

Mindfulness in Adolescents with Asthma:  
Role in Quality of Life and Asthma Control in an Observational and a Treatment Study

Master Thesis

Linda Cillessen, BSc.

Radboud University Nijmegen

Supervised by Dr. Monique O.M. van de Ven and Dr. Johan Karremans

Radboud University Nijmegen

Author Note

Special thanks to Anne Marlijn Hauserer for her help with creation of the mindfulness training and provision of the mindfulness exercises.



### Abstract

This paper focused on the role of mindfulness in asthma-related quality of life (QoL) and asthma control in adolescents with asthma in an observational and a treatment study. The observational study tested whether mindfulness was related to asthma-related QoL and asthma control, and whether this association was mediated by general stress and asthma-specific stress (i.e. worry about asthma). Eighty-nine adolescents with asthma that were prescribed daily asthma medication participated. We found that mindfulness was related to asthma-related QoL and asthma control (latter marginally significant). Both relationships were mediated by worry about asthma, but not by general stress. The treatment study looked at two aspects of feasibility (acceptability and limited-efficacy) of a 4-week mindfulness training for adolescents with asthma. Sixteen adolescents with asthma that were prescribed daily asthma medication participated in the training to evaluate acceptability. To test limited-efficacy, 16 matched controls were also included. Promising results were found for acceptability. With regard to limited-efficacy, preliminary evidence for training effects on asthma-related QoL was found. Taking results of both studies together, convenient evidence for a relation between mindfulness and asthma-related QoL is found, and some evidence for a relation between mindfulness and asthma control is found. Mindfulness could be a promising target for increasing asthma-related QoL, and possibly also asthma control, in adolescents with asthma.

*Keywords:* asthma, mindfulness, adolescent, quality of life, control

In the Netherlands 4 of every 100 adolescents suffer from the atopic disease asthma, making asthma one of the most common chronic diseases in adolescence (Gommer & Poos, 2011). Asthma-related quality of life (QoL) and asthma control are two important asthma outcomes that reflect the impact of asthma. Asthma-related QoL is defined as the inference of asthma and medication use with daily life (Rutishauser, Sawyer, Bond, Coffey & Bowes, 2001). Adolescents with asthma have a lower QoL than their healthy peers (Sawyer et al., 2000). This could be due to asthma symptoms, school absenteeism (Okelo, Wu, Krishnan, Rand, Skinner & Diette, 2004) and feelings of fear, anxiety and embarrassment about their disease (Cohen, Franco, Motlow, Reznik & Ozuah, 2003). Asthma control is associated with asthma-related QoL (Guilbert et al., 2011), and is defined as the current clinical control over asthma, which implies the frequency and intensity of asthma symptoms, and the functional limitations of asthma experiences (Bousquet et al., 2010). Having less asthma control is associated with more negative attitudes and feelings concerning asthma (Rhee, Belyea & Elward, 2008).

To improve outcomes in adolescents with asthma, it is important to study factors that could enhance asthma-related QoL and asthma control. To date, there is some evidence available that suggests mindfulness could be such a factor (Pbert et al. 2012). Building on this evidence, the current project is the first to focus on the relationships between mindfulness and the outcomes asthma-related QoL and asthma control in adolescents with asthma, in an observational and a treatment study.

A frequently used definition of mindfulness is ‘directing conscious attention to current moment experiences, in a non-judgmental and accepting manner’ (Williams, Teasdale, Segal & Kabat-Zinn, 2007). Mindfulness is known for its positive effects on various outcomes in a large variety of populations (Baer, 2003). The positive effects of mindfulness probably arise

by bringing acceptance and non-judgmental awareness to aversive feelings and thoughts (Shapiro, Carlson, Astin & Freedman, 2006). Due to acceptance and non-judgmental awareness, mindfulness prevents aversive feelings and thoughts from triggering further distress about the aversive feelings and thoughts. Stated otherwise, mindfulness blocks occurrence of an extra 'layer' of distress caused by aversive feelings and thoughts. Many studies have confirmed the stress-reducing capacities of mindfulness (e.g. Vlemincx, Vigeo, Vansteenwegen, Van den Bergh & Van Diest, 2013; Baer, 2003).

We suggest that these stress-reducing capacities play a key role in explaining the relationships between mindfulness and the outcomes asthma-related QoL and asthma control via two different mechanisms. The first mechanism could explain relations with both asthma-related QoL and asthma control. Research shows that higher levels of stress are associated with more asthma morbidity (Sandberg et al., 2000). Stress creates breathlessness, and breathlessness, an early sign of an asthma attack, can increase further stress (Rietveld, Van Beest & Everaerd, 1999). A positive feedback loop occurs, in which stress results in bodily signs of asthma, which lead to further stress, which leads to more bodily signs of asthma, and so on. By being mindful, one observes his or her current experiences, including stress, in an accepting and non-judgmental manner, which should prevent getting carried away by them and triggering more bodily symptoms. Ultimately, the resulting stress reduction could lead to better asthma control and even to a better asthma-related QoL, as asthma symptoms and QoL are related (Goldney, Ruffin, Fisher & Wilson, 2003). The second mechanism applies only to asthma-related QoL. Asthma can interfere with many aspects of daily life, like social and physical activities (Rutishauser et al., 2001). This interference may cause a lot of stress. Mindfulness may induce a more accepting stance about the asthma, and reduce the stress about the impairments of asthma on daily life. This stress reduction might result in a better

capacity to deal with the impairments caused by the asthma, which will ultimately increase asthma-related QoL.

There is some initial evidence that mindfulness is associated with positive outcomes in adult patients with asthma. Research shows that a mindfulness training reduces stress and increases QoL in adults with chronic illnesses like asthma (Reibel, Greeson, Brainard & Rosenzweig, 2001). Pbert et al. (2012) studied the effects of mindfulness-based stress reduction therapy in adults with asthma, and found positive effects on asthma-related QoL, but not on lung function (which is related to asthma control; Juniper, Guyatt, Ferrie & King, 1999; Juniper, Gruffydd-Jones, Ward & Svensson, 2010). Pbert et al. (2012) did find a non-significant increase in the percentage of well-controlled asthma. To the authors' best knowledge, this project is the first to look at the role of mindfulness in asthma outcomes in adolescents.

This paper describes two studies. Study 1 is an observational study looking at cross-sectional survey data. This study aimed to find support for the theoretical model described above, focusing on the role of mindfulness in asthma-related QoL and asthma control, and the explanatory function of stress in these relationships in adolescents with asthma. As stress is a broad construct, we decided to focus on two aspects of stress; general perceived stress and more asthma-specific stress, namely worry about asthma. We hypothesized that being more mindful was associated with better asthma-related QoL and more asthma control, and we expected that these relations were mediated by decreases in general stress and worry about asthma.

