Looking inside the black box of 'Hold on, for each other'

Investigating usage and non-adherence in a Web-based self-help intervention for partners of cancer patients: A log data analysis

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Abstract

Background: A cancer diagnosis not only affects the lives of the patients, but also the lives of their partners. To meet partners in their needs for supportive interventions, the web-based intervention '*Hold on, for each other'* has been developed. Web-based interventions have benefits like great potential for reaching people and the possibility to tailor information to the needs of a client. However, the effects of these interventions are small. This can partly be explained by the intensity of use of the participants and the problem of non-adherence. These insights in how individuals use a web-based intervention is often lacking. Therefore, the aims of the current study are (1) to give a general impression of the scope of non-adherence in current intervention and the intensity of use of different features in the intervention; (2) to find predictors of non-adherence by identifying differences between adherers and non-adherers in background variables, intervention usage and satisfaction; and (3) to identify the consequences of non-adherence and intensity of use on psychological distress.

Method: We combined questionnaire data of participants of '*Hold on, for each other'* with a log data analysis on data of the web-based intervention. Log data of 203 participants were collected within the web-based intervention itself.

Results: Of all 203 participants, 124 (61.1%) completed the intervention. Most of the non-adherers were of the waiting list condition and the log data analysis revealed that of all participants, 18 participants never started the intervention and were therefore never exposed to the intervention. Most logins were found in lesson 1 for both, the adherent and the non-adherent participants. On intervention usage, most participants (82.8%) used at least one time the mindfulness exercise during the intervention. In contrast, the participants hardly used the different elements of peer support, only 6.9% used the opportunity to send messages to others. In terms of predictors of non-adherence, a significant difference was found in satisfaction score between adherers and non-adherers (adherers were often more satisfied with the web-based intervention). Also significant differences were found between adherers and non-adherers on condition. Participants in the personal feedback condition did more often adhere to the intervention. In terms of consequences of non-adherence, the results show that (non)-adherence and intensity of use did not have an influence on psychological distress.

Conclusion: Log data combined with the questionnaire data provided valuable information about the black box of the web-based intervention. The study has shown that participants do not use all the element of the intervention and that there are important differences in usage between adherers and non-adherers within the intervention. With this information we pointed out issues intervention developers should keep in mind. First, intervention developers should identify the number of logins in the first lesson, in order to predict whether a person will adhere or not. Second, an online counselor can have an added value to improve adherence rates. Finally, intervention developers should investigate the added value of the different elements of peer support for the participants in an intervention.

Samenvatting

Achtergrond: De diagnose kanker heeft niet alleen een impact op het leven van de patiënt, maar ook op het leven van de partner. Om partners te voorzien in hun wensen en behoeften, is de online interventie *'Houvast, voor elkaar'* ontwikkeld. Web-based interventies hebben voordelen zoals het kunnen bereiken van veel mensen en de mogelijkheid om informatie persoonlijk af te stemmen aan de wensen van de cliënt. Echter, ondanks deze voordelen zijn de effecten van online interventies klein. Dit kan gedeeltelijk worden verklaard door de intensiteit waarin een interventie gebruikt wordt en het probleem van (non)-adherentie. Er is nog steeds te weinig inzicht in adherentie en hoe een interventie gebruikt wordt. Het doel van deze studie is (1) een algemeen beeld geven van de omvang van non-adherentie en de intensiteit van gebruik van de verschillende elementen in de cursus; (2) identificeren van voorspellers van non-adherentie door het onderzoeken van verschillen tussen adherente en non-adherente deelnemers in achtergrondvariabelen, intensiteit van gebruik en tevredenheid; en (3) het in kaart brengen van de consequenties van non-adherentie op psychologische *distress*.

Methode: In deze studie is vragenlijst data van '*Houvast, voor elkaar'* gecombineerd met een log data analyse van data van de online interventie. De log data van 203 deelnemers zijn verzameld via de web-based interventie.

Resultaten: Van alle 203 participanten hebben er 124 (61.1%) de cursus helemaal afgerond. De meeste participanten die de cursus niet hebben afgerond kwamen uit de wachtlijst conditie en van alle participanten zijn er 18 nooit begonnen met de cursus. De meeste logins zijn gevonden in les 1, voor zowel de adherente als de niet-adherente participanten. De meeste participanten gebruikten minstens 1 keer de mindfulnes oefeningen (82.2%) . Echter, de mogelijkheden tot lotgenotencontact zijn minder intensief gebruikt. Op het gebied van voorspellers van adherentie, is er een significant verschil gevonden in tevredenheid tussen adherente en niet-adherente deelnemers. Ook op het gebied van conditie (persoonlijke en automatische feedback) zijn er verschillen gevonden tussen adherente en niet adherentie deelnemers. Deelnemers in de persoonlijke feedback conditie waren vaker adherent. Echter, op het gebied van de consequenties van non-adherence en interventie gebruik laten de resultaten zien dat (non)-adherentie en intensiteit van gebruik geen invloed hebben op psychologische *distress*

Conclusie: Log data gecombineerd met de interview data heeft waardevolle informatie opgeleverd over het gebruik van de interventie. De resultaten tonen aan dat deelnemers niet alle elementen van een interventie gebruiken en dat er verschillen zijn in interventie gebruik tussen adherente en niet-adherente deelnemers. Aanvullend hierop hebben we belangrijke aanknopingspunten gevonden voor interventie ontwikkelaars die zij kunnen gebruiken bij het ontwikkelen van een interventie. Allereerst, ontwikkelaars zouden de aantal logins in de eerste week moeten identificeren om adherentie te voorspellen. Ten tweede blijkt de online begeleider een positieve rol te spelen bij het verhogen van adherentie. Tot slot, interventie ontwikkelaars zouden de toegevoegde waarde van peer support nader moeten onderzoeken voor deze doelgroep.

