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Exploratory Evaluation of an Intensive Smoking Reduction Intervention using a Single- Case Experimental Design

Differences in Cognitive Determinants of Smoking Cessation within Four COPD Patients with Varying Impairment in Health-Related Quality of Life

Bachelorthesis

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Abstract

Chronic obstructive pulmonary disease (COPD) is characterized by a progressing deterioration of lung functioning, with tobacco smoking as major risk-factor. Since smokers with COPD experience complete smoking cessation as too difficult to achieve, the REDUQ study employed a behavioral and pharmacological intervention that was tailored to smoking reduction in order to increase the motivation for complete smoking cessation in COPD patients that were not ready to quit. Based on the theoretical framework of the I-change model and the health-belief model of behavior change, the aim of the present study was to examine changes in cognitive determinants (attitude and self-efficacy) of smoking cessation in regard to changes in the smoking behavior within and between four smokers with COPD with varying impairment in health-related quality of life (HRQL) that participated in an intensive smoking reduction intervention. Therefore, a single-case experimental design (SCED) in combination with a multiple baseline design was implemented, with non-concurrent baseline phases and follow-up phases of 5, 6, 7, or 8 weeks and a concurrent treatment phase of 13 weeks. The cognitive determinants and the smoking behavior were weekly measured by the use of a telephone-interview. The main findings of this study were that (1) smokers with COPD who experienced varying severity of impairments in HRQL did not differ in their baseline-cognitions towards smoking cessation, (2) the smoking reduction intervention seemed to have a negative effect on the self-efficacy towards smoking cessation among participants with impairment in HRQL compared to participants with no impairment in HRQL, and (3) there was no significant relation found between changes in cognitive determinants of smoking cessation and changes in smoking behavior. The results indicated that the smoking reduction intervention was equally effective in smokers with COPD who reported varying severity in impairment in HRQL. Furthermore, this study supported the importance of self-efficacy as motivational determinant of subsequent changes in smoking behavior among COPD patients and suggests that smoking reduction interventions should incorporate frequent monitoring and enhancement of self-efficacy as a consistent part of the treatment.

Table of Content

Introduction

Chronic Obstructive Pulmonary Disease

Chronic Obstructive Pulmonary Disease (COPD) is an umbrella term for chronic lung diseases which cause limitations in lung airflow; breathlessness (dyspnea) and chronic cough with excessive sputum production (Espinoza de los Monteros, Peña, Hurtado, Jareño, & Miravitilles, 2012). In 2000, 2.75 million deaths worldwide were due to COPD, of which 400.000 occurred in industrialized countries (Lopez *et al.,* 2006). A dynamic population model projected that the number of patients diagnosed with COPD among the Dutch population will increase from 305.000 in 2000 to 494.000 in 2025, with an increase in mortality rate from 1.4 to 2.4/1000 during that year (Hoogendoorn *et at.,* 2005). COPD already represents the fourth most common cause of death, and statistics by the World Health Organization (2008) predicted it to become the third leading cause of death in 2030, worldwide. The major risk factor for the development of COPD is tobacco smoke: a study by Barnes (2004) showed that tobacco smoking, whether through tobacco use or second-hand smoking, accounts for 90% of the development of COPD. In addition, Lundbäck *et al.* (2003) found that approximately 50% of the life-long smokers develop COPD.

Even though the physical impairments of COPD are not reversible, long-term smoking cessation has proven to successfully prevent further progression of the disease: smokers with mild- or moderate COPD who quit smoking showed the same decline in lung function after four years as non-smokers and only 50% of the decline that was found in COPD patients who continued smoking (Scanlon *et al.,* 2000). However, a study by Hoogendoorn, Feenstra, Hoogenveen, and Rutten van Mölken (2009) has shown that COPD patients tend to experience abrupt smoking cessation as difficult. Another longitudinal survey showed that 50% of the smokers with COPD attempted to stop smoking but that only 14, 6% were successful (Schiller & Ni, 2006). Fagerström (2005) suggested that smoking reduction could help smokers who have difficulties to stop smoking immediately, as an alternative approach to reduce disease-related effects on the patient´s health (Fagerström, 2005). This was supported by a study by Carpenter, Hughes, Solomon, and Callas (2004) which showed that a behavioral intervention aimed at smoking reduction, combined with Nicotine Replacement Therapy (NRT) can have a beneficial effect on attempted smoking cessation

among smokers who were unwilling to quit. However, a study by Simmons *et al.* (2005) indicated that at least 85% percentage of smoking reduction would be necessary to positively influence the decline in lung functioning, which was only achieved by 2% of the patients after one year. This suggests that even though reduction in smoking behavior hardly achieves a sufficient disease-related harm reduction, it might still be an efficient tool to increase the motivation among COPD patients to quit smoking.

The REDUQ I Study

The REDUQ (REDUce & Quit) I study was a randomized and controlled, multicentred study with the aim to examine the effectiveness of an intensive smoking reduction intervention program for COPD patients who were not ready-to-quit. Participants in the REDUQ study either received an intensive smoking reduction program (experimental group) or a low intensive self-help intervention (control group). The smoking reduction intervention was a combination of a pharmacological and behavioral treatment that aimed at reduction of the smoking behavior in COPD patients in order to increase the motivation for complete smoking cessation (Hagens *et al.,* 2010). But even though the high intensive smoking reduction program in the REDUQ study was predicted to be more effective than a low intensive self-help intervention after a 18-month follow-up, the results of the study showed that there was no difference in the achieved smoking reduction and cessation between the experimental group and the control group, indicating no significant positive effect of the smoking reduction intervention on the smoking behavior of the patients.

The REDUQ II Study

In order to examine why the REDUQ I intervention was not successful in achieving long-term abstinence, a single case experimental design (SCED) was implemented within the Randomized Controlled Trial of the REDUQ I study design. The conditions of the intervention program were the same as in REDUQ I.SCEDs can be used to compare the effect of treatments in individual patients within clinical environments, since these individual variances in reactions to an intervention can hardly be detected in larger samples (Hadert & Quinn, 2008). By the use of repeated measurements during a pre-intervention phase, an active intervention phase and a post-intervention phase, it is possible to examine the change of

process- and outcome variables during the treatment phase and when exactly changes occurred (Borckardt *et al.,* 2008). This facilitates a faster and more client-centered evaluation and adaption of interventions.

The aim of the REDUQ II study was to examine changes in the cognitive and behavioral processes and patterns of individual patients during the intervention program and how they are associated with the patients' attempts to quit or reduce smoking. Weekly repeated measurements took place during the baseline phase (varying between 5 to 8 weeks), the active treatment phase (13 weeks) and a follow-up phase (5-8 weeks). For each participant there were thus 26 measurement moments during the entire SCED (Hagens *et al.,* 2013).

Cognitive Determinants of Behavioral Change

For the purpose of this paper, the Integrated Model for explaining motivational and behavioral change (I-change model, or integrated change model) was used as theoretical framework (de Vries, Mesters, van de Steeg, & Honing, 2004). The I-Change Model is a revised version of the attitude-social influence-self-efficacy model (ASE- model) and integrates several models that all attempt to explain behavioral change based on different approaches; Ajzen´s Theory of Planned Behavior (Ajzen, 1991), Bandura´s Social Cognitive Theory (Bandura, 1986), Prochaska´s Transtheoretical Model (Prochaska, 2008), the Health Belief Model (Rosenstock, 1966), and Implementation and Goal setting theories (Locke, 1996).

According to the I-Change model, the motivation or intention of a person to carry out a particular behavior determines the occurrence of behavioral changes. The level of motivation can be classified by five intentional stages that have to be passed in a successful process of behavior change; (1) precontemplation (no intention to change risk- behavior), (2) contemplation (intention to change risk-behavior within the next six months), (3) preparation (intention to change risk-behavior within the following month), (4) action (behavioral change was initiated), and (5) maintainance (prevention of relapse) (de Vries *et al.,* 2004). The intention to perform a certain action is influenced by three motivational cognitive determinants; (1) attitude, which refers to the experienced emotional and cognitive advantages and disadvantages of a particular behavior, (2) social influence, which refers to social modeling, norms and support, and (3) self-efficacy which refers to a person´s belief

regarding the own ability to successfully execute a certain behavior in order to achieve a specific outcome (de Vries *et al.*, 2003). For the purpose of this paper, the focus will lie on the examination of attitude and self-efficacy towards smoking cessation.

Attitude towards smoking cessation.

Studies have shown that many smokers with COPD belief that finding and maintaining internal motivation is the most crucial factor for successful smoking cessation but that they could not find it (van Eerd, Risør, van Rossem, van Schayck, & Kotz, 2015; Wilson, Elborn, & Fitzismons, 2010). This might be due to lower perceived advantages of smoking cessation related to benefits of continuing to smoke; A study by van Eerd *et al.* (2015) showed that smokers with COPD tend to associated few advantages with smoking cessation, mainly because they did not relate their health conditions to their own smoking behavior and therefore did not belief that stopping to smoke would improve their health. Additionally, a study by Wilson, Elborn, and Fitzismons (2010) showed that smokers with COPD perceived low benefits of smoking cessation because they thought their disease was too much advanced and that it would not be worth it anymore. They seemed to have accepted the progress of deterioration of their health conditions and did not perceive smoking cessation as a potentially achievable objective. Smoking was experienced as advantageous because it offered a daily structure and helped against feelings of loneliness and boredom. Furthermore, participants of the study perceived external support, e.g. in an intervention, not as useful in attempts to achieve smoking cessation (Wilson *et al.,* 2010).

Self- efficacy towards smoking cessation.

An initial feeling of self-efficacy determines the amount of effort with which the person engages in the execution of the behavior and its future adoption: patients with high self-efficacy in the beginning of a treatment tended to change their disease-specific behavior more successful, compared to patients with low initial self-efficacy (Bandura, 1986; Bandura, 2000). This was confirmed by studies by Devins and Edwards (1988) and Stuart, Borland, and McMurray (1994) which showed that the initially perceived self-efficacy towards smoking cessation was a significant predictor of subsequent smoking reduction and cessation. Additionally, smokers with COPD whom participated in the study by van Eerd *et al.* (2015)

often reported to experience quit attempts as very difficult because they did not have the feeling to be able to completely quit smoking. However, when a patient continuously experiences success in mastering new behavioral changes, the experienced self-efficacy also increases: a study by Bourbeau, Nault, and Dang-Tan (2004) showed that if a patient can perform new learned skills to handle disease-specific circumstances in a variety of different situations, he develops a confidence in his own abilities and continues to apply them and conduct the desired behavioral changes. Furthermore, a randomized clinical trial, conducted by Atkins, Kaplan, Timms, Reinsch, & Lofback (1984), suggested that interventions that incorporate cognitive and behavioral strategies to cope with the disease have a positive effect on the self-efficacy among moderate and severe COPD patients. Furthermore, a study by Hughes, Solomon, Livingston, Callas, and Peters (2010) which aimed to compare the effects of a gradual, an abrupt smoking cessation and a minimal treatment condition, found that participants in the gradual reduction treatment condition showed significant increase in self-efficacy and a decreased cigarette dependence and craving, which was not the case in an abrupt treatment group or a minimal treatment group. These findings suggest that smoking reduction can have beneficial effects on self-efficacy of smokers with COPD.

