psychological flexibility (AAQ-II) increased within High profile (within Cohen's $d = .34$), and thought suppression (WBSI) decreased in both profiles (within Cohen's $d = .33$).

Conclusion: The ACT-based peer-tutored online intervention was promising especially for participants with low physical activity participation.

1. Introduction

Low physical activity (PA) increases the risk of cardiovascular diseases (Li & Siegrist, 2012; Zhang, Cash, Bower, Focht, & Paskett, 2020) as well as overweight and obesity (Lee et al., 2012). Obesity itself is a risk for cardiovascular diseases (Zhang et al., 2020) and increased use of health care services (Bertakis & Azari, 2005; Raebel et al., 2004; OECD, 2019). It is also associated with higher all-cause mortality (Flegal, Kit, Orpana, & Graubard, 2013). In 2016, the prevalence of low PA was relatively high, with 27.5% of people worldwide engaging in insufficient physical activity (Guthold, Stevens, Riley, & Bull, 2018), while 39% of adults were overweight and 13% were obese (WHO, 2018). Yet the focus of individual well-being should be on disease prevention instead of on weight loss outcomes (Bombak, 2014; Penney & Kirk, 2015). Due to the multifaceted nature of low physical activity, there is a great need within health services to implement novel methods for health-related behavior

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change interventions for clients with overweight and low physical activity (Pearce, Rychetnik, Wutzke, & Wilson, 2019).

The design of interventions could be made more effective by developing an understanding of the mechanisms of action through which interventions bring about change (Moore & Evans, 2017). A more thorough understanding of how and why people achieve change also requires knowledge of the obstacles to change. Barriers for physical activity participation (PAP) include both external (such as environmental circumstances and social resources) as well as internal features. The internal level of barriers include insufficient physical condition and capability, lack of encouragement and support, and embarrassment about exercise (Spiteri et al., 2019), and problems related to coping with internal impulses of tiredness aiming to avoid physical exercise (Greaves, Poltawski, Garside, & Briscoe, 2017). Replacing sedentary habits with more physically active ones demands, from a psychological point of view, the ability to cope with external influences and internal cues such as emotions and fatigue (Greaves et al., 2017; Forman & Butryn, 2015). Previous studies suggest that regular PA can be maintained by clarifying one's own values and improving both metacognitive awareness and distress tolerance (Forman & Butryn, 2015), as well as by becoming aware of one's automatic daily activities and constant ways of thinking (Kangasniemi, Lappalainen, Kankaanpää, Tolvanen, & Tammelin, 2015).

Psychological flexibility enables a person to adapt to fluctuating situational demands (Zhang et al., 2018) and attenuates experiential avoidance, thus supporting efforts to change unwanted thoughts and memories (Hayes, Pistorello, & Levin, 2012; Lillis & Kendra, 2014). Psychological flexibility is a core concept of acceptance and commitment therapy (ACT) (Hayes, Luoma, Bond, Masuda, & Lillis, 2006; Hayes, Strosahl, & Wilson, 2003), which uses acceptance, mindfulness, value processes, and committed action to improve one's psychological flexibility in promoting healthy behavioral patterns. ACT also assists individuals in taking value-based actions despite the presence of suppressed thoughts, feelings and unwanted bodily sensations (Graham, Gouick, Krahe, & Gillanders, 2016; Hayes et al., 2006; Lillis & Kendra, 2014).

ACT-based interventions concentrate on increasing awareness of in-the-moment decision-making processes and behavior, as well as on coping with distress (Forman & Butryn, 2015; Graham et al., 2016; Hayes et al., 2012). For example, concerning the ACT approach to body weight management, Lillis and Kendra (2014) stated in their conceptual paper that ACT makes it possible to create intrinsic motivation for behavior changes by increasing one's awareness of the desired consequences. Moreover, ACT helps to decrease fusion with one's own thinking patterns and explanations for avoiding physically active occasions (Kangasniemi et al., 2015) by raising awareness of tiredness and self-judgment (Sairanen, 2016, p. 25). From a long-term perspective, when ACT is applied together with behavior change techniques (Michie et al., 2013), such as goal setting and problem solving, it may provide an effective way to conduct weight loss maintenance (Lillis & Kendra, 2014; Forman & Butryn, 2015). Previous reviews have shown that ACT can improve disease self-management and lifestyle (Graham et al., 2016; Yildiz, 2020). Previous ACT-based trials have found increases in clinical measures of PA (Kangasniemi et al., 2015; Martin, Galloway-Williams, Cox, & Winet, 2015; Butryn, Forman, Hoffman, Shaw, & Juarascio, 2011; Ivanova, Yaakoba-Zohar, Jensen, Cassoff, & Knäuper, 2016), more PA-related acceptance (Martin, Galloway-Williams, Cox, & Winett, 2015; Butryn et al., 2011), increased enjoyment (Ivanova et al., 2016), and better coping with barriers (Kangasniemi et al., 2015).

In recent years, online and peer-support have been relevant elements when designing more effective interventions. Earlier online-based interventions have been beneficial in increasing physical activity (Maher et al., 2014; Devi et al., 2015; Jonkman, van Schooten, Maier, & Pijnappels, 2018). PA has also been improved by peer tutors, since peers often share values and socioeconomic status (Foster, Taylor, Eldridge, Ramsay, & Griffiths, 2007; South, Meah, Bagnall, & Jones, 2013; Islam et al., 2015), and act as supporters, educators and role models to the people they serve (South et al., 2013). Peer-tutored behavior change interventions that maintained group meetings and focused on self-monitoring and enhancing social support have proved to be effective in increasing PA (Lynch, Liebman, Ventrelle, Avery, & Richardson, 2014; Punna, Kettunen, Bagnall, & Kasila, 2019). Some peer-tutored psychological interventions have also been shown to be as effective as ones led by health professionals, such as in online and face to face therapy for people with anxiety disorder (Robinson et al., 2010), and in online therapy for depression (Titov et al., 2010).

The number of participants in previous ACT-based health-related behavior change trials has often been relatively small, or the length of the intervention and/or follow-up short, which indicates a need for future research to investigate long-term effects and larger samples. There is also a lack of evidence about intervention efficacy and the identification of individuals or groups for whom ACT interventions would be especially beneficial (Lillis & Kendra, 2014). There is also a lack of evidence whether peer-led interventions based on acceptance and commitment therapy could be beneficial in increasing physical activity among adults with overweight.

