



ANU KANGASNIEMI

The mindfulness, acceptance and commitment approach to encouraging a physically more active lifestyle

**THE MINDFULNESS, ACCEPTANCE AND
COMMITMENT APPROACH TO ENCOURAGING
A PHYSICALLY MORE ACTIVE LIFESTYLE**

ANU KANGASNIEMI

Esitetään Jyväskylän yliopiston yhteiskuntatieteellisen tiedekunnan
suostumuksella julkisesti tarkastettavaksi Agora Centerin Lea Pulkkisen salissa
lokakuun 9. päivänä 2015 klo 12.

Academic dissertation to be publicly discussed, by permission of
the Faculty of Social Sciences of the University of Jyväskylä,
in the Lea Pulkkinen auditorium, on 9 October, 2015, at 12 o'clock.

LIKES – Research Center for Sport and Health Sciences
Jyväskylä 2015

University of Jyväskylä
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LIKES – Research Reports on Sport and Health 305
ISBN (nid.) 978-951-790-390-5
ISBN (pdf) 987-951-790-391-2
ISSN 0357-2498 | 2342-4788

Editor Tuija Tammelin

Distribution LIKES – Research Center for Sport and Health Sciences
 Viitaniementie 15a, FI-40720 Jyväskylä, Finland

Printing Digipaino Kirjaksi.Net

ABSTRACT

Kangasniemi, Anu

The mindfulness, acceptance and commitment approach to encouraging a physically more active lifestyle

LIKES – Research Reports on Sport and Health 305

Jyväskylä: LIKES – Research Center for Sport and Health Sciences, 2015.

The aims of this research were to examine the differences in psychological well-being between physically less active and active adults and to explore the effectiveness of an acceptance- and commitment-based behavioural intervention in encouraging a physically more active lifestyle among physically inactive adults.

The dissertation included a randomised controlled trial (RCT) among physically inactive adults aged 30 to 50 years ($N=138$) and a cross-sectional study on physically active ($N=50$) and less active adults ($N=58$). In the cross-sectional study, the participants completed a questionnaire reporting their mindfulness skills, psychological flexibility, and psychological and depressive symptoms. In both studies, physical activity was self-reported and measured using accelerometers. In the RCT, physically inactive participants were randomly allocated to a feedback-only group (FB, $N=69$) or to an acceptance- and commitment-based behavioral intervention group (ACT+FB, $N=69$). Both groups received written feedback concerning their physical activity and were offered a body composition analysis. In addition, the ACT+FB group attended six 1.5-hour group sessions and were given a pedometer during the nine-week intervention. All participants' self-efficacy, planning and acceptance of psychological and physical discomfort related to physical activity were evaluated at baseline and at three- and six-month follow-ups.

Physically active individuals had better mindfulness skills and less psychological and depressive symptoms compared to physically less active adults. No difference was observed in the change of physical activity between the FB and ACT+FB groups over time. Participants in both groups increased their physical activity with high individual differences. Self-efficacy, planning, and the acceptance of psychological and physical discomfort related to physical activity improved more in the ACT+FB group than in the FB group. In addition, after reanalysing the data among non-depressive adults, a higher stability was observed regarding objectively measured physical activity at the individual level between the three- and six-month follow-ups in the ACT+FB group as compared to the FB group. Furthermore, the change in acceptance of discomfort related to physical activity was associated with positive change in self-reported physical activity, but not with accelerometer-based physical activity and also mediated the association between change in barriers self-efficacy and change in self-reported physical activity in the ACT+FB group.

The results indicate that having a physically active lifestyle is related to better psychological well-being and mindfulness skills. Moreover, the results suggest that the ACT+FB intervention was beneficial in supporting the physically inactive adults' cognitive change related to physical activity and brought about a more stable improvement in physical activity behaviour at the individual level, especially among the non-depressive participants. The novel findings also suggest that the acceptance of discomfort related to physical activity may play an important, beneficial role when trying to change to a physically more active lifestyle.

Keywords: acceptance, physically inactive adults, behaviour change, commitment, mindfulness, physical activity, psychological flexibility.

TIIVISTELMÄ

Kangasniemi, Anu

Fyysisesti aktiivisempi elämäntapa arvo- ja hyväksyntäpohjaisen lähestymistavan avulla
Liikunnan ja kansanterveyden julkaisuja 305

Jyväskylä: LIKES-tutkimuskeskus, 2015.

Tutkimuksen tavoitteena oli selvittää tietoisuustaitojen, psykologisen joustavuuden ja psykologisten oireiden eroja vähän liikkuvilla ja aktiivisesti liikkuvilla aikuisilla sekä tutkia hyväksyntä- ja arvopohjaisen hyvinvointiohjelman vaikuttavuutta fyysisesti aktiivisempaan elämäntapamuutokseen vähän liikkuvilla aikuisilla.

Tutkimus koostui satunnaistetusta ja kontrolloidusta koeasetelmasta, jonka kohde-ryhmänä olivat vähän liikkuvat aikuiset ($N=138$). Lisäksi tutkimukseen kuului poikkileikkausasetelma, jossa verrattiin aktiivisten liikkujien ($N=50$) ja vähän liikkuvien aikuisten ($N=58$) tietoisuustaitoja, psykologista joustavuutta ja psykologisia oireita kyselylomakkeilla. Vähän liikkuvat aikuiset satunnaistettiin kahteen eri ryhmään. Palauteryhmä sai palautetta fyysisestä aktiivisuudestaan tutkimuksen alussa sekä 3 ja 6 kuukauden seurannassa. Arvopohjainen ryhmä sai saman palautteen kuin edellä ja osallistui hyvinvointiohjelmaan, johon kuului askelmittareiden käyttäminen 9 viikon aikana sekä pienryhmätapaamiset. Pienryhmätapaamisia oli yhteensä 6 x 1,5 tuntia. Niiden sisältö pohjautui hyväksymis- ja omistautumisterapian periaatteisiin, joiden tavoitteena on psykologisen joustavuuden kehittäminen arvoja, hyväksyntää ja tietoisuustaitoja hyödyntäen. Kummassakin osatutkimuksessa fyysistä aktiivisuutta mitattiin kiihtyvyyssmittareilla ja itseraportoidusti. Tutkittavien minäpystyvyyden tunnetta, suunnittelun taitoja sekä liikuntaan liittyvien epämiellyttävien psykologisten ja fyysisten tuntemusten hyväksyntää tutkittiin tutkimuksen alussa sekä 3 ja 6 kuukauden seurannassa.

Tutkimustulosten mukaan fyysisesti aktiivisemmilla liikkujilla oli paremmat tietoisuustaidot ja vähemmän psykologisia oireita verrattuna vähän liikkuviin aikuisiin. Sekä arvopohjaisessa että palauteryhmässä fyysinen aktiivisuus lisääntyi 3 ja 6 kuukauden seurannassa, eikä fyysisen aktiivisuuden muutoksissa ollut eroa ryhmien välillä. Yksilölliset vaihtelut muutoksessa olivat kuitenkin suuria. Arvopohjaisessa ryhmässä minäpystyvyyden tunne, liikuntaan liittyvä suunnittelu sekä liikkumiseen liittyvien epämiellyttävien ajatusten, tunteiden ja fyysisten tuntemusten hyväksyntä parantui enemmän verrattuna palauteryhmään. Edelleen havaittiin, että kiihtyvyyssmittarilla mitatun fyysisen aktiivisuuden muutokset olivat yksilöllisesti tarkasteltuna pysyvämpiä arvopohjaisessa ryhmässä verrattuna palauteryhmään niiden osallistujien joukossa, jotka eivät olleet masentuneita. Arvopohjaisessa ryhmässä muutos liikuntaan liittyvien epämiellyttävien tuntemusten hyväksynnässä oli yhteydessä itseraportoituun liikunta-aktiivisuuden muutokseen. Muutos hyväksynnässä välitti myös esteisiin liittyvän minäpystyvyyden muutoksen ja itseraportoidun liikunta-muutoksen välistä yhteyttä.

Tutkimustulokset antavat viitteitä siitä, että psyykkinen hyvinvointi ja tietoisuustaidot liittyvät fyysisesti aktiivisempaan elämäntapaan. Arvoja, hyväksyntää ja tietoisuustaitoja painottavan lähestymistavan avulla saattaisi olla mahdollista tukea muutokseen liittyvää ajattelutapaa sekä edistää fyysisen aktiivisuuden muutosten pysyvyyttä.

Avainsanat: vähän liikkuvat aikuiset, arvot, fyysinen aktiivisuus, elämäntapamuutos, hyväksyntä, liikunta, psykologinen joustavuus, tietoisuustaidot.

ACKNOWLEDGEMENTS

With a sense of joy, excitement and relief I write these last sentences of my PhD dissertation. Writing this study has been truly a great adventure, giving me new experiences and challenges. I feel that I have learnt a lot, both personally and professionally.

There are many people to whom I want to express my deepest gratitude. First and foremost I want to thank my supervisors, Professor Raimo Lappalainen and our research director of LIKES Dr. Tuija Tammelin. Thank you Raimo for sharing your knowledge and wisdom, and guiding me through the world of ACT. You have an amazing ability to encourage and guide people around you, always with a warm sense of joy. I also want to thank you, Tuija, for your careful comments, guidance and encouragement along the way. You had a great role in enabling this study from research plan into practise.

This study included many phases – from collecting the data to statistical analysis and writing. I am grateful to Anna Kankaanpää for analysing the data, being patient and enterprising all the way. It was not easy, that first time, making sense of the RCT data, and your statistical skills were essential. Thank you, Professor Asko Tolvanen for your valuable advice with the statistical analysis and the enjoyable meetings, even if we always had difficult questions for you. Warmest thanks to Janne Kulmala, Kirsti Siekkinen, Harto Hakonen and Virpi Inkinen who contributed to collecting the data. I also thank Essi Sairanen, Henna-Riikka Hoffren and Tanja Onatsu for your help in running the intervention groups, and Annaleena Aira for communicating the results to the outside world.

I also want to express my gratitude to my late colleague, Dr. Esa Rovio, who had a very special role at the beginning of my study. He encouraged me to write my research plan as a part of his bigger research plan, and I am very thankful for his pioneering work in this field. I still admire his courage, strength, belief and acceptance in the face of his serious illness. I also thank my great teacher in the past, Professor Taru Lintunen, whose inspiration and knowledge had been significant during my years as a young student. The impact of her teaching had long-lasting effects and after many years I still find the psychology of physical activity a fascinating field, and well worth committing my time to.

My sincere thanks go to Professor Stuart Biddle and Professor Joseph Ciarrochi for reviewing and giving valuable comments during the last phase of this dissertation. I admire your work and it was a great honour to have you both as my reviewers.

I have been fortunate in having the great support of my lovely colleagues. After four years I feel that we have become good friends. Thank you Kati K, Jaana, Maarit, Kirsti, Nina, Virpi, Katariina and many others for sharing this journey with me. You have given me so much joy and faith when it was sorely needed. I have enjoyed your company and our discussions, not only related to work, but also many other important issues related to everyday living.

My sincere thanks go to our director Eino Havas. You believed in my ideas, even though the combination of therapy and physical activity might have sounded a

bit strange in 2009 when I was first writing the research plan. You are a very special person who has the ability to look to the future and the flexibility to go on.

I also want to thank my two brothers and my parents Lea and Antero. You have given me a strong foundation on which to build my life. Your love, warm support and help, together with my parents-in-law Marjatta and Erkki, have been more than important.

I am also grateful to have very good friends, some of whom I have been lucky to know for over 30 years. Thank you 'girls' for your friendship and being in my life. You are very important for me.

And last, but not least I feel a bit a sense of pride and unconditional love when I think of my own family: Miska and my wonderful kids, Emil, Ada and Aino. Thank you Miska for your endless support and love. You are a great husband and father. Emil, Ada and Aino – there's nothing that compares to you and not enough words to express my feelings. I hope that your hearts will always know how much I love and care for you.

Jyväskylä 17.08. 2015

Anu Kangasniemi

This study was funded by the Finnish Ministry of Education and Culture and Juho Vainio säätiö.

LIST OF ORIGINAL PUBLICATIONS

The thesis is based on the following original publications, which are referred to in the text by their Roman numerals.

- I Kangasniemi, A., Lappalainen, R., Kankaanpää A. & Tammelin, T. 2014. Mindfulness skills, psychological flexibility, and psychological symptoms among physically less active and active adults. *Mental Health and Physical Activity* 7 (3), 121–127.
- II Kangasniemi, A.M., Lappalainen, R., Kankaanpää, A., Kulmala, J., Hakonen, H. & Tammelin, T. 2013. Towards a physically more active lifestyle based on one's own values: study design of a randomized controlled trial for physically inactive adults. *BMC Public Health* 13: 671.
- III Kangasniemi, A.M., Lappalainen, R., Kankaanpää, A., Tolvanen A. & Tammelin, T. 2015. Towards a physically more active lifestyle based on one's own values: the results of a randomized controlled trial among physically inactive adults. *BMC Public Health* 15:260.
- IV Kangasniemi, A.M., Lappalainen, R., Kankaanpää, A. Tolvanen A. & Tammelin, T. The role of acceptance of discomfort related to physical activity for change in physical activity behaviour among physically inactive adults. Submitted.

Taking into account the instructions given and comments made by the co-authors, the author of the present thesis has written the original research plan, developed the acceptance and commitment-based behavioural intervention applied to physical activity, carried out the interventions, participated in collecting the data, contributed the statistical analysis, and wrote the reports of the four manuscripts.

ABBREVIATIONS

AAQ-2	Acceptance and Action Questionnaire
ABBT	acceptance-based behaviour therapy
ACT	Acceptance and Commitment Therapy
BDI-II	Beck Depression Inventory
BMI	body mass index
cpm	counts per minute
FB	feedback
HEPA	health enhancing physical activity
KIMS	Kentucky inventory of mindfulness skills
MVPA	moderate-to-vigorous physical activity
PA	physical activity
PA-AAQ	Physical Activity Acceptance Questionnaire
RCT	randomised controlled trial
RFT	Relational Frame Theory

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ACKNOWLEDGEMENTS

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1 INTRODUCTION

Having a physically inactive lifestyle has been recognised as a widespread health problem in Western countries and has also increasingly become a great problem in low- and middle-income societies. Regarding health and well-being, physical inactivity has been observed as a risk factor, like smoking and obesity, in regard to health and well-being (Lee et al. 2012). Due to the low levels of participation in physical activity and inadequate adherence to exercise prescriptions, developing a greater understanding of the process of behavior change is especially warranted. Furthermore, it is essential to find methods that work for physically inactive people.

To promote physical activity effectively, more studies at different levels are needed. Ecological models integrate several perspectives—covering individual, interpersonal, organizational, community, and public policy—that help us to understand how people interact with their environments (Sallis, Owen & Fisher 2008). This comprehensive framework shows how complex physical activity behaviour is and how knowledge about all factors that affect physical activity can inform the development of interventions. However, various processes for deeper understanding need to be developed to understand questions such as why some people are physically active and others are not. Sallis and Owen (1999) have introduced the *behavioural epidemiology framework*, which suggests that it is important to first establish interrelations between physical activity and health. The development of measurement methods of physical activity are important to assess physical activity accurately and to identify the factors or correlates that are associated with the adoption and maintenance of physical activity. In the last phase of producing deeper understanding of physical activity behaviour, it is meaningful to design a randomised controlled trial and test if this correlate is, in fact, a determinant or mediator of change. If an intervention seems to work, it is also essential to translate the findings into practice (Biddle & Ekkekakis 2005).

Besides the multiple research levels, theories are needed for understanding and designing a process of change (Michie & Abraham 2004). Without a theory, the possible cause–effect relationships can be ambiguous. Likewise, while the theory can help in understanding the process of change, there is also a need for methods or techniques that are likely to have an effect on desirable determinants (Michie et al. 2008, Michie et al. 2011). In an ideal situation, there is basic research behind the development of methods that confirms that these are, in fact, theory-based and correspond well to the underlying theory; otherwise, the methods are more inspired by the theory, which makes it difficult to conclude what was really effective in the intervention (Michie & Abraham 2004, Michie & Prestwich 2010). Therefore, attempting to understanding behaviour change sets the requirements for the research very high and requires multilevel studies over many years to yield to a method that can be acknowledged for use in evidence-based practice in any field (e.g. medicine, psychology). With respect to promotion of physical activity, determining such evidence-based practices are still in the early stages of development.

Contextual behavioural science is a principle-focused approach, which has utilised inductive strategy in developing interventions based on theoretical models (Hayes et al. 2013). In practice, integrating basic and applied theories, and developing multiple levels of research for various settings and interventions has already been taking place over the last three decades. As a result of this, the Relational Frame Theory (RFT) was developed (Barnes-Holmes et al. 2002), which is a contextual behavioural account to human language and cognition. Its clinical application is called Acceptance and Commitment Therapy (ACT), which has been empirically tested, corresponding well with the underlying theory of RFT (Hayes et al. 2006).