Based upon the existing literature, it is expected that changes in self-efficacy and attitude towards smoking cessation are related to changes in the smoking behavior in COPD patients that participated in the current study, with a higher expected evidence for self-efficacy than for attitude. Additionally, it is expected that the initial level of self-efficacy towards smoking cessation is predictive for the achieved amount of smoking reduction. Since the REDUQ II intervention involves patient education and behavioral treatment that is aimed at enhancing cognitive determinants of smoking cessation, it is further expected that the intensive smoking reduction intervention program leads to an increase in self-efficacy and attitude towards smoking cessation during the intervention phase among COPD patients.

The Role of Disease Severity & Health-Related Quality of Life

According to Rosenstock´s health belief model, patients are more likely to change their behavior when the perceived severity of the current situation (e.g. negative consequences) and the perceived susceptibility to this situation are high (Rosenstock, 1966). This suggests that COPD patients who suffer a more severe form of the disease and who experience the personal consequences (e.g. severity of symptoms) as high are more likely to

show a change in their smoking behavior. This was supported by a longitudinal study among COPD patients which suggested that limitations of the individual´s activity that were due to impairment of lung functioning were positively associated with the attempt to quit smoking among COPD patients (Schiller & Ni, 2006). Additionally, a study by Schofield, Kerr, and Tolson (2006) showed that increasing disease severity was an important internal cue to smoking cessation among smokers with COPD. Conventional assessment of the disease-severity of COPD incorporates measures of The Forced Expiratory Volume in 1 second (FEV1), which measures lung functioning of the patient (GOLD, 2006). However, the disease severity was also found to be significantly related to the health status or Health-Related Quality of Life (HRQL) in COPD patients (Ståhl *et al.,* 2005; Ahmed, Neyaz, & Aslami, 2016); besides the symptom effects, COPD has shown to have a wide range of effects on the overall health status of an individual, such as physical activity or psychosocial functioning (Spencer, Calverley, Burge, & Jones, 2001). Such disease-related impairments in quality of life involve limitations in daily activities, such as in sports, sex life, family activities, household chores, and work loss (Rennard *et al.,* 2002). Furthermore, van Eerd *et al.* (2015) indicated that the experience of severe impairment in health and daily life was a motivating factor for smoking cessation. However, findings from a qualitative study that addressed lifestyle changes of COPD patients after a self-management program indicated that the progression of the disease was experienced as barrier to behavior changes by 69% of the patients (Nault, Pépin, & Dagenais, 2000). These findings suggest that COPD patients with higher disease-related impairment in daily activities show a higher motivation to quit smoking but also that the actual implementation of behavior change might be experienced as more difficult for these patients. Based thereon, it is expected that COPD patients of the current study who experience more severe disease-related impairment in HRQL initially show a more positive attitude but a lower self-efficacy towards smoking cessation than COPD patients without impairment in HRQL.

Even though previous studies indicated that the effect of smoking interventions differs among COPD patients with different level of disease severity (Anthonisen *et al.,* 1994; Pride, 2001; Bourbeau *et al.,* 2004), so far there have been no studies that examined whether cognitive and behavioral change patterns of COPD patients during a smoking reduction intervention differ depending on the individual level of experienced health status.

Purpose of this Paper

Based on the analysis of existing literature in regard to potential cognitive determinants of behavior change in COPD patients, this paper will aim at examining the following questions:

1. Is there a difference in the level of attitude- and self-efficacy towards smoking cessation in the baseline phase in COPD patients with no, mild, moderate or severe impairment in HRQL?

> *Hypothesis 1:* Subjects with more severe impairment in HRQL have a more positive attitude but a lower self-efficacy towards smoking cessation in the baseline phase, compared to subjects with less impairment in HRQL.

2. Is there a change in attitude and self-efficacy towards smoking cessation during the intervention phase compared to the baseline phase within COPD patients with no, mild, moderate or severe impairment in HRQL?

> *Hypothesis 2:* There is a change in levels of self-efficacy and attitude towards smoking cessation in the intervention phase, when compared to the baseline phase.

3. Are changes over time in attitude and self-efficacy towards smoking cessation associated with changes in smoking behavior (number of smoked cigarettes per day) in four COPD patients with no, mild, moderate and severe impairment in HRQL?

> *Hypothesis 3:* There is a significant negative relation between changes in attitude and self-efficacy towards smoking cessation and changes in the smoking behavior.
>
> *Hypothesis 4:* Self-efficacy during the baseline phase significantly negatively predicts the number of smoked cigarettes within the post-intervention phase.

Methods

Design & Procedure

A mono- centre randomized single case experimental design (SCED) was employed. The SCED was conducted in the form of an ABA´ design (with A as baseline phase/control, B as treatment phase, and A´ as follow-up). During the baseline phase, the smoking behavior and cognitions towards smoking cessation of the participants were measured in the absence of any smoking cessation or reduction treatment. This allows for participants to function as their own control group (Horner *et al*., 2005). In the 13 weeks of the intervention phase the

same measurements took place but the participants received the smoking reduction treatment. During the post- intervention measurements the treatment was withdrawn but since the intervention was aimed at long-term changes in cognitive and behavioral processes, there was no return to baseline conditions expected.

Experimental control was achieved by the implementation of a multiple baseline design; the participants of the intervention group were further randomly allocated to four groups with non-concurrent lengths of the baseline phases and concurrent length of the intervention phase, since the treatment was group-administered (Figure 1). The effect of the intervention on dependent variables can thereby be replicated across participants (Horner *et al.*, 2005) and changes in behavioral and cognitive patterns can be better attributed to the onset of an intervention program (Dallery, Casssidy, & Raiff, 2013).

Whether participants met the inclusion criteria was verified during a brief phone interview. Additionally, clinical inclusion criteria were screened by a physician during the initial intake visit. Participants, who met the inclusion criteria and who signed the written informed consent, filled in measurements concerning demographic background information, smoking behavior, tobacco dependence, health status, clinical symptoms of depression and determinants of behavioral change. Participants were further randomly allocated to an intervention arm or a control arm, by the use of a computer-generated schedule. Patients in the control group only anticipated a brief self- help intervention, consisting of a self-help manual and a meeting of 60 minutes during which they received information on COPD, smoking reduction and cessation. Patients in the intervention group participated in an intensive smoking reduction program, consisting of free NRT for 12 weeks and behavioral counseling in the form of 8 small-group sessions of 90 minutes and four telephone contacts of 10 minutes. Throughout the group sessions, the participants received disease-related information, e.g. about COPD, nicotine dependence, and advantages of smoking reduction and learned to apply strategies to reduce their smoking behavior and avoid relapses (APPENDIX A). The smoking reduction was implemented by the use of scheduled reduced smoking, which is a strategy where the patients are supposed to smoke at specific times during the day, based on fixed intervals that are continuously increased. The advantage of this technique is that the associations between smoking and external cues that the patient might have built up over several years or decades are disrupted (Cinciripini, Wetter, & McClure, 1997). In comparison to abrupt smoking cessation, a gradually prolonged interval between the cigarettes also decreased the symptoms of withdrawal and facilitates complete smoking cessation (Cinciripini *et al.,* 1997). Furthermore, the participants in the REDUQ intervention

had the opportunity to discuss experience- based positive and negative effects of the smoking reduction within group sessions. The full SCED had a duration of 26 weeks and was conducted by trained smoking cessation counselors. A participant, whether in the intervention group or control group, that expressed the motivation to quit smoking completely (ready to quit) was stimulated to enter an intensive smoking cessation intervention program.

Figure 1. Schematic Overview of the Multiple Baseline Design.

5 weeks (A)	13 weeks (B)	8 weeks (A´)
6 weeks (A)	13 weeks (B)	7 weeks (A´)
7 weeks (A)	13 weeks (B)	6 weeks (A´)
8 weeks (A)	13 weeks (B)	5 weeks (A´)

Figure 1. The Multiple Baseline Design of the REDUQ II study. A indicates the no- treatment baseline phase (5,6,7, or 8 weeks), B indicates the active smoking reduction treatment phase which is 13 weeks in all four groups, and A´ indicates the follow-up phase (5,6,7, or 8 weeks).

This study incorporated an open label design, since researchers, counselors and patients were not blinded regarding the allocation to the different treatment groups. However, the members of the staff that conducted the weekly telephone questionnaires were blinded for the patient´s allocation to the treatment group. Furthermore, the counselors of the group sessions were blinded to the outcomes of the baseline measurements to ensure that participants within the experimental group received the same treatment.

Participants

The participants of the study consisted of a randomized sample of 15 men and 7 women between 48 and 77 years of age (M=61.5, SD=7.5). They were all clinically diagnosed with COPD (GOLD stage I-IV) and patients at the pulmonary outpatient clinic of the Medisch Spectrum Twente hospital in Enschede. Nine participants were allocated to the

self-help intervention and thirteen participants to the intensive smoking reduction treatment group. Participants were included when they reported to smoke a minimum of 10 cigarettes a day at the moment of the baseline measurement. Further inclusion criteria were that the participants should be motivated to reduce their smoking behavior and that they experienced at least two unsuccessful lifetime quit attempts. All participants had to be able to write, speak and understand the Dutch language. Exclusion criteria were contraindication for all forms of nicotine replacement therapy (NRT); when the person was pregnant, breastfeeding or predictably will conceive during the study; when the person was `ready to quit´ (motivated to completely quit smoking 1 month from baseline); or when the person had a history of serious psychiatric morbidity or depressive symptoms.

In order to answer the earlier formulated research questions for individual COPD patients with different levels of HRQL respectively, four participants of the experimental condition (smoking reduction treatment) were selected for further analysis based on their CCQ- total score; one participant with no impairment (indicated by a total CCQ score of 0-1), mild impairment (indicated by a total CCQ score of 1-2), moderately severe impairment (indicated by a total CCQ score of 3-4), and very severe impairment in HRQL (indicated by a total CCQ score of 4-5) (van der Molen *et al.,* 2003). A further selection criteria was a low amount of missing data, since this can negatively influence the internal validity of the results (Borckardt *et al.,* 2008).