1.1. Aim and questions

The study was a part of a larger research project, "*Web-based healthy lifestyle intervention*". The general aim of the study was to determine if an ACT-based peer-tutored online intervention could increase self-reported physical activity participation and psychological flexibility among adults with overweight. In addition, the aim was to investigate whether the level of physical activity participation was associated with psychological flexibility and the number of symptoms of depression, anxiety and stress. The study addressed the following questions:

1. Can distinct physical activity change profiles be identified among intervention participants with overweight?
2. Is physical activity change profile membership associated with differences in psychological flexibility and psychological symptoms?
3. How do psychological flexibility and physical activity change during the intervention within identified physical activity change profiles?

2. Methods

2.1. Study design and participants

The study was undertaken in seven municipalities in Central Finland between 2015 and 2018. Six of the municipalities were rural and one was in an urban area. The study participants were clients from public health services from these areas and a few of the neighboring municipalities. Health professionals were provided an introduction to the intervention and its target group by the research team. The study was approved by the review boards of the health service centers and assessed by the Ethics Committee of Central Finland Health Care District. The study design was a non-randomized longitudinal intervention study. In this study, the main outcome was physical activity participation. Other outcomes included psychological flexibility, specifically experiential avoidance and thought suppression.

Health professionals (public health nurses and physicians) recruited volunteers by telling them about a behavior change intervention strongly focused on mental well-being and providing ongoing peer-tutoring. The recruitment occurred during individual health clinic visits, which were typically made as check-ups for cardiovascular symptoms or other long-term conditions. The inclusion criteria for participants were as follows: at least 18 years of age, BMI of 25 or greater (i.e., overweight), an oral statement by participants expressing their willingness to make health behavior changes, being cognitively capable (also in reading and writing), and having the possibility to use an online program. When a health professional considered that a client was

eligible to participate, the professional provided information on the intervention and the research study, and collected contact information from the clients who stated their willingness to participate. The intervention was conducted in a real-life context as a part of public health services. Therefore, it was not possible to set particular diagnosis-based inclusion criteria for study participants. Participants were not provided incentives for participating in the intervention.

A total of 183 persons were assessed for eligibility and 177 of them were allocated to the intervention (Fig. 1). The intervention drop-out rate was 40.7% (n = 105 at 24 months) (Fig. 1). There were altogether 16 small groups with 9–17 participants in each group at the beginning of the intervention, starting on different dates. All the group meetings and phone calls were implemented according to the pre-established intervention protocol. More details of participant characteristics are presented in Results.

2.2. Intervention

The general goal of the intervention was to increase the overall well-being of the participants and to make behavior changes concerning, for example, physical activity and nutrition, as well as psychological flexibility. The 24-month intervention consisted of two periods: the first period from start to 12 months as the supported intervention, and the second period between 12 and 24 months as maintaining the intervention. The intervention format included an online program consisting of three online modules of six weeks each, and five face-to-face group meetings (Fig. 2). The rationale for face-to-face meetings was to activate participants to move and to meet other participants who were dealing with a similar situation. Additionally, the purpose was to meet and become more familiar with their assigned peer tutors. During the first group meeting, participants received oral and written information about the study, gave their written consent, and completed the baseline study questionnaires. The first meeting was run by a group leader from the health care district (GLH), who was a health professional; a local health professional (LHP); a peer tutor; and a researcher. The second group

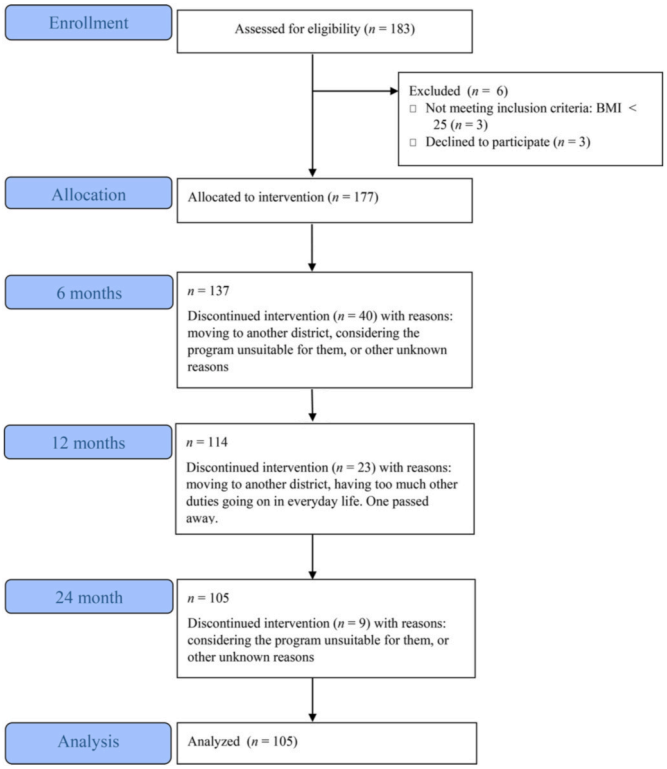

Fig. 1. Flow diagram of the progress through the intervention phases.

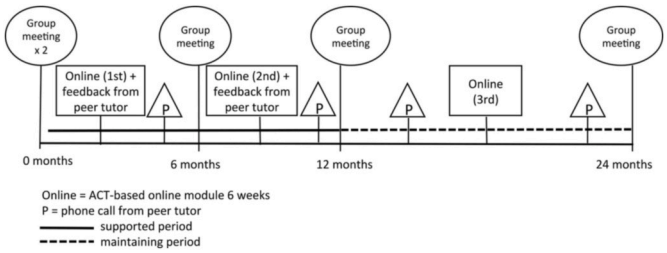

Fig. 2. The 24-month ACT-based behavior change intervention. Note the two group meetings at the beginning of the intervention, and three 6-week online modules.

meeting was held two weeks after the first one, and it consisted of clinical measurements, group discussions, and an introduction to the online modules.

Questionnaires were sent to participants before the group meetings at months 6, 12, and 24, who then brought the completed questionnaires to the meetings. These group meetings were held by the group leader, a health professional, and a peer tutor. They included group discussions led by the peer tutor, clinical measurements, and a review of the blood test results given by the local health professional. In group discussions, participants were asked to describe their ongoing behavior changes, including challenges and obstacles. Moreover, tasks and reflections related to the online modules were discussed. Each group meeting lasted 90–120 min depending on the number of participants present.

