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Mechanisms behind the success of exercise as an adjunct quit smoking aid

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Abstract

It is well documented that temporarily abstinent smokers who undergo an acute bout of moderate intensity exercise experience a reduction in nicotine craving and withdrawal. Conversely, available research in chronic exercise and smoking cessation does not reliably demonstrate that combining exercise with well established treatments increases smoking abstinence rates. The overall aim of this dissertation was to investigate mechanisms underlying the beneficial effects of exercise in a group of female smokers taking part in a 14 week exercise plus nicotine replacement therapy (NRT) patch programme. Determining how smokers may benefit from exercise has important implications for designing effective interventions. Three independent yet related studies were conducted. The specific aims of study one (Chapter two) were to determine whether an acute bout of exercise would further reduce craving and withdrawal symptoms in a group of female quitters using NRT, and to explore whether the magnitude of this relief would relate to quit success. It was demonstrated that exercise provided additional craving and withdrawal benefit for these quitters. Magnitude of relief was not found to be related to end of programme quit status. Study two (Chapter three) sought to examine what bearing exercise expectancy (EXP) and credibility (CRED) beliefs of recently quit smokers had on self-reported craving and withdrawal following an acute bout of exercise, and to compare participants' beliefs regarding NRT and exercise as quit smoking aids. Results showed that high exercise EXP and/or exercise CRED were found to be related to craving relief. Participants believed both NRT and exercise to be effective cessation aids. Study three (Chapter four) examined whether participants reported using exercise as a relapse prevention aid, and how readily these two behaviours can be concurrently changed. It was demonstrated that participants were able to simultaneously increase their exercise behaviour and decrease their smoking behaviour.

Exercise was not reportedly used as a relapse prevention strategy. Overall, the results of these studies provide evidence that exercise is a worthwhile adjunct smoking cessation treatment, and elucidate some of the reasons as to how it may help individuals quit smoking. The clinical implications of the findings are discussed throughout.

Keywords: Exercise, smoking cessation, withdrawal, craving, relapse, coping, expectancy, credibility, nicotine replacement therapy.

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CHAPTER ONE: GENERAL INTRODUCTION

1.1 A short history of the tobacco problem

Nicotiana tabacum is native to the Western Hemisphere, and in Native American culture tobacco was frequently used for religious and recreational purposes. In the 16th and 17th centuries Spanish and Portuguese travellers brought tobacco back from the Western Hemisphere as a novelty. During this colonial era tobacco use spread, as the Portuguese cultivated tobacco wherever they had trading colonies. Interestingly, during this time tobacco was used as a form of currency or an exchange medium. Indeed, George Washington, the first president of the United States (U.S.) is said to have paid the rent on his farm with tobacco (TTS, 2010).

A number of developments, when taken together, led to the widespread cigarette use seen today. Around 1835, novel approaches to tobacco processing taking place in North Carolina, led to the development of the flue-cured process. This process chemically changed the tobacco, making it less harsh and easier to inhale. By the 1870's a market for flue-cured tobacco had developed, such that factories making hand rolled cigarettes began to appear. In the 1880's, Buck Duke obtained the rights to a cigarette making machine, which quickly replaced hand rollers. With this machine, Duke was able to lower the costs of cigarette production and soon bought out all the competition. The problem for Duke then became that he was able to produce far more cigarettes than there was a market for. To expand the existing market he did two things: (1) he advertised to get new cigarette smokers (at this stage mostly young men); and (2) he sought overseas markets. During this period, improvements in railroads were made, safety matches were invented, and mass media began in the

form of nationally circulated magazines; all of which contributed to the rise of the cigarette (TTS, 2010).

From the early 1900's until the 1950's cigarette use rose rapidly with no real serious opposition from medical or public health groups. In 1950, U.S. and British case control studies began to emerge, linking cigarettes to lung cancer. In the late 1950's, British American Tobacco commissioned a team of scientists to investigate the problem of lung cancer and smoking. Without exception, these scientists concluded that cigarettes were a cause of lung cancer. For the first time public perception of tobacco began to change and people attempted to quit smoking. From the 1950's until present day the battle rages between the public health system and the tobacco companies. Despite tobacco companies actively opposing public health measures, slowly the public health side seems to be gaining important ground (TTS, 2010).

1.2 Damage caused by smoking and the benefits of quitting

Smoking is the leading preventable cause of death worldwide (USDHHS, 2004). It is estimated that, in the United States alone, each day more than 1200 people die from smoking cigarettes. No doubt about it, smoking kills. Adults who smoke will on average lose 13 years of their life, and half of all lifetime smokers will die early because they started, and continued to smoke (USDHHS, 2004)

Lung cancer was one of the first diseases found to be caused by smoking. Since the 1960's, the number of cancers linked to smoking has grown to include: mouth, throat, larynx, esophagus, pancreas, kidney, bladder, stomach, cervix, and acute myeloid leukemia. Smokers are about 20 times more likely to develop lung cancer than non-smokers and the vast majority of lung cancer cases are a result of cigarette smoking (USDHHS, 2004).

Heart disease and stroke are cardiovascular diseases caused by smoking. Coronary heart disease is the leading cause of death in middle and high income countries (WHO, 2008). Compared to non-smokers, smokers are four times more likely to die from heart disease. Smoking harms lung health and causes injury to lung tissues. This tissue damage leads to chronic obstructive pulmonary disease (COPD). COPD is the third and fourth leading cause of death in middle and high income countries and 90% of deaths related to COPD are caused by smoking (USDHHS, 2010; WHO, 2008). Sudden respiratory illnesses, such as bronchitis or pneumonia are cause by viral or bacterial infections. Smokers have more upper (nose, throat, and larynx) and lower respiratory (below the larynx) tract infections than non smokers. This is because smoking damages the body's defences against infection (USDHHS, 2004).

In general, smokers are less healthy than non-smokers. As well as being more likely to suffer from cancer, cardiovascular disease, and respiratory illness, smokers are also more likely to experience: (1) absence from work; (2) dental disease; (3) difficulty with wound healing; (4) hip fractures; (5) reproductive difficulties; (6) an increased risk of cataracts, a leading cause of blindness; and (7) peptic ulcers (USDHHS, 2004). The economic costs of smoking to the health system are astronomical. It is estimated that between 1995 – 1999, in the United States each year, the cost of smoking was $157.7 billion (USDHHS, 2004).

It is considered never too late to quit smoking, and the benefits of doing so are great. For example, a year or two after quitting, the excess risk of developing heart disease as a result of smoking may be reduced by 50% (USDHHS, 1990; USDHHS, 2001). In addition, people who quit smoking after having a heart attack are less likely to die within the next 10 years compared to those who continue to smoke (USDHHS, 1990). Five to 15 years post quit the chances of stroke are the same as those

who have never smoked (USDHHS, 1990). Quitting reduces the risk of lung cancer such that, ten years after quitting the risk of developing lung cancer is 30 – 50% that of the risk of those who smoke (USDHHS, 1990). Quitting also increases life expectancy, and the sooner the smoker quits the greater the number of years in life expectancy gained (USDHHS, 1990).

1.3 How bad is the problem today?

Despite the morbidity and mortality risks, a proportion of the population continue to smoke. It is estimated that 18% of the Canadian population aged 15 years or older smoke. More males (20%) report smoking than females (16%) (CTUMS, 2008). In the U.S., the prevalence rates are comparable. In a recent U.S. National Health Interview Survey, 20.6% of adults over 18 years of aged reported smoking (CDC, 2007). Twenty three percent of men were smokers compared to 18.3% of women (CDC, 2007). Increased tobacco use is associated with a number of socio-demographic factors, such as: low socio-economic status, ethnicity, and low education level (CDC, 2007; CTUMS, 2008).

1.4 What makes quitting smoking difficult?

In human nature there is a strong tendency to maintain a steady state and to resist change, and change when it comes to smoking, takes a great deal of work (TTS, 2010). Smoking behaviour is influenced by biological, psychological, and social factors.

Nicotine is the addictive substance found in cigarettes. Once an individual becomes dependent on nicotine physical cravings develop in response to a decrease in the body's level of nicotine (TTS, 2010). This dependence also has a psychological component; a nicotine deprived individual becomes pre-occupied with thoughts of smoking. In addition, nicotine is a psychoactive substance and has various effects on the central nervous system. Smokers will light another

cigarette to reduce the nicotine withdrawal symptoms that accompany nicotine abstinence. These withdrawal symptoms are many and varied and include: anxiety, depression, irritability, difficulty concentrating, difficulty sleeping, decreased heart rate, increased appetite and weight gain, and dizziness (American Psychiatric Association, 1994).

Smokers continue to smoke for the immediate positive consequences they come to expect. This positive expected benefit of smoking and the learned habit of continual pairing smoking with positive outcomes creates a psychological dependence on smoking (Abrams, Niaura, Brown, Emmons, Goldstein, & Monti, 2003). Smoking becomes a form of self-medication to cope with everyday life (Abrams et al., 2003). Smokers may use smoking to accomplish specific goals, such as: to relax, to control weight, to cope with boredom, or to feel less awkward in a social situation (TTS, 2010).

For many smokers cigarettes become integrated into social aspects of their lives. People smoke in a wide array of social settings (both positive and negative), and as a consequence, smoking becomes ingrained into many situations and events. In this way, smoking is associated with family, friends and identity. For instance, people smoke with their husbands or wives and it becomes part of their relationship. Smoking becomes a way of being connected to others and a way of expressing feelings toward others (e.g., light up a cigarette to express anger) (TTS, 2010). The complex interaction of the biopsychosocial pull of cigarettes makes it incredibly difficult for nicotine dependent individuals to quit smoking.

1.5 Smoking cessation interventions

For over 50 years health practitioners have been working to determine how best to treat nicotine dependence (USDHHS, 2010). Much work has

been done in this area and a good set of Clinical Practice Guidelines exist, developed by The Public Health Service (PHS) in the U.S. (Fiore, Jaen, & Baker, 2008). Smoking cessation is treated with interventions at the individual level and policy level interventions. The research contained with this dissertation concerns the individual. The best practice evidence based information will be presented.

1.5.1 Evidence-based cessation interventions for the individual

Cognitive behavioural interventions such as individual, group, and telephone counselling can dramatically increase the likelihood of quit success over and above attempting to quit unassisted. The chances of quitting successfully with these types of interventions increases with the number of different types of counselling formats utilised, the intensity and duration of the counselling sessions, as well as the number of counselling sessions completed (Fiore et al., 2008). Pharmacotherapy (e.g., nicotine replacement therapy, bupropion, varenicline) has been shown to double a smokers' chance of quit success. Combining pharmacotherapy with cognitive behavioural therapy increases a smokers' chance of quitting successfully even further. Research suggests that emerging technologies (e.g., web assisted interventions) may provide a promising modality in which to offer cessation services with a broad reach (Fiore et al., 2008) (Table 1.1).

Table 1.1. Chances of quit success at six months compared to treatment strategy (Fiore et al., 2008; West & Shiffman, 2007).

Cessation strategy	Maintained abstinence at six months (%)
Unassisted	4 – 7
Physician advice	10
Tailored online intervention	7 – 10
Individual cognitive behavioural therapy (CBT)	9 – 12
Group CBT	9 – 12
Telephone support	11 – 14
Pharmacotherapy	
Nicotine patch	15
Nicotine gum	19
Nicotine lozenge	16
Bupropion	20
Varenicline	23
Combined pharmacotherapy with CBT	25 – 33

1.5.2 Population-based interventions to promote cessation

Research has established that mass media campaigns can increase smoking cessation rates, particularly when they are part of a comprehensive tobacco control programme. For example, a study by Biener et al. (2006) surveyed a group of smokers and recently quit smokers. They found that most smokers reported an awareness of anti-tobacco advertisements on television and 30% of recent quitters surveyed reported these advertisements contributed to their quitting (Biener, Reimer, Wakefield, Szczypka, Rigotti, & Connolly, 2006).

A number of population level policy strategies have been implemented in an attempt to control the tobacco problem. For example, numerous studies have shown that tax increases and smoke-free policies (e.g., banning smoking in public places) reduce adults smoking rates and indirectly impact smoking initiation by changing social norms. Tax increases and smoke-free policies have been more effective at reducing smoking rates than any other intervention (Farrelly, Pechacek, Thomas, & Nelson, 2008; TTS, 2010).

1.5.3 Alternative smoking cessation interventions

A number of alternative smoking cessation interventions exist including: acupuncture, laser therapy, and hypnotherapy. A recent Cochrane review concluded that there is not enough evidence to definitively state that acupuncture or related techniques such as, electro-stimulation or laser acupuncture therapy, successfully improve quit smoking rates (White, Rampes, Liu, Stead, & Campbell, 2011). However, these authors also state that there is not enough evidence to dismiss the possibility that acupuncture may be a more effective quit smoking strategy than a placebo (White et al., 2011). A Cochrane review of the hypnotherapy literature found insufficient evidence to support its effectiveness as a quit smoking aid (Barnes, Dong, McRobbie, Walker, Mehta, & Stead, 2010).

1.5.4 Smoking cessation intervention summary

Population based indirect approaches that help smokers reduce or eliminate their tobacco use are effective. However, population based interventions can only do so much and it is essential that smokers are also provided with individual tobacco treatment. Effective smoking cessation programmes exist and have come a long way in the last 15 years (TTS, 2010). However, quit rates at six months, even with comprehensive programmes that include both pharmacotherapy and cognitive behavioural therapy have limited success (Table 1.1). Currently, there is insufficient evidence for alternative smoking cessation treatment strategies. Therefore, the importance of identifying adjunct therapies that improve and sustain quit smoking rates should be emphasised.

1.6 Exercise – a novel evidence based smoking cessation aid

Exercise has been proposed as an adjunct smoking cessation aid. Overall, of all the quit smoking adjuncts, exercise stands out as being the most evidence based. Two excellent reviews of the exercise and

smoking cessation literature have been conducted: (1) on the acute effects of exercise on craving, withdrawal, affect, and smoking behaviour (Taylor, Ussher, & Faulkner, 2007); and (2) on the effects of chronic exercise interventions on smoking cessation rates (Ussher, Taylor, & Faulkner, 2008). The following two sections will outline the key findings of these reviews and add to them.

1.6.1 Acute exercise evidence based studies

In a recent review of the acute exercise and smoking literature, Taylor and colleagues (2007) found that nine out of ten studies showed exercise to reduce cigarette cravings during temporary smoking abstinence (moderate to large effect sizes [ES] between 0.50–4.6). Significant reductions in desire to smoke have been observed for different intensities and types of exercise. For example, isometric exercise of a very low intensity and duration (five minutes) has been shown to reduce the urge to smoke by 0.7 on a seven point scale (ES = 0.29)(Ussher, West, Doshi, & Sampuran, 2006); whereas 15-20 minutes of self-paced walking reduced the urge to smoke by 4.6 on the same scale (ES = 3.7) (Taylor, Katomeri, & Ussher, 2005). In addition, longer periods of exercise (e.g., approximately 15 minutes of brisk walking) at a light to moderate intensity have been shown to delay ad libitum smoking by up to 50 minutes, even when the individual is presented with a challenging mental task or a lit cigarette (Taylor & Katomeri, 2006; Taylor & Katomeri, 2007; Taylor et al., 2005).

The magnitude of the reduction in cravings is encouraging and comparable with an acute response to oral nicotine replacement therapy (NRT) (Taylor et al., 2007). In 2001, West and Shiffman conducted a review of the acute effects of oral NRT on craving and withdrawal. Although many of the studies included in this review did not report effect sizes, it is possible to conclude that the reduction in desire to smoke and withdrawal following an acute bout of exercise is

comparable to that of oral NRT. In addition, the effect of exercise on craving is faster than oral NRT. Temporarily abstinent smokers who engage in a brief bout of exercise, even just five minutes of isometric exercise (Ussher et al., 2006), experience some relief immediately whereas it takes approximately 20 minutes for oral NRT to result in craving relief (West & Shiffman, 2001).

In terms of the withdrawal symptoms related to nicotine abstinence, Taylor and colleagues (2007) found eight out of nine studies reported a significant reduction in at least two withdrawal symptoms when the exercise group was compared to a control group. The withdrawal symptoms shown to be reduced by an acute bout of exercise include: stress, anxiety, tension, poor concentration, irritability, and restlessness (Taylor et al., 2007). However, it should be noted that an acute bout of exercise does not always successfully reduce all nicotine withdrawal symptoms experienced by temporarily abstinent smokers (Taylor et al., 2007).

Although results from the acute exercise and smoking paradigm are promising, this body of research has two inherent flaws that are worth mentioning. First, the majority of studies include temporarily abstinent smokers rather than people undergoing a real quit attempt. Therefore, the severity of symptoms experienced may not correspond entirely with those felt when a smoker is fully invested in their quit attempt. Second, acute studies often take place within a laboratory setting. Such an artificial environment bears little resemblance to actual scenarios in which a smoker attempting to quit may find themselves. These two flaws raise questions about the ecological validity of these studies and their findings.

1.6.2 Chronic exercise evidence based studies

The results of the chronic exercise and smoking cessation literature are not as promising or perhaps just not as clear cut as those obtained in the acute exercise and smoking cessation research. The current literature does not reliably show that chronic exercise interventions improve smoking cessation rates long-term. However, there is also no evidence to suggest that exercise interventions undermine smoking cessation (Fiore et al., 2008; Ussher et al., 2008).

The study with perhaps the most promising results to date was conducted in 1999 by Marcus and colleagues. In this study, participants engaged in a cognitive behavioural support programme combined with either: vigorous intensity exercise three times per week or equal contact time health education lectures. At the end of the 12 week programme, those in the exercise group had significantly higher levels of continuous abstinence compared to the control group. This same pattern of results was evident at three and 12 month follow-up. This led the authors to conclude that vigorous exercise when combined with cognitive behavioural smoking cessation support facilitates smoking cessation (Marcus, Albrecht, King, Parisi, Pinto, Roberts, Niaura, & Abrams, 1999). Following on from this work, studies that have administered moderate intensity exercise rather than vigorous intensity exercise have had mediocre results. Herein lies an intriguing disparity between the chronic and acute literature. That is, intensive exercise studies demonstrate that a vigorous programme of exercise yields better results than those that use a moderate intensity paradigm (Marcus et al., 1999; Prapavessis, Cameron, Baldi, Robinson, Borrie, Harper, & Grove, 2007) whereas in an acute exercise paradigm moderate intensity exercise appears to have an effect on craving and withdrawal which is as good if not better than a bout of vigorous intensity exercise (Taylor et al., 2007). It is possible that this disparity is related to poor adherence in intensive exercise programmes (Marcus,

Lewis, Hogan, King, Albrecht, Bock, Parisi, Niaura, & Abrams, 2005; Ussher, West, McEwen, Taylor, & Steptoe, 2003). Recently, Williams et al. (2010) sought to overcome the issue of poor adherence and determine if moderate intensity exercise would produce positive smoking cessation outcomes (Williams, Whiteley, Dunsiger, Jennings, Albrecht, Ussher, Ciccolo, Parisi, & Marcus, 2010). The findings from this trial indicate that if adherence is adequate, moderate intensity exercise may enhance the efficacy of a programme that combines the nicotine patch and cessation counselling. Although, the authors note that the study findings are preliminary and a larger trial is needed. If these results can be replicated it has important implications for chronic exercise interventions. Namely, a moderate intensity exercise programme is likely to be better tolerated amongst sedentary smokers than a vigorous intensity exercise programme and thus, more likely to be maintained.

Recently, Abrantes and colleagues (2009) compared the quit rates of exercisers vs. non-exercisers following either 12 weeks of bupropion or placebo. They found that at the end of a 12 week course of bupropion abstinence rates were not significantly higher between regular exercisers (43.1%) and non-exercisers (42.4%). However, smokers in the placebo condition who exercised regularly (36.9%) were significantly more likely to be smoke free at the end of the programme than their non-exercising counterparts (24.1%) (Abrantes, Strong, Lloyd-Richardson, Niaura, Kahler, & Brown, 2009). From this the authors concluded that exercise may a particularly useful smoking relapse strategy, thereby providing another dimension to exercise effects on smoking behaviour (Abrantes et al., 2009).

Looking at the chronic exercise and smoking cessation literature as a whole, the results are mixed. However, it is important to mention that studies that do not support exercise as an adjunct smoking cessation

aid may be limited by: (1) small sample size; (2) poor adherence to the exercise programme; (3) inadequate duration of the exercise programme; (4) little instruction as to how exercise might be of benefit during nicotine abstinence; and (5) lack of generalisability due to recruitment of a predominantly white sedentary sample (Marcus et al., 1999; Ussher et al., 2008). Considering the large number of studies that report the utility of exercise to acutely reduce craving and withdrawal and the studies that report some positive results in the chronic literature, it is reasonable to suggest that some smokers may derive benefit from exercise when combined with well established smoking cessation aids (e.g., CBT and pharmacotherapy).

1.6.3 Summary of exercise as a smoking cessation aid

There is little doubt that in a laboratory setting, with temporarily abstinent smokers (ranging from three hours to 18 hours) an acute bout of moderate intensity exercise (ranging from ten minutes to 30 minutes) can alleviate craving and withdrawal symptoms associated with nicotine deprivation (Taylor et al., 2007). Conversely, available research in chronic exercise and smoking cessation does not reliably demonstrate that combining exercise with well established treatments increases smoking abstinence rates (Ussher et al., 2008). To elucidate why this contradiction between laboratory studies and exercise based interventions exists, and to improve abstinence rates in an exercise aided quit smoking programme, investigation of exercise mechanisms of action on smoking cessation may be worthwhile. Determining why and how exercise works may increase the effectiveness of exercise as a smoking cessation aid.

1.7 Possible mechanisms and individual factors involved in the effects of exercise as a smoking cessation aid

Although the literature is not extensive, studies researching the mechanisms and individual differences involved in exercise effects on

smoking cessation have been conducted, and are presented in the following sections.

1.7.1 Shifts in attentional focus

Approximately 60% of smokers report poor concentration as a nicotine withdrawal symptom (McEwen, Hajek, McRobbie, & West, 2006). There is evidence to suggest that after a period of 12 hours without nicotine a smoker will have difficulty concentrating on tasks that were previously uncomplicated, which has been shown to lead to increased injury rates (Waters, Jarvis, & Sutton, 1998). In the general population exercise has been shown to enhance executive control processes, the same processes involved in concentration (Kubesch, Bretschneider, Freudenmann, Weidenhammer, Lehmann, Spitzer, & Grön, 2003). Exercise might work to improve concentration during nicotine withdrawal by shifting attentional bias away from the urge to smoke. In this way it may increase attentional capacity towards the task at hand and ultimately reduce the withdrawal symptom of poor concentration (Janse Van Rensburg & Taylor, 2008).

Janse Van Rensburg and Taylor (2008) sought to objectively measure cognitive performance in terms of 'poor concentration' amongst temporarily abstinent smokers. To do this, participants completed the computerised version of the Stroop (1935) colour-word interference task on two separate occasions. Following 15 hours of abstinence they completed the Stroop (1935) task after either a passive control condition where they sat for 15 minutes or an exercise condition where they walked on a treadmill for 15 minutes at a self-pace. Contrary to their hypothesis – exercise did not enhance cognitive functioning, relative to the passive control condition (Janse Van Rensburg & Taylor, 2008). The authors offer a number of plausible explanations as to why they believe exercise did not have a positive influence on cognitive function in this instance (see Janse Van Rensburg and Taylor, 2008 for

details). Ultimately, these researchers conclude that while exercise did not affect cognitive functioning, given the limitations, future research in this area is warranted.

Continuing on from this work, shifts in attentional focus have been investigated as a possible mechanism underlying the effects of exercise on craving and withdrawal (Janse Van Rensburg, Taylor, & Hodgson, 2009). Research has demonstrated that smokers show an enhanced attentional bias towards smoking cues (Waters, Shiffman, Bradley, & Mogg, 2003). For instance, a recently quit smoker may find themselves inadvertently staring at a person smoking a cigarette. It is postulated that when attentional bias toward smoking related cues increases so too does craving. It is also suggested that this attentional bias-craving relationship is associated with relapse. (Waters et al., 2003) Therefore, attentional bias toward smoking related cues is implicated as a mechanism for craving, and it was proposed by Janse Van Resburg et al. (2009) that exercise may diminish this relationship. The aim was to determine if 15 minutes of moderate intensity exercise (vs. passive sitting) had the ability to shift attentional focus away from smoking related images amongst temporarily abstinent smokers, as well as to examine the relationship between attentional bias and cigarette craving (Janse Van Rensburg et al., 2009). To measure attentional bias, a randomised cross-over design was utilised, and participants were shown matched paired smoking and neutral images (e.g., hand holding a cigarette and hand holding a pen). Percentage of dwell time and direction of initial fixation was measured through an eye-tracking system. It was demonstrated that: (1) exercise significantly reduced the amount of time spend looking at smoking images (percent dwell time); (2) exercise significantly reduced the tendency for participants to initially gravitate towards the smoking image; and (3) a negative correlation existed between initial image fixation and craving. This led the authors to conclude that exercise reduced

abstinent smokers' attentional bias towards environmental smoking triggers, and may be one mechanism by which exercise alleviates cigarette craving (Janse Van Rensburg, Taylor, Hodgson, & Benattayallah, 2009). Contrary to previous studies these researchers found a negative relationship between craving and smoking salient cues. They hypothesised that this was perhaps a limitation of the images shown. That is, the images may have been too similar (i.e., hand holding a pen vs. hand holding a cigarette) and there may not have been enough time for participants to quickly differentiate between them. Also, perhaps this postulated mechanism is subject to individual differences, whereby it is the mechanism of action for some smokers but not others. As an example of this, McRobbie and colleagues found that when attempting to quit, some smokers found the smell of cigarettes pleasant and others did not, and this preference was not related to relapse (McRobbie, Hajek, & Locker, 2008).

Additional work in this area by Janse Van Rensburg and colleagues (2009) was conducted with the primary aim of assessing the effects of 10 minutes of moderate intensity exercise (cross-over design, exercise vs. seated passive control condition) on regional brain activation (functional Magnetic Resonance Imaging [fMRI]), amongst temporarily abstinent smokers while being exposed to smoking cues (i.e., smoking images). At baseline, this group of abstinent smokers showed an increased activation in brain areas associated with cravings and visuospatial attention (i.e., orbitofrontal cortex and caudate nucleaus). Interestingly, following 10 minutes of exercise this same group had no such brain activation when presented with the same images. These researchers suggest that an acute bout of moderate intensity exercise may reduce cravings by shifting brain activation away from areas involved in the urge to smoke when in the presence of smoking triggers.

1.7.2 Alleviates weight gain and weight gain fears

Nicotine has been found to have powerful effects on the regulation of body weight. When a smoker quits it can lead to physiological pressure to gain weight (Grunberg & Bowden, 1985). The weight gain associated can have negative psychological consequences for the quitter and result in resumption of smoking (Brownell, Marlatt, Lichtenstein, & Wilson, 1986; Schneider & Waters, 2007). A recent review of exercise interventions for smoking cessation found that such programmes do not consistently report an end of programme reduction in weight gain (Ussher et al., 2008). For example, Prapavessis et al. (2007) found that during and immediately following a 12 week quit smoking programme, weight gain was attenuated to a greater extent in the exercise group (vigorous intensity) when compared to those that received cognitive behavioural therapy only (Prapavessis et al., 2007). In contrast, Ussher et al. (2003) found no different in post intervention weight gain between a brief exercise counselling group and a health counselling group. However, perhaps Ussher et al. (2003) found no difference because the exercise group were not exercising at a vigorous intensity (84% of participants were exercising at a moderate intensity). In this instance, the potential for exercise to moderate weight gain post smoking cessation may have been mitigated (Ussher et al., 2003). Therefore, the utility of exercise to reduce post cessation weight gain may be dependent on the type of exercise engaged in. Regardless, the general pattern of results seems to be that, at best, exercise interventions may delay post cessation weight gain but at six month and one year follow-up there will be no difference between exercise and other groups (Ussher et al., 2008).

In addition to actual weight gain, smoking specific weight concern (SSWC), the belief that smoking maintains weight and that quitting smoking will result in weight gain, has been investigated as a factor that may influence the success of an exercise smoking cessation

programme (Schneider & Waters, 2007). SSWC has been shown to be a barrier to cessation, is implicated in relapse to smoking, and has been shown to exacerbate negative affect during a quit attempt (Pinto, Borrelli, King, Bock, Clark, Roberts, & Marcus, 1999; Schneider & Waters, 2007). In a cross-sectional study, Schneider et al. (2007) found that women who were higher in SSWC, who were also exercising, had less of an increase in negative affect one week post quit; whereas there was no relationship between change in negative affect and exercise amongst women who were low in SSWC. From this, these researchers concluded that SSWC may be a moderating factor in determining who gets the most affective benefit from exercise. As such, perhaps exercise works as a mechanism to counter SSWC amongst abstaining smokers who have high levels of SSWC thereby enabling them to better tolerate and resist relapse when faced with typical post cessation weight gain.

1.7.3 Alleviates mood disturbance

There is much evidence to suggest that negative affect maintains smoking behaviour and thwarts quit attempts (Tart, Leyro, Richter, Zvolensky, Rosenfield, & Smitts, 2010). Smokers with a history of major depression or those who are high in negative affect are very likely to relapse (TTS, 2010). Accordingly, psychological and pharmacological smoking cessation programmes that successfully reduce negative affect show improved abstinence outcomes amongst their clients (Haas, Munoz, Humfleet, Reus, & Hall, 2004; Richmond & Zwar, 2003).

Exercise has been shown to have affect regulatory effects in both the general population and amongst those with major depression (Focht, Knapp, Gavin, Raedeke, & Hickner, 2007; North, McCullagh, & Tran, 1990). There is also some evidence that exercise can reduce this nicotine withdrawal side effect (negative affect) in nicotine deprived smokers (Bock, Marcus, King, Borrelli, & Roberts, 1999; Schneider & Waters, 2007; Taylor et al., 2007). In a recent cross-sectional study

conducted by Tart and colleagues (2010) negative affect was shown to partially influence the positive effects of vigorous exercise on smoking. In contrast, Daniel et al. (2006) found that a reduction in cigarette craving experienced by temporarily abstinent smokers following 10 minutes of moderate intensity exercise was not due to exercise effects on mood. They reached this conclusion as they found no significant relationship between negative affect, positive affect, and desire for a cigarette (Daniel, Cropley, & Fife-Schaw, 2006).

In addition to negative affect, Tart and colleagues (2010) also investigated the role anxiety sensitivity might play in the exercise-smoking-negative affect relationship. Anxiety sensitivity (AS) refers to the fear of experiencing sensations associated with anxiety (e.g., rapid heart beat, sweating, nausea) (Tart et al., 2010). These researchers found that people who were high in AS were more likely to smoke when they experienced negative affect. It was also demonstrated that the relationship between vigorous intensity physical activity, smoking, and negative affect was stronger for individuals considered high in AS compared to those who were low in AS. These results suggest that smokers who are high in AS may derive greater benefit in vigorous exercise as a way to alleviate the negative affect associated with nicotine deprivation, which may in turn help them quit smoking.

In 2006 Everson et al. conducted a study to see if exercise could induce a reduction in craving and withdrawal amongst a group of adolescents (16-19 years old) who were temporarily abstaining from cigarettes. Interestingly, they found that during ten minutes of cycling in a lab setting the moderate intensity exercise group experienced a greater degree of negative affect when compared to individuals in the placebo control condition (Everson, Daley, & Ussher, 2006). The group of adolescents chosen to take part in the study were all relatively sedentary and the researchers postulate that this group may have

found the moderate intensity exercise task demanding and distressing (Everson et al., 2006).

In 2008 this same group of researchers conducted a study to determine the differential effects of 10 minutes of vigorous versus moderate intensity exercise on craving and withdrawal in a group of temporarily abstinent young adults (18-25 years old). They found vigorous intensity exercise to be associated with adverse mood outcomes during the exercise bout. Despite this, when compared to the control group, both the vigorous and moderate intensity exercise groups showed a reduction in craving, both during the exercise bout and five minutes following the exercise bout (Everson, Daley, & Ussher, 2008). These two studies in concert bring to light a few considerations: (1) exercise mechanisms may differ between adolescents and adult smokers trying to quit; (2) for adolescents, if exercise helps them to quit long-term it may not be because of acute post-exercise reduction in craving and withdrawal symptoms; and (3) exercise might alter craving and withdrawal through different mechanisms.

It is evident amongst non-smokers that exercise decreases physiological and psychological responses to stress (Hughes, 1984; Sinyor, Schwartz, Peronnet, Brisson, & Seraganian, 1983). Lack of an alternative method for coping with stress is often cited by smokers as a reason for failed quit attempts (Shiffman, Kassel, Gwaltney, & McChargue, 2005). For temporarily abstinent smokers, self-paced walking has been shown to reduce tension both during the walk and up to 20 minutes after (Taylor, Katomeri, & Ussher, 2006). In this same study, exercise was shown to reduce craving up to 20 minutes after the brisk walk and this effect was found to be partially due to a reduction in tension (emotional stress) (Taylor et al., 2006). Therefore, the authors suggested that exercise can reduce the stress experienced during temporary abstinence which may in turn reduce the urge to smoke (Taylor et al., 2006).

1.7.4 Distraction

Tobacco treatment specialists often recommend that smokers trying to quit use distraction as a technique to deal with the intense urge to smoke a cigarette (TTS, 2010). The idea being that if the smoker redirects their attention toward something else, then the urge will pass without them breaking their resolve (TTS, 2010). Daniel et al. (2006) conducted a study to determine if the influence of an acute bout of exercise on craving and withdrawal symptoms was due to distraction. Temporarily abstinent smokers were required to either: (1) cycle at a moderate intensity for ten minutes (40-60% HRR); or (2) engage in a cognitively distracting task for 10 minutes. The distraction task involved sequentially adding numbers, at a rate of one per second as they appeared upon a screen. The exercise group demonstrated a significant reduction in withdrawal symptoms immediately during and after exercise when compared to baseline. In contrast, when compared to baseline, the cognitive distraction group did not demonstrate any difference in withdrawal symptoms and desire to smoke. Therefore, the authors concluded that cognitive distraction is not one of the main mechanisms responsible for acute exercise effects on craving and withdrawal. There is one important limitation of this study that is worth noting. That is, the authors postulated that the distraction task in this instance may have been too difficult for some people, and as such, rather than simply being distracting it may have been anxiety producing.

Taylor and Katomeri (2007) agreed with Daniel et al. (2006) in that distraction is not the main mechanism by which exercise works. These researchers found that following 15 minutes of light to moderate intensity exercise, followed by two mentally demanding tasks (Stroop colour word inference task and a speech task), temporarily abstinent smokers did not demonstrate an increase in craving in the presence of a lit cigarette. Additionally, an acute bout of exercise delayed the urge

to smoke for 50 minutes post exercise. Therefore, these researchers believe that the evidence does not support distraction as a mechanism. Namely, because it is difficult to comprehend that the distracting effects of 15 minutes worth of exercise could last as long as 50 minutes (Taylor & Katomeri, 2007).

In 2006 Ussher et al. compared five minutes of isometric exercise to five minutes of body scanning (relaxation technique). Up to five minutes post intervention both groups experienced a reduction in craving and withdrawal. They suggested that the short lived craving and withdrawal reduction demonstrated for both groups may implicate distraction as a plausible mechanism in this instance (Ussher et al., 2006). Considering these studies collectively, it is possible that distraction may play a small role in the mechanistic effects of exercise early on in the exercise bout, but it is unlikely to be the mechanism of action involved in any longer lasting effects.

1.7.5 Expectancy

Patient expectancy has been shown to influence treatment outcomes in populations such as those suffering from chronic lower back pain and generalised anxiety disorder (Newman & Fisher, 2010; Smeets, Beelen, Goossens, Schouten, Knottnerus, & Vlaeyen, 2008). In terms of exercise specifically, it has been proposed that expectancy of the benefits of exercise on mood may influence actual changes in mood following exercise (Salmon, 2001). Daniel et al. (2007) conducted a study to determine if smokers who enter an exercise programme may gain some relief from nicotine craving and withdrawal symptoms simply because they expect to (Daniel, Cropley, & Fife-Schaw, 2007). To achieve this, these researchers manipulated how credible participants believed exercise to be as a smoking cessation aid. Inactive smokers who had undergone a night of abstinence were then randomised into one of three groups: (1) positive – read a statement that exercise helps

with withdrawal; (2) negative – read a statement that exercise has no effect on withdrawal; and (3) ambiguous – read both a positive and a negative statement. The physical activity that all participants engaged in was 10 minutes on a stationary bicycle at a moderate intensity. These researchers found that regardless of the expectations of the participants, withdrawal symptoms were reduced both during and after exercise. From this they concluded that the expectation of the effects of exercise on withdrawal and craving does not influence actual reductions in these variables (Daniel et al., 2007). However, there were a number of limitations with this study that cast doubt as to whether or not expectancy as a mechanisms can be completely ruled out. These will be outlined and discussed in detail in study two (Chapter three) of this dissertation.

In 2003, Ussher and colleagues conducted a large trial and randomised smokers to either: NRT plus CBT plus brief exercise counselling or NRT plus CBT plus brief health information counselling. They found no differences between these two groups in terms of expectancy of intervention efficacy, post intervention abstinence, or weight and fat gain. In this instance, because the two groups were the same in terms of expectancy and treatment outcomes it is not possible to rule out expectancy as an influential factor in the effect of exercise on smoking cessation.

1.7.6 Incompatible behaviours

In the exercise and smoking literature there is a significant cross-sectional association between smoking cessation and exercise (King, Marcus, Pinto, Emmons, & Abrams, 1996). Research suggests that compared to sedentary individuals, people who engage in vigorous intensity exercise are less likely to smoke (Tart et al., 2010). It was demonstrated by Prochaska et al. (2008) that following a combined CBT and exercise intervention, individuals who at six month follow-up

were still exercising, were more likely to be smoke-free than their counterparts who were no longer active. It is postulated that an increase in confidence to quit smoking is associated with a concurrent increase in confidence to take up exercise and vice versa (King et al., 1996). Although a causal relationship cannot be inferred, it seems possible that exercise may exert some influence over smoking behaviour because the two behaviours are distinctly incompatible.

