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Living SMART — A randomized controlled trial of a guided online course teaching adults with ADHD or sub-clinical ADHD to use smartphones to structure their everyday life

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ABSTRACT

Objective: To evaluate an online intervention for adults with ADHD that aimed to improve organizational skills and attention with the help of smartphone applications.
Method: Participants (n = 57) were recruited and assessed through questionnaires and telephone interviews. Diagnoses of ADHD were confirmed for 83% of the participants, 5% most probably had the diagnoses, and 12% did not fulfill all diagnostic criteria despite high levels of symptoms. Participants were randomized between the intervention (n = 29) and a wait-list control group (n = 28). The 6-week intervention involved support from a coach in finding a routine for organizing everyday life with the help of smartphone applications. The primary outcome measure was ASRS Inattention. Secondary outcomes were ASRS sub-scale Hyperactivity and measures of depression, anxiety, stress, quality of life and general level of functioning. Blind evaluators also assessed improvement in organization and inattention at post treatment.
Result: The participants receiving the Living Smart course reduced their average scores on ASRS-Inattention from 28.1 (SD = 4.5) to 22.9 (SD = 4.3) which was a significantly larger reduction than found in the control group. 33% of participants were considered clinically significantly improved according to the blind evaluator, compared to 0% in the control group. The same results were found when only participants with a confirmed diagnose were included in the analyses.
Conclusion: Adults with ADHD seem to be able to use smartphone applications to organize their everyday life and can be taught how to do this via online interventions.

1. Introduction

Attention Deficit Hyperactivity Disorder (ADHD) is one of the most commonly diagnosed behavioral disorders for children and adolescents and often persists to affect 2–4% of the adult population (Biederman et al., 2011; Schilling et al., 2011). Adults with ADHD have an increased risks of engaging in criminal activities and drug use and abuse (Carpentier et al., 2011; Schilling et al., 2011) and develop anxiety and mood disorders more often, (R. Kessler and Adler, 2006). They are also in increased risk of showing suicidal behavior (Impey and Heun, 2012), and more often suffer from impairment in academic achievement and social performance (de Graaf et al., 2008). Core symptoms include difficulties in regulating attention, activity level, and impulses, along with impairments in working memory and executive functioning. Adults with ADHD often have difficulties planning and organizing life, perceiving time, performing multiple tasks simultaneously, staying organized and completing activities (Bálint et al., 2009; Barkley, 2002; Faraone et al., 2003). Because of the impairments associated with ADHD, effective treatment for adults is important.

The majority of adults diagnosed with ADHD are offered pharmacological treatments as the major treatment option and few patients are offered psychological treatment following completion of neuropsychiatric assessment and diagnosis (R. Kessler and Adler, 2006). However, pharmacological treatment is not sufficiently effective for 20–50% of adults, who do not experience satisfying symptom reduction, or find it difficult to take the medication because of side effects (Wilens et al., 2002). Cognitive behavioral therapy (CBT) has shown promising results in treating symptoms of ADHD. (Bramham et al., 2009; Emilsson et al., 2011; Mongia and Hechtman, 2012; Ramsay and Rostain, 2011; Safren et al., 2005; Weiss et al., 2012). A recent meta-analysis comparing psychosocial interventions and medication for adolescents with ADHD showed that behavior therapy produced the greatest effects on impairment and that medication

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produced the greatest effects on symptoms. Cognitive enhancement trainings were not effective treatments for ADHD in adolescence (Sibley et al., 2014).

One of the most commonly used treatment manuals has been developed by Stevenson et al. (2003). One of the main features in Safren's treatment is to improve the patients' organizational skills like planning, time management and to start and finish tasks.

To help the patients structure their life, the use of aids such as timers, a weekly schedule, agenda/calendar, reminders, shopping lists and schedules for cleaning, laundry etc. are common (Franck and Andréasson, 2003; Fernell, 2008; Hallberg, 2009). Tools like these are readily available on smartphones. According to Hallberg (2009) alarm functions, text messages, calendars, "to-do-lists", GPS, music, games, calculator, voice memos, and camera are all features that are useful for individuals with ADHD. Major advantages of the smartphone are that it is always accessible for most people and that the phone does not look like a treatment tool which can reduce the stigma of being dependent on an aid (Davies et al, 2002). Several of these tools are available in their analog form as parts of Safren's CBT treatment (2005), most notably calendar and to-do-lists. A review of which IT tools adults with ADHD desired found that tools that give support for organization, structure and scheduling and coordination of activities was the most desirable (Fernell, 2008). It was also important to use already established communication media such as a mobile phone or a laptop (Fernell, 2008). A project in which adult students with ADHD and Aspergers syndrome learned to use a smartphone-based calendar synchronized with a computer showed a reduction in stress for the participants (Steindal and Michelsen, 2011).