During the 24-month intervention period, peer tutors made four phone calls of approximately 15 min to each of their individually assigned participants. These included discussion of how participants were progressing towards their behavior change aims, as well as of their feelings and thoughts. Peer tutors also reminded participants about upcoming intervention events.

Each online module consisted of six sub-modules, and lasted for a total of six weeks. The sub-modules included text, audio exercises, videos, behavioral tasks, stories, and metaphors. The participants were instructed to write down their thoughts, feelings and emotions in the online logbooks according to specific tasks and assignments. The first online module (after the second group meeting) concentrated on the processes of ACT (values, value-based actions, present moment, defusion, self-as-context and acceptance, see Table 1). The participants were advised to reflect upon and name the individual changes they wanted to make. The second online module (at six months) consisted of ACT principles with physical activity guidance, nutrition, and well-being. The module included self-reflective assignments concerning value-based, health-related actions in daily life, as opposed to, for example, unpleasant sensations associated with exercise and some coincident comfort when watching TV instead of going for a walk (Table 1). The third online module (at 18 months) addressed themes concerning a flexible attitude towards health behavior, naming individual ways to take care of one's health, and identifying one's supportive network and sources of energy. The first and second module were tutored by the peers, whereas the third online module was based on the participants' own activity without peer tutoring.

2.3. Trained peer tutors

The intervention was tutored by 10 trained peers whose expertise and individual experience focused on chronic conditions, and who had earlier taken an eight-month training program to serve as a peer in long-term conditions. The first peer training was an educational program, organized by the local health care district, containing 103 h of classroom studies with additional homework. The program consisted of information about, for example, leading peer groups, providing mental support, and supporting lifestyle changes.

For research purposes, the peers attended an additional course

Table 1
Contents of the online modules (Kasila et al., 2020).

	Online module 1		Online module 2		Online module 3	
Week	Theme	Reflective tasks	Theme	Reflective tasks	Theme	Reflective tasks
1	Identify your values. What is important in your life?	-What kind of life do you want to live and what is important to you? -Are you acting according to your values? -Which small health-related actions could you take today to promote your own well-being?	Where have you succeeded in your change process? What is your aim now? What are your personal ways to make changes?	-What kind of changes do you want to make related to physical activity and nutrition? -In the course of next week, write down your activities, and the consequences of them. -Discuss and reflect with others about the changes you've made.	What are your personal ways to make changes? What is our aim now?	-Tips how to read information on food packages. -Advice on how to increase PA in daily routines. -Suggestions for sufficient sleep and recovery. -Encouragement for taking care of social relationship.
2	Act. Take small steps to improve your well-being.	-What steps could you take today to increase your well-being? -Observe what kind of barriers occur when you're trying to make changes.	Challenging situations and conditions. How to go through them?	-What have been your pitfalls in physical activity and nutrition during the past week? -Do you get hungry by cues? -Does your hungry arise from other occasions, e.g. watching TV or feeling sad? If yes, reflect, what happens then?	Flexible attitude towards a healthy life	-How can you do small actions to improve health and well-being? -Try to feel compassion and think friendly thoughts towards yourself and others around you. -Practice relaxation. Heal the pain in your body if you have it.
3	Increase your awareness. Do things mindfully.	-Do something mindfully that you usually do automatically. -Use all of your senses in your daily life context. -What steps have you taken towards well-being?	Mindful eating	-Try to eat slowly and consciously. How does it feel? -Try to make conscious choices in grocery shop. Can you see any differences compared to automatically made choices? -Try to recognize your eating-related feelings and desires. What are they?	Management of daily routines	-Have you faced challenges in terms of behavior changes? -Reflect on your challenges and obstacles. -Practice stress recovery.
4	Observe and monitor yourself. Learn to know yourself.	-In what situations are you stuck in your own stories and thoughts? -Distance yourself from your thoughts. -Do you realize which thoughts prevent or promote your change? -What value-based actions have you done this week?	Self-compassion Gratitude	-Reflect and write down the things that made you feel sad or that judged you somehow. Try to accept them and feel self-compassion about them. -Write down three things that make you thankful now.	Sources of energy	-What are your personal ways to receive energy? What are the positive consequences of them? -Nutrition, movement, rest, experiences.
5	Observe your thinking.	-What are the feelings and thoughts about yourself that you want to get distance from? Try to identify them whenever they occur. -Do you recognize some thoughts that you try to suppress? -What value-based actions have you done this week?	Physical activity Sleep Body consciousness	-Monitor your physical activity and sleep. -Can you see if physical activity provides you more energy, or does it, how? -Practice body consciousness by doing a reflective mindful exercise.	Get inspired	-Support of family, friends and peers – what is your supportive network like? -What are three things around you that make you happy and satisfied?
6	Let go and accept things you can't change.	-Is there something in your life that you should try to let go and accept? Practice acceptance towards one thing. -Try to feel compassion towards yourself. -What value-based health actions have you done this week?	Commitments Relapses and getting over them	-Which changes you've tried and which of them have succeeded? -What have you learned so far? -Which actions you will take in the near future? -What is your own value-based life like?	Well done!	-Reflect on all the things where you have succeeded. -What are valuable and important things for you? -What can you do right now, to feel even better after half a year?

focusing on peer tutoring in the current ACT-based intervention. Health professionals in each participating area also took part in the training of the ACT-based online intervention and the online program's first module. The training was given by the research team, including doctors of health sciences and clinical psychology with ample experience in health promotion and ACT.

The peers attended two 90-min workshops, familiarized themselves with the first online module with the supervision of the research team, and practiced how to start a group process, maintain group discussions, and give feedback. Additionally, they oriented themselves with the second and third online modules. The training period lasted six weeks. The training workshops consisted of an introduction to ACT as well as an introduction to the ACT-based online program and to online tutoring. The peers were also provided a handbook for online peer tutors and mentoring which was developed by the research team for this purpose. Each peer acted as a tutor for one to five groups and provided personal feedback for 6 to 30 participants during the intervention. Peers were instructed to ask for supervision from the group leader from the health care district (GLH) if needed. The peers received monetary compensation paid by the local Health Care District.

Online peer tutoring consisted of peers' written supportive feedback and responses to participants' written reflections about the content and tasks for the week. The time allocated for tutoring was 15 min for each participant per week. Health professionals did not have access to participants' written reflections.