1.7.7 Neurobiological mechanisms

A number of neurobiological mechanisms are involved in the maintenance of smoking behaviour. At this stage there are several mechanisms postulated to be involved in the link between exercise and the psychobiology of nicotine abstinence. Animal models have shown that exercise stimulates the release of dopamine into the striatum of the rat. This implies that exercise may be a mechanism for reducing the drive for drug administration in general, or nicotine specifically in the case of smoking (Wilson & Marsden, 1995). However, such a change in regional brain activation following vigorous exercise was not found in a group of regular exercisers (Wang, Volkow, Fowler, Franceschi, Logan, Pappas, Wong, & Netusil, 2000). Vigorous exercise has been shown to facilitate the release of endogenous opiods (e.g., Beta-endorphins), neurotransmitters that are also stimulated by smoking and known to enhance mood (Angelopoulos, 2001). An inherent difficulty with these neurotransmitter-exercise hypotheses is that both endogenous opoids and dopamine, the neurotransmitter so integrally linked to the addictive power of nicotine, are only triggered for release in vigorous exercise (Everson et al., 2008). Therefore, these mechanisms do not fit with the acute exercise finding that moderate intensity exercise is sufficient to reduce craving and withdrawal (Taylor et al., 2007).

Smokers have higher cortisol levels than non-smokers (36% higher) (Ussher, West, Evans, Steptoe, McEwan, & Clow, 2006). Between 12 and 24 hours after smokers quit, their cortisol levels will plummet (Steptoe & Ussher, 2006). It is hypothesised that this reduction in cortisol, makes quitting more difficult such that the greater the decline in cortisol the worse the craving and withdrawal experience (Steptoe & Ussher, 2006). Therefore, any method that could temporarily boost cortisol levels back up during a quit attempt has intuitive appeal. Exercise and cortisol have a unique relationship. Specifically, vigorous intensity exercise has been shown to increase cortisol levels among non-smokers (Jacks, Sowash, Anning, McGloughlin, & Andres, 2002). Scerbo and colleagues (2010) investigated the effects of exercise on cortisol amongst temporarily abstinent smokers in a cross-over design where participants engaged over three consecutive days in 15 minutes of: passive sitting, moderate intensity exercise (brisk walking), and vigorous intensity exercise (running). These researchers found that the decline in cortisol levels was attenuated in the vigorous intensity condition but not the moderate intensity exercise condition. However, no difference in cigarette craving was demonstrated between the two exercise conditions and participants experienced a reduction in craving during both exercise intensities (Scerbo, Faulkner, Taylor, & Thomas, 2010). Therefore, it is unlikely that reductions in cortisol contribute to the effect an acute bout of moderate intensity exercise has on craving and withdrawal. However, it cannot be ruled out as a possible physiological mechanism related to vigorous exercise effects on these variables.

1.8 The appeal of exercise as a smoking cessation strategy

The interest in multiple health behaviour change interventions is increasing (Prochaska, Spring, & Nigg, 2008). As a multiple behaviour change strategy, exercise and smoking cessation complement each other well. Recent research indicates that when smoking cessation is facilitated it may enhance an individual's motivation to change other

health behaviours (e.g., increase exercise). Considering that smoking cessation may be a catalyst for change in other behaviours and that exercise has been shown to acutely reduce the debilitating symptoms of nicotine withdrawal, incorporating these two behaviours into one intervention is appealing.

Due to the addictive nature of smoking cigarettes, those interested in quitting do not always achieve abstinence. This is evident by the fact that smoking rates amongst the general population in the developed world have remained at approximately 20% since the 1990's (TTS, 2010). A proportion of the smoking population are hardened smokers who may have unsuccessfully tried many times to quit. For these individuals a harm reduction strategy might be appropriate. The primary objective of a harm reduction strategy is to minimise the risk of harmful consequences associated with tobacco use in smokers who find it extremely difficult to quit and those who are unwilling to quit (deRuiter & Faulkner, 2006). While becoming completely nicotine free offers the best protection against morbidity and mortality; harm reduction is a concept that, under the right circumstances, is gaining favour amongst tobacco treatment specialists (TTS, 2010). For a smoking cessation aid to be considered an effective harm reduction approach it must fulfil certain criteria such as: (1) it should not increase or contribute to the individuals' level of nicotine dependence; and (2) the reduction approach should not present any additional harm to the individual (for the full list of harm reduction criteria see deRuiter and Faulkner [2006]). Presently, the only smoking cessation aid that fulfils all the criteria to be considered a harm reduction strategy is nicotine replacement therapy. The evidence is certainly shaping up to align physical activity as another harm reduction strategy (deRuiter & Faulkner, 2006; Hatsukami et al., 2004).

Smoking relapse rates are alarmingly high. Between 60% and 98% of quit attempts will end in relapse within the first year; with the majority (44%) occurring in the first two weeks (Garvey, Bliss, Hitchcock, Heinold, & Rosner, 1992). There are a number of reasons why people relapse that exercise may directly impact. For instance, post cessation weight gain (10 lbs on average) is a leading cause of relapse (Bush, Levine, Zbikowski, Deprey, Rabius, McAfee, & Wiatrek, 2009; Parsons, Shraim, Inglis, Aveyard, & Hajek, 2009). Although the research on the potential of exercise to ward off post cessation weight gain is equivocal, exercise is nevertheless an essential component of any weight management programme and should be encouraged (Fiore et al., 2008). Cigarette cravings are one of the most often expressed difficulties related to quitting. The intensity of craving experienced by an abstinent smoker over the first few days of quitting often predicts their success (Ferguson, Shiffman, & Gwaltney, 2006). The acute exercise and smoking literature has demonstrated that an acute bout of moderate intensity exercise has great potential to reduce cigarette cravings in temporarily abstinent smokers (Taylor et al., 2007). Thus, exercise has potential as a relapse prevention strategy.

In summary, a number of benefits specific to the promotion of physical activity as a smoking cessation treatment cannot be overlooked: (1) it is cost effective as part of a multiple behaviour change intervention; (2) it is inexpensive for the smoker (as opposed to NRT); (3) it can safely be indefinitely sustained; (4) it has minimal negative side effects; (5) it has the opposite effect on morbidity and mortality amongst smokers and as such provides great health benefits (deRuiter & Faulkner, 2006); and (6) it is a quit smoking aid that spans the continuum of the quit process – from quit attempt to relapse prevention. Given these potential benefits continuing to pursue exercise as a quit smoking strategy is worthwhile

1.9 Objectives and hypotheses of this dissertation

Much work has been done on the benefits of exercise as a smoking cessation intervention. This thesis will concentrate on an area of the research which has not been as well covered – mechanisms involved in the utility of exercise and individual factors that may contribute to how well exercise works as an adjunct smoking cessation aid. The objectives and hypotheses of each study are outlined below.

1.9.1 Study one (Chapter two): Exercise provides further craving and withdrawal relief for recently quit women who are using nicotine replacement therapy (NRT)

Study one is an examination of exercise mechanisms of action that might contribute to quit success in a combined NRT and exercise aided smoking cessation programme. Smokers followed during a 14 week NRT plus exercise aided smoking cessation programme which allowed for: (1) the first examination of exercise as an adjunct to NRT to reduce withdrawal symptoms and cigarette craving; (2) more accurate estimates of the craving and withdrawal relief experienced following exercise during a real quit attempt; and (3) exploration of exercise mechanisms of action that might contribute to quit success in a combined NRT and exercise aided smoking cessation programme (e.g., magnitude of withdrawal and craving relief experienced following a bout of exercise).

It was hypothesised that an acute bout of exercise would reduce nicotine craving and withdrawal in a group of women attempting to quit using NRT and exercise. It was believed that the greatest withdrawal and craving relief would occur in the first week following the quit date and at the NRT (NicoDerm® patch) nicotine drop-down time points (i.e., 21mg to 14mg, 14mg to 7mg). It was further hypothesised that women who experience a greater magnitude of relief from craving and withdrawal following a 20-30 minute bout of

moderate intensity exercise would be more successful at abstaining from cigarettes at the end of the 14-week NRT plus structured exercise programme.

1.9.2 Study two (Chapter three): Exercise may help smokers quit because they expect it will and because they believe it is a credible quit smoking aid

Study two sought to examine whether treatment expectancy and credibility were associated with outcome in terms of self-reported craving and withdrawal in a group of women undergoing a real quit attempt. The women involved were supplied with nicotine replacement therapy patches (NRT) as well as an exercise regimen. This provided the opportunity to compare expectancy and credibility beliefs regarding a well established quit smoking aid such as NRT with a novel quit smoking aid such as exercise. Furthermore, rather than only assess treatment expectancy and credibility before the start of the treatment when participants may have difficulty judging their actual beliefs regarding treatment outcomes; it was possible to measure these two variables immediately after quitting and at the end of the programme once they had actually been through the process (Smeets et al., 2008).

It was hypothesised that exercise expectancy and credibility beliefs would contribute to a reduction in craving and withdrawal symptoms following an acute bout of exercise. It was also hypothesised that as participants progressed through the NRT plus exercise quit smoking programme their exercise expectancy and credibility beliefs would increase.

1.9.3 Study three (Chapter four): Exercise may be an effective behavioural support strategy for coping with smoking temptations during a quit attempt

The exercise and smoking literature supports the notion of exercise as a meaningful coping resource during abstinence to prevent relapse (Taylor et al., 2006). Exercise has been proposed as a strategy to enhance coping ability and confidence to remain smoke free (Ussher et al., 2008). However, it is not known if abstaining smokers would confidently report replacing smoking with exercise when imagining a relapse inducing situation. It is also unknown whether the quitter's confidence in exercise as a behavioural support strategy is situation specific. With this in mind, the purpose of the present study was to determine: (1) if women taking part in a combined NRT and exercise aided smoking cessation programme report a temporal progression from smoking to exercising in high risk situations; and (2) whether confidence to use exercise as a coping strategy is situation dependent.

It was hypothesised that women engaging in an exercise aided quit smoking programme would naturally substitute smoking for exercise as a means of coping with situations that promote the resumption of smoking. It was also hypothesised that of all high-risk relapse situations those related to affect, particularly negative affect, would be the most amenable to exercise as a coping strategy. Finally, it was hypothesised that women who showed an increase in confidence to quit smoking would demonstrate a reciprocal increase in exercise confidence.

1.10 Integrated article format

This dissertation is presented in an integrated article format. Therefore, there is some overlap in material throughout, which is a product of this dissertation style.

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CHAPTER TWO: EXERCISE PROVIDES FURTHER CRAVING AND WITHDRAWAL RELIEF FOR RECENTLY QUIT WOMEN WHO ARE USING NICOTINE REPLACEMENT THERAPY

2.1 Introduction

Cigarettes kill millions of people worldwide every year (USDHHS, 2010). For over 50 years health practitioners have been working to determine how best to treat nicotine dependence (USDHHS, 2010). Current guidelines recommend tobacco treatment specialists advocate a combination of tobacco dependence counselling, and pharmacotherapy (Fiore, Jaen, & Baker, 2008). First line pharmacotherapies such as the nicotine patch, bupropion, and varenicline have been shown to double chances of quitting (TTS, 2010). Unfortunately, this increased chance of becoming smoke-free only equates to a 23% success rate at six months. Even comprehensive programmes, that include both pharmacotherapy and behavioural support, have limited success, with six month abstinence rates of 30% (Fiore et al., 2008). Sobering statistics like these highlight the need for identifying adjunct therapies that improve and sustain quit smoking rates.

Cigarette cravings are one of the most often expressed difficulties related to quitting. The intensity of craving experienced by an abstinent smoker over the first few days of quitting often predicts their success (Ferguson, Shiffman, & Gwaltney, 2006). When undergoing a period of abstinence, smokers are likely to experience two forms of cigarette cravings, background and episodic (Ferguson et al., 2006). Background craving denotes a steady state of craving where the individual is

plagued by a constant desire for a cigarette. Background craving may be controlled by pharmacotherapy such as the nicotine patch, bupropion and varenicline. Episodic cravings are surges in craving that result in an intense desire to light up a cigarette. These are triggered by exposure to stimuli associated with smoking (e.g., after a coffee or when having a bad day at work) (Ferguson & Shiffman, 2009). The only pharmacotherapy known to assist with episodic craving is oral nicotine replacement therapy (NRT; e.g., gum and lozenge) (Ferguson & Shiffman, 2009). A single session of exercise has been shown to have an acute effect on cigarette cravings. In a recent review of the acute exercise and smoking literature, Taylor and colleagues (2007) found that nine out of ten studies showed exercise to reduce cigarette cravings during temporary smoking abstinence (moderate to large effect sizes [ES] between 0.50–4.6). Significant reductions in desire to smoke have been observed for different intensities and types of exercise. For example, isometric exercise at a very low intensity and of a five minute duration has been shown to reduce the urge to smoke by 0.7 on a seven point scale (ES = 0.29)(Ussher, West, Doshi, & Sampuran, 2006) whereas 15-20 minutes of self-paced walking reduced the urge to smoke by 4.6 on the same scale (ES = 3.7) (Taylor, Katomeri, & Ussher, 2005). In addition, longer periods of exercise (e.g., approximately 15 minutes of brisk walking) at a light-moderate intensity have been shown to delay ad libitum smoking by up to 50 minutes, even when the individual is presented with a challenging mental task or a lit cigarette (Taylor & Katomeri, 2006; Taylor & Katomeri, 2007; Taylor et al., 2005). The magnitude of the reduction in cravings is encouraging and comparable with an acute response to oral NRT (Taylor, Ussher, & Faulkner, 2007). Given the literature, it is plausible that the magnitude of craving and withdrawal relief an abstinent smoker experiences through a bout of exercise might influence their quit success.

Although results from the acute exercise and smoking paradigm are promising, this body of research has two inherent flaws. First, the majority of studies include temporarily abstinent smokers rather than quitters per se. Therefore, the severity of symptoms experienced may not correspond entirely with those felt when an individual is fully invested in their quit attempt. It also provides little insight into the utility of exercise to help people quit more long-term and no insight into the utility of exercise to help decrease withdrawal symptoms while on pharmacotherapy (i.e., nicotine replacement therapy). Second, acute studies take place within a laboratory setting. Such an artificial environment bears little resemblance to an actual scenario a smoker attempting to quit may experience. In short, these two flaws raise questions about the ecological validity of these studies and their findings.

Only one study appears to have combined an examination of the acute and long-term effects of exercise on craving, withdrawal, and smoking status amongst the same group of participants (Bock, Marcus, King, Borrelli, & Roberts, 1999). Sixty two women (44 exercise, 18 contact control) participated in 12 weeks of one hour weekly smoking cessation cognitive behavioural therapy plus either: (1) three times per week, 30-40 minutes of vigorous intensity exercise, or (2) three times per week 30-40 minutes of wellness information. Cigarette craving and nicotine withdrawal measures were administered immediately before and after the last exercise session of each week of the programme. When compared to the contact control, the exercise group reported significantly less craving and withdrawal symptoms immediately following exercise most weeks of the programme. These researchers showed that exercise can be used throughout a quit attempt to decrease feelings of nicotine withdrawal and cigarette cravings. Additionally, exercise was found to be beneficial for weeks into a quit attempt and reduced negative symptoms related to abstinence

unrelated to the presence of a smoking trigger. The effects of an exercise aided pharmacological based smoking cessation programme (i.e., NRT) on nicotine withdrawal and cravings is unknown. There is some evidence, however, that exercise combined with NRT facilitates smoking cessation (Prapavessis, Cameron, Baldi, Robinson, Borrie, Harper, & Grove, 2007). It should be noted that not all combined NRT and exercise protocols yield promising results. Those that find no benefit from exercise may be partially explained by poor adherence to the exercise protocol (Kinnunen, Leeman, Korhonen, Quiles, Terwal, Garvey, & Hartley, 2008; Ussher, Taylor, & Faulkner, 2008).

The present study followed smokers during a 14 week nicotine replacement therapy patch plus exercise aided smoking cessation programme which allowed for: (1) the first examination of exercise as an adjunct to NRT to reduce withdrawal symptoms and cigarette craving; (2) more accurate estimates of the craving and withdrawal relief experienced following exercise during a real quit attempt; (3) determination of how structured and progressive acute exercise relates to quit success; and (4) exploration of exercise mechanisms of action that might contribute to quit success in a combined NRT and exercise aided smoking cessation programme (e.g., magnitude of withdrawal and craving relief experienced following a bout of exercise).

It was hypothesised that an acute bout of exercise would reduce nicotine craving and withdrawal in a group of women attempting to quit and using NRT. It was believed that the greatest withdrawal and craving relief would occur in the first week following the quit date and at the NRT (NicoDerm® patch) nicotine drop-down time points (i.e., 21mg to 14mg, 14mg to 7mg). It was further hypothesised that women who experience a greater magnitude of relief from craving and withdrawal following a 20 minute bout of moderate intensity exercise

would be more successful at abstaining from cigarettes at the end of the 14 week NRT plus structured exercise programme.

2.2 Method

2.2.1 Participants

Participants included 119 females undertaking the first and second round of the Getting Physical on Cigarettes trial. Inclusion criteria included: (1) aged between 18 and 70 years; (2) smoked in excess of 10 cigarettes per day for the past two years; and (3) wished to achieve smoking abstinence. Exclusion criteria included: (1) contraindication to regular exercise (e.g., disability, unstable angina); (2) contraindication to using NRT; and (3) pregnancy. Participants provided written consent and were also required to obtain written consent from a physician, verifying that they were fit to exercise and use NRT before beginning the programme.

It is important to emphasise that all participants taking part in the research contained within this dissertation were female. A purely female population was chosen because, in terms of quitting, women are reported as being less successful than men (Jung, Fitzgeorge, Prapavessis, Faulkner, & Maddison, 2010). In addition, women often report post-cessation weight gain concern, which has been shown to be associated with relapse (USDHHS, 2001). Given this, exercise may be a particularly pertinent adjunct smoking aid for women (USDHHS, 2001). Perhaps the most important reason of all is that some women, especially those who prior to the trial were sedentary, would not have taken part in this research if it involved exercising in front of men. Therefore, to improve adherence to the programme it was determined that an all female environment would be best. However, this means that the findings contained within this body of work are not able to be

generalised to men. In addition, determining gender differences is beyond the scope of this dissertation

2.2.2 Ethical approval

The conduct of the trial followed the principles outlined in the Declaration of Helsinki (World Medical Association, 2008) and the World Health Organization, 2002 Good Clinical Research Practice. The conduct and reporting of the trial followed CONSORT principles (www.consort-statement.org). Ethical approval was obtained from the University of Western Ontario Health Sciences Research Ethics Board (#16306) and participation was entirely voluntary.

2.2.3 Design

2.2.3.1 Getting Physical on Cigarettes

The Getting Physical on Cigarettes (GPOC) trial was a Canadian Cancer Society Research Institute funded trial (#019876) examining smoking relapse prevention following a smoking cessation intervention. The 14 weeks of the trial consisted of an exercise and NRT smoking cessation intervention. On the fourth week participants quit smoking and began the NicoDerm® 10 week transdermal patch programme. Participants took part in three supervised exercise sessions per week (between 20-30 minutes duration each session) for weeks one through eight of the programme; followed by two supervised sessions per week during weeks nine through 11, and one supervised session per week during weeks 12, 13, and 14. For more information on the trial rationale and method of Getting Physical on Cigarettes please see Jung, Fitzgeorge, Prapavessis, Faulkner, and Maddision (2010). The Getting Physical on Cigarettes trial registration can be found at clinicaltrials.gov identifier NCT01305447. The women who took part in the GPOC trial were the same as those who took part in the present study.

2.2.3.2 The Exercise and Health Psychology Laboratory

The trial was delivered at the Exercise and Health Psychology Laboratory (EHPL; www.ehpl.uwo.ca) at The University of Western Ontario in London, Ontario. The laboratory houses aerobic exercise machines (treadmills, stair climbers, stationary bicycles, and rowing machines) as well as a conference room for participants to complete questionnaires pre- and/or post-exercise.

2.2.3.3 General procedure

The present study consisted of three acute exercise sessions, which occurred on week five, week 11 and week 13. The first acute exercise session (week five) occurred shortly after the participants quit smoking and started NRT (week four). The second and third exercise bout coincided with the period of time soon after participants reduced the level of NRT patch strength from 21 mg to 14 mg (week 11) and 14 mg to 7 mg (week 13). A flow-chart of the research design is displayed in Figure 2.1 and a time line of the measurements and assessments in Table 2.1.

Participants completed the Shiffman-Jarvik withdrawal scale (Shiffman & Jarvik, 1976) immediately prior to and following the three acute exercise sessions. Change in smoking withdrawal symptoms due to an acute bout of exercise was determined by comparing Shiffman-Jarvik subscale scores pre- to post-exercise. To be eligible for this analysis, participants had to demonstrate that they were smoke-free (CO < six ppm), adhered to their NRT programme, and followed their acute exercise regime at the appropriate intensity (see Figure 2.1).

Table 2.1. Schedule of Assessments

	Week					
	Base-line	**4**	**5**	**11**	**13**	**14**
Quit smoking		X				
Acute Exercise Session						
Moderate/Vigorous Intensity			X	X	X	
Exercise Intensity Verification						
Peak VO_2 Fitness Assessment	X					
Heart-Rate Monitor			X	X	X	
Smoking Abstinence Verification						
Carbon Monoxide Assessment	X		X	X	X	X
Measures						
Shiffman-Jarvik Withdrawal Scale (pre-exercise)			X	X	X	
Shiffman-Jarvik Withdrawal Scale (post-exercise)			X	X	X	
Fagerström Nicotine Dependence	X					
Demographics Questionnaire	X					
Actical Exercise Behaviour	X					X
Smoking Information	X					

Note. Baseline refers to pre-trial and week 14 refers to post-trial. Week five acute exercise session occurred just after the quit smoking date (week four); week 11 and week 13 acute exercise sessions occurred just after a drop-down in nicotine patch strength.

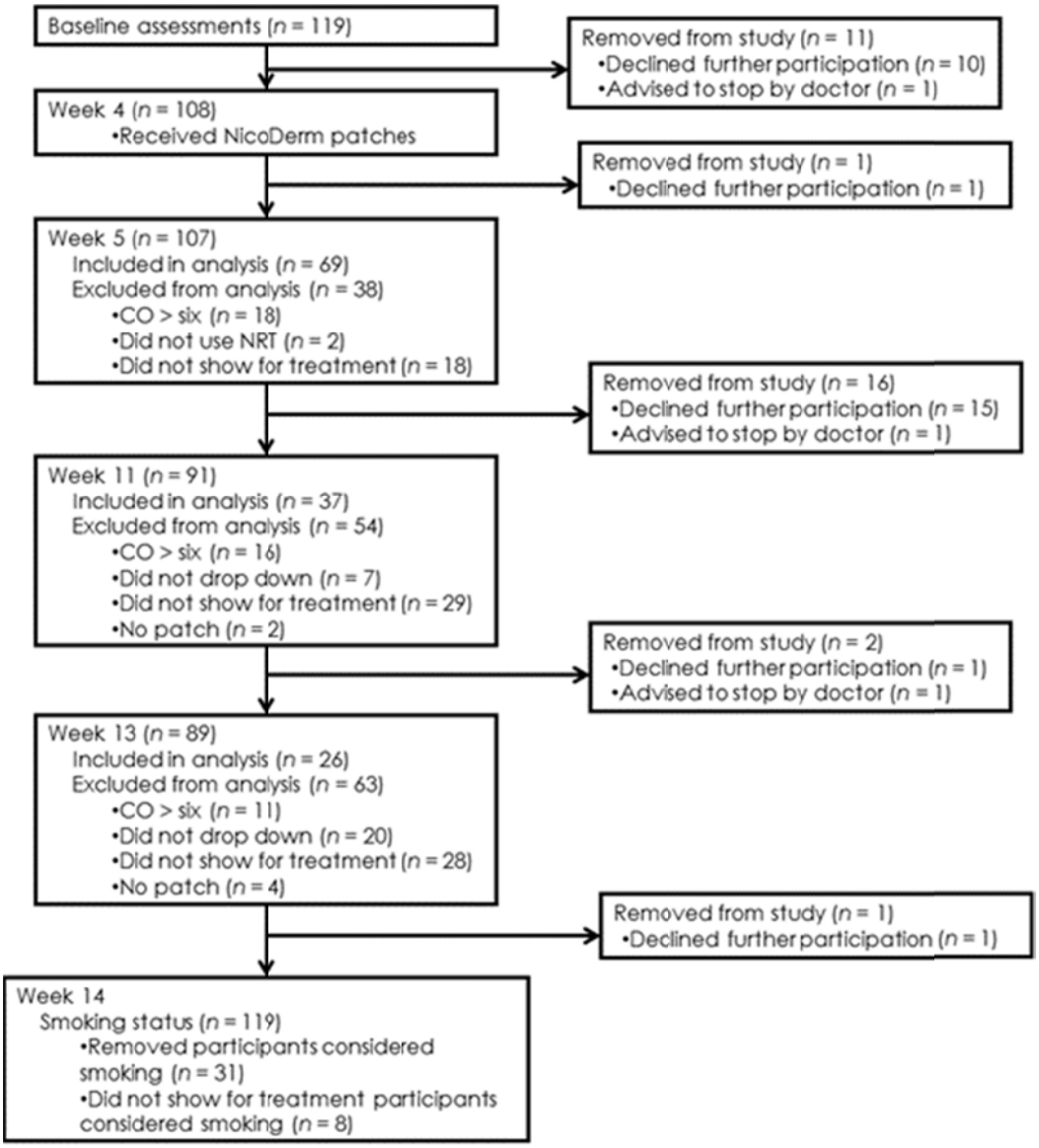

Figure 2.1. Research design and flow of participants through the trial.

2.2.4 General GPOC exercise regimen

Participants exercised in groups of 10-15 ladies at the EHPL. Exercise sessions consisted of aerobic exercise with the option to use a treadmill, rowing machine, stair climber, or stationary bicycle. At each exercise session participants completed a five minute warm-up, 20 minutes of exercise, a five minute cool down, and a series of static stretches. Participants' exercise intensity and duration was verified by Polar heart-rate monitors.

Participants' heart rate max was determined by the max heart rate achieved during an aerobic fitness test completed at baseline. Aerobic fitness was evaluated using a standardised, maximal, incremental exercise protocol (Bruce Test) on a Woodway PPS treadmill.

As a part of the GPOC trial participants were asked to adhere to an individualised set exercise regimen for the 14 weeks of the trial. Exercise sessions on week one through week three participants' exercised at a mild intensity, defined as 40-50% of their heart-rate reserve (HRR) (e.g., 40% of HRR was defined as, heart-rate max [HRMax] – resting heart-rate [RHR] x .4) + RHR) (CSEP). For exercise sessions from week four (quit week) to week six participants were to exercise at a moderate intensity, defined as 50-60% of their HRR (CSEP). For weeks seven to nine they were required to exercise at between 60-70% of their HRR. From week 10 until the end of the programme participants were asked to engage in vigorous intensity exercise, defined as 70%+ of their HRR (CSEP). Inspection of the Polar heart-rate data revealed that all participants met the week one – three exercise prescription. For the following weeks (week four – 14) participants engaged in at least moderate intensity exercise, or 50-60% of their HRR (CSEP). That is, not all participants engaged in vigorous intensity exercise although it was asked of them.

2.2.4.1 Acute exercise session: week five protocol

The first acute exercise session, which occurred on week five, consisted of 20 minutes of moderate intensity exercise. Moderate intensity exercise was defined as the participant's heart-rate being between 50% and 60% of heart-rate reserve (HRR). For example, 60% of the participants' HRR was defined as, (heart-rate max [HRMax] – resting heart-rate [RHR] x .6) + RHR (CSEP).

2.2.4.2 Acute exercise session: week 11 protocol

The second acute exercise session, which occurred on week 11, consisted of 20 minutes of vigorous intensity exercise. Vigorous intensity exercise was defined as the participant's heart-rate being at least 70% of her HRR ([HRMax – RHR x .75] + RHR) (CSEP).

2.2.4.3 Acute exercise session: week 13 protocol

The third acute exercise session, which occurred on week 13, consisted of 20 minutes of vigorous intensity exercise (CSEP).

2.2.5 Nicotine replacement therapy regimen

All participants were provided with NRT in the form of NicoDerm® transdermal patches. Participants were asked to wear the nicotine patches for 24 hours a day, seven days a week, for 10 weeks as per the manufacturer's recommendations.

2.2.5.1 NicoDerm® three step programme

The NicoDerm® 10 week, three step programme, designed for smokers who smoke 10 (or more) cigarettes per day, was followed. Accordingly, a step one (21 mg) patch was to be applied daily for six weeks, followed by a step two (14 mg) patch applied daily for two weeks, and finally a step three (7 mg) patch applied daily for two weeks.

At the beginning of week four participants were given seven, step one (21 mg) patches. Participants were to quit smoking and start the patches within two to three days; hence, by week five participants had been on NRT for three to five days. Patches containing 21 mg of nicotine were distributed for six weeks. On week 10, participants were given seven, step two (14 mg) patches; hence, by week 11 participants had 'stepped down' to the lower dose of NRT. Patches containing 14 mg of nicotine were distributed for two weeks. Finally, on week 12, participants were given seven, step 3 (7 mg) patches; hence, by the

week 13 exercise session, participants had 'stepped down' again to a lower dose of NRT. Patches containing the lowest dose of nicotine, 7 mg, were distributed for two weeks. Participants were not given patches at the exercise session on week 14. Post-intervention, week 14, assessments were scheduled at the end of the week to ensure participants were no longer on NRT (absorbing nicotine).

2.2.5.2 NicoDerm® two step programme

Although all participants were smoking at least 10 cigarettes per day at baseline, a few decreased their smoking prior to the week four quit date. The participants who were smoking less than 10 cigarettes per day at the week four quit date completed the NicoDerm® two step, 10 week, NRT patch programme (*n* = 14). The two step programme consisted of step two (14 mg) and step three (7 mg) patches and is designed specifically for smokers who smoke less than 10 cigarettes per day. A step two (14 mg) patch was to be applied once daily for six weeks, followed by a step three (7 mg) patch applied once daily for four weeks.

Participants on the two patch 10 week protocol 'stepped down' from 14 mg NRT to 7 mg NRT on week 11. These participants, like the three step programme participants, finished the 10 week system on week 14.

2.2.6 Demographic measures

Participant demographic information was gathered via self-report, including age, employment, language spoken at home, number of children and household income. These variables are described in Table 2.2. See Appendix 1 for a copy of this questionnaire.

2.2.6.1 Programme adherence

Programme adherence was determined by attendance to the exercise sessions. One session had to be cancelled due to a national holiday.

Participants' attendance was compared to a total number of 32 exercise sessions ([eight weeks x three sessions] + [three weeks x two sessions] + [three weeks x one session] – one session).

2.2.6.2 Nicotine dependence and other smoking characteristics

The Fagerström Test for Nicotine Dependence (FTND) (Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991) was administered at baseline (Figure 2.1) to measure perceived cigarette dependence. The FTND is scored out of 10 points (total) and is interpreted as follows: a score of zero to two is indicative of very low addiction; a score of three to four, low addiction; a score of five is related to medium addiction; a score of six to seven, high addiction; and a score of eight to10 is related to very high addiction. The FTND has shown high internal consistency and adequate retest reliability (Pomerleau, Carton, Lutzke, & Flessland, 1994). This variable is described in Table 2.2. See Appendix 3 for a copy of this questionnaire.

In addition to the FTND, participants were asked to indicate the number of previous quit attempts they have undergone, length of the longest quit attempt, the number of years they have smoked, the number of cigarettes they smoked per day, and the percentage of family and friends who smoke. These questions were asked of participants during baseline assessments prior to the first exercise session. These variables are described in Table 2.2. See Appendix 2 for a copy of this questionnaire.

2.2.7 Physical activity behaviour

2.2.7.1 Actical® accelerometer

Moderate and vigorous (MV) intensity structured exercise minutes (bouts of 10 minutes plus) were measured objectively pre- and post-intervention using the Actical® Accelerometer (Minimitter, Oregon). The

Actical® Accelerometer is sensitive to low frequency movements in the range of 0.5-3.2 Hz, which is the common range for human movement and has been shown to be a valid and reliable measure of physical activity (Heil, 2006). Participants were instructed to wear the device on the right hip for seven consecutive days during waking hours for the week prior to the first exercise session (baseline). For complete data, participants were required to provide a minimum of 10 hours per day for at least five days (including one weekend day) (Trost, McIver, & Pate, 2005). The raw data were analysed using custom software KineSoft version 2.0.95 (KineSoft, New Brunswick, Canada). These variables are described in Table 2.2.

2.2.7.2 Peak VO_2 fitness assessment

Aerobic fitness was evaluated using a standardised, maximal, incremental exercise protocol (Bruce Test) on a Woodway PPS treadmill. A Cosmed Quark b^2 indirect calorimetry metabolic system (Cosmed S.r.l, Rome, Italy) was used to assess gas exchange variables. Peak VO_2 was expressed in (ml/kg/min) units. These data were used to determine entry level fitness as well as fitness level changes from pre- to post-intervention (Sjostrand, 1947). These variables are described in Table 2.2.

Table 2.2. Demographic characteristics, exercise and smoking behaviour.

Variable	Mean (SD), %
Demographics:	
Age	40.64 (13.17)
Language spoken at home (English)	95 %
Married	25.9 %
Yearly household income:	
Below $50,000	71.7 %
Between $50,000 and $75,000	12.3 %
Above $75,000	16.0 %
Number of children	1.22 (1.29)
Occupation:	
Employed	71.1 %
Student	9.6 %
Unemployed	19.3 %
Objective weekly physical activity (Actical):	
Pre-intervention (exercise minutes at MV)	20.89 (41.75)
Post-intervention (exercise minutes at MV)	30.21 (55.00)
Peak VO_2 (ml/kg/min)	
Pre-intervention	28.56 (7.01)
Post-intervention	30.42 (7.57)
Carbon monoxide (CO) reading:	
Pre-intervention	17.33 (9.02)
Post-intervention (14 weeks)	6.48 (10.71)
Smoking behaviour at baseline:	
Cigarettes per day	16.76 (6.13)
Number of years smoking	22.06 (12.16)
Fagerström test of nicotine dependence	5.65 (1.95)
Percentage of family and friends that smoke:	
Between 0 and 10%	72 %
Between 10 and 20%	12 %
Above 20%	16 %
Number of previous quit attempts	3.91 (2.86)

2.2.8 Primary outcome measures

2.2.8.1 Smoking withdrawal

The Shiffman-Jarvik withdrawal scale is a 15 item questionnaire that assesses withdrawal symptoms in abstaining smokers. The items were presented as seven-point scales, where one indicates 'definitely not' and seven indicates 'definitely'. The items were divided into five subscales based on factor analysis: craving (five items), psychological

symptoms (five items), physical symptoms (three items), sedation (one item) and appetite (one item). Shiffman-Jarvik subscale scores do not tend to drift over repeated assessments and use factor analysis to group items according to their inter-correlations, which generally results in reliable scales (Shiffman, West, & Gilbert, 2004). Reliability analyses (Cronbach's alpha scores) were computed at week five, week 11 and week 13 for the constructs of craving, psychological symptoms and physical symptoms. All alpha values reflected an acceptable level of reliability and are presented in Appendix 16 (Kline, 1993).

The scale was administered immediately before and after the acute exercise sessions during week five, week 11 and week 13. Only data pertaining to those participants who reached the exercise intensity goals, followed the NRT protocol and abstained from smoking prior to the acute exercise sessions were included in the analyses. Data were expressed as an average value for each subscale (out of seven) for pre- and post-exercise as well as a percentage change (pre- to post-exercise) reduction score.

2.2.1 Secondary outcome measure

2.2.1.1 Smoking abstinence

Smoking abstinence was verified post-intervention by self-report, and a breath carbon monoxide (CO) reading of less than six parts per million (ppm). Participants who failed to attend the post-intervention assessment appointment, scored greater than six ppm breath carbon monoxide, and/or reported smoking behaviour were considered a smoker at week 14 (post-intervention).

2.2.2 Adherence challenges and considerations

2.2.2.1 Smoking abstinence

Smoking abstinence was verified before the three acute exercise sessions by self-report and a breath CO Smokerlyzer (the Micro Smokerlyzer®; Bedfont Scientific) reading of less than six ppm (Middleton & Morice, 2000). The measurement of breath CO level provided an immediate, non-invasive, method of assessing smoking status. Carbon monoxide monitors are sufficient to detect recent smoking; CO has a half-life of about five to six hours (Middleton & Morice, 2000). Withdrawal symptoms pre- and post-exercise from participants who scored greater than six ppm breath carbon monoxide and/or reported smoking within the last 10 hours were not included in the analyses.

Although, CO measurement is acceptable it would have been prudent to also report salivary cotinine levels. Cotinine is a bi-product of nicotine and provides a more accurate representation of a smokers' behaviour than CO. All participants who took part in the research contained in this dissertation provided salivary cotinine samples at baseline and week 14. Unfortunately, within the research time frame cotinine analyses were not received, and it is an acknowledged limitation of this dissertation as a whole.

2.2.2.2 Acute exercise heart-rate prescription

Although participants were cautiously introduced to exercise, the moderate and vigorous intensity did lead to discomfort for some of the women. Some women were not fond of sweating, working hard, or experiencing physical stiffness. To assist in alleviating stiffness and physical discomfort, research staff taught participants to properly warm-up prior to exercise, to cool down following an exercise session and to stretch. In addition, to promote appropriate exercise intensity,

research staff provided participants with a weekly exercise intensity goal at the beginning of each exercise session and remained visible throughout the exercise session.

As previously mentioned, exercise intensity was monitored and recorded using polar heart-rate monitors. For the vigorous acute exercise sessions, a few participants did not reach the exercise intensity goal (week 11 - *n* = 8; week 13 - *n* = 4) but engaged in at least moderate intensity exercise, or 50-60% of their HRR (CSEP). These data were included in the analyses. Therefore, not all participants engaged in vigorous intensity exercise although it was asked of them.