Measures

During the intake visit, background information and several physical conditions, such as the lung function, weight, cotinine level, and monoxide in expired air were collected. Furthermore, a questionnaire was implemented that included items regarding potential confounding variables, such as smoking determinants, the patient´s motivation/ intention to quit smoking, the current smoking habits, previous attempts to stop smoking and the current health condition of the patients, including the CCQ. For the purpose of this study, the CCQ-score was used as indicator of the HRQL of the participants. During the A, B and A' phase, in total 26 weekly measurements were collected by the use of a telephone-conducted questionnaire that consisted of 12-15 questions concerning the smoking behavior of the participant, the intention to quit smoking and cognitive determinants of smoking cessation (APPENDIX B). For the purpose of this paper, the 26 repeated measures of attitude- and self-

efficacy towards smoking cessation and the smoking behavior (for each participant) were used.

Smoking behavior

To examine changes in the individual´s smoking behavior, the self-reported number of smoked cigarettes per day within the previous seven days was used as indicator. The total score of smoked cigarettes was thereby derived from the number of cigarettes that were smoked during the weekdays and the number of smoked cigarettes during the weekend, which were assessed separately in the questionnaire.

Cognitions

Attitude towards smoking cessation was assessed by four items, with answers ranging from 0 to 10; "I think that quit smoking is *bad* (0)/ *good* (10)", "I think that quit smoking is *unhealthy* (0)/ *healthy* (10)", "I think that quit smoking is *not comprehensible* (0)/ *comprehensible* (10)", and "I think that quit smoking is *unpleasant* (0)/ *pleasant* (10)". The total score for attitude towards smoking cessation was derived by calculating the mean scores of the single items. A higher score indicated a more positive attitude towards smoking cessation. Self-efficacy was assessed by measuring the participant´s confidence in his ability to successfully quit smoking; "How much trust do you have in your ability to stop smoking or maintain not to smoke?" with answer categories ranging from 0 = *not at all* to 10 = *very much*. Thereby, a higher score on the scale was an indication for a higher self-efficacy regarding smoking cessation.

Health- Related Quality of Life

The Clinical COPD Questionnaire (CCQ), developed by van der Molen *et al.* (2003) was implemented to assess the health status, or HRQL of the participants. The international Primary Care Respiratory Group has ranked the CCQ as the most appropriate measure to assess the health status in COPD patients when compared to alternative disease-specific measures of HRQL (Cave, Atkinson, Tsiligianni, & Kaplan, 2012). Illness-specific health status questionnaires do not only address the primary physical effects but also secondary

emotional and psychological consequences of COPD (Jones, 2001). Therefore they allow a more client-centered view on the impact of the disease on the individual patient. The CCQ consists of 10 items, with answers ranging from 0 to 7, with 0 = *asymptomatic/ no limitation* and 6 = *extremely symptomatic/ totally limited*. Besides the total score of the whole scale, the CCQ can also be divided into three domains; symptoms (items 1, 2, 5, 6), functional state (items 7, 8, 9, 10) and mental state (items 3, 4). The overall scores and the domain scores are calculated by dividing the sum of all single scores in a domain by the number of items. A higher total score or higher sub- scores indicate a more severe impact of the disease on the patient´s experience of health and quality of life. The CCQ has shown high test-retest reliability for the total CCQ score and all three domain scores, with an alpha of 0.91 for the total score (van der Molen *et al.,* 2003). A study by Kocks *et al.* (2010) has also shown that the CCQ can be appropriately applied for the individual patient level.

Analysis

Data for each participant were analyzed separately, except for the comparison of the mean tendency in cognitive determinants towards smoking cessation in the baseline phase between the four participants. All analyses were performed using IBM SPSS 22.0 statistics.

Missing data & outliers

Participant 1 (P1), who had no impairment in HRQL, had only one missing data point for self-efficacy at the last measurement of phase A. Participant 2 (P2), who had mild impairment in HRQL, also had one missing data point for self-efficacy within the baseline phase (A5). Participant 3 (P3), who had moderate impairment in HRQL, had no missing data points for attitude, self-efficacy, smoking behavior or CCQ. Participant 4 (P4), who showed severe impairment in HRQL, had two missing values for self-efficacy and three missing measurement points for attitude within the post-intervention phase. These missing data points were substituted through the mean of the respective phase when there was little variation in the scores of the particular cognition and through the mean score of the adjacent measurement points when the cognition showed variability within the phase (P1, P2). The intervention graphs indicated that scores at measurement point 1 during the baseline phase tended to be outliers across the subjects. These single outliers can have an impact on the

measure of the central tendency in the phase-mean, therefore the attitude- and self-efficacy scores at measurement point 1 were excluded from the further analysis process, for each subject.

Autocorrelation

A first-order autoregression analysis was conducted with a Durbin-Watson test as indicator for serial dependence in the cognitive determinants for smoking cessation and the smoking behavior of the participants (Durbin & Watson, 1950). The Durbin-Watson test indicated no significant serial dependence in the data, except a slightly negative first-order autocorrelation in self-efficacy towards smoking cessation in P1 ($d = 2.697$). Based on these findings, the following analyses were not corrected for serial dependence.

Difference in baseline- level of self-efficacy and attitude towards smoking cessation

To test the hypothesis that patients with more severe impairment in HRQL have a higher level of attitude but a lower level of self-efficacy towards smoking cessation in the baseline phase, compared to subjects with less impairment in HRQL, a Kruskal-Wallis test for independent samples with pairwise comparisons was conducted (Kruskal & Wallis, 1952).

Changes in cognitive determinants during the intervention phase, compared to the baseline phase

In order to test the hypothesis that self-efficacy and attitude towards smoking cessation increase during the treatment phase, the line graphs which represent the cognitive determinants of smoking cessation of the individual patients were visually examined in regard to changes in (1) level, (2) trend, (3) immediacy, and (4) variability (Riley- Tillman & Burns, 2009). The Percentage of Nonoverlapping Data (PND), as proposed by Scruggs, Mastropieri and Casto (1987) was used to indicate whether the intervention had a positive effect on the range of cognitive determinants. Since the expected effect of the intervention was an increase in cognitive determinants of smoking cessation, a line was drawn through the

intervention data, with the most positive baseline data point as indicator. The number of data points in phase B that were above this line was considered as nonoverlapping. An observed new range of behavior in the intervention phase indicates an effect of the intervention on the cognitive determinants; a PND of minimal 80% indicates a large effect of the intervention (Scruggs *et al*., 1987). Additionally, within-phase changes were visually examined in regard to changes in the smoking behavior, as indicated by the line graphs (Riley- Tillman & Burns, 2009).

Relation between cognitive determinants and smoking behavior

In order to test the hypothesis that there is a negative relation between the cognitive determinants (attitude and self-efficacy towards smoking cessation) and the smoking behavior, a bivariate Spearman correlation analysis was conducted with p < .05 (Spearman, 1904). Additionally, a linear regression analysis was conducted to examine if attitude and self-efficacy towards smoking cessation significantly explained the smoking behavior, with attitude- and self-efficacy scores as independent variables and the number of smoked cigarettes per day as dependent variable. The hypothesis that self-efficacy towards smoking cessation during the baseline phase predicts the smoking behavior in the post-intervention phase was also tested by the use of a linear regression analysis, with self-efficacy scores during phase A as predictor variable and the number of smoked cigarettes during phase A´ as dependent variable.

Results

Between- Subject Analysis of the Differences in Baseline-Level of Cognitive Determinants

A Kruskal-Wallis test for independent samples with pairwise comparisons showed that there was a significant difference in the mean tendency in self-efficacy, $x^2(3) = 18.262$, $p = 0.000$, and attitude towards smoking cessation, $x^2(3) = 16.219$, $p = 0.001$, during the baseline phase between the four subjects. The pairwise comparisons of the Kruskal-Wallis test showed   that only P2 showed a significantly lower self-efficacy than P1($x^2(3) = 14.833$, $p < 0.01$) and P4 ($x^2(3) = -10.875$, $p < 0.05$), and a significantly lower attitude than P3 ($x^2(3)$

= - 13.167, $p < 0.01$) and P4 ($x^2(3)$ = - 13.625, $p < 0.01$), whereas the variance in cognitive determinants did not significantly differ among P1, P3, and P4. This indicates that the reported significant difference in the variance of cognitive determinants towards smoking cessation at baseline among the four participants were due to generally lower scores in the participant with mild impairment in HRQL and not to different level of impairment in HRQL. The first hypothesis that participants with more impairment in HRQL (P3 and P4) would show a higher attitude but a lower self-efficacy towards smoking cessation than participants with less severe or not impairment in HRQL (P1 and P2) was thus not confirmed.

Table 1. *Descriptive Statistics for The Four Participants in Regard to Health-Related Quality of Life, Smoking Behavior and Cognitive Determinants Towards Smoking Cessation Across Phase A, B, and A´.*

	P1	P2	P3	P4
Age	48	58	56	77
Gender	Male	male	Male	male
HRQL				
Total Score	0.0	1.2	3.2	4.5
Symptom Score	0.0	2.0	4.5	5.75
Functional State	0.0	1.0	2.5	4.0
Mental State	0.0	0.0	2.0	3.0
Smoking Behavior				
Phase A (M,[SD])	19.33 [1.033]	15.29 [1.38]	22.67 [0.82]	13.75 [2.5]
Phase B (M,[SD])	13.31 [2.136]	10.46 [1.39]	16.54 [2.50]	3.77 [3.94]
Phase A´(M,[SD])	12.17 [0.408]	9.80 [0.447]	16.50 [0.84]	6.5 [3.78]
Reduction rate (A- B13[%])	38	41	29	64
Self-Efficacy				
Phase A (M,[SD])	9.33 [1.033]	3.57 [1.27]	7.83 [0.41]	8.25 [0.50]
Phase B (M,[SD])	9.85 [0.555]	4.08 [1.38]	6.15 [1.46]	9.38 [0.96]
Phase A´(M,[SD])	10.0 [0.00]	2.80 [0.45]	5.00 [1.67]	7.25 [1.16]
Attitude				
Phase A (M,[SD])	8.29 [0.68]	6.78 [0.27]	9.04 [0.19]	9.31 [0.80]
Phase B (M,[SD])	8.67 [0.31]	4.08 [1.38]	8.53 [0.48]	10.0 [0.00]
Phase A´(M,[SD])	8.45 [0.10]	2.80 [0.46]	8.58 [0.37]	10.0 [0.00]

Note. HRQL = Health- Related Quality of Life; M = mean tendency; SD = standard deviation.