1. Introduction

1.1 Caregivers of cancer patients

Cancer has an enormous impact on patients affected by this disease. Many types of cancer may be considered a chronic disease, requiring long-term care (Nijboer, Triemstra, Tempelaar, Mulder, Sanderman & Van den Bos, 2000). Because of this long-term care and the impact of the disease, not only patients are affected by the disease, but also caregivers of patients (O'Brien, 2014). Most cancer patients receive support at home from informal caregivers. Informal caregivers include friends, neighbours and relatives. In most cases it involves a nearby family member providing direct personal support, for example the patient's partner (O'Brien, 2014). Partners are often closely involved in the disease of the patient by offering emotional support, providing care and being responsible for household tasks (Lund, Ross & Petersen, 2014). This implies that the partner has to reorganize and modify his or her tasks and obligations, such as housekeeping, work and caring for children (Effendy, Vernooij-Dassen, Setiyarini, Kristanti, Tejawinata, Vissers & Engels, 2015). Partners are therefore considered the primary source of support for the patient. Being partner of a cancer patient can have an enormous impact on the partner's lives. Partners of cancer patients may suffer from diminished emotional, social, physical and relational functioning (Applebaum & Breitbart, 2013). Recent studies have shown that levels of psychological distress are highly prevalent in partners of cancer patients and can even surpass the levels of distress experienced by the patients themselves (Janda, Steginga, Dunn, Langbecker, Walker & Eakin, 2008).

1.2 Psychological interventions

Despite the serious effects of cancer on the lives of the partners, psychological interventions for partners of cancer patients are hardly available and hardly used. Most existing interventions are aimed at couples and usually no differentiation is made between the needs of partner and patient (Northouse, Katapodi, Song, Zhang & Mood, 2010; Ussher, Perz, Hawkins & Brack, 2009). Furthermore, partners of cancer patients often make no or only limited use of the existing interventions (Ussher et al., 2009). Identified barriers among caregivers of cancer patients are, for example, a lack of familiarity with mental health services, prioritizing the patient's needs, desire to cope with emotional concerns independently and the conviction that use of health services is a weakness (Ussher et al., 2009). It seems that, despite a clear diminished psychological well-being, partners are not inclined to use existing interventions. A reason for this may be that the existing interventions do not match the needs and wishes of partners of cancer patients. Because of the importance of psychological interventions for partners, Ussher et al. (2009) recommended to conduct a needs assessments to get insight in the needs of this target group, before

development of interventions. Another recommendation was to use the Internet to deliver interventions to the caregivers of cancer patients (Ussher et al., 2009).

1.3 Web-based interventions

Increasingly, traditional health programs are replaced by web-based interventions, delivered through the Internet. The Internet can have possible advantages, including a low threshold, high flexibility and the possibility to engage in the intervention at any time (Ussher et al., 2009; Applebaum & Breitbart, 2013). Web-based interventions are conceptualized as primarily self-guided intervention programs that operate through a website, including key components as program content, multimedia use/choices, interaction, online activities and provision of guidance and supportive feedback (Barak, Klein & Proudfoot, 2009). From a research point of view, these web-based interventions have an advantage over traditional interventions in terms of measuring usage because there are many objective metrics readily available, for example the number of times the participant logged in to the intervention (Couper, Alexander, Zhang, Little, Maddy & Nowak, 2010). What all web-based interventions have in common, is great potential for reaching people and the possibility to tailor information to the individual needs of a client (Eysenbach, 2005). This may be beneficial, especially for partners of cancer patients, because this allows them to receive only information that is relevant to them (Wangberg, Bergmo & Johnsen, 2008; Leykin, Thekdi, Shumay, Muñoz, Riba & Dunn, 2012). In addition, web-based interventions aimed at caregivers have shown that they can increase communication between patient and caregiver, support the caregiver, improve negative affect, reduce distress and increase the emotional well-being of the caregiver (Zuhlman et al., 2012; Scott & Beatty, 2013).

Despite these benefits, there are a few disadvantages of web-based interventions. One important disadvantage is that the effects of these interventions are small, especially on the long-term (Kloek, Bossen, Veenhof, van Dongen, Dekker & Bakker, 2014). These modest effects can partly be explained by the intensity of usage of the participants and the problem of non-adherence (Kelders, Kok, Ossebaard & Van Gemert-Pijnen, 2012; Kloek et al., 2014).

1.4 Non-adherence and intensity of use

Non-adherence is an issue for a lot of web-based interventions. A systematic review of Kelders et al. (2012), that assessed 83 web-based interventions on chronic disease, lifestyle and mental health found that, on average, only 50% of the participants adhere to an intervention, which confirms that non-adherence is a problem for web-based interventions. There is a high variety in current literature in how adherence is conceptualized and a clear definition has not been found yet. In a systematic review of Christensen, Griffiths and Farrer (2009), the researchers found that adherence was defined using indications such as number of logins, duration of web exposure, number of modules or exercises completed, and number of postings on forums. Also Donkin et al. (2011) found a high variety of definitions in their systematic review, including the number of times the participant accessed or logged

into the program, completed modules or activities, visits made to forums, posts made to the forums, pages viewed and printed, and self-reported completion of activities (Donkin et al., 2011). Despite the fact that there are several ways to define adherence, in general it is conceptualized as the observation that not all participants use or keep using the intervention in the desired way and the intensity to which individuals experience the content of an intervention (Christensen et al.,2009; Kelders et al., 2012; Wangberg, Bergmo & Johnsen, 2008). Because of this variety in definitions, comparing adherence rates between studies on web-based interventions is complex. Besides, this variation in measurement of adherence makes it difficult to accurately determine the impact of adherence on the outcome of the intervention (Donkin et al., 2011). Therefore, it is not sufficient to only focus on adherence, rather it is recommended to focus on adherence in combination with intensity of intervention usage. Or, in other words: it is important not only to examine if participants logged in to the program, but also to examine which elements are used most and which elements are hardly used by the participants. By investigating this intervention usage, more insight is gained in the 'black box' of the intervention. This insight is important in order to improve interventions and increase their effectiveness (Bartholomew, Parcel, Kok & Gottlieb., 2006; Kelders et al., 2012; Donkin et al., 2011). Besides, it provides valuable information about how users 'pass through the intervention', to know for whom the technology works or does not work, to identify critical moments for drop-outs and to assess what actions participants perform during the login period (Van Gemert-Pijnen, Kelders & Bohlmeijer, 2014). Finally, the combination of adherence and intensity of use provides a measure of activity within an intervention and can provide an opportunity for researchers to understand whether it is usage of the program or adherence that is needed to obtain a clinically effect (Donkin et al., 2013).