2.4. Measures/outcomes

Demographic variables included age, sex, working status, self-estimated health assessed with a five-point -scale from *very good health* to *poor health*, and long-term diseases (LTD). The Body Mass Index (BMI) as a measure of an individual's weight associated to their height was measured at baseline by health professionals. A BMI score between 18 and 24.9 indicates normal weight, 25 and over indicates overweight with increased risk, and 30 and over indicates overweight with severe risk for comorbidities (Nuttal, 2015; WHO, 2020). Except for BMI all the measures were self-reported or self-estimated.

The Depression, Anxiety and Stress Scale (DASS-21) was used to clarify *negative emotional states of depression, anxiety and stress* during the past week at baseline. Participants answered on a scale from 0 (*did not apply to at all*) to 3 (*applied to me very much or most of the time*), with seven items dealing with depression (e.g., *I couldn't seem to experience any positive feeling at all*), seven with anxiety (e.g., *I experienced breathing difficulty*), and seven with stress (e.g., *I found it hard to wind down*) with the range being from 0 points at the lowest to 63 points at the highest. The reliability of DASS-21 has been demonstrated in previous studies (Lovibond & Lovibond, 1995; Osman et al., 2012).

Physical activity participation (PAP) was measured by the FIT (Frequency, Intensity, Time) index of Kasari, which is a combination of three self-reported questionnaire scales of physical activity: frequency, intensity, and time (Hicks, Stiolarczyk, Heyward, & Baumgartner, 2000; Karjalainen et al., 2018; Repo et al., 2019). Frequency was indicated on a five-point scale from less than once per month (1) to a minimum of six times per week (5). Intensity was also a five-point scale from light aerobic activity such as normal activity (1) to high intensity activity such running (5). Time devoted to exercise was a four-point scale ranging from less than 10 min (1) to longer than 30 min (4). The total FIT score ranges from 1 to 100, where a higher sum indicates higher PAP.

Psychological flexibility was measured by the acceptance and action questionnaire (AAQ-II; Bond et al., 2011) with seven multiple-choice questions assessing psychological inflexibility, particularly experiential avoidance, as one of its dimensions (e.g., *I'm afraid of my feelings* and *Emotions cause problems in my life*). The AAQ-II scale was used in exploring psychological flexibility skills with a maximum of 49 and a minimum of 7 points. Each question has a seven-point scale from "never true" (1) to "always true" (7). A lower score indicates a higher level of psychological flexibility. Results have indicated that the reliability and validity of the AAQ-II is satisfactory, the mean alpha coefficient being .84 (Bond et al., 2011). In this study, the alpha was .92 at baseline, and the reliable change of the AAQ-II was 10.5 points.

Thought suppression. The White Bear Suppression Inventory (WBSI) questionnaire with 15 multiple choice questions concerning thought suppression was used to assess obsessional thinking with depressive and anxious affect (Wegner & Zanakos, 1994) (e.g., *There are things that I try not to think about*, and *I often do things to distract myself from my thoughts*). In previous studies, the WBSI was used to measure lack of acceptance as a dimension of psychological flexibility (Lappalainen, Langrial, Oinas--Kukkonen, ; Lappalainen, Langrial, Oinas-Kukkonen, Tolvanen, & Lappalainen, 2015). The WBSI is a five-point Likert scale from "strongly disagree" (1) to "strongly agree" (5). The total score ranges from 15 to 75, where a higher score expresses a higher tendency to suppress thoughts. The reliability and validity of the WBSI has been shown to be satisfactory (Muris, Merckelbach, & Horselenberg, 1996; Wegner & Zanakos, 1994). In this study, the alpha was .93 at baseline, and the reliable change of the WBSI was 16.8 points.

2.5. Statistical methods

Descriptive analysis and the comparison between the completer and dropout participants at baseline were made in SPSS 24 using chi-square and *t*-tests. The participants who attended clinical measurements at 24 months with their available FIT scores were named completers. In order to study the changes over the 24-month period, the data were analyzed with Mplus version 8.4 (Muthén & Muthén, 2017) with the full information maximum likelihood (FIML) estimation method. The missing data were assumed to be missing at random (MAR), and all the participants who met the inclusion criteria ($N = 177$) and completed the baseline measurements were included in the analyses.

The main interest in this study was the individual differences in physical activity participation. A person-centered approach was applied to investigate the individual development in a longitudinal study (Kinnunen, Puolakanaho, Tolvanen, Mäkikangas, & Lappalainen, 2019). With *latent profile analysis (LPA)* the participants sharing strong similarities in their process of physical activity were identified, and the models were evaluated based on fit criteria (Table 2). The aim of LPA

Table 2
Latent profile analysis (LPA) identifying participants sharing strong similarities in their process of physical activity. Information criteria values for different class solutions.

Number of classes	BIC	p_{VLMR}	p_{LMR}	Entropy	Cp	Group sizes
1	4794.409	–	–	–	1.000	177
2	*4674.436*	*0.0007*	*0.0009*	*0.747*	*0.927/ 0.920*	*96/81*
3	4665.994	0.0201	0.0227	0.830	0.724/ 0.939/ 0.914	4/88/ 85
4	4666.484	0.2847	0.2970	0.729	0.711/ 0.766/ 0.891/ 0.893	51/4/ 56/66
5	4673.928	0.1345	0.1425	0.781	0.757/ 0.913/ 0.860/ 0.781/ 0.766	53/69/ 49/2/4
6	4676.543	0.1402	0.1517	0.799	0.955/ 0.805/ 0.675/ 0.845/ 0.918/ 0.728	68/36/ 19/46/ 6/2

BIC = Bayesian information criterion.
Cp = Classification probabilities.

analysis was to identify latent groups with similar patterns of physical activity participation based on the means of the FIT index. As in K-means and hierarchical clustering techniques, the final number of latent classes was not predetermined prior to analysis with latent class models. To choose the best-fitting model, the Bayesian information criterion (BIC), *p* levels of vuong–Lo–Mendell–Rubin (vLMR) and adjusted Lo–Mendell–Rubin (LMR) likelihood ratio tests, and entropy values were used as the statistical criteria. In addition, classification quality, usefulness, the interpretability of the latent classes, and the reasonableness of the solutions in relation to the model and to previous research findings were considered when comparing different models. In this study, the latent class 2 was chosen due to the model fit statistics and sufficient equal number of participants in the class. The indexes of latent class 3 would have been good but the size of one of its profiles remained too small.