P1 (no impairment in HRQL)

P1 is a 48-years old man with a CCQ-score of 0.00, which indicates that he has no health-related impairment within his daily life. Figure 2 shows the line graph of the cognitive determinants and the smoking behavior of P1 across the phases of the REDUQ study. P1 had a baseline phase duration of seven weeks and a follow-up phase of six weeks. In the end of the treatment phase, P1 had achieved a smoking reduction of 38% until the last measurement point of phase B, relative to the average number of cigarettes in phase A. During the A phase, P1 reported the intention to stop smoking during the following five years, whereas after the first week of phase B he reported intending to stop smoking within the next year, but not in the following six months. P1 remained in the precontemplation stage of behavior change.

Changes in Cognitive Determinants during the Intervention Phase, Compared to the Baseline Phase

As indicated in Table 1, there was no change in level of attitude or self-efficacy in P1 during the intervention phase relative to the baseline phase; both cognitive determinants remain stable at a high level, except a low score on self-efficacy in the sixth week of phase B. This was supported by the PND between the baseline phase and the intervention phase, which was 0% for both cognitions, suggesting no change in trend and thus no evidence for an effect of the intervention on self-efficacy and attitude towards smoking cessation in the patient with any impairment in HRQL. Hypothesis 2 was not confirmed for P1.

Relationships between cognitive determinants and smoking behavior

A Spearman- Rho test for bivariate correlation indicated that in P1 neither self-efficacy nor attitude towards smoking cessation were significantly related to the smoking behavior, even though there was a tendency towards significance in self-efficacy which was negatively related to the smoking behavior of P1, $\tau = -.323$, p (one-tailed) $=.058$. However, the multiple regression analysis showed that weekly changes in the cognitive determinants towards smoking cessation did not significantly explain the amount of weekly variance in the number of smoked cigarettes per day $(F(2,22) = 2.54$, $p > .05$, $R^2 = .19$, adjusted $R^2 = .11)$. Additionally, visual inspection of the graphs (Figure 2) indicated that, even though P1

showed a reduction in smoking behavior after the onset of the intervention phase, the cognitive determinants remained stable at a high level across the phases. The third hypothesis that there was a significant negative relation between the cognitive determinants and smoking behavior was not confirmed for P1. Furthermore, SE during the baseline phase did not significantly predict the number of smoked cigarettes per day within the post-intervention phase ($F_{(1, 4)} = 1.42$, $p > .05$, $R^2 = .26$, adjusted $R^2 = .08$). The fourth hypothesis was thus not supported for the subject with no impairment in HRQL.
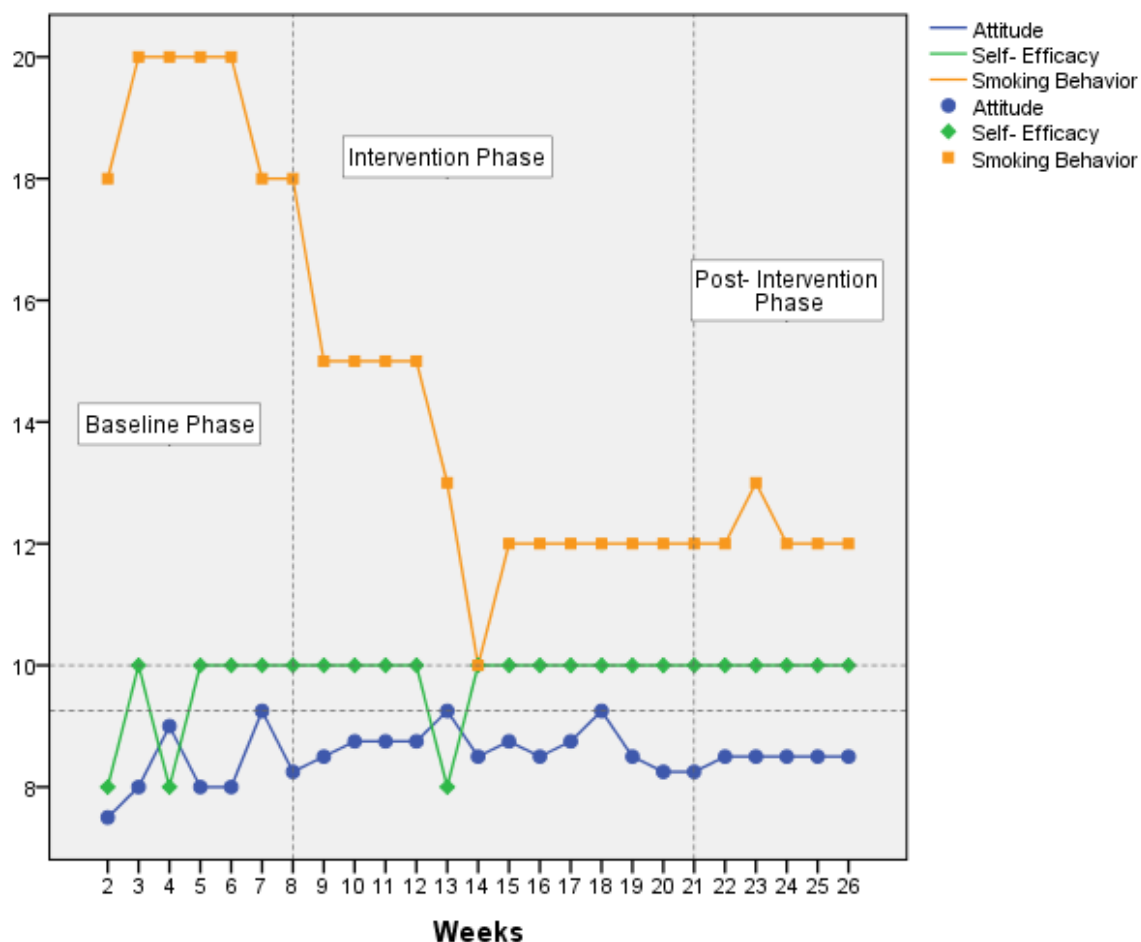
Figure 2: Variability over time for P1 (no impairment in HRQL) in attitude and self-efficacy towards smoking cessation (ranging from 0 to 10), and smoking behavior indicated by the number of smoked cigarettes per day. The vertical dashed lines mark the onset of the intervention phase in week 8 and the onset of the post-intervention phase in week 21. The horizontal dashed lines indicate the Percentage of Nonoverlapping Data (PND) for the cognitive determinants between the baseline phase and the intervention phase.

P2 (mild impairment in HRQL)

P2 is a 56- years old man with a CCQ-score of 1, 2, which indicates mild health-related impairment in daily activities. Figure 3 shows the line graph of the cognitive determinants and the smoking behavior of P2 across the phases of the REDUQ study. P2 had a baseline phase of eight weeks and a follow-up phase of five weeks. In the end of the treatment phase, P2 had achieved a smoking reduction of 41% until the last measurement point of phase B, relative to the average number of cigarettes in phase A. Furthermore, P2 intended to stop smoking within the next five years, which did not change enduring the study. P2 thus remained on the precontemplation stage of behavior change.

Changes in cognitive determinants during the intervention phase, compared to the baseline phase

Table 1 indicates a potential positive change in level in self-efficacy towards smoking cessation, from 3.6 ± 1.3 in phase A to 4.1 ± 1.4 in phase B. However, Figure 3 shows that none of the measurement points in phase B were located above the line for nonoverlap of data, indicating no difference in the range of self-efficacy compared to phase A. Furthermore, visual inspection of the graphs indicated a positive baseline trend in self-efficacy in the direction of the indicated change in level in phase B. Additionally, there was an observable negative trend in self-efficacy within phase B that occurred towards the end of the intervention and continued in phase A´. In regard to attitude towards smoking cessation, Table 1 indicated a negative change in level between phase A (M = 6.8, SD = 0.3) and phase B (M = 4.1, SD = 1.4). However, visual inspection of the graphs (Figure 3) showed that attitude remained stable across phase A and phase B, with a negative trend towards the end of phase B, similar to the negative trend in self-efficacy. Furthermore, there was a small PDN for the variability of attitude towards smoking cessation (7, 7%), which was only indicated at the first measurement point of the intervention phase. These findings suggest a delayed negative effect of the intervention on cognitive determinants towards smoking cessation in the participant with mild impairment in HRQL. Hypothesis 2 was thus not confirmed for P2.
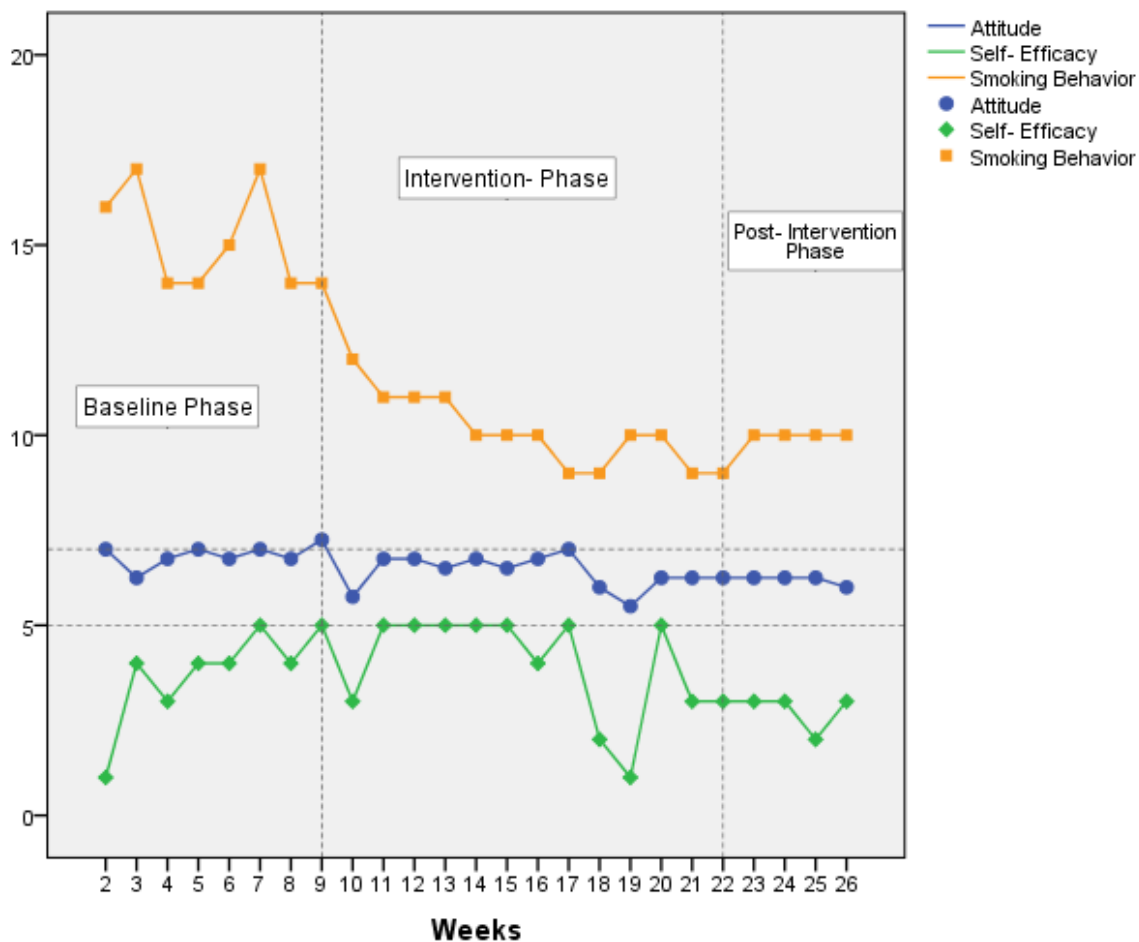
Figure 3: Variability over time for P2 (mild impairment in HRQL) in attitude and self-efficacy towards smoking cessation (ranging from 0 to 10), and smoking behavior indicated by the number of smoked cigarettes per day. The vertical dashed lines mark the onset of the intervention phase in week 9 and the onset of the post-intervention phase in week 22. The horizontal dashed lines indicate the Percentage of Nonoverlapping Data (PND) for the cognitive determinants between the baseline phase and the intervention phase.