Study 2 is a treatment study focusing on the feasibility of a mindfulness training for adolescents with asthma. We focused on two areas of feasibility identified by Bowen et al. (2009); acceptability and limited-efficacy (limited due to small sample size). To evaluate

acceptability, adolescents with asthma evaluated participation in a mindfulness training. To learn about limited-efficacy a quasi-experimental design with matched controls was used. We expected medium to large effects of the mindfulness training on the self-reported outcomes mindfulness, asthma-related QoL, asthma control and stress (again divided into general stress and asthma-specific stress, namely worry about asthma).

## **Method Study 1**

### **Participants**

This study was approved by the ethics committee of the Faculty of Social Sciences of the Radboud University in Nijmegen. The study is part of the fifth wave of a five-year longitudinal study, in which 268 adolescents with asthma and their parents participate (Tiggelman, van de Ven, van Schayck, Kleinjan & Engels, 2014). The adolescents were recruited via primary and secondary schools, and via an advertisement in the magazine published by the Dutch Lung Association. More details about the recruiting procedure can be found elsewhere (see Tiggelman et al., 2014). The current study included only adolescents that were prescribed daily preventive asthma medication (anti-inflammatories) by a doctor at the fifth wave. This inclusion criteria was chosen to ensure that the asthma had a certain level of severity and interference with daily life. Of the original group of participants, 115 dropped out in the current or a previous wave, 54 did not use daily asthma medication and 10 were not tested before May 2015 due to problems with reaching the participants or scheduling home visits. Thus, the final sample included 89 adolescents (50 boys), aged between 14 and 18 years ( $M=15.81$ ,  $SD=1.10$ ).

### **Measures**

All constructs were measured with questionnaires filled out by the adolescents. A higher score implied more of the measured construct on all questionnaires. Only the CAMM

had to be recoded in order to fulfil this requirement.

**Mindfulness.** Mindfulness was measured with the Child and Adolescent Mindfulness Measure (CAMM; Greco, Baer & Smith, 2011) and the Mindfulness Attention Awareness Scale Adolescents (MAAS-A; Brown & Ryan, 2003; Brown, West, Loverich, & Biegel, 2011). We chose to use two questionnaires because the questionnaires reflect slightly different aspects of mindfulness (respectively mindfulness and mindful attention), that are both important to get a good insight in mindfulness. The CAMM ( $\alpha = .83$ ) consists of 10 items that were answered on a 5-point Likert scale (never true to always true). An example of an item is ‘I get upset when I have feelings that don’t make sense’. The MAAS-A ( $\alpha = .84$ ) has 14 items, that were answered on a 6-point Likert scale (always to never). An example item is ‘I notice I do things without paying attention’.

**Asthma-related QoL.** Asthma-related QoL was measured with the subscales medication, physical activities, social interactions and emotions of the Adolescent Asthma Quality of Life Questionnaire (AAQOL; Rutishauser et al., 2001). Questions were answered on a 7- or 8-point Likert scale (response categories varied per question). In the case of an 8-point question the last category was ‘not applicable’, which was recoded to a 7 (which reflects high QoL) as instructions of the AAQOL suggest. The medication subscale has 5 items (e.g. “How bothered did you feel about having to carry your inhaler with you”), the physical activities subscale has 6 items (e.g. “How often have you been restricted in sports, hobbies or other recreational activities because of your asthma”), the emotions subscale has 5 items (e.g. “How often did you feel frustrated because of your asthma”) and the social interaction subscale has 5 items (e.g. “How often have you been annoyed by your asthma when going to a party”). Based on these four subscales, an overall QoL score was created ( $\alpha = .90$ ). Two other subscales in the AAQOL, positive effects and symptoms, were not used in this overall

score due to lacking correlations with other subscales in validation research (positive effects) and because of overlap with the asthma control measure (symptoms).

**Asthma Control.** Asthma control was measured with the first 6 items of the Asthma Control Questionnaire (ACQ; Juniper et al., 1999; Juniper et al., 2010). These items of the ACQ ( $\alpha = .83$ ) were answered on a 7-point Likert scale (always to never). An example item is ‘How often did you wake up because of your asthma in the last week?’.

**Stress.** General stress was measured with the 10 item version of Perceived Stress Scale (PSS; Cohen, Kamarck, & Mermelstein, 1983). Items of the PSS ( $\alpha=.84$ ) were answered on a 5-point Likert scale (never to very often). An example item is ‘I was upset because something unexpectedly happened’. Asthma-specific stress, i.e. worry about asthma was measured with two items of the four-item worry subscale of the Asthma-Specific Coping Scale (Aalto, Harkapaa, Aro & Rissanen, 2002), namely ‘I am afraid my asthma will get worse’ and ‘I worry about my asthma’. Only these two items of the subscale were used because of their face validity and because of extremely low reliability if one or more of the other items were included. The two questions used to measure worry about asthma ( $\alpha=.68$ ) were answered on a 4-point Likert scale (hardly ever to almost always).

## **Procedure**

The data collection consisted of a two-hour home visit conducted by one of six trained test leaders, between February and April 2015. During the home visit, participants completed various questionnaires on paper, did two computer tasks and a lung function test. The questionnaires used in this study took about 30 minutes to complete, the total home visit lasted around 1.5 hours. Adolescents received a voucher of 20 euros for their participation.

## **Data analysis**

Data were analyzed in SPSS 21, except for the Structural Equation Models (SEMs),



which were analyzed in R (version 3.1.2; R Core Team, 2014). Firstly, mean scores of all questionnaires were computed and descriptive statistics and reliability coefficients were calculated. The data set contained less than 1% missing values. To answer the research questions, two Structural Equation Models (SEMs), a direct model and a mediation model, were performed with the R package ‘lavaan’ (Rosseel, 2012). The maximum likelihood estimator (MLR) was used to estimate the models, as this estimator deals effectively with missing values. We tested whether gender or age needed to be included as control variables by means of correlations with the constructs in the models. As none of the control variables correlated significantly and at least moderately ( $r$  below  $-.3$  or above  $.3$  according to Cohen, 1988) to one of the constructs, no control variables were included. In both models, the two mindfulness questionnaires CAMM and MAAS-A were combined in one latent construct. In the direct model, we tested whether this latent construct of mindfulness predicted asthma-related QoL and asthma control. In the mediation model, general stress and worry about asthma were included as mediators of the relations in the direct model to test for indirect effects. Both models are visually displayed in Figure 1.