1.5 Predictors of non-adherence

Non-adherence in web-based interventions can be caused by various aspects. Several studies (e.g. Christensen et al., 2009; Everts, Bruggeman, van der Lee & de Jager Meezenbroek, 2015; Batterham, Neil, Bennet, Griffiths and Christensen, 2008; Kelders et al., 2011) investigated the baseline differences between adherers and non-adherers, in order to predict adherence in web-based interventions. Depression is for example a common found predictor of non-adherence. Many studies (Christensen et al. 2009; Batterham et al., 2008; Everts et al., 2015) found higher baseline rates for depression in participants who non-adhere in web-based interventions. Also personal support of an online counselor can influence adherence. In general, higher non-adherence rates are reported in web-based interventions without guidance of a counselor (Christensen, Griffiths, Korten, Brittliffe & Groves, 2004), while the number of adherers is higher in interventions where feedback is provided and reminders are sent (Eysenbach, 2005). Kelders (2012) also found that interaction with a counselor significantly predicted better adherence. Furthermore, Everts et al. (2015) and Batterham et al. (2008) found that often more men, participants of older age and participants with a lower education level did not adhere. Additionally,

research on non-adherence indicates that an important reason for non-adherence is related to dissatisfaction with the intervention program (Kelders et al., 2011).

1.6 Consequences of non-adherence

Non-adherence is an issue for web-based interventions, because it can have a negative influence on the effectiveness of the intervention. In recent studies (e.g. Donkin et al., 2013) researchers have begun to explore the relationship between program usage and outcomes. This 'dose response' relationship is important to gain insights in the effects of the web-based intervention. It appears that participants who were more actively engaged in an intervention (completing more activities and spending more time in the program), were most likely to benefit from the program (Donkin et al., 2013). In an analysis of intensity of use and changes in depression scores in a web-based cognitive behaviour therapy (CBT) program, greater improvements in anxiety and depression were seen when individuals worked through increasing numbers of modules (Christensen, Griffiths & Korten, 2002). Furthermore, 'high users' (based on number of logins multiplied by duration in minutes per login) of a web-based program aimed at smoking cessation, were more likely to quit smoking and remain continually abstinent compared with 'low users' (Cobb, Graham, Bock, Papandonatos & Abrams, 2005). Besides, in a study of Mohr et al. (2013) adherence was strongly associated with improvement in depression. They found that a higher login frequency, a higher number of lessons used and a higher variety of tools used had a positive influence on depression outcome (Mohr et al., 2013). For this reason, in current study we will not only focus on intervention usage and adherence, but also on the relationship with the outcomes of the web-based intervention to gain insight in the interventions' black box.

1.7 Log data

One possibility to create insight in the black box of an intervention is the use of log data. Log data analysis can be seen as a unique method to investigate the black box of intervention processes and it provides further explanations on the efficacy of such interventions (Han, 2011). Log data analysis is valuable because it provides 'real-time' use statistics that document the specific steps in individual intervention usage, including an in-depth insight into adherence or non-adherence during a process (Han, 2011; Van Gemert-Pijnen et al., 2014). In addition, the use of log data provides knowledge about practical applications of an intervention, which functionalities of an intervention are most often used and which elements in an intervention should be improved in a way that participants can have more benefit from an intervention (van Gemert-Pijnen et al., 2014; Han, 2011; Kelders et al., 2013; Sieverink, Kelders, Braakman-Jansen & van Gemert-Pijnen, 2014). For this reason, the current study will use log data to focus on the general use and adherence of a web-based intervention for partners of cancer patients. By doing so, we are able to establish an overview of the usage of different elements in this intervention. This overview provides a detailed insight of the black box of the web-based intervention.

In other words, insight in which elements are used most and which elements are hardly used by the partners of cancer patients.

In order to provide points for improvement of the web-based intervention, this paper presents analyses of log data collected in a study into the general use and the adherence of the web-based intervention. The aims of current study are (1) to give a general impression of the scope of non-adherence in current intervention and the intensity of use of different features in the intervention; (2) to find predictors of non-adherence by identifying differences between adherers and non-adherers in background variables, intervention usage and satisfaction; and (3) to identify the consequences of non-adherence and intervention usage on psychological distress.

2. Method

In the current study log data of the web-based intervention "Hold on, for each other" were studied and related to questionnaire data derived from an randomized control trial (RCT) of Köhle et al. (2015).

2.1 The web-based intervention '*Hold on, for each other'*

2.1.1 Content

'Hold on, for each other' is an online delivered self-help intervention for partners of cancer patients. It aims to inform and support them in the difficult times they are in. The intervention is based on the Acceptance and Commitment Therapy (ACT). ACT focuses on changing a person's relationship with their thoughts instead of changing the content of their thoughts (Feros, Lane, Ciarrochi & Blackledge, 2013). ACT aims to develop psychological flexibility to enable a person to cope with their situation through the use of acceptance, mindfulness techniques, and a wide range of behavioural approaches (Feros et al., 2013). It can support a partner of a cancer patient to cope with negative thoughts and feelings such as "what if the cancer comes back?" or "what if my partner dies?". People often need to learn to defuse themselves from these negative thoughts, this process is called cognitive defusion (Masuda, Hayes, Sackett & Twohig, 2004). It may help partners of cancer patients to focus on what is really important in their lives and relationships and they also learn to choose actions that are consistent with their own values (Feros et al., 2013). This could be useful for partners of cancer patients, since existing values, patterns, and roles may have been seriously threatened or challenged by the illness (Northouse et al. 2010; Applebaum & Breitbart, 2013).

'Hold on, for each other' consists of six modules, which can be worked through in six weeks. In case participants need more time, they have the opportunity to complete the total intervention in 12 weeks. In each module one particular theme is discussed. The first module focuses on the emotional consequences of being a partner of a patient with cancer. In module two, participants learn how to manage a period of chronic stress and module three focuses on worrying and negative thoughts. Module four and five are focused on values in life and the relationship and the commitment to those values. Module six is about the importance of communication. There are also two optional modules included in the intervention. One optional module (7) focuses on how to move on with life after successful cancer treatment and the other (8) focuses on the terminal phase. For a more detailed description of *'Hold on, for each other',* see Köhle et al. (2015a).