Internet-based CBT (ICBT) has received good scientific support for several disorders (Andrews et al., 2010; Cuijpers et al., 2010). ICBT has the advantage of requiring less therapist time and being more accessible (Andersson, 2009). ICBT interventions are structured as online-courses including a number of modules with text, homework assignment, and quizzes and utilizes the same methods as traditional face-to-face CBT. A CBT intervention for adults with ADHD consisting of a self-help book, three therapist-led sessions, and weekly telephone calls with coaches to guide the participants through the program have previously shown promising effects on ADHD-symptoms with 36% in the clinical group reporting a clinical relevant reduction in symptoms which was significantly more than a wait-list control (Stevenson et al., 2003). Recently, Pettersson et al. (2014) published a trial where an internet-based self-help CBT intervention for adults with ADHD was supported in two different ways; by automatic e-mail prompts combined with non-active therapist support (i.e. the patients had to initiate the contact with the therapist) and by weekly group sessions led by a therapist. The results were promising in that both types of support provided a significantly better outcome than a wait-list control, but the study was underpowered (largest group n = 18) and was not informative about differences about the two treatment groups. To date there has been no randomized controlled trial evaluating the effect of internet-delivered interventions utilizing the form of active therapist support that is generally more effective (Johansson and Andersson, 2012) or teaching adults with ADHD to use smartphones to specifically target their problems with inattention and deficits in organizational skills. Combining smartphone applications such as calendars and to-do-lists with technical instructions and teaching strategies on how to use them in one's everyday life are probably more efficacious than using the applications without the strategies or the strategies without the applications.

The purpose of this study is to evaluate if an internet-based course, Living Smart, can teach adults with ADHD and pronounced current difficulties with inattention to use smartphone applications in order to improve their everyday organizational skills and if this will decrease their problems with inattention compared to a wait-list. The effects on hyperactivity, general mental health, stress, and overall functioning will also be evaluated.

2. Method

2.1. Design

Participants were randomly assigned on a 1:1 ratio to either the internet-based course with support (Living Smart) or to a wait-list control group. The control condition later received the online course without support. The study was approved by the local research ethics review board in Stockholm (identifier number 2012334314) and was registered at ClinicalTrials.gov with the Identifier: NCT01663610. Participation in the study was voluntary and all participants provided informed consent to participate and were not given any economical compensation for participating.

2.2. Procedure and measurement overview

Individuals interested in the study first filled out a screening questionnaire via a secure internet platform where the participants first created their own log in. This was followed by a structured telephone interview with a preliminary diagnostic assessment, confirmation of diagnoses through medical records (when these were available), a decision on inclusion or exclusion, and finally randomization. Before and after the intervention all participants filled out questionnaires on the internet platform. Participants in the intervention group also filled out the primary measure once a week during the intervention. Furthermore, blind evaluators made a structured interview and assessment at post-treatment.

2.3. Participants and recruitment

Recruitment was conducted through postings on a patient association website, status updates at Facebook sharing information on where to sign up, and via the website of the ICBT unit (www.internetpsykiatri.se) within the Stockholm County Council, a routine care setting for internet-based treatment and the base for the current trial.

The study's target group was adults over the age of 18 in Sweden with a diagnosis of ADHD and judged to currently have pronounced problems with organization and inattention. Since citizens from all Sweden were included and the timeframe and resources for the trial were limited, a complete neuropsychiatric assessment was beyond the scope of this trial. It was thus decided to relay on previous diagnostic assessments made in regular care and in cases where this could not be used to confirm diagnosis, a structured assessment to identify participants with 'probable diagnosis' was performed (see section 'Diagnostic assessment'). Participants with a probable diagnose and current pronounced deficits in organizational skills and attention were included in the study.

2.3.1. Inclusion criteria

a) confirmed or probable diagnosis of ADHD,
b) current problems with organizing daily activity and inattention defined as 17 or more points on the ADHD Self-Report Scale (ASRS; R. C. Kessler et al., 2005) subscale for Inattention (items 1–4 and 7–11),
c) has access to a smartphone (android or Iphone) with internet access,
d) at least 18 years,
e) speaks, writes and read Swedish, and
f) cannot foresee any practical barriers to participation such as travels or medical operations.

2.3.2. Exclusion criteria

g) has a high alcohol or drug use assessed by the AUDIT/DUDIT and assessment interview,
h) somatic or psychiatric problems that are directly contraindicated or seriously hamper the implementation of the treatment (eg, psychotic disorders),

i) has severe depression, defined as MADRS-S over 30 or suicidal risk judged by more than 4 points on the MADRS-S question 9 or according to the structured telephone assessment, and
j) currently undergoing some form of treatment that focuses on reducing symptoms of ADHD.

Descriptive data and sample characteristics are presented in Table 1. The two groups did not differ significantly on any demographic or clinical variables at baseline. Participant flow through the trial is shown in Fig. 1.