2.2.2.3 Nicotine replacement therapy

Prior to week four, participants were aware of the NicoDerm® 10 week NRT protocol and which programme they were going to undertake (two step programme or three step programme). Before starting the patch, participants were told to read the booklet provided in the NicoDerm® box and call the NicoDerm® 1-800 number with questions and concerns.

To facilitate compliance with the NRT protocol, the appropriate patches were distributed to each participant in weekly batches. Compliance with the NicoDerm® protocol was monitored via the completion of daily logs by participants. Recorded on the log was the time of day a new patch was administered, when patches were removed, any deviation from the 10 week NRT programme and any problems or concerns. At the beginning of each week, log sheets from the prior week were submitted to research staff and discussed with the participant.

Failure to follow the NicoDerm® 10 week patch programme generally stemmed from one of three themes: (1) the misconception that the

patch eliminated all cigarette withdrawal symptoms or withdrawal symptoms being misinterpreted as incorrect nicotine patch strength; (2) the sense of eagerness to be finished using nicotine; or (3) sleep disturbance or vivid dreams. Reluctance to follow protocol was countered with the fact that smoking cessation is more likely when pharmacotherapy is used as a part of the quit attempt (TTS, 2010) and with the fact that smoking cessation using the NRT patch is highest when proper NRT protocol is followed (TTS, 2010). Of the participants who reported sleep disturbances, many persevered with 24 hour patch use until the disturbances decreased or until the end of the 10 week programme. However, 36 of the 119 participants opted to take the patch off while sleeping. These participants were warned that nicotine levels will be decreased in the morning and withdrawal symptoms and cravings may be higher. Data from these individuals were included in the analyses if the participants met the smoking abstinence and exercise intensity requirements.

One participant (*n* = 1) a very heavy smoker, reported using self-purchased patches in addition to the NRT provided by researchers. This participant followed the NicoDerm® three step programme twice, concurrently (i.e., two patches per day). Data from this individual were included in the analyses if the participant met the appropriate smoking abstinence and exercise intensity requirements.

One participant (*n* = 1) reported an 'allergy' to the NicoDerm® brand NRT patches. To satisfy this individual, researchers provided her with the Life® brand NRT patches (i.e., 21mg, 14mg and 7mg). This individual followed the NicoDerm® protocol using Life® brand NRT patches. Data from this individual were included in the analyses if the participant met the appropriate smoking abstinence and exercise intensity requirements.

Participants who did not wear the patch daily and/or did not 'step down' at the proper time (week 11, week 13) were removed from subsequent analyses. Withdrawal and craving data for the participants who completed the two step 10 week NRT programme were analysed separately from the participants who completed the three step protocol for week five (n = 14) and week 11 (n = 9). No differences were revealed between the two protocols, hence the data were combined. Participants who did the two step patch protocol did not provide week 13 withdrawal and craving data because they did not decrease patch nicotine at that time.

2.2.2.4 Participant retention

Although no costs were incurred by the participants for the use of the exercise equipment, NRT, or for campus parking, retention of participants for 14 weeks was a challenge. Despite contacting participants via telephone and email to keep them in the trial, participant drop-out still occurred. See the flow chart for a schedule of participant drop-out (Figure 2.1). Participants who dropped out prior to week 14 assessments and/or did not attend week 14 assessments were considered to be smoking post-intervention.

Due to attrition, absenteeism and/or smoking lapses from week to week, the number of participants fluctuated over the three acute exercise sessions (week five, n = 69; week 11, n = 37; week 13, n = 26) (Figure 2.1). A total of 20 participants engaged in all three acute exercise sessions.

2.2.3 Power calculation

25 participants are required at week five, week 11, and week 13 exercise sessions to provide power of 80% (p < 0.05) to detect a 0.8 (*SD* – 1.2) difference between pre- and post-exercise cigarette craving (SamplePower 3-IBM SPSS). No power calculation was computed for

the exploratory research question – is there a difference between week 14 non-smokers and week 14 smokers on the magnitude of change of withdrawal symptoms pre- to post-exercise.

2.2.4 Statistical Analyses

Separate repeated ANOVAs were used to analyse differences in the withdrawal scales of the Shiffman-Jarvik questionnaire pre- to post-exercise for each acute exercise session (week five, week 11, week 13). Bonferroni correction set the alpha at .003. Planned comparison t-tests at week five were used to compare the magnitude of relief found on the scales of the Shiffman-Jarvik questionnaire between week 14 smokers and non-smokers. In addition, t-tests were used to analyse differences in pre-exercise withdrawal symptoms for week 14 smokers and non-smokers. Because pre-exercise craving scores differed for week 14 smokers and non-smokers, an ANCOVA was used to compare the craving magnitude between the two groups (non-smokers vs. smokers at week 14). Assumptions for ANCOVA (i.e., homogeneity of regression) were met. A chi-square was used to determine the relationship between week 14 smoking abstinence and exercise programme adherence.

2.3 Results

2.3.1 Did exercise reduce withdrawal?

Significant reductions in cigarette craving were demonstrated following exercise at all three time points (week five: $F[1,68] = 28.281$, $p < .001$, $\eta^2 = .294$; week 11: $F[1,36] = 12.245$, $p < .001$, $\eta^2 = .252$; week 13: $F[1,25] = 4.522$, $p < .05$, $\eta^2 = .153$) [1] (Figure 2.2).

1. No difference was found between withdrawal results at any of the time points dependent on mg dose of NRT. Therefore, all individuals wearing a patch and meeting inclusion criteria were included in each craving and withdrawal analysed time point.

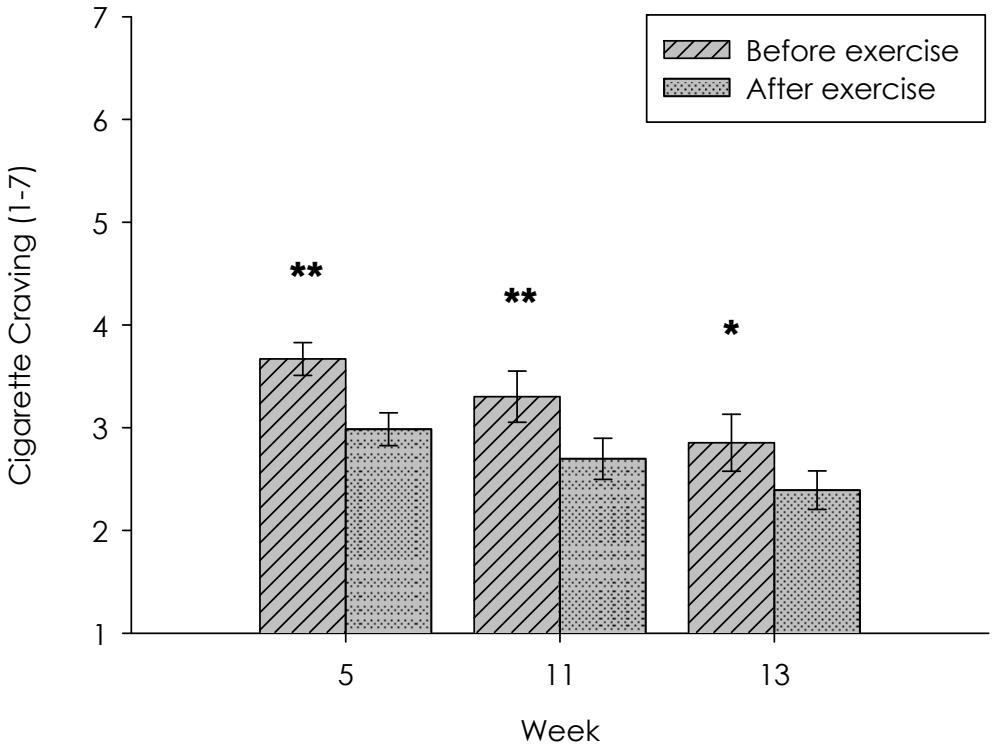

Figure 2.2. Cigarette craving before and after an acute bout of exercise for women that met inclusion criteria at each time point (week five *n* = 69, heart-rate [HR] ≥ 50% of heart-rate reserve [HRR]; week 11 *n* = 37, HR ≥ 70% of HRR; week 13 *n* = 26, HR ≥ 70% of HRR).

* $p < 0.05$ difference in cigarette craving before and after exercise.

** $p < 0.001$ difference in cigarette craving before and after exercise.

Significant increases in the physical symptoms related to nicotine withdrawal were demonstrated following exercise at all three time points (week 5: $F[1,68] = 21.698$, $p < .001$, $\eta^2 = .242$; week 11: $F[1,36] = 21.719$, $p < .001$, $\eta^2 = .376$; week 13: $F[1,25] = 5.849$, $p < .05$, $\eta^2 = .190$) (Figure 2.3)

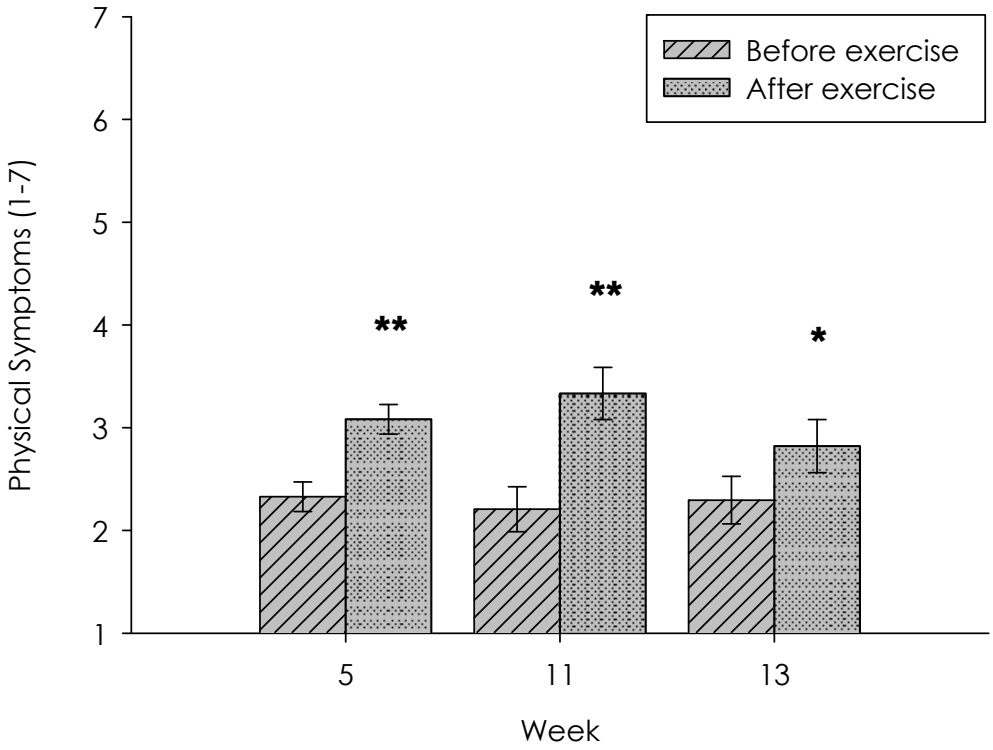

Figure 2.3. Physical withdrawal symptoms before and after an acute bout of exercise for women that met inclusion criteria at each time point (week five *n* = 69, heart-rate [HR] ≥ 50% of heart-rate reserve [HRR]; week 11 *n* = 37, HR ≥ 70% of HRR; week 13 *n* = 26, HR ≥ 70% of HRR).

* $p < 0.05$ difference in nicotine withdrawal symptoms before and after exercise.

** $p < 0.001$ difference in cigarette craving before and after exercise.

A significant reduction in the nicotine withdrawal symptom of sedation was shown following exercise at week five ($F[1,68] = 20.464$, $p < .001$, $\eta^2 = .231$) and 11 ($F[1,36] = 8.945$, $p < .001$, $\eta^2 = .199$) (4). No significant acute change in sedation was observed at week 13. It is however worth noting that week 13 acute reductions in sedation approached significance ($F[1, 25] = 3.585$, $p = .070$, $\eta^2 = .125$) (Figure 2.4).

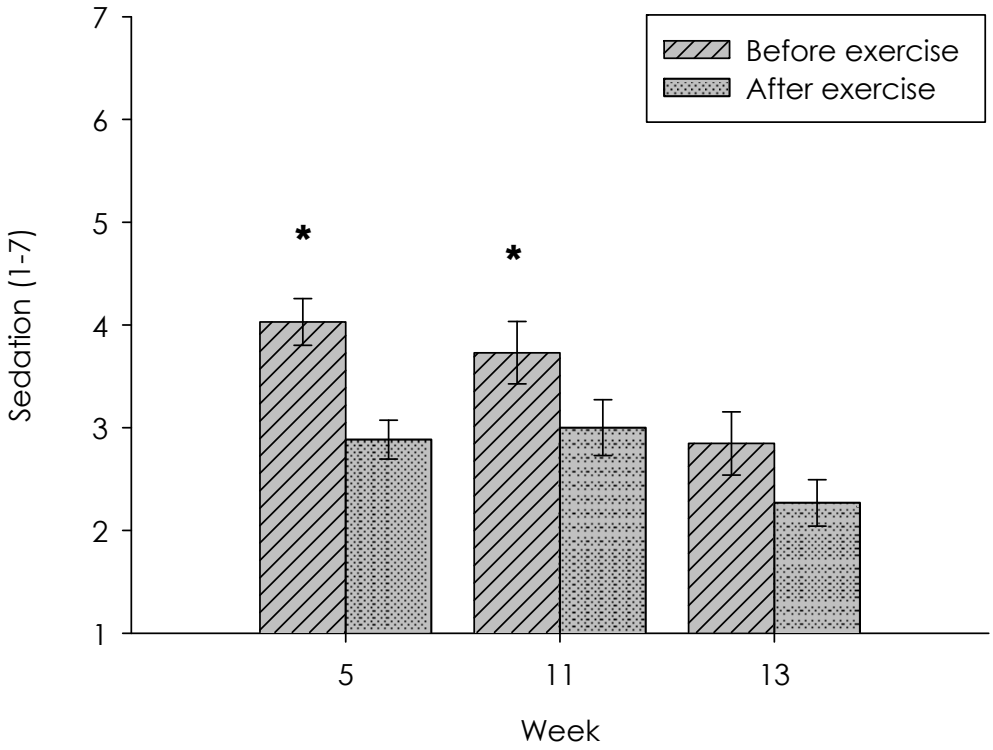

Figure 2.4. Sedation withdrawal symptoms before and after an acute bout of exercise for women that met inclusion criteria at each time point (week five *n* = 69, heart-rate [HR] ≥ 50% of heart-rate reserve [HRR]; week 11 *n* = 37, HR ≥ 70% of HRR; week 13 *n* = 26, HR ≥ 70% of HRR).

* $p < 0.001$ difference in nicotine withdrawal symptoms before and after exercise.

Significant reductions in psychological withdrawal symptoms were demonstrated following exercise at week five ($F[1,68] = 28.354$, $p < .001$, $\eta^2 = .294$) and 11 ($F[1,36] = 16.885$, $p < .001$, $\eta^2 = .319$) (Figure 2.5). No significant acute change in psychological withdrawal was observed at week 13. However, it should be noted that week 13 acute reductions in this withdrawal symptom approached significance ($F[1, 25] = 3.252$, $p = .083$, $\eta^2 = .115$) (Figure 2.5).

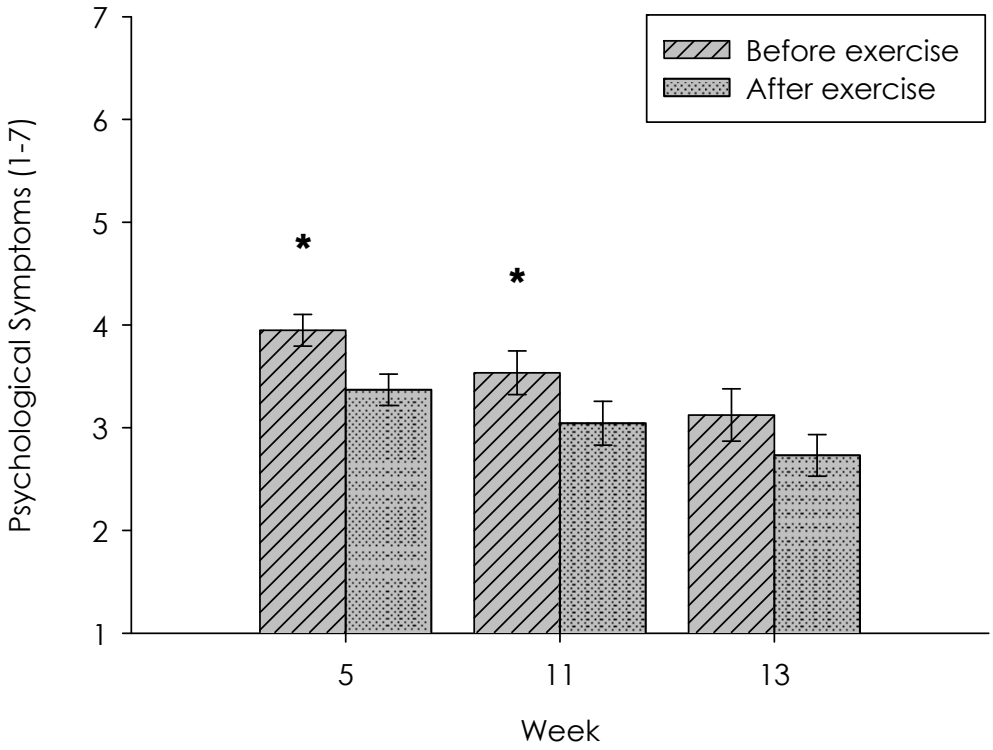

Figure 2.5. Psychological withdrawal symptoms before and after an acute bout of exercise for women that met inclusion criteria at each time point (week five *n* = 69, heart-rate [HR] ≥ 50% of heart-rate reserve [HRR]; week 11 *n* = 37, HR ≥ 70% of HRR; week 13 *n* = 26, HR ≥ 70% of HRR).

* p < 0.001 difference in nicotine withdrawal symptoms before and after exercise.

No significant reduction in appetite was shown following exercise at week five (F[1,68] = .169, p < .682, η^2 = .002), week 11 (F[1,36] = .030, p < .865, η^2 = 0.865) or week 13 (F[1,25] = .658, p < .425, η^2 = .026) (Figure 2.6).

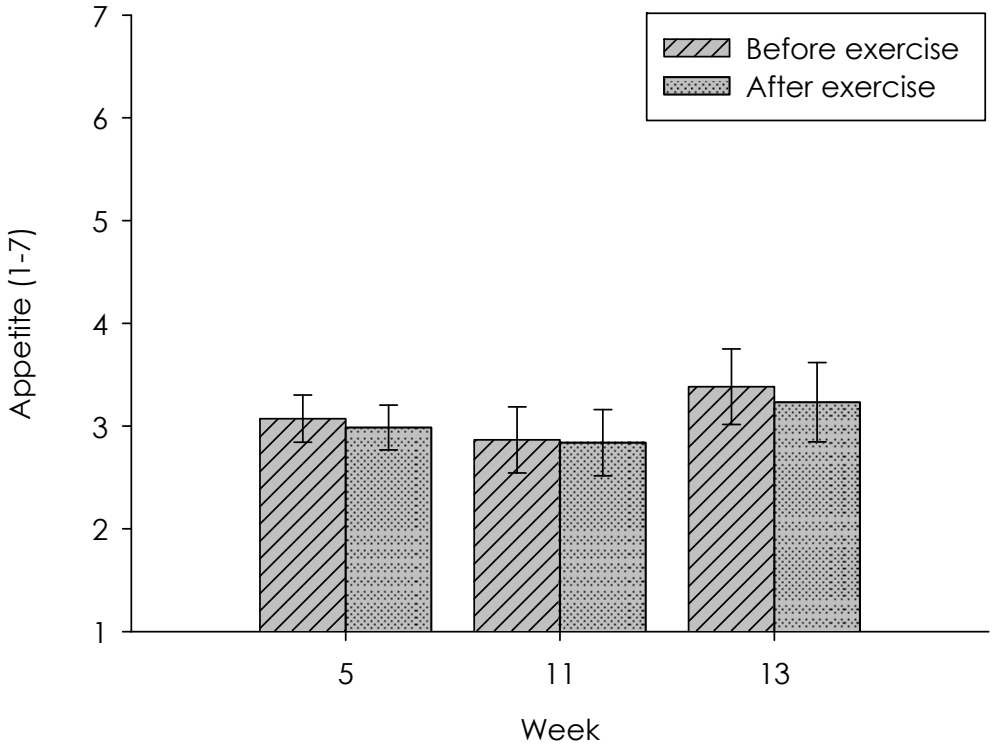

Figure 2.6. Appetite withdrawal symptoms before and after an acute bout of exercise for women that met inclusion criteria at each time point (week five *n* = 69, heart-rate [HR] ≥ 50% of heart-rate reserve [HRR]; week 11 *n* = 37, HR ≥ 70% of HRR; week 13 *n* = 26, HR ≥ 70% of HRR).

2.3.2 Did the magnitude of withdrawal relief experienced following exercise relate to end of programme abstinence?

There was no difference in the magnitude of change in the withdrawal subscales experienced following an acute bout of exercise at week five between women classified as non-smokers at week 14 and smokers at week 14 (Figure 2.7).

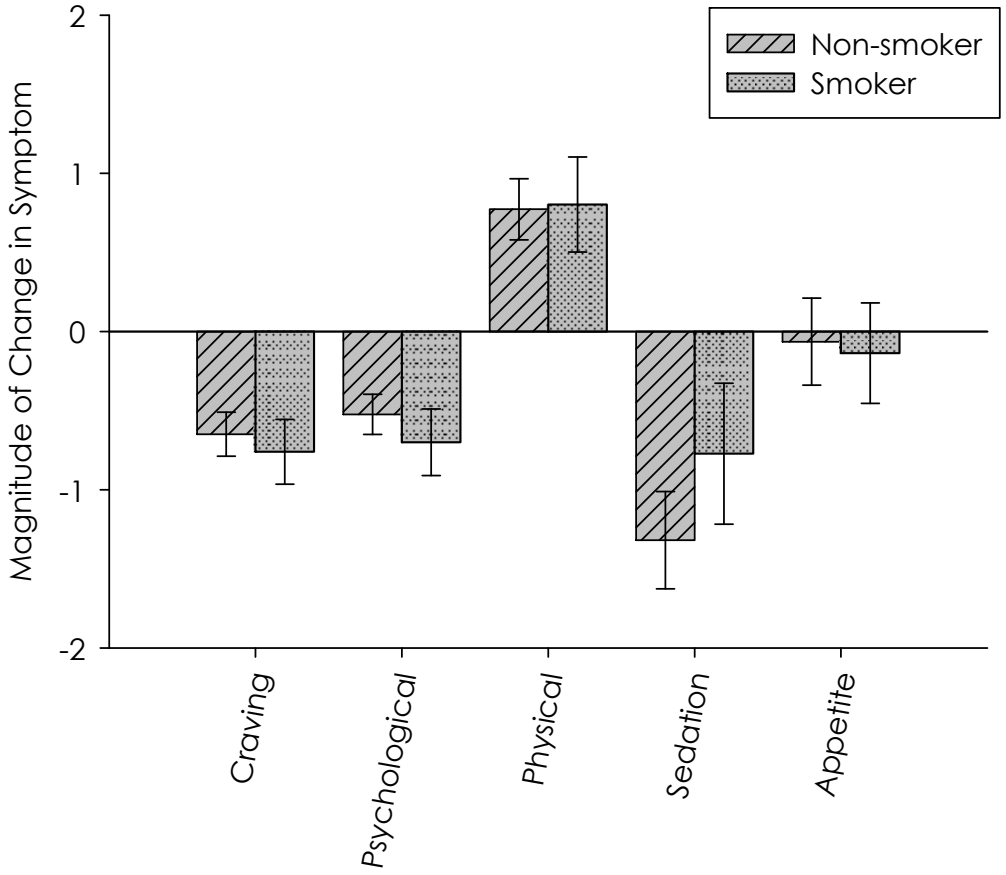

Figure 2.7. The magnitude of change in withdrawal symptoms following an acute bout of exercise for women who that met inclusion criteria at week five. Smoking (*n* = 22) vs. non-smoking (*n* = 47) status is as at week 14. A negative score denotes a reduction in symptoms; a positive score denotes an increase in symptoms.

2.3.3 Smoking cessation outcomes

Fifty eight percent (*n* = 69) of participants were able to quit smoking on the week four quit date (CO < six ppm). At the end of the programme (week 14) 51.3% of participants were considered smoke free (CO < six ppm). Smoking abstinence was related to attendance to the exercise programme (x^2[2, *n*=119] = 52.27, *p* < .001) (Table 2.3).

Participants smoking at week 14 (*M*=4.19, *SD*=1.45) experienced greater craving prior to exercise than those considered smoke-free at week 14 (*M*=3.43, *SD*=1.48) (*t* = -2.007, *p* < .05).

Table 2.3. Breakdown of participants smoking status at week 14 in relation to attendance to the exercise portion of the programme (*n* = 119)

	Exercise Programme Attendance			
	80-100%	60-80%	<60%	Total
Non-smoking at week 14				
Number of participants	45	12	4	61
Percent of total	37.8%	10.1%	3.4%	51.3%
Smoking at week 14				
Number of participants	7	17	34	58
Percent of total	5.9%	14.3%	28.6%	48.7%

2.4 Discussion

2.4.1 Craving and withdrawal

The present study examined the potential of exercise to reduce withdrawal symptoms and cigarette cravings related to smoking abstinence. The results were obtained in a design that overcame numerous limitations of previous acute exercise and smoking cessation research (e.g., a more ecologically valid setting, used NRT, true quit attempt) and made several novel contributions to the literature.

Results of the present study indicate that an acute bout of moderate to vigorous intensity aerobic exercise can reduce symptoms of nicotine withdrawal and cigarette craving early in the quit attempt of women trying to give up cigarettes. Three to five days into the quit attempt, exercise reduced craving and withdrawal for individuals on NRT. These first few days and weeks of the quit attempt often determine success or failure (Shiffman, Paty, Gnys, Kassel, & Hickcox, 1996). These findings demonstrate that early in a quit attempt, exercise is a useful tool for the kit of a smoker attempting to quit; a tool that does not become redundant in the presence of NRT. In exercise, tobacco treatment specialists have an evidence based adjunct therapy to recommend for reducing craving and withdrawal symptoms during this critical time in their quit attempt.

The results suggest that there may be a timing effect for exercise. That is, it may have the greatest effect during the early stages of a quit attempt. However, seven and nine weeks into the quit attempt (week 11 and 13 of the programme) the beneficial effects of exercise were still visible, although they were not always significant. These results correspond with those demonstrated by Bock et al. (1999). These researchers also found a reduction in craving and withdrawal following exercise for the majority of the weeks they measured it. The important distinction between their work and the present study is the absence of NRT. No doubt when used appropriately, over time NRT improves abstinent rates. Perhaps, NRT so effectively controlled withdrawal symptoms later in the quit attempt that exercise no longer made a significant contribution. Nevertheless, the effect size for overall withdrawal at week 13 (.128) was large enough to warrant recommending exercise at any point in the quit attempt. In addition, the decrease in craving demonstrated at all time points justifies promoting exercise as a strategy for dealing with cue-elicited cigarette cravings.

Craving can be conceptually compartmentalised into two categories - cue-induced craving and background craving. Clinically, craving is one of the most common symptoms that smokers are concerned about and the average intensity level of craving an abstinent smoker experiences in the first few days or weeks of the quit attempt often predicts quit success (Shiffman et al., 1996). The identification of adjunct quit smoking therapies to address both types of craving is of clinical importance.

Exercise has been shown to ameliorate cue-induced craving in temporarily abstinent smokers (Janse Van Rensburg, Taylor, Hodgson, & Benattayallah, 2009; Taylor & Katomeri, 2007). In a laboratory setting, exercise has the potential to reduce an individual's cigarette craving

reactions to a smoking related cue and delay ad libitum smoking. Cue-induced, or episodic cravings, are generally conceptualised as bouts of intense craving characterised by a surge in craving usually triggered by exposure to stimuli associated with smoking (Ferguson & Shiffman, 2009). In this case, no such stimuli was presented and, when participants entered the facility, the craving they were experiencing was not greatly spiked, as evident by the before exercise craving scores at all time points. Therefore, it seems reasonable to suggest that background craving was being assessed and that early on in a quit attempt exercise has the ability to at least temporarily reduce background craving. This finding is novel for two reasons. First, up until now, research evidence suggested that exercise was useful for reducing episodic craving but provided limited protection against background craving. Second, it highlights the potential of exercise as a harm reduction strategy – extending the period of time between cigarettes and effectively reducing the number of cigarettes smoked in a day (deRuiter & Faulkner, 2006).

A review of the acute exercise and smoking literature suggests that a single session of exercise has the ability to reduce craving, withdrawal and negative affect (Taylor et al., 2007). The DSM-IV lists eight symptoms related to nicotine withdrawal (depressed mood, insomnia, irritability, anxiety, difficulty concentrating, restlessness, decreased heart rate, increased appetite or weight gain) (American Psychiatric Association, 1994) and exercise has been shown to acutely reduce many of these (Taylor & Katomeri, 2007). However, it is important to note that exercise does not consistently alleviate these symptoms. For example, Ussher and colleagues (2001) found that 10 minutes of moderate intensity exercise reduced the symptom of poor concentration, whereas Janse Van Rensburg et al. (2008), using the same duration and intensity, did not (Janse Van Rensburg & Taylor, 2008; Ussher, Nunziata, Cropley, & West, 2001). The results of the present

study also suggest that an acute bout of exercise may reduce some nicotine withdrawal symptoms to a greater extent than others.

Within the present study the withdrawal symptoms were broken down into four categories: psychological symptoms, physical symptoms, appetite, and sedation. This made it possible to specify which withdrawal constructs exercise was able to ameliorate and at what stage in the quit attempt.

Research supports the psychological mood enhancing benefits of acute exercise within the general adult population (Biddle, 2000). The same also seems to be true for female smokers undergoing a quit attempt (Bock et al., 1999). The present study demonstrated that an acute bout of both moderate and vigorous exercise is an effective way to reduce psychological withdrawal symptoms at the beginning and throughout a quit attempt. At week 13 of the programme the results were non-significant. This may be a result of the combination of variables that made up psychological withdrawal on the Shiffman-Jarvik scale. For instance, the withdrawal symptoms of irritability and concentration both contributed to this variable. As previously mentioned exercise does not consistently reduce concentration difficulties associated with quitting; a lack of effect in this instance would have diminished any significant psychological withdrawal effect. An alternative explanation is that the sample size at week 13 was too small for a significant difference to be detected, considering the size of the effect (.115) this is definitely possible.

Amongst the general population vigorous intensity exercise has been shown to suppress appetite (Blundell & King, 2000). It is very common for women to gain weight when they quit smoking (average five kilograms) (Parsons, Shraim, Inglis, Aveyard, & Hajek, 2009). For many women this weight gain is unacceptable and drives them back to

smoking (Schneider & Waters, 2007). Identifying adjunct therapies that can assist quitters trying to avoid weight gain is essential. To our knowledge only one other study has assessed the effect of exercise on the self-reported withdrawal symptom of appetite (Ussher et al., 2001). These researchers found exercise had no effect on appetite, perhaps because they used a less than vigorous intensity exercise protocol. However, the present study found similar results to that of Ussher et al. (2001) when quitters were exercising at both moderate and vigorous intensities. Exercise interventions for smoking cessation do not always report a reduction in post cessation weight gain at the end of the programme (Ussher et al., 2008). If exercise does not effectively reduce the increase in appetite experienced during quitting then potential weight reduction benefits may be thwarted by powerful food cravings. Further research is needed to determine whether exercise leads to a delay in snack foods high in fat and sugar content (Thayer, Peters III, Takahashi, & Birkhead-Flight, 1993).

Following an acute bout of both moderate and vigorous intensity exercise participants experienced an increase in the physical symptoms associated with withdrawal. This finding is most likely a result of the question 'is your heart beating faster than usual'. As you would expect following a bout of moderate to vigorous intensity exercise participants answered yes to this question. Perhaps of clinical importance is determining individual differences, which may influence recommending exercise as an adjunct therapy. For instance, individuals who suffer from anxiety or panic disorders, of which a rapid heartbeat is a distressing symptom, may benefit from reassurance that an increased heartbeat is a normal consequence of exercise (American Psychiatric Association, 1994). Furthermore, it has been suggested that because the decrease in heart-rate is most likely an offset effect (due to less nicotine in the body), there is no relevance for using heart-rate decrease to assess withdrawal (Shiffman et al., 2004).

Hence, the inclusion of heart-rate questioning in the Shiffman-Jarvik scale may be perceived as a limitation of this assessment.

Within the smoking and exercise literature, Taylor and colleagues (2006) reported increases in energy following a one mile brisk walk amongst temporarily abstinent smokers; and Thayer et al. (1993) demonstrated that immediately following five minutes of brisk walking, smokers' energy levels were increased (Taylor, Katomeri, & Ussher, 2006; Thayer et al., 1993). The present study demonstrated that following an acute bout of moderate or vigorous intensity exercise the physical withdrawal symptom of sedation was significantly reduced. Smokers who quit are often plagued by extreme fatigue (TTS, 2010). Present study findings combined with previous research indicate that exercise has great potential to alleviate this debilitating withdrawal symptom.

The current study involved abstinent smokers engaging in both moderate and vigorous intensity exercise. Bock and colleagues (1999) demonstrated that vigorous exercise has the ability to produce acute improvements in withdrawal symptoms, cigarette craving, and negative affect among sedentary women attempting to quit smoking. In comparison, other studies have found vigorous intensity exercise increased withdrawal symptoms in young, adult, sedentary smokers whereas moderate intensity did not (Everson, Daley, & Ussher, 2008).

It was demonstrated that early in a quit attempt involving NRT a bout of moderate intensity exercise was enough to reduce craving and withdrawal symptoms. Later on in the quit process, once smokers garnered some exercise experience, vigorous intensity exercise continued to reduce craving and some withdrawal symptoms. Unfortunately, as the two intensities of exercise occurred at such different times in the quit attempt it was not possible to directly compare intensity effects. It is however possible to infer that an exercise

programme that moves individuals from moderate through to vigorous intensity exercise is feasible. If recently quit smokers can leave a structured exercise programme working out at a vigorous intensity then they have a health advantage over those who leave at a moderate intensity (CSEP). Future research should compare the effects of moderate versus vigorous intensity exercise at different points during the quit attempt.

2.4.2 Magnitude of acute exercise relief as a factor of quit success

The acute exercise paradigm more often than not involves a smoker undergoing a period of temporary abstinence before engaging in exercise. It is assumed from these experimental studies that measures of cigarette craving and nicotine withdrawal symptoms provide a prediction of how well exercise works to keep people off cigarettes (Taylor & Katomeri, 2007). However, a disconnect exists within the literature; whereas temporarily abstinent smokers in an acute setting show a reduction in craving and withdrawal symptoms long-term exercise interventions do not reliably boost smoking abstinence rates (Fiore et al., 2008; Taylor et al., 2007; Ussher et al., 2008).

This study attempted to bridge the gap between these two bodies of research and investigate a possible mechanism responsible for the beneficial effects of exercise. The magnitude of craving and withdrawal relief experienced did not differ between successful and unsuccessful quitters (in an NRT and exercise programme). This finding highlights the complexity of quit success and suggests that numerous factors are involved in determining an individual's quit status.

Craving ratings are a reliable indicator of relapse (Shiffman et al., 1996). Indeed, the present study showed that those who would eventually relapse by the end of the programme started out with higher cigarette cravings following initial smoking abstinence. The findings suggest that

the benefits of exercise are not discriminatory. If the effort is made to exercise during abstinence, regardless of background craving levels, most individuals will experience some acute craving relief. This implies that health practitioners can confidently recommend exercise as a cessation aid to any woman attempting to quit and know that in all likelihood she will experience some acute craving relief. In addition, irrespective of smoking outcome, increases in physical activity should be seen as an important outcome in its own right (deRuiter & Faulkner, 2006).

2.4.3 Limitations

As with any research, there are limitations to this study that are worth noting. The fact that the present study did not include an equal contact control group is a limitation. As such, it cannot be said for certain that any reduction in craving and withdrawal following exercise was specifically related to exercise and not to other environmental factors such as group interaction. However, the main aim was not to determine how well an acute bout of moderate-vigorous intensity exercise reduces craving and withdrawal, as this is reasonably well established, but to determine what factors might be related to exercise effectiveness; and whether exercise reduces craving and withdrawal when on NRT. Regardless, in the future it may be advantageous to have a standard treatment control condition (e.g., NRT plus cognitive behavioural therapy) (Bock et al., 1999).

The findings from the present study are only generalisable to female smokers who managed to use NRT. A large number of individuals were excluded from the analyses because they were not considered smoke free at the time of the intervention. The women included in the week five analyses had a mean Fagerström nicotine dependence score of 5.65, which is considered a medium level of dependence. It may be that this type of intervention in general is more suited to individuals who

are only moderately dependent on nicotine and who can tolerate both regular exercise and NRT use.

Finally, there were many criteria that had to be met (e.g., CO < six ppm, on NRT, came for exercise) before an individual was included in the dataset. The strict inclusion criteria invariably led to a small sample size by week 13, which resulted in the analyses being underpowered.

2.4.4 Future direction

A number of important research questions remain unanswered. For example, the duration of craving and withdrawal relief experienced following the exercise bout was not assessed. Therefore, it remains unclear as to how long post exercise relief persists. Determining the duration of relief exercise provides would help provide insight into the clinical relevance of this type of adjunct as a harm reduction technique.

The present study determined that it is not just the craving and withdrawal relief experienced from a bout of exercise per se that makes exercise a useful tool for quitters. Future research should continue to explore the mechanisms underpinning the beneficial effects of exercise. Determining how exercise works and for whom would allow clinicians to prescribe this cessation aid more effectively.