In general, a review of the correlational, experimental as well as component and outcome studies shows coherent evidence in support of the effectiveness and workability of the ACT model (Ruiz 2010, Ruiz 2012, Powers, Zum Vörde Siwe Vörding & Emmelkamp 2009). ACT has been used successfully in treating patients in different areas of health like depression (Lappalainen et al. 2007, Lappalainen et al. 2014), chronic pain (Wicksell et al. 2008), type 2 diabetes (Gregg et al. 2007) and weight regain among bariatric surgery patients (Weineland et al. 2012, Weineland, Hayes & Dahl 2012). Promising results have also been achieved in enhancing the sports performance of athletes through coaching, using the ACT (Gardner & Moore 2012). Based on the current understanding of research evidence, ACT seems to be working not only for treating a range of health related problems, but also for personal development and growth in the education, prevention and counselling psychology (Biglan, Hayes & Pistorello 2008). Concerning physical activity, the promotion this area of research is still scant, but the existing research has shown some evidence of ACT improving physical activity (Butryn et al. 2011, Tapper et al. 2009).

Despite people being well-aware of the health benefits of physical activity and the available options, they are still unable to maintain or change their behavior to a healthier lifestyle (Im et al. 2011). Researchers have suggested two reasons why people do not adhere to a healthy diet and physical activity (Forman, in press). The first reason is related to a biological predisposition to humans to prefer high calorie foods and minimal energy expenditure. The second reason is related to our constant exposure to an 'obesogenic' environment (e.g. being surrounded by easily accessible high-calorie foods and labor-saving devices). The methods of ACT may be particularly beneficial in facing the challenges of our biology and environment due to the special features including: an emphasis on enhancing intrinsic motivation and a commitment based on one's own values in life and offering tools to deal with the internal (e.g. thoughts and feelings) and external (e.g. using labor-saving devices) cues that might be preventing people from changing or maintaining healthy behavior. Moreover, due to the nature of the contextual basis of ACT, physical activity is seen part of an individual's personal life (health history, physical, psychological, social circumstances etc.), taking into account of several other factors that are associated with the physical activity and behavior change.

The aims of this study were to examine the differences in psychological well-being among physically inactive and active adults and to explore the effectiveness of acceptance- and commitment-based intervention in encouraging a physically more active lifestyle among physically inactive adults.

1.1 Physical activity as a health behaviour

1.1.1 Definitions and assessment of physical activity

Physical activity has been defined as any bodily movement that is produced by skeletal muscles resulting in energy expenditure (Caspersen, Powell & Christenson 1985). Physical activity includes not only deliberate exercise but also all other types of activities, like incidental walking, occupational and leisure time physical activity, and household chores. Thus, physical activity can be performed in many ways and contexts that are strongly influenced by our psychological processes, such as motivation and decision-making (Biddle, Mutrie & Gorely 2015).

Health professionals often describe individuals who do not meet the recommended and favourable levels of physical activity as *physically inactive or insufficiently active* (Tudor-Locke & Myers 2001). Based on current recommendations, “adults should do at least 150 minutes per week of moderate-intensity, or 75 minutes per week of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate- and vigorous-intensity aerobic activity” (World Health Organization 2010). It is also recommended that aerobic activity should be performed in episodes of at least 10 minutes, preferably with the episodes spread evenly across the week. The recommendation also reminds adults about additional health benefits that are gained by engaging in physical activity beyond this amount and muscle-strengthening activities two or more days a week.

Remarkably, despite the increasing knowledge and physical activity recommendations, physical inactivity has remained a public health problem. Based on international comparison data from 122 countries, about 31% of adults are physically inactive worldwide. Inactivity rises with age, is higher in women than in men, and has increased in high-income countries (Hallal et al. 2012). The same trend is also observed in Finland. Approximately half of all Finnish adults are not engaging in levels of aerobic physical activity that would be sufficient for good health, and only a tenth achieved the recommended levels of both aerobic and muscle-strength activity (Husu et al. 2011). This report shows, for example, how habitual activities such as actively commuting to work have decreased while participation in leisure-time physical activities has increased in recent decades.

Traditionally, adults’ physical activity has been measured with self-report questionnaires and diaries, but besides this way of assessing physical activity, the development of accelerometer-based measurements has brought more accuracy to assessing the complex nature of physical activity behaviour (Tudor-Locke et al. 2010). According to the results from the population-based accelerometer data, the mean accumulated minutes of moderate-to-vigorous physical activity (MVPA) is approximately 36 minutes per day in men and 32 minutes per day in women worldwide (Hallal et al. 2012).

The Terveys 2011 sub-study showed the prevalence of physical activity and sedentary behaviour based on accelerometry data of adults in Finland. According to that study, Finnish adults were sedentary most of their waking time, mainly sitting or lying down. Participants spent about 20% of their time engaged in light intensity,

4% (\approx 34 minutes per day) in moderate-to-vigorous (MVPA) physical activity and less than one percent in vigorous physical activity, with high individual variation. Approximately 25% achieved the recommended amount of physical activity (Husu et.al. 2014), which is about half that of the estimation based on the average level of the self-reported physical activity. The present study is thus far the only population-based study in Finland using accelerometers. However, one should take care when attempting to generalise the results, due to the discrepancy in the use of the accelerometers by the participants: those who used their accelerometer according to the set criteria had better health and were more highly educated than those who did not use accelerometers according to the set criteria, or not at all.

1.1.2 Physical activity behaviour change

Changing one's lifestyle toward a physically more active one might require intrinsic or self-determined motivation (Thøgersen-Ntoumani & Ntoumanis 2006), increased intentions to be physically active (Scholz et al. 2008) and actual changes in behaviour (Michie et al. 2009). There are no established criteria for a successful change, but one aspect of change is said to be achieved when a previously sedentary individual meets the recommendations for regular physical activity (Haskell et al. 2007). Alongside the importance of the change in physical activity level, the aspect of maintenance of the change is significant for sustaining the health benefits (Marcus et al. 2000).

Behavioural interventions are largely heterogeneous in their content and effectiveness to enhance physical activity (Michie et al. 2009, Foster, Hillsdon & Thorogood 2005). This makes it difficult to draw conclusion regarding what may be the most effective way to enhance individuals' physically active lifestyle. In general, behaviour interventions have only small (Michie et al. 2009, Johnson, Scott-Sheldon & Carey 2010) to moderate (Foster, Hillsdon & Thorogood 2005) effects on self-reported physical activity levels. Also, the interventions that are theory-based (Noar, Benac & Harris 2007) and include self-regulatory (e.g., self-monitoring, feedback, goal-setting, etc.) constructs seemed to be more effective than the other types of interventions (Michie et al. 2009, Rhodes & Pfaeffli 2010).

Despite the vast research related to health behaviour theories, the understanding of the processes related to behaviour change is still rather limited and debated (Rhodes & Pfaeffli 2010, Noar & Zimmerman 2005). Physical activity interventions have been studied, for example, within a social-cognitive framework, including the Theory of Planned Behaviour (Ajzen & Driver 1991), Transtheoretical Model (Prochaska & Velicer 1997), Self-Determination Theory (Deci & Ryan 1985; 2008), Social Cognitive Theory (Bandura 1998) and Protection Motivation Theory (Rogers 1983). However, several theories have similar and overlapping constructs (Noar & Zimmerman 2005), which has caused fragmentation and a lack of consensus on what is essential for behaviour change to take place (Rhodes & Pfaeffli 2010).

In order to develop a better understanding of behaviour change, especially new theories and methods are warranted. This study's framework is based on a

mindfulness, acceptance and commitment approach and its clinical model of Acceptance and Commitment Therapy (ACT) (Hayes et al. 2012).

1.2 Psychology of physical activity

The psychology of physical activity has traditionally focused on factors that enhance motivation to become physically more active, and explores the main psychological benefits of physical activity (Biddle, Mutrie & Gorely 2015). However, the association between objectively measured physical activity and psychological well-being, and the role of mindfulness and psychological flexibility in the engagement of physical activity have not been studied much.

1.2.1 Physical activity and psychological well-being

The relationship between physical activity and psychological well-being is traditionally based on self-report questionnaires that support the protective benefits of physical activity regarding several aspects of psychological well-being (Biddle, Mutrie & Gorely, 2015). The evidence pertaining to the health benefits of physical activity and psychological well-being has been strongest with respect to preventing and reducing symptoms of depression regardless of age, sex, ethnicity, or medical condition. In addition, existing studies also suggest that physical activity reduces anxiety, feelings of distress and fatigue, as well as enhancing individuals' quality of sleep and well-being (Physical Activity Guidelines Advisory Committee 2008).

Despite the strong evidence of the benefits of physical activity for psychological well-being, only a few studies have used direct or objective measures of physical activity, such as involving accelerometers. Past results concerning the relationship between physical activity and psychological health among adults have been inconsistent (Loprinzi, Franz & Hager 2013, Hamer & Stamatakis 2010, Hamer, Coombs & Stamatakis 2014, Vallance et al. 2011). A population-based study among US adults showed that lower levels of depression were associated with increasing MVPA and decreasing sedentary time, at least in overweight and obese adults (Vallance et al. 2011). Respectively, MVPA was negatively associated with depression among diabetics (Loprinzi, Franz & Hager 2013). However, in a study by Health Survey for England, objectively assessed MVPA was not associated with psychological health (Hamer & Stamatakis 2010, Hamer, Coombs & Stamatakis 2014). Furthermore, only light-intensity activity was associated with lower risk for psychological distress (Hamer, Coombs & Stamatakis 2014).

Lack of psychological well-being, such as in the form of depression, may also contribute to a sedentary lifestyle and poor adherence to physical activity behavior (Roshanaei-Moghaddam, Katon, & Russo 2009). Adults who experienced depression spent significantly less time on both light and moderate physical activity than non-depressed participants assessed with accelerometers (Song et al. 2012). Respectively, the study of Lucas et al. (2011) showed that the risk of depression increased with time spent on sedentary behavior e.g. tv watching.

1.2.2 Physical activity, mindfulness and psychological flexibility

Mindfulness, as a fundamental skill in psychological well-being (Baer 2003, Brown & Ryan 2003), is a concept that has attracted researchers' and practitioners' interest worldwide over the last decade. Mindfulness refers to a particular qualities of attention and awareness that can be cultivated or developed through meditation. An operational definition of mindfulness is: "the awareness that emerges through paying attention on purpose, in the present moment, and non-judgmentally to the unfolding of experience moment by moment" (Kabat-Zinn 2003). Mindfulness includes two facets. The first involves the ability to self-regulate and maintain attention on immediate experience, allowing increased recognition of the mental event in the present moment. The second component involves adopting an orientation toward one's own experiences, characterised by curiosity, openness and acceptance (Bishop et al. 2004).

The concept of psychological flexibility complements the definition of mindfulness by taking into consideration the dynamic nature of behaviour that unfolds over time. More specifically, psychological flexibility refers to the "ability to be in the present moment more fully as a conscious human being, and to change or persist in behavior when doing so serves valued ends" (Hayes et al. 2006). This ability can be reflected in, for instance, how a person adapts to changing situational demands, re-configures mental resources, shifts perspectives and balances between competing desires, needs and life domains (Kashdan & Rottenberg 2010). Thus, the definition of psychological flexibility also relates to people's behavior within their different environmental contexts.

Several studies have shown the relationship between mindfulness and physical activity (Ulmer, Stetson & Salmon 2010, Gilbert & Waltz 2010, Roberts & Danoff-Burg 2010, Chatzisarantis & Hagger 2007). Based on these studies, having good mindfulness skills were associated with the engagement in physical activity (Gilbert & Waltz 2010, Roberts & Danoff-Burg 2010). In addition, higher levels of mindfulness, acceptance and lower levels of suppression were associated with the maintenance of exercise behavior (Ulmer, Stetson & Salmon 2010). Mindfulness has also been found to moderate the intention-behavior relationship in the physical activity context in that intentions have predicted leisure-time physical activity in mindful individuals but not among less mindful ones (Chatzisarantis & Hagger 2007).

However, the relationship between physical activity and psychological flexibility or acceptance is a relatively new area of research. Little is known about whether increased psychological flexibility and mindfulness can contribute to increased physical activity levels assessed with objective measurement methods, such as accelerometers, among physically inactive individuals. The associations between psychological flexibility and physical activity are described in more detail in relation to interventions studies in chapter 1.4.3.

1.3 Mindfulness, Acceptance and Commitment approach

Mindfulness-, acceptance- and commitment-based approaches can be linked to the broader field of Contextual behavioural science (CBS). CBS has been defined as a principle-focused, inductive strategy approach to psychological systems that emphasises developing interventions based on theoretical and constantly evaluated models (Hayes et al. 2013). Before the development of contextualistic approaches, traditional behaviour therapy was divided into behaviour analysis and cognitive behavior therapy (Hayes et al. 2006). Contextual behavioral science has been evolved and extended from traditional behaviour therapy and currently covers different types of interventions, such as Acceptance and Commitment Therapy (ACT) (Hayes et al. 2006, Hayes 2004), dialectical behaviour therapy (Linehan 1993) and mindfulness-based cognitive therapy (Segal, Williams & Teasdale 2012). Rather than changing psychological symptoms directly, the contextual treatments tend to aim to change the function of these events and the individual's relationship to them through strategies such as mindfulness, acceptance or cognitive defusion (Hayes et al. 2006).

1.3.1 Acceptance and Commitment Therapy (ACT)

The basic assumptions behind ACT are based on the pragmatic philosophy called *functional contextualism*, which aims to predict and influence behaviour within cultural practices (Biglan & Hayes 1997). The truth criterion in contextualism is *successful working*. Thus, the emphasis is on the outcome, and the worth of the analysis is viewed in terms of its contribution to, for example, public health or prevention science (Biglan 2004).

ACT has been empirically derived from the Relational Frame Theory (RFT) (Hayes 2004), which is a comprehensive research programme based on the theory of human language and cognition (Barnes-Holmes et al. 2002, Hayes, Barnes-Holmes & Roche 2001). RFT has advanced the understanding of human behaviour and basic principles of learning (Biglan 2004). According to the definition of RFT “the core of human language and cognition is the learned and contextually controlled ability to arbitrarily relate events mutually and in combination, and to change the functions of specific events based on their relations of others” (Hayes et al. 2006). RFT enables approaching most human actions and events behaviourally, taking into account the verbal and cognitive nature of human behavior (Barnes-Holmes et al. 2002). From the ACT perspective, psychological problems can emerge when language and cognition interact with direct contingencies and produce an inability or inflexibility that persists and changes one's behavior in a direction that is not in the service of one's own values. For example, words such as “exercise” or “sport” may be associated and linked very differently depending on the person, leading to very different kinds of behavior choices. If these associations are very negative, including e.g. aversive feelings and bad past experiences, it is likely that these associations will negatively affect the likelihood of being physically active. The aim of ACT is to overcome these

maladaptive effects of language on behavior called cognitive fusion and experiential avoidance.

Cognitive fusion. Cognitive fusion is defined as the tendency to react and behave according to the content of one's mind, such as in reaction to thoughts, memories, sensations or feelings (Hayes, Pistorello & Levin 2012). Mostly, acting on one's own thoughts is not harmful, but in problematic situations or conditions, such as when suffering chronic pain (Wicksell et al. 2009), or engaging in binge eating (Lillis, Hayes & Levin 2011) cognitive fusion can lead to a rigid, avoidant and narrow behavior repertoire that is less guided by one's own experience. Similar patterns of fusion can be found in experiences of physical activity, as can be seen in a study by Williams and colleagues (2008) where participants' affective response at baseline predicted the amount of physical activity they engaged in 12 months later; these results indicated that less pleasurable experiences lead to fewer minutes in physical activity. Other studies have reported several barriers (e.g. being too busy, feeling too tired, lack of time) blocking people from engaging in physical activity (Kowal & Fortier 2007, Salmon et al. 2003). Thus, a tendency to behave too rigidly according to one's own thoughts and feelings might be one reason for having an inactive lifestyle.

Experiential avoidance. Experiential avoidance refers to the avoidance or effort to escape from private events that are experienced as aversive, even when behaving that way leads to actions that are inconsistent with the things that are meaningful and important to oneself (Hayes et al. 2006). This is often a consequence of cognitive fusion, that is, when a person does not have the skill to distance him- or herself from unwanted thoughts, feeling or sensations. A substantial amount of research evidence shows the maladaptive role of experiential avoidance in many psychological problems, health conditions and task performance (Hayes et al. 1996, Boulanger, Hayes & Pistorello 2010, Lillis, Hayes & Levin 2011, López et al. 2010). In relation to physical activity, avoidance of psychological or physical discomfort (e.g. anxiety, fear, fatigue) can lead to avoidance behavior such as skipping opportunities to be active by, for example, not going to the gym, or not going for a run or walk. Physical inactivity is also associated with overweight and obesity (Troost et al. 2002), which are conditions that may cause additional discomfort in situations involving physical activity due to the stigmatisation of weight (Puhl & Heuer 2009).