2.4. Diagnostic assessment

All included participants living in Stockholm gave their permission to have their medical records examined by the researchers in the current study to confirm previous assessment and diagnoses concerning ADHD. If medical records were unavailable for evaluation, the below procedure to estimate the probability of having an ADHD diagnose was used.

The participants stated in the screening questionnaires if they (I) themselves believed they had the diagnosis, (II) had been through a neuropsychiatric assessment and if so where and when this had been performed, and (III) if this resulted in a diagnosis or not. To evaluate how reliable a stated diagnosis was, we controlled or contacted the clinics mentioned by the participants to ensure that they actually did provide high quality neuropsychiatric assessments. Finally, in the structured telephone interview, the DSM-IV diagnostic criteria of ADHD were evaluated in such extent that was possible (i.e. without performing neuropsychiatric tests or double-checking childhood anamnestic information with parents). The two assessors BM and LK, further described below since they also were therapists, both had prior experience of diagnosing ADHD according to the DSM-IV criteria.

Of the total 57 included participants, medical records confirmed ADHD in 29 (51%). Besides these, 18 (32%) participants stated that they had been diagnosed with ADHD, and were judged to fulfill diagnostic criteria at the telephone interview. Also, the clinics where they had been assessed were judged to have the competence to perform a thorough neuropsychiatric assessment. Thus, they were judged as very probable to have an ADHD diagnose. Additionally, three more participants (5%) were deemed to have a probable diagnosis even though they stated that they so far had not received a formal diagnosis due to delayed assessment process.

Unfortunately, for several participants bureaucratic delays caused the review of their medical records to be performed after they had been included in the trial. This resulted in that 7 participants (12%) first were deemed to have a probable diagnosis and pronounced difficulties with inattention and organizational skills, but afterwards the medical records revealed that their previous neuropsychiatric assessment did not confirm the diagnose. These participants were classified as not having the diagnosis but only pronounced current difficulties with inattention and organization. Diagnostic status did not differ significantly between the groups with 23 individuals in the intervention group and 22 in the control group having a confirmed or very probable diagnosis of ADHD (Chi-2(1) = 0.03; p = .86).

Table 1
Sample characteristics, and demographic variables.

	Living Smart (n = 29)	Control group (n = 28)	Statistics (*T*-test or Chi-2)
Mean age (sd)	36.3 (11.1)	37.3 (10.8)	t(55) = −.36; p = .72
Gender (%)			
Male	7 (24%)	11 (39%)	Chi-2(1) = 1.51; p = .22
Female	22 (76%)	17 (61%)	
Relationship status			
Married/registered partner	21 (73%)	15 (53%)	Chi-2(3) = 5.18; p = .16
Divorced/Widow/Widower	3 (10%)	1 (4%)	
Single	3 (10%)	9 (32%)	
Other	2 (7%)	3 (11%)	
Highest education			
Elementary school	1 (3%)	4 (14%)	Chi-2(3) = 2.45; p = .48
High school	11 (38%)	11 (39%)	
College/University	15 (52%)	12 (43%)	
Other	2 (7%)	1 (4%)	
Employment (several options possible)			
Working/Self-employed/Studying	23 (67%)	22 (67%)	Chi-2(4) = 4.79; p = .31
Sick leave/Disability retired	6 (21%)	4 (12%)	
Seeking employment	2 (7%)	4 (12%)	
House wife/House husband	0	1 (3%)	
Other	3 (10%)	1 (3%)	
Self-reported somatic illness			
Yes	11 (38%)	9 (32%)	Chi-2(1) = 0.01 p = .91
No	18 (62%)	19 (68%)	
Self-reported comorbid psychiatric disorder			
Yes	8 (28%)	13 (46%)	Chi-2(1) = 1.46; p = .23
No	21 (72%)	15 (54%)	

3. Measures

3.1. Primary outcome

The primary outcome was the ASRS subscale measuring Inattention (R. C. Kessler et al., 2005). ASRS is a self-report scale for diagnosing ADHD and consists of 18 items, divided in two subscales; one scale measuring problems with Inattention (9 questions), and one scale measuring problems with Hyperactivity (9 questions). The response type consists of a 5-point Likert scale with options “Never” (0), “Rarely” (1), “Sometimes”(2), “Often” (3) or “Very Often”(4) giving the scale a total point of 72 for full-scale ASRS and 36 each on the two subscales inattention and hyperactivity. Test–retest reliability of the ASRS is 0.878 (Kim et al., 2013). The cut-offs are the following for each subscale: 0 to 16 means unlikely to have ADHD, 17 to 23 means likely to have ADHD, and 24 to 36 means highly likely to have ADHD.