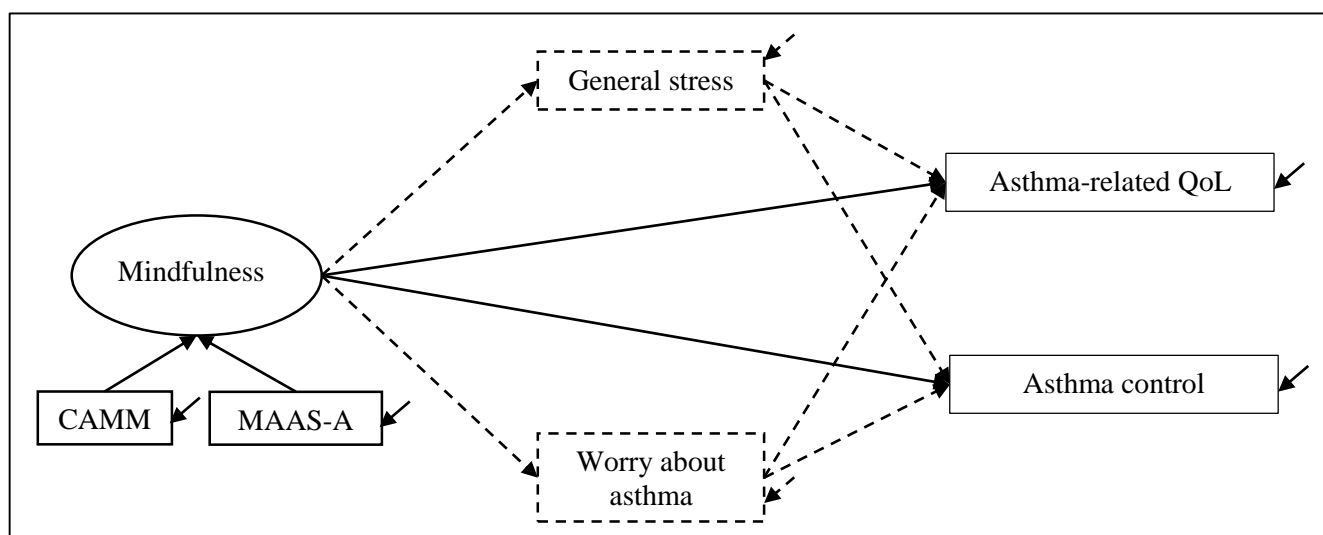


Figure 1. Models Study 1: lines and boxes with unbroken outlines display the direct model, lines and boxes with unbroken and dotted outlines combined display the mediation model.

Goodness of fit of both models was evaluated with several fit indices ( $\chi^2$ ,  $p$ , CFI, TLI and RMSEA), according to established guidelines (Schreiber, Nora, Stage, Barlow & King, 2006). Following the advice of Hayes (2013), no claims were made about the size of the mediation (full or partial). This is due to low power of direct effects when indirect effects (mediators) are also taken into account (Kenny & Judd, 2014).

### Results Study 1

Means, standard deviations and correlations of all variables included in Study 1 can be found in Table 1.

Table 1.  
*Correlations between the variables*

Variable	1.	2.	3.	4.	5.	6.
1. Mindfulness (CAMM)	-	.68**	.36**	.15	-.23*	-.56**
2. Mindfulness (MAAS-A)	-	-	-.35**	.19	-.16	-.52**
3. Asthma-related QoL	-	-	-	.66**	-.51**	-.39**
4. Asthma control	-	-	-	-	-.48**	-.17
5. Worry about asthma	-	-	-	-	-	.201
6. General stress	-	-	-	-	-	-
Mean	3.09	4.50	6.26	5.15	1.24	2.18
Standard Deviation	.58	.69	.68	.76	.40	.83

\*  $p < .05$ , \*\*  $p < .001$ .

The results of the SEM of the direct model, reflecting relationships between mindfulness, asthma-related QoL and asthma control can be found in Table 2. The model had an excellent fit based on all fit indices. The standardized factor loadings for the mindfulness questionnaires CAMM and MAAS-A were high, indicating existence of a latent factor for mindfulness.

The factor loadings revealed that mindfulness was related to asthma-related QoL, specifically, more mindfulness was associated with better asthma-related QoL. The relationship between mindfulness and asthma control was marginally significant, which implied that more mindfulness might be related to better asthma control. The direct model

explained 18.3% of the variance of asthma-related QoL and 3.9% of the variance of asthma control.

Table 2

*Results of direct model SEM of Study 1 (N=89)*

Parameter	Unstandardized factor loadings (standard error)	Standardized factor loadings	<i>p</i> -value
<b>Measurement model</b>			
Mindfulness > CAMM	1.00	.86	NA
Mindfulness > MAAS-A	1.10 (.26)	.80	<.001
Error in CAMM	.09 (.05)	.27	NA
Error in MAAS-A	.17 (.08)	.36	NA
Error in asthma-related QoL	.37 (.07)	.82	NA
Error in asthma control	.54 (.14)	.96	NA
Covariance asthma control – asthma-related QoL	.29 (.08)	.65	<.001
<b>Structural model</b>			
<i>Direct paths</i>			
Mindfulness > asthma-related QoL	.58 (.17)	.43	<.001
Mindfulness > asthma control	.30 (.17)	.20	.087

Note:  $\chi^2(1)=.511$ ;  $p= .475$ ; CFI =1.00; TLI=1.03; RMSEA=.00.

The results of the SEM of the mediation model, which looked at the potential mediators general stress and worry about asthma, can be found in Table 3. The mediation model had an excellent fit based on all fit indices. The standardized factor loadings for the mindfulness questionnaires CAMM and MAAS-A were high, indicating existence of a latent factor for mindfulness.

The relationship between mindfulness and asthma-related QoL was mediated by worry about asthma based on a marginal significance level. This implies that being more mindful is associated with less worry about asthma, which in turn is associated with better asthma-related QoL. General stress did not mediate the relationship between mindfulness and asthma-related QoL. The marginally significant relation between mindfulness and asthma control was significantly mediated by worry about asthma. This suggested that being more mindful is associated with less worry about asthma, which in turn is associated with more asthma

control. General stress did not mediate the relationship between mindfulness and asthma control. The mediation model explained 39.6% of variance in asthma-related QoL and 27.0% of variance in asthma control.

Table 3  
Results of the mediation model SEM Study 1 (N=89)

Parameter	Unstandardized factor loadings (standard error)	Standardized factor loadings	p-value
<b>Measurement model</b>			
Mindfulness > CAMM	1.00	.86	NA
Mindfulness > MAAS-A	1.09 (.24)	.79	<.001
Error in CAMM	.09 (.05)	.26	NA
Error in MAAS-A	.18 (.06)	.37	NA
Error in asthma-related QoL	.27 (.05)	.60	NA
Error in asthma control	.41 (.11)	.73	NA
Error in general stress	.39 (.18)	.57	NA
Error in worrying about asthma	.16 (.04)	.94	NA
Covariance general stress – worry	.01 (.02)	.06	.723
Covariance asthma control – AAQoL	.18 (.05)	.52	.001
<b>Structural model</b>			
<i>Direct paths</i>			
Mindfulness > general stress	-1.08 (.18)	-.66	<.001
Mindfulness > worry about asthma	-0.20 (.09)	-.25	.019
Mindfulness > asthma-related QoL	0.28 (.21)	.20	.192
General stress > asthma-related QoL	-0.14 (.10)	-.17	.165
Worry about asthma > asthma-related QoL	-.75 (.16)	-.45	<.001
Mindfulness > asthma control	0.06 (.22)	.04	.777
General stress > asthma control	-0.04 (.10)	-.05	.658
Worry about asthma > asthma control	-0.91 (.18)	-.49	<.001
<i>Indirect paths</i>			
Mindfulness > worrying about asthma > asthma-related QoL	.15 (.08)	.11	.056
Mindfulness > general stress > asthma-related QoL	.15 (.12)	.11	.211
Mindfulness > general stress > asthma control	.05 (.12)	.03	.667
Mindfulness > worrying about asthma > asthma control	.19 (.10)	.12	.049

Note:  $\chi^2(3)=1.19$ ;  $p=.757$ ; CFI =1.00; TLI=1.05; RMSEA=.00.