After the number of profiles was determined, the differences in participants' baseline characteristics in two profiles were tested with *LPA* using an auxiliary command with the 3-step method when the variables were treated as a distal outcome with unequal means and variances (Asparouhov & Muthén, 2013).

Additionally, the significance of changes and group (latent profile) differences in changes were tested with structural equal modeling using *latent change scores*, which is analogous to repeated measures ANOVA. There were four time points: 0, 6, 12, and 24 months. Effect sizes (Cohen's *d*) were estimated with Mplus. Within-group Cohen's *d* was calculated by mean difference between two measurement points, and these were divided by pooled standard deviation between measures. Corrected between-group Cohen's *d* calculated group difference at baseline, and subtracted from group difference at 24 months, and which was divided by pooled (between groups) standard deviation at baseline. The post hoc power (PHP) for group (latent profile) differences in changes between two time points, 0 and 24 months, was calculated using Monte Carlo simulation (reported in Results).

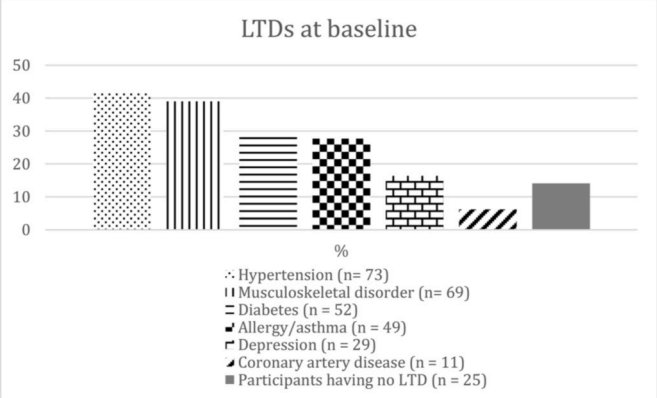

Fig. 3. Frequency of self-reported long-term diseases at baseline.

3. Results

3.1. Participant characteristics

All of the participants were Finnish, and the majority of them were women (83.7%), and obese with a BMI of 30 or higher (87.0%) (Table 3). Half of the participants were working (49.2%), and others were retired, on long-term sick leave or full-time students. Over half of the participants reported their self-estimated health as moderate or poor (53.1%). Baseline characteristics among those who completed the program and those who did not are presented in Table 3. There were no differences between the groups in any of the baseline characteristics.

The majority of the participants reported having at least one long-term disease (LTD, Fig. 3), cardiovascular diseases and musculoskeletal disorders being the most common. However, 14% had no long-term disease.

Table 3
Baseline characteristics with comparison between completers and dropouts.

Measure	N	All	SE	SD	Completer participants, mean (SD)	Non-completer participants, mean (SD)	*p*
Sex, woman[a]	177	83.6% ($n = 148$)			85.7% ($n = 90$)	80.6% ($n = 58$)	.362
Age, mean[b]	177	52.81	0.88	11.69	53.70 ($n = 105$) (11.63)	51.51 ($n = 72$) (11.75)	.224
Working status, employed[a]	177	49.2% ($n = 87$)			46.7% ($n = 49$)	52.8% ($n = 38$)	.424
Participants having ≥ 1 LTD[a]	177	85.9% ($n = 152$)			89.5% ($n = 94$)	80.6% ($n = 58$)	.092
Weight (kg)[b]	177	101.37	1.58	21.01	100.95 ($n = 105$) (19.58)	101.97 ($n = 72$) (23.07)	.752
BMI[b]	177	36.94	0.51	6.74	36.76 ($n = 105$) (6.06)	37.20 ($n = 72$) (7.66)	.675
< 30[a]		13% ($n = 23$)			12.4% ($n = 13$)	13.9% ($n = 10$)	.769
≥ 30		87% ($n = 154$)			87.6% ($n = 92$)	86.1% ($n = 62$)	.769
Physical activity participation, FIT[b]	177	35.11	1.68	22.30	33.52 ($n = 105$) (22.13)	37.42 ($n = 72$) (22.51)	.255
Self-estimated health[a] moderate/poor	177	53.1% ($n = 94$)			60.6% ($n = 57$)	39.4% ($n = 37$)	.704
good		46.9% ($n = 83$)			57.8% ($n = 48$)	42.2% ($n = 35$)	.704
Psychological flexibility, AAQ-II [b]	177	16.31	0.62	8.26	16.85 ($n = 105$) (8.36)	15.53 ($n = 72$) (8.12)	.298
Thought suppression, WBSI[b]	177	40.17	1.00	13.24	40.70 ($n = 105$) (13.50)	39.39 ($n = 72$) (12.91)	.517
DASS[b]	177	10.29	0.64	8.53	10.52 ($n = 105$) (9.08)	9.94 ($n = 72$) (7.71)	.658
Stress[b]	171	3.86	0.26	3.34	3.78 ($n = 103$) (3.31)	3.99 ($n = 68$) (3.40)	.690
Anxiety[b]	173	6.31	0.33	4.35	6.56 ($n = 104$) (4.80)	5.94 ($n = 69$) (3.56)	.363
Depression[b]	168	3.29	0.25	3.19	3.32 ($n = 99$) (3.24)	3.25 ($n = 69$) (3.15)	.878

The level of significance was tested with
[a] Chi-square test
[b] *t*-test

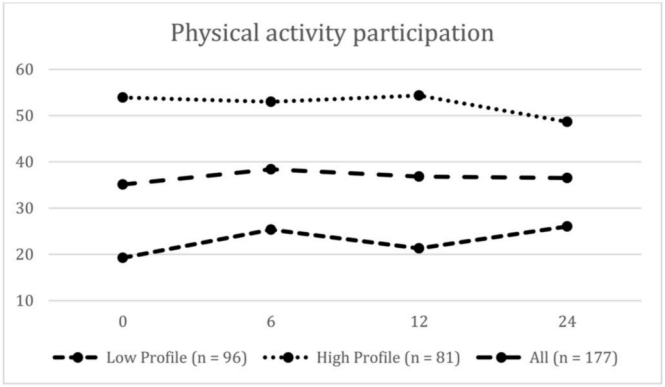

Fig. 4. The profiles of physical activity participation (FIT total) with estimated means during the 24-month period.

Table 4
Profile characteristics at baseline. Mean values, standard errors (SE) and *p* values.