2.4.5 Conclusions

Promoting exercise among individuals using NRT is appropriate; and can reduce withdrawal and craving symptoms associated with smoking abstinence. The findings demonstrate that exercise can alleviate negative withdrawal symptoms and cigarette cravings at any point during the quit attempt but is of upmost importance early on in the quit. It is important for clinicians recommending exercise to consider the potential benefits (e.g., will help with craving) and limitations (e.g.,

may not help with all psychological withdrawal symptoms) of exercise as a quit smoking aid. The magnitude of the relief felt does not translate to nicotine abstinence success in a 14 week exercise and NRT aided smoking cessation programme. Knowledge of these mechanisms is vital as it offers precise guidance and understanding for both the health professional and quitter. No matter what the mechanism, the immediate relief that female quitters experience following exercise are concrete and universal.

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CHAPTER THREE: EXERCISE MAY HELP SMOKERS QUIT BECAUSE THEY EXPECT IT WILL AND BECAUSE THEY BELIEVE IT IS A CREDIBLE QUIT SMOKING AID

3.1 Introduction

There is much research to suggest that moderate intensity exercise has a positive acute effect on cigarette craving and withdrawal symptoms in temporarily abstinent smokers (Taylor, Ussher, & Faulkner, 2007). The magnitude of reduction in craving and withdrawal reported in these experimental studies shows an acute bout of exercise to be at least as effective as oral nicotine replacement therapy (NRT) (Taylor et al., 2007; West & Shiffman, 2001). However, while there is enough evidence to support clinicians recommending exercise as an adjunct therapy to reduce nicotine craving and withdrawal, there remains scope for improving its effectiveness.

One way to improve the effectiveness of exercise interventions is to identify modifiable factors accountable for the influence of exercise on craving and withdrawal. Beliefs related to treatment credibility and expectancy have been proposed as two such factors in other treatable conditions, such as chronic lower back pain and generalised anxiety disorder (Newman & Fisher, 2010; Smeets, Beelen, Goossens, Schouten, Knottnerus, & Vlaeyen, 2008). These two variables have been shown to be distinct from one another. Credibility refers to how believable, convincing, and logical the treatment seems whereas expectancy refers to treatment outcomes the individual believes or hopes will take place (Kazdin, 1979). Both definitions involve beliefs, which are thought to consist of cognitive and affective components (Devilly & Borkovec, 2000). It is proposed that credibility beliefs are

cognitive in nature whereas expectancy beliefs are affective, similar to those involved in hope (Devilly & Borkovec, 2000).

Patient expectancy and credibility has been shown to influence treatment outcomes in a number of populations. For example, Smeet and colleagues (2008) showed that treatment credibility and expectancy had modest predictive power when it came to treatment outcomes for sufferers of chronic lower back pain (Smeets et al., 2008). Newman and Fisher (2010) found evidence for their hypothesis that positive changes in expectancy and credibility with regards to cognitive behavioural therapy led to positive symptom changes in those suffering from generalised anxiety disorder (Newman & Fisher, 2010). In terms of exercise specifically, it has been proposed that expectancy of the benefits of exercise on mood may influence actual changes in mood following exercise (Salmon, 2001). As an example, Desharnais et al. (1993) conducted an experiment to determine if the exercise-psychological enhancement connection was based on expectancy. They found that following 10 weeks of supervised exercise the control group and experimental group (received information that exercise enhances psychological well-being) had the same fitness improvements. However, the experimental group showed a significant increase in self-esteem over time whereas the control group did not (Desharnais, Jobin, Cote, Levesque, & Godin, 1993). Research on whether credibility beliefs are involved in the actual mood enhancing benefits of exercise does not seem to have been conducted.

Given the research on the psychological constructs of expectancy and credibility it seems reasonable that these beliefs may be associated with the effects of exercise on craving and withdrawal outcomes in an exercise aided quit smoking programme. Daniel and colleagues (2007) have published the only known study to investigate exercise expectations and specific craving and withdrawal outcomes. These

researchers examined whether expectations of the effects of exercise would relate to reductions in cigarette craving and withdrawal in temporarily abstinent smokers following a 10 minute bout of moderate intensity exercise (Daniel, Cropley, & Fife-Schaw, 2007). Forty five sedentary smokers were randomised into one of three groups where they read either a positive, negative or neutral statement concerning the effects of exercise on the withdrawal symptoms associated with smoking abstinence; the manipulation of participants' exercise expectations was deemed successful. Immediately prior to reading the expectancy text and completing a credibility questionnaire, temporarily abstinent smokers engaged in 10 minutes of moderate intensity exercise. Regardless of group, all participants showed a significant reduction in cigarette craving and withdrawal symptoms (e.g., irritability, depression, tension, restlessness, stress, difficulty concentrating) following the bout of exercise. This led these researchers to conclude that "expectations of the effects of exercise on withdrawal and desire to smoke does not influence actual reductions in withdrawal symptoms and desire to smoke" (p. 129). However, the conclusion reached by Daniel et al. (2007) requires further investigation before it can be accepted confidently.

The results of Daniel et al. (2007) were based on the manipulation of expectancy but measured on a credibility scale. Though the terms expectancy and credibility are sometimes used interchangeably there is evidence to suggest that these two constructs are distinct (Devilly & Borkovec, 2000). As such, distinguishing between these two constructs is important (Devilly & Borkovec, 2000). In addition, the results were garnered from a group of temporarily abstinent smokers rather than a group of quitters. Therefore, the severity of symptoms experienced may not correspond entirely with those felt when an individual is fully invested in their quit attempt. As such, it is not possible to generalise these findings to smokers undergoing a real quit attempt. Finally, Daniel

et al. (2007) manipulated exercise expectancy beliefs through text and categorised smokers as either: high, ambiguous or low in expectancy. External validity might be improved by measuring actual exercise expectancy of smokers and categorising them accordingly (Newman & Fisher, 2010). All things considered, the results obtained by Daniel et al. (2007) do not definitively rule out expectancy effects as a possible mechanism for the reductions in craving and withdrawal demonstrated following an acute bout of exercise.

The primary objective of the present study was to examine whether treatment expectancy and credibility were associated with outcome in terms of self-reported craving and withdrawal in a group of women undergoing a real quit attempt. The women involved were supplied with NRT patches as well as an exercise regimen. Thus providing the opportunity for the secondary objective, to compare expectancy and credibility beliefs regarding a well established quit smoking aid such as NRT with a novel quit smoking aid such as exercise. Furthermore, rather than only assess treatment expectancy and credibility before the start of the treatment, when participants may have difficulty judging their actual beliefs regarding treatment outcomes; the present study allowed for the measurement of participants' credibility and expectancy beliefs of two treatments (exercise and NRT) immediately after quitting and at the end of the 14 week programme (Smeets et al., 2008).

It was hypothesised that exercise expectancy and credibility beliefs would contribute to a reduction in craving and withdrawal symptoms following an acute bout of exercise. It was also hypothesised that as participants progressed through the NRT plus exercise aided quit smoking programme their exercise expectancy and credibility beliefs would increase.

3.2 Methods

3.2.1 Participants

Participants included 58 females undertaking the third round of the Getting Physical on Cigarettes (GPOC) trial (Jung, Fitzgeorge, Prapavessis, Faulkner, & Maddison, 2010). The inclusion and exclusion criteria were the same as that outlined in section 2.2.1.

3.2.2 Ethical approval

See section 2.2.2 for details.

3.2.3 Design

3.2.3.1 Getting Physical on Cigarettes

See section 2.2.3.1 for details. The 58 women who took part in the present study all took part in the GPOC trial.

3.2.3.2 The Exercise and Health Psychology Laboratory

See section 2.2.3.2 for details.

3.2.3.3 General procedure

The present study examined whether participants' expectancy and credibility beliefs regarding exercise as a smoking cessation treatment were associated with change, from pre- to post-exercise, in self-reported cigarette craving and withdrawal symptoms (psychological and sedation) at week five. This study also compared participants' expectancy and credibility beliefs regarding NRT and exercise over a 14 week exercise aided smoking cessation programme.

Participants engaged in a 14 week exercise programme, GPOC (Jung et al., 2010), at the Exercise and Health Psychology Laboratory at the University of Western Ontario. On the fourth week of the exercise

programme participants began a smoking cessation attempt, and a 10 week NicoDerm® NRT transdermal patch programme. Pre-intervention assessments were completed before week one, at baseline; post-intervention assessments were completed on a date after the participants' last exercise session, when they had finished the NRT programme, on week 14. A flow-chart of the research design is displayed in Figure 3.1 and a timeline of the measurements and assessments in Table 3.1.

The acute bout of exercise under investigation occurred on the first exercise session on week five, shortly after the participants quit smoking and started NRT (week four). Participants completed the Shiffman-Jarvik Withdrawal Scale (Shiffman & Jarvik, 1976) immediately prior to and following the 20 minute moderate intensity exercise session. Change in nicotine craving and withdrawal symptoms due to an acute bout of exercise was determined by comparing Shiffman-Jarvik subscale scores pre- to post-exercise. To be eligible for this analysis, participants had to demonstrate a carbon monoxide score of < six ppm, adhere to their NRT programme, and follow their acute exercise regime at the appropriate intensity.

Questionnaires pertaining to participants' perceived expectancy and credibility of the two smoking cessation aids (exercise and NRT) were completed immediately before the first exercise session on the appropriate week (Table 3.1). To be eligible for analyses, the participants had to adhere to the NRT programme, and follow the exercise regime.

Table 3.1. Schedule of Assessments

	Week			
	Base-line	**4**	**5**	**14**
Quit Smoking		X		
Demographics Questionnaire	X			
Smoking Ladder	X			
Exercise Readiness	X			
Treatment Expectancy and Credibility Scale	X		X	X
Acute Exercise Regimen			X	
Shiffman-Jarvik Withdrawal Scale (pre-exercise)			X	
Shiffman-Jarvik Withdrawal Scale (post-exercise)			X	
Smoking Variables				
Carbon Monoxide Assessment	X	X	X	X
Fagerström Nicotine Dependence	X			
Smoking Information	X			
Previous Patch Use	X			
Exercise Variables				
Actical Exercise Behaviour	X			
Godin Lesiure Time Questionnaire	X			X
Peak VO_2 Fitness Assessment	X			X

Note. Baseline refers to pre-trial and week 14 refers to post-trial. Participants began their smoking cessation attempt and nicotine replacement therapy (NRT) on week four (quit week).

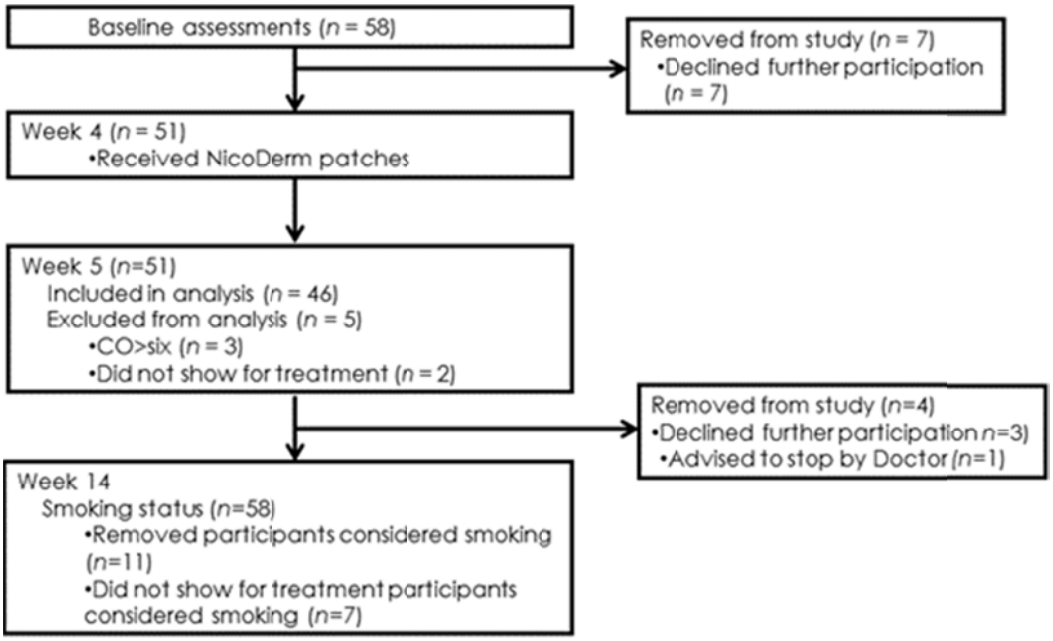

Figure 3.1. Research design and flow of participants through the trial.

3.2.4 Exercise regimen

See section 2.2.4 for details

3.2.4.1 Acute exercise regimen: Week 5

The acute exercise session, which occurred on week five, consisted of 20 minutes of at least moderate intensity exercise, defined as the participant achieving a heart-rate of at least 50% of her heart-rate reserve (HRR) (CSEP).

3.2.5 Nicotine replacement therapy regimen

All participants were provided with NRT in the form of NicoDerm® transdermal patches. Participants were asked to wear the nicotine patches for 24 hours a day, seven days a week, for 10 weeks as per the manufacturer's recommendations.

3.2.5.1 NicoDerm® three step programme

See section 2.2.5.1 for details.

3.2.5.2 NicoDerm® two step programme

See section 2.2.5.2 for details. Seven of the 58 participants were on the two step programme.

3.2.6 Demographic measures

See section 2.2.6 for details. These variables are described in Table 3.2.

3.2.6.1 Nicotine dependence and other smoking characteristics

See section 2.2.6.2 for details. These variables are described in Table 3.2.

3.2.6.2 Previous patch use

Participants were asked whether they had used the nicotine replacement therapy patch in the past, the number of quit attempts it was used with and whether they found it enhanced their previous quit attempt. These variables are described in Table 3.2.

3.2.6.3 Programme adherence

See section 2.2.6.1 for details.

3.2.6.4 Smoking ladder scale

The smoking ladder scale was administered at baseline and used to determine whether or not a participant was ready to quit smoking (Biener & Abrams, 1991; Prochaska & DiClemente, 1983). This scale separated smokers into one of five categories of varying degrees of readiness to quit, and is based on the stages of change: pre-contemplation (one and two on the ladder); contemplation (three and four on the ladder); preparation (five and six on the ladder); maintenance (seven and eight on the ladder); and action (nine and 10 on the ladder). Ten statements were presented (two based on each stage) and participants were asked to tick only one statement – the statement that best described their current thoughts about quitting

smoking. These variables are described in Table 3.2. See Appendix 5 for a copy of this questionnaire.

3.2.7 Physical activity behaviour

3.2.7.1 Godin leisure time exercise questionnaire (LTEQ)

Subjective accounts of exercise behaviour were obtained via the Godin LTEQ at baseline and week 14 assessments. The Godin LTEQ measured exercise specifically, covering the frequency of mild, moderate and strenuous exercise performed during free time for at least 15 minutes during the past seven days. A total score was derived by summing the reported weekly frequency (f) of participation at each of the three intensity levels multiplied by the corresponding estimated metabolic equivalents (METs) value (e.g., [f]3 [mild] + [f]5 [moderate] + [f]9 [strenuous]). A MET is a unit that represents the metabolic equivalent of an activity expressed in multiples of resting rate of oxygen consumption (CSEP). These variables are described in Table 3.2. See Appendix 6 for a copy of this questionnaire.

3.2.7.2 Actical® accelerometer

See section 2.2.7.1 for details. Only the pre-intervention results for this objective measure of exercise behaviour were collected and presented. This variable is described in Table 3.2.

3.2.7.3 Peak VO_2 fitness assessment

See section 2.2.7.2 for details. These variables are described in Table 3.2.

3.2.7.4 Stage of exercise readiness questionnaire

The stage of exercise readiness questionnaire was administered at baseline and used to determine whether or not a participant was physically active on a regular basis (Prochaska & DiClemente, 1983).

This questionnaire separated people into one of five categories of varying degrees of exercise behaviour: pre-contemplation – do not exercise on a regular basis and are not thinking about changing in the next six months, contemplation – do not currently exercise on a regular basis but are thinking about changing in the next six months, preparation – exercise sometimes but not on a regular basis, maintenance – exercise regularly and have been doing so for the last six months, or action – exercise regularly and have done so for longer than six months. Five statements were presented (one based on each stage) and participants were asked to tick only one statement – the statement that best describes their current physical activity behaviour. The SERQ has a demonstrated reliability of 0.78 when taken over a two week period (Marcus, Rakowski, & Rossi, 1992). This variable is described in Table 3.2. See Appendix 7 for a copy of this questionnaire.

Table 3.2. Demographic characteristics, exercise and smoking behaviour.

Variable	Mean (SD), %
Demographics:	
Age	42.72 (13.43)
Language spoken at home (% English)	96 %
Married	32 %
Yearly household income:	
Below $50,000	56 %
Between $50,000 and $75,000	11 %
Above $75,000	33 %
Number of children	1.89 (2.35)
Occupation:	
Employed	73 %
Student	13 %
Unemployed	14 %
Value quitting smoking at baseline (one - nine)	
Four – six = somewhat	2%
Seven – nine = extremely	98%
Readiness for Change:	
Cessation Readiness:	
Pre-contemplation	0 %
Contemplation	0 %
Preparation	53 %
Action	40 %
Maintenance	7 %
Exercise Readiness:	
Pre-contemplation	0 %
Contemplation	51 %
Preparation	35 %
Action	7 %
Maintenance	7 %
Exercise behaviour:	
Objective physical activity (Actical)	
Pre-intervention (minutes per week MPVA)	99.50 (73.31)
Pre-intervention (number of bouts > 10 minutes)	0.80 (1.54)
Self-report physical activity (Godin)	
Pre-intervention (metabolic equivalent)	18.22 (17.13)
Post-intervention (metabolic equivalent)	39.69 (21.86)
Peak VO_2 (ml/kg/min):	
Pre-intervention	23.23 (6.32)
Post-intervention	31.16 (6.82)
Carbon monoxide (CO) reading:	
Pre intervention (baseline)	11.96 (9.25)
Post intervention (14 weeks)	6.83 (11.07)
Smoking behaviour:	
Cigarettes per day	17.80 (8.24)
Number of years smoking	22.54 (12.93)

Fagerström test of nicotine dependence	5.02 (2.16)
Percentage of family and friends that smoke:	
Between 0 and 10%	32 %
Between 10 and 20%	14 %
Above 20%	54 %
Number of previous quit attempts	6.49 (14.54)
Previously tried to quit smoking with nicotine patch	51%
Previous quit attempts with nicotine patch:	
One	56%
Two	26%
Three	9%
Four	9%

3.2.8 Outcome Measures

3.2.8.1 Treatment expectancy and credibility questionnaire

The treatment expectancy and credibility questionnaire (ECQ) was developed by Devilly and Borkovec (2000) and adapted for use in the current study. The original showed good internal consistency and good test-retest reliability (Devilly & Borkovec, 2000). The participant was asked to judge whether she thought or felt that the treatment would help her to quit smoking. The ECQ consisted of seven items. Items one, two, and three in set I, relate to the construct of credibility and are considered 'think' items. Item four from set I, and items one and two from set II, relate to the construct of expectancy. Expectancy item four was a 'think' item and items one and two were 'feel' questions. In addition, item five was a measure of how valued the outcome of quitting smoking was to the individual. The ECQ used a nine point scale, and responses to questions were either one (not at all) to nine (extremely), or one (none) to nine (all). For each question (except question five) participants had to provide a response for both exercise and NRT. To examine change over time, the CEQ was administered at baseline, week five, and week 14. Reliability analyses (Cronbach's alpha scores) were computed for EX-EXP, EX-CRED, NRT-EXP, and NRT-CRED at these time points. All alpha values reflected an acceptable

level of reliability and are presented in Appendix 16 (Kline, 1993). See Appendix 9 for a copy of this questionnaire.

3.2.8.2 Smoking withdrawal

See section 2.2.8.1 for details of the Shiffman-Jarvik withdrawal scale. Only the craving, sedation, and psychological symptoms subscales were analysed. The rationale was that only these variables exhibited pre- to post-exercise change in study one (chapter two). Reliability analyses (Cronbach's alpha scores) were computed at week five, using the before acute exercise session raw data for the constructs of craving and psychological symptoms. All alpha values reflected an acceptable level of reliability and are presented in Appendix 16 (Kline, 1993).

The scale was administered immediately before and after the acute exercise session on week five; only data pertaining to those participants who reached the exercise intensity goal, followed the NRT protocol, and abstained from smoking were included in the analyses. Data were expressed as a magnitude of change (pre- to post-exercise) reduction score.

3.2.8.3 Smoking abstinence

See section 2.2.1.1 for details.

3.2.9 Challenges and considerations

3.2.9.1 High versus low exercise expectancy and credibility

Participants were categorised as either 'high' or 'low' in terms of their perceptions of exercise credibility and expectancy as a smoking cessation treatment. The categories were developed using the cut point function in the IBM SPSS Statistics 19 software. The number of cut points chosen was one. The low group (credibility and expectancy)

was only low relative to the high group (*M* [low group] = 6.93 vs. *M* [high group] = 8.71, credibility; *M* [low group] = 7.01 vs. *M* [high group] = 8.80, expectancy). Descriptive statistics for the high and low exercise credibility and expectancy groups can be found on Table 3.3.

3.2.9.2 Physical activity measurement

Due to the time frame of the research it was not possible to obtain an objective measurement of post-intervention physical activity behaviour for this group of participants. Therefore, in terms of post-intervention physical activity behaviour only self-report data was available and reported in this study. It has been demonstrated that people tend to over report their physical activity data when they self-report, making it a less accurate measurement of physical activity than when objectively measured (Taber, Stevens, Murray, Elder, Webber, Jobe, & Lytle, 2009).

3.2.9.3 Smoking abstinence

See section 2.2.2.1 for details.

3.2.9.4 Nicotine replacement therapy

See section 2.2.2.3 for details. Specific to this group of women, four participants opted to take the patch off while sleeping. These participants were warned that their nicotine levels would be decreased in the morning and withdrawal symptoms and cravings may be higher. Data from these individuals were included in the analyses if the participants met the smoking abstinence and exercise intensity requirements.

3.2.9.5 Participant retention

Although no costs were incurred to the participants for the use of the exercise equipment, NRT, or for campus parking, retention of participants for 14-weeks was a challenge. Despite contact via

telephone and email to keep participants in the trial, participant drop-out occurred. Participants who dropped out prior to week 14 assessments and/or did not attend week 14 assessments were considered to be smoking post-intervention.

The number of participants differed from week to week due to attrition and absenteeism. A total of 28 participants provided continuous (baseline, week five, week 14) abstinent smoker questionnaire data; nine participants provided continuous (baseline, week five, week 14) non-abstinent smoker questionnaire data.

3.2.10 Power calculation

20 participants would be required in both the high and low expectancy groups to provide power of 80% ($p < 0.05$) to detect a 1.1 mean difference (SD – 1.2) between groups (pre- to post-exercise) for cigarette cravings. Hence, if the low expectancy group has a 0.7 magnitude of change pre- to post-exercise, the high expectancy group must have a 1.8 magnitude of change to detect a significant difference. No power calculation was computed for the exploratory question – comparing between participants' expectancy and credibility beliefs regarding NRT and exercise over a 14-week NRT plus exercise aided smoking cessation programme.

3.2.11 Statistical analyses

Separate repeated ANOVAs were used to analyse differences between the high and low expectancy groups in cigarette craving and psychological withdrawal pre- to post-exercise for the acute exercise session at week five. Separate repeated ANOVAs were also used to analyse differences in the expectancy and credibility constructs of exercise and NRT at different time points (baseline, week five, week 14), and to determine change over time. Univariate ANOVAs were conducted to compare week 14 EX-EXP between smokers and non-

smokers, and differences between week 14 EX-CRED with NRT-CRED for non-smokers. Pearson product moment correlations were used to examine relationships between EX-EXP, EX-CRED, NRT-EXP, NRT-CRED, NRT patch experience, and exercise programme attendance. Planned comparison t-tests were used to compare baseline exercise variables to week 14 exercise variables. A chi-square was used to determine the relationship between week 14 smoking abstinence and exercise programme adherence.

3.3 Results

3.3.1 Does the magnitude of withdrawal relief relate to exercise expectancy and exercise credibility beliefs?

Exercise expectancy and exercise credibility scores at week five were highly correlated (n = 47, r = .847, p < .001 [2-tailed]). Descriptive statistics for the high and low[2] EX-EXP and EX-CRED groups are presented in Table 3.3.

Table 3.3. Descriptive statistics for the classifications of high and low exercise expectancy and credibility at week five.

	Exercise Expectancy					Exercise Credibility				
	N	Min	Max	Mean	SD	N	Min	Max	Mean	SD
LOW	30	3.00	8.00	7.01	1.14	21	3.67	8.00	6.93	1.25
HIGH	17	8.33	9.00	8.80	.26	26	8.33	9.00	8.71	.29

Those considered high in EX-EXP at week five had a significantly greater reduction in cigarette craving following an acute bout of exercise when compared to those lower in EX-EXP (F[1,39] = 5.591, p < .05, η^2 = .113) (Figure 3.2). Similar results were demonstrated for EX-CRED at week five, with those in the high EX-CRED group experiencing a greater

[2] For ease of expression the two expectancy and credibility groups will be called high and low. However, in this instance the low group is only low relative to the high group. See Table 3.3 for a breakdown of the group actual frequencies.

reduction in craving compared to their counterparts who were lower in EX-CRED (F[1,44] = 6.511, p < .05, η^2 = .129) (Figure 3.3).

Following an acute bout of exercise at week five, there was no significant difference in the magnitude of reduction for psychological or sedation withdrawal symptoms between women high in EX-EXP and those who were low in EX-EXP (psychological: F[1,39] = 2.556, p = .117, η^2 = .055; sedation: F[1,39] = .257, p = .615, η^2 = .006) (Figure 3.2). Similar results were demonstrated for EX-CRED at week five, (psychological: F[1,39] = 2.413, p = .127, η^2 = .052; sedation: F[1,39] = 1.425, p = .239, η^2 = .031) (Figure 3.3). It is however worth mentioning that for both EX-CRED and EX-EXP those in the high group experienced a greater reduction in psychological and sedation withdrawal symptoms following an acute bout of exercise.

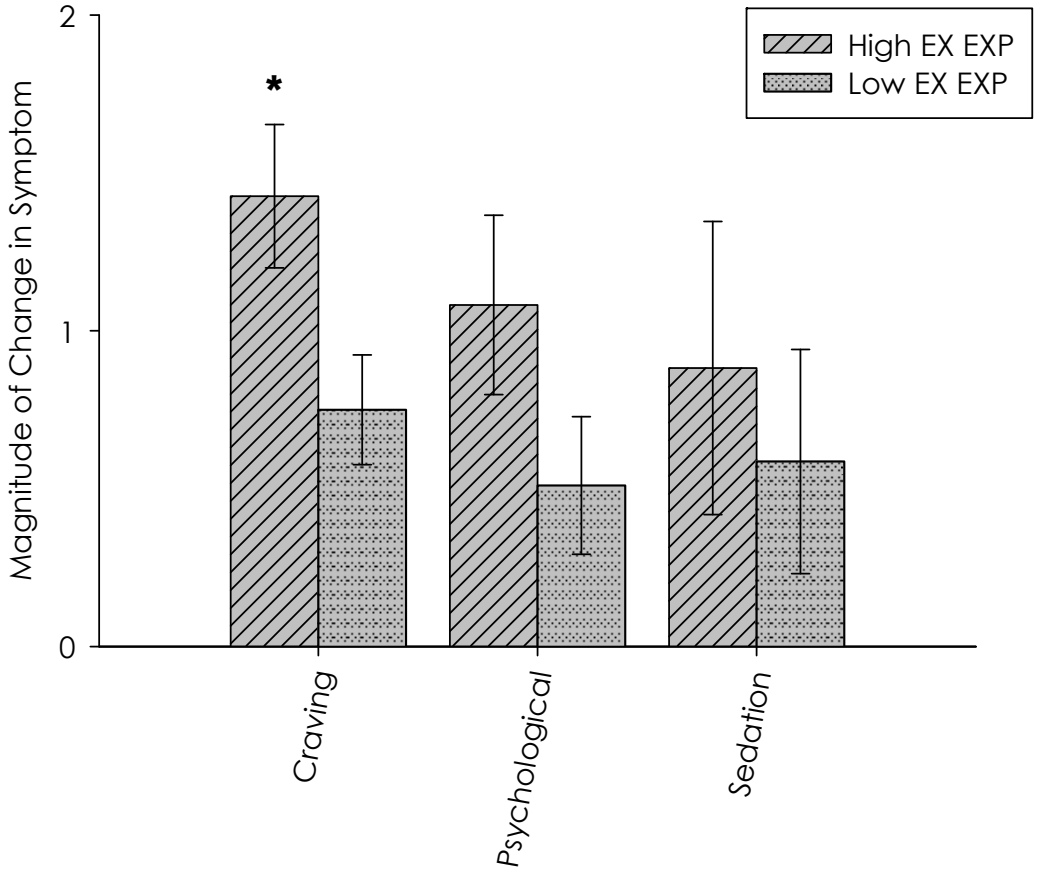

Figure 3.2. Change in withdrawal symptoms before and after an acute bout of exercise at week five between recently quit smokers classified as high (*n* = 14) or low (*n* = 27) in exercise expectancy (EX-EXP) (* $p < 0.05$).

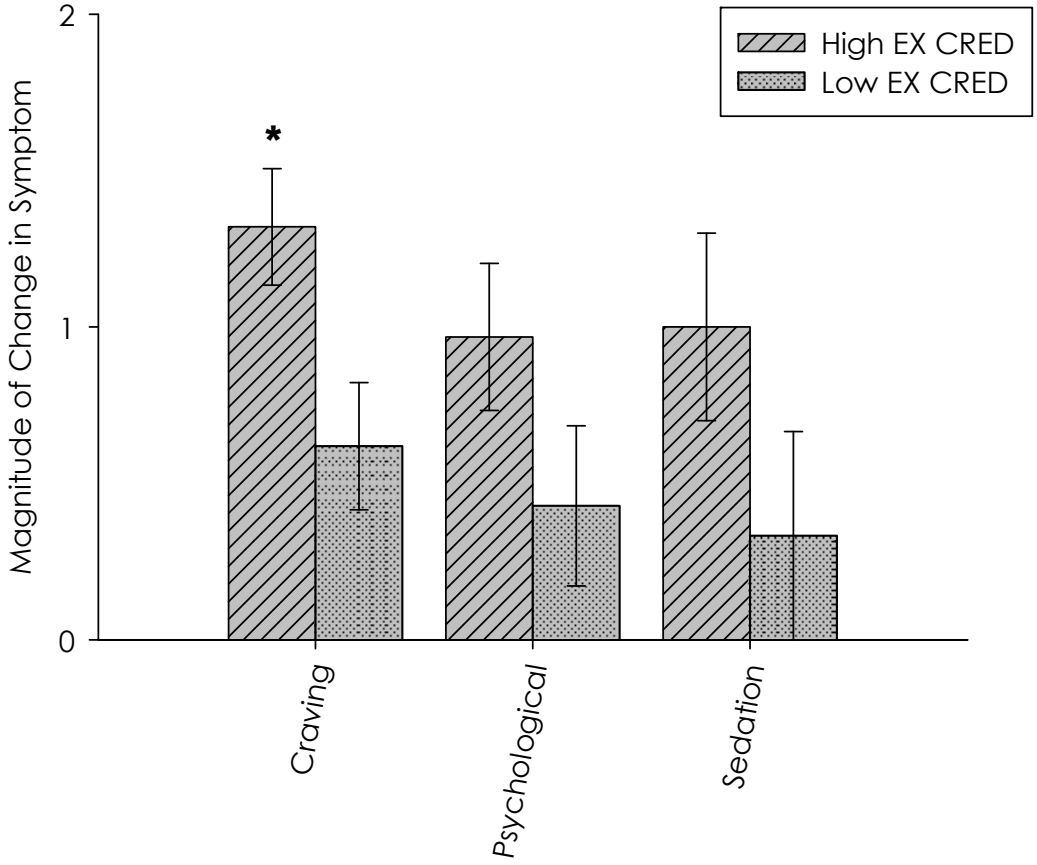

Figure 3.3. Change in withdrawal symptoms before and after an acute bout of exercise at week five between recently quit smokers classified as high or low in exercise credibility (EX-CRED). Craving: high (*n* = 25) low (*n* = 21); psychological and sedation: high (*n* = 22) low (*n* = 19) (* $p < 0.05$).

Irrespective of EX-EXP and EX-CRED beliefs significant reductions in cigarette craving at week five were demonstrated following exercise for all participants regardless of week five exercise EX-EXP (*n* = 41) or EX-CRED (*n* = 46) score (EX-EXP: $F[1,39] = 45.952$, $p < .001$, $\eta^2 = .541$; EX-CRED: $F[1,44] = 50.453$, $p < .001$, $\eta^2 = .534$). Significant reductions in psychological symptoms related to nicotine abstinence were also demonstrated at week five following exercise regardless of EX-EXP or EX-CRED beliefs at week five (*n*=41) (EX-EXP: $F[1,39] = 19.941$, $p < .001$, $\eta^2 = .338$; EX-CRED: $F[1,39] = 15.181$, $p < .001$, $\eta^2 = .280$). Similarly, a significant reduction in the nicotine withdrawal symptom of sedation

was demonstrated at week five for all participants regardless of EX-EXP or EX-CRED beliefs reported at week five (*n*=41) (EX-EXP: *F*[1,39] = 12.504, $p < .001$, $\eta^2 = .243$; EX-CRED: *F*[1,39] = 10.153, $p < .003$, $\eta^2 = .207$).

3.3.2 Expectancy and credibility change throughout the programme

A significant increase over time for ratings of NRT expectancy (NRT-EXP) and exercise expectancy (EX-EXP) was demonstrated for women who were smoke free at week 14 (CO<6ppm) (*F*[2,108] = 3.720, $p < .05$, $\eta^2 = .064$) (Figure 3.4). There was no significant group (NRT, exercise) by time interaction (*F*[2,108) = .021, $p = .980$, $\eta^2 = .000$) (Figure 3.4).

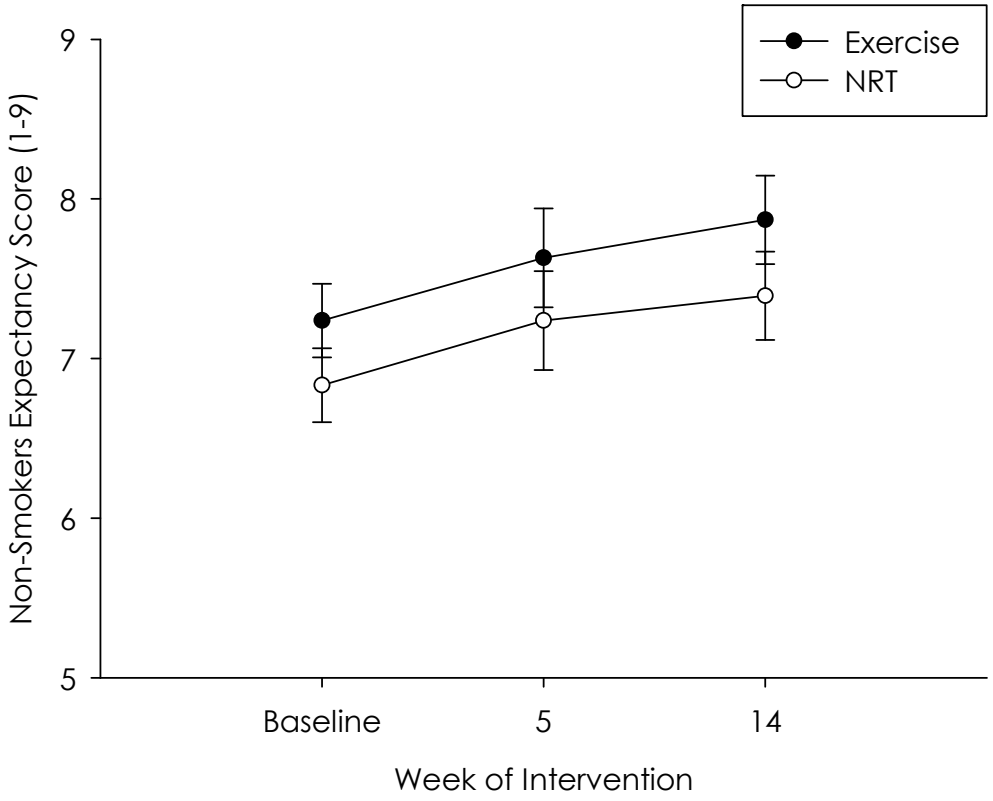

Figure 3.4. Exercise and NRT expectancy scores for women considered non-smokers at the end of the programme (*n* = 28; CO < six ppm). Significant change over time for both exercise and NRT expectancy ($p < 0.05$).

A significant increase over time for ratings of NRT credibility (NRT-CRED) and exercise credibility (EX-CRED) was demonstrated for women who were smoke free at week 14 (CO < six ppm) (F[2,108] = 8.920, p < .001, η^2 = .252) (Figure 3.5). Overall there was no significant time by group interaction (F[2,108] = 1.990, p = .147, η^2 = .070) (Figure 3.5). Between baseline and week 14 both EX-CRED and NRT-CRED increased; from week five to week 14 EX-CRED reduced slightly whereas NRT-CRED increased slightly. However, due to the exploratory nature of the research a univariate ANOVA was conducted to determine if there was a significant difference between week 14 EX-CRED (M – 7.399, SD – 1.659) and NRT-CRED (M – 8.016, SD – 1.125) for these non-smokers. No significant difference was demonstrated (F[1,58] = 2.837, p = .097, η^2 = .047) (Figure 3.5).