Besides the information about the indirect paths, the mediation model also provided information about direct paths. More mindfulness was related to less worry about asthma; less worry about asthma was related to better asthma-related QoL and to better asthma control. These direct paths exactly confirm the indirect mediation paths of worry about asthma, adding more weight to these mediation results. Furthermore, more mindfulness was related to less general stress, but mindfulness and general stress did not relate to asthma-related QoL or asthma control. These direct path results confirmed the absence of a mediating role for general stress.

### **Discussion Study 1**

Study 1, the observational study, looked at cross-sectional relationships of mindfulness with asthma-related QoL and asthma control and the mediating role of general stress and worry about asthma. We found that mindfulness relates to asthma-related QoL, being more mindful is associated with better asthma-related QoL. This relation was mediated by worry about asthma on a marginal significance level; more mindfulness is associated with less worry, and less worry is associated with better asthma-related QoL. In addition, we found that mindfulness is related to asthma control on a marginal significance level, more mindfulness relates to more asthma control. This relationship was also mediated by worry about asthma; more mindfulness results in less worry about asthma, which results in more asthma control. General stress did not mediate any relationship included in this study.

The relationship between mindfulness and asthma-related QoL is in accordance with the studies of Reibel et al. (2001) and Pbert et al. (2012), who found that mindfulness training increased (asthma-related) QoL. The positive relationship between mindfulness and asthma control is marginally significant. The intervention study of Pbert et al. (2012) found that a mindfulness training did not affect lung function, which is related to asthma control (Juniper

et al., 1999; Juniper et al., 2010). This is inconsistent with the results of the current study. However, the study of Pbert et al. (2012) did find a non-significant increase in the percentage of asthma patients with well-controlled asthma after the mindfulness training, which is consistent with the results of the current study. Based on the results of the current study and previous studies, more consistent evidence for effects of mindfulness on asthma-related QoL than on asthma control is found. Furthermore, mindfulness explained more variance in asthma-related QoL than in asthma control. Taken these notions together, it seems that mindfulness relates more strongly to more psychological factors such as asthma-related QoL, less strongly to more physical factors such as asthma control and (based on previous research) not at all to a purely physical measures such as lung function. However, more research is necessary to validate this claim.

The relationship between mindfulness and asthma-related QoL is mediated by asthma-specific worry on a marginal significance level. An explanation for this result is based on the finding that being more mindful results in more acceptance of negative emotions (Morgan, 2003). Therefore, mindfulness is likely to cause acceptance of a negative emotion such as worry about asthma. This could result in a decrease of worry about asthma because acceptance makes continuing worry less likely. Following, less worry about asthma might result in a better asthma-related QoL, as worries might prevent an adolescent with asthma from participating in sport or social activities. Less worry about asthma could also give an adolescent more confidence about handling asthma and being able to live life to the fullest, which ultimately will increase asthma-related QoL.

The relationship between mindfulness and asthma control is also mediated by asthma-specific worry. As explained above, the accepting nature of mindfulness is likely to decrease worry about asthma. This could imply that worry about actual symptoms also decreases. As

adolescents experience less worry about their symptoms, they are likely to stay more calm and worry less when experiencing actual symptoms, which could result in more controlled and calm breathing (Rietveld et al., 1999). More control over breathing might result in less asthma symptoms, and this decrease in symptoms implies a higher asthma control.

Furthermore, the decrease in asthma symptoms resulting from the decrease in worry about asthma might be another explanation for the relationship between mindfulness and asthma-related QoL. As less symptoms are experienced due to a decrease in worry, there is likely to be less interference of asthma with the desired lifestyle of the adolescents, leading to a higher QoL. This is confirmed by research showing that having fewer symptoms is associated with a better asthma-related QoL (Goldney et al., 2003).

General stress does not explain the relationship between mindfulness and asthma-related QoL or asthma control, although it does relate to mindfulness. An explanation for this finding might be that general stress is less specified towards asthma than worry about asthma. Thus, the relationship between general stress is a more distal predictor in comparison to worry about asthma, which is a more proximal predictor. General stress has to pass a lot more links than worry about asthma to affect asthma outcomes. This can explain why general stress did not explain relations between mindfulness and asthma outcomes and worry about asthma did.

Study 1 has some specific limitations. Firstly, marginally significant results were discussed, as the alpha level .05 is rather arbitrary. We must keep in mind that the potential of a Type 1 error (finding a significant effect in research, while the effect is non-existent in the real world) is higher for the marginally significant findings in comparison to significant findings (Cohen, 1992). Therefore, we must be careful not to draw too strong conclusions from the marginally significant results, which should be specifically replicated in future research. Secondly, the model tested in this study, was a cross-sectional model. This implies

we cannot infer causality for the relationships found in this study. However, the intervention study of Pbert et al. (2012) showed that mindfulness training influences QoL and the percentage of well-controlled asthma, which suggest that relationships found in the current study are in the predicted directions. More studies using research designs such as experiments or intervention studies, that can give more insight in causal directions, must be conducted. Study 2 is an intervention study focusing on feasibility of a mindfulness training, that can give some information on causal directions.

## **Method Study 2**

### **Participants**

This study was approved by the ethics committee of the Faculty of Social Sciences of the Radboud University in Nijmegen. Participants in Study 1 (who were all prescribed daily preventive asthma medication by a doctor) were approached via telephone and email to ask whether they wanted to participate in the mindfulness training of Study 2, until 16 participants who were willing to participate were found. In total, 19 potential participants were contacted, which implies three potential participants did not take part in the study, because they did not want to participate (N=2) or had no smartphone (N=1, mindfulness training was delivered via smartphone). For the final sample, matched controls (based on gender and age) were selected and recruited via telephone and mail from the remaining participants of Study 1. In total, there were 32 participants (14 boys), aged between 14 and 18 years (M=15.66, SD=1.18). Only one participant (mindfulness condition) dropped out of Study 2, due to a depression diagnosis. Of two other participants (1 in the mindfulness condition, 1 in the control condition) the mail with the completed post-measures was not received by the first author. One other participant filled out the post-measure too late, creating a time span between pre- and post-measure that was too long. Data of these four participants was not included in analyses.