Variable	Profile Low ($n = 96$)	Profile High ($n = 81$)	*p*
FIT[a]	19.91 (2.09)	53.38 (3.96)	<.001 [e]
AAQ-II [b]	18.45 (1.04)	13.70 (1.04)	.005
WBSI[c]	41.29 (1.53)	38.82 (1.55)	.301
DASS[d] total	12.48 (1.06)	7.50 (0.71)	<.001
Stress	4.48 (0.44)	3.10 (0.42)	.051
Anxiety	7.37 (0.56)	5.01 (0.40)	.002
Depression	4.09 (0.41)	2.28 (0.29)	.001
BMI	38.13 (1.98)	35.26 (2.80)	.514
Weight kg	105.26 (2.45)	96.68 (2.97)	.053
Self-estimated health moderate/poor = 0 good = 1	0.37 (0.06)	0.59 (0.06)	.017

[a] Physical activity participation measured by FIT (Frequency, Intensity, Time) index of Kasari.
[b] Psychological flexibility measured by Acceptance and action questionnaire.
[c] Thought suppression measured by The White Bear Suppression Inventory.
[d] Psychological symptoms measured by The Depression, Anxiety and Stress Scale.
[e] The significance of means of FIT was tested using additional model parameters. Other variables in this table were tested using a chi-square test and 3-step method.

3.2. Profiles of physical activity participation and their associations with psychological symptoms and flexibility

Our first research question investigated whether distinct physical activity change profiles could be identified among intervention participants with overweight. The LPA analysis resulted in two particular profiles of self-reported physical activity with good fit (Table 3). Profile A was labeled as *Low* ($n = 96$), representing a low amount of physical activity scores. Profile B was named *High* ($n = 81$), representing higher physical activity over time (Fig. 4).

Second, we investigated whether membership in a physical activity change profile was associated with differences in psychological flexibility and psychological symptoms. The analysis confirmed that there was a significant difference in physical activity participation (FIT total) between the Low and High profile groups at baseline (Table 4). Psychological flexibility was higher (less experiential avoidance) with physically more active participants (High profile group), who also estimated their health to be better than did participants in Low profile group. In addition, in Low profile, participants reported more anxiety and stress. No difference was found concerning thought suppression (WBSI), body weight, and BMI.

3.3. Changes in physical activity and psychological flexibility

Our third research question investigated how psychological flexibility and physical activity changed during the intervention within all participants, and within the Low and High physical activity profile groups. The results showed that the levels of physical activity as measured by FIT total remained relatively stable during the intervention when considering all participants (Fig. 3). However, the frequency of physical activity increased significantly over time (Table 5). The comparison between the Low and High profile groups showed that the groups changed differently during the 24-month intervention, with the post hoc power (PHP) for FIT total being .98. This was due to a significant increase in FIT total, FIT frequency and FIT intensity in the Low profile group. In Low profile, the increase in FIT total was statistically significant from baseline to 6 months (within group $d = .45$), and from 12 months to 24 months ($d = .32$). No within-group changes were observed related to the time spent in physical activity. Among participants belonging to High profile, the physical activity did not change statistically significantly during the 24-month intervention.

There was no significant interaction effect in psychological flexibility (AAQ-II) in the current study. However, AAQ-II improved statistically significantly among all participants and especially with those representing High profile group from 0 to 12 months (within group $d = .20$) and from 0 to 24 months ($d = .34$). For the Low profile group, there was no significant within group change over time (Table 5 and Fig. 5). The PHP for profile group difference in AAQ-II was .56. Thought suppression (WBSI) decreased statistically significantly among all participants and in both profiles (within-group $d = .33$ from 0 to 24 months in both groups), with the PHP for profile group difference still being .73. Among all participants, a small number of individuals eventually crossed the reliable change. Within AAQ-II, a total of 11 participants did so, and within WBSI, a total of 10 participants did.

4. Discussion

4.1. Study outcomes

This study aimed to determine if an ACT-based peer-tutored online intervention could increase self-reported physical activity participation and psychological flexibility among adults with BMI 25+. There were two novel findings in this study. First, two physical activity change profiles were identified, meaning that nearly half (46%) of the intervention participants with BMI 25+ were identified as being physically more active (High profile group) than the rest (Low profile group). Participants in High profile also showed higher psychological flexibility at baseline, displaying particularly less experiential avoidance and thought suppression, at baseline. Second, this study showed that participants with low physical activity benefitted from the current two-year intervention when aiming to increase their physical activity.

In the current study, at baseline, participants in Low profile experienced lower psychological flexibility as well as higher anxiety and depression, and also reported poorer or moderate self-estimated health than did those with High profile. Further, among the Low profile, their physical activity increased throughout the intervention, while their thought suppression decreased. Among High profile, the psychological flexibility increased during the intervention, and thought suppression and physical activity decreased. There are few studies that have explored the impact and processes of ACT-based interventions over a long period of time (Yildiz, 2020). The intervention in this study consisted of supportive and maintaining periods, and it seems that the achieved positive changes in physical activity and psychological flexibility occurred during both periods. Additionally, the successful behavior changes were not stable during the two-year study period demonstrating the variability in behavior change process.

Earlier studies have found that learning psychological flexibility can promote individual health behavior, such as healthy eating (Forman

Table 5
Changes in physical activity, psychological flexibility (AAQ-II), and thought suppression (WBSI) scores during the 24-month intervention. Standard errors (SE) and *p* values reported for the changes when the Wald test was statistically significant.