3.2. Secondary outcomes

3.2.1. Sheehan disability scale (SDS)

Sheehan Disability Scale (SDS) is a self-report instrument designed to measure global level of functioning. Each of its three questions can be estimated from 0 to 10 and reflects how much problems the individuals impairments cause in the areas of Employment, Social Life/Leisure and Family Life/Chores. The total value ranges from 0, unmanaged function level, to 30, severely impaired level of functioning. For American primary care patients the internal reliability was high, with Cronbach's alpha 0.89 (Leon et al., 1997).

3.2.2. Hospital anxiety and depression scale (HADS)

HADS is a self-report scale using 14 items and two subscales to measure depression (HADS-D) and anxiety (HADS-A) symptoms. Each subscale consists of seven questions that scores 0–3. The scale has good internal reliability (Lisspers et al., 1997). Eleven points can be seen as a clinical threshold on the scale (Zigmond and Snaith, 1983). The HADS-A cut-off of above 7 to indicate a probable anxiety diagnosis has a sensitivity of 0.66 and specificity of 0.93 and HADS-D cut-off (also above 7) has a sensitivity of 0.66, and a specificity of 0.97 to detect a probable diagnosis of depression (Bjelland et al, 2002).

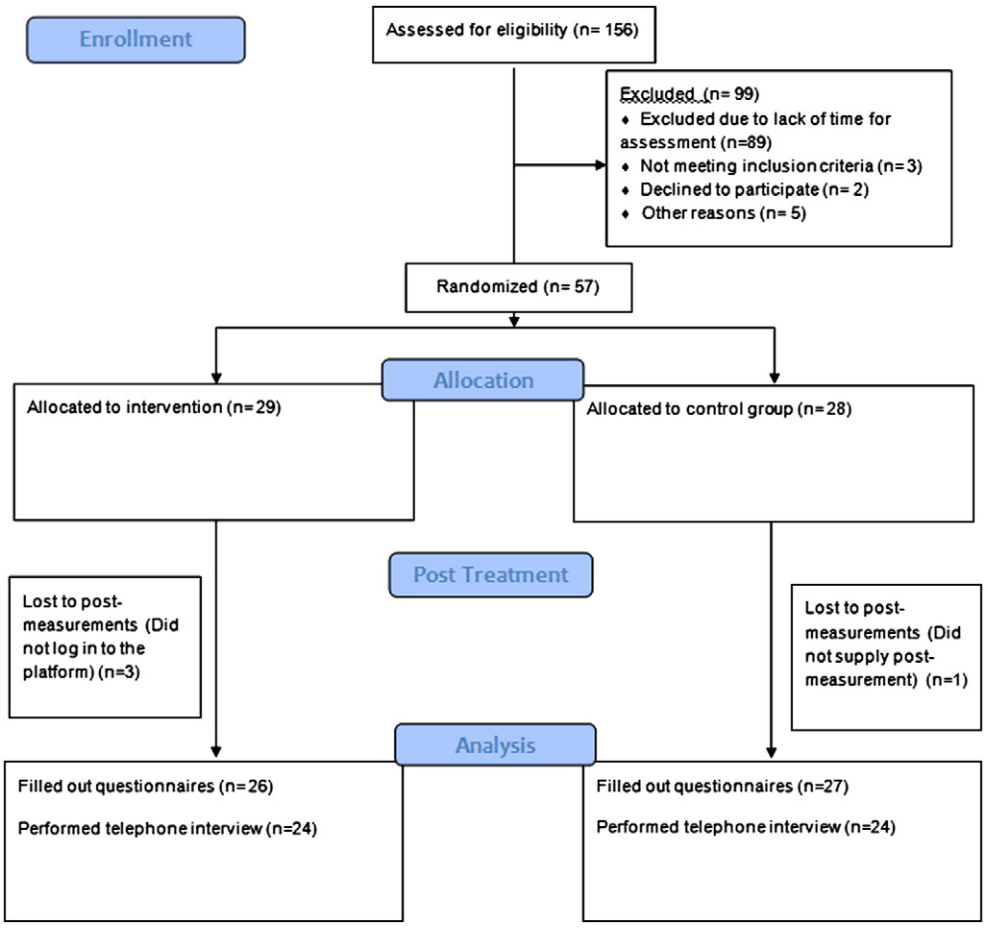

Fig. 1. CONSORT flow chart.