## Materials & Measures

**Mindfulness training.** The mindfulness training was designed specifically for this study in cooperation with an expert on mindfulness programs for adolescents. The 4-week training, delivered via participants' smartphones and instruction booklets, was based mostly on self-study with weekly guidance from the first author. The choice for self-study and smartphone delivery was made for several reasons. Firstly, a traditional mindfulness program usually consists of 8 weekly meetings at a fixed time, date and place. A self-study training via smartphone can be practiced on at any place and time convenient for the adolescent. This is likely to be more practical for busy adolescents, which could possibly result in a higher completion rate. In addition, a smartphone training might also be more appealing to adolescents than a conventional mindfulness training.

The 4-week training covered a different topic each week, respectively introduction, acceptance, stress and self-compassion. Each week started with a telephonic guidance session from the first author or, if participants could not be reached on two occasions, guidance from the first author in form of written messages via 'Whats App' ('Whats App' is a widely utilized smartphone application in the Netherlands to send messages in form of text, pictures or audio files). During this conversation questions and concerns of the participants were addressed, and the mindfulness exercises of that week were scheduled to increase fidelity to the training. After each guidance session, a link to download the exercises of that week was sent to the participants via 'Whats App'. In each week, 3 exercises needed to be completed, short instructions about the exercises were in the instruction booklets. **The exercises were audio files extracted from the CD of the book of Snel (2014), a respected mindfulness trainer in the Netherlands specializing in mindfulness for children and adolescents.** Exercises took between 3 and 22 minutes to complete. For information about the content of the exercises, see

Table 7 in Appendix A. In order to increase their fidelity to the training, every week participants received ‘Whats App’ messages on two out of three days an exercise was scheduled to remind them to complete their exercises.

**Acceptability.** To measure acceptability, the subtopics satisfaction, intent of future participation, perceived appropriateness, perceived effects and demand were addressed. In the first three columns of Table 5 (in the results section of Study 2), the questions that were used to address the different subtopics can be found. Questions were only answered by participants in the mindfulness condition as part of the post-measure one week after the training.

**Limited-efficacy.** Limited-efficacy of the mindfulness training was tested on several outcomes, which were all constructs of interest in Study 1. This implies the tested outcomes were mindfulness (CAMM, MAAS-A) asthma-related QoL (AAQOL), asthma control (ACQ), general stress (PSS) and worry about asthma (worry subscale of Asthma-Specific Coping Scale). More information about these questionnaires can be found in the Method section of Study 1. Reliability coefficients of the questionnaires for this study specifically, can be found in Table 4.

Table 4  
*Reliability coefficients Study 2*

Questionnaire	Pre-measure Chronbach's $\alpha$	Post-measure Chronbach's $\alpha$
CAMM (mindfulness)	.83	.87
MAAS-A (mindfulness)	.88	.88
Asthma-related QoL	.88	.84
Asthma control	.90	.83
General stress	.90	.87
Worry about asthma	.76	.68

## Procedure

Participants and their parent(s) provided written informed consent before participation. All participants received the pre- and post-measure questionnaires via mail. These consisted of the questionnaires to test for limited-efficacy, and for participants in the mindfulness

condition, the post-measure also included the acceptability questions. After returning the completed pre-measure via mail, participants in the mindfulness condition started with the training via their smartphone and the instruction booklet. Participants in the control group received no training of any kind. One week after completion of the training, participants completed the post-measure questionnaires, and returned them via mail. Efforts have been made to ensure that participants in both conditions completed the pre- and post-measure questionnaires at the same moments. Participants in the mindfulness condition received 35 euro in vouchers for their participation; participants in the control received 5 euro in vouchers for their participation.

### **Data Analysis**

Data were analyzed in SPSS 21. For each of the acceptability questions, a type of summarizing statistic (e.g. percentage, mean) was calculated (see fourth column of Table 5 in the Results section of Study 2, for the type of summarizing statistic per question). For limited-efficacy testing, mean scores on the questionnaires measuring the outcomes mindfulness, asthma control, asthma-related QoL, general stress and worry about asthma were calculated. Multiple independent samples *t*-tests and a chi-square test were used to check for baseline differences on the pre-measure between the mindfulness and control condition on gender, age and the outcome measures. Thereafter, multiple paired samples *t*-tests were performed for the mindfulness and the control condition separately, to test for pre- and post-measure differences in each of the outcomes. In addition, several repeated measures ANOVAs were performed to test for condition (between-subject factor; training/control) x measure (within-subject factor; pre/post) interaction effects in each of the outcomes. When testing for limited-efficacy, focus is on effect sizes in addition to *p*-values, as *p*-values were not likely to reach statistical

significance due to the low power caused by the small sample size (Cohen, 1992). Effect size conventions of Cohen (1992) were used to interpret the effect sizes.

### **Results Study 2**

**Acceptability.** Acceptability results were summarized per subcategory. With regard to *satisfaction*, participants rated their satisfaction level between ‘a bit satisfied’ and ‘satisfied’, and they rated the training as ‘a little’ attractive. Taking this together, it seems participants were somewhat satisfied with the training. With regard to *intention of future participation*, results showed 85% of participants would like to take part in the training again, which is a large majority of the participants. Looking at *perceived appropriateness*, 71% of participants would recommend the training to their friends, and participants took the exercises ‘seriously’ to ‘very seriously’. These results infer that the training was perceived as quite appropriate. With regard to *perceived effects*, 43% of the participants stated the training changed their thinking about asthma, and 57% of the participants said they changed their manner of dealing with their asthma. It can be concluded that around half of the participants perceived some effect of the training. The *demand* of the training seemed acceptable, or even too low, as participants completed 100% of exercises and stated that the time spent on the program was ‘worth it’.

**Limited-efficacy.** *T*-tests and a chi-square test showed no baseline differences on the pre-measure between participants in the mindfulness and control condition on gender, age and the outcome measures. Full results of limited-efficacy testing can be found in Table 6. There was no evidence for effects of the mindfulness training on any of the outcomes (no significant *p*-values and no medium or high effect sizes of the training), except on the outcome asthma-related QoL. A paired samples *t*-test with the pre- and post-measure of asthma-related QoL in the mindfulness condition, revealed a marginally significant positive effect of the mindfulness

training on asthma-related QoL. This effect was of medium size. A similar paired samples *t*-test in the control condition, revealed there were no significant differences between the pre- and post-measure of asthma-related QoL combined with a small effect size. Although the condition x measure interaction in a repeated measures ANOVA with asthma-related QoL as outcome was not significant and of small size, these findings are at least suggestive and in line with the notion that a mindfulness training can increase asthma-related QoL among adolescents suffering from asthma.