All modules start with a short introduction that matches the theme of each module and psychological exercises based on ACT. Next to the exercises, in each module a meditation exercise based on mindfulness and self-compassion is included. Mindfulness is defined as a form of non-judgmental awareness of present-moment experiences, including emotions, cognitions, and bodily sensations, as well as external stimuli such as sight, sound, and smell (Kabat-Zinn, 2005). This leads to a feeling of being fully present in the moment (Bishop et al., 2004). Next to information and exercises, participants also receive practical information, tips and references to relevant websites and

organizations. In addition, if desirable, there is the opportunity for peer support. Participants have the possibility (1) to share their answers and experiences on some exercises with other participants, (2) to add tips and experiences and to read tips and experiences of others, and (3) to get in contact with other participants in a private e-mail conversation. Participants are randomly divided in two different conditions according to support: personal support versus automated support. Participants in the "personal support" condition received weekly feedback from a personal counselor through e-mail contact. Participants in the "automated support" condition received short, automatic feedback messages directly after completing some of the exercises.

2.1.2 System

When participants logged in to *'Hold on, for each other*' they started in their 'Cockpit' (Figure 1). From there, they could access all elements of the intervention. The elements that were included for all participants were: (1) lessons, (2) overview of completed exercises, (3) feedback, (4) contact with other people, (5) experiences of other people, (6) text message service, (7) personal account and (8) help.

Figure 1. Personal home screen of the web-based intervention *'Hold on, for each other*'.

2.1.3 Service

Participants were able to access the web-based intervention at any time, from any place, free of charge. The participants gained access to the next lesson when he or she completed the previous lesson and was engaged in this lesson for one week. After finishing a lesson, the participants in the 'personal support' condition received a feedback message from a counselor through e-mail contact. After the completion

of a module, a counselor did send an e-mail to the participant (at an appointed day of the week) with a reflection on the progress of the participant and a response to possible problems and questions. Participants were free to choose whether they worked through a lesson in one session, or in multiple sessions.

2.1.4 Interaction

User interaction with the system was only web-based. Interaction in the form of feedback (personal or automatic) was also provided within the system. In addition, interaction with the system took place through email messages which were send to the participants to remind them to start, continue or complete a module. Furthermore, it was optional to receive text messages on their mobile phone. This interaction was only one directional, there was no possibility to reply.

2.1.5 Participants and procedures

The analysis described in this study were performed on data of '*Hold on, for each other'*. Participants were adult partners of cancer patients. 203 partners of cancer patients participated in the web-based intervention. Inclusion criteria for participating in the web-based intervention were: (1) age of 18 years and older; (2) being partner of a cancer patient or cancer survivor; (3) having internet access; (4) proficiency of the Dutch language; (5) and having mild to moderate symptoms of psychological distress symptoms (>3 on the Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983). Exclusion criteria for participating in the intervention were: (1) severe anxiety (score on HADSA $\geq$ 15) and severe depression (score on HADS-D $\geq$ 15); (2) recently started with psychological treatment; (3) not being able to weekly spend 1 hours on the intervention; (4) partner died because of cancer and (5) diagnosis of partner's disease is less than 3 months ago.

The log data of the current study were combined with data of a questionnaire study. In this study, 139 participants completed the questionnaire at t1 of Köhle et al. (2015). So, the analysis on the questionnaire data were performed on 139 participants. Furthermore, we included analysis on the differences in HADS between the personal and automatic feedback condition. Therefore, we excluded all participants of the waiting list condition. Of the personal and automatic feedback condition, 94 participants completed the questionnaire at T1. So, the analysis on differences between the personal feedback condition and automatic feedback condition were performed on 94 participants.

2.2 Data collection

2.2.1 Log data

Usage of the web-based intervention was measured objectively through log data obtained from the intervention system. For every participant, sessions (actions performed between logging in and logging out to the system) were identified. Logins within 1 minute of the previous login were not counted, to

make the logins reflect the number of sessions more. All the other actions were taken into account within 1 minute in order to get a more detailed insight in the black box of the intervention.

Log information of interest included three important parts of the intervention: (non)-adherence, intensity of usage and differences between adherers and non-adherers. Therefore, we identified at first the scope of non-adherence in current intervention. In the current study, a person was defined as adherent when he or she logged in in the last lesson (lesson 6). Therefore, he or she has to complete all the previous lessons. Subsequently we identified the intensity of usage of different elements in the intervention. Therefore, we identified the intensity of use of peer support, the mindfulness exercises and the feedback messages. For the subject *peer support* we identified (1) the number of times participants shared their experiences and tips with other users, (2) the number of times participants read tips and experiences of other users and (3) the number of times participants actually send a private messages to other participants. For the *mindfulness exercises* we investigated whether a person opened the mindfulness exercise. On the subject *feedback*, we identified (1) the number of times a participants opened the feedback message they received from their online counselor and (2) whether and the number of times participants reacted on these feedback messages. Besides, we identified whether participants used the tips provided within the intervention. Furthermore, we examined the predictors of non-adherence. Therefore we investigated the differences between adherers and non-adherers in number of logins, satisfaction and conditions. Finally, we identified the consequences of (non)-adherence and intensity of use on psychological distress. Of each lesson and for each participant, we recorded all actions in between the time they started the lesson and the time they logged out. For example, possible actions were: opening feedback messages, reading tips of the intervention and sending messages to other participants. Moreover, the number of sessions used to complete exercises and content of the lessons were counted.

2.2.2 Questionnaire data

Additional to the log data analysis, we included questionnaire data received from the ongoing RCT of Köhle et al. (2015). Information of interest for the current study were the demographic variables of the participants, the psychological distress of the participants at T0 and T1 and the satisfaction grade given by the participants. The questionnaire at T0 was completed at baseline and the T1 took place 3 months later.