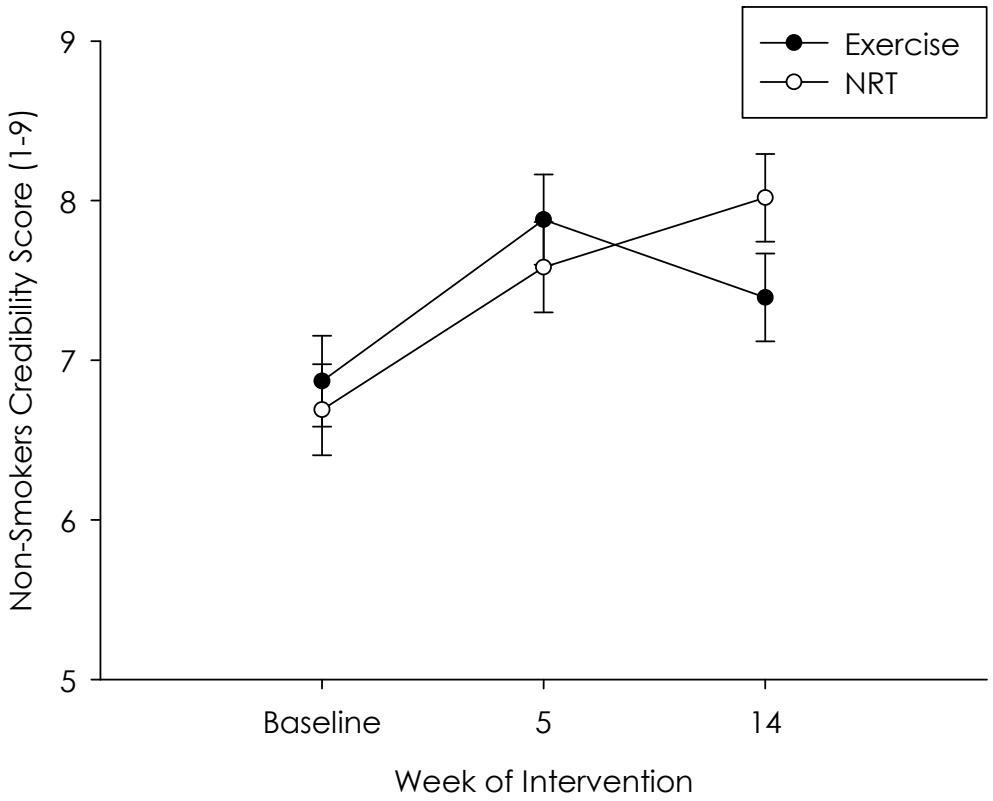

Figure 3.5. Exercise and NRT credibility scores for women considered non-smokers at the end of the programme (*n* = 28, CO < six ppm). Significant change over time for both exercise and NRT credibility ($p < 0.05$).

No significant change over time for ratings of EX-EXP were observed for women considered smokers at week 14 (CO > six ppm) and women considered non-smokers at week 14 (CO < six ppm) ($F[2,70] = 1.068$, $p = .355$, $\eta^2 = .059$) (Figure 3.6). Both groups of women (week 14 smokers, non-smokers) showed a slight increase from baseline to week five for EX-EXP and then diverged, with non-smokers demonstrating a slight increase from week five to week 14 and smokers showing a slight decrease from week five to week 14. However, there was no significant difference over time between these two groups on EX-EXP ($F[2,70] = 1.180$, $p = .319$, $\eta^2 = .065$) (Figure 3.6). Again, due to the exploratory nature of the research a univariate ANOVA was conducted to determine if there was a significant difference between week 14 EX-EXP

for smokers (*M* – 7.233, *SD* – 1.165) and non-smokers (*M* – 7.799, *SD* – 1.176). No significant difference was demonstrated (*F*[1,58] = 1.748, *p* = .194, η^2 = .044) (Figure 3.6).

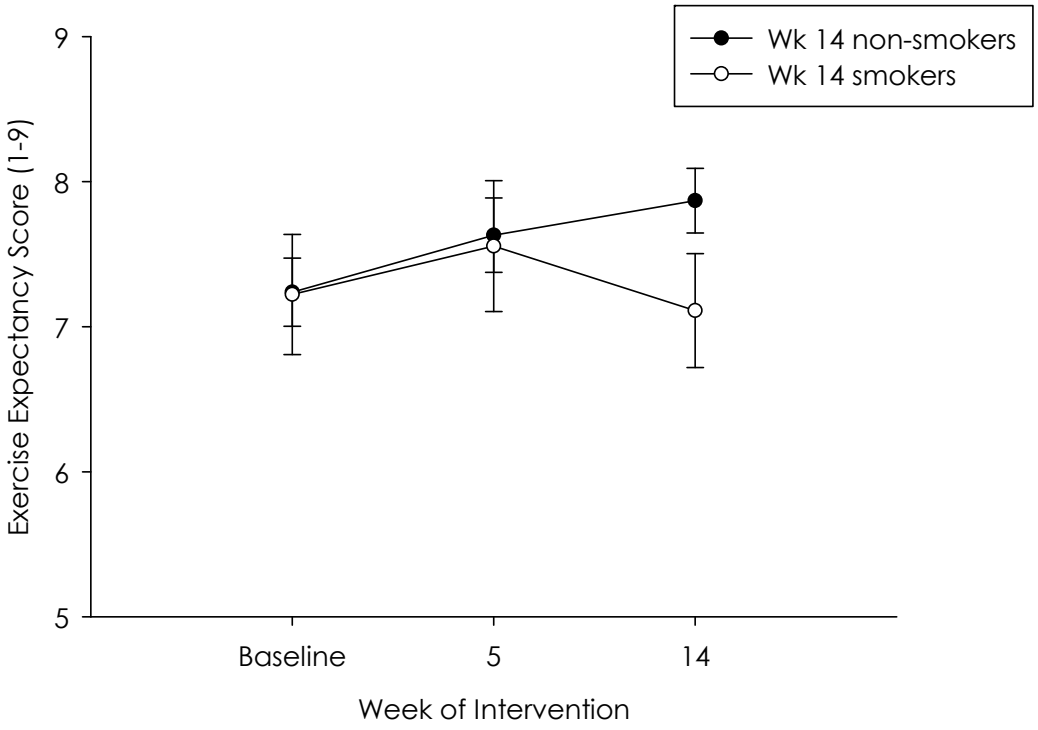

Figure 3.6. Exercise expectancy scores for women considered smokers (*n* = 9, CO > six ppm) and non-smokers (*n* = 28, CO < six ppm) at the end of the programme.

A significant change over time for ratings of EX-CRED was observed for women considered smokers at week 14 (CO > six ppm) and women considered non-smokers at week 14 (CO < six ppm) (F[2,70] = 4.968, p < .01, η2 = .124) (Figure 3.7). Both groups of women showed an increase from baseline to week five for EX-CRED and a slight decrease from week five to week 14. However, EX-CRED at week 14 for both groups was higher than at baseline (Figure 3.7). There was no significant difference between over time these two groups on EX-CRED (*F*[2,70] = .036, *p* = .965, η^2 = .001) (Figure 3.7).

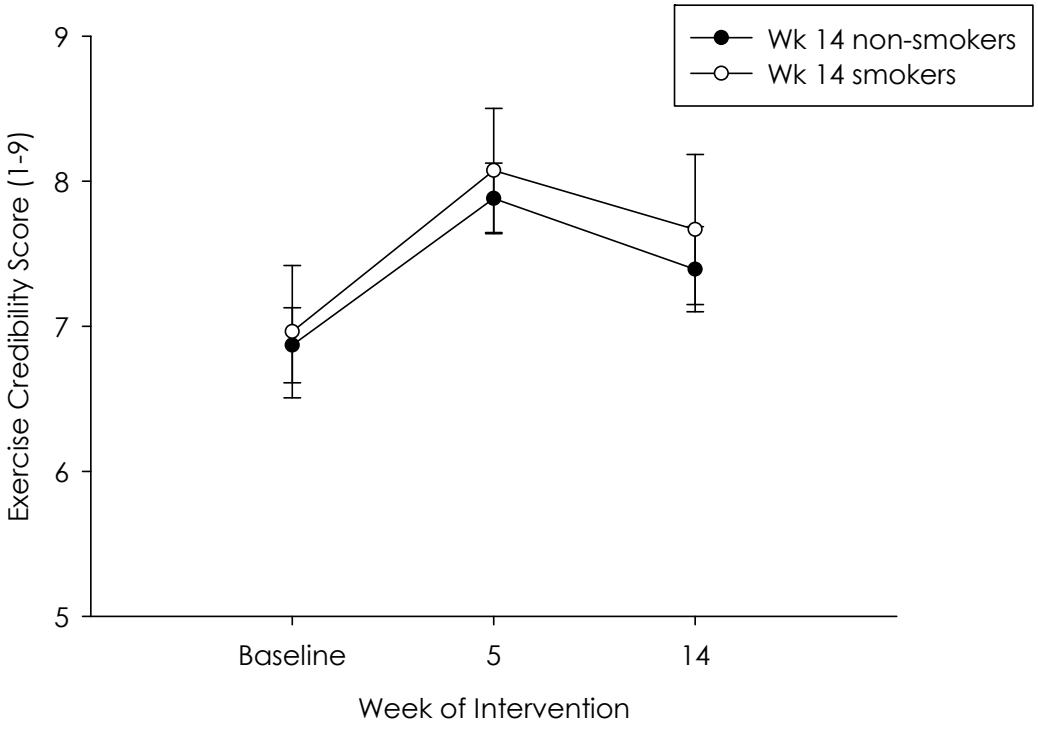

Figure 3.7. Exercise credibility scores for women considered smokers (*n* = 9, CO > six ppm) and non-smokers (*n* = 28, CO < six ppm) at the end of the programme. Significant change over time for exercise credibility ($p < 0.05$).

No significant change over time was demonstrated for ratings of NRT-EXP for women who were smoking at week 14 and those who were not smoking at week 14 ($F[2,70] = 1.751$, $p = .181$, $\eta^2 = .048$) (Figure 3.8). There was no significant interaction effect between smokers and non-smokers in NRT-EXP ($F[2,70] = .322$, $p = .726$, $\eta^2 = .009$) (Figure 3.8).

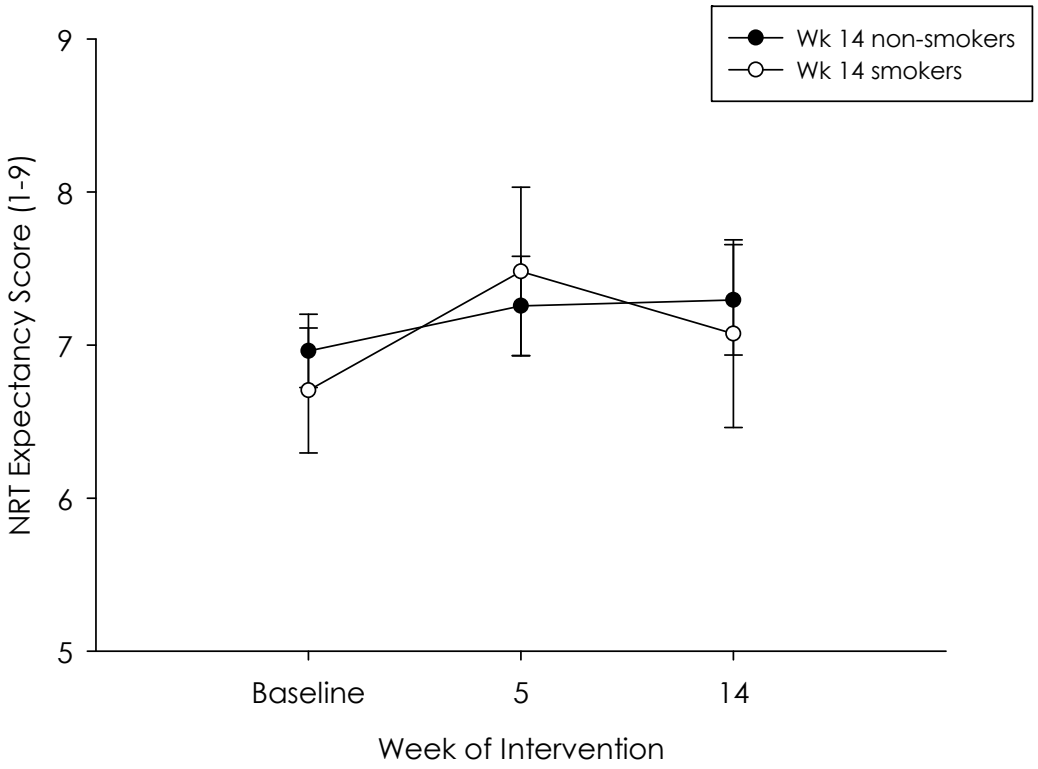

Figure 3.8. NRT expectancy scores for women considered smokers (*n* = 9, CO > six ppm) and non-smokers (*n* = 28, CO < six ppm) at the end of the programme.

A significant increase over time for ratings of NRT-CRED was observed for smokers and non-smokers ($F[2,70] = 7.355$, $p < .001$, $\eta^2 = .174$) (Figure 3.9). There was no significant interaction effect between smokers and non-smokers in NRT-CRED ($F[2,70] = .175$, $p = .840$, $\eta^2 = .005$) (Figure 3.9).

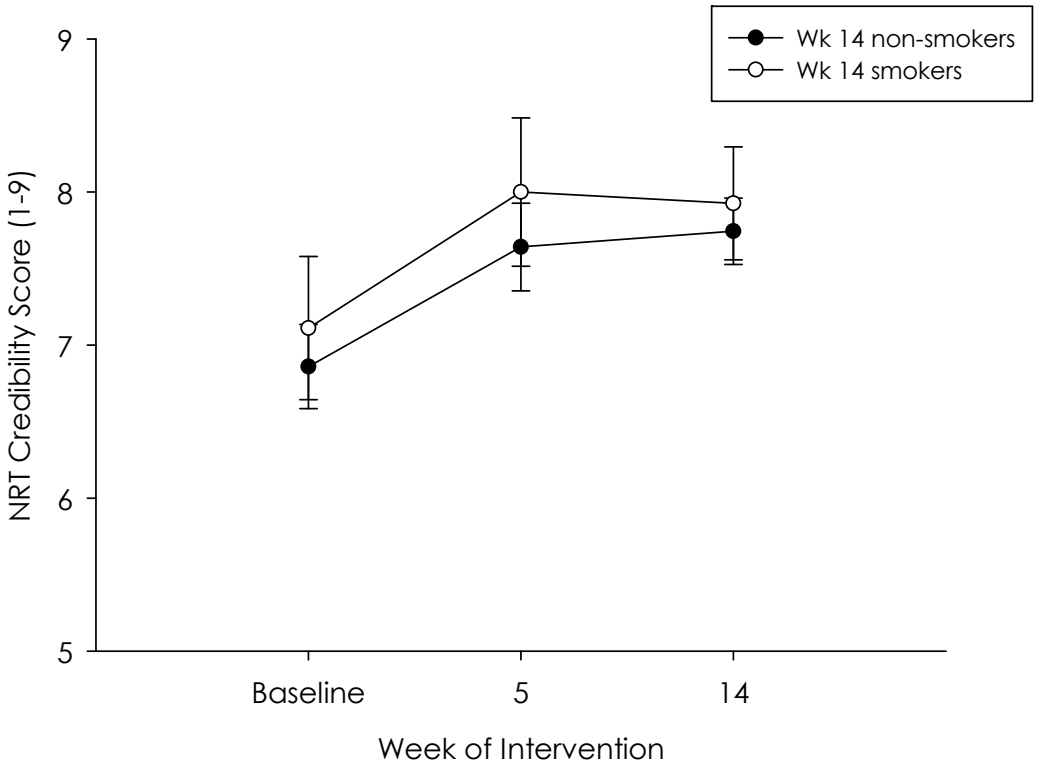

Figure 3.9. NRT credibility scores for women considered smokers (*n*=9, CO>6ppm) and non-smokers (*n*=28, CO<6ppm) at the end of the programme. Significant change over time for NRT credibility ($p < 0.05$).

3.3.3 Were EX-EXP and EX-CRED changes over time different between those who were high vs. low in these variables?

No significant difference in change in EX-EXP over time (baseline to week five) was demonstrated between the low and high EX-EXP groups ($F[1,40] = 3.390$, $p = .073$, $\eta^2 = .078$). Similarly, no significant difference in EX-CRED over time (baseline to week five) was demonstrated between the low and high EX-CRED groups ($F[1,40] = 3.320$, $p = .076$, $\eta^2 = .077$) However, a trend effect was observed for both EX-EXP and EX-CRED, with the high expectancy and credibility groups exhibiting a greater increase in EX-EXP and EX-CRED than the low expectancy and credibility groups (Table 3.4).

Table 3.4. Baseline and week five exercise expectancy and credibility scores for high and low exercise expectancy and credibility groups.

	Exercise Expectancy				Exercise Credibility			
	LOW (*n* = 28)		HIGH (*n* = 14)		LOW (*n* = 19)		HIGH (*n* = 23)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Baseline	7.00	1.14	7.97	0.93	6.49	1.41	7.46	1.25
Week five	7.05	1.16	8.78	0.28	6.89	1.30	8.71	0.29

3.3.4 Correlations

No significant correlations (p > .05) were found between previous patch use experience and NRT-EXP (baseline [r = .198]; week five [r = .030]; week 14 [r = -.036]) or NRT-CRED (baseline [r = .150]; week five [r = -.098]; week 14 [r = -.134]). Similarly, no significant correlations were demonstrated between the percent of previous quit success attributed to the patch and NRT-EXP (baseline [r = .382]; week five [r = .027]; week 14 [r = .047]) or NRT-CRED (baseline [r = .100]; week five [r = .006]; week 14 [r = .013]).

No significant correlations (p > .05) were found between exercise programme attendance and EX-EXP (baseline [r = -.044]; week five [r = .144]; week 14 [r = .257]) or EX-CRED (baseline [r = -.162]; week five [r = .241]; week 14 [r = .192]).

A significant correlation (p < .05) was found between EX-CRED and NRT-CRED (r = .447, p < .01). However, no significant correlation (p > .05) was found between EX-EXP and NRT-EXP (r = .227).

3.3.5 Smoking cessation outcomes

48.1% (n = 38) of participants were able to quit smoking on the week four quit date (CO < six ppm). At the end of the programme (week 14) 60.3% of participants were considered smoke free (CO < six ppm). Smoking abstinence was related to attendance to the exercise programme (x^2[2, n = 58] = 14.758, p = .001) (Table 3.5).

Table 3.5. Breakdown of participants smoking status at week 14 in relation to attendance to the exercise portion of the programme (*n* = 58)

	Exercise Programme Attendance			
	80-100%	60-80%	<60%	Total
Non-smoking at week 14				
Number of participants	27	2	6	35
Percent of total	46.6%	3.4%	10.3%	60.3%
Smoking at week 14				
Number of participants	6	4	13	23
Percent of total	10.3%	6.9%	22.4%	39.7%

3.4 Discussion

3.4.1 Exercise expectancy and credibility scores as a factor of craving and withdrawal relief

Similar to the work of Daniel et al. (2007), participants were categorised as either high or low in EX-EXP and EX-CRED at week five. Interestingly, it was demonstrated that individuals who were categorised as high in EX-EXP and EX-CRED had a significantly greater reduction in craving following an acute 20 minute bout of moderate intensity exercise, compared to those who were categorised as low in these two variables. This finding contradicts the findings of Daniel et al. (2007), but is in accordance with the psychotherapy outcome research that underscores the influence of these two variables (Newman & Fisher, 2010; Smeets et al., 2008). However, no significant differences between high and low groups were found for either psychological withdrawal, or the withdrawal symptom of sedation, findings that concur with those reported by Daniel et al. (2007). In addition, in accordance with Daniel and colleagues (2007), regardless of EX-EXP and EX-CRED beliefs all participants experienced a reduction in craving and withdrawal following an acute bout of moderate intensity exercise. Taken together, these findings suggest that expectancy and credibility beliefs are not a major mechanism by which exercise reduces the debilitating effects of

nicotine abstinence amongst both temporarily and recently quit smokers, but they may play some role.

Overall, the findings relating to the magnitude of craving and withdrawal relief experienced following exercise, both contradict and corroborate those of Daniel et al. (2007). This disparity may best be explained by examining the differences between these two studies. In the first instance, the participants that took part in the Daniel et al. (2007) study were required only to engage in temporary abstinence (12-15 hours) whereas the women who took part in the present study signed up for a 14 week exercise aided quit smoking programme. Therefore, the women in this study were fully invested in a quit attempt at week five of the programme, when the difference in craving between groups was observed. In the psychotherapy literature, there is evidence to suggest that the more invested in treatment outcomes an individual is, the greater the influence of expectancy and credibility beliefs on therapeutic effects (Greenberg, Constantino, & Bruce, 2006).

Recently, change in expectancy has been suggested as a mechanism by which cognitive behavioural therapy leads to symptom change in generalised anxiety disorder (Newman & Fisher, 2010). Within the present paradigm, women in the high EX-EXP and EX-CRED group demonstrated an increase in these variables from baseline to week five whereas those in the low EX-EXP and EX-CRED groups did not. Although this difference was not significant, it provides support for the notion that positive changes in expectancy and credibility beliefs, in relation to treatment, support improvement in symptoms.

The results of Daniel and colleagues (2007) were based on a manipulated EX-EXP. In contrast, participants EX-EXP in the present study developed throughout the five weeks they were taking part in the intervention. As such, naturally occurring exercise expectancy

scores in the high EX-EXP group (mean 8.8/9) were greater than those in the Daniel et al. (2007) manipulated high EX-EXP group (mean 7.5/10). Perhaps, to experience an added reduction in craving recently quit smokers had to believe, almost without a doubt, that exercise would reduce the cigarette cravings associated with nicotine abstinence.

Daniel and colleagues (2007) based their findings on the manipulation of expectancy measured on a credibility scale. Although expectancy and credibility beliefs may share commonalities they are essentially different (Devilly & Borkovec, 2000). Smokers may think that a new treatment such as exercise is credible, but this may differ from what they really feel or expect will be the outcome of treatment. As such, the findings of Daniel et al. (2007) may not actually be based on participants' expectancies and should be interpreted with caution.

In the present study participants engaged in 20 minutes of moderate intensity exercise as opposed to 10 minutes. In the acute exercise and smoking literature 20 minutes of moderate intensity exercise has been shown to have a greater impact on craving and withdrawal symptoms in temporarily abstinent smokers compared to 10 minutes of the same intensity exercise (Taylor et al., 2007). Perhaps, duration of exercise and EX-EXP interact in a way that impacts the influence of this variable on craving outcomes following an acute bout of exercise.

All women in the present study were using NRT in conjunction with exercise to help them quit smoking. Smokers in the Daniel et al. (2007) study were only temporarily abstinent and as such were not on NRT. In this instance, it is difficult to explain how NRT use might have influenced the results. Previous NRT and expectancy research has demonstrated that smokers strongly believe NRT will effectively reduce cigarette cravings (Juliano & Brandon, 2004). Possibly, the simultaneous administration of exercise with NRT, a well established credible quit

smoking aid, guided participants to believe exercise to be a relevant and logical quit smoking aid also. That is, participants' predictions regarding the beneficial effects of exercise were bolstered because they believed they could fall back on NRT. It was demonstrated that week five EX-CRED and NRT-CRED were highly related, which supports this notion, but it is refuted by the lack of correlation between EX-EXP and NRT-EXP at week five. This finding also underscores the difference between expectancy and credibility as constructs.

A number of demographic variables were different between the two studies. For instance, women in the present study were more likely to be: older, employed, smoking for longer, smoked more per day, and were more heavily addicted. There were also gender differences. Namely, the present study was a cohort of women only whereas Daniel et al. (2007) included both men and women. It is perhaps unlikely that any of these variables made any real contribution to the resultant differences however it is worth acknowledging them.

EX-EXP and EX-CRED do not invariably carry the burden of craving and withdrawal outcome following an acute bout of exercise. However, individuals who held strong EX-EXP and EX-CRED beliefs did experience an added reduction in cigarette craving following an acute bout of moderate intensity exercise. The question is whether or not this added reduction in craving is clinically relevant (Smeets et al., 2008). Cigarette cravings are one of the most often expressed difficulties related to quitting. The intensity of craving experienced by an abstinent smoker over the first few days of quitting is often predictive of their success (Ferguson, Shiffman, & Gwaltney, 2006). That being the case, every further reduction, no matter how small, may be of clinical relevance. Each year at least 70 percent of smokers see a physician (Fiore, Jaen, & Baker, 2008). Others come into contact with dentists, nurse practitioners, nurses, physical therapists, occupational therapists,

pharmacists, and counsellors (Fiore et al., 2008). Therefore, almost all clinicians are in a position to intervene with smokers and offer them tobacco treatment (Fiore et al., 2008). If clinicians were to advocate exercise as an adjunct cessation aid it may serve to bolster smokers EX-EXP and EX-CRED beliefs. The challenge with this rests not so much on the smoker as it does on the clinician.

3.4.2 Comparison of exercise and NRT expectancy and credibility beliefs

Expectancy and credibility are intervention components common to all treatment modalities (Newman & Fisher, 2010). One aim of the present study was to compare smokers' expectancy and credibility beliefs concerning exercise as a quit smoking aid with their beliefs pertaining to NRT as a quit smoking aid. The framework of the present study provided the opportunity to investigate initial expectancy and credibility beliefs, as well as an examination of change in these variables over time. Although expectancy and credibility scores at week five were found to be highly correlated, previous research provides evidence that these two variables are related yet separate (Devilly & Borkovec, 2000). As such, separate analyses of these variables were conducted and commentary on each is provided.

Amongst women who were successfully quit at week 14 of the NRT plus exercise aided cessation programme both NRT-EXP and EX-EXP showed a significant increase over time. To appreciate the importance of this finding a major perceptual difference between these two cessation aids needs to be highlighted. The nicotine patch has been sold over the counter since 1996 and is a well established smoking cessation treatment, recognised and used by many smokers (TTS, 2010). In contrast, exercise is a comparatively unknown and novel adjunct quit smoking therapy (Ussher, Taylor, & Faulkner, 2008). Despite this, this group of women believed they would derive benefit from both

treatments offered. By no means does this result imply that NRT and exercise are equally effective quit smoking treatments. It does however infer that quitters likely attribute some of their success to the exercise portion of the programme (Kazdin, 1979). Two possible consequences of this result are worth noting. First, if these women believe exercise to be a useful quit smoking aid, then they may be more likely to recommend it to others trying to quit. Second, continued exercise adherence post intervention is a common problem with intensive supervised exercise and smoking cessation programmes (Ussher et al., 2008). Believing exercise contributes to abstinence may make these women more likely to continue exercising upon programme termination.

Among those non-smoking at week 14 EX-CRED and NRT-CRED scores significantly increased over time. Interestingly, although not statistically significant, as these women were about to leave the programme (week 14) their EX-CRED beliefs reduced slightly (remaining above baseline) whereas their NRT-CRED beliefs increased slightly. These women successfully quit using NRT, leaving little doubt in their mind that NRT is a credible quit smoking aid. In addition, at the time of questionnaire completion they had been without the patch for at least one week and were possibly experiencing renewed craving and withdrawal symptoms, albeit psychological in nature (TTS, 2010). It is speculated that these factors may have influenced their NRT-CRED scores. In contrast, EX-CRED may have been eroded at programme termination, due to a lack of confidence in exercise without concurrent NRT administration and the Getting Physical on Cigarettes programme. Perhaps, it may have been possible to bolster EX-CRED for these women with an end of programme debrief and counselling session (Greenberg et al., 2006).

The results indicate that EX-EXP for both smokers and non-smokers (at week 14) was comparable. However, it is worth noting that EX-EXP increased from week six to week 14 for women who were successful in the programme, and decreased during the same period for women who were not. Perhaps, if the smoking group had comparable numbers to the non-smoking group a significant difference at week 14 may have been demonstrated. It is logical that at the end of an exercise aided quit smoking programme, women who had not succeeded would lose hope in exercise as a cessation strategy. Perhaps, these smokers engaged in a form of self-serving bias, whereby they began to doubt the value of exercise as a quit smoking strategy in order to attribute their cessation failure to an external factor (the exercise programme) (Greenberg, Pyszczynski, & Solomon, 1982). Interestingly, no discernable pattern for NRT-EXP was demonstrated between smokers and non-smokers.

Regardless of quit success, during the intervention all women believed exercise to be a highly credible quit smoking aid. For the majority of smokers quitting is not a one-time event. Seventy six percent of people who have quit smoking made at least one attempt before they were successful, and approximately 80% of current smokers have attempted to quit at least once (TTS, 2010). In addition, six months post intervention, relapse is an unfortunate possibility for those who initially achieve abstinence (Fiore et al., 2008). In all eventuality, a significant proportion of these women will attempt to quit smoking again in the 12 months following programme termination (TTS, 2010). Strong positive credibility beliefs make it more likely that they will try to quit smoking using exercise in the future (Juliano & Brandon, 2004).

Expectancy and credibility are variables common to all smoking cessation treatment strategies. Research in the field of clinical psychology substantiates that these variables exert some influence

over behavioural outcomes, and that this influence should be utilised (Kirsch & Lynn, 1999). In the present study, EX-EXP and EX-CRED remained high throughout the course of the programme, without any explicit intervention or manipulation. It would seem that taking part in the programme was sufficient enough to keep EX-EXP and EX-CRED ratings high. Researchers in the expectancy and credibility area have demonstrated that actual experience with therapeutic treatment exerts a powerful influence over these two variables (Kazdin, 1979). Any quit smoking treatment that smokers can believe in from pre- to post-quit and beyond has merit. That is, exercise may be a cost effective quit smoking aid because it spans the gamut, from an initial quit smoking treatment to relapse prevention strategy.

It was demonstrated that EX-EXP and EX-CRED were not related to adherence. Previous research with clinically depressed individuals has shown that those who believed in the effectiveness of their therapy were less likely to drop out, and more likely to adhere to the treatment offered (Elkin, Yamaguchi, Arnkoff, Glass, Sotsky, & Krupnick, 1999). Finding EX-EXP and EX-CRED to be unrelated to adherence in an exercise aided quit smoking programme seems counterintuitive. However, the clinical implications are great. Specifically, it provides some indication that smokers' who do not have complete faith in exercise as a quit smoking strategy, may still be willing to adhere to a programme such as this. As previously mentioned, adherence is one of the biggest hurdles with exercise aided smoking cessation programmes. This finding implies that factors other than these variables are implicated in adherence difficulties related to an exercise aided quit smoking programme.

3.4.3 Limitations

A potential bias regarding EX-EXP and EX-CRED beliefs can be identified. Expectancy and credibility scores for this group of women

were high upon entry into the programme (EX-EXP and EX-CRED mean of 7/9). The results were obtained from a group of female smokers who agreed to participate in a research programme involving exercise. It is possible that offering exercise to these women as a quit smoking aid may have had some bearing on their expectancy and credibility beliefs. For example, it is likely that they believed exercise to be a credible quit smoking aid and hoped that it would help them to quit smoking, because it was being offered through a reputable institution. Similarly, the manipulated scores reported by Daniel et al. (2007) were relatively high even in the low condition (five and a half out of 10 on the credibility scale). In addition, when compared to a control group, Ussher et al. (2009) found that temporarily abstinent smokers who engaged in 10 minutes of isometric exercise believed it to be a credible quit smoking strategy, and reported that they would recommend it to other smokers trying to quit (Ussher, Cropley, Playle, Mohidin, & West, 2009). Therefore, generalising results obtained to smokers who do not take part in research studies such as this may not be possible. Perhaps, the only way to truly minimise this expectancy effect would be to enrol participants into an acute exercise study, and conceal the exercise portion of the intervention until the last moment. Such a study design would only be feasible in an acute setting due to the deception involved.

A factor known to influence expectancy and credibility is knowledge gained from others (Wilson, Lisle, Kraft, & Wetzel, 1989). It is possible that women in this study discussed their own personal experiences and beliefs in relation to the quit smoking aids offered. Such interactions would potentially be an influencing factor in the change demonstrated in these variables over time. To control for this, it may have been prudent to separate women according to their expectancy and credibility beliefs upon entering into the programme.

Although the group size of week 14 smokers was small (*n* = 9), and was not equal to that of week 14 non-smokers (*n* = 28), the research was exploratory in nature, and as such it was deemed acceptable to compare these two groups. However, these results should be interpreted with caution. To rectify this, and gain an accurate profile of smokers who were unsuccessful, it would have been ideal to obtain questionnaire data by phone or email during missed assessment times.

3.4.4 Future research

Interestingly, no differences were found between EX-EXP and NRT-EXP or between EX-CRED and NRT-CRED amongst women who were successfully quit at week 14. Regardless of the accuracy of these beliefs, stronger positive beliefs would likely increase the use of exercise as a quit smoking aid and perhaps improve treatment outcomes (Juliano & Brandon, 2004). Physical activity is a behavioural strategy that is increasingly advocated by tobacco treatment specialists and often reportedly used by quitters (Abrams, Niaura, Brown, Emmons, Goldstein, & Monti, 2003; Everson, Taylor, & Ussher, 2010; O'Connell, Gerkovich, Cook, Shiffman, Hickcox, & Kakolewski, 1998). Thus, it seems important to determine the impact clinicians might exert on EX-EXP and EX-CRED beliefs in the real world, and how such strategies might influence cessation outcomes (Greenberg et al., 2006).

3.4.5 Conclusions

In general, people who join a novel exercise aided smoking cessation intervention have some expectation that exercise will help them quit smoking and believe it to be a credible quit smoking aid. Regardless of exercise expectancy and credibility, all recently quit smokers received a significant reduction in craving and withdrawal relief following an acute bout of moderate intensity exercise. Nevertheless, the results provide some evidence that expectancy and credibility may have some influence on treatment outcomes. The aim is not to denigrated

the value of exercise as an adjunct smoking cessation aid (Kirsch & Lynn, 1999). Rather, tobacco treatment specialists should be trying to maximise expectancy and credibility beliefs amongst smokers attempting to quit and using exercise as a means to control craving and withdrawal.

3.5 References

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CHAPTER FOUR: EXERCISE MAY BE AN EFFECTIVE BEHAVIOURAL SUPPORT STRATEGY FOR COPING WITH SMOKING TEMPTATIONS DURING A QUIT ATTEMPT

4.1 Introduction

Cigarette smoking is the single greatest cause of preventable death worldwide because it is associated with numerous dire health consequences; these adverse effects include an increased risk of heart attack, stroke, chronic obstructive pulmonary disorder, and many cancers (USDHHS, 2010). Although tobacco use has declined markedly since the 1960's, there has been a levelling off of cessation since the 1990's (Fiore, Jaen, & Baker, 2008). Approximately one quarter of the North American population currently smoke (Fiore et al., 2008). Tobacco dependence treatment has improved greatly and there is now much support available for smokers who want to quit. Despite this, the likelihood of remaining abstinent, six months post-quit, even with the most comprehensive of programmes (pharmacotherapy plus cognitive-behavioural support) is only between 25-30% (Fiore et al., 2008). Smoking relapse rates are also alarmingly high. Between 60% and 98% of quit attempts will end in relapse within the first year, with the majority (44%) occurring in the first two weeks (Garvey, Bliss, Hitchcock, Heinold, & Rosner, 1992).

There are a number of reasons why dependent smokers find it incredibly difficult to remain smoke-free. Specifically, there are three distinct constructs known to entice smoking relapse (Brownell et al., 1986; Velicer et al., 1990), and include: (1) individual factors which involve affect, in particular negative emotional states (N/A); (2)

situational factors which involve environmental and social factors (P/S); and (3) physiological factors which correspond to the subjective feelings of craving, urges, and withdrawal associated with nicotine deprivation (H/A) (Brownell, Marlatt, Lichtenstein, & Wilson, 1986).

To reduce relapse and maintain abstinence in high-risk situations cognitive (e.g., positive self-talk) and behavioural (e.g., exercise) coping strategies are recommended (Abrams, Niaura, Brown, Emmons, Goldstein, & Monti, 2003). Self-quitters report the use of behavioural coping skills more often than cognitive coping strategies (O'Connell, Gerkovich, Cook, Shiffman, Hickcox, & Kakolewski, 1998). Physical activity is a behavioural strategy that is increasingly advocated by tobacco treatment specialists and often reported as beneficial by quitters (Abrams et al., 2003; Everson, Taylor, & Ussher, 2010; O'Connell et al., 1998). Abstinent smokers are encouraged by health professionals to substitute smoking for the alternative health behaviour of exercise to prevent smoking relapse (TTS, 2010).

Research on relapse has consistently shown that individuals are much more likely to relapse when they experience negative affect (Zeidner & Endler, 1996). Smokers turn to cigarettes as a way of managing negative affect; they learn to rely on cigarettes to cope with situations that induce feelings of anger, frustration, depression, and anxiety (Abrams et al., 2003). It is posited that when nicotine deprived dependent individuals find themselves in stressful situations it activates nicotine craving, which may lead to relapse if not managed by an alternative to smoking (i.e., a coping strategy) (Shadel & Mermelstein, 1993). Exercise may be an appropriate coping strategy because it has been shown to reduce negative affect experienced by individuals attempting to quit (Bock, Marcus, King, Borrelli, & Roberts, 1999). In addition, exercise is known to reduce withdrawal symptoms such as stress, anxiety, tension, and irritability in temporarily abstinent smokers

(Taylor, Ussher, & Faulkner, 2007). Conversely, smokers also turn to cigarettes to enhance already pleasurable situations (e.g., at the bar with friends) (Velicer, DiClemente, Rossi, & Prochaska, 1990). Whether an alternative behaviour such as exercise might work as a coping strategy or substitute behaviour in this type of high-risk situation is unknown.

One of the reasons smokers find it difficult to quit is because smoking becomes a learned habit through years of repetition (Abrams et al., 2003). This renders the abstinent smoker susceptible to cue-induced cravings when in situations previously linked to smoking (e.g., getting up in the morning). There is evidence to suggest that following moderate intensity exercise, temporarily abstinent smokers are less likely to respond to a smoking cue (e.g., lit cigarette or smoking related images) (Janse Van Rensburg, Taylor, Hodgson, & Benattayallah, 2009; Taylor & Katomeri, 2007). Therefore, an exercise aided quit smoking programme may reduce the intensity of cue-induced craving and in turn reduce the likelihood of relapse (Ferguson & Shiffman, 2009).

Exercise and smoking are two behaviours that do not normally co-occur (Prochaska, 2008). To suggest that smokers will use exercise as a strategy to cope with temptation implies that these two behaviours can be concurrently altered. Unfortunately, many exercise and smoking cessation studies do not report changes in physical activity, which limits the understanding of whether smokers can simultaneously quit smoking and adopt exercise. There is however research to suggest that as a smoker increases in confidence to quit smoking, he/she increases in confidence to undergo other health behaviour changes, such as exercise (Prochaska, 2008). Data concerning whether these two behaviours can be simultaneously modified would provide valuable information for developing cost-effective strategies for multiple behaviour interventions (King, Marcus, Pinto, Emmons, & Abrams, 1996).