3.2.3. The perceived stress scale (PSS)

The Perceived Stress Scale (PSS) is a widely used psychological instrument for measuring stress. Items were designed to measure stress and how uncontrollable respondents find their lives during the last month (Cohen et al, 1983). The PSS version used in this study has 10 items with response alternatives 0 (never) to 4 (very often) and an internal reliability of a Chronbach's alpha of 0.89 (Roberti et al, 2006)

3.2.4. Clinical significant change

Following the intervention, four blind assessors who were psychologist students in their last semester of the Swedish five-year clinical psychologist program or in their first year of clinical practice telephoned all participants and asked questions regarding organization, inattention, medication, and other treatments. In the end of the interview, they also made an assessment of change in the participants' difficulties with organization and inattention. The assessment used were a slightly adapted version of the Clinical Global Impressions scale — Improvement (Kadouri et al., 2007): "Compared to how you described your problems with organization and inattention the last time you were interviewed, about six weeks ago, how would you perceive that you have changed?". The blind assessor listened to the participants answer, asked some clarifying questions if needed and then used this information together with the impression from the rest of the interview to rate the participants as Very much improved (1), Much improved (2), Minimally improved (3), No change (4), Minimally worse (5), Much worse (6), or Very much worse (7). Clinical significant change was then defined as Very much improved or Much improved. The blind evaluators were not aware about this definition when performing the adapted CGI-I.

In addition to this, clinical significant improvement was also calculated as the number of participants who fell below 17 on ASRS inattention (i.e. being unlikely to have a diagnosis) and at the same time had had a reliable change of 5 points on the ASRS, as calculated from the test–retest reliability in accordance with the procedure described by Jacobson & Truax (1991).

3.3. Other measures

At the end of the intervention the participants also answered open ended questions to provide for a qualitative evaluation of the treatment.

During the intervention the following measures of activity and compliance were measured; number of messages to and from the participants; number of text messages to the participants' smartphones related to their course progress or reminding participants of weekly assessments; total time spent by the coach giving support to each participant; and finally how many modules each participant finished.

At the post-course assessment, the participants were also asked if they had made any changes in medication or been engaged in other kind of possible therapeutic interventions during the course period.

4. Intervention

4.1. The living smart course

The course Living Smart was inspired by specific parts of an existing CBT intervention manual for ADHD (Safren et al., 2005), what previous studies have found to be important IT tools for adults with ADHD (Fernell, 2008; Hallberg, 2009) and the general structure of internet-based CBT interventions (Andersson et al., 2008). Providing support

through a coach was seen as important in light of previous findings that internet-delivered CBT works best with therapist support (Palmqvist et al., 2007) and the fact that we expected the target group to need help to focus on the treatment. The course consisted of 7 text modules distributed over 6 weeks. The weekly modules taught the use of an online calendar (via computer and smartphone) and applications for reminders and to-do-lists. Furthermore, additional apps were introduced that previously had been shown beneficial for adults with ADHD (Fernell, 2008; Hallberg, 2009; Steindal and Michelsen, 2011; Sikstro and Smart, 2007; Studer et al., 2009). The content of each module including the relevant smartphone applications and their assumed useful effects are presented in Table 2.

The course began with the participants gaining access to the internet platform that included course materials and a messaging system for secure communication with the coach. During the course the participants received homework related to the techniques and apps used in each part. Technical lessons about how to use the applications were adjusted to fit booth Iphone and Android smartphones. Participants were also encouraged to use the help of a friend or relative if they experienced technical difficulties.

During the course all participants used Google Calendar as their main tool. The calendar was synchronized to the individual's smartphones and learning organization through the use of the calendar was one of the primary goals of the intervention. Some parts of the calendar could be shared with the course coach if the participant wanted to. Learning to use the to-do-list application G-tasks was also an important and reoccurring feature in the intervention.

In addition to these fundamental and mandatory apps, a range of other apps targeting specific problem areas in ADHD were briefly introduced and voluntarily used by the participants. Evernote is an app for making notes and remembering thoughts and ideas and was used as a complement to G-tasks. N-back was used to train working memory functioning and fluid intelligence and has previously shown promising results in this area (Studer et al., 2009). Simply Noise produces white noise which has been shown to be beneficial in improving concentration among adults with ADHD (Sikstro and Smart, 2007). Two online browser extensions Stayfocusd and Leechblock were introduced for blocking distracting internet sites. General administrative apps such as Dropbox, banking apps, and apps for commuting were also briefly presented.

4.2. Support during the intervention

The coaches in the study were in their last semester of the Swedish five-year clinical psychologist program (BM) or in their first year of clinical practice (LK) after the program. This program incorporates a basic 1.5-year psychotherapy course in CBT. Both coaches had previous experience in diagnosing and treating adults with ADHD. BM treated 19 participants and LK treated the remaining 10 participants. The coaches received regular supervision by a licensed clinical psychologist with a long clinical and research experience in internet-delivered interventions (VK) and when needed a clinician with previous extended experience of CBT for adults with ADHD (BN). The coaches gave written individual feedback to the participants regarding their progress when they had completed a module. No outside e-mail was used due to privacy concerns. Throughout the course the coaches attempted to contact the participants once a week through telephone calls to ensure progress and help participants with technical and motivational issues. On average, each participant had telephone contact with the coaches 3–4 times in total. Furthermore, participants were encouraged to write to the coaches whenever they needed coaching regarding their own work with the course material. Text messages (SMS) were used to remind participants to continue working with the course material and fill out weekly assessments.