1.3.2 The ACT model

In the ACT model, adaptive behavior is referred to as *psychological flexibility* (Hayes et al. 2006, Hayes 2004), which is developed through six core processes or skills relating to: values, committed action, acceptance, self-as-context, defusion and contact with the present moment (see Figure 1). The available research evidence support the view that ACT seems to work through its proposed processes of change (Ruiz 2012). Unlike the outcomes in cognitive therapy, mediated by cognitive and affective *change* strategies (e.g., restructuring or replacing dysfunctional cognitions, distraction from unhelpful thoughts and feelings), the mediation in the ACT model seem to occur through utilisation of psychological *acceptance* (e.g., viewing thoughts

and emotions as they are with acceptance, without needing to alter or reduce them) strategies (Forman et al. 2012). Studies support this view with respect to the treatment of epilepsy (Lundgren, Dahl & Hayes 2008), chronic pain (Wicksell, Olsson & Hayes 2011), anxiety and depression (Forman et al. 2007). In the treatment of epilepsy, the beneficial outcomes were mediated by the ACT processes to some degree, indicating improvement in acceptance, values attainment, or persistence in the face of barriers, or a combination of these (Lundgren, Dahl & Hayes 2008). In addition, the evidence for the mediating role of psychological flexibility was also observed in regard to pain-related disability and life satisfaction in people with chronic pain (Wicksell, Olsson & Hayes 2011). In the treatment of anxiety and depression involving experiential avoidance, acting with awareness and acceptance mediated outcomes in the ACT group (Forman et al. 2007).

The ACT model can be divided into two parts. The first part includes acceptance and mindfulness, and the second part commitment and behavioural change processes (Hayes et al. 2006, Hayes 2004). Acceptance refers to the process in which individuals can choose to experience the full range of private experiences without having to change or defend against them. Mindfulness is a process that concentrates on the present moment as it is, not living excessively in the past or in the future. Commitment and behavioural change processes focus on value-based actions and behaviour, which lead toward a higher quality and more meaningful life. These processes are linked to each other and support each other in targeting to increase psychological flexibility, which is characterized by a broad repertoire of behavior that moves the individual in valued directions (Dahl et al. 2009).

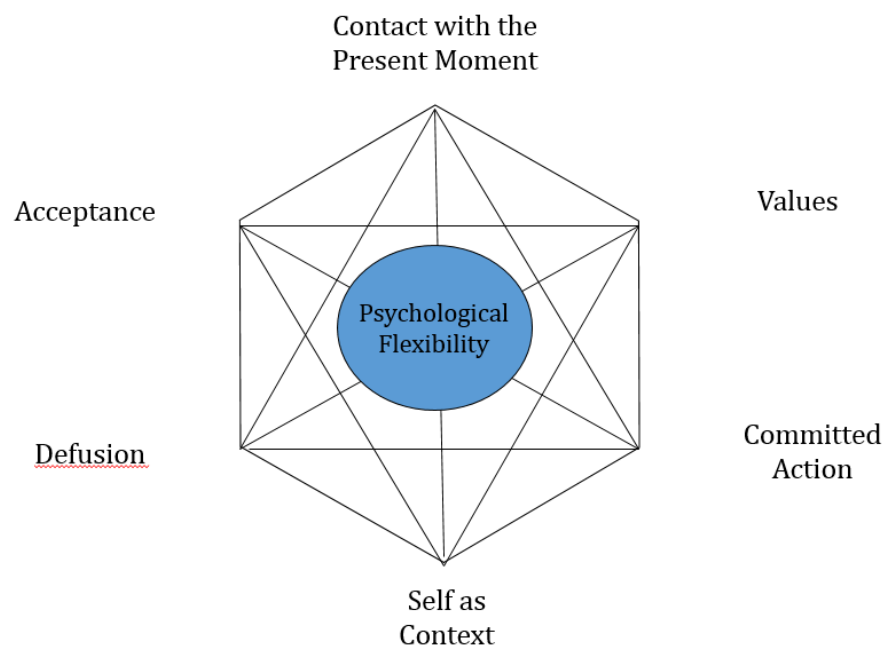


FIGURE 1. The Acceptance and Commitment Therapy (ACT) model of health and treatment processes (Hayes et al. 2006)

1.3.3 Mindfulness-, acceptance- and commitment-based interventions to enhance physical activity

Research evidence supporting that mindfulness- and acceptance-based interventions enhance physical activity is relatively scarce. However, a number of studies have applied mindfulness- and acceptance-based behavioural approaches to enhancing physical activity (Butryn et al. 2011), and in combination with weight-related goals (Tapper et al. 2009, Goodwin et al. 2012, Katterman et al. 2013). A pilot study regarding college students (Butryn, Forman, Hoffman, Shaw & Juarascio 2011) showed that a short ACT based intervention was more effective in increasing physical activity levels compared to students who participated in the education group.

In another pilot study on adult cardiac outpatients, acceptance-based behaviour therapy (ABBT) was found to increase adherence to physical activity and diet. The participants reported high treatment satisfaction and comprehension, and the results showed that they made positive changes to their diet and moderate increases in physical activity (Goodwin et al. 2012).

Another study that involved an ABBT intervention to facilitate weight gain prevention among college students showed a significant decrease in weight and body mass index (BMI) in the ABBT group compared to the control group at six weeks. This result was maintained across one year. Positive improvements in physical activity were also observed, but these changes did not differ significantly between the groups (Katterman et al. 2013).

Tapper and colleagues (2009) examined an ACT-based intervention for weight loss for women. Participants in the mindfulness-based intervention showed significantly greater increases in physical activity compared to the control group, but no significant differences in weight loss or mental health were found between the groups at six months. However, after reanalysing the data excluding participants who “never” applied ACT principles during those six months, greater reductions in body mass index within the ACT group became evident (Tapper et al. 2009).

1.4 Summary of the literature

In sum, the high prevalence of physical inactivity has caused substantial health problems worldwide. The same trend has also been observed in Finland, where approximately half of the adults' physical activity levels are insufficient for good health. Strong evidence has shown that physical inactivity is associated with many health problems, such as heart disease, type 2 diabetes, depression, and breast and colon cancer. Despite the increasing knowledge of the health benefits of physical activity, people are still unable or not motivated to change their behavior. There is a great need for interventions that aim to increase motivation and behavior change, especially among physically inactive individuals.

Behavioral interventions seem to have small to moderate effects on self-reported physical activity levels. The current understanding of processes related to

behaviour change is still rather limited or under debated. Many theories have similar and overlapping constructs, making it difficult to conclude what is essential for behaviour change to take place.

The Relational Frame Theory (RFT) is a comprehensive behavioural account of human language and cognition, which includes a clinical model called Acceptance and Commitment therapy (ACT). ACT aims to increase psychological flexibility, which is defined as the ability to be in the present moment with full awareness and openness to experiences based on one's own values in life. Thus, psychological flexibility can be seen in people's behavior when facing changing situations in their environmental context, and in how they balance mental resources and competing desires and needs between different life domains. The available research evidence supports the view that ACT utilises psychological acceptance strategies in its proposed change processes.

Cross-sectional studies have shown that greater mindfulness skills are associated with higher levels of physical activity. However, research evidence is still relatively scarce, especially concerning psychological flexibility in relation to physical activity. A number of studies have applied mindfulness- and acceptance-based behavioral approaches to enhance physical activity, sometimes in combination with weight related goals. The results are promising, but more research is needed, especially among physically inactive individuals. There is also a lack of randomised controlled trials, and studies on outcomes based on the objective measures of physical activity, such as accelerometry.

1.5 Aims of the empirical studies

The present study aimed to contribute to the understanding of the relationships between mindfulness, psychological flexibility, psychological symptoms and physical activity. Furthermore, the study aimed to examine the effectiveness of the acceptance- and commitment-based behavioural intervention with respect to encouraging a physically more active lifestyle among physically inactive adults. In addition, the study aimed to explore the role of acceptance of psychological and physical discomfort related to physical activity in relation to change in physical activity behaviour. More specifically, the study focused on four aims:

Study I. The aim of Study I was to examine the differences in psychological well-being between physically active and physically inactive adults. In particular, the differences in mindfulness, psychological flexibility, and psychological and depressive symptoms were evaluated, and the associations between these variables were described in detail (article I). It was hypothesised that physically active adults have better mindfulness skills, greater psychological flexibility, and less psychological and depressive symptoms compared to physically less active adults.

Study II. Study II had two aims, including two articles (II and III). The first aim was to describe the study setting and develop the acceptance- and commitment-based

(ACT+FB) behavioural intervention to encourage a physically more active lifestyle (article II).

The second aim was to investigate the effectiveness of the acceptance- and commitment-based behavioural intervention (ACT+FB) concerning the physical activity level and self-efficacy, as well as regarding planning and the acceptance of psychological and physical discomfort related to physical activity after three and six months, compared to providing only individual written feedback (FB) on their physical activity. A further aim was to explore stability and maintenance of changes in physical activity at the six months follow-up (article III). It was hypothesised that ACT+FB group is more effective than the FB group in improving physical activity and related beliefs and cognitions.

Study III. The aim of study III was to examine the associations between self-efficacy, planning, acceptance of psychological and physical discomfort related to physical activity, and change in physical activity behavior in the acceptance- and commitment-based behavioural intervention. The second aim was to explore if these possible associations between self-efficacy, planning and change in physical activity were mediated by the change in the acceptance of psychological and physical discomfort related to physical activity (manuscript IV). It was hypothesized that the change in acceptance of psychological and physical discomfort related to physical activity is the most salient factor associated with the change in physical activity and mediating the possible other associations in the change of physical activity in the acceptance- and commitment-based behavioural intervention.

2 METHODS

2.1 Study designs and population

The present study included a cross-sectional evaluation of physically active and inactive adults and a randomised controlled trial (RCT) examining physically inactive adults. The protocol was approved by the Scientific Ethics Committee of the University of Jyväskylä, Finland. The trial is registered with ClinicalTrials.gov, number NCT01796990. The flow chart of the study designs is shown in Figure 2.

Study I. The study's sample of physically active adults was recruited in 2011. Using a cross-sectional design, the main aim was to compare the differences between physically less active and physically active adults' psychological well-being. Physically active participants were recruited through three local fitness centres using advertisements. All 65 applicants were then screened using an online questionnaire with regard to the following selection criteria: 1) age 30–50 years, 2) in work, and 3) engaged in moderate-to-vigorous physical activity at least 2.5 hours per week. All selected applicants met these three selection criteria (age, working status, activity level); however, 10 of the selected individuals could not participate due to health-related reasons and scheduling issues. Also, five individuals' data were excluded due to technical problems relating to their physical activity monitoring. Subsequently, the sample for analysis was comprised of 50 physically active adults. The group of physically inactive adults was part of the RCT study design (Study II, baseline data collected 2011), which is described next.

Study II. The study population of the RCT consisted of working adults, aged 30 to 50 years, who were defined as a physically inactive adults based on the selection criteria. Participants were recruited through advertisements in the local newspaper. All interested individuals were screened in more detail via an online questionnaire. The criteria for selection were: 1) age 30–50 years, 2) in work, and 3) not meeting the total minimum time of 2.5 hours per week of moderate-to-vigorous physical activity. All eligible participants received written confirmation of their acceptance to the study and were informed about the study protocol. The participants gave written informed consent for enrolment in the study. The data were collected during the years 2011 and 2012.

After combining the data collected in 2011 and 2012, altogether 138 participants were randomly assigned to the two parallel study groups, that is, the feedback, FB ($N=69$) and the acceptance- and commitment-based behavioral intervention, including also feedback and self-monitoring of physical activity, ACT+FB ($N=69$). At the baseline, 128 participants (93%) attended the measurements, of whom 125 participants met the criteria and were included in the analysis. At the first follow-up, after three months, 110 participants (80%) completed the measurements. At the

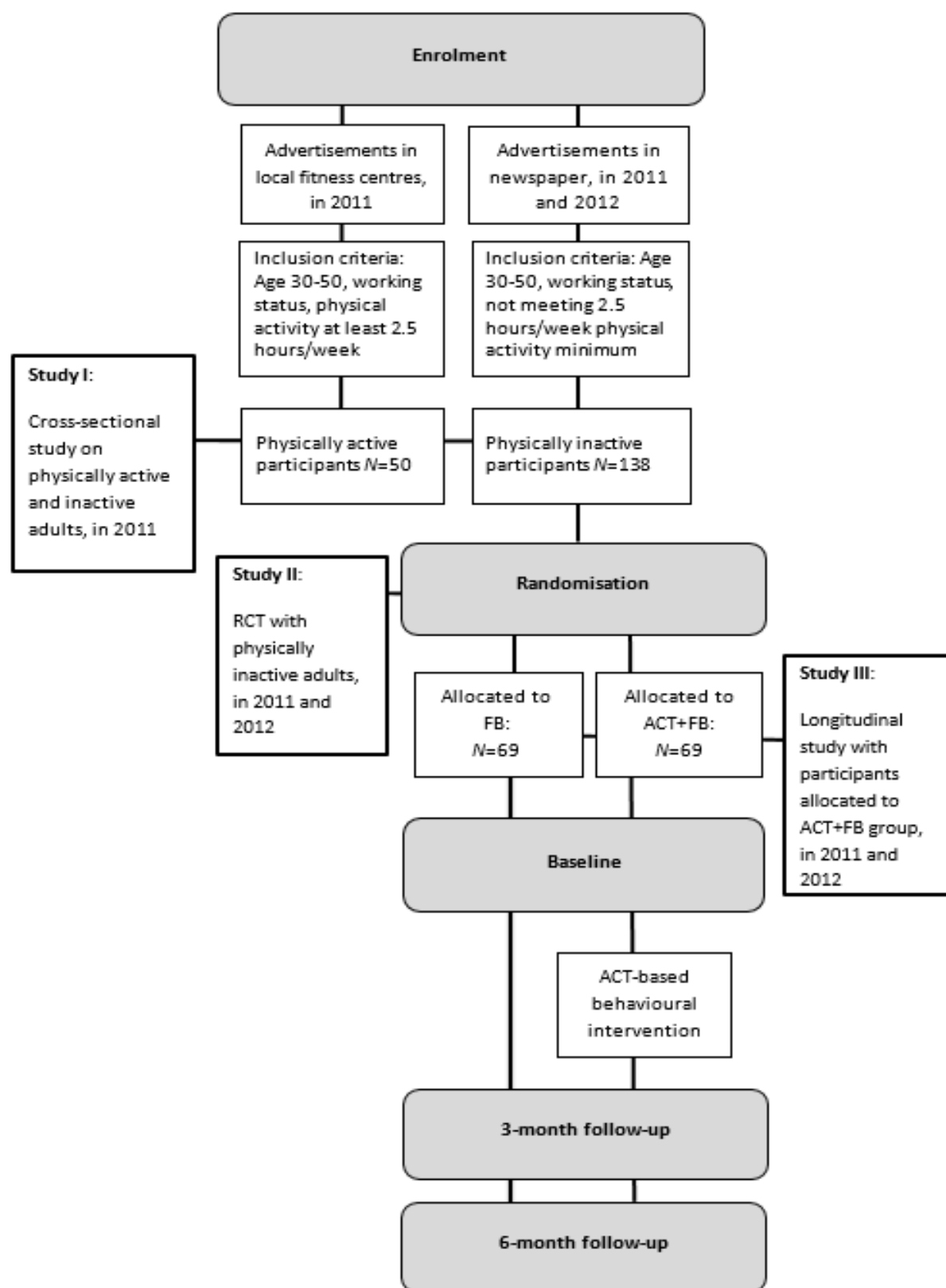


FIGURE 2. Flow chart of the study designs.

second follow-up, after six months, 103 participants (75%) completed the measurements. The reasons for drop out were 1) lack of time ($N=7$), 2) pregnancy ($N=1$), 3) the death of a close relative ($N=1$), and 4) no specified reason ($N=26$).

Study III. The study population were drawn from the previously described RCT data collected during 2011 and 2012, who attended to the acceptance- and commitment-based behavioral intervention (ACT+FB group, $N=69$).

2.2 Interventions

In the RCT design, physically inactive participants were randomly allocated to either a feedback (FB, $N=69$) or an acceptance- and commitment-based behavioural intervention (ACT+FB, $N=69$).

Feedback (FB). All the participants in this group received individual feedback about their physical activity level at the baseline, and at three-month and six-month follow-up measurement points. This written feedback included information on participants' accelerometer-measured daily physical activity level compared to the current physical activity recommendations by using the histograms. The first histogram described how much time was spent during the last seven days on at least moderate-to-vigorous physical activity, MVPA, lasting at least 10 minutes at a time. In addition, the second histogram described how much in total time was spent on physical activity of at least moderate intensity. The feedback also included a count of the number of steps taken daily during the week and the time spent on the activities, which were reported in the diary. Individual feedback was posted to the homes of the participants.

As an incentive for participation, participants were also the opportunity to attend a body composition analysis and receive a short personal interpretation and feedback of the results at the LIKES - Research Center for Sport and Health Sciences (see Table 1).

Acceptance- and commitment-based behavioural intervention (ACT+FB). The ACT+FB group underwent the same feedback procedures as the FB-only group, but participated in an acceptance- and commitment-based group programme involving behavioral techniques. The intervention programme consisted of six group sessions, each lasting for about 90 minutes. The programme was conducted over a nine week period, with one session taking place per week; the participants had three weeks off during this period, that is, a week after the 2nd, 3rd and 5th sessions.