Table 5  
*Study 2 acceptability questions, descriptive statistics and outcomes*

Subcategory	Question(s)	Scale	Statistic	Outcome
Satisfaction	Did you like doing the exercises?	5 point Likert scale: 'not' to 'very'	M (SD)	3.43 (1.02)
	Was the content presented in an attractive manner?	5 point Likert scale: 'not' to 'very'	M (SD)	2.86 (.77)
Intention of future participation	Would you participate in this program again?	Yes/No	Percentage yes	85%
Perceived appropriateness	Would you recommend this program to your friends?	Yes/No	Percentage yes	71%
	Question per exercise: how serious did you complete the exercise?	10-point Likert scale: 'not' to 'very'	M (SD)	8.04 (1.08)
Perceived effects	Do you think the training helped you in some way?	5-point Likert scale: 'not at all' to 'very'	M (SD)	3.07 (1.00)
	Did the training changed you thinking about asthma?	Yes/No	Percentage yes	43%
	Did the training changed your way of dealing with your asthma?	Yes/No	Percentage yes	57%
Demand	Per exercise: did you complete the exercise?	Yes/No	Percentage completed exercises	100%
	Was the time you spent on the exercises, worth it?	5-point Likert scale: 'not' to 'very'	M (SD)	3.79 (.89)

Table 6  
*Study 2 descriptive statistics and limited-efficacy testing*

Outcome	Group	Pre-measure M (SD)	Post-measure M(SD)	T-Test paired samples	RM Anova, condition x measure effect
Mindfulness (CAMM)	Mindfulness Control	3.10 (.51) 3.17 (.62)	3.01 (.45) 3.14 (.81)	$t(13)=.84, p=.41, d=.22$ $t(13)=.21, p=.840, d=.06$	$F(1,26)=.08, p=.783,$ $\eta^2=.003$
Mindfulness (MAAS-A)	Mindfulness Control	4.32 (.74) 4.58 (.91)	4.38 (.68) 4.69 (.94)	$t(13)=-.41, p=.687, d=-.11$ $t(13)=-.85, p=.409, d=-.23$	$F(1,26)=.09, p=.767,$ $\eta^2=.003$
Asthma control	Mindfulness Control	4.64 (1.18) 4.68 (1.02)	4.76 (.93) 4.97 (.79)	$t(13)=-.59, p=.567, d=-.16$ $t(13)=-1.21, p=.248, d=-.32$	$F(1,26)=.31, p=.580,$ $\eta^2=.01$
Asthma- related QoL	Mindfulness Control	5.91 (.75) 6.14 (.60)	6.19 (.46) 6.21 (.60)	$t(13)=-2.01, p=.065, d=-.54$ $t(13)=-.76, p=.462, d=-.20$	$F(1,26)=.140,$ $p=.248, \eta^2=.05$
General stress	Mindfulness Control	2.07 (.59) 1.97 (.54)	2.01 (.60) 1.97 (.70)	$t(13)=.64, p=.535, d=.17$ $t(13)=-.01, p=.993, d=.00$	$F(1,26)=.23, p=.639,$ $\eta^2=.01$
Worry about asthma	Mindfulness Control	1.31 (.52) 1.43 (.70)	1.27 (.39) 1.32 (.42)	$t(12)=.562, p=.584, d=.16$ $t(13)=.641, p=.533, d=.17$	$F(1,25)=.14, p=.715,$ $\eta^2=.01$

### Discussion Study 2

This treatment study focused on the feasibility areas acceptability and limited-efficacy of a mindfulness training delivered via smartphone for adolescents with asthma. With regard to acceptability, participants were somewhat satisfied with the training, a large majority intended to participate again in the future and the training was perceived as quite appropriate. Around half of the participants perceived some effects of the training, and the demand seemed just right or too little. With regard to limited-efficacy testing, we found preliminary evidence for positive effects of the training on asthma-related QoL, but not on any of the other outcomes.

The evidence for effects of the training on asthma-related QoL is in line with results from Reibel et al. (2001) and Pbert et al. (2012), who found positive effects of mindfulness training on QoL in respectively adults with chronic diseases and adults with asthma. Our results are promising, as it shows mindfulness might be an important target to increase asthma-related QoL in adolescents with asthma. However, we must keep in mind that the results of limited-efficacy were based on a quasi-experiment, which implies division of

participants in conditions was not random. Participants in the mindfulness condition could be different from the participants in the control condition on non-measured characteristics that might have affected our results. However, we tried to limit this problem by matching participants in both groups based on age and gender, and we did not find any baseline differences between the groups on the pre-measure. More research on the effects of mindfulness training in adolescents with asthma, aimed at increasing asthma-related QoL, should be conducted. Specifically, randomized controlled trials might be useful, as these could overcome the issues of the current quasi-experiment.

Although we did find preliminary evidence for effects of the mindfulness training on asthma-related QoL, we did not find any evidence for effects of the training on the outcomes mindfulness, asthma control, general stress and worry about asthma. Specifically, the absence of training effects on the mindfulness questionnaires is unexpected, as the training was aimed to target mindfulness. This prompts the possibility that the training did not affect asthma-related QoL via an increase of mindfulness skills. Adolescents knew they were invited for the training because they had asthma, and simply doing something related to their asthma might have increased their asthma-related QoL. However, we argue the lack of training effects on the mindfulness questionnaires has another explanation, based on arguments of Grossman (2011). As the participants learned more about mindfulness in the training, they also learned to notice the moments when they are not mindful, which they could not identify before the training. Because of all this new information about non-mindful moments, their scores on the mindfulness questionnaire might have not increased from pre- to post-measure, even if they actually became more mindful. An explanation for the lack of effects of the training on all outcomes might be the relatively low intensity of the training with just three exercises per week during a 4-week period. Participants in our mindfulness training received around 4

times less mindfulness practice than participants in a conventional mindfulness group training. This dose might be simply too low to find effects of the training. It might be possible that with a longer, more intensive training stronger effects on multiple outcomes are found.

The ratings on the different aspects of acceptability showed a promising pattern overall. This implies there seems to be support for mindfulness training via smartphone in the target group, adolescents with asthma. This is very valuable, as the adolescents themselves must be motivated to do the training in a serious manner, before positive effects of a training will occur. Some comments based on the acceptability ratings must be made. The satisfaction ratings should be improved, as participants were only somewhat satisfied with the current training. A possibility for increasing satisfaction might be to use a smartphone application. This form of smartphone delivery might be more appealing than the 'Whats App' structure used in the current study. In addition, it is possible that the demand of the training is too low. More weekly exercises could be added to increase the demand to a level acceptable to the participants. An additional benefit of increasing the number of exercises would be that participants get more practice with mindfulness, which could increase the beneficial effects of the training.

### **General discussion**

This study focused on the role of mindfulness in asthma control and asthma-related QoL in adolescents with asthma. In Study 1, the observational study, we found that mindfulness was related to asthma-related QoL and asthma control (only marginally significant to the latter), which was mediated by worry about asthma, but not by general stress. In Study 2, the treatment study, we found preliminary evidence for effects of a mindfulness training on asthma-related QoL. The mindfulness training scored promising on acceptability ratings, showing that participating adolescents seemed to value the training.