Relationships between cognitive determinants and smoking behavior

A Spearman- Rho test for bivariate correlation indicated that only attitude towards smoking cessation was significantly positive related to the smoking behavior, $\tau = .476$, p (one-tailed) = 0.008. These findings were supported by the multiple regression analysis, which showed that changes in self-efficacy and attitude towards smoking cessation significantly explained 25, 4% of the variance in the number of smoked cigarettes per day (F (2, 22) = 3.74, $p < .05$, $R^2 = .254$). Nevertheless, only attitude significantly explained variance in

smoking behavior when self-efficacy was held constant (Beta = 3.57, t (2, 24) = 2.7, $p < .05$), suggesting that P2 smoked more cigarettes per day during weeks within which he reported an increase in attitude towards smoking cessation. This pattern was not observable by visual inspection of the graphs (Figure 3), which indicated a decrease in cognitive determinants and a subsequent increase in smoking behavior in week 18 and 19. Furthermore, SE during the baseline phase did not significantly predict the number of smoked cigarettes per day during the post-intervention phase (F (1, 3) = 0.79, $p > .05$, $R^2 = .21$). Hypothesis 3 and hypothesis 4 were not confirmed for the COPD patient with mild impairment in HRQL.

P3 (moderate impairment in HRQL)

P3 is a 56- years old man with a CCQ-score of 3, 2, which indicates that he has moderate health-related impairment in his daily life. As Table 1 shows, this impairment can mostly be attributed to COPD symptoms which were experienced as severe (4.5) by P3. Figure 4 shows the line graph of the cognitive determinants and the smoking behavior of P3 across the phases of the REDUQ study. P3 had a baseline phase length of seven weeks and a follow-up phase of six weeks. In the end of the treatment phase, P3 had achieved a smoking reduction of 29% until the last measurement point of phase B, relative to the average number of cigarettes in phase A. During phase A, P3 intended to quit smoking within the following six months but this intention decreased enduring the study; after week 17, P3 reported that he did not intent to quit smoking but to reduce it. P3 thus made a transition from the contemplation stage to the precontemplation stage of behavior change.

Changes in cognitive determinants during the intervention phase, compared to the baseline phase

Table 1 indicated a potential slightly negative change in level in attitude towards smoking cessation in phase B (M = 8.53, SD = 0.48) compared to phase A (M = 9.04, SD = 0.19), but visual inspection of the graphs (Figure 4) showed that attitude remained stable across the phases on a high level. Furthermore, Table 1 indicated that there was a negative change in level in self-efficacy between phase A (M = 7.8, SD = .41) and phase B (M = 6.15, SD = 1.46). Figure 4 shows that this change first occurred directly after the onset of the

intervention program in week eight, indicating a negative effect of the smoking reduction intervention on the self-efficacy towards smoking cessation in P3. This was supported by a PND of 0% for both cognitive determinants, suggesting that the intervention did not have a positive effect on self-efficacy or attitude. Hypothesis 2 was thus not confirmed for P3.

Figure 4: Variability over time for P3 (moderate impairment in HRQL) in attitude and self-efficacy towards smoking cessation (ranging from 0 to 10), and smoking behavior indicated by the number of smoked cigarettes per day. The vertical dashed lines mark the onset of the intervention phase in week 8 and the onset of the post-intervention phase in week 21. The horizontal dashed lines indicate the Percentage of Nonoverlapping Data (PND) for the cognitive determinants between the baseline phase and the intervention phase.

Relation between cognitive determinants and smoking behavior

A Spearman- Rho test for bivariate correlation indicated a significant positive relation between attitude towards smoking cessation and smoking behavior, $\tau =.382$, p (one-tailed)

=.03, and a significant positive relation between self-efficacy towards smoking cessation and smoking behavior, r = .487, p (one-tailed) = .007. This was partly supported by the multiple regression analysis, which indicated that self-efficacy and attitude towards smoking cessation significantly explained 29, 8% of the variance in the number of smoked cigarettes per day (F (2, 22) = 4.67, $p < .05$, R^2 = .298, R^2adjusted = .234). However, post hoc analysis revealed that only changes in self-efficacy did significantly account for the variance in the number of smoked cigarettes per day (Beta = .85, t(24) = 2.18, p < .05), whereas changes in attitude did not (Beta = 1.5, t(2,24) = 1.04, $p > .05$). This suggests that in weeks within P4 reported a higher level of self-efficacy towards smoking cessation; he also showed an increase in the number of smoked cigarettes per day. An additional regression analysis showed that SE in the baseline phase did not significantly predict the number of smoked cigarettes per day during the post-intervention phase. Hypothesis 3 and hypothesis 4 were thus not confirmed for the patient with moderate impairment in HRQL.

P4 (severe impairment in HRQL)

P4 is a 77-years old man with a CCQ-score of 4.5, which indicates that he experiences severe health-related impairment within his daily life. Figure 5 shows the line graph of the cognitive determinants and the smoking behavior of P4 across the phases of the REDUQ study. P4 had a baseline phase duration of five weeks and a follow-up phase of eight weeks. In the end of the treatment phase, P4 had achieved a smoking reduction of 64% until the last measurement point of phase B, relative to the average number of cigarettes in phase A. In the beginning of the study P4 was in the precontemplation stage of behavior change and intended to stop smoking enduring the next year. After six weeks of treatment P4 stopped with smoking, but experienced a relapse two weeks before the end of the intervention phase and reported to intent to quit within the following six months but not within three months. P4 thus made a transition from a precontemplation stage of behavior change, over a maintenance stage, to a contemplation stage.
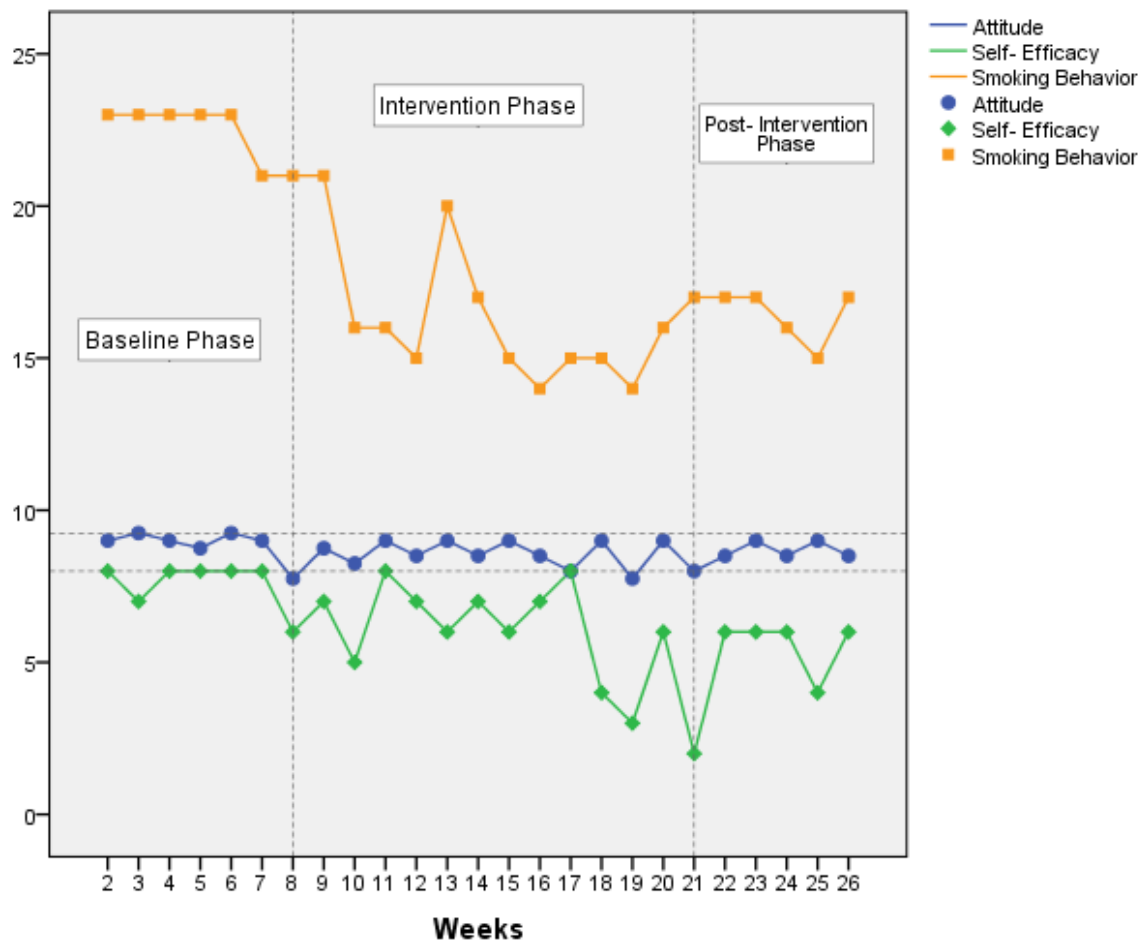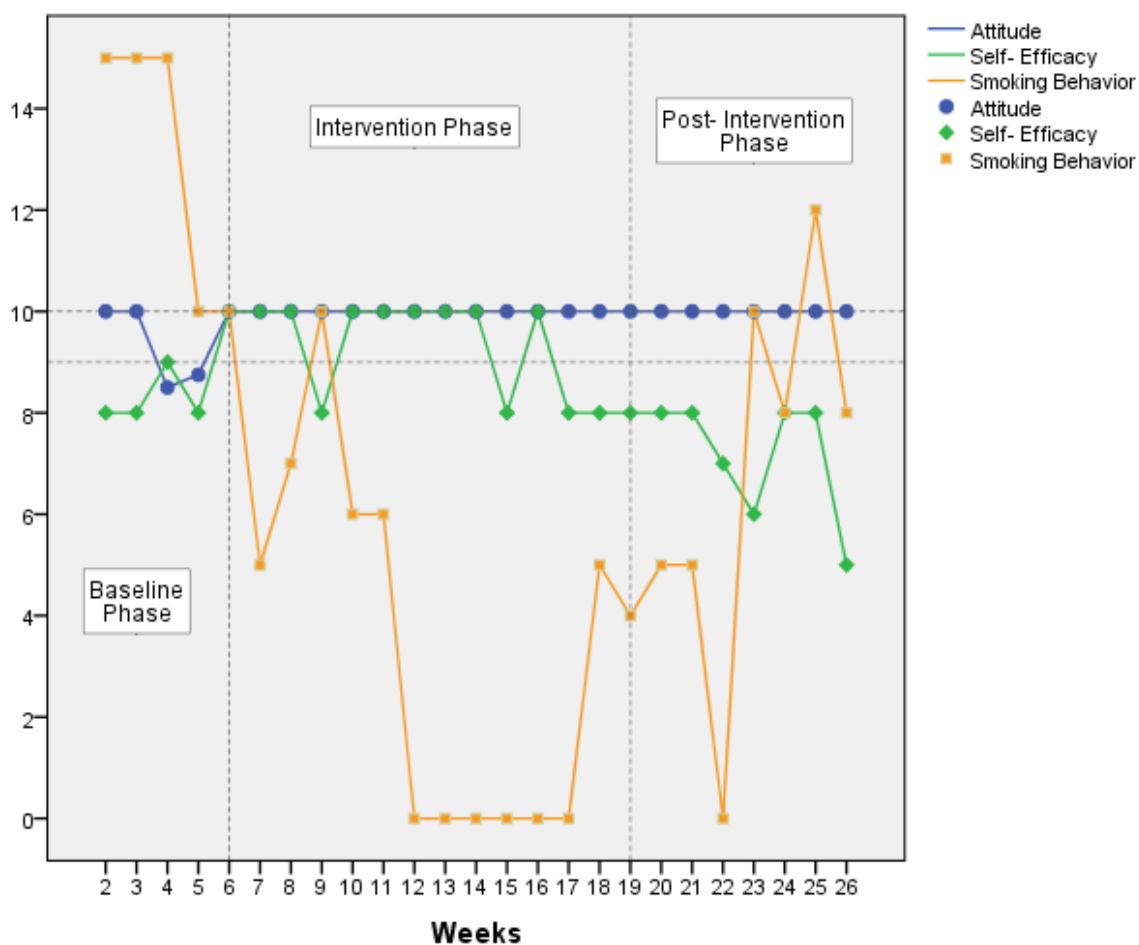
Figure 5: Variability over time for P4 (severe impairment in HRQL) in attitude and self-efficacy towards smoking cessation (ranging from 0 to 10), and smoking behavior indicated by the number of smoked cigarettes per day. The vertical dashed lines mark the onset of the intervention phase in week 6 and the onset of the post-intervention phase in week 19. The horizontal dashed lines indicate the Percentage of Nonoverlapping Data (PND) for the cognitive determinants between the baseline phase and the intervention phase.