The content of the programme was developed based on the available material and books related to behavior analysis and ACT (Hayes & Smith 2008, Lappalainen, Miettinen & Lehtonen 2007, Batten 2011), applied by the responsible researcher (AK) to encourage participants to develop a physically more active lifestyle. For the ACT-based intervention, a workbook was developed for participants, which contained short descriptions of the sessions as well as space for individual reflections

and notes. In addition, a guide was produced for the counsellors in order to monitor the comparative fidelity of the intervention. The group size varied from five to eight participants. All counsellors were trained in ACT and all received ACT protocol training applied in relation to physical activity. In total, eight groups were led by four different counsellors during 2011 and 2012. All counsellors were supervised by the responsible researcher (AK) during the intervention programme.

The programme aimed to enhance intrinsic motivation through important life values. Based on the reflection upon what is meaningful in life, in general, participants set goals and plans that targeted enhancing their lifestyle in harmony with their values. The programme did not exclude goals unrelated to physical activity, such as wanting to make improvements in the other life domains like personal relationships. The purpose was to support individual decisions and respect the participants' reflections as such, beyond guiding them to achieve physical activity recommendations or other advice from professionals. The programme started with presenting and clarifying the ACT approach for the participants and introducing the aims for the sessions. Each session started with a mindfulness exercise and included its own special topics with the different sets of exercises, pair and group discussions, and homework related to the session's topic. The programme did not include psychoeducational elements or direct health counselling, information about the health benefits of physical activity, or concrete physical exercise. In addition, participants in the ACT+FB group were given a pedometer for self-monitoring daily physical activity during the nine-week intervention.

TABLE 1. Content of the interventions for the Feedback-only group (FB) and Acceptance- and commitment-based behavioural group (ACT+FB) in the Randomised Controlled Trial.

Interventions	Feedback-only group (FB)	Acceptance- and commitment-based behavioural intervention group (ACT+FB)
1. Feedback of accelerometer measurements + diary at the base-line, 3- and 6-month follow-ups	x	x
2. Opportunity to attend body composition analysis	x	x
3. Six group sessions		x
4. Pedometer		x

2.2.1 Drop out and adherence to the interventions

The drop out from the time of allocation ($N=69$ in each group) to the time of the six-month follow-up was 29% in the FB group and 22% ACT+FB group. The background characteristics of the participants with complete data did not differ from those participants who dropped out of the follow-ups, except for one detail: the dropouts had

children younger than seven years of age in their household in more cases (52% among dropouts compared to 15% among those with complete data $p<0.001$).

The participants in the ACT+FB group showed rather good acceptance of and adherence to the group intervention. 75 % of the participants attended five or all six of the six sessions. The overall attendance varied from participation in one to all six sessions. Participants' pedometer use was checked by referring to the data recorded by the device. The pedometers were used by 56% of the participants in the ACT+FB group for at least 90% of the total time during the nine-week intervention. There were only eight participants who used the pedometers less than 10 days and six of these participants dropped out.

2.2.2 Experiences of the participants

As part of the new approach to encourage a physically more active lifestyle, the participants in the ACT+FB group were asked to complete a questionnaire after six group meetings in regard to their relevant experiences. Each questionnaire included five questions with response alternatives to be rated on a scale from 1 to 5: 1) How satisfied were you with the content of the program? (*1= not satisfied at all; 5= very satisfied*); 2) How has your general well-being changed? (*1= got significantly worse; 5= improved very much*); 3) How has your motivation to be active changed? (*1= got significantly worse; 5= improved very much*); 4) How much has your level of physical activity/exercise changed? (*1= decreased very much; 5 = increased very much*); 5) How useful was the following exercises or methods (value work, conversations, metaphors, mindfulness-exercises, health behaviour analysis, pedometer)? (*1= not at all useful; 5= very useful*). These experiences were treated as additional information in examining users' feedback on the programme (see Appendix 1).

2.3 Measures

In the preliminary studies of the present report, different sets of measures were used. Measurements took place at baseline (Studies I, II, III) and at three (Study II and III) and six-month (Study II) follow-up points (Figure 2). The baseline demographic characteristics of the participants were also documented, using a questionnaire, and included socioeconomic, physical, and psychological health variables.

2.3.1 Physical activity

Accelerometer-based physical activity. Physical activity was measured by using an accelerometer (ActiGraph GT1M, GT3X, Actigraph, Pensacola, Florida). The ActiGraph accelerometer is a small, light instrument that records acceleration information as an activity count, providing an objective estimate of the intensity of vertical bodily movement. Participants were instructed to wear the accelerometer, which is positioned over the right hip with an elastic belt, during all waking hours for seven consecutive days (Matthews et al. 2002). The outcome variables were time spent

on health enhancing physical activity (HEPA, min/day) and time spent on moderate-to-vigorous intensity physical activity (MVPA, min/day) (Matthews 2005). HEPA time was defined as continuous MVPA lasting at least 10 minutes at a time, that is, according to the current physical activity recommendation (World Health Organization 2010). The validity and reliability of the Actigraph GT3X has been shown to be similar to the GT1M devices in laboratory testing with regard to the measuring of everyday activities (Sasaki, John & Freedson 2011, Vanhelst et al. 2012). The ActiLife accelerometer software (ActiLife version 5; <http://support.theactigraph.com/dl/ActiLife-software>) was used for data collection. The epoch length used for analysis was 60 seconds, and non-wearing time was identified as a continuous zero registered for more than 60 minutes. Customised software was used for data reduction and analysis. A cut-off value of 1,952 counts per minute (cpm) was used for the MVPA (Freedson, Melanson & Sirard 1998). In order to meet at least 80% of the data reliability criterion (Matthews et al. 2002), at least three days of the seven days and a minimum of 500 minutes per day of physical activity was set as the minimum criterion for the representative data.

Self-reported physical activity. Self-reported physical activity was measured with questions related to participants' MVPA during the last seven days. Respondents were told to include all activity for which the physical effort was moderate or strenuous, including travelling to work and leisure-time physical activity, and other kinds of activities that accelerate heart rate and breathing (e.g., brisk walking, running, and heavy gardening). The participants' overall physical activity level was determined with the questions: *"During the last 7 days, on how many days did you carry out at least moderate-intensity physical activity that lasted for at least 10 minutes each time and for a total of at least 30 minutes per day?"* The response options ranged from 0 to 7 days per week. In addition, they were asked *"How much time in total did you spend doing this type of physical activity during leisure time?"* Estimates were rounded off to the nearest half an hour. The results of the validation study have shown that questions worked as intended and reflect the accelerometer-based levels of physical activity (Fagt et al. 2011).

2.3.2 Psychological measures

Self-efficacy. Self-efficacy was measured using questionnaires, which assessed adoption of self-efficacy concerning physical activity with five items and barriers to exercising with five items (Schwarzer 2000).

Planning. Action planning for exercise was assessed with four items and coping with planning for exercise with four items (Sniehotta, Schulz & Schwarzer 2006). Response alternatives range from 1 (*very certain I cannot*) to 4 (*very certain I can*).

Mindfulness skills. Participants' ability to be mindful in the present moment was measured using the Kentucky inventory of mindfulness skills, KIMS. The KIMS is a 39-item self-report inventory used to assess mindfulness skills. The questionnaire

contained four different, specific subscales measuring mindfulness skills, namely: 1) Observing, 2) Describing, 3) Acting with awareness, and 4) Accepting without judgment (Baer, Smith & Allen 2004). The observing subscale involves observing, noticing, or attending to various stimuli, including internal (cognitions, bodily sensations) and external phenomena (sounds, smells); rating items include statements such as, *"I notice changes in my body, such as whether my breathing slows down or speeds up"*. The describing subscale measures the participant's ability to describe, label, or notice observed phenomena by applying words in a nonjudgemental way; ratings include statements such as *"I'm good at finding the words to describe my feelings"*. The acting with awareness subscale measures the ability to be attentive and engage fully in one's current activity; rating items include statements such as, *"When I do things, my mind wanders off and I'm easily distracted"*. The subscale of accepting without judgment measures how reality is allowed to be perceived with neutrality, that is, without judging, avoiding, changing, or escaping from it; ratings item include statements such as, *"I criticize myself for having irrational or inappropriate emotions"*. Participants rated each item on a 5-point Likert-type scale ranging from 1 (*never or very rarely true*) to 5 (*almost always or always true*). Items reflected either direct descriptions of mindfulness skills or their absence (reverse-scored) (Baer, Smith & Allen 2004).

Psychological flexibility. Psychological flexibility was assessed using the Acceptance and Action Questionnaire, AAQ-2 (Hayes et al. 2006), which is a 10-item Likert-type questionnaire that assesses people's ability to take a nonelaborative, nonjudgemental approach to their internal events, in order to focus on the present moment and act in a way that is congruent with their values and goals, rather than merely reacting to their internal events (e.g., fears, urges, prejudices). The questions of the AAQ-2 were formulated as statements, such as: *"It's okay if I remember something unpleasant"*; *"My painful experiences and memories make it difficult for me to live a life that I would value"* and, *"I'm afraid of my feelings"*. The items were rated from 1 (*never true*) to 7 (*always true*). Negative items were reverse-scored. Individuals' total score indicated their amount of psychological flexibility. The AAQ-2 has been reported to have shown good reliability and validity (Bond & Bunce 2003, Hayes et al. 2004).

Acceptance of psychological and physical discomfort related to physical activity. The Physical Activity Acceptance Questionnaire, PA-AAQ, measured the acceptance of psychological and physical discomfort related to physical activity and includes 12 items (Forman et al. 2009) (e.g., *I continue to exercise, even when I have the desire to stay home or do something else; I am committing to being physically active no matter what feels uncomfortable or challenging about that*). The participants were instructed to respond to the following request: *"Below you will find the list of statements. Please rate the truth of each statement as it applies to you, using the following rating scale"*. The rating scale ranged from 1 (*never true*) to 7 (*always true*). Higher total scores indicated a greater amount of psychological flexibility related to physical activity.

Psychological symptoms. Psychological symptoms were also measured with the Symptom Checklist-90, SCL-90 (Holi, Marttunen, & Aalberg, 2003). Participants were asked to score the questionnaire's 90 items using its 5-point Likert-type scale, ranging from 0 (*not at all*) to 4 (*very much*), indicating the rate of occurrence of the symptoms during the reference time. In the questionnaire the participants were asked to evaluate their symptoms as follows: "How much you have experienced or suffered from e.g. 1) headache, 2) nervousness, 3) fear, 4) loss of appetite during the last week". The instrument's global index of distress is the Global Severity Index (GSI), which is the mean value of all of the 90 items combined. The cut-off score in the SCL-90 for the psychiatric screening purposes regarding the Finnish population is ≥ 0.91 (Holi et al., 2003).

Depressive symptoms. The Beck Depression Inventory, BDI-II (Beck et al. 1961, Dozois, Dobson & Ahnberg 1998), was used to measure various characteristics of depression. The BDI-II is a 21-item scale measuring depressive symptoms, including components with cognitive, behavioural, affective and somatic aspects. Based on the scores, depressive symptoms were categorised into two groups: 1) *none at all or minimal depression* (0-13 points) and *at least mild depression* (≥ 14 points), the latter being used as a cut-off score for psychiatric screening purposes in aiming to detect depression in participants.

2.4 Statistical analysis

Study I. The data were analysed using IBM SPSS Statistics, version 19.0. Means and standard deviations were calculated for both the physically less active and the active group. A univariate analysis of variance (ANOVA) was used to test differences between group means. Furthermore, a univariate analysis of covariance (ANCOVA) was conducted to compare the psychological well-being of the two groups after controlling for potential confounding variables, such as body mass index (BMI) and diagnosed health problems, as well as possible interactions between the variables. To control for Type I errors, the Bonferroni alpha correction procedure was used for all pairwise comparisons (adjusted significance level: $p=.05/4$). As the assumption of normality was not met, all p -values were calculated using the bootstrap method for stratified sampling (1,000 resamples). Bootstrap is a method for approximating the distribution of an estimator by sampling with replacement from the original data set (Boos & Stefanski 2010). Cohen's d (standardised mean difference) was reported to estimate between-group effect size. The between-group effect size was calculated by dividing the difference between the group means by the pooled standard deviation of the two groups. A between-group effect size of ≥ 0.2 was considered small, ≥ 0.5 medium and ≥ 0.8 large (Roth & Fonagy 1996).

The relation of accelerometer-measured physical activity to mindfulness skills, psychological flexibility and psychological symptoms was studied regarding the whole sample ($N=108$). The correlation coefficients between measures of psychological well-being and accelerometer-assessed physical activity were calculated and

tested for significance via bias-corrected, 95% confidence intervals. These confidence intervals were calculated using the bootstrap method for stratified sampling (1,000 resamples). The significance level baseline was set at $p=0.05$.

Study II. Data were analyzed using the Mplus statistical package 7.1 (Muthén & Muthén 1998-2012). First, the intervention effect on objectively measured physical activity, as well as on secondary outcome variables, was examined between baseline (t1) and three-month follow-up (t2) and between t2 and six-month follow-up (t3) using a multilevel random regression model. Each outcome variable was regressed on two dummy coded variables c1 (0,1,1 for time t=1,2,3, respectively) and c2 (0,0,1, for time t=1,2,3, respectively) in within level. After that, this random regression was regressed on condition in between levels. The difference in mean change within and between the groups was tested using the Wald test. If Wald test was statistically significant, the change from t1 to t2 and t2 to t3 were tested using two dummy coded variables c1 and c2. Cohen's d was used as a measure of effect size for within-group change, and it was calculated by dividing the difference of the means by pooled standard deviation at baseline. The effect size for between group change of 0.2-0.3 is considered small, 0.66 medium, and 0.81 large.

Furthermore, differences in the stability of physical activity (PA) between the ACT+FB and FB groups were examined in accelerometer measured and self-reported physical activity. At first, a path model (PA at t2 was predicted by PA at t1 and PA at t3 was predicted by PA at t1 and t2) was fitted in both groups by using the multiple-group analysis method. All the regression coefficients were estimated freely (saturated model). After that, the more constrained model in which the corresponding regression coefficients were fixed to be equal across groups, was estimated. The Satorra-Bentler scaled χ^2 -difference test was used to compare the nested models (in this case, the χ^2 -difference test is equal to the χ^2 -test of the constrained model). The estimation results of the saturated model were reported. In addition, the equality of each regression coefficient between groups was tested for significance. In both multilevel and structural equation models, full information maximum likelihood (FIML) estimation under the assumption of data missing at random (MAR) was used in analyzing incomplete data. Thus, incomplete data were analysed according to intention to treatment principles. As the normality assumption is violated, the maximum likelihood with robust standard errors (MLR) was used.

Study III. Data were analysed using the Mplus statistical software package, version 7.1 (Muthén & Muthén 1998-2012). The sample correlations were calculated in order to investigate the associations between the change scores (post-pre) of physical activity (HEPA time and self-reported physical activity) and psychological variables, as well as the baseline level of physical activity. After that, a path model was used to examine whether the change in acceptance related to physical activity mediates the possible associations between self-efficacy, planning and change in physical activity. The variables were selected for the model based on correlations. The depressive symptoms at the baseline were included in the model as a confounding factor.

Full information maximum likelihood (FIML) estimation with robust standard errors (MLR) was used to estimate the parameters of the path model. FIML uses all the information of the observed data (no e.g. listwise deletion) and produces unbiased estimates under the assumption of data are missing at random (MAR). When data are assumed to be MAR, missingness can be associated with observed variables in the model, but not with unobserved ones. MLR estimation method was used, because some of the variables were skewed. Several indices were used to measure goodness-of-fit between the hypothesised path model and observed data: a Satorra-Bentler scaled chi-square test, comparative fit index (CFI), the Tucker-Lewis index (TLI), as well as root mean square error of approximation (RMSEA) and standardized root mean square residual (SRMR). A non-significant p -value in the chi-square test indicates that the model fits the data well. CFI and TLI values close to 0.95, RMSEA values close to 0.06, and SRMR close to 0.08 indicate a good fit between the hypothesised model and the observed data (Hu & Bentler 1999). Modification indices (MI) were explored when the model did not fit the data adequate well. The indirect effect of interest was estimated and tested for significance.

TABLE 2. Summary of the variables and statistical methods used in the Studies I, II and III.