In the study of Köhle et al. (2015) the researchers identified demographic characteristics of the participants in the intervention. Variables of interest for current study were age, gender, ethnicity and employment status of the participants. Additionally, the researchers examined the effectiveness on partners' psychological distress. This psychological distress was assessed with the Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983). This 14-item questionnaire measures the presence and severity of anxiety and depressive symptoms. Answering categories range from 0 to 3 and the items were added to a scale score that can range from 0 – 42 on the total scale ($\alpha = .89$) and 0 – 21 for both subscales anxiety ($\alpha = .81$) and depression ($\alpha = .84$). Reliability scores were calculated at T1. Higher

scores on HADS imply more symptoms for psychological distress. In the current study, we investigated whether there are differences in HADS-score between adherers and non-adherers and if the intensity of usage influences this psychological distress. This psychological distress was calculated as the difference between T1 and T0. Additional to the HADS-score we identified the satisfaction score of participants of the intervention. Participants evaluated the web-based intervention on a scale from 1 to 10. A higher score implies more satisfaction with the intervention. In the current study, we included this satisfaction score to identify whether there are differences in satisfaction between adherers and non-adherers.

2.3 Data analysis

Statistical analyses were done using Statistical Package for the Social Science (IBM SPSS 22.0 for Windows, Chicago, IL, USA). The scope of non-adherence was investigated by identifying the amount of non-adherers for each lesson. Furthermore, the intensity of use was investigated by comparing the mean scores of usage per lesson. Differences in intensity of use was investigated using a Chi square test (X^2). Subsequently, we looked at predictors for non-adherence. Therefore we identified differences in login frequency, satisfaction score and between the conditions (personal feedback, automatic feedback and waiting list). Differences between adherers and non-adherers were investigated using a one-way analysis of variance (ANOVA) and X^2 tests. To identify the consequences of (non)-adherence and intervention usage on psychological distress, a Pearson's rho (r) test was performed. The Pearson's r was performed with intervention usage and adherence as predictors and psychological distress as an outcome variable.

3. Results

3.1 User characteristics

Baseline demographics of the 203 participants that used the web-based intervention *'Hold on, for each other' are* shown in Table 1. Most of the participants were females of Dutch nationality with a higher educational level and a paid job. The mean age of the participants was 56. On gender, there were more female participants compared to male participants in both, the adherent and non-adherent participants.

Table 1. Participant characteristics for adherers and non-adherers (N = 203)

Participant characteristics	Total (N = 203)		Adherers (N = 124)		Non-adherers (N = 79)		*P*[a]
	n	%	n	%	n	%	
Age (M years) [range]	55.9 [27 - 82]		56.3 [33 - 79]		55.3 [27 - 82]		.39
Gender (women)	142	70	89	72.6	52	66.3	
Ethnicity							.52
Dutch	193	95.2	119	96	74	94	
Other	10	4.8	5	4	5	6	
Education							.62
High	107	52.7	63	50.1	44	55.7	
Middle	60	29.6	40	32.3	20	25.3	
Low	34	16.8	18	14.5	16	20.3	
Employment							.17
Paid job > 20h	90	44.3	52	41.9	38	48.1	
Paid job < 20h	14	6.9	11	8.9	3	3.8	
Voluntary work	10	4.9	4	3.2	6	7.6	
Unemployed	5	2.5	3	1.5	2	2.5	
Retirement	37	18.2	25	20.2	12	15.2	
HADS (M)[b]	12.2		11.9		13.3		.89

[a] Differences were tested with Chi square (χ^2) test. [b] HADS score at baseline (T0). * Significant difference at $p < .05$.

3.2 Non-adherence and usage intensity

In the current study, 203 partners of cancer patients participated in the web-based intervention. Of all these participants, 124 (61.1%) completed the intervention by reaching the last module (lesson 6). The other 79 participants did not fully adhere in the web-based intervention. Most of the non-adherers were of the waiting list condition and the log data analysis revealed that of all participants, 18 persons never started the online intervention and were thus never exposed to the intervention content. The average number of lessons started was 4.5 out of a possible 6. Table 2 shows the number of participants who reached a certain lesson. This table shows that the largest group of non-adherers (8.8%) started to non-adhere in lesson 4 or did not start the intervention at all.

Table 2. Furthest lesson reached for all participants (N = 203)

Lesson reached	n	%
0	18	8.8%
1	11	5.4%
2	12	5.9%
3	11	5.4%
4	18	8.8%
5	9	4.4%
6	124	61.1%

3.2.1 Usage of peer support, mindfulness and feedback messages

The number of participants who used the elements of peer support, mindfulness and feedback at least once are presented in Table 3. Most participants used at least one time the mindfulness exercise (82.8%) during the intervention. Besides, 60.1 % of the participants opened at least once the tips which are provided by the intervention. Also, half of the participants opened at least one time the experiences of other participants. Apparently, as shown in Table 4, most participants only use tips and experiences once. Participants opened tips of the intervention and of other participants multiple times in lesson 1, but in the other lessons they did not use it intensively. The average usage in Table 4 shows a pattern in which we can see that the intensity of use is declining. This indicates that participants looked at these elements at the beginning of the intervention, but afterwards they hardly use it. Furthermore, as shown in Table 3, only 6.9% of the participants did send private messages to other participants. Besides, the intensity of use of the opportunity to send messages to other participants is constant for all the 6 lessons. However, the participants who engaged in lesson 7 or 8 sent messages to each other more often than 1 time per lesson. This indicates, that the intensity of use of the opportunity to send messages to each other in the additional lessons, is higher compared with the other lessons.

The feedback messages of the online, personal counselor are used intensively by the participants in the personal feedback condition. As shown in Table 3, almost everyone (97.1%) opened the messages and reacted on it at least one time. Furthermore, as shown in Table 4, the participants opened and reacted on the feedback messages multiple times per lesson. Especially in the additional lessons (lesson 7 and 8) the feedback messages are used intensively. This implies, that the online counselor plays an important role in de intervention.

Table 3. Number of participants who used (at least once) the elements of peer support, the mindfulness exercises and the feedback messages (N = 203)

	N	%
Mindfulness exercise	168	82.8
Opens tips of 'Hold on, for each other'	122	60.1
Peer support:		
Opens experiences of others	106	52.2
Adds tip at own list	55	27.1
Opens tips of others	49	24.1
Sends messages to others	14	6.9
Open feedback message [a]	66	97.1
React on feedback message [a]	66	97.1

[a] Only participants in the personal feedback condition received personal feedback.