	All (n = 177)				*Profile Low (n = 96)*				*Profile High (n = 81)*				*The difference in change between profiles*	
	change mean	SE	*p*	Cohen *d*	change mean	SE	*p*	Cohen *d*	change mean	SE	*p*	Cohen *d*	*p*	Cohen *d*
FIT total	W(3), 4.110 $p = .250$				**W(3), 15.475 $p = .002$**				W(3), 5.251 $p = .154$				**W(3), 12.898 $p = .005$**	
0 to 6	3.29			.15	**6.11**	1.95	**.002**	**.45**	−0.93			.06	**.032**	
6 to 12	−1.59			.08	−4.05	2.25	.072	.29	1.37			.09	.123	
12 to 24	−0.32			.02	**4.74**	**2.13**	**.026**	**.32**	−5.69			.35	**.003**	
0 to 12	1.71			.08	2.06	1.93	.286	.16	0.44			.03	.570	
0 to 24	1.39			.07	**6.80**	**2.12**	**.001**	**.48**	−5.25			.31	**.002**	**.85**
FIT frequency	**W(3), 10.983 $p = .012$**				**W(3), 24.796, $p < .001$**				W(3), 0.633, $p = .889$				**W(3), 13.273, $p = .004$**	
0 to 6	**0.25**	**0.08**	**.003**		**0.48**	**0.12**	**< .001**		−0.06				**.001**	
6 to 12	−0.09	0.08	.258		−0.24	0.14	.072		0.05				**.046**	
12 to 24	0.05	0.09	.539		0.19	0.13	.146		−0.05				.140	
0 to 12	**0.16**	**0.07**	**.029**		**0.24**	**0.10**	**.020**		−0.01				.149	
0 to 24	**0.21**	**0.09**	**.014**		**0.43**	**0.12**	**< .001**		−0.07				**.006**	
FIT intensity	W(3), 4.983, $p = .173$				**W(3), 10.095, $p = .018$**				W(3), 7.802, $p = .050$				**W(3), 12.496, $p = .006$**	
0 to 6	0.15				**0.24**	**0.10**	**.016**		0.03				.136	
6 to 12	−0.06				−0.10	0.11	.373		−0.03				.682	
12 to 24	−0.06				0.17	0.11	.129		−0.29				**.009**	
0 to 12	0.08				0.14	0.12	.235		−0.00				.356	
0 to 24	0.02				**0.31**	**0.11**	**.004**		−0.29				**.001**	
FIT time	W(3), 0.283, $p = .963$				W(3), 2.026, $p = .567$				W(3), 2.553, $p = .466$				W(3), 4.411, $p = .220$	
0 to 6	−0.02				0.05				−0.11					
6 to 12	−0.01				−0.14				0.12					
12 to 24	0.03				0.08				−0.04					
0 to 12	−0.03				−0.08				0.01					
0 to 24	−0.00				−0.00				−0.03					
AAQ-II	**W(3), 9.896 $p = .020$**				W(3), 3.744 $p = .291$				**W(3), 18.027 $p < .001$**				W(3), 3.932 $p = .269$	
0 to 6	−0.33	0.53	.536	.04	−0.34			.04	−0.36	0.72	.617	.05		
6 to 12	**−1.46**	**0.70**	**.036**	**.17**	−1.57			.17	−1.20	0.84	.152	.15		
12 to 24	0.34	0.71	.631	.04	1.25			.04	−1.01	0.96	.294	.12		
0 to 12	**−1.79**	**0.64**	**.005**	**.21**	−1.91			.21	**−1.56**	**0.75**	**.038**	**.20**		
0 to 24	**−1.45**	**0.65**	**.024**	**.17**	−0.66			.07	**−2.56**	**0.79**	**.001**	**.34**		.24
WBSI	**W(3), 38.034 $p < .001$**				**W(3), 16.445 $p < .001$**				**W(3), 32.822 $p < .001$**				W(3), 6.251 $p = .100$	
0 to 6	−1.52	0.97	.117	.11	−0.77	1.32	.557	.05	−2.28	1.39	.101	.17		
6 to 12	**−2.86**	**0.99**	**.004**	**.19**	−1.74	1.40	.214	.12	**−4.20**	**1.34**	**.002**	**.29**		
12 to 24	−0.30	1.04	.771	.02	−2.21	1.33	.098	.15	1.85	1.49	.213	.12		
0 to 12	**−4.38**	**0.89**	**< .001**	**.31**	**−2.51**	**1.26**	**.046**	**.17**	**−6.48**	**1.19**	**< .001**	**.48**		
0 to 24	**−4.68**	**0.97**	**< .001**	**.33**	**−4.72**	**1.23**	**< .001**	**.33**	**−4.63**	**1.51**	**.002**	**.33**		.01

Bold signifies the (< .05).

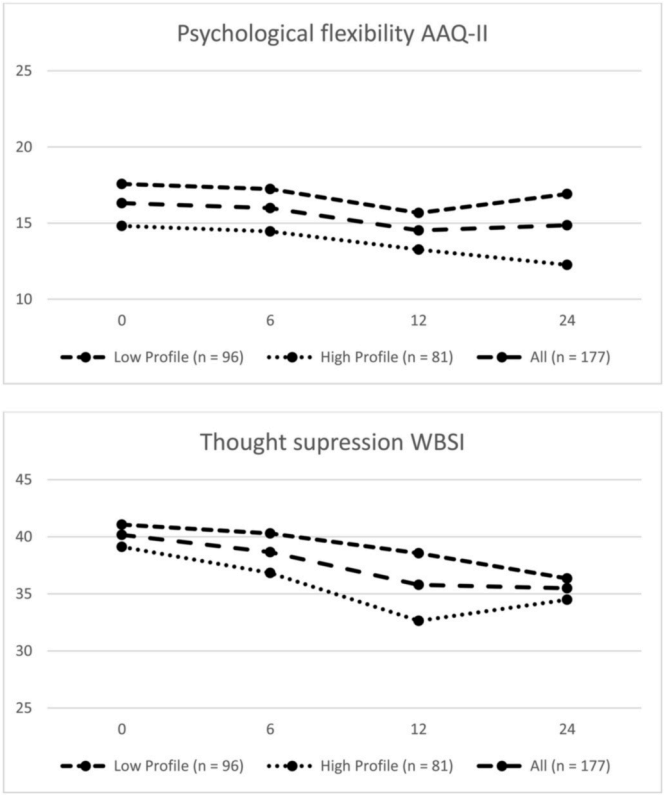

Fig. 5. Mean scores of AAQ-II and WBSI in the two profiles with estimated mean.

et al., 2007; Järvelä-Reijonen et al., 2018; Sairanen et al., 2015), and physical activity (Butryn et al., 2011). Due to relatively minor changes in psychological flexibility and thought suppression, the analysis in the current study did not allow us to study specific associations between the changes of psychological flexibility and physical activity participation. Nevertheless, from a clinical point of view, the achieved positive changes of psychological flexibility in this study can be considered a resource for individuals in the future when making new health behavior changes.

The participants' mean physical activity at baseline was similar to a previous study that also measured FIT scores of patients with chronic conditions (Repo et al., 2019). In this study, there was a high variation of physical activity level (FIT scores) among all participants, but no difference was observed in BMI among those who had high or low physical activity participation. Besides nutrition, physical activity is a key for overweight and obesity self-management, and nearly half of the participants were considered to be physically active in the current study. There are at least three possible explanations for this. First, there are several other variables in addition to physical activity influencing body weight (e.g., eating habits). Second, it may be challenging to objectively assess, for example, the intensity and type of physical exercise. Third, a person can simply be physically active regardless of the size of their body.