Changes in Cognitive Determinants during the Intervention Phase, Compared to the Baseline Phase

Table 1 indicates that there was a slight positive change in level in self-efficacy between phase A (M = 8.2, SD = .5) and phase B (M= 9.4, SD = .96). This was supported by the PND in self-efficacy between phase A and phase B; nine measurement points in phase B were above the PND- line indicating a nonoverlap of data of 69%. However, the observed

PND is below the recommended PND of 80% for a large intervention effect. Furthermore, visual inspection of the graphs (Figure 5) showed that baseline data of self-efficacy was ascending in the same direction as the level change, which has a magnifying effect on the observed change in level. Furthermore, there was an observable decrease in self-efficacy towards the end of phase B, indicating a delayed negative effect of the intervention on the self-efficacy towards smoking cessation in P4. The mean tendency of attitude towards smoking cessation in phase B (M = 9.3, SD = .8) was slightly higher compared to phase A (M = 10.0, SD = 0.0), as indicated in Table 1. However, Figure 5 shows that attitude remained stable on a high level across the three phases, except for lower scores in weeks four and five (phase A). This is supported by the PND between phase A and phase B, which was 0% for attitude, indicating no effect of the intervention on attitude towards smoking cessation, compared to baseline. Hypothesis 2 was only partly but not significantly confirmed in regard to self-efficacy towards smoking cessation in the participant with severe impairment in HRQL.

Relation between Cognitive Determinants and Smoking Behavior

A Spearman- Rho test for bivariate correlation indicated that only attitude was significantly negative related to the smoking behavior, τ= -.367*, p* (one-tailed) < 0.05, suggesting that P4 showed a reduction in smoking behavior in weeks within which he reported a higher level of attitude towards smoking cessation. This was not supported by the multiple regression analysis; attitude and self-efficacy towards smoking cessation did not account for a significant amount of variance in the number of smoked cigarettes per day ($F(2,22) = 3.02$, p = .069, R^2 = .215, R^2 adjusted = .144). Hypothesis 3 was thus only partly confirmed for attitude in P4. Furthermore, there was also no significant relation found between SE in the baseline phase and the number of smoked cigarettes per day during the post-intervention phase ($F (1, 2) = .429$, p > .05, R^2 = .176, adjusted R^2 = -.23), indicating that hypothesis 4 was also not confirmed for P4.

Integrated Summary of Results

Table 2 provides an overview of the findings of this study for all four participants, in regard to the (non)confirmation of the stated hypotheses. In line with the first hypothesis, the

results indicate that participants with more severe impairments in HRQL did not show a significantly higher initial attitude and lower initial self-efficacy towards smoking cessation, when compared to participants with no or less severe impairments in HRQL: All participants, except P2, reported a highly positive attitude and experienced moderate (P3) or high (P1, P4) self-efficacy towards smoking cessation. Second, the intervention program had no positive effect on the cognitive determinants of smoking cessation within any of the four participants, except a slight increase in self-efficacy. Whereas attitude remained stable at a high level in all four participants, self-efficacy showed a higher variability across the three phases. In three of the four participants (P2, P3, and P4), self-efficacy towards smoking cessation showed a negative trend towards the end of the treatment, together with a relapse in smoking behavior. In regard to the third hypothesis, only the participant with severe impairments in HRQL showed a decrease in smoking behavior during weeks within which he reported a more positive attitude towards smoking cessation (as indicated by the correlation analysis but not by the regression analysis). Finally, the baseline-level in self-efficacy did not significantly predict the smoking behavior in the post-intervention phase in any of the four participants.

Table 2. *Overview of results regarding (non)confirmation of hypotheses, for each cognitive determinant of smoking cessation (attitude and self-efficacy) separately and across participants.*

Hypothesis	P1	P2	P3	P4
	ATT / SE	*ATT / SE*	*ATT / SE*	*ATT / SE*
H1: P with more severe impairment in HRQL show more positive ATT but lower SE in phase A than P with less severe impairment in HRQL.	0 / 0	0 / 0	0 / 0	0 / 0
H2: Positive change in level in ATT and SE in phase B, compared to phase A	0	0	0	0 / (+)
H3: Negative relation between cognitive determinants and smoking behavior	0 / 0	0 / 0	0 / 0	(+) / 0
H4: Initial SE negatively predicts achieved smoking reduction in A′	0	0	0	0

Note. 0 = hypothesis rejected; + = hypothesis confirmed; (+) hypothesis partly confirmed; ATT = attitude towards smoking cessation; SE = self-efficacy towards smoking cessation.

Discussion & Conclusion

The aim of this study was to examine changes in cognitive determinants (attitude and self-efficacy) of smoking cessation in regard to changes in the smoking behavior within and between four smokers with COPD with varying impairment in HRQL who participated in an intensive smoking reduction intervention. There were three main findings in this study that will be further discussed within the following paragraphs; first, smokers with COPD who experienced varying severity of impairments in HRQL did not differ in their baseline-cognitions towards smoking cessation. Second, the smoking reduction intervention seemed to have a negative effect on the self-efficacy towards smoking cessation among participants with impairment in HRQL compared to participants with no impairment in HRQL. Third, there was no significant relation found between changes in cognitive determinants of smoking cessation and changes in smoking behavior.

Based on the health belief model and previous research findings, it was expected that patients with more severe impairment in HRQL would have a higher level of attitude but a lower level of self-efficacy towards smoking cessation in the baseline phase, compared to subjects with less impairment in HRQL. The current study showed that all four smokers with COPD reported a highly positive attitude towards smoking cessation which further remained stable throughout the phases of the study. This is not confirmed by other studies that showed that COPD patients tend to have a negative attitude towards smoking cessation (Schroedl *et al.,* 2014; van Eerd *et al.,* 2015). A possible explanation for the observed high and stable scores in attitude towards smoking cessation is that the used measure did not discriminate between the affective component of attitude, which refers to the emotional evaluation of smoking cessation, and the cognitive component of attitude, which refers to positive and negative outcome expectations towards this behavior (de Vries & Mudde, 1998).
As previous studies indicated, smokers with COPD generally do know that smoking reduction or cessation would improve their health condition but they tend to trivialize the relation between their smoking behavior and the progress of the disease and find different explanations for their health conditions, such as ageing (Schofield, Kerr, & Tolson, 2007; Schroedl *et al*., 2014; van Eerd *et al.,* 2015); van Eerd *et al.* (2015) suggested that smokers with COPD show this cognitive dissonance to avoid changes in their lifestyle as a smoker. This and the findings from the current study might suggest that the optimism towards

smoking cessation that the four participants reported was more due to cognitive beliefs than emotional evaluation. Furthermore, social desirability bias might have influenced the responses of the participants; a study by Halding, Heggdal, and Wahl (2011) indicated that smokers with COPD perceive a high level of guild and stigmatization which was related to social pressure from the environment to stop smoking and to the feeling of being personally responsible for the deterioration of the own health. This might indicate that the participants in the current study reported a positive attitude towards smoking cessation because they thought that others expect them to judge smoking cessation as a positive change.