Study	Data set	Variables and their categorisation	Statistical method
Study I	Cross-sectional data: physically inactive adults, <i>N</i> =58; physically active adults, <i>N</i> =50; data from 2011	Accelerometer-based physical activity Self-reported physical activity Mindfulness skills Psychological flexibility Psychological symptoms Depressive symptoms	A univariate analysis of variance and covariance (SPSS) Cohen's <i>d</i>
Study II	Randomized controlled trial: physically inactive adults, <i>N</i> =138; data from 2011 and 2012	Accelerometer-based physical activity Self-reported physical activity Self-efficacy Planning Acceptance of psychological and physical discomfort related to physical activity Depressive symptoms	Multilevel random regression model Structural equation model (Mplus) Cohen's <i>d</i>
Study III	Longitudinal data: physically inactive adults, <i>N</i> =69; participants in the acceptance- and commitment-based behavioural intervention; data from 2011 and 2012	Accelerometer-based physical activity Self-reported physical activity Self-efficacy Planning Acceptance of psychological and physical discomfort related to physical activity Depressive symptoms	Sample correlation (Mplus) Path model

3 OVERVIEW OF THE ORIGINAL STUDIES

3.1 Study I: Mindfulness skills, psychological flexibility and psychological symptoms among physically less active and active adults

Aim. The aim of Study I was to examine the differences in psychological well-being among physically active and physically less active adults. Differences in mindfulness, psychological flexibility, and psychological and depressive symptoms were evaluated, and their associations described (article I).

Results. The physically active group engaged in on average 38 min/day more moderate-to-vigorous physical activity (MVPA), 32 min/day more health-enhancing physical activity (HEPA), and had 5,128 more steps/day compared to the physically less active group. The individuals in the physically less active group also had significantly greater body weight and had been diagnosed with more physical health problems than the physically active group. Physically active individuals had better mindfulness skills and showed more psychological flexibility than the physically less active group. In addition, physically active adults also had less psychological symptoms and scored lower in depression than physically less active adults when body mass index, diagnosed health problems and their interactions were controlled for (see Figure 3). After the Bonferroni adjustments, the results remained significant with respect to the variables of mindfulness skills and psychological and depressive symptoms. A consistent positive correlation was observed between accelerometer-based physical activity and psychological well-being.

Key findings. The results are in line with earlier studies (Lucas et al. 2011, Galper et al. 2006, Dunn, Trivedi & O'Neal 2001) that physically active adults were found to have better psychological well-being, and fewer psychological and depressive symptoms compared to physically less active adults. The results also support the view that a physically active lifestyle is related to better mindfulness skills (Ulmer, Stetson & Salmon 2010, Gilbert & Waltz 2010, Roberts & Danoff-Burg 2010). A new finding indicated that accelerometer-measured MVPA time was associated with mindfulness skills. MVPA time was also associated with psychological and depressive symptoms that is consistent with the previous studies among overweight and obese adults (Vallance et al. 2011).

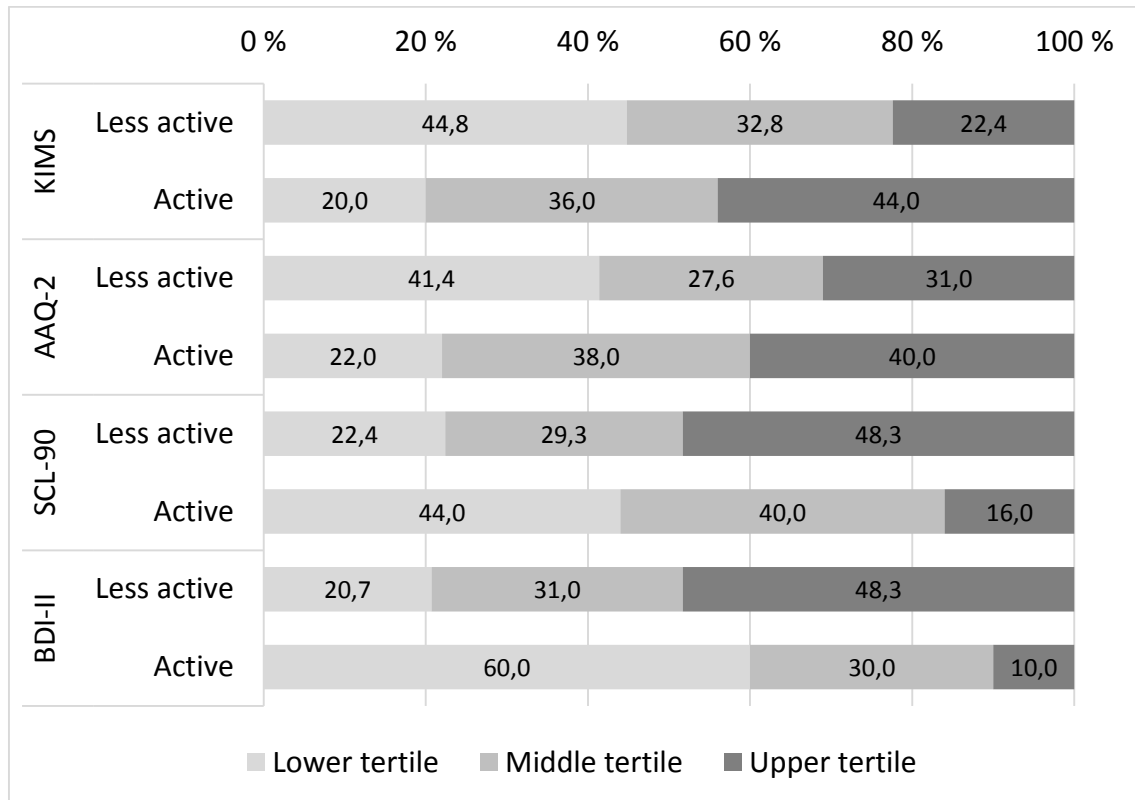


FIGURE 3. Prevalence of mindfulness skills (KIMS), psychological flexibility (AAQ-2), psychological symptoms (SCL-90), and depressive symptoms (BDI-II) among physically less active ($N=58$) and physically active groups ($N=50$), by tertiles calculated for all population.

3.2 Study II: Towards a physically more active lifestyle based on one's own values -a randomised controlled trial among physically inactive adults

3.2.1 A study protocol of a randomised controlled trial among physically inactive adults

Aim. The aim of Study II was, first, to describe the research setting and develop protocol for an acceptance- and commitment-based behavioural intervention for encouraging physically inactive adults to adopt a more active lifestyle (article II). The conceptual framework of the programme was based on an innovative behavioural therapy called Acceptance and Commitment Therapy (ACT), which aims to increase an individual's psychological flexibility and to support behaviour change toward a higher quality and more meaningful life.

Acceptance- and commitment-based behavioural intervention. The acceptance- and commitment-based behavioural intervention consisted of six group sessions (I-VI) combined with pedometer use over nine weeks (see Table 3). In addition, this group received feedback of their physical activity levels at three- and six-month follow-up points as did the comparison "feedback group". The sessions were led by the counsellors or coaches who were trained in ACT. The group size was on average 8–10 participants. The programme aimed to encourage a physically more active lifestyle and well-being using the ACT model.

Session I: the first session started with a short presentation about the elements of ACT (values, committed action, acceptance, self-as-context, defusion and contact with the present moment) and aimed to clarify for the participants how this ACT-based intervention is different compared to more traditional behavioural change strategies. The first session targeted increasing the participants' awareness of their own health behaviour and factors related to health and well-being. During the first session, participants received pedometers and were given information on how to use the device during the nine weeks. Session II: the second session's main focus was to increase the participants' intrinsic motivation based on each one's own values; this is referred to as "value work". The aim of value work is to identify and clarify what is important and meaningful in life. Session III: after value clarification during the third session, participants integrated their values into behavior changes by setting goals and defining value-based actions and plans. Session IV: the fourth session focused on learning mindfulness skills and how to use these skills in the context of everyday life, such as noticing barrier-type thoughts and feelings related to physical activity. Session V: the aim of the fifth session was to teach taking new perspectives regarding one's self-experience. For example, to overcome a conceptualised self-image such as "I'm bad at sports and always lazy", participants were taught skills to observe these thoughts as mere thoughts instead of as literal truths about themselves. Participants reflected their negative evaluations and thoughts in relation to physical activity and recognised that such negative self-evaluations can result in

maladaptiveness, hindering positive changes in one's physical activity behaviour, especially if one sees one's self-evaluation as an absolute truth. Session VI: the last session focused on evaluating and reviewing the participants' process. Reflections were written down and discussed in relation to the role of psychological flexibility in developing a physically more active lifestyle.

The programme included some home assignments after each session as well as a one-week gap after the 2nd, 3rd and 5th sessions. The purpose of the gaps was to allow time for personal activation, progression, and the application of the intervention's teachings in everyday practice.

TABLE 3. Content of the acceptance- and commitment-based behavioural intervention in six sessions (I-VI) during nine weeks.

Week	Session	Topics of the group sessions	Aim	Key questions	ACT-based methods	Behavioural techniques
1	I	Health Behaviour: past, present and future	Increase awareness	What are the factors and/or behaviours that affect my health and well-being? What is the direction where I want to take? What are the things I have tried in order to improve my well-being?	Health behaviour analysis Exploring willingness Experiential exercisers: Mindfulness exercise	Listing the previous attempts to affect one's own well-being Self-monitoring: Pedometer
2	II	Values and Value clarification	Enhance intrinsic motivation	What are the most important values for me? Am I living/behaving according to my values? What is the simplest action that could bring me closer to the life I value?	Value work with paper and pencil Experiential exercises: Mindfulness exercise '90 th birthday' exercise Lifeline	Self-monitoring: Pedometer
3		<i>Individual activation</i>				
4	III	Value-based actions and barriers	Set goals and overcome barriers	What are my specific goals and actions regarding valued behaviour? Why is being active so difficult? What kinds of subjective barriers or explanations block my physical activity?	Value-based goals and actions Barriers identification Experiential exercises: Mindfulness exercise 'Little man' metaphor 'Compass heading' metaphor Defusion exercise: 'Thoughts on paper' Exposure to unwanted thoughts and feelings	Self-monitoring: Pedometer
5		<i>Individual activation</i>				

6	IV	Present-moment awareness and mindfulness skills	Learn mindfulness skills	How can I contact the present moment? How can I use mindfulness skills in order to be more aware of my own behaviour, such as regarding my physical activity in everyday life?	Experiential exercises: Mindfulness exercise Eating raisin exercise Leaves on the stream exercise	Self-monitoring: Observation form Pedometer
7	V	Observing self and physical activity	Learn self as a context	How do I see myself and how does that affect my behaviour? Can I notice the way I think about myself and can I learn non-reactive ways of responding to my thoughts?	Experiential exercises: Mindfulness exercise Defusion exercise Observer exercise 'The house' metaphor	Self-monitoring: Pedometer Use of reward Plan social support
8		<i>Individual activation</i>				
9	VI	Psychological flexibility and being physically active	Review and evaluate the process	How am I doing? What are the actions that help me to achieve my valued life? Do I need to change my goals? Am I living according to my values? Can I be more flexible regarding my behaviour and lifestyle in respect to physical activity?	Experiential exercises: Mindfulness exercise 'Little man' metaphor	Self-monitoring: Pedometer Reflective writing about the learning process

3.2.2 The results of the randomised controlled trial among physically inactive adults

Aim. The second aim of Study II was to investigate the effectiveness of the acceptance- and commitment-based behavioural intervention (ACT+FB) with respect to the participants' physical activity levels and self-efficacy as well as their physical activity planning and acceptance of psychological and physical discomfort related to physical activity after 3 and 6 months compared to a comparison group that had only received written feedback (FB). A further aim was to examine the stability and maintenance of changes-in physical activity six months after the intervention (article III).

Results. No difference was observed in the change of physical activity level between the FB and ACT+FB groups over time. Participants in both groups increased their accelerometer-measured (see Figure 4) and self-reported physical activity with high individual differences. The mean change in accelerometer-based HEPA time from the baseline (5.8 min/day) to the follow-up measurement six months after the intervention was 4.5 min/day in FB group, while in the ACT+FB group it was to 5.5 min/day (baseline 6.4 min/day). However, self-efficacy related to the adoption of and barriers to exercise, action and coping planning, as well as acceptance of psychological and physical discomfort related to physical activity improved more in the ACT+FB group than in the FB group (see Table 4). Moreover, after re-analysing the data of the non-depressive participants, higher stability in objectively measured physical activity was observed on the individual level between the three- and six-month follow-ups in the ACT+FB group compared to the FB group (Figure 5). The experiences of the participants in the ACT+FB group were enquired about in a questionnaire after the six group sessions were completed. In a nutshell, the ACT-based programme was accepted well by the participants. 70% of the participants gave a rating of "4" and 23% of "5", when evaluating their satisfaction with the programme on a scale from 1 (*not satisfied at all*) to 5 (*very satisfied*) (see Appendix 1).

Key findings. The results of Study II suggest that acceptance- and commitment-based group intervention combined with self-monitoring of physical activity was beneficial in: supporting self-efficacy related to adoption of exercise and overcoming barriers to exercise such as feelings of distress, depression or anxiety; encouraging the devising of more concrete and realistic plans to increase one's physical activity; improving individuals' tolerance and acceptance of psychological and physical discomfort related to physical activity; and in bringing more stability to physical activity behaviour change at the individual level, especially among the non-depressive participants. The experiences of the participants in the ACT+FB group show that the ACT-based programme was an accepted and useful intervention that encouraged physical activity and well-being.

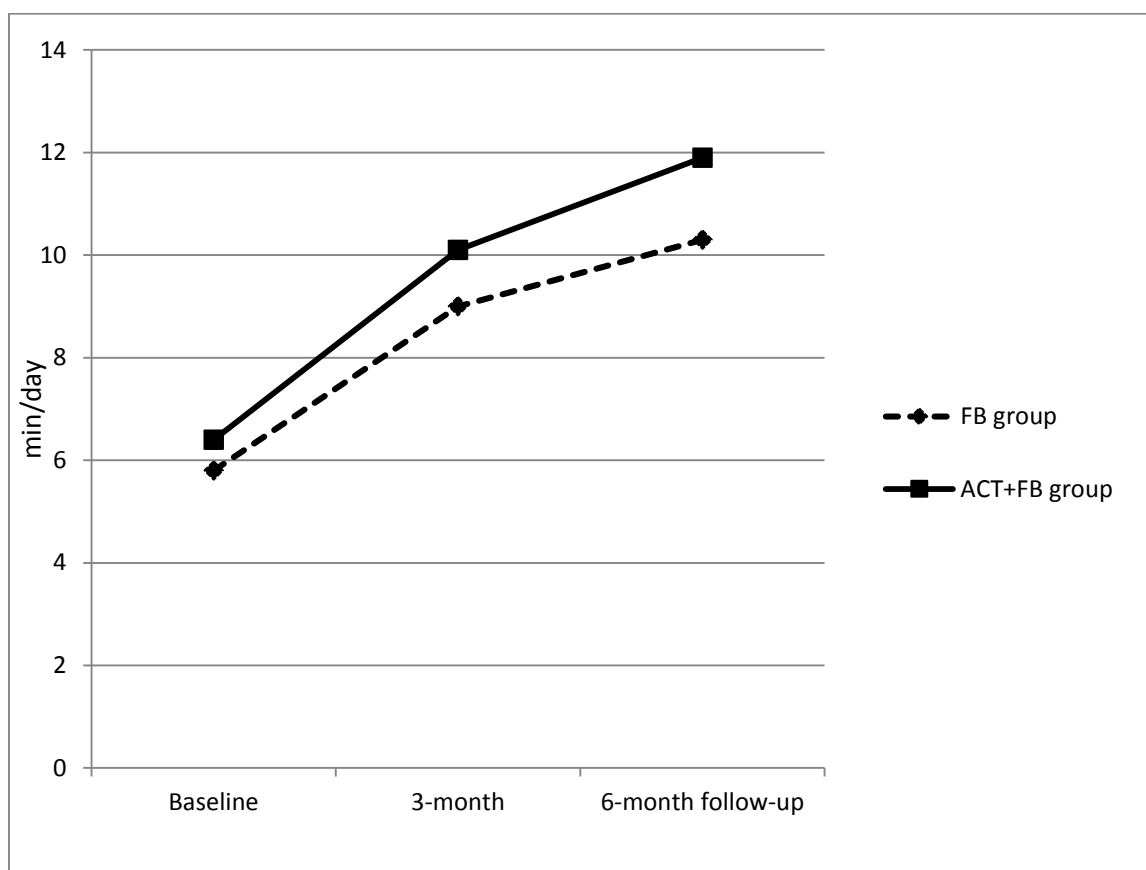


FIGURE 4. Accelerometer-measured health-enhancing physical activity (min/day) at the baseline and 3- and 6-month follow-ups in the FB and ACT+FB groups.

TABLE 4. Objectively measured physical activity, self-reported physical activity and psychological variables related to physical activity.