The present study provided an ideal platform to examine co-variation; defined as two behaviours that do not normally co-occur changing together.

The exercise and smoking literature supports exercise as a meaningful coping resource during abstinence to prevent relapse (Taylor, Katomeri, & Ussher, 2006). Exercise has been proposed as a strategy to enhance coping ability and confidence to remain smoke free (Ussher, Taylor, & Faulkner, 2008). However, it is not known if abstaining smokers would confidently report replacing smoking with exercise when imagining a relapse-inducing situation. It is also unknown whether the quitter's confidence in exercise as a behavioural support strategy is situation specific. With this in mind, the purpose of the present study was to determine: (1) if women taking part in a combined nicotine replacement therapy (NRT) and exercise aided smoking cessation programme report a temporal progression from smoking to exercising in high risk situations; (2) whether confidence to use exercise as a coping strategy is situation dependent; and (3) whether concurrent behaviour change would occur (e.g., exercise increase and smoking decrease).

It was hypothesised that women engaging in an exercise aided quit smoking programme would naturally substitute smoking for exercise as a means of coping with situations that promote the resumption of smoking. It was also hypothesised that of all high-risk relapse situations those related to affect, particularly negative affect, would be the most amenable to exercise as a coping strategy. Finally, it was hypothesised that women who showed an increase in confidence to quit smoking would demonstrate a reciprocal increase in exercise confidence.

4.2 Methods

4.2.1 Participants

Participants included 58 females undertaking the third round of the Getting Physical on Cigarettes (GPOC) trial (Jung, Fitzgeorge, Prapavessis, Faulkner, & Maddison, 2010). The inclusion and exclusion criteria were the same as that outlined in section 2.2.1.

4.2.2 Ethical approval

Ethical approval to amend the GPOC trial to contain the necessary questionnaires was obtained from the University of Western Ontario Health Sciences Research Ethics Board (#16306).

4.2.3 Design

4.2.3.1 Getting Physical on Cigarettes

See section 2.2.3.1 for details.

4.2.3.2 The Exercise and Health Psychology Laboratory

See section 2.2.3.2 for details.

4.2.3.3 General procedure

Participants engaged in a 14 week exercise programme at the Exercise and Health Psychology Laboratory at the University of Western Ontario. On the fourth week of the exercise programme participants began a smoking cessation attempt and the 10 week NicoDerm® nicotine replacement therapy (NRT) transdermal patch programme. Pre-intervention assessments were completed before week one, at baseline; post-intervention assessments were completed on a date after the participants' last exercise session, when they had finished the NRT programme, on week 14.

Questionnaires that were completed during the trial were done immediately following the first exercise session on the appropriate week (see Table 4.1). To be eligible for analyses, the participants demonstrated smoking abstinence (i.e., breath CO < six ppm), adhered to the NRT programme, and followed the exercise regime. To answer the research questions participants completed questionnaires every week with the exception of week 11 and 13. A flow-chart of the research design is displayed in Figure 4.1 and a timeline of the measurements and assessments in Table 4.1.

Table 4.1. Schedule of Assessments

	Week													
	Base-line	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Quit Smoking				X										
Demographics Questionnaire	X													
Smoking Ladder	X													
Exercise Readiness	X													
Temptations Questionnaire	X	X	X	X	X	X	X	X	X	X		X		X
Smoking Variables														
Carbon Monoxide Assessment	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Fagerström Nicotine Dependence	X													
Smoking Information	X													
Cessation Self-Efficacy (SE)	X					X								X
Exercise Variables														
Actical Exercise Behaviour	X													
Godin Leisure Time Questionnaire	X													X
Peak VO_2 Fitness Assessment	X													X
Exercise Task SE	X					X								X
Exercise Scheduling SE	X					X								X
Exercise Barrier SE	X					X								X

Note. Baseline refers to pre-trial and week 14 refers to post-trial. Participants began their smoking cessation attempt and nicotine replacement therapy on week four.

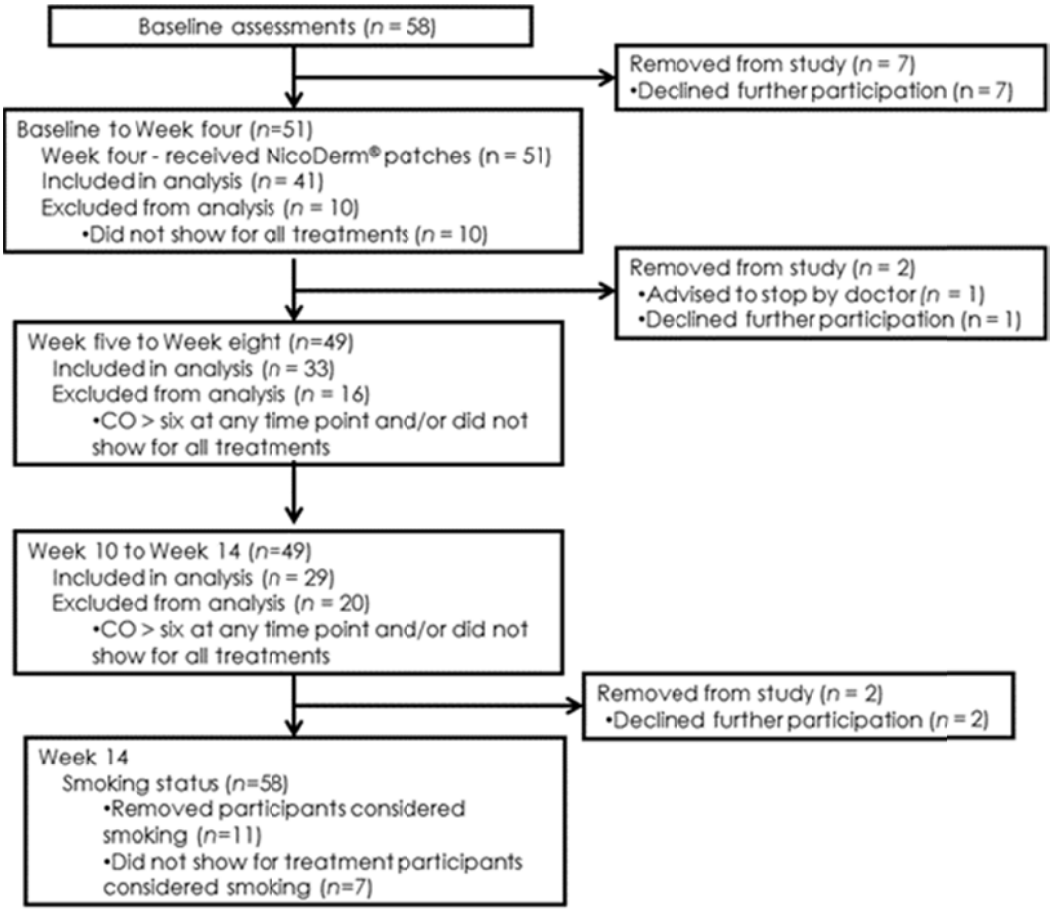

Figure 4.1. Research design and flow of participants through the trial.

4.2.4 Exercise regimen

See section 2.2.4 for details.

4.2.5 Nicotine replacement therapy regimen

All participants were provided with NRT in the form of NicoDerm® transdermal patches. Participants were asked to wear the nicotine patches for 24 hours a day, seven days a week, for 10 weeks as per the manufacturer's recommendations.

4.2.5.1 NicoDerm® three step programme

See section 2.2.5.1 for details.

4.2.5.2 NicoDerm® two step programme

See section 2.2.5.2 for details. Seven of the 58 participants were on the two step programme.

4.2.6 Demographic measures

See section 2.2.6 for measurement details. These variables are described in Table 2.2.

4.2.7 Nicotine dependence and other smoking characteristics

See section 2.2.6.2 for measurement details. These variables are described in Table 2.2.

4.2.7.1 Smoking ladder scale

See section 3.2.6.4 for details. This variable is described in Table 2.2.

4.2.8 Physical activity behaviour

4.2.8.1 Godin leisure time exercise questionnaire (GLTEQ)

See section 3.2.7.1 for details. These variables are described in Table 2.2.

4.2.8.2 Actical® accelerometer

See section 2.2.7.1 for details. This variable is described in Table 2.2.

4.2.8.3 Peak VO_2 fitness assessment

See section 2.2.7.2 for details. These variables are described in Table 2.2.

4.2.8.4 Stage of exercise readiness

See section 3.2.7.4 for details. This variable is described in Table 2.2.

Table 4.2. Demographic characteristics, exercise and smoking behaviour.

Variable	Mean (SD), %
Demographics:	
Age	42.72 (13.43)
Language spoken at home (% English)	96 %
Married	32 %
Yearly household income:	
Below $50,000	56 %
Between $50,000 and $75,000	11 %
Above $75,000	33 %
Number of children	1.89 (2.35)
Occupation:	
Employed	73 %
Student	13 %
Unemployed	14 %
Readiness for Change:	
Cessation Readiness:	
Pre-contemplation	0 %
Contemplation	0 %
Preparation	53 %
Action	40 %
Maintenance	7 %
Exercise Readiness:	
Pre-contemplation	0 %
Contemplation	51 %
Preparation	35 %
Action	7 %
Maintenance	7 %
Exercise behaviour:	
Objective physical activity (Actical)	
Pre-intervention (minutes per week MVPA)	99.50 (73.31)
Pre-intervention (number of bouts > 10 minutes)	0.802 (1.545)
Self-report physical weekly activity (Godin)	
Pre-intervention (metabolic equivalent)	18.22 (17.13)
Post-intervention (metabolic equivalent)	39.69 (21.86)
Peak VO_2 (ml/kg/min):	
Pre-intervention	23.23 (6.32)
Post-intervention	31.16 (6.82)
Carbon monoxide (CO) reading:	
Pre intervention (baseline)	11.96 (9.25)
Post intervention (14 weeks)	6.83 (11.07)
Smoking behaviour:	
Cigarettes per day	17.80 (8.24)
Number of years smoking	22.54 (12.93)
Fagerström test of nicotine dependence	5.02 (2.16)
Percentage of family and friends that smoke:	
Between 0 and 10%	32 %

Between 10 and 20%	14 %
Above 20%	54 %
Number of previous quit attempts	6.49 (14.54)

4.2.9 Primary outcome measures

4.2.9.1 Temptations questionnaire

The temptations questionnaire is a 25 item questionnaire that combined two questionnaires: The Revised Self-Efficacy Temptations scale long form (SET) (Velicer et al., 1990) and the Cessation Self-Efficacy questionnaire (CSE) (DiClemente, 1981). Both of these questionnaires have shown reliability and validity in terms of assessing smokers' confidence in their ability to avoid smoking in relapse inducing situations (DiClemente, 1981; Velicer et al., 1990). The scales of these two questionnaires were modified such that participants had to choose how likely they would be to either smoke or to exercise in situations known to induce smoking urges. Participants were required to choose between the response of smoking and exercising on a nine point scale (four points on the exercise side + unsure + four points on the smoking side). The scale was scored such that a score of -4 = extremely likely to smoke and -1 = a little likely to smoke, 0 = unsure, 4 = extremely likely to exercise and 1 = a little likely to exercise.

For the purpose of analysis the scale was separated into four components, corresponding to: cessation self-efficacy (12 items from DiClemente, 1981), negative/affect (N/A – six items from Velicer et al., 1990), positive/social (P/S – six items from Velicer et al., 1990), habit/addiction (H/A – five items from Velicer et al., 1990). There was some overlap between questionnaires (i.e., some items appeared on both questionnaires). The three categories of the SET scale (N/A, P/S, H/A) were used to determine whether participants in an exercise-aided smoking cessation programme reported a progression from smoking to exercising when faced with a relapse inducing situation, and to

determine whether or not exercise is a situation dependent coping strategy. The items from the CSE scale were used to determine if participants may be more or less likely in specific situations to exercise as a relapse coping strategy. This questionnaire was administered weekly from baseline to week eight, and at week 10, 12, and 14. Reliability analyses (Cronbach's alpha scores) were computed at all time points for the constructs (P/S, N/A, H/A). All alpha values reflected an acceptable level of reliability and are presented in Appendix 16 (Kline, 1993). See Appendix 10 for a copy of this questionnaire.

4.2.10 Secondary outcome measures

4.2.10.1 Smoking abstinence

Smoking abstinence was verified post-intervention by self-report, and a breath carbon monoxide reading of less than six ppm. Participants who failed to attend the post-intervention assessment appointment, scored greater than six ppm breath carbon monoxide, and/or self-reported smoking behaviour were considered a smoker at week 14 (post-intervention).

4.2.10.2 Cessation self-efficacy

Participants' confidence in their ability to avoid smoking was assessed with the Cessation Self-Efficacy Questionnaire (DiClemente, 1981). This questionnaire was administered at baseline, week six and week 14 of the trial. The scale consisted of 12 items on a seven point scale (one = completely sure – seven = completely unsure). For ease of interpretation the raw data was reverse scored, such that a higher score on this questionnaire indicates a higher confidence in ability to avoid smoking in various situations. Reliability analyses (Cronbach's alpha scores) were computed at baseline, week six, and week 14. All alpha values reflected an acceptable level of reliability and are

presented in Appendix 16 (Kline, 1993). See Appendix 11 for a copy of this questionnaire.

4.2.10.3 Exercise task self-efficacy

Participants' confidence in their ability to engage in increasing intensities and durations of physical activity was assessed at baseline, week six and week 14 using the exercise task self-efficacy questionnaire (McAuley & Mihalko, 1998). Responses to nine items were given on a 0% to 100% scale ranging from not at all confident (0%) to extremely confident (100%). The scale consisted of three items pertaining to light/mild intensity physical activity (e.g., "How confident are you that you can complete 10 minutes of physical activity at a light intensity three times next week?"), three items on moderate intensity physical activity, and three items on hard/vigorous intensity physical activity. Reliability analyses (Cronbach's alpha scores) were computed at baseline, week six, and week 14. All alpha values reflected an acceptable level of reliability and are presented in Appendix 16 (Kline, 1993). The results of this questionnaire are presented on a 0-10 scale, where 0 corresponds to 0% confidence and 10 corresponds to 100% confidence. See Appendix 12 for a copy of this questionnaire.

4.2.10.4 Exercise scheduling self-efficacy

Participants' confidence in their ability to schedule exercise into their daily routine was assessed at baseline, week six and week 14 using the seven item exercise scheduling self-efficacy measure (Woodgate, Brawley, & Weston, 2005). Responses were given on a 0% to 100% scale ranging from not at all confident (0%) to extremely confident (100%). Reliability analyses (Cronbach's alpha scores) were computed at baseline, week six, and week 14. All alpha values reflected an acceptable level of reliability and are presented in Appendix 16 (Kline, 1993). The results of this questionnaire are presented on a 0-10 scale,

where 0 corresponds to 0% confidence and 10 corresponds to 100% confidence. See Appendix 14 for a copy of this questionnaire.

4.2.10.5 Exercise barrier self-efficacy

Participants' confidence in their ability to engage in exercise when faced with various barriers to do so was assessed using a five item questionnaire modified from the barrier self-efficacy scale (Garcia & King, 1991). Participants reported their confidence to participate in 60 minutes of physical activity when faced with situations known as barriers to exercise. Responses were given on a 0% to 100% scale ranging from not at all confident (0%) to extremely confident (100%). Reliability analyses (Cronbach's alpha scores) were computed at baseline, week six, and week 14. All alpha values reflected an acceptable level of reliability and are presented in Appendix 16 (Kline, 1993). The results of this questionnaire are presented on a 0-10 scale, where 0 corresponds to 0% confidence and 10 corresponds to 100% confidence. See Appendix 13 for a copy of this questionnaire.

4.2.11 Challenges and considerations

4.2.11.1 Smoking abstinence

See section 2.2.2.1 for details.

4.2.11.2 Physical activity measurement

See section 3.2.9.2 for details.

4.2.11.3 Nicotine replacement therapy

See section 2.2.2.3 for details.

4.2.11.4 Participant retention

See section 2.2.2.4 for details. The number of participants differed between analyses due to attrition, absenteeism and/or smoking lapses

(e.g., baseline to week four temptations questionnaire, *n* = 41; week five to week eight, *n* = 33; week 10 to week 14, *n* = 29) (Figure 4.1). A total of 12 participants provided continuous, baseline to week 14, temptation questionnaire data.

4.2.12 Power calculation

Due to the exploratory nature of this study, no power calculation was computed.

4.2.13 Statistical analyses

Separate repeated ANOVAs were used to analyse differences in the temptation constructs of the Temptation Questionnaire at different time points (baseline – week four, week five – week eight, week 10 – week 14), and to determine change over time. Planned comparison t-tests were used to determine at what time point (week) differences between the scales occurred. For these analyses Bonferroni correction set the alpha at .005. Separate repeated ANOVAs were also used to analyse differences in the self-efficacy scales over time. For the self-efficacy scales that were measured at three time points, planned comparison t-tests were used to compare baseline to week six and baseline to week 14 if differences were found. Pearson product moment correlations were used to examine relationships between exercise self-efficacy's and smoking cessation self-efficacy (change from baseline to week six, CO < six ppm at week 14). A univariate ANOVA was used to compare baseline exercise self-report behaviour to week 14 exercise self-report behaviour. A chi-square was used to determine the relationship between week 14 smoking abstinence and exercise programme adherence.

4.3 Results

4.3.1 Baseline to quit week (week four)

A significant change over time (baseline to week four, n = 41) occurred for all three temptation constructs (Positive/Social [P/S], Negative/Affect [N/A], Habit/Addictive Qualities [H/A]) (F[3,360] = 94.529, p < .001, η^2 = .706) (Figure 4.2). Scores changed from smoking in relapse provoking situations (at baseline) to being 'unsure' or 'a little likely' to exercise in such situations (at week four). Significant differences in scores over the weeks are presented in Table 4.3. There were no differences over time (baseline to week four) between the three categories of temptation [3] (F[6,360] = .898, p = .497, η^2 = .015).

[3] Scores on the three temptation constructs over time for women who attended each assessment time point and were continuously abstinent from week four onwards (n = 12) were no different to those who were continuously abstinent at the distinct time points (baseline – week four; week five – week eight; week 10 – week 14).

Table 4.3. Baseline to week four change in score over time t-test results. Baseline – week two, *n* = 51; week two – week three, *n* = 44; week three – week four, *n* = 44.

Construct	Comparison	*Mean (sd)*		*T*	*Sig.*	η^2
Positive Social	Baseline – week two	-2.85 (1.01)	-2.81 (1.18)	-0.268	.789	.001
	Week two – week three	-2.73 (1.17)	-2.07 (1.12)	-7.013	**.001**	**.534**
	Week three – week four	-2.14 (1.03)	-0.29 (1.27)	-7.573	**.001**	**.572**
Negative Affective	Baseline – week two	-3.06 (1.01)	-2.38 (1.37)	-3.915	**.005**	**.235**
	Week two – week three	-2.32 (1.37)	- 2.16 (1.52)	-1.104	.276	.028
	Week three – week four	-2.23 (1.53)	- 0.20 (1.69)	-6.464	**.001**	**.493**
Habit Addiction	Baseline – week two	-2.15 (1.21)	-1.60 (1.51)	-2.937	**.005**	**.147**
	Week two – week three	-1.50 (1.48)	-1.32 (1.46)	-1.162	.251	.001
	Week three – week four	-1.32 (1.43)	0.56 (1.52)	-6.909	**.001**	**.526**

4.3.2 Week five to week eight

No significant change over time (week five to week eight, *n* = 31) was demonstrated for any of the three temptation constructs (F[3,288] = .282, p = .838, η^2 = .003) (Figure 4.2). Values remained between zero (unsure) and one (a little likely to exercise). It should be noted that none of the post quit scores were negative (negative score denotes likely to smoke). There was no difference in participants scores between the three categories of temptation during this time period (F[6,288] = .529, p = .786, η^2 = .011).

4.3.3 Week 10 to end of programme (week 14)

No significant change over time (week 10 to week 14, *n*=29) was shown for the three temptation constructs (F[2,168] = 3.252, p = .061, η^2 = .037) (Figure 4.2). Similar to mid-intervention scores (week five to eight) participants scores remained consistently between zero (unsure) and one (a little likely to exercise). Again, it should be noted that none of

the post quit date reports leaned towards smoking. There were no differences between the three categories of temptation during this time period (week 10 to 14) (F[4,168] = 1.125, p = .346, η^2 = .026).

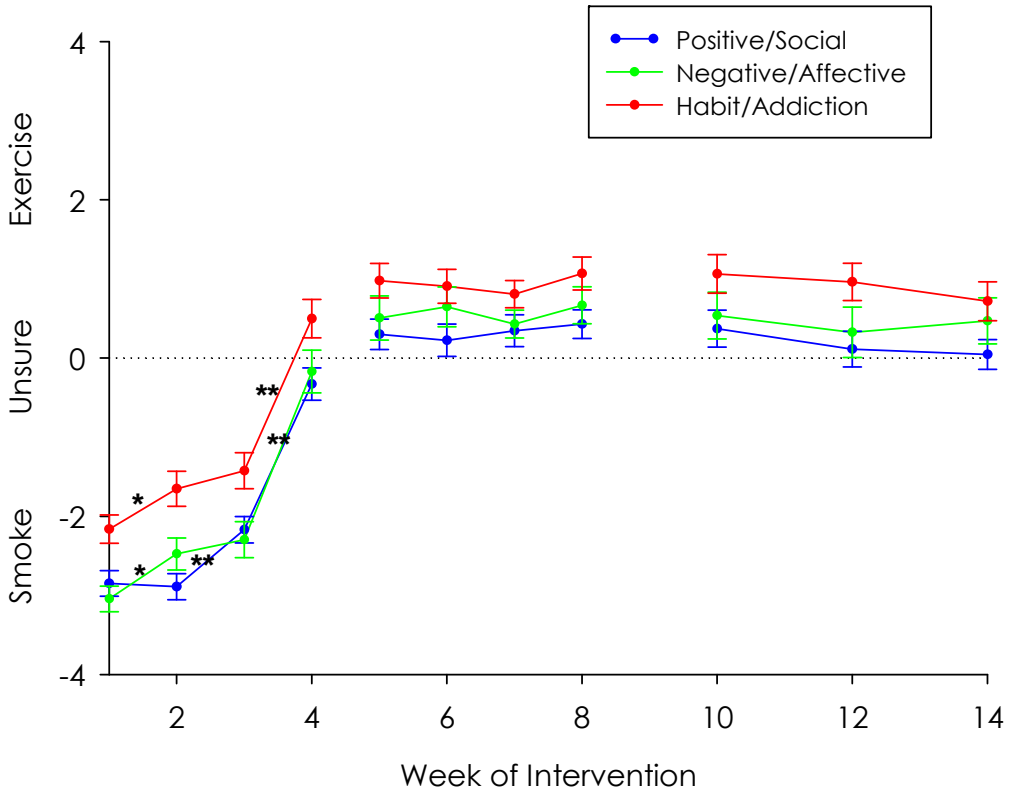

Figure 4.2. Scores on the three temptation constructs over time. Minus four = 'extremely likely to smoke' vs. four = 'extremely likely to exercise'. Baseline – week four, n = 41; week five – week eight, n = 33; week 10 – week 14, n = 29. Week four denotes quit week; the y-axis reference line denotes a score of zero (unsure).

* p < 0.05 increase in confidence to exercise in relapse inducing situations.

** p < 0.001 increase in confidence to exercise in relapse inducing situations.

4.3.4 Are certain individual temptations more responsive to exercise behaviour as a coping strategy than others?

The frequencies of each question on the temptations inventory at week five and week 14 are presented in Appendix 17. Participants answered that they would be highly likely to exercise in the scenario 'when I see

that I am gaining weight' (question 25 [week five – 40% responded with three or four out of four; week 14 – 38% responded with three or four out of four]). They reported being highly likely to smoke at both week five and 14 in the scenario 'when I experience an emotional crisis (i.e., an accident or death in the family)' (question 24 [week five – 26% responded with minus three or minus four out of minus four; week 14 – 21% responded with minus three or minus four out of minus four]).

4.3.5 Exercise self-efficacy

Exercise self-efficacy was measured at three time points over the course of the programme (baseline, week six, week 14). The results demonstrated that individuals who were considered abstinent (CO < six ppm) and provided data at each time point showed a significant difference over time for exercise task self-efficacy (n = 28; F[2,54] = 3.421, $p < .05$, $\eta^2 = .112$). Exercise task self-efficacy significantly improved from baseline to week six (t = -2.150, $p < .05$, $\eta^2 = .146$) and from baseline to week 14 (t = -2.325, $p < .05$, $\eta^2 = .167$) (Figure 4.3).

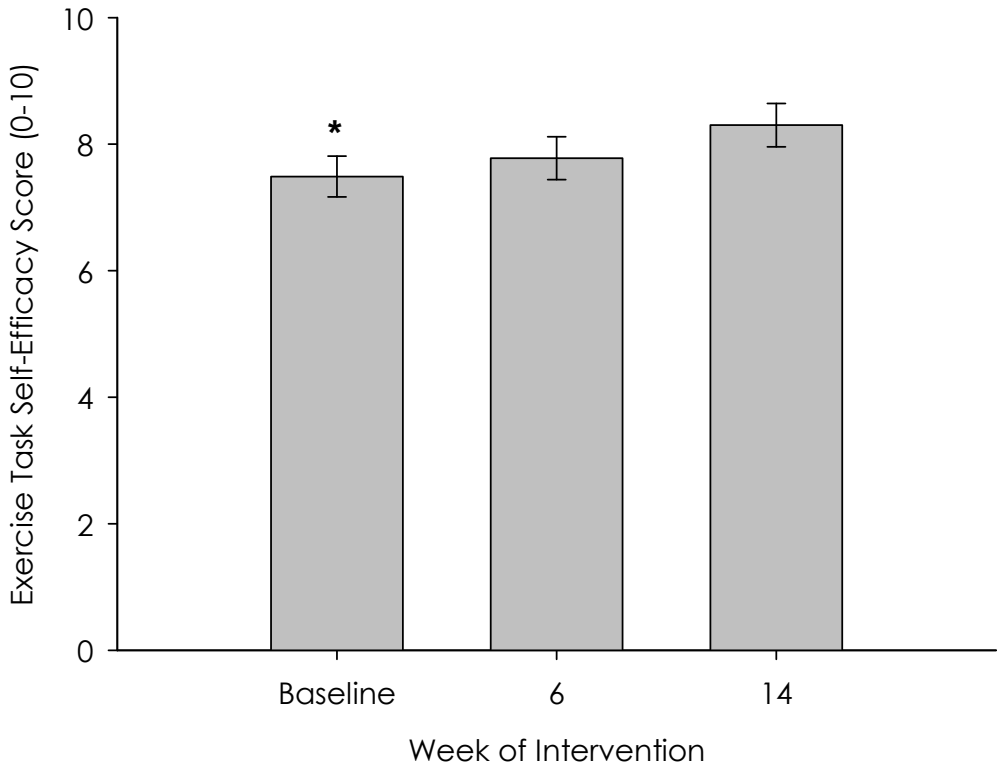

Figure 4.3. Exercise task self-efficacy scores for women considered abstinent (CO < six ppm at week six and 14) and competed questionnaires at all three time points (*n* = 28).

* $p < 0.05$ significant difference between baseline and week six and week 14.

No change over time was found for either exercise scheduling self-efficacy (*n* = 27; *F*[2,52] = 7.674, *p* = .073, η^2 = .096 [baseline – *M* = 7.042 *SD* = 3.020; week six – *M* = 6.814, *SD* = 2.778; week 14 – *M* = 7.830, *SD* = 2.249]) or exercise barrier self-efficacy (*n* = 27; *F*[2,52] = 1.491, *p* = .235, η^2 = .054 [baseline – *M* = 7.725, *SD* = 2.249; week six – *M* = 7.377, *SD* = 2.874; week 14 – *M* = 7.007, *SD* = 2.167]).

4.3.6 Cessation self-efficacy

Cessation self-efficacy was measured at three time points over the course of the programme (baseline, week six, week 14). The results demonstrated that individuals who were considered abstinent (CO < six

ppm) and provided data at each time point showed a significant difference over time for smoking cessation self-efficacy (n = 26; F[2,50] = 57.859, p = .000, η^2 = .698). Smoking cessation self-efficacy was significantly greater at week six (t = -10.510, p = < .001, η^2 = .804) and week 14 (t = -7.959, p = < .001, η^2 = .701) when compared to baseline (Figure 4.4).

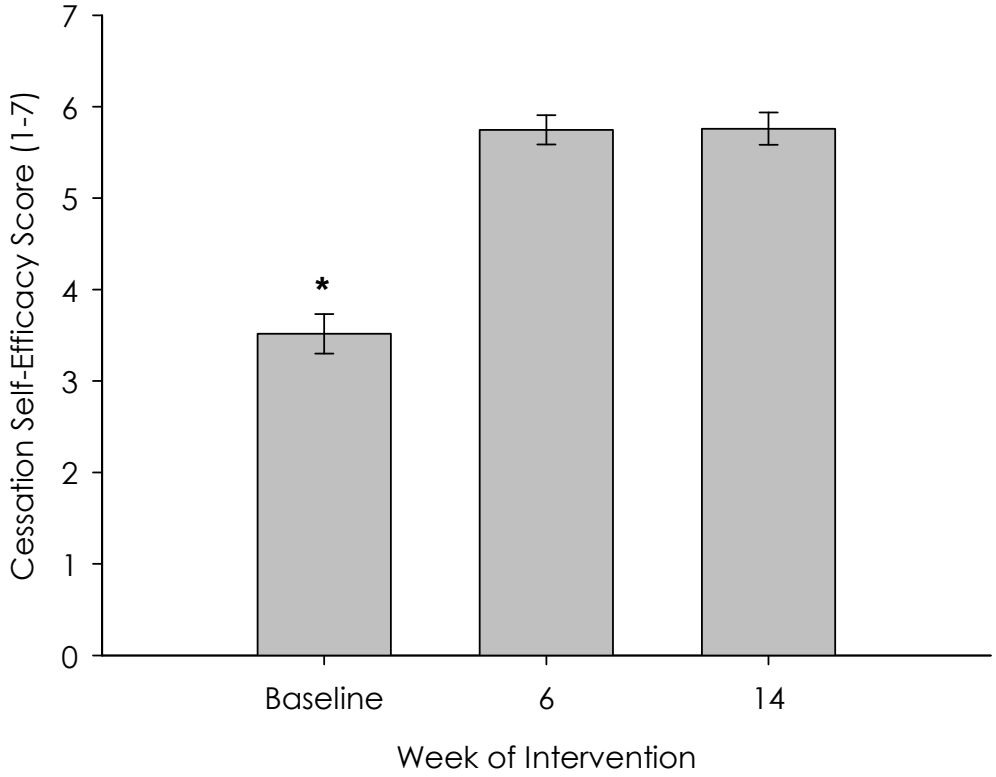

Figure 4.4. Cessation self-efficacy scores for women considered abstinent (CO < six ppm at week six and 14) and competed questionnaires at all three time points (n = 26).

* p < 0.001 significant difference between baseline and week six and week 14.

4.3.7 Exercise behaviour

Self-reported leisure time physical activity behaviour questionnaire scores significantly increased from pre- to post-exercise for those

participants that provided data (n = 36; F[1,35] = 44.536, p < .001, η^2 = .560)

4.3.8 Correlations

No significant correlations were found between change in cessation self-efficacy over time (baseline to week six) and change in any of the exercise self-efficacy variables over the same time period (task [r = .319, p = .091]; scheduling [r = -.077, p = .697]; barrier [r = .294, p = .121]). However, a trend effect for change over time (baseline to week six) was demonstrated between cessation self-efficacy and task self-efficacy.

4.3.9 Smoking cessation outcomes

48.1 percent (n = 38) of participants were able to abstain from cigarettes on the week four quit date (CO < six ppm). At the end of the programme (week 14) 60.3% of participants were considered smoke free (CO < six ppm). Smoking abstinence was related to attendance to the exercise programme (x^2[2, n=58] = 14.758, p < .001) (Table 3.5).

Table 4.4. Breakdown of participants smoking status at week 14 in relation to attendance to the exercise portion of the programme (n = 58)

	Exercise Programme Attendance			
	80-100%	60-80%	<60%	Total
Non-smoking at week 14				
Number of participants	27	2	6	35
Percent of total	46.6%	3.4%	10.3%	60.3%
Smoking at week 14				
Number of participants	6	4	13	23
Percent of total	10.3%	6.9%	22.4%	39.7%

4.4 Discussion

Successfully coping with situations that invoke the desire for a cigarette is essential to quit success. The present study sought to determine whether women undergoing a NRT and exercise aided quit attempt would report a temporal progression away from smoking in tempting situations. It was hypothesised women engaging in 14 weeks of structured exercise would report incrementally swapping smoking behaviour for exercise behaviour when faced with relapse provoking situations. Certainly this was the case from baseline to quit week (week four). During this time period there was a significant shift in reported response from smoking to exercise on all three temptation constructs (positive/social, negative/affective, habit/addiction). This finding indicates that smokers engaging in regular exercise could imagine how exercise might help them cope with the urge to smoke when faced with a smoking trigger.

An additional hypothesis addressed in the present study was that from quit week to the end of the programme (week 14) participants who had successfully quit smoking and continued to take part in the intervention would report confidence in exercising instead of smoking in tempting situations. This was not however the case; the results suggest that women undergoing a quit attempt are not likely to report exercise as a coping mechanism to deal with future potential smoking urges.

Due to the complexity of quitting smoking the null findings for switching to exercise post-target quit date are clinically relevant. The exercise intervention progressed quitters to the point where they did not believe they would smoke in tempting situations; although, they reported that they would not exercise either. Considering that quitting smoking is a process that unfolds over time and that abstinent smokers often relapse, any quit smoking aid that steers the recent quitter away from

succumbing to smoking temptation is worthwhile (Shiffman, Kassel, Gwaltney, & McChargue, 2005).

One of the most commonly reported immediate coping strategies utilised by self-quitters is informal exercise (O'Connell et al., 1998). However, coping skills training research shows that in order for a coping strategy to be reliably utilised when abstinence is threatened it needs to be well learned, such that it becomes a habitual response (Shiffman et al., 2005). Perhaps additional intensive exercise coping skills training was required and simply engaging in exercise on a regular basis was not sufficient to perceive exercise as a behavioural coping strategy in high-risk situations. Perhaps, had these women received intensive training in the use of exercise as a relapse coping strategy they may have reported more confidence in its use. If this is the case then it challenges the cost effectiveness and scalability of an intervention such as this for relapse prevention. However, it should be noted that recent research in both the United Kingdom and New Zealand have demonstrated that it is feasible to embed the promotion of physical activity into existing smoking cessation services (Maddison, Roberts, Bullen, McRobbie, Jiang, Prapavessis, Glover, Taylor, & Brown, 2010; Taylor, Everson-Hock, & Ussher, in press).

The preferred coping response inventory was separated into three distinct constructs known to entice smoking relapse (Velicer et al., 1990). This allowed for investigation into the perceived utility of exercise as a strategy for coping with each construct separately. Given the effects of exercise in the general population, and the acute smoking and exercise literature, it was hypothesised that participants would be more likely to report using exercise as a strategy to cope with a negative emotional state (N/A construct). This was not the case; there was no difference in perceived likelihood of using exercise to prevent relapse between the different constructs. These three constructs are

not only predictors of relapse they are also associated with the maintenance of smoking behaviour. For example, some people continue to smoke to reduce negative affect whereas for others smoking is maintained through the social networks of family and friends (TTS, 2010). In addition, subjective impressions of craving and withdrawal are also important; physical nicotine dependence also varies for individuals and may be a central determinant of smoking maintenance (Brownell et al., 1986). Perhaps a participant's response to the use of exercise as a relapse coping strategy was contingent on what maintains their smoking behaviour. For example, if an individual continues to smoke because it is their social norm, they may not be able to imagine exercising when faced with a temptation (e.g., at a party).

Previous researchers have posited that exercise is likely to be a less than practical solution to counter craving in many environments where abstinence is enforced (e.g., a bar or workplace) (Ussher, Nunziata, Cropley, & West, 2001). The results from the current study concur with this notion and suggest that recently quit smokers were unable to comprehend how exercise would be an appropriate response in many tempting situations. The relevance of exercise as a coping strategy may have been undermined by the fact that these women were engaging in aerobic exercise only; a type of exercise that may not be a natural coping choice in many situations (e.g., when with friends at a party). The majority of acute exercise and smoking research has investigated aerobic exercise but there are an increasing number of studies researching the effects of isometric exercise on craving and withdrawal symptoms (Ussher, Cropley, Playle, Mohidin, & West, 2009; Ussher, West, Doshi, & Sampuran, 2006). The findings from these studies are promising and short bouts of isometric exercise (five or 10 minutes) seem to reduce desire to smoke and withdrawal symptoms in temporarily abstinent smokers. Additionally, individuals engaging in this

type of exercise believed it to be a credible strategy for dealing with craving and withdrawal (Ussher et al., 2009). The present study findings for the week five to week 14 time period would suggest that extensive training is needed before individuals will confidently use exercise as a behavioural coping strategy. Imagined future use of exercise to prevent relapse may have been boosted had participants been schooled in different types of exercise strategies for different situations (e.g., at a bar socialising - use isometric contractions; stressed at work - go for a walk at lunch time). The results highlight that simply engaging in exercise does not constitute situation specific relapse prevention training.