The second major finding of the current study was that the smoking reduction intervention seemed to have a negative effect on the self-efficacy towards smoking cessation in three of four participants, which is contradictory to the findings made by Cinciripini *et al.* (1995) which showed that achieved scheduled reduced smoking was associated with an increase in self-efficacy and a reduction in the perceived urge to smoke. In the cases of the participants with mild and severe impairment in HRQL that participated in the current study, there was a subsequent increase in self-efficacy in the weeks before and after the initiation of the intervention that occurred contemporaneously to a reduction in smoking behavior, followed by a decrease in self-efficacy and a relapse in smoking behavior. These participants also achieved a higher subsequent reduction rate in smoking behavior, compared to the participant with no impairment in HRQL. This is in line with the health belief model which states that patients who perceive a high disease-related harm-susceptibility or severe health consequences due to the risk-behavior (smoking) are more likely to show behavioral changes (Rosenstock, 1966). However, since this pattern was similarly apparent in the three participants who perceived any kind of impairment in HRQL but not in the participant without impairment in HRQL, the findings may suggests that self-efficacy towards smoking cessation is more relevant than attitude in successful attempts of smoking reduction in smokers with COPD experiencing disease-related limitations in their daily live, independent of the level of severity. A study by Bonsaksen, Fagermoen, and Lerdal (2014) found a similar increase-decrease change pattern in self-efficacy among smokers with COPD and suggested that the initial increase in self-efficacy, on the one hand, might be due to the participants´ expectation that the intervention might help them to cope with their disease and to the implementation of newly learned strategies for behavior change. The later decrease in self-efficacy, on the other hand, was suggested to be the result of the persistence of impairments in physical functioning (Bonsaksen *et al.,* 2014). It is important to note that these findings were based on general self-efficacy measures concerning the general belief to be able to cope

with demands in life, whereas this study employed specific self-efficacy measures in regard to smoking cessation. Nevertheless, another study by Baldwin *et al.* (2006) found that self-efficacy was a significant predictor of the initiation of quit attempts but satisfaction with achieved outcomes of behavior change had more predictive power in regard to the maintenance of the newly adopted behavior. This was supported by the study by Schofield et *al.* (2006), which indicated that smokers with COPD commonly did not perceive the expected benefits from smoking cessation; only one of 22 participants reported improvements in HRQL. Schroedl *et al.* (2014) and van Eerd *et al.* (2015) also indicated that this absence of experienced improvements in health status can have a negative effect on the motivation to change smoking behavior. These findings suggest that the relapse in smoking behavior that was reported in three of four participants in the current study may have been related to low perceived satisfaction of expected outcomes after the initiation of behavioral changes, which might in turn had a negative subsequent influence on self-efficacy and the effort they put forth in implementing strategies for smoking reduction. Bonsaksen *et al.* (2014) concluded that smokers with COPD might need more frequently support in increasing their self-efficacy in order to achieve a successful behavior change, compared to other illness groups. This might be due to the higher perceived barriers that smokers with COPD experience during attempts to stop smoking when compared to smokers without COPD, such as a higher nicotine dependence (Jiménez-Ruiz *et al.,* 2001), strong perceived feelings of craving and a lifelong history of smoking behavior (van Eerd *et al.,* 2015).

Another important finding of the current study was that changes in cognitive determinants did not significantly explain subsequent changes in smoking behavior. This is contrary to the previously outlined research findings which identified self-efficacy and attitude towards smoking cessation as significant predictors of smoking reduction and smoking cessation (Bandura, 2000; Devins & Edwards, 1988; Atkins *et al.,* 1984). In regard to attitude, these findings may probably have been the result of the observed high level and stable pattern persisting across the phases. However, the similar time-related patterns of change in self-efficacy and smoking behavior that were observed across three participants in the current study suggest that self-efficacy towards smoking cessation may have had an indirect effect on the smoking behavior. A study by Scholz, Nagy, Göhner, Luszczynska, and Kliegel (2009) showed that baseline- self-efficacy was significantly related to changes in intention but not to changes in smoking behavior among smokers with COPD. It was further found that changes in self-efficacy had an indirect effect on changes in smoking behavior, via the intention to change the behavior. In the current study, the negative trend in self-efficacy

in the participant with moderate impairment in HRQL occurred after week 17, within which he also reported for the first time that he did not intend to stop smoking anymore, but to reduce it. Since there was also an increase in the number of cigarettes after week 17, this would suggest that self-efficacy towards smoking cessation had an indirect effect on the smoking behavior, mediated by the intentional stage of behavior change. This conforms to the I-change model, according to which self-efficacy influences the intention to change a specific behavior, which in turn is the primary determinant for the actual execution of the desired behavior (de Vries *et al.,* 2003). That the current study did not show significant relations between cognitive determinants of smoking cessation and smoking behavior could also indicate that measures of self-efficacy and attitude towards smoking cessation may not be efficient cognitive determinants for smoking reduction. Bandura (2006) suggested that self-efficacy measures should address the specific behavior of interest, except when two kinds of behavior require the same set of sub-skills. Previous research findings have shown that smoking reduction seems to be easier to achieve for smokers with COPD than smoking cessation (Carpenter *et al.,* 2004), suggesting that smoking cessation may require more advanced sub-skills. In regard to attitude, Schofield *et al.* (2006) found that smokers with a highly negative attitude towards smoking cessation perceive smoking reduction as more reasonable. Furthermore, the current study showed that the single participant that achieved an interim smoking abstinence was also the only participant in which changes in attitude significantly negatively correlated with changes in smoking behavior. These findings might support the suggestion that separate measures are required for cognitive determinants towards smoking reduction.

The finding of the current study that changes in cognitive determinants were not associated with changes in smoking behavior may also be related to the fact that there was no significant serial dependency found in the data across the four participants; this indicates that the single weekly observations of cognitive determinants and smoking behavior were not related to previous observations in the same variables. For the purpose of interventions it is commonly assumed that cognitive and behavioral patterns that are repeatedly measured in a single participants show a serially correlated pattern; otherwise changes in observations are random and therefore not predictable (Borckardt *et al.,* 2008). Future research should aim at examining whether these findings represent a common pattern among smokers with COPD, compared to smokers without COPD.

Limitations of the Current Study

One limitation of the current study is that the research design does not reveal clear causal relationships or generalization of findings; in order to build an evidence-base for intervention effects within a SCED, the findings of this study would have to be replicated across 20 cases in total, with at least three studies conducted at geographically alternating locations which replicate the effect across a minimum of five cases (Kratochwill *et al.,* 2010). Another limitation of this study is that the four cases that were used for analysis were not randomly selected. The selection was based on the level of HRQL and the number of missing values. The four cases might thus not be representative for the whole sample. Furthermore, all four participants were men, which means that the findings of the current study may not be representative for female patients. A study by Hynninen, Pallesen, & Nordhus (2007) indicated that female COPD patients reported similar impairment in health status, compared to men, and even higher levels of psychological distress (as indicated by the level of anxiety and depression) than male patients, even though they were younger and diagnosed with a less severe stage of COPD. This suggests that women who suffer COPD generally tend to experience the disease as more restrictive and psychologically distressing in their daily life than men. Additionally, COPD patients who suffered from symptoms of depression were excluded from this study. However, studies have shown that a significant amount of variance in the perceived health status of COPD patients was accounted for by symptoms of depression and anxiety (Hajiro, Nishimura, Tsukino, Ikeda, & Oga, 2000; Gudmundsson *et al.,* 2006), which might suggest that the findings are not representative for smokers with COPD who experience high impairments in the mental component of HRQL. Additionally, the reliance on self-report measurements might also be a limitation of the current study, since they can be influenced by social desirability bias (Murray, Connett, Lauger, & Voelker, 1993).

Practical Implementations

The implementation of the SCED as an intervention-evaluation tool enables to test established theories in health care at the subject-level and to examine changes in cognitive determinants of smoking cessation within the period of the intervention. One advantage of this design is that treatment programs can be altered enduring the course of the treatment

phase when the intervention does not show the expected effect (Gravetter & Forzano, 2009). Based on the former discussed findings from the current study, future research on smoking reduction in COPD could incorporate a SCED to monitor changes in self-efficacy and (if necessary) tailor the components of the intervention to support the participant´s self-efficacy, for example by attempting to increase the experienced satisfaction of the participant in regard to achieved changes in smoking behavior. Furthermore, the findings indicated that smokers with COPD who experience different levels of severity in the impairment in HRQL did not differ in their initial level in cognitive determinants and showed similar patterns of change during the treatment phase, suggesting that the smoking reduction intervention is equally applicable for COPD patients who experience any kind of impairment in HRQL.

Conclusion

Based on the conducted literature search, this was the first study that examined changes in attitude and self-efficacy towards smoking cessation during an intensive smoking intervention program in regard to the perceived impairment in HRQL within four smokers with COPD. All in all, the findings indicate that the smoking reduction intervention was equally effective in smokers with COPD who reported varying severity in impairment in HRQL. Furthermore, this study supported the importance of self-efficacy as motivational determinant of subsequent changes in smoking behavior among COPD patients and suggests that smoking reduction interventions should incorporate frequent monitoring of self-efficacy and distal determinants related to self-efficacy during the entire treatment in order to prevent relapses in smoking behavior towards the end of the intervention. Further research needs to examine whether separate measures are required for cognitive determinants towards smoking reduction.