	FB group					ACT+ FB group				
	Baseline	3 month	6 month	Cohen <i>d</i>	Cohen <i>d</i>	Baseline	3 month	6 month	Cohen <i>d</i>	Cohen <i>d</i>
	t1	follow-up t2	follow-up t3	t1 vs. t2	t1 vs. t3	t1	follow-up t2	follow-up t3	t1 vs. t2	t1 vs. t3
Objectively measured PA min/day										
MVPA, min/day	22.8 (12.5)	24.3 (14.9)	26.6 (16.8)	0.12	0.31	26.2 (12.4)	27.4 (14.5)	29.5 (17.6)	0.10	0.27
HEPA, min/day	5.8 (6.1)	9.0 (11.8)	10.3 (13.4)	0.47	0.66	6.4 (7.4)	10.1 (9.9)	11.9 (14.0)	0.54	0.81
Self-reported, PA min/day	11.6 (11.4)	15.6 (15.7)	18.9 (14.5)	0.30	0.56	15.4 (14.6)	17.4 (14.3)	25.1 (18.0)	0.15	0.74
Adoption self-efficacy	13.7 (2.5)	13.7 (3)	13.9 (3.7)	0	0.08	14.2 (2.7)	14.7 (2.6)	15.3 (3.1)	0.19	0.42
Barriers regarding exercise	11.9 (2.3)	11.7 (2.8)	11.9 (3.1)	-0.08	0	11.4 (2.9)	12.8 (2.6)	13.0 (2.8)	0.53	0.61
Action planning	8.8 (3.4)	9.3 (3.7)	9.8 (3.5)	0.16	0.32	8.0 (2.9)	11.2 (3)	11.0 (2.9)	1.02	0.95
Coping planning	6.2 (2.4)	7.2 (2.7)	7.6 (3.4)	0.43	0.61	5.7 (2.2)	9.5 (3)	9.1 (3.1)	1.65	1.48
PA-AAQ ^a	41.8 (11.7)	46.5 (13.2)	45.2 (12.7)	0.45	0.32	44.4 (9.2)	52.6 (9.7)	54.5 (9.7)	0.78	0.96

FB, feedback; ACT+FB, acceptance- and commitment-based behavioural intervention; SD, standard deviation; PA, physical activity; MVPA, moderate-to-vigorous intensity physical activity; HEPA, health-enhancing physical activity; PA-AAQ, physical activity acceptance questionnaire;

^a PA-AAQ was measured only during the second trial (FB group: *N*=27, ACT+FB group: *N*=32)

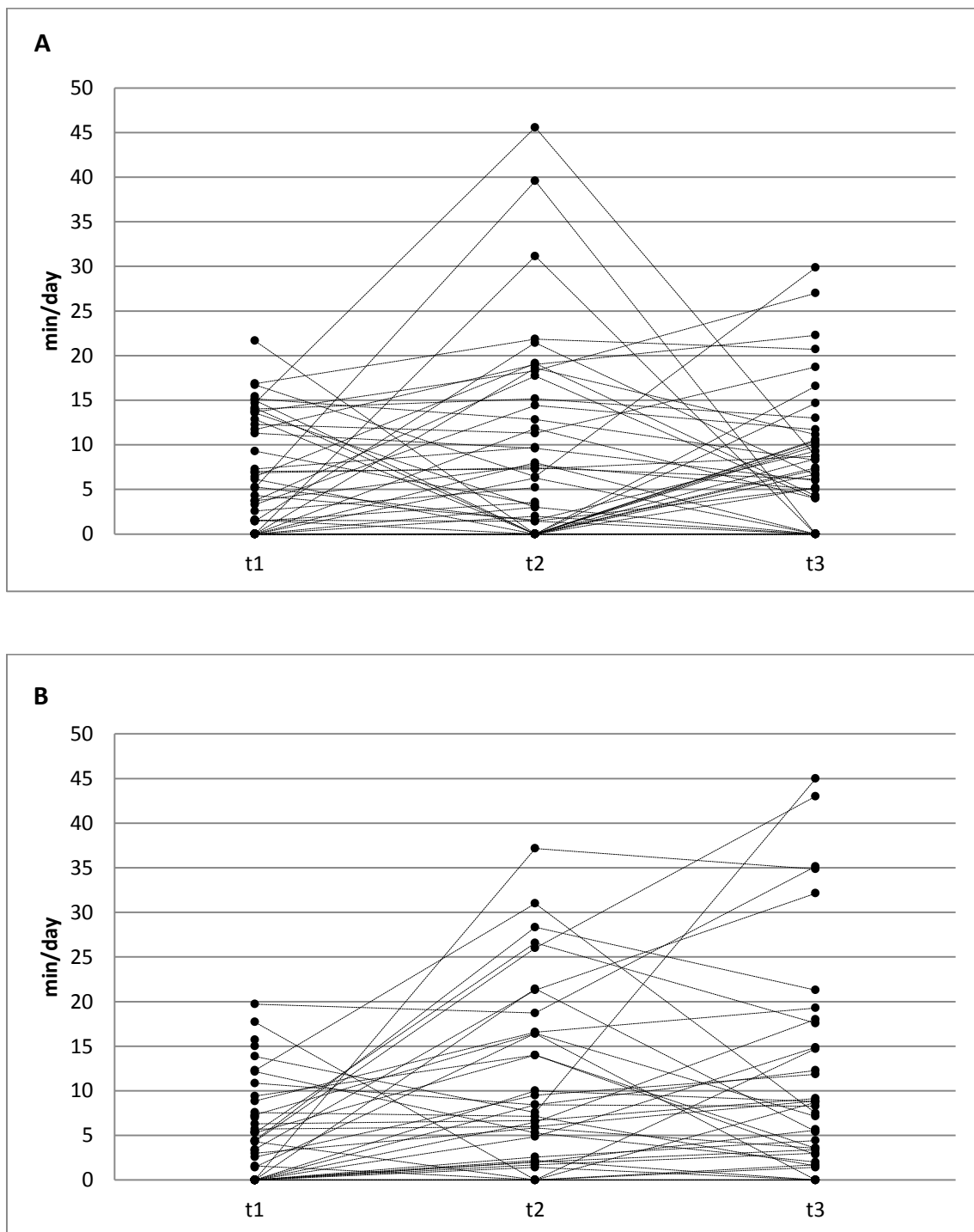


FIGURE 5. Individual trajectories of health-enhancing physical activity (min/day) of non-depressed participants (BDI-II<14). Values are presented with different time points (t1-t3). A) The feedback group, N=53 and B) acceptance- and commitment-based group, N=48.

3.3 Study III: The role of acceptance of discomfort related to physical activity for change in physical activity behaviour among physically inactive adults

Aim. The aim of Study III was to to examine the associations between self-efficacy, planning, acceptance of psychological and physical discomfort related to physical activity, and change in physical activity behavior in the acceptance- and commitment-based behavioural intervention. The second aim was to explore if the possible associations between self-efficacy, planning and change in physical activity were mediated by the change in the acceptance of psychological and physical discomfort related to physical activity (article IV).

Results. The change in acceptance of psychological and physical discomfort related to physical activity was associated with the positive change in self-reported physical activity. The change in acceptance also mediated the association between a change in the barriers self-efficacy and the change in self-reported physical activity.

Key findings. This study suggests that acceptance of psychological and physical discomfort related to physical activity may be a new correlate of change in increasing physical activity among physically inactive adults. These results support the view that acceptance of psychological and physical discomfort may be important when adopting and developing a physically more active lifestyle among the physically inactive participants (Butryn et al. 2015, Ivanova 2015).

4 GENERAL DISCUSSION

The aims of this study were to examine the differences in mindfulness skills, psychological flexibility and psychological symptoms among physically active and less active adults; as well as to develop an acceptance- and commitment-based behavioural (ACT+FB) intervention to encourage a physically more active lifestyle, and to review the intervention's effectiveness in improving physical activity and cognitions related to physical activity after three and six months by comparing the intervention group's results to a comparison group who was only provided written feedback (FB). In addition, the stability of changes in physical activity was examined at the six month follow-up. The study also investigated the associations between cognitions related to physical activity and physical activity change during the acceptance- and commitment-based behavioural intervention.

The results showed that physically active adults had better psychological well-being, having fewer psychological and depressive symptoms, compared to physically less active adults. The results also support the view that a physically active lifestyle is related to better mindfulness skills. No difference was observed in the change of mean physical activity level between the feedback group (FB) and the acceptance- and commitment-based behavioural intervention (ACT+FB) group over time. Participants in both groups increased their accelerometer-measured and self-reported physical activity with high individual differences. However, the results showed that the acceptance- and commitment-based behavioural intervention was more beneficial compared to the feedback only in supporting self-efficacy related to adoption and the overcoming of barriers to exercise, as well as in making more concrete and realistic exercise plans, and improving individuals' acceptance of psychological and physical discomfort related to physical activity. Furthermore, the acceptance- and commitment-based behavioural intervention brought more stability to the individual-level physical activity behaviour change, especially among the non-depressive participants. It was also observed that change in acceptance of psychological and physical discomfort related to physical activity was associated with the positive change in self-reported physical activity. In addition to these results, it was found that change in acceptance mediated the association between a change in the self-efficacy related to barriers of exercise and the change in physical activity.

4.1 Physical activity, mindfulness, psychological flexibility and depressive symptoms

The findings of Study I showed that physically active adults experienced better psychological well-being, and fewer psychological and depressive symptoms compared to physically less active adults. The results are in line with the current view that physical activity is associated with greater psychological well-being and fewer psychological symptoms, like depression (Lucas et al. 2011, Galper et al. 2006, Dunn, Trivedi & O'Neal 2001). In addition, it was observed that physically active adults had

better mindfulness skills compared to physically less active adults, which supports previous studies in regard to the association between mindfulness skills and physical activity (Ulmer, Stetson & Salmon 2010, Gilbert & Waltz 2010, Roberts & Danoff-Burg 2010). However, the association between psychological flexibility and physical activity was not demonstrated after adjusting for multiple comparisons (Bonferroni adjustments).

Few studies have evaluated the associations between physical activity and psychological well-being using direct measures of physical activity such as accelerometers (Loprinzi, Franz & Hager 2013, Hamer & Stamatakis 2010, Hamer, Coombs & Stamatakis 2014, Vallance et al. 2011). The results of the present study suggest that accelerometer measured MVPA is associated with mindfulness skills and psychological, and depressive symptoms. Similar results have been found in population-based studies among U.S. adults, which showed that lower levels of depression were associated with increasing MVPA and decreasing sedentary time, at least regarding overweight and obese adults (Vallance et al. 2011) as well as diabetics (Loprinzi, Franz & Hager 2013). However, in studies based on the Health Survey for England, objectively assessed MVPA was not associated with psychological health (Hamer & Stamatakis 2010, Hamer, Coombs & Stamatakis 2014).

The inconsistency of findings concerning psychological well-being in comparisons between self-reported versus directly measured physical activity, using accelerometers for example, may be due to the nature of those measurements to capture the same parameters of physical activity (Prince et al. 2008). The self-reported measures of physical activity may provide a more complete picture of how one perceives or evaluates one's own physical activity levels, regarding all types of physical activity taking into account that self-reported measures may still have limited reliability and validity (Shephard 2003). In turn, accelerometers may produce exact durations in terms of minutes as objective levels of physical activity, but these results are limited to the activities that can be reliably measured by the device, such as walking and jogging, and thus exclude certain types of exercise such as swimming, strength training and yoga.

The results failed to show an association between psychological flexibility and physical activity. However, in this comparison the sample size was relatively small and it is possible that the general Acceptance and Action Questionnaire, AAQ, is not sufficiently sensitive to measure the variation in psychological flexibility related to physical activity among non-clinical adults. The results showed that the scores of psychological flexibility were relatively high in both groups. At the time of this research, the validated version of the AAQ for measuring psychological flexibility in the context of physical activity was not yet available. In order to measure psychological flexibility in the context of physical activity, a more suitable measure might be the Physical Activity Acceptance Questionnaire, PAAQ, which measures the acceptance of psychological and physical discomfort related to physical activity (Butryn et al. 2015).

4.2 Applying an acceptance- and commitment-based approach to encouraging a physically more active lifestyle

The intervention, which utilises the principles of ACT combined with behavioural techniques in order to encourage a physically more active lifestyle, was developed based on the results of several other studies (Butryn et al. 2011, Tapper et al. 2009). The following issues related to the ACT model will be explored. First, values are discussed in relation to increasing motivation for behavior change. Second, the results are debated in regard to the intervention's effectiveness in improving physical activity levels and cognitions related to physical activity. In addition, the role of acceptance of discomfort related to changing physical activity behaviour among physically inactive adults is discussed.

The results of this study are in line with the view that changing behavior has been observed to be more difficult than changing attitudes, thoughts or feelings (Johnson, Scott-Sheldon & Carey 2010). This raises several interesting questions. For example, why is behaviour change more difficult to achieve compared to the changes in cognitions related to physical activity (e.g. self-efficacy, acceptance). In addition, what is the value of ACT-based intervention in developing a physically more active lifestyle, if changes in cognitions related to physical activity does not lead to behaviour change.

4.2.1 Using values to build motivation for change

Changing one's lifestyle to be more physically active requires intrinsic or self-determined motivation (Thøgersen-Ntoumani & Ntoumanis 2006). In the ACT approach, the motivation for behavior change is built on the individual's own values and what they consider as personally important in their life. These aspects were highlighted in particular during the first sessions at the beginning of the intervention, and referred to as "valuework". The value work consisted of different sets of exercises in which the participants reflected on their values and current lifestyle, and determined their value-based goals for change. A further step was to more specifically define actions and behaviours that would support a more meaningful life.

Instead of focusing directly on health related goals, such as when using a goal-setting technique (Michie et al. 2011, Shilts, Horowitz & Townsend 2004), in value work attention is paid to individuals' primary life goals. Due to the fact that health-related goals often conflict with other life goals, the motivation to reach these goals, especially over time, may be weak or wavering in nature (Bodenheimer & Handley 2009). This factor has been taken into consideration in the intervention's ACT-based model, with the aim of participants identifying what they most want in life in order to set meaningful goals based on such reflections. When goals are seen to be value based actions and choices, the planned behavior change is felt to have a deeper purpose worthy of personal dedication and responsibility. Similar issues (e.g., values,

intrinsic motivation, autonomy) have been addressed also in self-determination theory (Deci & Ryan 2008) and applied to improve physical activity and exercise behavior (Hagger & Chatzisarantis 2007).

However, from an ACT perspective, the initial goal, such as increasing one's physical activity or "get in shape", can actually be a part of the problem and lead to the use of unworkable strategies. Thus, in this study's intervention the primary aim was to first have individuals establish a connection to their own personal values, and only after that to explore if their goals related to physical activity were really linked to something that they experienced as important or meaningful in life. After clarifying the values, the objective was to engage in life, which is vital and affords behaviour that supports one's own values.

In practice, clarifying values and value-based behaviours was promoted with the different sets of exercises during the intervention (Hayes & Smith 2008, Batten 2011, Harris 2009). In this intervention participants clarified and described their values by writing them down using paper and pencil and shared their thoughts in groups and pairs. Experience-oriented values exercises were explored using imaginary-based exercises (e.g. 90th birthday) and metaphors (e.g. life-compass). After defining what they felt to be important or meaningful in their life, the participants reflected on and responded to questions such as *"What does this goal mean to you?"* *"Is reaching this goal helping you to get closer to fulfilling your values?"* *"What are your actions or concrete behaviour that support the important things in your life"* Thus, at the beginning, the focus in planning was not on the questions of *what, when, how much or how often* in regard to physical activity, but rather on *why*. After that, the participants proceeded to seek more practical and concrete solutions for increasing their physical activity that were in line with their more profound, value-based goals in life.

Due to the novelty of this type of intervention in the context of physical activity promotion, the experiences of the participants in the ACT+FB group were explored by means of a questionnaire after the six group sessions (see Appendix 1). According to the participants' self-rated experiences, the programme was accepted well and the ratings were positive and encouraging overall. The participants rated their motivation for being active after the intervention with response alternatives on a Likert scale from 1 (*not at all*) to 5 (*very much so*). Of the respondents, 63% evaluated their resulting motivation to become more physically active as high (score 4) and 25 % as very high (score 5). The value work was assessed from the perspective of how useful this techniques was for the participants, rated on a scale from 1 (*not at all*) to 5 (*very much so*); of the respondents, 66% rated the usefulness as high (score 4) and 21% as very high (score 5).

4.2.2 Changes, maintenance and stability in physical activity behaviour

In Study II, both the acceptance- and commitment-based intervention group that involved self-monitoring and feedback on their physical activity (ACT+FB) and the feedback only group (FB) increased their physical activity levels, but with high individual variation. Unlike the hypothesis, the groups did not differ at the three- and

six-month follow-up points regarding a change in their mean physical activity level. However, a higher stability at the individual level was observed pertaining to the objectively measured physical activity in the ACT+FB group compared to FB group with regard to non-depressive participants between the three- and six-month follow-up measurements.

Based on the self-reported and accelerometer-based HEPA times, mean physical activity times had increased in both groups at the three- and six-month follow-up measurement points. Specifically, the increase in HEPA from the baseline was on average 5.5 min/day in the ACT+FB group at the six-month follow-up point, which means around 39 minutes more HEPA per week. Respectively, in the FB group, the increase in HEPA was 4.5 min/day, meaning around 32 minutes more HEPA per week at the six-month follow-up. Regarding the self-reported MVPA time, the mean change from baseline was 68 minutes per week in the ACT+FB group and 51 minutes per week in the FB group at the six-month follow-up point. The effect sizes in behaviour change interventions concerning physical activity and healthy eating are normally small (Michie et al. 2009, Johnson, Scott-Sheldon & Carey 2010), and medium with respect to self-reported physical activity (Foster, Hillsdon & Thorogood 2005). In this study the within-group effect size for the self-reported physical activity was considered almost as medium in the FB group and medium in the ACT+FB group.