4.3. Statistical analyses and handling of missing data

The analyses were done according to the principles of intent-to-treat. All participants, including those who ended the course prematurely, were asked to fill out the post-measurement after the 6-week period of the online course. For all statistical analyses, observed data were used in the primary analyses. To evaluate the effect of missing data, additional sensitivity analyses were performed using last-observation-carried-forward where the last ASRS-score of the weekly measures was used to replace missing data at post-treatment.

To ensure that the results were not due to the inclusion of the seven participants not fulfilling all criteria for ADHD (three in the Living Smart group and four in the control group), a sensitivity analysis for each outcome measure was made without these participants.

T-tests and Chi-2 tests were used to compare the groups at baseline. To determine difference in outcomes, the interaction in a 2×2 repeated measures ANOVA was tested with time (pre- and post) as within subject variable and group as between subject factor.

5. Results

5.1. Baseline differences and sensitivity analyses

No significant differences between the Living Smart and the control group on any of the outcome measures were found at baseline (p-values between .0.1 and 0.49). The sensitivity analyses with last-observation-carried-forward did not differ from the main analyses, and the same was true when the seven participants without an ADHD-diagnosis were removed from the analyses. Hence, only the main analyses on observed data for all participants regardless of diagnostic status are presented below.

5.2. Attrition, dropout and compliance

Fig. 1 shows the flow through the course phase of the study. Three participants in the course group dropped out, stating that they did not

Table 2
Overview of the internet-based course Living Smart.

Module	Content	Smartphone applications
1	Introduction to the course, goal setting	–
2	Introduction to Google Calendar, shared calendar and weekly planning	Google Calendar (Time management) N-back (improving working memory)
3	Smartphone calendar, using reminders, daily planning	Google Calendar Evernote (Notes to aid memory)
4	Using to-do-lists, working with difficult tasks	G-tasks (to-do-list) Google Tasks (organization)
5	Reducing distractions and stopping procrastination	Stayfocusd (block distractions) SimplyNoise (reduce distractions)
6	Problem solving, advanced features and repetition	Dropbox, Banking apps
7	Summary of the course, planning for the future	All applications

intend to finish the course. Participants completed on average 3.7 modules (SD = 1.6) out of 7.

On average participants received 12.9 (SD = 7.2) messages with feedback from their coach and on average 3.6 (SD = 2.4) telephone calls. The participants sent on average 11.6 (SD = 7.0) messages to their coach in the platform.

To keep up with the general progress the participants received an average of 20.5 (SD = 6.1) text messages to their smartphones where 9.7 (SD = 4.6) were related to course progress and 10.3 (SD = 4.3) were reminders of pending weekly assessments. On average the course support person spent 59.8 min (SD = 35.7) on each participant in the platform during the intervention. No correlation between the time the support person spent and change in outcome was found (r = −.049; p = .81).

5.3. Primary outcome

Participants in the Living Smart group presented a significantly larger decrease in the ASRS subscale for Inattention as compared to the control group (Table 3).

Measures from screening, pre-treatment, post-treatment and each week during treatment (intervention group only) are shown in Fig. 2, indicating that the groups start to differ at week 3 when the 95% confidence intervals in the intervention group no longer overlap the control groups' confidence interval at pre or post.

5.4. Secondary outcomes

Effects on secondary outcomes are presented in Table 3. HADS Depression and the Hyperactivity subscale of ASRS showed significantly larger improvements for participants in Living Smart compared to the control group, for the other secondary measures no significant interactions were found.

5.5. Clinical significant change

Table 4 presents the blind assessors' ratings of change in organization and inattention during the course period, as measured with the adapted CGI-I scale (Berk et al, 2008). Clinical significant change was defined as Much or Very much improved and these criteria were reached by 8 (33%) in the intervention group which was significantly more than in the control group where none were significantly improved (Fisher's Exact Test; p < .01).

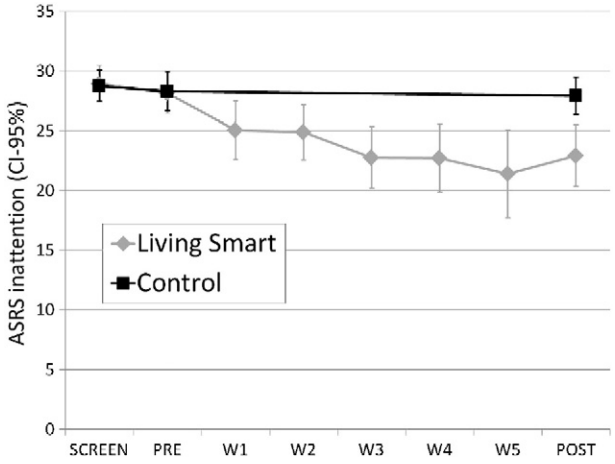

Fig. 2. Weekly change in primary outcome with 95% confidence intervals.