Combining the results of Study 1 and Study 2 reveals a consistent relationship between mindfulness and asthma-related QoL in adolescents with asthma. The quasi-experimental nature of Study 2 provides information about the direction of this relationship, and suggests that mindfulness influences asthma-related QoL. To our best knowledge, this study is the first to document this specific relationship. Implications of this finding are major. Mindfulness training, for instance via smartphone as in Study 2, but also conventional group training, might be a relatively simple manner to increase QoL in adolescents with asthma. This is important, as adolescents with asthma have a lower QoL than their healthy peers (Sawyer et al., 2000). Mindfulness could become an important aspect of conventional treatment for asthma, as it seems to be a promising method to help adolescents with asthma. The promising scores on acceptability ratings in Study 2 reveal that adolescents value mindfulness training. Therefore, it seems that support for mindfulness training could be found in the target group.

With regard to the relationship between mindfulness and asthma control in adolescents, results of both studies are less consistent. Study 1 showed a marginally significant relation between mindfulness and asthma control, while Study 2 showed no effects of the training on asthma control. The results of the study of Pbert et al (2012) might explain these results. Their research found effects of a mindfulness training on asthma control marginally significant, but only 12 months after the training. This implies effects of mindfulness on asthma control might occur after a longer period of time, which could not be captured in Study 2 by our post-measure 1 week after the training. In Study 1, we measured self-reported mindfulness which, based on high test-retest reliabilities of mindfulness questionnaires (e.g. Brown et al., 2011), seems to be quite stable. Thus, adolescents who reported high mindfulness levels are likely to have those higher levels for a longer time,

enabling mindfulness to affect their asthma control in a positive manner over a longer time span. This can explain a relationship between mindfulness and asthma control was found in Study 1. However, more research is necessary to clearly map the relationship between mindfulness and asthma control. Specifically, intervention studies with several post-measures over a longer timespan would be helpful to give more insight.

Study 1 showed worry about asthma explains the relationships of mindfulness with asthma-related QoL and asthma control. However, Study 2 showed no effects of the mindfulness training on worry about asthma, but did find effects of the training on asthma-related QoL. This could imply that mindfulness also influences asthma-related QoL via paths other than worry about asthma that have not been studied in the current research. However, an alternative explanation is that the low dose of mindfulness training the participants in our study received, resulted in the lack of training effects on worry about asthma. The low dose of the training might also explain the absence of training effects on general stress and asthma control in Study 2, while mindfulness did relate to general stress and asthma control (latter only marginally significant) in Study 1.

This project has some limitations. Firstly, mindfulness was measured with questionnaires in both studies. However, there are some concerns with mindfulness questionnaires according to Grossman (2011). The biggest concern is the lacking evidence about external validity. This implies that the questionnaires used in the study might not measure exactly what we aimed to measure, namely mindfulness as it exists in the real world. By using two different mindfulness questionnaires in these two studies, we were able to examine at least whether these corresponded, which they did as was revealed by their high correlation. However, we should take into consideration that it is possible that the questionnaires measured something slightly different than, or just an aspect of, mindfulness.

A second limitation of this project is that asthma control in this participant group was quite high, even though we only included adolescents that were prescribed daily preventive asthma medication by a doctor. As many participants had well-controlled asthma, the scores on the ACQ, measuring asthma control, were subject to a ‘ceiling effect’ meaning that many participants had the highest score. This could be an alternative explanation for the only marginally significant effects of mindfulness on asthma control in Study 1, and the lack of effects on asthma control in Study 2.

The current project was the first to study mindfulness in adolescents with asthma. Promising results were found, as mindfulness is related to both asthma-related QoL and asthma control via worry about asthma. Furthermore, mindfulness is found to be a promising target for increasing asthma-related QoL in adolescents with asthma, and potentially also for increasing asthma control.

## References

- Aalto, A. M., Harkapaa, K., Aro, A. R., & Rissanen, P. (2002). Ways of coping with asthma in everyday life: validation of the Asthma Specific Coping Scale. *Journal of Psychosomatic Research, 53*, 1061–069. doi: 10.1016/S0022-3999(02)00339-2
- Baer, R. A. (2003). Mindfulness training as a clinical intervention: A conceptual and empirical review. *Clinical psychology: Science and practice, 10*(2), 125-143. doi: 10.1093/clipsy.bpg015
- Bousquet, J., Mantzouranis, E., Cruz, A. A., Ait-Khaled, N., Baena-Cagnani, C. E., Bleecker, E. R., ... & Zuberbier, T. (2010). Uniform definition of asthma severity, control, and exacerbations: document presented for the World Health Organization Consultation on Severe Asthma. *Journal of Allergy and Clinical Immunology, 126*(5), 926-938. doi:10.1016/j.jaci.2010.07.019
- Bowen, D. J., Kreuter, M., Spring, B., Cofta-Woerpel, L., Linnan, L., Weiner, D., ... & Fernandez, M. (2009). *How we design feasibility studies. American journal of preventive medicine, 36*(5), 452-457. doi: 10.1016/j.amepre.2009.02.002
- Brown, K. W., & Ryan, R. M. (2003). The benefits of being present: mindfulness and its role in psychological well-being. *Journal of personality and social psychology, 84*(4), 822-48. doi: 10.1037/0022-3514.84.4.822
- Brown, K. W., West, A. M., Loverich, T. M., & Biegel, G. M. (2011). Assessing adolescent mindfulness: validation of an adapted Mindful Attention Awareness Scale in adolescent normative and psychiatric populations. *Psychological assessment, 23*(4), 1023-33. doi: 10.1037/a0021338.
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Erlbaum.

- Cohen, J. (1992). A power primer. *Psychological bulletin*, *112*(1), 155-159. doi: 10.1037/0033-2909.112.1.155
- Cohen, R., Franco, K., Motlow, F., Reznik, M., & Ozuah, P. O. (2003). Perceptions and attitudes of adolescents with asthma. *Journal of Asthma*, *40*(2), 207-211. doi: 10.1081/JAS-120017992
- Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of health and social behavior*, *24*(4), 385-396. Retrieved from <http://www.jstor.org/stable/2136404>
- Delgado, L. C., Guerra, P., Perakakis, P., Vera, M. N., del Paso, G. R., & Vila, J. (2010). Treating chronic worry: Psychological and physiological effects of a training programme based on mindfulness. *Behaviour research and therapy*, *48*(9), 873-882. doi: 10.1016/j.brat.2010.05.012
- Goldney, R., Ruffin, R., Fisher, L., & Wilson, D. (2003). Asthma symptoms associated with depression and lower quality of life: a population survey. *Medical Journal of Australia*, *178*(9), 437-441. Retrieved from: <http://hdl.handle.net/2440/9948>
- Gommer, A.M. & Poos, M.J.J.C. (2011). Astma: prevalentie, incidentie en sterfte naar leeftijd en geslacht. In: *Volksgezondheid Toekomst Verkenning, Nationaal Kompas Volksgezondheid*. RIVM: Bilthoven. Retrieved from <http://www.nationaalkompas.nl>
- Greco, L. A., Baer, R. A., & Smith, G. T. (2011). Assessing mindfulness in children and adolescents: development and validation of the Child and Adolescent Mindfulness Measure (CAMM). *Psychological assessment*, *23*(3), 606-14. doi: 10.1037/a0022819
- Grossman, P. (2011). Defining mindfulness by how poorly I think I pay attention during everyday awareness and other intractable problems for psychology's (re) invention of mindfulness: comment on Brown et al.(2011). *Psychological Assessment* *23*(4), 1034-

1040. doi:10.1037/a0022713

Guilbert, T. W., Garris, C., Jhingran, P., Bonafede, M., Tomaszewski, K. J., Bonus, T., ... & Schatz, M. (2011). Asthma that is not well-controlled is associated with increased healthcare utilization and decreased quality of life. *Journal of Asthma*, *48*(2), 126-132. doi:10.3109/02770903.2010.535879

Hayes, A. F. (2013). *Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach*. New York, NY: The Guilford Press.