Table 4. Average usage of peer support, mindfulness exercises and feedback messages for all the lessons in the intervention (N = 203)

	Lesson 1 (N = 185)	Lesson 2 (N = 174)	Lesson 3 (N = 162)	Lesson 4 (N = 151)	Lesson 5 (N = 133)	Lesson 6 (N = 124)	Lesson 7 (N = 34)	Lesson8 (N = 58)
Mindfulness exercise	1.7	1.7	1.3	1.2	1.6	1.2	.8	1.4
Opens tips of *'Hold on to each other'*	1.1	.5	.4	.2	.3	.2	.2	.7
Peer support:								
Opens tips of others	1.5	.8	.6	.4	.4	.3	.4	1.0
Adds tip at own list	.5	.2	.1	.0	.0	.0	.1	.1
Opens experiences of others	.4	.5	.4	.3	.3	.1	.4	.7
Sends messages to others	.3	.2	.0	.2	.1	.3	1.3	1.5
Open feedback message (n)[a]	4.5 (66)	5.7 (64)	4.4 (62)	6.0 (59)	5.9 (52)	4.3 (49)	8.5 (16)	8.6 (26)
React on feedback message (n)	1.6 (66)	2.2 (64)	1.7(62)	2.3 (59)	1.9 (52)	1.1 (49)	2.7 (16)	2.2 (26)

Note: all values are presented as means. [a] Only participants in the personal feedback condition received personal feedback.

3.3 Predictors of non-adherence

As shown in Table 1, no significant differences were found on baseline characteristics between adherers and non-adherers on gender, ethnicity or age. This implies, that these aspects are not predictive for (non)-adherence.

3.3.1 Number of logins

A considerable difference between adherers and non-adherers is found in the number of logins. As can be seen in Table 5, already in the first lesson adherers logged in more often compared with non-adherers. This result indicates, that the intensity of use in the first lesson is predictive for adhering to the intervention program. The number of logins for each lesson in the web-based intervention are shown in

Table 5. The most logins were found in lesson 1 for both, the adherent and the non-adherent participants. Furthermore, the average logins in the additional lessons are higher compared with the other lessons (8.6 times in lesson 7 and 8.9 times in lesson 8). This indicates that the intensity of use in the additional lessons is higher compared with the other lessons.

Table 5. Number of logins per lesson [a]

	Total		Adhere (N = 124)			Non-adhere (N = 79)		
	Mean	SD	Mean	SD	Valid n	Mean	SD	Valid n
Lesson 1	6.7	3.8	5.7	4.1	185	2,7	1.8	61
Lesson 2	4.4	3.7	5.2	4.0	174	2,5	1.8	51
Lesson 3	3.5	3.3	4.0	3.5	162	2.0	2.3	38
Lesson 4	3.9	3.3	4.2	3.4	151	2,1	1.9	27
Lesson 5	4.3	3.9	4.4	3.9	133	2,3	2.6	9
Lesson 6	3.5	4.2	3.5	4.2	124	-		
Lesson 7	8.6	13.1	8.6	13.1	34	-		
Lesson 8	8.9	13.1	8.9	13.1	58	-		
Total			5.6		203	1,4		

[a] Logins within 1 minute of the previous login were not counted to make the logins reflect the number of sessions more.

3.3.2 Satisfaction

To identify whether there are differences between adherent participants and non-adherent participants in satisfaction we investigated the difference in grades between these groups. These results are shown in Table 6. A significant difference was found in satisfaction score between adherers and non-adherers. Adherers were often more satisfied with the web-based intervention ($x^2 = 16.722$, $P = .01$). This may imply that participants start to non-adhere because they are less satisfied with the intervention.

Table 6. Differences in satisfaction score between adherers and non-adherers

Participant characteristics	Total (N = 203)	Adherers (N = 124)	Non-adherers (N = 79)	*P* [b]
Satisfaction score (M)[a]	7.2 (N = 120)	7.4 (N = 102)	6.3 (N = 18)	.01*

[a] The mean score of a satisfaction survey assessed at T1. [b] Differences were tested with Chi square (χ^2) test

3.3.3 Conditions

As mentioned, the participants in the web-based intervention were divided in three different conditions: the automatic feedback, the personal feedback and the waiting list condition. We identified usage differences between these three groups. As shown in Table 8, there were differences found between adherers and non-adherers on condition. The percentage of adherers is highest in the personal feedback condition (39.5%), followed by the automatic feedback condition (35.5%). So, the participants in the

personal feedback condition did more often adhere to the intervention. (x^2 = 10,111, P = .006). Furthermore, an analysis of variance shown in Table 7 revealed that participants in the personal feedback condition did significantly logged in more frequently compared with the automatic feedback. This indicates that participants in the personal feedback are more engaged in the intervention.

Table 7. Analysis of variance in login frequency between personal feedback and automatic feedback (N=185)[b]

	n	M	F	df	*P*[a]
Lesson 1	185	4.68	4.0	2	.020*
Lesson 2	175	4.39	5.3	2	.006*
Lesson 3	162	3.51	7.2	2	.001*
Lesson 4	151	3.84	5.5	2	.005*
Lesson 5	133	4.29	3.5	2	.032*
Lesson 6	124	3.51	8.4	2	.000*
Lesson 7	35	8.63	1.5	2	.249
Lesson 8	58	8.72	2.9	2	.062

* Significant difference at p < .05 two tailed. [a] Differences are tested with a One way Anova. [b] Participants are divided in three different conditions: personal feedback (feedback on a weekly basis), automatic feedback (automatic feedback immediately after completing an exercise) and the waiting list group

Table 8. Differences in the number of logins between the three conditions: personal feedback, automatic feedback and the waiting list

	Personal feedback (N = 68)	Automatic feedback (N = 68)	Waiting list (N = 67)	P
Adherers (%) [a]	49 (39.5%)	44 (35.5%)	31 (25%)	.01*
Total number of logins (M)[b]	20.1	34.5	12.1	.26

[a] Opened lesson six. [b] The mean number of logins during the whole intervention. Differences were tested with a Chi square (χ^2) test

3.4 Consequences of non-adherence

To get insight in the consequences of non-adherence on the outcome of the intervention, we examined the differences between adherers and non-adherers on psychological distress. These mean differences are found in Table 9. As shown, no significant differences were found between adherers and non-adherers on psychological distress. This implies, that adherence did not have an influence on psychological distress.

Table 9. Mean differences between adherers and non-adherers on changes in psychological distress (N = 136)[b].