In addition to examining each relapse category and how it may relate to exercise as a coping strategy, each of the questions on the coping with temptation inventory was examined individually. Of the 25 items pooled from the Revised Temptations Inventory and the Cessation Self-Efficacy Questionnaire (DiClemente, 1981; Velicer et al., 1990), two items stood out as worthy of mention. First, a large number of participants (40% at week five, 38% at week 14) responded that they would be highly likely to exercise to avoid relapse 'when I see that I am gaining weight'. Nicotine has been found to have powerful effects on the regulation of body weight. When a smoker quits it can lead to physiological pressure to gain weight (Grunberg & Bowden, 1985). The weight gain associated can have negative psychological consequences for the quitter and result in the resumption of smoking (Brownell et al., 1986; Schneider & Waters, 2007). Therefore, identifying adjunct therapies that can assist quitters in avoiding weight gain is clinically important. A recent review of exercise interventions for smoking cessation found that such programmes do not consistently report an end of programme reduction in weight gain (Ussher et al., 2008). However, the results from the present study suggest that ex-smokers consider exercise a useful strategy to deal with post cessation

weight gain. This implies that though exercise may not always be enough to ward off weight gain it may help with the negative affective portion of this weight gain that drives quitters to relapse (Schneider & Waters, 2007). The second stand out item was 'when I would experience an emotional crisis (i.e., an accident or death in the family'). In this instance many of the participants (26% at week five, 21% at week 14) responded that they would be highly likely to go back to smoking. This result indicates that while exercise might help with daily stressors, participants require additional cognitive coping strategies to avoid smoking in an emotional crisis.

Smoking and a sedentary lifestyle are two behaviours that co-occur (Nagaya, Yoshida, Takahashi, & Kawai, 2007), and the smokers in the present study were no exception. Nagaya and colleagues (2007) examined the longitudinal impact of quitting smoking and relapse on exercise behaviour in a group of Japanese men (n = 750). They found smoking cessation to be associated with an increase in exercise behaviour whereas smoking relapse was associated with reduced exercise behaviour. It may be that these two behaviours are closely linked and that the process of change in one is similar to the other. Indeed, it was demonstrated that an abstinent smoker's increase in confidence to perform exercise paralleled confidence in her ability to successfully quit smoking. In addition, although change in task self-efficacy from baseline to week six was not significantly related to change in cessation self-efficacy over this same time period, a trend effect was observed. Perhaps, the complex cognitions involved in these two behaviours share similarities, which may be an underlying factor as to why these women were unsure of their ability to use exercise as a temptation coping strategy. That is, imagining urge inducing situations led them to feel weakness for both behaviours.

The majority of participants, coming into the programme, were not meeting the current Canadian Society for Exercise Physiology guidelines for physical activity (150 minutes of moderate to vigorous intensity aerobic physical activity per week, in bouts of 10 minutes or more) (CSEP). Likely, when this group of women began the programme they did not consider themselves to be exercisers. Although they did increase their confidence in their ability to exercise, they did not experience an increase in their confidence to overcome barriers to being active or to schedule exercise into their lives. It is possible that after being sedentary, 14 weeks of exercise was not enough time for them to truly imagine exercise as a coping strategy and believe they could overcome barriers to its use (Anderson & Cychosz, 1995).

Smoking cessation rates were highest when individuals attended more than 80% of the programme. Engaging in exercise may have reinforced participant's commitment to making healthy lifestyle changes, in particular giving up smoking (Prochaska, Hall, Humfleet, Munoz, Reus, Gorecki, & Hu, 2008). It has been reported in the literature that individuals who believe they can increase their physical activity levels are also confident about reducing their smoking behaviour and vice versa (Boudreaux, Francis, Carmack Taylor, Scarinci, & Brantley, 2003; King et al., 1996; Prochaska et al., 2008). The present study demonstrated a similar result (i.e., exercise task and cessation self-efficacy increased over time). These findings taken together make it possible to suggest that female smokers who are confident in their ability to change their smoking behaviour also have an increased confidence in their ability to improve their exercise regimen (Prochaska, Spring, & Nigg, 2008). It is also postulated that developing confidence to exercise provided quitters with confidence not to give in to the urge to smoke and resulted in temptation scores staying above zero.

It should be noted that these results were demonstrated when exercise behaviour was specifically targeted. Other researchers have found that targeting a single behaviour for change does not necessarily translate into healthy changes in other behaviours (Dutton, Napolitano, Whiteley, & Marcus, 2008). Therefore, changes in physical activity may not simply occur because the individual quits smoking or vice versa. In addition, the majority of participants were highly motivated and ready to change both behaviours entering into the programme. As such, it is not possible to say that change in one lifestyle behaviour increases an individual's confidence to improve behaviours that they lack motivation for or are not ready to change.

Interventions designed to concurrently change multiple health behaviours are often challenged by poor adherence as participants may find them overwhelming (Prochaska et al., 2008). Indeed, previous exercise and smoking cessation trials are often limited by a lack of exercise adherence (Ussher et al., 2008). To improve exercise adherence rates in the current study the two behaviours were sequentially introduced (i.e., four weeks of exercise before attempting to quit smoking) and participants were identified as being ready to change both their smoking and exercise behaviour (Prochaska et al., 2008). As previously mentioned, smoking cessation was highest when individuals attended more than 80% of the programme and almost half of all participants did so. While this adherence rate is not dismal it is somewhat sobering and considering that exercise programme attendance influenced quit status, attendance stands out as one of the greatest barriers to multiple behaviour change programme success.

4.4.1 Limitations

All participants received a comprehensive intervention that involved NRT and exercise in a group setting. Pharmacotherapy and social

support are considered essential components of any effective quit smoking programme (Fiore et al., 2008). Therefore, it is possible that the significant change in the temptation inventory demonstrated between baseline and quit week was not solely due to exercise. However, this notion is somewhat mitigated by the fact that exercise task self-efficacy increased from baseline to week six. This increase suggests that any increase in confidence to exercise in high-risk situations would be related to the exercise portion of the intervention.

Newly abstinent smokers reported that when confronted with a trigger they would neither smoke nor exercise. A limitation of this research is that alternative behavioural (e.g., do something else) or cognitive (e.g., positive self-talk) coping strategies were not measured. Asking participants at an exit interview how they dealt with temptations may have provided valuable insight into the type of coping strategies being used over and above exercise.

The study was also limited by the fact that participants had to imagine whether or not they would exercise when faced with a trigger. A more ecologically valid way to measure the use of exercise as a relapse coping strategy would have been through real time reporting with electronic devices (Shiffman, Paty, Gnys, Kassel, & Hickcox, 1996).

The findings from the present study are only generalisable to female abstinent smokers who completed the questionnaire assessments. A large number of individuals were excluded from the analyses because they were not considered smoke-free at the time of assessment. Future research should examine the temptation inventory responses of non-abstinent smokers. However, the majority of participants considered to have relapsed were also those who stopped attending the programme and as such these data were scant. Similarly, it would have been advantageous to examine self-efficacy to quit smoking and exercise

based on adherence to the exercise programme. Unfortunately, because only a few participants with poor adherence attended the three self-efficacy assessment time points these comparisons could not be made. To rectify this it would have been worthwhile to contact absent participants and have them email or provide their answers over the phone.

Due to the time frame of the research it was not possible to obtain an objective measurement of post-intervention physical activity behaviour for this group of participants. Therefore, in terms of pre- and post-intervention physical activity behaviour only self-report data was available and reported in this study. It has been demonstrated that people tend to over report their physical activity data when they self-report, making it a less accurate measurement of physical activity than when objectively measured (Taber, Stevens, Murray, Elder, Webber, Jobe, & Lytle, 2009).

Finally, there were many criteria that had to be met (e.g., CO < six ppm, consistent exercise attendance) before an individual was included in the dataset. The strict inclusion criteria led to a small sample size for the self-efficacy data set (n = 25), which resulted in these analyses being underpowered. Had these analyses been adequately powered we may have found significant change in the other exercise self-efficacy variables.

4.4.2 Future research

When planning a relapse prevention intervention psychological and situational factors that underlie why an individual smokes should be considered. For example, if an individual smokes to suppress anger and frustration at work, they will need to be taught alternative anger management skills to use in preparation for cessation (Abrams et al., 2003). The point is, in the future it may be beneficial to determine what

sustains cigarette use for the individual and determine if exercise proves to be an effective adjunct under the circumstances.

Multiple health behaviour change interventions may be the future of preventive medicine. There is a growing body of research to suggest that concurrently and successfully targeting change in health behaviours is possible (Prochaska, 2008). However, there is also evidence to suggest that it is not as simple as a change in one behaviour translating to a change in another behaviour (Dutton et al., 2008). Finding that individuals experience a simultaneous increase in confidence to quit smoking and exercise leads to a number of important questions worthy of future research: (1) does confidence to change one behaviour come before confidence to change the other i.e., increased confidence in changing exercise behaviour leads to confidence to quit smoking or vice versa?; (2) are smokers who become regular exercisers likely to spontaneously quit smoking?; (3) in the interest of cost effectiveness, what is the minimum treatment required to get these two behaviours to change together?; (4) how many ex-smokers continue to exercise at six and 12 months post intervention?; and (5) are there identifiable individual factors that contribute to success in multiple health behaviour change programmes involving exercise and smoking cessation?

4.4.3 Conclusions

The findings from the present study highlight the importance of focusing interventions on behavioural problem solving treatments (e.g., exercise) leading up to a quit attempt. They also suggest that smokers, who are preparing to quit, can realise how exercise might be a useful strategy to help them resist the urge to resume smoking in tempting situations. However, despite the appeal of exercise as a coping strategy, recently quit smokers may require intensive behavioural coping skills training before they accept using exercise in future tempting situations. Finding

that greater exercise adherence increased smoking cessation, and that amongst those who remained abstinent, cessation self-efficacy and exercise self-efficacy both increased provides evidence that it is possible to successfully change these two incompatible behaviours at once. Finally, when an individual is confident in her ability to change a complex behaviour it may be a good time to capitalise on her being in a time for multiple complex behaviour changes.

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CHAPTER FIVE: GENERAL DISCUSSION

The research contained within this dissertation provided valuable information about the mechanisms underlying how exercise might assist female smokers deal with the craving and withdrawal symptoms associated with nicotine deprivation, and how it might help them to quit. Elucidating the mechanisms behind the beneficial effects of exercise on smoking cessation outcomes is important for designing maximally effective interventions. Additionally, identification of such mechanisms might increase the prescription of exercise as an adjunct smoking cessation aid by tobacco treatment specialists. Exercise is an important health behaviour in its own right. Therefore, anything researchers can do to improve the odds of exercise being accepted and recommended as a smoking cessation aid is worthwhile.

The studies contained within this dissertation were all based on a female population. This was done for a number of reasons: (1) women are able to refrain from smoking for shorter periods and report greater nicotine withdrawal compared to men (USDHHS, 2001); (2) the underlying factors for relapse may be different for men and women (e.g., females specifically site concerns about post-cessation weight gain as a barrier to quitting) (Marcus, Albrecht, King, Parisi, Pinto, Roberts, Niaura, & Abrams, 1999); and (3) for the comfort and satisfaction of the participants, creating a female only exercise environment was necessary. In line with profiling and tailoring of interventions it is possible that there may be a difference between intervention saliency when gender is considered, and the findings may not be generalisable to male smokers. Future research to determine whether these results hold for a group of male smokers undergoing a quit attempt may be warranted.

The results of the present dissertation were obtained in a design that overcame some of the limitations of previous acute exercise and smoking cessation research. For instance, the majority of studies investigating the acute effects of exercise on smoking involve smokers undergoing a period of temporary smoking abstinence before engaging in an acute bout of exercise. It is assumed from these experimental studies that cigarette craving and nicotine withdrawal symptom outcomes can be extrapolated to smokers going through a real quit attempt (Taylor & Katomeri, 2007). Presumably, as these types of studies involved temporarily abstinent smokers rather than quitters per se, it was not appropriate to have participants wear the nicotine patch, and therefore the effects of exercise in conjunction with NRT were understudied. Additionally, the majority of acute exercise and smoking research took place in a lab setting, which limited the ecological validity of the findings. The acute exercise research conducted in both study one (Chapter two) and study two (Chapter three) overcame these limitations by: (1) engaging smokers in a serious quit attempt; (2) participants were using the patch; and (3) the setting for the exercise bout was more like a gym than a laboratory.

The specific aims of this dissertation were: (1) to determine whether an acute bout of exercise would further reduce craving and withdrawal symptoms in a group of female quitters using the nicotine patch; (2) an exploration of whether the magnitude of withdrawal and craving relief experienced following an acute bout of exercise would relate to quit success in this same group of women; (3) to examine whether recently quit smokers expectancy and credibility beliefs regarding exercise as a quit smoking treatment had any bearing on self-reported craving and withdrawal relief following an acute bout of exercise; (4) to compare smokers expectancy and credibility beliefs regarding a well established quit smoking aid such as NRT with a novel quit smoking aid such as exercise; (5) to determine if women taking part in a combined NRT and

exercise aided smoking cessation programme would report using exercise as a relapse prevention aid.

Within the limitations of the studies contained within this dissertation the following conclusions were drawn:

The results of study one indicated that an acute bout of moderate intensity aerobic exercise reduced symptoms of nicotine withdrawal and cigarette craving for women on NRT who are attempting to quit. Three to five days into the quit attempt an acute bout of exercise reduced craving and withdrawal symptoms (psychological and sedation) for recently quit smokers using NRT (nicotine patch). The first few days and weeks of the quit attempt often determine success or failure (Shiffman, Paty, Gnys, Kassel, & Hickcox, 1996). The results also demonstrated that the effects of exercise seven to nine weeks into an NRT assisted quit attempt were still visible though not as large as those demonstrated during the first week of the quit attempt. These findings demonstrated that the beneficial effects of a bout of exercise did not become redundant when combined with NRT. Similarly, in study two, the week five result shown in study one was replicated. That is, women in the first week of their quit attempt using the patch showed a reduction in cigarette craving, psychological withdrawal, and sedation following an acute bout of moderate intensity exercise. A review of the acute exercise and smoking literature suggests that a single session of exercise has the ability to reduce craving and withdrawal amongst temporarily abstinent smokers (Taylor, Ussher, & Faulkner, 2007). Study one and two add to this body of research by demonstrating that these results hold with a group of women who are not only undergoing a real quit attempt but using NRT as well.

It is well demonstrated that the nicotine patch, which delivers a steady release of nicotine, does not help quitters manage cue-induced

craving (Ferguson & Shiffman, 2009). Finding that a bout of exercise reduced craving amongst quitters using the patch has important implications for tobacco treatment. Namely, it implies that exercise and the patch are compatible, and exercise could be an alternative to nicotine gum or lozenges to manage cue-induced cravings. Being able to offer quitters an alternative to buying and using NRT (gum and lozenges) is beneficial because: (1) it will save the consumer money (i.e., exercise is free and gum and lozenges are not); (2) ultimately engaging in exercise is a healthier behaviour than using NRT; and (3) it may reduce the time it takes the ex-smoker to wean off nicotine altogether.

In study one it was determined that the magnitude of craving and withdrawal relief experienced did not differ between women who were successfully quit at week 14 and those who were unsuccessful at week 14. That is, all newly quit smokers at week five experienced a reduction in craving and withdrawal regardless of what the end of programme outcome was. This finding highlights the complexity of quit success and suggests that numerous factors are involved in determining an individual's quit status. It also suggests that the benefits of exercise are not discriminatory, and implies that health practitioners can confidently recommend exercise as a cessation aid to any woman attempting to quit and looking for an adjunct therapy to help manage craving and withdrawal.

Individuals who strongly believed exercise to be a credible quit smoking aid, and/or expected that they would derive benefit from exercise, experienced a greater reduction in cigarette craving following an acute bout of moderate intensity exercise. This contradicted the findings of Daniel et al. (2007), but is in accordance with the psychotherapy outcome research that underscores the influence of these two variables (Smeets, Beelen, Goossens, Schouten, Knottnerus, &

Vlaeyen, 2008; Newman & Fisher, 2010). However, no significant differences between high and low expectancy and credibility groups were found for either psychological withdrawal, or the withdrawal symptom of sedation, findings that concur with those reported by Daniel et al. (2007). Nevertheless, the intensity of craving experienced by an abstinent smoker during the first few days of quitting is often predictive of his/her success (Ferguson, Shiffman, & Gwaltney, 2006), which may make this further reduction in craving of clinical importance. Although, exercise expectancy and credibility beliefs may not be a major mechanism involved in the acute effects of exercise on craving and withdrawal amongst temporarily and recently quit smokers they may play some role.

The concurrent measurement of exercise expectancy and credibility with NRT expectancy and credibility amongst a group of female smokers, who were provided with both cessation aids, allowed for a comparison of actual expectancy and credibility beliefs related to these two treatments (study two). It was demonstrated that women who managed to successfully quit smoking by the end of the programme believed both exercise and NRT had merit as quit smoking aids. By no means does this imply that exercise and NRT are equally effective smoking cessation strategies. However, it does imply that quitters likely attributed some of their success to the exercise portion of the programme (Kazdin, 1979).

Throughout the programme both NRT and exercise expectancy and credibility beliefs fluctuated over time and often showed a different pattern of change depending on participants quit success. One thing that remained constant is that for all participants who attended the programme exercise expectancy and credibility beliefs remained high. Expectancy and credibility are variables common to all smoking cessation treatment strategies, and research in the field of clinical

psychology substantiates that these variables exert some influence over behavioural outcomes, and that this influence should be utilised (Kirsch & Lynn, 1999). Any quit smoking treatment that smokers can believe in from pre- to post-quit and beyond has merit. This implies that exercise may be a cost effective quit smoking aid because it spans the gamut, from an initial quit smoking treatment to relapse prevention strategy.

The results of study three (Chapter four) suggested that leading up to a quit attempt smokers who are regularly engaging in exercise can envisage how exercise might help them to cope once they quit and find themselves in relapse provoking situations. Once they actually quit, and experienced tempting situations either first hand or hypothetically, they were no more likely to report that they would exercise in such situations than they were to report that they would smoke. Smoking relapse rates are alarmingly high (between 60-98% at one year), and unfortunately a number of women who at first achieve quit success will be smoking again at 12 months (Garvey, Bliss, Hitchcock, Heinold, & Rosner, 1992). Considering this, progressing these women to the point where they did not believe they would smoke in tempting situations may still be relevant. That is, regardless of whether they chose to use exercise to cope with temptation, perhaps becoming regular exercisers helped them to resist the urge to smoke (Shiffman, Kassel, Gwaltney, & McChargue, 2005). This notion is strengthened by the finding that abstinent smokers who increased in their confidence to change their smoking behaviour also showed an increased confidence in their ability to improve their exercise behaviour and vice versa. It is possible that simultaneously being confident in changing these two complex behaviours resulted in participants reporting they would not give in to the urge to smoke.

The majority of participants, coming into the programme, were inactive and not meeting the current Canadian Society for Exercise Physiology guidelines for physical activity (CSEP). Although they were engaging in exercise on a regular basis throughout the programme, intensive exercise coping skills training may be required before they perceive exercise as a behavioural coping strategy in high-risk situations. Providing participants with such training would not have been out of the question. These skills could have been taught weekly at the end of the first exercise session over a 15-20 minute session. Alternatively, in the interest of cost and for improved scalability of such an intervention they could have been administered over the internet or in a take-home package.

One of the aims of study three was to determine under what circumstances smokers or abstinent smokers would perceive exercise to have the greatest utility as a relapse coping strategy. No difference was observed between the different relapse constructs investigated. It is possible that imagined future use of exercise to prevent relapse may have been improved by instructing participants as to different types of exercise strategies for different situations (e.g., at a bar socialising - use isometric contractions; stressed at work - go for a walk at lunch time).

Quitting tobacco involves three phases: (1) preparation or getting ready to quit; (2) cessation or actually quitting; and (3) maintenance or relapse prevention (TTS, 2010). Any effective treatment plan must address all three phases. The results of the present dissertation provide evidence that exercise is an adjunct therapy that covers all three to varying degrees.

When preparing to quit, smokers are advised to begin the process of investigating alternative coping behaviours to smoking (TTS, 2010). Both varenicline and bupropion, pharmacotherapy for smoking cessation,

were designed to be initiated before the smoker attempts to quit. Similarly, exercise is a smoking cessation aid that can be effectively provided to smokers before their quit date. There is evidence in study three to suggest that sedentary female smokers who successfully increased their exercise behaviour demonstrated both an increased confidence to exercise and an increased confidence to quit. Although, it is not possible to say which change occurred first, it is possible that exercise helped these women prepare to quit by increasing their confidence in their ability to change in general.

Cigarette cravings are one of the most often expressed difficulties related to quitting, and the intensity of craving experienced by an abstinent smoker over the first few days of quitting often predicts their success (Ferguson et al., 2006). The results of study one and two showed that an acute bout of exercise not only relieved nicotine craving and withdrawal symptoms (psychological and sedation) but it did so for a group of abstinent smokers supplementing their nicotine with the patch. These findings provide evidence for exercise supporting the cessation phase (and the relapse phase) of becoming smoke-free. Further, study two showed that an acute bout of exercise has the potential to reduce cigarette craving even further if women undergoing a quit attempt believe it to be an effective smoking cessation treatment.

For both cohorts of women who took part in this research (study one, two, and three) smoking cessation rates were highest when more than 80 percent of the programme was attended. Engaging in exercise may have reinforced a participant's commitment to making healthy lifestyle changes, in particular giving up smoking (Prochaska, Hall, Humfleet, Munoz, Reus, Gorecki, & Hu, 2008). In addition, these findings support the notion that exercise and smoking are incompatible behaviours and as such complement one another other when an individual is going

through a period of lifestyle change (King, Marcus, Pinto, Emmons, & Abrams, 1996).

Evidence for exercise as a relapse prevention strategy comes from the craving and withdrawal relief demonstrated following an acute bout of exercise in study one and two. In addition, study three also provided some evidence that exercise can assist with relapse prevention. Specifically, a large number of participants (40% at week five, 38% at week 14) responded that they would be highly likely to exercise to avoid relapse 'when I see that I am gaining weight'. Nicotine has been found to have powerful effects on the regulation of body weight. When a smoker quits it can lead to physiological pressure to gain weight (Grunberg & Bowden, 1985). The weight gain associated can have negative psychological consequences for the quitter and result in resumption of smoking (Brownell, Marlatt, Lichtenstein, & Wilson, 1986; Schneider & Waters, 2007). Therefore, although study three did not show quitters to consistently report that they would use exercise to help them remain abstinent, they did report that they would use exercise to counter this leading cause of relapse.

The results of the present dissertation also provided some evidence for exercise as an effective harm reduction strategy. It is presumed that there will always be a percentage of smokers that find it extremely difficult to quit. These so called hardened smokers, likely smoke many cigarettes a day and have been doing so for many years (TTS, 2010). Although, completely quitting smoking is always best, a harm reduction strategy may be appropriate for smokers who find it extremely difficult to quit and are repeatedly unsuccessful (TTS, 2010). In order for a smoking cessation treatment to be considered an effective harm reduction strategy it must fulfil a number of criteria (eight criteria in total) (deRuiter & Faulkner, 2006). Pertaining to this dissertation, evidence for exercise as a harm reduction strategy was found for the

following five criteria: (1) the harm-reduction strategy should not increase or contribute to the individuals level of nicotine dependence; (2) the strategy should not sabotage the likelihood of eventual cessation; (3) the strategy should not lead to an increased population prevalence of tobacco dependence; (4) the strategy should eventually allow the smoker to become nicotine free; and (5) information that might ultimately lead an individual to quit smoking should be able to be incorporated into the harm-reduction strategy (Hatsukami, Henningfield, & Kotlyar, 2004; deRuiter & Faulkner, 2006).

Evidence from study one and two suggests that an acute bout of exercise in a more natural setting (e.g., gym setting) amongst those who had recently quit had the effect of reducing craving and withdrawal symptoms. Therefore, as exercise lessens craving and withdrawal symptoms it is unlikely to increase or contribute to the individual's level of nicotine dependence. On the contrary, reducing craving and withdrawal would likely increase the time between cigarettes (Taylor & Katomeri, 2007). Additionally, the intensity of craving and withdrawal symptoms experienced during a quit attempt are a good indicator of relapse. The ability of an acute bout of exercise to ameliorate craving and withdrawal symptoms, demonstrated in study one and two, make it possible that exercise participation would contribute to the individual eventually becoming nicotine free.

The results of study three indicated that an increase in exercise behaviour would not lead to an increase in population prevalence of tobacco dependence. Specifically, it was demonstrated that participants concurrently increased in both cessation and exercise self-efficacy, and those who maximally attended the exercise sessions were more likely to quit. These two findings suggest that exercise and smoking are not compatible behaviours. Therefore, it is unlikely that exercise would sabotage eventual cessation.

More and more, tobacco treatment specialists are integrating physical activity promotion into their smoking cessation programmes (TTS, 2010). Indeed, exercise and smoking cessation research has shown it is possible to successfully incorporate exercise as part of a multi-component cessation strategy (Marcus et al., 1999; Ussher, West, McEwen, Taylor, & Steptoe, 2003). In study two it was demonstrated that smokers believed exercise and NRT to be equally as credible and expected both cessation strategies would help them quit smoking. Thus, it is likely that the incorporation of smoking cessation and physical activity messages would be well received by smokers.

However, it should be noted that the promising results in this dissertation were found when exercise behaviour was specifically targeted, which challenges the cost effectiveness and scalability of an exercise aided intervention such as this. Nevertheless, exercise as a smoking cessation adjunct has great potential as both a harm reduction strategy and as a multi-phase treatment. For these reasons, finding a way to incorporate exercise into cessation treatment such that it becomes widely available and easily accessible has great public health potential (Fiore, Jaen, & Baker, 2008; Maddison, Roberts, Bullen, McRobbie, Jiang, Prapavessis, Glover, Taylor, & Brown, 2010). In study three of this dissertation evidence was garnered to suggest that it is possible to concurrently change these two behaviours (smoking behaviour and physical activity behaviour). Research in New Zealand is currently underway to determine the feasibility of incorporating two national services (Quitline and Green Prescription) (Maddison et al., 2010). Similarly, a group of researchers in the United Kingdom have investigated the feasibility of embedding physical activity promotion into existing smoking cessation services (Taylor, Everson-Hock, & Ussher, in press). The results of these two trials are eagerly awaited and will pave the way for future exercise and smoking cessation work. As an alternative to incorporating exercise into smoking programmes, smoking cessation treatment could be

incorporated into exercise environments such as in gyms or in community centres.

Overall, the present dissertation addressed the need for research on the mechanisms responsible for exercise effects on smoking cessation. It did so in a more natural environment with women undergoing a real quit attempt and using NRT. In addition, evidence was provided that exercise may be a smoking cessation strategy that can help a smoker quit and resist relapse. Finally, evidence is provided to further the cause for exercise as a potential harm reduction strategy. Ultimately it is hoped that the information contained within this dissertation will assist researchers and clinicians to improve cessation rates.

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Appendix 1. Sociodemographic questionnaire

CONTACT INFORMATION:

First Name:_____ Last Name:_____

Address:_____
STREET ADDRESS, CITY, POSTAL CODE

Home Phone: _____- _____-_____

Email Address: _____@_____

Date of Birth: _____/_____/_____
DD MM YYYY

Section A

1. Age:_____ (*in years*)

2. What language do you speak most often at home?

(Please check one)
- ☐ English
- ☐ French
- ☐ Cantonese
- ☐ Mandarin
- ☐ Italian
- ☐ German
- ☐ Punjabi
- ☐ Spanish
- ☐ Polish
- ☐ Portugese
- ☐ Arabic
- ☐ Other (*specify:*_____)

3. Were you born in Canada? (*Please check one)* ☐ Yes ☐ No

4. Marital status: (*Please check one)*
   - ☐ single ☐ separated ☐ married
   - ☐ divorced ☐ widowed ☐ common law

Section B – Children

Please complete the following questions about any children you may have.

5. Do you have any children? (*Please check one)* ☐ Yes ☐ No

6. If yes, please list their ages, separated by commas:

Section C – Education & Employment

7. What is the highest grade (or year) of regular school have you completed?
(please check one)

Elementary	*High school*	*College/University*	*Graduate school*
☐ 01	☐ 09	☐ 01	☐ 01
☐ 02	☐ 10	☐ 02	☐ 02
☐ 03	☐ 11	☐ 03	☐ 03
☐ 04	☐ 12 +	☐ 04 +	☐ 04
☐ 05			
☐ 06			
☐ 07			
☐ 08			

8. What is the highest degree you earned?
(*Please check one)*
- ☐ High school diploma
- ☐ College certificate
- ☐ Bachelor's degree
- ☐ Masters degree
- ☐ Doctorate
- ☐ Professional (MD, LLB, DDS, etc.)
- ☐ Other (specify: _____)
- ☐ None of the above

9. Which of the following best describes your main daily activities and/or responsibilities?
(*Please check one)*
- ☐ Working full-time
- ☐ Working part-time
- ☐ Unemployed or laid-off
- ☐ Looking for work
- ☐ Student
- ☐ Keeping house or raising children full-time

10. Are you currently working? *(Please check one)* ☐ Yes ☐ No
If **YES,** approximately how many hours/week are you working?_____

11. Which of these categories best describes your total combined family income for the past 12 months? This should include income (before taxes) from all sources, wages, rent from properties, social security, disability and/or veteran's benefits, unemployment benefits, workman's compensation, help from relatives (including child payments and alimony), and so on.
(Please check one)

☐ Less than $5 000	☐ $25 000 - $34 999	☐ $100 000 +
☐ $5 000 - $11 999	☐ $35 000 - $49 999	☐ don't know
☐ $12 000 - $15 999	☐ $50 000 - $74 999	☐ no response
☐ $16 000 - $24 999	☐ $75 000 - $99 999	

Section D – Smoking History & Current Practices

12. What is the approximate date and time of the last cigarette you have smoked?

Date: _____ Time: _____

13. Does anyone in your household currently smoke?
(Please check one) ☐ Yes ☐ No

14. In your best estimate, what percentage of your friends and family smoke?
(*Please check one)*
☐ 0 – 10%
☐ 11 – 20%
☐ 21 - 30%
☐ 31 - 40%
☐ 41 - 50%
☐ 51% +

Section E – Medical Information

To the best of your knowledge, do you have:

	Yes	No
High blood pressure	☐	☐
High blood cholesterol	☐	☐
High blood sugar	☐	☐
Diabetes (Type II)	☐	☐

Please list your current drugs & medications (i.e., blood pressure pills, prescribed medicine):

Do you drink Alcohol? ☐ Yes ☐ No

If yes, number of drinks per week? _____ _____ _____
(Beer) (Wine) (Hard Liquor)

Section F

How did you hear about our programme?

☐ UWO Staff email
☐ UWO Student email
☐ Your place of work (please name workplace) _____
☐ The Londoner Newspaper
☐ The London Free Press
☐ Smokers' Helpline
☐ The Canadian Cancer Society
☐ The Health Unit
☐ Other (please specify) _____

Appendix 2. Fagerström nicotine dependence

1. How many cigarettes per day do you usually smoke?	_____
2. How soon after you wake up do you smoke your first cigarette? *(circle one response)*	Within 5 minutes 6-30 minutes 31 or more
3. Do you find it difficult to refrain from smoking in places where it is forbidden (e.g. in the mall, at the library, in the cinema?) *(circle one response)*	No Yes
4. Which cigarette would you most hate to give up? *(circle one response)*	The first of the morning Other
5. Do you smoke more frequently in the first hours after waking than during the rest of the day? *(circle one response)*	No Yes
6. Do you smoke if you are so ill that you are in bed most of the day? *(circle one response)*	No Yes

Appendix 3. Motivation to quit smoking and smoking and physical activity history

1. Do you want to quit smoking for good?
   a. Yes
   b. No
   c. Unsure

2. Do you intend to make a serious attempt to stop smoking for good?
   a. Yes
   b. No
   c. Unsure

3. How many cigarettes do you smoke, on average, per day?
   _____ cigarettes/day

4. How many years have you been smoking the above number of cigarettes per day?
   _____ years

5. How many years ago did you begin to smoke regularly?
   _____ years

6. Have you tried to quit smoking in the past?
   a. Yes
   b. No

7. If you have attempted to quit smoking in the past, how many times have you tried?
   _____ times

8. Think about your physical activity behaviour in the past month. On average, how many times ***per week*** have you engaged in 30 minutes or more of regular moderate (e.g., jogging, playing tennis, riding your bike) to vigorous (e.g., running, spin classes, high impact aerobics classes) physical activity during your spare time?
   _____ times per week

9. How many months have you been exercising at the above frequency per week?
   _____ months

Appendix 4. Shiffman-Jarvik withdrawal scale

INSTRUCTIONS: Please CIRCLE the number to the right of each question that most accurately reflects how you feel at this moment.

		Definitely not						Definitely
1.	If you could smoke freely, would you like a cigarette right now?	1	2	3	4	5	6	7
2.	Is your heart beating faster than usual?	1	2	3	4	5	6	7
3.	Do you feel more calm than usual?	1	2	3	4	5	6	7
4.	Are you able to concentrate as well as usual?	1	2	3	4	5	6	7
5.	Do you feel wide awake?	1	2	3	4	5	6	7
6.	Do you feel content?	1	2	3	4	5	6	7
7.	Are you thinking of cigarettes more than usual?	1	2	3	4	5	6	7
8.	Do you have fluttery feelings in your chest?	1	2	3	4	5	6	7
9.	Do you feel hungrier than usual for this time of day?	1	2	3	4	5	6	7
10.	If you were permitted to smoke, would you refuse a cigarette right now?	1	2	3	4	5	6	7
11.	Do you feel more tense than usual?	1	2	3	4	5	6	7
12.	Do you miss a cigarette?	1	2	3	4	5	6	7
13.	Do you have an urge to smoke a cigarette right now?	1	2	3	4	5	6	7
14.	Are you feeling irritable?	1	2	3	4	5	6	7
15.	Are your hands shaky?	1	2	3	4	5	6	7

Scoring:
Craving – 1, 7, 10 reversed, 12,13
Physical – 2, 8, 15
Sedation – 5 reversed
Psychological – 3 reversed, 4 reversed, 6 reversed, 11,14
Appetite – 9

Appendix 5. Smoking ladder

Below are some thoughts that smokers have about quitting. On this ladder, circle the one number that shows what you think about quitting. Please read each sentence carefully before deciding.

10	I have quit smoking and I will never smoke again.
9	I have quit smoking, but I still worry about slipping back, so I need to keep working on living smoke free.
8	I still smoke, but I have begun to change, like cutting back on the number of cigarettes I smoke. I am ready to set a quit date.
7	I definitely plan to quit smoking with the next 30 days.
6	I definitely plan to quit smoking in the next 6 months.
5	I often think about quitting smoking, but I have no plans to quit.
4	I sometimes think about quitting smoking, but I have no plans to quit.
3	I rarely think about quitting smoking, and I have no plans to quit.
2	I never think about quitting smoking, and I have no plans to quit.
1	I enjoy smoking and have decided not to quit smoking for my lifetime. I have no interest in quitting.

Appendix 6. Godin leisure-time exercise questionnaire

During the last 7 days, how many times did you do the following kinds of exercise for more than 15 minutes during your free time (write on each line the appropriate number)?

Times Per Week

a) STRENUOUS EXERCISE (heart beats rapidly)

(e.g., running, jogging, hockey, football, soccer, squash, basketball, cross country skiing, judo, roller skating, vigorous swimming, vigorous long distance bicycling). _____ times

b) MODERATE EXERCISE (not exhausting)

(e.g., fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, popular and folk dancing). _____ times

c) MILD EXERCISE (minimal effort)

(e.g., yoga, archery, fishing from river bank, bowling, horseshoes, golf, snow-mobiling, easy walking). _____ times

During the last 7-Day period (week), in your leisure time, how often did you engage in any regular activity long enough that your heart would beat rapidly (work up a sweat)?

1. Often _____ 2. Sometimes _____ 3. Rarely/Never _____

Appendix 7. Stage of exercise readiness

Please place a tick (√) next to the statement that best applies to you. **Only tick one statement**.

___ I do ***not*** currently exercise and am ***not*** seriously thinking about changing in the next 6 months.

___ I do ***not*** currently exercise ***but*** I am seriously thinking about changing in the next 6 months.

___ I exercise sometimes but ***not*** regularly.

___ I have started to exercise regularly (most days of the week for at least 45 minutes each time) in the last 6 months.

___ I exercise regularly (most days of the week for at least 45 minutes each time) and have done so for ***longer*** than 6 months.

Appendix 8. Previous patch experience form

ID Number: _____

The questions below ask about your previous experience with the patch (nicotine replacement therapy e.g. NicoDerm, Nicorette). Please answer the questions as honestly as possible there are no right or wrong answers.

1. Have you ever tried to quit smoking using the patch before?

   a. Yes
   b. No

2. If you have, how many times have you used the patch?

   _____

3. How would you rate your previous experience with using the patch?

Extremely poor			Unsure			Extremely good
1	2	3	4	5	6	7

4. If you have managed to quit using the patch before, how much of your quit success do you attribute to the patch?

0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

Appendix 9. Expectancy and credibility questionnaire

INSTRUCTIONS: We would like you to indicate how much you believe, right now, that the two quit smoking aids [NicoDerm® patch (NRT) and EXERCISE] you receive during this programme will help you to quit. Belief usually has two aspects to it: (1) what you *think* will happen; and (2) what you *feel* will happen. Sometimes these are similar, sometimes they are different. Please answer the questions below. In the first set, answer in terms of what you *think*. In the second set answer in terms of what you really and truly *feel*.

Set I

1. At this point, how logical do the quit smoking aids offered to you seem?

	Not at all			Somewhat					Extremely
NRT	1	2	3	4	5	6	7	8	9
EXERCISE	1	2	3	4	5	6	7	8	9

2. At this point, how successfully do you think these treatments will manage your craving and withdrawal symptoms?

	Not at all			Somewhat					Extremely
NRT	1	2	3	4	5	6	7	8	9
EXERCISE	1	2	3	4	5	6	7	8	9

3. How confident would you be in recommending these treatments to a friend who wants to quit smoking?

	Not at all			Somewhat					Extremely
NRT	1	2	3	4	5	6	7	8	9
EXERCISE	1	2	3	4	5	6	7	8	9

4. By the end of the programme how much of your success do you think will be attributed to each of the quit smoking aids offered?

	None			Some					All
NRT	1	2	3	4	5	6	7	8	9
EXERCISE	1	2	3	4	5	6	7	8	9

5. How important is quitting smoking to you?

Not at all			Somewhat					Extremely
1	2	3	4	5	6	7	8	9

Set II

For the next two questions, close your eyes for a few moments, and try to identify what you really ***feel*** about the quit smoking aids offered. Then answer the following questions.