Juniper, E. F., Gruffydd-Jones, K., Ward, S., & Svensson, K. (2010). Asthma Control Questionnaire in children: validation, measurement properties, interpretation. *European Respiratory Journal*, *36*(6), 1410-1416. doi:10.1016/j.rmed.2004.10.008

Juniper, E. F., Guyatt, G. H., Ferrie, P. J., & King, D. R. (1999). Development and validation of a questionnaire to measure asthma control. *European Respiratory Journal*, *14*(4), 902-907. doi: 10.1034/j.1399-3003.1999.14d29.x

Kenny, D. A., & Judd, C. M. (2014). Power anomalies in testing mediation. *Psychological Science*, *25*(2), 334-339 doi: 10.1177/0956797613502676

Morgan, D. (2003). Mindfulness-based cognitive therapy for depression: A new approach to preventing relapse. *Psychotherapy Research*, *13*(1), 123-125. doi: 10.1080/713869628

Okelo, S. O., Wu, A. W., Krishnan, J. A., Rand, C. S., Skinner, E. A., & Diette, G. B. (2004). Emotional quality-of-life and outcomes in adolescents with asthma. *The Journal of Pediatrics*, *145*(4), 523-529. doi: 10.1016/j.jpeds.2004.06.043

Pbert, L., Madison, J. M., Druker, S., Olendzki, N., Magner, R., Reed, G., ... & Carmody, J. (2012). Effect of mindfulness training on asthma quality of life and lung function: a randomised controlled trial. *Thorax*, *67*(9), 769-776. doi:10.1136/thoraxjnl-2011-200253

- R Core Team. (2014). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL <http://www.R-project.org/>.
- Reibel, D. K., Greeson, J. M., Brainard, G. C., & Rosenzweig, S. (2001). Mindfulness-based stress reduction and health-related quality of life in a heterogeneous patient population. *General hospital psychiatry*, *23*(4), 183-192. doi:10.1016/S0163-8343(01)00149-9
- Rhee, H., Belyea, M. J., & Elward, K. S. (2008). Patterns of asthma control perception in adolescents: associations with psychosocial functioning. *Journal of Asthma*, *45*(7), 600-606. doi: 10.1080/02770900802126974
- Rietveld, S., Van Beest, I., & Everaerd, W. T. A. M. (1999). Stress-induced breathlessness in asthma. *Psychological medicine*, *29*(06), 1359-1366. Retrieved from <http://journals.cambridge.org/>
- Rosseel, Y (2012). lavaan: An R Package for Structural Equation Modeling. *Journal of Statistical Software*, *48*(2), 1-36. URL <http://www.jstatsoft.org/v48/i02/>.
- Rutishauser, C., Sawyer, S. M., Bond, L., Coffey, C., & Bowes, G. (2001). Development and validation of the Adolescent Asthma Quality of Life Questionnaire (AAQOL). *The European Respiratory Journal*, *17*, 52–8. Retrieved from <http://erj.ersjournals.com/content/17/1/52.long>
- Sandberg, S., Paton, J. Y., Ahola, S., McCann, D. C., McGuinness, D., Hillary, C. R., & Oja, H. (2000). The role of acute and chronic stress in asthma attacks in children. *The Lancet*, *356*(9234), 982-987. doi:10.1016/S0140-6736(00)02715-X
- Sawyer, M. G., Spurrier, N., Whaites, L., Kennedy, D., Martin, A. J., & Baghurst, P. (2000).

- The relationship between asthma severity, family functioning and the health-related quality of life of children with asthma. *Quality of life research*, 9(10), 1105-1115. doi: 10.1023/A:1016655511879
- Schreiber, J. B., Nora, A., Stage, F. K., Barlow, E. A., & King, J. (2006). Reporting structural equation modeling and confirmatory factor analysis results: A review. *The Journal of educational research*, 99(6), 323-338. doi: 10.3200/JOER.99.6.323-338
- Shapiro, S. L., Carlson, L. E., Astin, J. A., & Freedman, B. (2006). Mechanisms of mindfulness. *Journal of clinical psychology*, 62(3), 373-386. doi: 10.1002/jclp.20237
- Snel, E. (2014) *Stilzitten als een kikker*. Utrecht: Uitgeverij ten Have.
- Tiggelman, D., van de Ven, M. O., van Schayck, O. C., Kleinjan, M., & Engels, R. C. (2014). Sport club participation of adolescents with asthma: maternal factors and adolescent cognitions. *Pediatric pulmonology*, 49(9), 835-841. doi: 10.1002/ppul.22902
- Vlemincx, E., Vigo, D., Vansteenwegen, D., Van den Bergh, O., & Van Diest, I. (2013). Do not worry, be mindful: Effects of induced worry and mindfulness on respiratory variability in a nonanxious population. *International Journal of Psychophysiology*, 87(2), 147-151. doi:10.1016/j.ijpsycho.2012.12.002
- Williams, J.M.G., Teasdale, J.D., Segal, Z.V., Kabat-Zinn, J. (2007). *The mindful way through depression: Freeing yourself from chronic unhappiness*. Guilford: New York



## Appendix A

Table 7

### *Content exercises smartphone mindfulness training*

Week	Exercises	Content
1: Introduction	Sitting still like a frog	Training on the 'attention muscle'
	The art of listening	Poem about listening and the advice to listen extra carefully to people you encounter
	Body scan	Body scan exercise to get more in touch with your body parts, and getting out of your head.
2: Acceptance	The spaghetti test	Exercise to relax your body completely
	Time out, tune in	Exercise that helps you stop and take time to notice how you feel on the inside.
	The safe spot	Training to create a relaxing moment in rough times
3: Stress	Solid as a rock	Exercise that teaches you how strong you can be in tough times
	The paper factory	Exercise that helps to choose whether you want to listen to your thoughts, or not.
	Dealing with difficult feelings	Exercise that teaches not to ignore, suppress or worry about negative feelings
4: Self-compassion	The polite wish	Exercise that teaches to be very kind to yourself and allows yourself to be happy
	Search for talent	Exercise in which you create your own movie in your head, in which you see how you get better at things that you want.
	Sitting still like a frog	Training on the 'attention muscle'