	Total (n = 136)	Adherers (n = 91)	Non-adherers (n = 45)	P[c]
Delta HADS[a]	.85	1.03	.48	.57

Note: all values are presented ad means. * Significant difference at p < .05. [a] Differences in psychological distress is calculated by T1 – T0 of RCT data. [b] Participants of the personal and automatic feedback condition. [c] Differences were tested with a Chi square (χ^2) test

Correlations between intervention usage and the difference in psychological distress are presented in Table 10. Bivariate correlation analyses revealed no significant relations between intensity of use and the outcome on psychological distress. This implies that the intensity of use did not have an influence on psychological distress.

Table 10. Correlation of Pearson's r between intervention usage and psychological distress (N = 94).

	Delta HADS[a]	P	N[b]
Number of logins	.04	.69	94
Mindfulness exercise	.14	.17	94
Open tips 'Hold on, for each other'	.07	.52	94
Open feedback of counselor	-.01	.95	94
React on feedback	-.01	.95	94
Send message to other participants	-.02	.85	94
Open tips of other participants	-.02	.96	94

[a] Differences in psychological distress is calculated byT1 – T0 of RCT data. [b] Participants of the personal and automatic feedback condition, who completed the questionnaire at T1 of Kohle et al. (2015). *Significant difference at $p < .05$, two tailed. Differences were tested with a Pearson's R correlation.

4. Discussion

The goal of the present study was to investigate non-adherence and intensity of intervention usage of ' Hold on, for each other', a web-based self-help intervention for partners of cancer patients. Furthermore, we identified usage differences between adherers and non-adherers in order to provide starting points for intervention improvement. Another goal of this study was to investigate the consequences of non-adherence by comparing the outcome for psychological distress between adherers and non-adherers. In this study, we combined questionnaire data of an ongoing RCT on participants of '*Hold on, for each other'* with a log data analysis on data of this web-based intervention. This study is, as far as we know, the first log data analysis that investigates the usage of a web-based intervention for partners of cancer patients.

4.1 Non-adherence

Results on non-adherence showed that of the 203 participants that accessed the web-based intervention *'Hold on, for each other'*, 61.1% completed the intervention. This is in line with the results of Christensen et al. (2009). The researchers found in their systematic review that adherence to the complete web-based intervention was approximately 50 - 70% for depression interventions for patients. The relatively high adherence rates in current study may be caused by the intervention being developed in such a way that each module could be completed within 1 hour and participants could choose whether to only read information or do assignments such as the psychological exercises. In addition, the content and design of the web-based interventions is matched with the needs of partners of cancer patients, by actively and repeatedly involving partners in the developmental process (Köhle et al., 2015).

4.2 Intensity of use

In the current study, we found an average login of 5.6 times per lesson. In addition we found that participants logged in most frequently in the first lesson and the number of logins decreased over the weeks. This is a common finding in research to web-based intervention and is known as the law of attrition (Eysenbach, 2005). The decrease in logins might also be a learning effect; participants might need fewer sessions to complete a lesson at the end of the intervention compared to the first lessons of the intervention program (van Gemert-Pijnen et al., 2014).

We also found that participants do not use all the elements of the intervention. For example, participants did not intensively use the elements of peer support. Our results show that only 6.9 % of the participants use the opportunity to send messages to each other at least one time. This is remarkable because in a study of Köhle et al. (2015) the researchers identified the needs and preferences of partners of cancer patients regarding a web-based intervention. In this study, the researchers found that the majority of participants was interested in some form of peer support.

However, this result matches the results found by Mosher, Ott, Hanna, Jalal and Champion (2015). In their qualitative study about coping with lung cancer for patients and their caregivers the researchers found that individuals viewed online peer support as unhelpful due to the tragic nature of participants' stories. Furthermore, evidence for the psychological benefits of peer support in cancer patients and their caregivers has been mixed (Hoey, Ieropoli, White & Jefford, 2008) and the uptake of peer support services has been low among caregivers of cancer patients (Mosher et al., 2013). For further research, it would be interesting to identify why the participants did not use this aspect of the intervention.

Finally, when we look at the contacts between the participants in the personal feedback condition and their online counselor, we found that participants intensively used the possibility to open and react on the feedback messages. It seems that, in current study the online counsellor plays an important role for the participants. This result is in contrast with Kok et al. (2014). In their study about adherence in an online intervention for patients with depression the researchers found that a low number of mails were send by participants to their online counselor. In their study the main aim of the counselor was to help participants to work through the modules through email contact and telephone support. This contrast could be explained by these telephone contacts. In current study, no telephone contacts were included and contact only took place by e-mail. Additionally, this contrast could be explained by the nature of the mails sent by the counselor. In current study, the counselor often asked for a response or confirmation of the participant. Besides, it might be that participants found it pleasant when they could share their experiences with a counselor and used the feedback mails as a way to clarify and explain their answers in the exercises.

4.3 Predictors of non-adherence

The participants in current study were mainly Dutch females with a higher educational level and a paid job. This group of participants is comparable to the groups reached by other web-based interventions (e.g. Eysenbach, 2005; Andersson et al., 2009; Kok et al., 2014). However, in contrast to previous findings (Christensen et al., 2009; Everts et al. 2015), these baseline characteristics such as education level, gender and age are not predictive for intervention adherence in current study.

There were differences found in login frequency between adherers and non-adherers. Participants who completed the intervention logged in more frequent than participants who did not reach the last lesson. These login differences are already visible in the first lesson of the intervention. This implies, that we may be able to predict after a single lesson, whether a participant will adhere or not. This is an important fact were intervention developers can early respond and anticipate on. This result also indicates that adherers not only complete more lessons compared to non-adherers, but are also more engaged with the intervention compared to non-adherers. These results are in line with results of Kelders et al. (2012), investigating usage of web-based intervention for the prevention of depression. In their study, the researchers also found that participants who complete the intervention login more frequently.

On the results of the satisfaction grade of the intervention we found that adherers were more satisfied with the web-based intervention compared with the non-adherers. This result is in line with a qualitative study of Bendelin, Hesser, Dahl, Carlbring, Nelson and Andersson (2011). The researchers found in their study that participants who reported that they only worked sporadically with the intervention, were less inclined to evaluate the intervention positively (Bendelin et al., 2011). Also Kelders et al. (2011) found that adherers score significantly higher on satisfaction with their web-based intervention, compared with non-adherers. This may indicate that participants start to non-adhere because they were not satisfied with the intervention, however, further research is necessary to conform this result.