Of the 52 telephone interviews performed, 46 remained blind during the whole interview. During 8 interviews the participants despite the clear instructions told the interviewers which group they belonged to. Removing these interviews from the data did not alter the result.

Using more conservative criteria for clinical significance, 6 people in the intervention group (21%) and 0 people in the control group showed a reliable changed of 5 or more points on the ASRS and had scores below the cut-off (17) for probable diagnosis. These analyses were also significantly in favor of the Living Smart group (Fisher's Exact Test; p = .02).

5.6. Qualitative evaluation of the intervention

Participants allocated to the Living Smart course answered open ended questions about how they felt regarding the course at the end of it. They were overall happy with the course and reported that it had been a good intervention. Some individuals reported that they wanted more guidance. Several reported that the course gave them a better understanding of their own shortcomings, which they found helpful. Several participants had experienced events in their private lives that made it hard for them to work on the course and several also reported that

Table 3
Outcome of Living Smart and control group.

	Pre (SD)	Post (SD)	Within-group effect size *d*	Between-group effect size *d*	Interaction effect
ASRS Inattention					
Living Smart (n = 26)	28.12 (4.45)	22.92 (4.34)	1.18	1.21	F(1, 53) = 23.75; p < .001
Control (n = 27)	28.22 (4.34)	27.93 (3.93)	0.07		
ASRS Hyperactivity					
Living Smart (n = 26)	23.15 (6.07)	19.54 (7.09)	0.55	0.19	F(1, 53) = 6.38; p = .02
Control (n = 27)	21.67 (6.52)	20.85 (6.38)	0.13		
HADS anxiety					
Living Smart (n = 26)	8.85 (3.95)	7.96 (4.10)	0.22	0.24	F(1, 53) = 2.75; p = .10
Control (n = 27)	8.52 (2.48)	8.81 (2.83)	0.10		
HADS depression					
Living Smart (n = 26)	7.08 (4.21)	6.62 (4.54)	0.11	0.23	F(1, 53) = 4.79; p = .03
Control (n = 27)	6.44 (3.99)	7.70 (4.70)	−0.28		
PSS					
Living Smart (n = 26)	21.27 (6.42)	21.08 (8.16)	0.025	0.33	F(1, 53) = 1.13; p = .29
Control (n = 27)	21.67 (6.87)	23.74 (7.79)	0.28		
SDS					
Living Smart (n = 26)	20.08 (5.99)	16.46 (8.97)	0.47	0.33	F(1, 54) = 2.33; p = .13
Control (n = 28)	20.18 (4.02)	19.04 (6.20)	0.21		

ASRS — ADHD Self-Report Scale, PSS — The Perceived Stress Scale, HADS — Hospital Anxiety and Depression Scale, SDS — Sheehan Disability Scale.

Table 4
Blind assessors rating of change on the adapted CGI-I scale for organization and inattention.

	Very much worse	Much worse	Minimally worse	No change	Minimally improved	Much improved	Very much improved
Intervention	0	1	0	6	9	6	2
Group (n = 24)	0%	4%	0%	25%	38%	25%	8%
Control	0	4	3	17	4	0	0
Group (n = 28)	0%	14%	11%	61%	14%	0%	0%

problems with lack of energy and time that made it hard to focus on the course. Many participants requested a longer treatment time.

5.7. Changes in medication and other interventions during the course period

In total, 14 individuals made some kind of change in ADHD medications during the 6 weeks between pre and post-measurement. 10 individuals were involved in other interventions during the same time period. There was no significant difference between the number of individuals who changed medication or were involved in other intervention between the two groups (Chi-2(1) = 0.03; p = .86). A comparison between those in the Living Smart group that was exposed to other possible therapeutic activities and those who were not revealed no significant difference in outcome (t(24) = −0.79; p = .44). Table 5 presents a more detailed overview of the changes made in each group.

6. Discussion

The aim of this study was to evaluate the online course Living Smart for adults with ADHD, teaching them how to use smartphone applications as an aid in everyday life. The participants in Living Smart showed larger improvements regarding attention and organization skills compared to a wait-list control group, both according to self-report measures and when evaluated as clinical significant change by a blind assessor. There was also a significant decrease in hyperactivity and depression, however the other secondary outcomes of anxiety, stress, and overall functioning did not indicate superiority towards the wait-list. This study demonstrates that adults with ADHD can be reached via the internet if the course material and routines are adapted to online format and the ADHD group.

The dropout from the intervention was low but the number of completed course modules was just slightly over 50%, and although the most fundamental methods and applications were included in the first half of the modules, this indicates that the participants might have needed more time. This was also clearly supported by the results of the qualitative evaluation where many participants expressed concerns over lack of time.