In the discussion on statistical significance within and between the groups, it is also important to consider the clinical or practical significance of the results. One way to assess the health benefits of increasing physical activity might be by comparing the results to the current physical activity recommendation for aerobic activity (World Health Organization 2010). In consideration of the results of the accelerometer-measured physical activity mean levels, both groups examined in Study II were still insufficiently active six months after intervention when evaluated according to the current recommendation for physical activity. However, regarding the self-reported physical activity times, the ACT+FB intervention group reached a total time 176 min/week and the FB group 132 min/week of physical activity. Going by these figures, the participants in the ACT+FB group were actually no longer insufficiently active at the six-month follow-up stage with respect to the current official physical activity recommendation.

Based on the current official recommendation, the amount of self-reported physical activity in the ACT+FB group might be enough to yield some health benefits (Warburton, Nicol & Bredin 2006). However, the amount of increase in physically inactive adults' daily or weekly physical activity necessary to gain definite health benefits has not been determined. Studies using accelerometers are particularly scarce. A few studies have suggested that the amount of activity required for good health (e.g. metabolism indicators) is likely to be lower for objectively measured compared to self-reported activity (Celis-Morales et al. 2012, Troiano 2007, Atienza et al. 2011). It is likely that the increases in the groups' physical activity levels will have some clinically significant health benefits if the individuals sustain their improvements over time.

Although the self-reported and accelerometer-based HEPA increased within the groups, large individual differences in the change of physical activity levels were

observed in the measurements and reports. In practice, some participants improved their physical activity level a lot and some very little or not at all. The results support the view that behaviour change at the individual level rarely follows the average trajectory of change (Renner et al. 2012). Therefore, it was important to examine the changes and their maintenance at the individual level as well (Laursen & Hoff 2006) in order to be able to draw more reliable conclusions regarding the individuals. Despite the similar change in the mean level between ACT+FB groups and the FB group, these results showed a different kind of individual development between the groups in the stability of accelerometer-measured physical activity among non-depressive participants (see path models in the manuscript III). The reanalysis showed that the changes in physical activity were better maintained in the ACT+FB group compared to the FB group among the non-depressive participants. A similar but not statistically significant development was observed between the groups with respect to self-reported physical activity.

When exploring the development of change in the FB group at the individual level, the positive change that took place regarding physical activity from the baseline up to the follow-up measurement three months after was not sustained up to the time of the six-month follow-up assessment. This indicates that the maintenance of the mean-level change was due to different individuals' improvements at the three- and at six-month follow-ups. The results also showed that the participants in the FB group had a high risk of regressing to their baseline physical activity level by the time of the six-month follow-up. In light of the stability analysis, the maintenance of changes based only on the mean group level can be misleading at the individual level. These results indicate that ACT-based intervention may possibly have brought more stability to the change in physical activity at the individual level, especially among the non-depressive participants. However, it must be acknowledged that ACT-based intervention seemed to have enabled a more stable development in both physically more active and less active directions. The high variation in change at 3 month follow-up indicates that some people maintained their physically active change, while others changed their behaviour only little or not at all.

The fact that the difference in stability between the groups was not observed across the whole data leads to the interesting question of what impact the factor of depression has on maintaining a physical activity level. Changing a lifestyle physically more active requires psychological resources, and experiencing depressive symptoms above the normal variation (BDI-II, from 0-13) is likely to negatively affect the adherence to physical activity (Wing, Phelan & Tate 2002, Penninx et al. 1999, Roshanaei-Moghaddam, Katon & Russo 2009). In this study, the number of participants with depressive symptoms in the ACT+FB group ($N=16$) was more than double that of the FB group ($N=7$). Although this difference did not yield a statistical difference between the groups ($p=.056$), depressive symptoms might have had some influence on the results in practice. However, due to the small number of depressive participants, it is difficult to draw strong conclusions regarding the impact of depression on physical activity based on this study's data.

4.2.3 Effects on cognitions related to physical activity

The results of this study showed that acceptance- and commitment-based behavioural intervention was beneficial in supporting self-efficacy related to the adoption and the overcoming of barriers to exercise, leading individuals to make more concrete and realistic plans as well as increasing the levels of their acceptance of psychological and physical discomfort related to physical activity.

Despite the acceptance- and commitment-based behavioural intervention not being directly targeted towards enhancing participants' self-efficacy, the results showed an increase in self-efficacy related to the adoption of exercise and the overcoming of barriers to exercise, as well as in action and coping planning in the ACT+FB group compared to the FB group. Furthermore, the results show that the acceptance- and commitment-based behavioural intervention was more beneficial in improving action and coping plans compared to the feedback group only. The benefits of goals setting (Michie et al. 2011), planning (Hankonen et al. 2010, Sniehotta, Scholz & Schwarzer 2006) and the use of abstract goals (Sweeney & Freitas 2014) in motivating and changing individuals' health behavior and physical activity have also been observed and reported in previous studies.

Also, it is likely that enhancing participants' mindfulness skills during the intervention was one, but an essential part, in improving self-efficacy (Gilbert & Waltz, 2010) and physical activity behaviour (Gilbert & Waltz, 2010, Ulmer, Stetson & Salmon 2010, Chatzisarantis & Hagger 2007, Roberts & Danoff-Burg 2010), exercise planning, and the acceptance of discomfort related to physical activity (Ivanova et al. 2015). Mindfulness skills have also been linked to greater acceptance and awareness of both internal (e.g. thoughts, feelings, sensations) and external experiences, which, in turn, can lead to better self-control and self-monitoring skills (Dutton 2008). This may mean that by developing mindfulness skills an individual may become more aware of his or her own everyday routines and thinking styles, and may thus improve his/her ability to consciously make decisions which promote his/her own activity.

The benefits of mindfulness skills are also linked to better psychological well-being (Baer 2003, Brown & Ryan 2003) and may thus be especially important for physically inactive individuals, who are more likely to experience psychological distress in the form of depressive symptoms than physically active ones (Lucas et al. 2011). Thus, engaging in mindfulness may elicit change over time and integrating mindfulness in exercise interventions could be one way to initiate exercise adherence, improve self-efficacy, and promote psychological well-being.

Despite the changes in cognitions related to the physical activity not resulting in a change in physical activity behavior, it must be acknowledged that the change in the mindset is part of the behavior change process. The likelihood of changing behavior is higher in future, if people feel e.g. more competent about themselves. The role of self-efficacy has been acknowledged in many theories (Ajzen & Driver 1991, Deci & Ryan 2008, Bandura 1998, Rogers 1983, Hagger, Chatzisarantis & Biddle 2002), supporting the view that self-efficacy may play an important role in

boosting motivation and adopting physical activity behavior (Deci & Ryan 2008, Hagger & Chatzisarantis 2007, Hankonen et al. 2010).

The reason why changes in self-efficacy, planning and acceptance were not enough to produce changes in behavior at the group level, still remains unclear based on these results. One possible explanation for that might be that a change in physical activity needs a longer period of time, and that the benefits would therefore be gained in physical activity beyond the study period. On the other hand, based on the theory of ACT, it is also possible that people considered something else more important. Perhaps, value-based motivation triggered some people to change some other domains in their lives instead - areas which they felt to be more important during the course of the study.

4.2.4 Change in acceptance of discomfort was associated with physical activity change

In line with the background theory and model of ACT (Hayes et al. 2006, Hayes, Pistorello & Levin 2012), this study showed that acceptance of psychological and physical discomfort related to physical activity improved more in the ACT+FB group compared to the FB group. Furthermore, change in acceptance of psychological and physical discomfort was associated with self-reported physical activity change in the acceptance- and commitment-based behavioural intervention. Increase in acceptance also mediated the association between change in barriers self-efficacy and positive change regarding self-reported physical activity. These novel results suggest that improving acceptance of psychological and physical discomfort related to physical activity may be important for change among physically inactive adults when changing the lifestyle a physically more active one.

Unlike the cognitive behavioural techniques that aim to directly change an outcome, ACT-based interventions tend to utilise acceptance strategies (Forman et al. 2012). Previous studies have supported this view in relation to the treatment of epilepsy (Lundgren, Dahl & Hayes 2008), chronic pain (Wicksell, Olsson & Hayes 2011), anxiety and depression (Forman et al. 2007). However, little is yet known about the role of acceptance of discomfort in improving physical activity. The acceptance of psychological and physical discomfort has been observed to predict accelerometer measured physical activity level over a period of six months (Butryn et al. 2015). Also, another study by Ivanova et al. (2015) has described an ACT intervention increasing high-intensity exercise tolerance time and post-exercise enjoyment as well as reducing perceived effort in low-active women.

The new finding of the present study suggests that acceptance may play an important role in physically inactive adults increasing their physical activity levels, as seen in this study's ACT-oriented behavioural intervention. Interestingly, in the ACT intervention, participants' increase in acceptance mediated the association between change in barriers self-efficacy and positive change in self-reported physical activity. This new factor might be the answer to the question of why the evidence is limited regarding self-efficacy's mediating role in physical activity interventions (Rhodes & Pfaeffli 2010, Anderson et al. 2006).

The association between self-efficacy and change in physical activity seem to be at least partly explained through self-regulation skills (Anderson et al. 2006, Annesi 2011) and in the ACT-based intervention this is reflected in the change in participants' acceptance of psychological and physical discomfort. The results of this ACT-based intervention suggest that the acceptance of discomfort related to physical activity plays an important role in promoting physical activity among individuals who are not physically active or used to exercising. It is likely that physically inactive or less active individuals may face different kinds of discomfort regarding situations involving physical activity due to their greater body weight, worse physical fitness, and feeling and emotions related to their condition. Thus, this study's ACT-based intervention may be useful when trying to improve individuals' tolerance of discomfort and willingness to engage in and maintain physical activity levels (Ivanova et al. 2015).

4.2.5 Fidelity of the programme

The fidelity of a programme is an important aspect to consider in administering an intervention (Dusenbury et al. 2003). In research such as this study, fidelity refers to the methodological strategies used in monitoring and enhancing the reliability and validity of the behavioural interventions. However, commonly, relatively little attention is paid to the fidelity of interventions compared to reporting their effectiveness and study designs (Bellg et al. 2004). According to Dusenbury et al. (2003), fidelity evaluation considers an intervention's adherence, quality of program delivery, dose, participants' responsiveness and programme's differentiation.

Adherence and quality of programme delivery. The first step in assessing the fidelity of a treatment should be the identification of the critical elements of its programme (McGrew et al. 1994). The present study's intervention programme was a combination of elements from Acceptance and Commitment Therapy (ACT) and behavioural techniques (e.g. self-monitoring). Although behavioural elements were integrated into the intervention, the intervention was delivered based on the ideology and principles of the ACT model. The original ACT model includes six main processes - values, committed action, acceptance, self-as-context, defusion, and contact with the present moment (see Figure 1)- and, in this study's intervention, each process was promoted during the six group sessions with varying emphasis (see Table 3). Despite every session having its own topic (e.g. values), the processes partly overlapped. Also, every session included a mindfulness exercise. Thus, the theoretical side of the ACT model was an important element in delivering the programme. In order to achieve good adherence to the ACT model and protocol, all counsellors received ACT protocol training applied to physical activity. The majority of the sessions were video recorded (only responsible researcher's AK), which enabled the modelling counselor's (AK) behavior during the sessions to be as a model for training purposes. In addition, all counsellors received manuals including short descriptions of the aims of the sessions and planned exercisers. Furthermore, the counsellors assessed their own behaviour after the sessions, such as how well they followed

the protocol and which techniques they used. Based on these ratings, the intervention was assessed as having been delivered with very good adherence. The counsellors also received guidance from the responsible researcher (AK) between the sessions.

Dose. This study's intervention included six group sessions. The number of sessions was decided based on earlier experiences with ACT programmes at the University of Jyväskylä (Lappalainen et al. 2007, Kohtala et al. 2013) and previous research of relevance conducted in the other countries (Ruiz 2010, Powers, Zum Vörde Sive Vörding & Emmelkamp 2009). A new element differentiating this intervention from earlier ACT research was the detail that the whole intervention was delivered within nine weeks, which included a gap of one week after the 2nd, 3rd and 5th sessions. The gap of one week between some of the sessions allowed more time for individual progression, including homework and participants implementing the ACT strategies into their everyday practice. Additional reasons for conducting only six sessions were cost-effectiveness and implementation practicalities.

Participants' responsiveness. Based on records of the participants' adherence to the ACT protocol within the sessions, 75% of the participants attended at least five or all six sessions, which shows a rather good responsiveness to the programme. Furthermore, the participants' ratings of the programme (see Appendix 1) indicated that this type of intervention was accepted well and the methods were experienced as useful by the participants. However, there is no clear information about how much or how often participants applied techniques or certain techniques in their everyday context.

Programme differentiation. This research focused on studying acceptance- and commitment-based behavioural intervention. The intervention was (see Table 3.) based on the ACT approach and applied in the context of promoting physical activity. A special feature of the program was the emphasis on ACT principles, especially in motivating and managing difficult thoughts and feelings related to physical activity. These issues were worked through experiential exercisers, which differentiates this programme from more commonly used health behavior change techniques (Michie et al. 2011).

4.3 Strengths and limitations

To the best of my knowledge, the particular approach taken to promote physical activity in this study's intervention is unique; it is the first time that an ACT-based intervention has been conducted with the aim of encouraging physically inactive adults to develop a physically more active lifestyle. One of the strengths of this study is the use of a randomised controlled trial, which enabled drawing a more reliable conclusion regarding the effects of the intervention on participants' physical activity levels and cognitions. Furthermore, the participants' physical activity levels were

assessed both with self-reports and accelerometers. In addition, a new acceptance- and commitment-based behavioural protocol was developed as part of this study, which can be used and developed further in future studies on improving physical activity.

Despite its strengths, there are several limitations that must be acknowledged when evaluating the study and its contribution to physical activity enhancement. In evaluating the benefits that were gained by participants in the ACT+FB group, it should be remembered that the ACT-based intervention included also the use of pedometers for self-monitoring of physical activity over its nine-week duration; the study setting did not allow for evaluation of the effects of the ACT-based intervention on its own. In order to evaluate the effectiveness of the six group sessions only, the use of pedometers in the ACT+FB group should have been controlled for by also giving pedometers to the FB-only group or including a group that attend only ACT-based intervention. Due to the fact that only eight participants used the pedometers less than 10 days in the ACT+FB group and six of these dropped out, it was not possible to statistically calculate the impact of the pedometers on the changes in physical activity levels and cognition related to physical activity at the three and six-month follow-ups. It must also be acknowledged that the beneficial effects of ACT+FB interventions on participants' cognition may be the results of extra attention these participants received compared to those in the FB group. Nonetheless, it can be concluded that receiving only feedback was not enough to modify participants' cognitions related to physical activity.

Caution is also warranted concerning the use and comparison of accelerometers and self-reports, due to the different ways in which the data were assessed and calculated regarding physical activity. In this study, the correlation between the self-reported moderate-to-vigorous physical activity time and accelerometer-based measures was low. This has also been the results in other studies (Prince et al. 2008). The results suggest that these two methods may not be comparable and it seems that these two measurement methods are not able to capture the same parameters of physical activity. Self-reports may not be as accurate to capture all levels of physical activity (e.g. intensity of physical activity) compared to, for example, information yielded by accelerometers, but they can capture how individual perceives his or her activity level and types of activities (e.g. strength training, yoga). On the other hand, direct measures may better reflect incidental activity during the day (e.g. household activities), but such measures are generally limited to activities that are performed in a standing position and often exclude various modes of exercise (e.g. swimming, cycling) (Strath et al. 2013). As long as there is no definitive consensus on the validity of self-reports measurements compared to various direct methods, caution should be taken when comparing methods across studies (Prince et al. 2008).

It is also possible that this study's sample is not entirely representative of typical physically inactive adults since the participants were recruited for the intervention using advertisements, meaning the participants were more motivated to change their behavior than typical physically inactive individuals might generally be. To draw reliable conclusions regarding the general physically inactive population, a

random sampling method should have been used. In addition, diagnosing participants in terms of their physical and psychological health may have improved accuracy and representativeness of the sample.

The quality and fidelity of the acceptance- and commitment-based behavioural intervention could have been enhanced through more detailed documentation, such as by video- or audio recording the sessions and then letting independent expert rate the adherence to the ACT-oriented protocol based on a random selection of the recorded material (e.g. 20%).

Although the mediation analysis (Study III) was consistent with the ACT hypothesis, this does not rule out the alternative hypothesis that increases in physical activity lead to better acceptance of psychological and physical discomfort related to physical activity. In this study, changes in these variables were measured simultaneously, which needs to be taken into account when interpreting the results. In order to draw a more reliable conclusion regarding the direction of mediation, changes in acceptance should have been identified first, before the post-measurements that was conducted three months after the intervention.