In this study, psychological flexibility measured with AAQ-II at baseline was especially higher among those with high physical activity profile than it was in an earlier study of sedentary people (Martin et al., 2015). Additionally, compared to a study of adults with sleep disturbances, in this study psychological flexibility was higher and thought suppression was minor (Lappalainen et al., 2019). At baseline, the measured negative emotional states of depression, anxiety, and stress were higher among Low profile group. This supported the finding that psychological well-being differed between physical activity profiles in this study, which is a subject for further study. Furthermore, among all participants both of the psychological measures (AAQ-II, WBSI) improved through the intervention, even though the very small improvement of AAQ-II in Low profile was not significant. By using latent profile analysis and a person-centered approach in the current study, it was possible to detect the two distinct change profiles.

The current study applied a novel approach to support long-term health behavior changes in primary health services. In an earlier peer-led home visit intervention, Vidoni, Lee, Mitchell-Bennett, and Reininger (2019) found that physical activity levels declined after home visits ended. However, in the present study, the increase of physical activity, especially regarding its intensity and frequency, occurred during the supportive peer tutoring, and was maintained or even further improved during the self-management period. The results of the current study support the previous findings that peer tutors can mentor the increase of physical activity (Punna et al., 2019). Yet, there are alternatives to increase the impact of these type of low-intensity ACT-interventions. These include, for example, increasing the number of face-to-face contacts with participants and peer tutors, as well as providing more concrete support and encouragement in physically active lifestyle. This study showed that involving trained peers in ACT-based physical activity interventions seems to be one potential method to support individual behavior changes, but more evidence is still needed.

4.2. *Limitations and future directions*

In line with another online two-year online behavior change intervention (Schulz et al., 2014), the dropout rate in this study was relatively high. Earlier reported attrition rates of group-based physical activity and behavior change interventions with a total duration of between 6 and 24 months were from 3.9% to 58.5%, with a mean of 22.1% (Borek, Abraham, Greaves, & Tarrant, 2018). In this study, the participants were allowed to withdraw at any phase without disclosing the reasons, and therefore all the causes are not known. However, there were no differences in the baseline characteristics between those who completed the intervention and those who discontinued it. Moreover, the applied statistical methods aimed to minimize the effect of missing data. The study was implemented as part of a public health service for individuals who were aiming for health behavior changes. One of its strengths was that it was a realistic intervention in a real-life context, and so it provides knowledge on using a peer-tutored online ACT-based intervention as a format of health counseling. In the future, individual behavior change processes will be investigated with qualitative methods as well. Furthermore, the acceptability of the intervention will be examined to obtain further insight into the factors related to engagement and attrition.

The impact of the investigated peer-tutored online intervention was encouraging, but the conclusions regarding inactive adults with BMI 25+ must be taken with caution. First, despite the significant outcomes in changes of AAQ-II and WBSI, the intervention effect on the psychological flexibility among all participants remains limited. That may be due to the normal baseline levels of AAQ-II and WBSI on average, and to the small number of participants exceeding the reliable changes. Second, the research design did not apply a randomization procedure. Third, the effect sizes of the changes were small. Thus, it is possible that some other variables (e.g., repeated measures) are responsible for the increase in physical activity. Additionally, the identified physical activity profiles provided the opportunity to observe whether, and how, the profiles (representing the individual differences) moderated the effects of the intervention. It is also possible that the physical activity scores of individuals have a tendency to move towards the group mean (regression to the mean), which may explain the increase of activity in Low profile group and the decrease in High profile group. Overall, the study highlights the processes of physical activity and psychological flexibility in an everyday life context over a period of 24 months among adults with BMI 25+.

The reliability of self-reported physical activity may be considered to be moderate (Jakicic, Polley, & Wing, 1998; Paul et al., 2018) and some participants may have overestimated their frequency, intensity, and time of exercise. In addition, the FIT index of Kasari may not measure accurately all the activity due to the overestimation of self-reported exercise, a limitation that has been noted in earlier studies (Jakicic et al., 1998; Paul et al., 2018). Additionally, as with the AAQ-II and WBSI, a ceiling effect may exist in the individual items of the FIT. The scales of the items considerably prevent participants with high physical activity at baseline from being able to increase their physical activity participation scores (including the items of frequency, intensity and time) due to the pre-stated scale and their maximum level. However, when measuring physical activity from a long-term perspective it was decided to use a self-reported questionnaire in this study. For people with low physical activity the Kasari FIT index may be a favorable tool for measurement and self-monitoring due to their low levels of frequency, intensity, and time of PA.

AAQ-II as a measure of psychological flexibility has been criticized for being a broadband measure of inflexibility, which does not cover the lack of contact with values, self-as-content, flexibility, and present moment awareness (Rogge, Daks, Dubler, & Saint, 2019), and focusing on psychological distress and avoidance (Tyndall et al., 2019). However, the AAQ-II is a commonly used measure of general psychological flexibility. In the current study, AAQ-II was used together with a measure of thought suppression (WBSI) in order to approach the process of psychological flexibility more broadly.

It can be considered a strength of the study design that the study was able to reach clients with overweight and obesity with long-term conditions using public health services. Low physical activity and long term-conditions are also critical in terms of public health resources and expenditure. Implementing evidence-based online services that use peer tutoring may, over the long term, reduce health care costs. This study highlights that psychological flexibility skills are associated with physical activity levels among adults with BMI 25+, and that the ACT-based peer-tutored online intervention can be beneficial for people with low physical activity participation. The achieved individual changes may generate both physical and psychological long-term well-being. We call for more longitudinal research on the effects of ACT-based health behavior interventions. Additionally, there is a need for future studies to explore whether changes in psychological flexibility predict changes in physical activity, or vice versa. Overall, these findings highlight the importance of studying individual differences when providing interventions for people with low physical activity and overweight.

Declarations of competing of interest

Dr Kaipainen is the co-founder of Headsted Ltd, which develops online interventions for mental health issues and maintains the online programme examined in this study. Given their role as an Editorial Board Member, Lappalainen R. had no involvement in the peer-review of this article and had no access to information regarding its peer-review. The other authors declare that they have no conflict of interest.

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