Furthermore, in the current study we found that participants in the personal feedback condition more often adhere to the web-based intervention compared with the participants who received automatic feedback. This result is substantiated by the results of a study of Brouwer et al. (2011). They observed that support of a counselor was related to higher frequency of logins and longer visit duration. Also Mohr et al. (2013) found a significantly higher adherence in the group with supportive feedback. In addition, Kelders et al. (2012) found that interaction with a counselor significantly predicted better adherence.

4.4 Consequences of non-adherence

In current, existing literature a lot of contradictory results are found on the impact of non-adherence and intensity of use on outcome measures of web-based interventions. Prior to current study we expected that adherent participants who intensively used the intervention had more effect on psychological distress compared with non-adherent participants. However, we found no significant relationships between intensity of use, non-adherence and psychological distress. This result implies, that it is not relevant whether a participant adheres to the intervention or how a participant use the intervention. This is a remarkable result which is not always confirmed by other recent studies. For example Mohr et al. (2013) did found in their study that adherence was strongly associated with improvement in depression. They found that higher login frequency, a higher number of lessons used, higher variety of tools used had a positive influence on depression (Mohr et al., 2013). However, in contrast to this result, van Gemert-Pijnen et al. (2014) found that intervention usage and the login frequency per lesson did not predict the outcomes in a web-based intervention aimed at depression. Also Donkin et al. (2013) investigated the dose-response relationship between usage and outcome in a web-based intervention. They found in their RCT relationships between only a few usage variables and clinically significant improvement. Only the number of activities completed per login predicted outcome measurers. Furthermore, in a systematic review of Donkin et al. (2011), the researchers identified that most studies found a positive relationship between intensity of use and intervention outcome (Donkin et al. 2011). However, when further analysis is performed, the ability of these variables to predict improvement in outcome measures is limited (Donkin et al. 2013). This implies that the relationship between (non)-

adherence, intensity of use and intervention outcome is not straightforward and further research is necessary.

4.5 Strengths and limitations

The results of this study add to our knowledge about non-adherence and the intensity of use of web-based intervention, which can be used when designing web-based interventions, in order to increase adherence, usage and effectiveness. Because of the use of a log data analysis, our results are not influenced by, for example, socially desirable behaviour, but instead it gives us objective and real time information.

It is important to also consider a number of methodological limitations of the present study when interpreting the results. First, we analyzed and interpreted the log data without involving the participants. We did not ask participants why they used the intervention this way. However, we were interested in general use and differences between adherers and non-adherers in this study, the log data provided us with this objectively measured and real-time information.

Second, our study was performed on the data of one intervention for partners of cancer patients. The observed use patterns may be specific for this group using this intervention. This limitation goes together with another limitation to this and most other studies on web-based interventions. There is no universally accepted measure of adherence to web-based interventions and multiple definitions of adherence exist, varying from frequency of logins, time on website and number of modules completed (Christensen et al., 2009). Comparing adherence rates between studies on web-based interventions is therefore complex.

Third, it is possible that participants have stopped to adhere in the intervention because their ill partner died of the disease, and therefore the intervention may not have supported the partners' needs anymore. This is not due to the intervention itself.

Fourth, unfortunately, no information was available in the log data on the date and amount of time spent by participants per module. This is an important limitation of this study. While we advised participants to finish around one module in 1 hour per week, we were not able to check whether they actually did this. This limitation goes together with another limitation for this study. In current study the used log data was not always very clear. All the data of the participants was logged, therefore it was very hard to identify useful data and to interpret the available data. This may lead to incomplete interpretations of the data. For intervention developers it is important to pay attention to the way they want their data to be logged. They should think on the forehand what could be important to them.

At last, we investigated adherence in a web-based intervention. However, it is complex to investigate adherence in an intervention like *'Hold on, for each other'.* This because participants could decide for themselves whether they wanted to do an exercise or not; completion of the exercises were not mandatory to go to the next lesson. The online counselor repeatedly emphasized that it is not a

problem if participants skip an exercise because the exercise do not appeal to them or do not suit their situation. For this reason, we could not specifically define adherence as the completion of exercises, but we could only look at the starting of lessons. This implies, that if participants only opened the six lessons and perform no further actions, they could be categorized as adhere.

4.6 Further research

A number of recommendations based on these findings can be made. Future research should continue on the topic of log data, as it is a promising and rising method to investigate the black box of web-based interventions.

When the log data of '*Hold on, for each other'* is used more intensively, it is important to further identify the available data. As mentioned before, there is a lot of data available and the interpretation of this data is sometimes unclear. For further research, it should be interesting to investigate the fact that participants in the intervention hardly used the elements of peer support. It could be useful to identify why they did not used this, by conducting interview sessions. It would also be interesting to look more specific at the psychological exercises of the intervention. In the current study, we only identified the mindfulness exercises, but also the other psychological exercises should be investigated for a more detailed insight in the usage of exercises. Additionally, it could be interesting to identify the self-reported use of the participants and compare these data with the log-data. In this way a more complete overview of the intervention usage is created. Finally, in the current study we investigated whether adherence and intervention usage had an influence on the outcome for psychological distress. For further research it could be interesting to look at the effect of adherence and intervention usage on other psychological aspects, for example mental health or caregiver strain.

5. Conclusion

For this study, we may conclude that using log data combined with the questionnaire data provides valuable information about the black box of the web-based intervention '*Hold on, for each other'*. We identified that participants did not use all the elements of the intervention and that there are important differences in usage between adherers and non-adherers within the web-based intervention. However, adherence and intensity of use of different elements in the intervention did not have an influence on the outcome on psychological distress. With this information we pointed out issues that intervention developers should keep in mind. First, intervention developers should identify the number of logins in the first lesson, this login frequency can predict whether a participant will adhere to the intervention or not. By identifying this first week, a developer can intervene if necessary. Second, an online counselor can have an added value in the improvement of adherence in the web-based intervention. Participants who receive feedback from an online counselor are more often adherent to the intervention. Finally, intervention developers should investigate the added value of the different elements of peer support for the participants in an intervention.

6. Literature

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