In addition, it is also important to point out that the weather and season may have had an impact on the physical activity measurements (Tucker & Gilliland 2007). Even though the intervention (ACT+FB group) and comparison were (FB only group) were carried out at the same time of the year, it must be acknowledged that the weather conditions in Finland were not similar between the different time points and also not between the two trials. The whole RCT data included two trials, the first trial started in 2011 and the second trial in 2012. For example in the beginning of December in 2012, it was -20 degrees Celcius colder compared to the weather conditions in December 2011. Due to the fact that baseline measurements were conducted at the beginning of September and a three-month follow-up at the beginning of December, plus a six-month follow-up in March, it is likely that the different seasons and weather conditions might have had some impact on the changes in physical activity behavior between the two RCTs.

4.4 Practical implications for physical activity promotion

The acceptance, mindfulness and commitment approach taken in this study is a new evidence-based behavior change model for physical activity promotion. This specific ACT-oriented intervention utilising six core processes—values, committed action, acceptance, self-as-context, defusion, and contact with the present moment—offers new behaviour change techniques that health professionals or practitioners can apply in encouraging physically inactive adults or clients to adopt a physically more active lifestyle. This new ACT-based method might be especially helpful when traditional health-related goal strategies do not generate sufficient motivation. In general, the practical aim is to teach psychological skills that help individuals to live a more meaningful and committed life based on one's own values regardless of the internal experiences (e.g. thoughts, feelings) that might be preventing the change. Furthermore, ACT-based intervention might be helpful in being more mindful in decision

making processes and thus help individuals who have a tendency to react to internal (e.g. emotions, like tiredness) and external (e.g. using escalators, cars) cues that drive a physically passive lifestyle. Based on the current research evidence, the knowledge gained from this dissertation and my experience as a health psychologist, I have highlighted five key areas in physical activity promotion that could be enhanced using ACT techniques.

Building motivation for change. Motivation for behavior change, that is, changing one's lifestyle to a physically more active one, is built on personally meaningful values; in short, working with values means considering and clarifying what is important in one's life and enhancing one's commitment to these values. Health related goals can be part of these reflections or seen as a way or a means to achieve something that has a deeper meaning in one's life (e.g. primary life goal: to be a caring parent). This ACT-oriented technique involves several cognitive exercisers how to clarify values, including experiential exercisers (e.g. 90th birthday). Valuing is seen as a feeling, a behavior (action), and a choice. When values are guiding one's own choices in life, the motivation for behavior change is likely to be more self-determinant and intrinsic, linked to life goals and meaningful behavioural changes. This way of approaching lifestyle changes is more likely to have a long-lasting effect and support maintenance and stability in health behaviour.

Increasing adaptivity to become physically more active. The ACT model helps individuals to increase psychological flexibility. Applied to the context of adopting a new lifestyle behavior, this means the ACT model can be useful in helping individuals to develop a more adaptive and flexible perspective in regard to becoming more physically active. According to learning theories and the relational frame theory (RFT), too strict instructions, thinking styles or verbal rules can prevent individuals from adapting to internal or external contexts, including learning that is based on one's own experience. In the context of being physically active, for example, many people try to hold on to their goals or "rules" (e.g. "at least 30 minutes of MVPA or 10 000 steps a day is sufficient for my health"; or, "go to gym 2-3 times a week") even when they find that following these plans is not working for them. Subsequently, when not achieving these goals, such people begin to feel unmotivated and become disappointed with themselves, but they may not see other possibilities. Smaller activity breaks, such as walking 10-15 minutes during the day, may be possible, but not validated as being "active". Thus, ACT techniques help in offering solutions that work for the individual and help him or her to identify and overcome their own mental "rules" or explanations that are acting as barriers to positive change. The emphasis regarding behavior change is on *workability*, not on preconceptions of how one "should" be physically active. Thus, when learning new behavior or developing a new lifestyle, people are encouraged to learn based on their own experiences, not merely based on external advice or recommendations.

Managing psychological barriers to change. Through the ACT processes of acceptance, present moment and defusion, it is possible to learn new ways to respond

and to develop a non-reactive way to act in regard to ineffective internal (e.g. thoughts in one's mind or feelings of discomfort) or external cues (e.g. seeing an escalator, using a car). The ACT method features several experiential exercises and metaphors that help develop skills related to a mindful decision making process to experience feelings as feelings and thoughts as thoughts (e.g. "I feel tired"), not necessarily as cues to act on them (e.g. to stop exercising, skip walking, or stay on the couch). The aim is to enhance individuals' sense of attentiveness in order to become more flexible, focused and volitional (Hayes, Strosahl & Wilson 2011).

Mindfulness skills training is e.g. one practical way to help clients to learn a non-reactive way to respond to their own difficult thoughts and feelings with acceptance and self-compassion, and learn to live more in the present moment rather than thinking excessively about their past and future. People easily become fused with their barrier-type thoughts or explanations regarding exercise and may adopt a procrastinating thinking style that hinders a positive behavior change from taking place in the present moment (e.g. "When I have this work done next week, I will have time to go walking more often"). Mindfulness skills may also be helpful in increasing individuals' tolerance of discomfort related to physical activity. Tolerance of the physical discomfort to exercise (muscle pain, fatigue) as well as to the psychological side, such as the ability to accept and expose oneself to the negative thoughts (I can't do this) or feelings (shame, anxiety), is often needed when adopting behavior that is first found to be difficult or even aversive.

Focus on behaviour. Although the ACT approach includes many psychological skill exercises, its emphasis is on improving behavior or action in line with clients' values. The ACT approach encourages individuals to take responsibility for their own behavior by teaching commitment and skills for breaking old routines and habits. It is not enough to be aware of one's own values and to know what is important in one's life when one still does not behave accordingly. For example, if one values one's health and recognizes that it is important and it even has a deeper meaning as a parent, then it would be contradictory if one's lifestyle would include little or no physical activity with choices being made in favour of passivity.

Integrating mindfulness in physical activity. The evidence presented earlier in this study suggests that mindfulness training might be helpful in developing a physically more active lifestyle. Mindfulness skills can be practised on their own or integrated in physical activity through mindful movements (Asztalos et al. 2012). Through mindful movements physical activity is experienced more consciously and exercises become deliberate. Teaching physically inactive adults to be more mindful during physical activity and exercise might enhance the quality their physical activity experience and improve exercise adherence and mindfulness skills. These skills, or elements, increase the ability to concentrate on the present moment (reducing thinking such as, "When is this going to end?") and train individuals to observe their own thoughts, feelings and bodily sensations, similar to what is taught in yoga, Pilates and tai-chi. This skill could easily be integrated in physical activity interventions and physical activity promotion in general.

Enhancing psychological well-being and self-compassion. For physically inactive adults to change to a physically more active lifestyle is in many cases very challenging, particularly when a comorbidity of other health problems, such as obesity, depression, and type 2 diabetes. Thus, when working with physically inactive clients in order to increase their physical activity, it can be valuable improve their psychological well-being or psychological resources and self-compassionate attitude toward themselves in the challenging change process. In practice, this means teaching clients to improve their ability to observe own behavior and to respect their changes in relation to their own lives. For most inactive people, it is probably not particularly motivating to constantly evaluate their own actions as good or bad, or sufficient or insufficient, or to compare their own physical activities and performance to official recommendations. Thus, it may be important to learn to appreciate small changes and to increase self-awareness, such as through mindfulness skills, in order to be more aware of available options in the present moment (e.g. using stairs instead of the lift, going for a 10-minute walk as a break during the working day, not sitting constantly). ACT method includes several exercises that can improve individuals' psychological well-being and train them to develop acceptance and self-compassion skills.

4.5 Future directions for research

Along with providing some evidence of applying acceptance- and commitment-based behavioural intervention in improving physical activity among physically inactive population, the findings of this dissertation raise some important questions for the future research. Due to the novel nature of this research, particularly longitudinal research in particular is needed in the future in order to increase our understanding of the behaviour change related to physical activity among physically inactive adults. The development of the study protocol within this dissertation is one example of how ACT-based methods can be applied to encourage a physically more active lifestyle. However, it is recommended for this research design to be replicated and developed further.

The results of this dissertation indicate that the applied ACT-oriented methods have been particularly helpful in maintaining changes in physical activity. In future studies, it would be interesting and useful to examine whether such ACT methods can increase the maintenance of changes over longer periods than other types of interventions and what role flexibility versus rigidity (strict plans, fixed programmes) plays in this. In relation to the findings of this dissertation, the role of depression in the maintenance of improved physical activity behavior is also thought to be worthwhile examining further.

As physical inactivity is strongly associated with many health problems, such as being overweight, obesity and depression, there is a need for approaches that enable broader psychological well-being and a higher quality of life. The ACT model presents one possible approach for examining and developing different areas of life simultaneously, taking into consideration the individual's life and well-being as a

whole. Furthermore, little is known about the influence of depression on individuals' level of adherence to physical activity programmes, specifically concerning physically inactive and obese adults. It could be useful to conduct more detailed research on what would be the best way to progress with depressive adults in a physical activity intervention. Furthermore, the dose-response of physical activity on depression needs further study as well.

The role of stigma in physical activity or health behavior is also interesting and understudied. Previous studies have indicated that experiencing stigma may hinder obese adults from managing their weight effectively (Lillis et al. 2009). Due to the fact that being physically active is a socially desirable behavior, it is possible that some physically inactive and less active adults may experience shame and feelings of guilt regarding their inactivity. The impact of these types of feelings on such individuals' ability to change and maintain healthy physical activity behavior is also deemed worthwhile closer examination.

Future studies should focus also on encouraging a physically more active lifestyle across the lifespan. In particular, ACT-based interventions among children, families and youths would provide an opportunity to improve their physical activity and thus their well-being and quality of life. ACT skills can be valuable among developing children and youth, and help them to find their own best way to be physically active. It is unrealistic to expect that all children would be interested in exercising and sports. Through the ACT approach, children could learn more adaptive strategies in regard to improving physical activity.

The development of measurement methods (e.g. accelerometers) have made it possible to assess physical activity levels more objectively and precisely compared to self-reports. However, longer periods of wearing the accelerometer should be considered, as well other types of assessment that capture the modes of physical activity (e.g. cycling, swimming) that are currently not reliably recorded by accelerometers. This might be particularly useful with respect to physically inactive adults, who may favour softer modes of physical activity (swimming, strength training, Pilates) due to their greater body weight, poorer fitness, and typically chronic diseases.

In line with research that focuses on the effectiveness of the interventions related to physical activity, future studies should conduct a more detailed investigation into exactly why certain participants drop out of such interventions and fail to make positive lifestyle changes, as well as why some individuals are not actually willing to change their lifestyle and why they insist on continuing unhealthy habits. On the other hand, it would be worthwhile to examine the "success" stories as well and point out the factors that have been helpful in individuals' change process.

5 CONCLUSIONS

In line with earlier findings, this dissertation confirmed that physically active adults had better psychological well-being, having less psychological and depressive symptoms compared to physically less active adults. The results also show that having a physically active lifestyle is related to better mindfulness skills. The research involved a randomized controlled trial (RCT) utilising the Acceptance and Commitment Therapy (ACT) to encourage a physically more active lifestyle among physically inactive adults. No difference was observed in the change of physical activity mean level between the feedback (FB) and the acceptance- and commitment-based behavioural intervention (ACT+FB) over time. Participants in both groups increased their accelerometer-measured and self-reported physical activity levels with high individual differences. However, acceptance- and commitment-based behavioural intervention was beneficial in supporting self-efficacy related to the adoption of exercise and overcoming barriers to physical activity and exercise, as well as to making more concrete and realistic plans. It also increased the acceptance of psychological and physical discomfort related to physical activity compared to receiving feedback only. In addition, the results suggest that acceptance- and commitment-based behavioural intervention brought more stability to the individual-level physical activity behaviour change, especially among the non-depressive participants. The change in acceptance of discomfort related to physical activity was associated with the positive changes in self-reported physical activity in the acceptance- and commitment-based behavioural intervention. The change in acceptance also mediated the association between change in barriers self-efficacy related to exercise and changes in physical activity.

In conclusion, the results indicate that a physically active lifestyle is related to better psychological well-being and mindfulness skills. Moreover, the results suggest that acceptance- and commitment-based behavioural intervention was beneficial in supporting physically inactive adults' cognitive change related to physical activity, and it brought more stability to the individual-level physical activity behaviour changes, especially among the non-depressive participants. Finally, the findings also suggest that the change in acceptance of psychological and physical discomfort related to physical activity may be important when developing a physically more active lifestyle among physically inactive adults.

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Appendix 1.

Experiences of the participants in the acceptance- and commitment-based behavioural intervention (ACT+FB). Distribution of the responses for different questions for response alternatives 1 to 5.

	1	2	3	4	5	Missing
Self-rated experiences						
1. Satisfaction, N=55		1.8	3.6	69.6	23.2	1.8
2. Well-being, N=55			19.6	66.1	12.5	1.8
3. Motivation to be active, N=54			8.9	62.5	25.0	3.6
4. Physical activity/exercise, N=52			26.8	50.0	16.1	7.1
5. Usefulness of the methods						
Value work, N=56		3.6	8.9	66.1	21.4	
Conversations, N=56	1.8	7.1	8.9	37.5	44.6	
Metaphors, N=56	3.6	8.9	42.9	28.6	16.1	
Mindfulness-exercises, N=56	5.4	3.6	16.1	50.0	25.0	
Health behaviour analysis, N=53		3.6	14.3	46.4	30.4	5.4
Pedometer, N=56	3.6	1.8	12.5	21.4	60.7	

Note. Each questionnaire included five questions with response alternatives to be rated on a scale from 1 to 5:

- 1) How satisfied were you with the content of the program? (1= *not satisfied at all*; 5= *very satisfied*);
- 2) How has your general well-being changed? (1= *got significantly worse*; 5= *improved very much*);
- 3) How has your motivation to be active changed? (1= *got significantly worse*; 5= *improved very much*);
- 4) How much has your level of physical activity/exercise changed? (1= *decreased very much*; 5 = *increased very much*);
- 5) How useful was following exercises or methods (value work, conversations, metaphors, mindfulness-exercises, health behaviour analysis, pedometer)? (1= *not at all useful*; 5= *very useful*).

Appendix 2.

Summary of the acceptance- and commitment-based behavioural interventions to enhance physical activity among adults 2000-2014.

Authors / year	Background theory	Subjects	Condition	Measurements	Results/Effects
Butryn et al. 2013	ACT Intrinsic motivation theory	Young female adults	Education group ($N=19$) ACT group aiming to increase physical activity ($N=35$) 2 hours x 2 group sessions	Number of visits per week to campus Athletic center	Participants in the ACT group increased their level of physical activity more than education group.
Goodwin et al. 2012	ACT CBT	Female cardiac outpatient, adults	ABBT intervention for physical activity and diet ($N=16$), no control group, 90 min x 4 group sessions	Self-reported physical activity and diet.	Moderate increases of physical activity ($d= 0.54$)
Katterman et al. 2013	ACT CBT	Young female adults	ABBT intervention preventing weight gain ($N=29$), 8 group sessions Control group ($N=29$)	Measured weight and BMI, self-reported physical activity.	ABBT group decreased weight ($p=.008$) and BMI ($p=.015$) compared to the control at 6 weeks. The results maintained across 1 year. Positive improvements in physical activity ($d= 0.51$ at 6 weeks, $d= 0.25$ at 1 year), but changes were not significant between the groups.
Tapner et al. 2009	ACT, mindfulness	Female adults, who were actively attempting to lose weight	ACT Intervention ($N=31$), 2 hours x 4 group sessions Control group ($N=31$)	Self-reported physical activity and measured BMI.	In the ACT group at 6 months greater increases in physical activity ($p=.05$) compared to control group. After re-analysing the data excluding those who “never” applied ACT principles at 6 months, greater reductions in BMI ($p=.05$) and physical activity ($p=.05$) in the ACT group compared to the control group.

Note. ACT, Acceptance and Commitment Therapy; ABBT, Acceptance based behavioural treatment.

ORIGINAL PUBLICATIONS

- I Kangasniemi, A., Lappalainen, R., Kankaanpää A. & Tammelin, T. 2014. Mindfulness skills, psychological flexibility, and psychological symptoms among physically less active and active adults. *Mental Health and Physical Activity* 7 (3), 121–127.
- II Kangasniemi, A.M., Lappalainen, R., Kankaanpää, A., Kulmala, J., Hakonen, H. & Tammelin, T. 2013. Towards a physically more active lifestyle based on one's own values: study design of a randomized controlled trial for physically inactive adults. *BMC Public Health* 13: 671.
- III Kangasniemi, A.M., Lappalainen, R., Kankaanpää, A., Tolvanen A. & Tammelin, T. 2015. Towards a physically more active lifestyle based on one's own values: the results of a randomized controlled trial among physically inactive adults. *BMC Public Health* 15:260.
- IV Kangasniemi, A.M., Lappalainen, R., Kankaanpää, A. Tolvanen A. & Tammelin, T. The role of acceptance of discomfort related to physical activity for change in physical activity behaviour among physically inactive adults. Submitted.

The original publications are not included in the electronic version of the dissertation.