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APPENDIX A: Components of the eigth group sessions of the intensive smoking reduction intervention within the REDUQ II Study

Bijeenkomst 1 – week 1
- Opzet en structuur van het programma
- Relatie roken en COPD
- Rookverslaving (geestelijk en lichamelijk)
- Minderen met roken
- Geleidelijke gecontroleerde reductie (*'scheduled reduced smoking'*)
- Kennismakingsrondje
- Thema's:
  - Inzicht huidig rookgedrag (bespreken vooraf ingevulde observatielijst rookgedrag)
  - Voor- en nadelen (verandering) rookgedrag
- Werkboekopdrachten

Bijeenkomst 2 – week 2
- Ervaringenrondje *
- Uitwerking thema:
  - Voor- en nadelen van (verandering) rookgedrag
- Nieuwe thema's:
  - Barrières om te minderen
  - Risicosituaties en trek
- Ontwenningsverschijnselen
- Nicotinevervangende middelen
- Werkboekopdrachten

Bijeenkomst 3 – week 4
- Ervaringenrondje
- Uitwerking thema's:
  - Barrières om te minderen
  - Risicosituaties en trek
- Nieuwe thema's:
  - Zelfcontrolemaatregelen
  - Omgaan met trek
- Werkboekopdrachten

Bijeenkomst 4 – week 8
- Ervaringenrondje
- Uitwerking thema's:
  - Zelfcontrolemaatregelen
  - Omgaan met trek
- Nieuwe thema's:
  - Doelen (bij)stellen
  - Omgaan met druk uit de omgeving
- Werkboekopdrachten

Bijeenkomst 5 – week 13

- Ervaringenrondje
- Uitwerking thema's:
  - Doelen (bij)stellen
  - Omgaan met druk uit de omgeving
- Nieuwe thema's:
  - Veranderen van gedachten (4 G's + niet-helpende gedachten omzetten in helpende
    gedachten)
  - Uitglijders en terugval: noodplan
- Werkboekopdrachten

Bijeenkomst 6 – week 26

- Ervaringenrondje
- Uitwerking thema's:
  - Veranderen van gedachten
  - Uitglijders en terugval: noodplan
- Nieuw thema:
  - Doorzetten/Volhouden!
- Werkboekopdrachten

Bijeenkomst 7 – week 52

- Ervaringenrondje
- Uitwerking thema:
  - Doorzetten/Volhouden!
- Nieuw thema:
  - Evaluatie van het programma
- Werkboekopdrachten

Bijeenkomst 8 – week 78

- Ervaringenrondje
- Evaluatie REDUQ II-programma
- De toekomst
- Afsluiting

N.B. Tijdens alle programmaonderdelen wordt gebruik gemaakt van motiverende gespreksvoering
* Tijdens het ervaringenrondjes worden ervaringen met minderen met roken, NRT, ontwenningsverschijnselen etc. gedeeld. De counselor complimenteert wanneer vooruitgang geboekt is. Als er minder positieve ervaringen of negatieve ervaringen zijn wordt getracht deze te her-etiketteren naar een positieve invalshoek, zodat voorkomen wordt dat de deelnemers zichzelf demotiveren of het roken idealiseren. De deelnemer wordt gevraagd hoe hij/zij het anders zou kunnen aanpakken ("U hebt nu ervaren waar uw uitdagingen liggen, hoe zou u het anders kunnen aanpakken?") en evt. wordt de groep gevraagd oplossingen aan te dragen. De deelnemer/groep moet 'het werk doen', maar het is wel mogelijk om deelnemers in een bepaalde richting te sturen ("Is dit de juiste manier voor u, of zou u het nog beter kunnen aanpakken?").

APPENDIX B: Weekly conducted Questionnaire within Phase B in the REDUQ II Study

Dhr/mw ………………………………........ Geboortedatum …………………….………..
Randomisatienummer…………..
Subgroep: A / B / C / D   Fase: B (13 interviews/metingen)   Metingnummer:
B…….(1 t/m13)
Invuldatum ……………………………………
Interviewer:

1) Bent u van plan om te stoppen met roken in de toekomst?
     O ik ben gestopt met roken, stopdatum: ..……./………/……………… *dd/mm/jjjj*
     O ja, binnen een week
     O ja, binnen een maand, maar niet binnen de komende een week
     O ja, binnen 3 maanden, maar niet binnen de komende maand
     O ja, binnen 6 maanden, maar niet binnen de komende 3 maanden
     O ja, binnen een jaar, maar niet binnen de komende 6 maanden
     O ja, binnen 5 jaar
     O ja, maar niet binnen 5 jaar
     O nee, niet van plan om te stoppen, maar wel om te minderen met roken
     O nee, niet van plan om te stoppen en niet van plan om te minderen met roken
     O weet niet → **Als u toch zou moeten kiezen, wat zou u dan antwoorden op de vraag: bent u van plan**
     om te stoppen met roken?

2) Heeft u de afgelopen 24 uur één of meer sigaretten (shagjes, cigarillo's, sigaren, pijp) gerookt?
     O ja *(ga naar vraag 4)*
     O nee, maar wel een paar trekjes
     O nee, zelfs geen trekje

3) Heeft u de afgelopen 7 dagen één of meer sigaretten (shagjes, cigarillo's, sigaren, pijp) gerookt?
     O ja
     O nee, maar wel een paar trekjes *(ga naar vraag 5)*
     O nee, zelfs geen trekje *(ga naar vraag 5)*

4) Hoeveel sigaretten (shagjes, cigarillo's, sigaren, pijp) heeft u de afgelopen 7 dagen gemiddeld per dag gerookt
     a) op doordeweekse dagen?

………. sigaretten, shagjes, cigarillo's, sigaren, pijp *(doorhalen wat niet van toepassing is en 1 getal noteren)*

b) in het weekend?
……….. sigaretten, shagjes, cigarillo's, sigaren, pijp *(doorhalen wat niet van toepassing is en 1 getal noteren)*

5) Heeft u de afgelopen 24 uur een nicotinehoudende e-sigaret/shisha-pen gedampt?
O ja *(ga naar vraag 7a)*
O nee

6) Heeft u de afgelopen 7 dagen een nicotinehoudende e-sigaret/shisha-pen gedampt?
O ja
O nee *(ga naar vraag 9)*

7) a. Wat is het nicotinegehalte van de vloeistof (e-liquid) die u gebruikt voor uw e-sigaret/shisha-pen?
❑ 6 mg ❑ 12 mg ❑ 18 mg ❑ 24 mg ❑ anders, namelijk…………..mg

b. Wat is de inhoud van een flesje vloeistof (e-liquid) dat u gebruikt?
❑ 7 ml ❑ 10 ml ❑ 15 ml ❑ 30 ml ❑ anders, namelijk…………..ml

c. Hoeveel (flesjes) vloeistof gebruikt u gemiddeld per week?
……………… flesje(s) per week
(Als u geen heel flesje gebruikt dan kunt u hier bijvoorbeeld ook aangeven: de helft (½) een kwart (¼) etc.)

8) Bent u van plan om te stoppen met dampen van de nicotinehoudende e-sigaret/shisha-pen in de toekomst?
O ja, binnen een week
O ja, binnen een maand, maar niet binnen de komende een week
O ja, binnen 3 maanden, maar niet binnen de komende maand
O ja, binnen 6 maanden, maar niet binnen de komende 3 maanden
O ja, binnen een jaar, maar niet binnen de komende 6 maanden
O ja, binnen 5 jaar
O ja, maar niet binnen 5 jaar
O nee, niet van plan om te stoppen, maar wel om te minderen met dampen
O nee, niet van plan om te stoppen en niet van plan om te minderen met dampen
O weet niet → **Als u toch zou moeten kiezen, wat zou u dan antwoorden op de vraag: bent u van plan
om te stoppen met dampen?**

9) Stimuleren mensen in uw omgeving u om blijvend niet te roken *(te stoppen met roken)?*
O veel
O gemiddeld

O weinig

O nee

O niet van toepassing

10) Lukt het u om niet te roken (en indien van toepassing: niet te dampen) in elke situatie die zich kan voordoen?

(Bijvoorbeeld bij stress/spanning, somberheid, kwaadheid, verveling)

O zeker wel

O waarschijnlijk wel

O neutraal/weet niet

O waarschijnlijk niet

O zeker niet

11) a. Op een schaal van 1 (*slecht*) tot 10 (*goed*) vind ik stoppen met roken

1	2	3	4	5	6	7	8	9	10

(omcirkelen wat van toepassing is)

b. Op een schaal van 1 (*ongezond*) tot 10 (*gezond*) vind ik stoppen met roken

1	2	3	4	5	6	7	8	9	10

(omcirkelen wat van toepassing is)

c. Op een schaal van 1 (*onverstandig*) tot 10 (*verstandig*) vind ik stoppen met roken

1	2	3	4	5	6	7	8	9	10

(omcirkelen wat van toepassing is)

d. Op een schaal van 1 (*onplezierig*) tot 10 (*plezierig*) vind ik stoppen met roken

1	2	3	4	5	6	7	8	9	10

(omcirkelen wat van toepassing is)

12) Op een schaal van 1 (*helemaal oneens*) tot 10 (*helemaal eens*): in hoeverre bent u het eens met de volgende
stelling:

Alleen voor rokers: Binnen de komende 6 maanden stoppen met roken, past bij wie ik ben.

1	2	3	4	5	6	7	8	9	10

(omcirkelen wat van toepassing is)

Alleen voor niet-rokers: Binnen de komende 6 maanden niet roken, past bij wie ik ben.

(omcirkelen wat van toepassing is)

1	2	3	4	5	6	7	8	9	10

13) a. Op een schaal van 1 (*helemaal geen*) tot 10 (*heel veel*): hoeveel **trek** in een sigaret heeft u de afgelopen 7
dagen gehad?

(omcirkelen wat van toepassing is)

1	2	3	4	5	6	7	8	9	10

b. Op een schaal van 1 (*helemaal niet*) tot 10 (*heel erg*): hoe **gemotiveerd** bent u om rookvrij te worden
(als u nu rookt) of te blijven *(als u gestopt bent/rookvrij bent)?*

1	2	3	4	5	6	7	8	9	10

(omcirkelen wat van toepassing is)

c. Op een schaal van 1 *(helemaal niet)* tot 10 *(heel veel)*: hoeveel **vertrouwen** heeft u dat het u lukt om rookvrij
te worden (als u nu rookt) of rookvrij te blijven (als u gestopt bent/rookvrij bent)?

(omcirkelen wat van toepassing is)

1	2	3	4	5	6	7	8	9	10

14) a. Heeft u de afgelopen 7 dagen hulpmiddelen of methoden gebruikt bij het minderen of stoppen met roken?

U kunt hierbij bijvoorbeeld denken medicatie zoals nicotinevervangers of receptgeneesmiddelen, een cursus

of training, ondersteuning door een arts/hulpverlener, folders of boeken etc.

O ja *(ga door naar vraag 14b)*

O nee *(einde van de vragenlijst)*

b.

O Niet-roken cursus of groepstherapie
  (anders dan deelname aan REDUQ II-studie)

O Nicotinekauwgom

O Nicotine pleisters

O Nicotine zuigtabletten

O Nicotine microtabs (tabletje voor onder de tong)

O Zyban (bupropion)

O Champix (varenicline)

O Nortrilen (nortriptyline)

O Met de huisarts (of praktijkondersteuner)
  gesproken over stoppen met roken

O Acupunctuur

O Lasertherapie

O Telefonische ondersteuning

O Folder

O Boek (bijvoorbeeld Allen Carr)

O Andere hulpmiddelen of methodes, namelijk:

....
.

c. Bij gebruik nicotinevervangers en/of stoppen-met-rokenmedicatie (Zyban, Champix, Nortrilen) graag

naam, sterkte en dosering

vermelden……………………………………………………………………………………………
……………………......
……
………………………………………………………………......

15) a. Op een schaal van 1 **(helemaal niet)** tot 10 **(heel goed)**, lukt het u om te roken op vaste tijden, m.a.w. om u

aan uw rookschema te houden?

1	2	3	4	5	6	7	8	9	10

O niet van toepassing, ik rook niet meer (einde interview/vragenlijst)