The rather weak or even non-significant effects on the secondary outcomes, where also the effect on depression could be questioned since it partly depends on a worsening among controls, might be due to the relatively short interventions period and to floor-effects, since many measures indicated rather low levels at baseline. At the same time, it indicates that Living Smart had a specific effect on inattention and organizational skills rather than a broad general effect. This specificity of the intervention is supported by the finding that the effect on hyperactivity, although significant, was much smaller than the effect on inattention, which is well in line with the therapeutic content in the course. The specificity also gains support by the fact that the effect on inattention (d = 1.27) was slightly larger than the effect previously found for a longer and more comprehensive ICBT-intervention (d = 1.07; Pettersson et al., 2014). However, as the participants learned a number of ways to manage their everyday life, it is a little bit surprising that the intervention did not seem to affect the participants' perceived level of stress. It is also important to notice that although the reduction in inattention was large and significant, the average level of inattention was still above the threshold of 17 on the ASRS and few met the more conservative criteria of clinical significant change. This indicates that the Living Smart course should be used as an add-on to other interventions for adults with ADHD, rather than a substitute.

During the intervention the participants received support both in the form of telephone calls and encouraging text messages from the coaches. The qualitative evaluation revealed that some participants wished to have more support, and it is possible that one face-to-face session with a more hands on demonstration of the mobile applications would have been beneficial to some participants. It is reasonable to assume that this type of support is important for any interventions with adults suffering from ADHD since they usually have severe problems with procrastination. The role of support should be tested more specifically in future studies, especially since we did not find a correlation between the amount of therapist support and outcome, an observation that might be caused by less successful participants requiring more support which has been previously observed (Kaldo-Sandström et al., 2004). The participants were overall happy with the course even though many participants requested a longer treatment time and more support. For future interventions with a similar format it would be recommended to somewhat lengthen the intervention to further improve the number of completed modules and hopefully the intervention effects.

This study was not without limitations. The primary limitation is the lack of confirmed ADHD-diagnoses for some of the participants and the fact that 12% did not receive an ADHD diagnose after their previous neuropsychiatric assessment and hence were classified as sub-clinical ADHD. However, in 88% of the cases the diagnoses were either confirmed or highly probable and all participants did meet the cut-off score of 17 on ASRS and evidently suffered from significant problems with attention and organization which were the target for the intervention. But most important, the sub-analyses where the participants without an ADHD diagnose were removed did not alter the results, which indicates that the findings are generalizable to adults with ADHD.

Another limitation was the use of a wait-list control group, with insufficient ability to control for placebo or unspecific treatment effects. That means that the observed superiority of the intervention could have been caused by the mere attention, self-reflection, increased level of activity, the relationship with the coach, or some other mechanism other than the intended; i.e. the use of the mobile applications and the organizational skills taught in the course. The absence of a

Table 5
Possible therapeutically relevant events during the course period (self-reports).

Type of event	Living Smart (n = 29)	Control group (n = 28)
Attended psychotherapy or psycho-educational groups about ADHD	7	4
Attended other psychological intervention	1	2
Lowered dosage[a]	2	2
Increased dosage[a]	1	1
Stopped medication[a]	0	1
Adjusting dose, changed drug, took drug irregularly, or changed distribution of the dose throughout the day[a]	3	3
Total number of participants engaging in at least one self-reported therapeutically relevant event	14	13

[a] Applies to ADHD-related drugs.

correlation between amount of support and outcome and rather large specific effects on the target symptoms, but not on secondary measures, make this a little less probable since a placebo effect is more likely to be broad and general rather than specific, but future studies should use more active controls.

During the course period about half of the participants were involved in other therapeutic relevant activities such as changes in ADHD-medication or some kind of psychological or psycho-educational intervention. This could be a confounding factor in two ways. The primary concern is that the beneficial outcome in the Living Smart group might be due to other interventions and not the internet-course itself. However, because these other interventions were so evenly distributed between the two groups, an equally large reduction of inattention would have been expected in the control group. Also, a comparison between those in the Living Smart group that was exposed to other possible therapeutic activities and those who were not revealed no difference in outcome. A secondary concern would be that being involved in more than one therapeutic activity actually could cause negative effects such as presenting conflicting therapeutic models or information, stress, or a of lack of time or energy to fully utilize any of the offered interventions. This kind of negative interaction was however not reported by any of the participants in the qualitative evaluation.

Finally, the number of participants and hence the statistical power were rather low, which specifically calls for some caution when interpreting the secondary outcomes where effects might be lower. In conclusion, this study shows that adults with ADHD benefit from a coach-guided online intervention teaching how to use smartphones and online tools to decrease the negative effects of inattention and increase organization skills. On a more general level, it clearly supports the notion that internet is a feasible way to reach this patient group.

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