1. At this point, how much do you really ***feel*** that the quit smoking aids offered will help you to manage your craving and withdrawal symptoms?

	Not at all			Somewhat			Extremely		
NRT	1	2	3	4	5	6	7	8	9
EXERCISE	1	2	3	4	5	6	7	8	9

2. By the end of the programme, how much of your quit success do you really ***feel*** will be related to the quit smoking aids offered?

	None			Some			All		
NRT	1	2	3	4	5	6	7	8	9
EXERCISE	1	2	3	4	5	6	7	8	9

Questionnaire adapted from the Credibility/Expectancy Questionnaire (Devilly and Borkovec, 2000).

Appendix 10. Temptations questionnaire

INSTRUCTIONS: Listed below are situations that lead some people to smoke. We would like to know HOW LIKELY you would be to SMOKE OR EXERCISE in each situation.

Please answer the questions using the four point scale with 1 = A LITTLE LIKELY and 4 = EXTREMELY LIKELY. You may choose to respond by either SMOKING OR EXERCISE. Please circle ONLY ONE RESPONSE.

REMEMBER: Circle the answer that best reflects how you would respond. There is no right or wrong answer. It is very important that you are honest.

HOW LIKELY ARE YOU TO SMOKE?					**HOW LIKELY ARE YOU TO EXERCISE?**			
Extremely likely	Very likely	Somewhat likely	A little likely	Unsure	A little likely	Somewhat likely	Very likely	Extremely likely
4	3	2	1	0	1	2	3	4

		SMOKE					**EXERCISE**			
1.	When I am desiring a cigarette	4	3	2	1	0	1	2	3	4
2.	When things are just not going the way I want and I am frustrated	4	3	2	1	0	1	2	3	4
3.	With my spouse or close friend who is smoking	4	3	2	1	0	1	2	3	4
4.	When there are arguments and conflicts with my family	4	3	2	1	0	1	2	3	4
5.	When I am very angry about something or someone	4	3	2	1	0	1	2	3	4
6.	When I see someone smoking and enjoying it	4	3	2	1	0	1	2	3	4
7.	When I realise that quitting smoking is a difficult task for me	4	3	2	1	0	1	2	3	4
8.	When I am craving a cigarette	4	3	2	1	0	1	2	3	4
9.	When I first get up in the morning	4	3	2	1	0	1	2	3	4
10.	When I feel I need a lift	4	3	2	1	0	1	2	3	4
11.	When I begin to let down on my concern about my health	4	3	2	1	0	1	2	3	4
12.	When I am depressed	4	3	2	1	0	1	2	3	4
13.	When I am anxious and stressed	4	3	2	1	0	1	2	3	4
14.	When I realise I haven't smoked for a while	4	3	2	1	0	1	2	3	4
15.	When alone and feeling depressed	4	3	2	1	0	1	2	3	4
16.	When I am nervous	4	3	2	1	0	1	2	3	4
17.	With friends at a party	4	3	2	1	0	1	2	3	4
18.	Over coffee while talking and relaxing	4	3	2	1	0	1	2	3	4
19.	At work when I am experiencing some pressure in my job	4	3	2	1	0	1	2	3	4
20.	At a bar or cocktail lounge having a drink	4	3	2	1	0	1	2	3	4
21.	When I wake up in the morning and face a tough day	4	3	2	1	0	1	2	3	4
22.	When I am happy and celebrating	4	3	2	1	0	1	2	3	4
23.	When I am bored and have nothing to do	4	3	2	1	0	1	2	3	4
24.	When I would experience an emotional crisis (i.e. an accident or death in the family)	4	3	2	1	0	1	2	3	4
25.	When I see that I am gaining weight	4	3	2	1	0	1	2	3	4

Velicer, W. F., DiClemente, C. C., Rossi, J. S., & Prochaska, J. O. (1990). Relapse situations and self-efficacy an integrative model. *Addictive Behaviors, 15,* 271-283

DiClemente, C. C. (1981). Self-efficacy and smoking cessation maintenance: a preliminary report. *Cognitive Therapy and Research, 5(2),* 175-187.

Negative/affective questions – 2, 4, 5, 12, 13, 24
Habit/addictive questions – 7, 9, 10, 11, 14
Positive/social questions – 3, 6, 17, 18, 20, 22
Cessation self-efficacy questions – 3, 15-25

Appendix 11. Cessation self-efficacy

For each the items below, please rate your degree of certainty that you could avoid smoking in each of the situations.

		Completely sure						**Completely unsure**
1.	When alone and feeling depressed	1	2	3	4	5	6	7
2.	When I am nervous	1	2	3	4	5	6	7
3.	With friends at a party	1	2	3	4	5	6	7
4.	Over coffee while talking and relaxing	1	2	3	4	5	6	7
5.	With my spouse or a close friend who is smoking	1	2	3	4	5	6	7
6.	At work when I am experiencing some pressure in my job	1	2	3	4	5	6	7
7.	At a bar or cocktail lounge having a drink	1	2	3	4	5	6	7
8.	When I wake up in the morning and face a tough day	1	2	3	4	5	6	7
9.	When I am happy and celebrating	1	2	3	4	5	6	7
10.	When I am bored and have nothing to do	1	2	3	4	5	6	7
11.	When I would experience an emotional crisis (i.e. an accident or death in the family)	1	2	3	4	5	6	7
12.	When I see that I am gaining weight	1	2	3	4	5	6	7

Appendix 12. Exercise task self-efficacy

The next questions ask how confident you are that you can participate in physical activities classified as "**light**", "**moderate**" and "**hard**". The word "confident" refers to the belief that you have in yourself that you can do something well. Please circle the number that best represents your confidence level to do the following:

1. How confident are you that you can complete **10 minutes** of physical activity at a **light** intensity level three times next week?

0	10	20	30	40	50	60	70	80	90	100
not at all confident					*somewhat confident*					*extremely confident*

2. How confident are you that you can complete **30 minutes** of physical activity at a **light** intensity level three times next week?

0	10	20	30	40	50	60	70	80	90	100
not at all confident					*somewhat confident*					*extremely confident*

3. How confident are you that you can complete **60 minutes** of physical activity at a **light** intensity level three times next week?

0	10	20	30	40	50	60	70	80	90	100
not at all confident					*somewhat confident*					*extremely confident*

4. How confident are you that you can complete **10 minutes** of physical activity at a **moderate** intensity level three times next week?

0	10	20	30	40	50	60	70	80	90	100
not at all confident					*somewhat confident*					*extremely confident*

5. How confident are you that you can complete **30 minutes** of physical activity at a **moderate** intensity level three times next week?

0	10	20	30	40	50	60	70	80	90	100
not at all confident					*somewhat confident*					*extremely confident*

6. How confident are you that you can complete **60 minutes** of physical activity at a **moderate** intensity level three times next week?

0	10	20	30	40	50	60	70	80	90	100
not at all confident					*somewhat confident*					*extremely confident*

7. How confident are you that you can complete **10 minutes** of physical activity at a **hard** intensity level three times next week?

0	10	20	30	40	50	60	70	80	90	100
not at all confident					*somewhat confident*					*extremely confident*

8. How confident are you that you can complete **30 minutes** of physical activity at a **hard** intensity level three times next week?

0	10	20	30	40	50	60	70	80	90	100
not at all confident					*somewhat confident*					*extremely confident*

9. How confident are you that you can complete **60 minutes** of physical activity at a **hard** intensity level three times next week?

0	10	20	30	40	50	60	70	80	90	100
not at all confident					*somewhat confident*					*extremely confident*

Appendix 13. Exercise barrier self-efficacy

How confident (from 0% - 100%) are you that when faced with one of the situations below, you will still be able to participate in 60 minutes of physical activity most days next week?

10. If it is bad weather?

0	10	20	30	40	50	60	70	80	90	100
not at all confident					*somewhat confident*					*extremely confident*

11. If I am tired?

0	10	20	30	40	50	60	70	80	90	100
not at all confident					*somewhat confident*					*extremely confident*

12. If I am sore?

0	10	20	30	40	50	60	70	80	90	100
not at all confident					*somewhat confident*					*extremely confident*

13. If I have work to do?

0	10	20	30	40	50	60	70	80	90	100
not at all confident					*somewhat confident*					*extremely confident*

14. If I have family obligations?

0	10	20	30	40	50	60	70	80	90	100
not at all confident					*somewhat confident*					*extremely confident*

Appendix 14. Exercise scheduling self-efficacy

The following is a list of behaviours associated with participating in INDEPENDENT exercise for the **next week**. Please consider each specific behaviour as it applies to you.

In addition to attending your weekly exercise program sessions, how confident are you that you can …

1. Participate in independent exercise three times per week next week.

0	10	20	30	40	50	60	70	80	90	100
not at all confident					*somewhat confident*					*completely confident*

2. Plan for participation in my independent exercise sessions in my daily activities next week.

0	10	20	30	40	50	60	70	80	90	100
not at all confident					*somewhat confident*					*completely confident*

3. Arrange my schedule to do independent exercise regularly no matter what next week.

0	10	20	30	40	50	60	70	80	90	100
not at all confident					*somewhat confident*					*completely confident*

4. Maintain a definite plan to restart my independent exercise if I should miss any sessions next week.

0	10	20	30	40	50	60	70	80	90	100
not at all confident					*somewhat confident*					*completely confident*

5. Make up times when I miss my regular independent exercise sessions next week.

0	10	20	30	40	50	60	70	80	90	100
not at all confident					*somewhat confident*					*completely confident*

6. Make sure that I do not miss more than one day of independent exercise due to other obligations next week.

0	10	20	30	40	50	60	70	80	90	100
not at all confident					*somewhat confident*					*completely confident*

7. Organize next week's time and responsibilities around each of my independent exercise sessions no matter what.

0	10	20	30	40	50	60	70	80	90	100
not at all confident					*somewhat confident*					*completely confident*

Appendix 15. Physical activity readiness questionnaire

1. Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?
   [ ] Yes
   [ ] No

2. Do you feel pain in your chest when you do physical activity?
   [ ] Yes
   [ ] No

3. In the past month, have you had chest pain when you were not doing physical activity?
   [ ] Yes
   [ ] No

4. Do you lose your balance because of dizziness or do you ever lose consciousness?
   [ ] Yes
   [ ] No

5. Do you have a bone or joint problem that could be made worse by a change in your physical activity?
   [ ] Yes
   [ ] No

6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart?
   [ ] Yes
   [ ] No

7. Do you know of any other reason why you should not do physical activity?
   [ ] Yes
   [ ] No

_____ _____

Name Signature

_____

Date

To be completed by Physician:

Patient is fit to start an exercise programme

☐ Recommended/Approved ☐ Contraindicated

Patient is fit to use NicoDerm patch

☐ Recommended/Approved ☐ Contraindicated

_____ _____

Physician's Name Signature

_____

Date

Appendix 16. Cronbach's alphas

Chapter Two

Shiffman-Jarvik withdrawal scale

Time	Craving	Psychological	Physical
Week 5	.834	.817	.680
Week 11	.770	.790	.779
Week 13	.854	.833	.669

Chapter Three

Temptation questionnaire

Time	EX-EXP	EX-CRED	NRT-EX	NRT-CRED
Baseline	.709	.829	.781	.824
Week 5	.891	.891	.930	.886
Week 14	.923	.857	.932	.722 (question 2 removed)

Shiffman-Jarvik withdrawal scale

Time	Craving	Psychological
Week 5	.875 (question 10 removed)	.767

Chapter Four

Temptation scale

Time	Positive/Social	Negative/Affective	Habit/Addiciton
Baseline	.799	.759	.669
Week 2	.798	.837	.734
Week 3	.802	.926	.775
Week 4	.785	.913	.846
Week 5	.864	.882	.785
Week 6	.861	.859	.825
Week 7	.909	.772	.813
Week 8	.928	.924	.862
Week 10	.891	.922	.826
Week 12	.881	.909	.840
Week 14	.874	.876	.772

Exercise and cessation self-efficacy

Time	Barrier	Task	Scheduling	Cessation
Baseline	.940	.954	.977	.842
Week 6	.921	.921	.961	.880
Week 14	.965	.959	.985	.849

Appendix 17. Temptations questionnaire frequencies

Question Number	Week 5			Week 14		
	Response	Frequency	Percent	Response	Frequency	Percent
1	-4.00	1	2.1	-4.00	1	2.5
	-3.00			-3.00	3	7.5
	-2.00	2	4.3	-2.00	2	5.0
	-1.00	8	17.0	-1.00	6	15.0
	.00	9	14.8	.00	10	25.0
	1.00	17	36.2	1.00	9	22.5
	2.00	5	10.6	2.00	5	12.5
	3.00	3	6.4	3.00	4	10.0
	4.00	2	4.3	4.00		
2	-4.00			-4.00		
	-3.00	4	8.5	-3.00	4	10.0
	-2.00	5	10.6	-2.00	2	5.0
	-1.00	3	6.4	-1.00	6	15.0
	.00	8	17.0	.00	12	30.0
	1.00	17	36.2	1.00	8	20.0
	2.00	4	8.5	2.00	7	17.5
	3.00	6	12.8	3.00	1	2.5
	4.00			4.00		
3	-4.00	1	2.1	-4.00		
	-3.00	2	4.3	-3.00	3	7.5
	-2.00	3	6.4	-2.00	1	2.5
	-1.00	12	25.5	-1.00	9	22.5
	.00	13	27.7	.00	19	47.5
	1.00	8	17.0	1.00	5	12.5
	2.00	4	8.5	2.00	2	5.0
	3.00	3	6.4	3.00		
	4.00	1	2.1	4.00	1	2.5
4	-4.00	2	4.3	-4.00		
	-3.00	2	4.3	-3.00	4	10.0
	-2.00	2	4.3	-2.00	1	2.5
	-1.00	12	25.5	-1.00	7	17.5
	.00	15	31.9	.00	13	32.5
	1.00	7	14.1	1.00	7	17.5
	2.00	3	6.4	2.00	6	15.0
	3.00	3	6.4	3.00		
	4.00	1	2.1	4.00	2	5.0
5	-4.00	2	4.3	-4.00		
	-3.00	1	2.1	-3.00	3	7.5
	-2.00	4	8.5	-2.00		
	-1.00	10	21.3	-1.00	4	10.0
	.00	6	12.8	.00	13	32.5
	1.00	11	23.4	1.00	6	15.0
	2.00	66	12.8	2.00	9	22.5
	3.00	5	10.6	3.00	3	7.5

	4.00	2	4.3	4.00	2	5.0
6	-4.00	2	4.3	-4.00		
	-3.00			-3.00		
	-2.00	1	2.1	-2.00	2	5.0
	-1.00	11	23.4	-1.00	8	20.0
	.00	19	40.4	.00	17	42.5
	1.00	7	14.9	1.00	6	15.0
	2.00	1	2.1	2.00	4	10.0
	3.00	5	10.6	3.00	1	2.5
	4.00	1	2.1	4.00	2	5.0
7	-4.00	2	4.3	-4.00		
	-3.00			-3.00		
	-2.00	2	4.3	-2.00		
	-1.00	5	10.6	-1.00	6	15.0
	.00	12	25.5	.00	16	40.0
	1.00	12	25.5	1.00	8	20.0
	2.00	8	17.0	2.00	6	15.0
	3.00	3	6.4	3.00	3	7.5
	4.00	3	6.4	4.00	1	2.5
8	-4.00			-4.00	1	2.5
	-3.00	2	4.3	-3.00		
	-2.00	3	6.4	-2.00	3	7.5
	-1.00	5	10.6	-1.00	8	20.0
	.00	13	27.7	.00	8	20.0
	1.00	13	27.7	1.00	10	25.0
	2.00	6	12.8	2.00	6	15.0
	3.00	3	6.4	3.00	3	7.5
	4.00	2	4.3	4.00	1	2.5
9	-4.00	1	2.1	-4.00	1	2.5
	-3.00	2	4.3	-3.00		
	-2.00	2	4.3	-2.00	1	2.5
	-1.00	6	12.8	-1.00	7	17.5
	.00	12	25.5	.00	16	40.0
	1.00	14	29.8	1.00	4	10.0
	2.00	3	6.4	2.00	3	7.5
	3.00	5	10.6	3.00	7	17.5
	4.00	2	4.3	4.00	1	2.5
10	-4.00	1	2.1	-4.00		
	-3.00			-3.00		
	-2.00	1	2.1	-2.00	1	2.5
	-1.00	2	4.3	-1.00	3	7.5
	.00	10	21.3	.00	11	27.5
	1.00	13	27.7	1.00	7	17.5
	2.00	11	23.4	2.00	9	22.5
	3.00	6	12.8	3.00	7	17.5
	4.00	3	6.4	4.00	2	5.0
11	-4.00			-4.00	1	2.5
	-3.00	2	4.3	-3.00		
	-2.00	1	2.1	-2.00	1	2.5

	-1.00	7	14.9	-1.00	3	7.5
	.00	9	19.1	.00	11	27.5
	1.00	11	23.4	1.00	5	12.5
	2.00	7	14.9	2.00	7	17.5
	3.00	9	19.1	3.00	8	20.0
	4.00	1	2.1	4.00	4	10.0
12	-4.00	1	2.1	-4.00	1	2.5
	-3.00	3	6.4	-3.00	1	2.5
	-2.00	3	6.4	-2.00	1	2.5
	-1.00	1	2.1	-1.00	5	12.5
	.00	15	31.9	.00	11	27.5
	1.00	10	21.3	1.00	9	22.5
	2.00	8	17.0	2.00	5	12.5
	3.00	4	8.5	3.00	4	10.0
	4.00	2	4.3	4.00	3	7.5
13	-4.00	1	2.1	-4.00	1	2.5
	-3.00	1	6.4	-3.00	2	5.0
	-2.00	7	6.4	-2.00	1	2.5
	-1.00	5	2.1	-1.00	5	12.5
	.00	7	31.9	.00	11	27.5
	1.00	13	21.3	1.00	6	15.0
	2.00	5	17.0	2.00	9	22.5
	3.00	5	8.5	3.00	3	7.5
	4.00	3	4.3	4.00	2	5.0
14	-4.00			-4.00		
	-3.00	2	4.3	-3.00	1	2.5
	-2.00	1	2.1	-2.00		
	-1.00	2	4.3	-1.00	5	12.5
	.00	16	34.0	.00	21	52.5
	1.00	15	31.9	1.00	5	12.5
	2.00	5	10.6	2.00	6	15.0
	3.00	4	8.5	3.00	1	2.5
	4.00	2	4.3	4.00	1	2.5
15	-4.00	1	2.1	-4.00	1	2.5
	-3.00	2	4.3	-3.00		
	-2.00	4	8.5	-2.00		
	-1.00	7	14.9	-1.00	6	15.0
	.00	14	29.8	.00	14	35.0
	1.00	9	19.1	1.00	6	15.0
	2.00	6	12.8	2.00	7	17.5
	3.00	3	6.4	3.00	3	7.5
	4.00	1	2.1	4.00	3	7.5
16	-4.00	1	2.1	-4.00	1	1.5
	-3.00	1	2.1	-3.00	1	1.5
	-2.00	5	10.6	-2.00		
	-1.00	7	14.9	-1.00	5	12.5
	.00	16	34.0	.00	17	42.5
	1.00	8	17.0	1.00	3	7.5
	2.00	5	10.6	2.00	10	25.0

	3.00	3	6.4	3.00	1	2.5
	4.00	1	2.1	4.00	2	5.0
17	-4.00	3	6.4	-4.00	1	2.5
	-3.00	1	2.1	-3.00	1	2.5
	-2.00	3	6.4	-2.00	2	5.0
	-1.00	7	14.9	-1.00	12	30.0
	.00	24	51.1	.00	20	50.0
	1.00	6	12.8	1.00	1	2.5
	2.00	1	2.1	2.00	3	7.5
	3.00	2	4.3	3.00		
	4.00			4.00		
18	-4.00			-4.00		
	-3.00	2	4.3	-3.00		
	-2.00	4	8.5	-2.00	1	2.5
	-1.00	4	8.5	-1.00	7	17.5
	.00	24	51.1	.00	27	67.5
	1.00	9	19.1	1.00	2	5.0
	2.00	4	8.5	2.00	3	7.5
	3.00			3.00		
	4.00			4.00		
19	-4.00	1	2.1	-4.00		
	-3.00	1	2.1	-3.00		
	-2.00	4	8.5	-2.00	1	2.5
	-1.00	6	12.8	-1.00	4	10.0
	.00	19	40.4	.00	22	55.0
	1.00	8	17.0	1.00	5	12.5
	2.00	3	6.4	2.00	3	7.5
	3.00	5	10.6	3.00	5	12.5
	4.00			4.00		
20	-4.00	1	2.1	-4.00	1	2.5
	-3.00	1	2.1	-3.00	1	2.5
	-2.00	6	12.8	-2.00	3	7.5
	-1.00	8	17.0	-1.00	8	20.0
	.00	19	40.4	.00	23	57.5
	1.00	9	19.1	1.00	1	2.5
	2.00	1	2.1	2.00	3	7.5
	3.00	1	2.1	3.00		
	4.00	1	2.1	4.00		
21	-4.00	1	2.1	-4.00		
	-3.00	4	8.5	-3.00	2	5.0
	-2.00	4	8.5	-2.00		
	-1.00	2	4.3	-1.00	7	17.5
	.00	14	29.8	.00	14	35.0
	1.00	11	23.4	1.00	5	12.5
	2.00	7	14.9	2.00	7	17.5
	3.00	3	6.4	3.00	3	7.5
	4.00	1	2.1	4.00	2	5.0
22	-4.00	1	2.1	-4.00		
	-3.00			-3.00	2	5.0

	-2.00	1	2.1	-2.00	2	5.0
	-1.00	5	10.6	-1.00	5	12.5
	.00	16	34.0	.00	17	42.5
	1.00	13	27.7	1.00	6	15.0
	2.00	4	8.5	2.00	7	17.5
	3.00	5	10.6	3.00	1	2.5
	4.00	2	4.3	4.00		
23	-4.00	2	4.3	-4.00		
	-3.00	4	8.5	-3.00	1	2.5
	-2.00	4	8.5	-2.00		
	-1.00	6	12.8	-1.00	6	15.0
	.00	15	31.9	.00	13	32.5
	1.00	5	10.6	1.00	5	12.5
	2.00	9	19.1	2.00	6	15.0
	3.00	2	4.3	3.00	5	12.5
	4.00	47		4.00	4	10.0
24	-4.00	7	14.9	-4.00	7	17.5
	-3.00	5	10.6	-3.00	1	2.5
	-2.00	2	4.3	-2.00	3	7.5
	-1.00	5	10.6	-1.00	3	7.5
	.00	19	40.4	.00	16	40.0
	1.00	5	10.6	1.00	3	7.5
	2.00	1	2.1	2.00	5	12.5
	3.00	2	4.3	3.00		
	4.00	1	2.1	4.00	2	5.0
25	-4.00	1	2.1	-4.00		
	-3.00			-3.00		
	-2.00			-2.00	4	10.0
	-1.00			-1.00	4	10.0
	.00	11	23.4	.00	9	22.5
	1.00	9	19.1	1.00	4	10.0
	2.00	7	14.9	2.00	4	10.0
	3.00	9	19.1	3.00	6	15.0
	4.00	10	21.3	4.00	9	22.5

Appendix 18. Letter of information and consent

Study Title: Getting Physical on Cigarettes

Principal Study Investigator:
Harry Prapavessis, Ph.D. (School of Kinesiology, The University of Western Ontario)
519-xxx-xxxx extension: xxxxx

Co-Investigators:
Guy Faulkner, Ph.D. (Faculty of Physical Education and Health, University of Toronto)
Ralph Maddison, Ph.D. (Clinical Trials Research Unit, University of Auckland)
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Therese Harper MSc. (School of Kinesiology, The University of Western Ontario)
Kevin Shoemaker, Ph.D. (School of Kinesiology, The University of Western Ontario)

You are being invited to participate in a research study looking at the long-term effects of exercise on helping women quit smoking. This is a clinical trial (a type of research study) which includes eligible volunteers who choose to take part. Please take your time to make a decision, and discuss this proposal with your personal doctor, family members and friends as you feel inclined. The purpose of this letter is to provide you with the information you require to make an informed decision on participating in this research and to help us talk to you about smoking cessation (quitting). This letter contains information to help you decide whether or not to participate in this research study. It is important for you to understand why the study is being conducted and what it will involve. Please take the time to read this carefully and feel free to ask questions if anything is unclear or there are words or phrases you do not understand. We are asking you to take part because you are a woman who smokes and wishes to quit. We hope to recruit a total of 420 women and help them quit smoking and remain smoke-free over a total of 13 months, as well as examine the effect of exercise on maintaining a healthy body weight.

Invitation to Participate in Research and Eligibility Criteria

You are being invited to take part in this research study because you:

(a) are between the ages of 18 and 65
(b) smoke 10 or more cigarettes per day for the past 2 years or more and want to quit
(c) engage in 2 or less 30-minute bouts of moderate (e.g., jogging, playing tennis) or vigorous (e.g., running, spin classes, high impact aerobics) intensity exercise over the past 6 months
(d) do not have a medical condition that prevents you from exercising
(e) are not pregnant or intending on being pregnant over the next 13 months
(f) are able to read and write in English
(g) have a telephone or an email account that we can reach you at over the next 13 months

Please note that if you are pregnant, or wish to become pregnant during the course of the study, you are NOT eligible to participate. If you become pregnant during the course of the study, you must notify the study researchers immediately. This is because low doses of radiation will be administered during one of the tests of the study, and this could cause harm to a foetus or breast-fed baby.

What is the purpose of this study?

This study is intended to evaluate how useful an exercise program, nicotine replacement therapy (e.g., Nicoderm®), and support and advice from an exercise counselor, is at helping women who smoke become smoke-free and remain physically active for 13 months. We will also examine the effects of this program on body composition (e.g., your weight, the ratio between your body fat and your body muscle mass), your physical fitness, and your confidence to perform certain activities.

It has been shown in past research that exercising can help women quit smoking by alleviating smoking withdrawal symptoms. Unfortunately, if the exercise program is stopped, women often resume smoking. Our goal in this study is to help women learn how to stick with an exercise program in their own homes, maintain their health and weight through exercise, and subsequently stay motivated to remain smoke-free. The information we gather will help guide the development of future programs to help women like you who wish to quit.

Specific questions we hope to answer by conducting this study are:

1) Does the type of information and support given by the exercise counsellor make a difference in terms of how long women who have recently quit smoking can remain smoke-free?
2) Does the type of information and support given by the exercise counsellor make a difference in terms of how long women who have recently quit smoking can continue with their exercise program?

WHAT YOU ARE ASKED TO DO IN THIS STUDY?

1) Participate in a lab-based exercise program

Time involvement = 3 x 45 minutes each week for 14 weeks

If you choose to participate in this study, you will be asked to take part in an exercise program three times per week for a total of 14 weeks. These exercise sessions will be supervised by a trained exercise counselor, and will all take place in the Exercise and Health Psychology Laboratory (EHPL) at the University of Western Ontario in the Arthur and Sonia Labatt Health Sciences building. Each exercise session will last 45 minutes, and will consist of a warm-up, cardiovascular work-out, and cool-down on pieces of equipment such as the treadmill, stationary bike, stepper, and rower. You will be asked to wear a heart rate monitor so that your efforts can be monitored to ensure that you are working at an effective and safe exercise intensity, based on your fitness level. A trained councilor will be there at all times to assist you. If you miss an exercise session, you will be asked to make up for the missed session on the weekend at a scheduled time.

2) Quit smoking

Time involvement = 0 minutes

After 4 weeks of this exercise program, we will ask you to stop smoking cigarettes completely. To assist you in doing this, we will be providing you with commercially-available nicotine replacement therapy (NICODERM®) in the form of daily patches that adhere to your skin like a small band-aid. This will be dispersed to you in weekly allotments each week from week 4 through 14 at the EHPL after your exercise sessions. The dose that you will receive from this patch depends on your current level of smoking, but will most likely result in you following the recommended guidelines of:

A) Wearing a 21mg patch each day for 6 weeks (weeks 4 through 10 of the study)
B) Wearing a 14 mg patch each day for 2 weeks (weeks 11 and 12 of the study)
C) Wearing a 7 mg patch each day for 2 weeks (weeks 13 and 14 of the study)

In total, you will wear these daily patches for 10 weeks while you continue to exercise at our exercise facility.

3) Participate in support group that you are randomly assigned to
Time involvement = 3 x 15 minutes for a total of 3 weeks

You will also be provided with group counseling and support information during weeks 12 through to week 14 of the program. The type of support information you will receive during these weeks depends on which group you are randomized to. In other words, the participants in the study will be assigned at random (like a flip of a coin), that is, by a method of chance, to one of 4 groups. You will have a 1 in 4 chance of being in any one of the support groups. The four support groups are as follows:

1. Lifestyle Exercise Maintenance Group
2. Relapse Prevention Group
3. Health and Nutrition Maintenance Group
4. Lifestyle Exercise Maintenance and Relapse Prevention Group

ALL support groups will receive information related to health for women from the trained exercise counselor you have been working with in a group format (e.g., with the other women you have been exercising with). This information will be delivered for 15 minutes at the end of each exercise session in the EHPL during weeks 12 through 14 of the study.

The trained exercise counselor you have been working with will also follow-up with you via either phone or email (it is your choice which mode of communication you would like to be contacted through) to provide support and encourage you to remain physically active and remain smoke free after the program has ended for 10 additional months.

4) Perform tests

There are a number of tests that you will be asked to do if you choose to participate in this study. ALL tests will be performed within the EHPL under trained research staff. These tests provide the study researchers with evidence that will help us answer the research questions. At baseline testing (before the exercise program begins), we will ask you to perform a number of these tests so that we may measure how you are doing before you quit smoking and before you begin to exercise.

i) Baseline Testing
Time involvement = 3 hours

For baseline testing, you will be asked to visit our exercise facility (the Exercise and Health Psychology Laboratory; EHPL) at the University of Western Ontario. Baseline testing will begin after you have provided the study researchers with written consent from your family physician indicating that he or she supports your involvement in this study. Baseline testing will take approximately 4 hours and will include completing a number of questionnaires, or surveys, as well as some physical tests.

The **surveys** will ask you about:

- Your motivation to quit smoking ("How motivated are you to quit smoking in the next 7 days?")
- Physical activity ("In the past week, how often did you do light activities, such as yoga or slow walking?", "Has your doctor ever advised you NOT to engage in physical activity?")
- Your personal goals for quitting smoking ("Please identify your most important smoking cessation goal")
- Your personal goals for engaging in exercise ("Please identify your most important exercise goal")
- Smoking history ("In the past week, how many cigarettes did you consume?")
- A demographic questionnaire (which asks you about information such as your age, education, martial status, income)
- Your satisfaction with your weight ("How satisfied, or content, are you with your current body weight?")

- Your confidence in your abilities to do activities related to exercise and quitting smoking ("How confident are you in your ability to exercise for 30min continuously, once per week?")
- Your smoking cravings ("How irritable do you feel right now?")
- Your dependence on nicotine ("How soon after you first wake up do you have a cigarette?")
- Your sleeping patterns ("In the past week, how often did you have trouble falling asleep?")
- Your mood ("How often during the past week did you feel full of pep?")

It is important to note that there are no correct or incorrect answers to these questions, and you may choose to skip any questions you do not feel comfortable in answering.

The **physical tests** will consist of:

- An aerobic fitness test on a treadmill (often called a *maximal oxygen uptake treadmill test*). A trained research technician will be performing the test on you, making sure you are safe and comfortable at all times. This test is performed regularly in our laboratory. Length of the treadmill test varies from 9 to 18 minutes, depending on your level of physical fitness. The test begins by having you walk at an easy pace on a treadmill (e.g., the pace you walk when you walk down the street). The speed and incline of the treadmill will then be gradually increased every 3 minutes until you indicate to us that you do not wish to continue, or you reach your age-predicted maximum heart rate, as determined by a trained research technician. During this test you will breath through a mouthpiece connected to a computer that will measure your oxygen consumption. By doing this test, we will be able to assess your aerobic fitness and also determine the level of training intensity that is safe for you to exercise at during the exercise program. The test will end with a cool-down, where you will walk at an easy, self-selected pace for 5 minutes.

- A non-invasive body composition test. The body composition test uses a machine called Dual-Energy X-Ray Absorptiometry (DXA; GE Lunar). This machine measures the amount of fat and muscle you have in your body without touching you. We will want to measure your body composition throughout the study, so that we may look for any changes that may occur due to exercise. Although this machine does use an X-ray, the amount of radiation is very minimal. The amount of radiation used in one test is extremely small (0.01 mSv). Each day, you receive approximately 0.01 mSv of natural background radiation from the earth. In comparison, flying on a commercial airplane exposes humans to approximately 0.03 mSv per trip. All that is required of you is that you lie down on the bed surface of the DXA for approximately 5 minutes, while the monitoring arm scans the length of your body. You will be asked to take off any metals you may be wearing, such as earrings, as they could alter the results of the test. You will feel absolutely no pain or discomfort.

- Measures of your smoking status. We will measure your smoking status using physical tests in two separate ways. First, we will ask you to breath into a machine called the Bedfont Smokerlyzer. This machine measures the amount of carbon monoxide (CO) as you breathe out. It does not cause any harm or discomfort to you. This smokerlyzer measures how much you have smoked in the past several hours. Second, we will ask you to provide us with a saliva sample by spitting approximately 10mL into a special test tube. If you have difficulties producing that much saliva, you will be given parafilm (an odourless, tasteless product) to chew on. From this saliva sample, we will measure cotinine, which tells us about your smoking behaviour in the past several days, and 3-hyrdroxycotinine: cotinine ratio, which tells us about the rate at which your body metabolizes (breaks down) nicotine.

- A measure of your lung health, using a device called spirometry. To complete this test, you will take your deepest possible breath and then let all of the air out (exhale) into the sensor on the device. You will breathe out as hard as you possibly can, and for as long as you possibly can.

- Measures of your vascular (blood vessel) health. Smoking could cause damage to your blood vessels, which is a leading cause for cardiovascular disease. In order to measure your vascular health, a trained research technician will perform a total of 5 non-invasive measures on you. The first is a measure of **blood pressure**. First, a small cuff will be placed around one finger. Second, a cuff will be placed around your upper arm and inflated periodically in the same manner as blood pressure measurements made by your family physician. An additional cuff will be placed around one of your toes to measure the blood pressure changes in your feet. In addition, a small cuff will be placed around one of your toes in order to measure the blood pressure pulse wave in that region. An **electrocardiogram** will also be conducted by placing 3 sticky buttons (electrodes) on your chest in order to measure the electrical activity of your heart. The third measure of vascular health that will be measured is **images of your heart and blood vessels**. Specifically, your heart and blood vessels in your leg, arm and neck will be measured with an ultrasound system. For these tests you will be placed in the supine (lying down) position, where you will relax as a "flash-light" sized probe is held gently on your skin over your heart and blood vessels and applied for up to 10-15 minutes at each site. The fourth measurement of vascular health is similar to the third: a **3-D ultrasound measurement of carotid artery and plaque volume**. This will measure the extent of plaque buildup in the arteries of your neck using ultrasound. The same probe used for blood vessel imaging (above) will be mounted in a special device that moves the probe in precise, stepped movements along the neck. This procedure should take approximately 45 minutes, which includes setup time and verification of the data. Finally, we will measure **forearm endothelial function.** The size of the brachial artery in your arm will be measured by the ultrasound in this test. You will be asked to lie quietly while a blood pressure cuff is inflated around your forearm to prevent blood flow into your hand for 5 minutes. When this cuff is released and blood flow to your hand is restored, you will be asked to lie quietly for an additional 5 minutes.

- Wearing an accelerometer. At the end of baseline testing, we will give you an accelerometer (motion detector) to wear around your waist at all times except for when sleeping and bathing, for 7 days. This device is small and unobtrusive. After one week, you will be asked to return the device to the study researchers. We will then download the data from the device you wore onto our computer programs.

ii) Post-Testing

Time involvement = 3 hours

The same number of tests will be performed again after the study ends, 13 months after baseline, so that we may measure the effects of the program.

iii) Testing throughout the study

Time involvement = approximately 15 minutes each week

There will also be periodic testing that you will be asked to do throughout the study (in between baseline and post-testing). These tests will consist of tests that you already did at baseline, so you will be familiar with the procedures. The table that follows shows which tests you will be asked to do, and at what times. Please do not hesitate to ask for clarification – we realize there is a lot of information in this table.

What are the risks associated with my involvement in this study?
While in the study, you may experience side effects. Known side effects are listed below, but other effects may occur that we cannot predict.

Exercise: There are some inherent risks of injury associated with exercise participation, particularly among people who are not used to exercising. You may, for example, feel mild muscle "tightness" or soreness that lasts for a couple of days after their first few bouts of exercise. The possible benefits associated with exercise may outweigh the potential minor discomfort of beginning a supervised, laboratory-based exercise program. To minimize the physical risks of exercise, proper warm-up/cool-down and stretching protocols will be performed, with each exercise session being supervised by a trained exercise counsellor. Additionally, the exercise program delivered will be tailored to your individual fitness level, and modified according to your comfort level. You will gradually, under the supervision of a trained exercise facilitator, work up to a moderate intensity for your aerobic exercise training bouts. Furthermore, you will only be allowed to participate in this exercise program if you provide medical clearance from your physician, and complete the PAR-Q (Physical Activity Readiness Questionnaire) forms to ensure that it is safe for you to begin an exercise program. The exercise facilitator will be both CPR and First Aid trained, and experienced in working with previously inactive populations. Throughout, if any physical or mental risks arise, you will be referred to the Middlesex London Health Unit if issues arise that fall outside of the scope of the study.

Quitting Smoking: You may experience withdrawal symptoms during the first few days after you quit smoking in this program. Such symptoms may include feeling edgy and nervous, dizzy, sweaty, having trouble concentrating, headaches, difficulty sleeping, increased appetite and weight gain, muscular pain, constipation, fatigue, or having an upset stomach. All of these symptoms are common for those who quit smoking so you should not be alarmed, as these symptoms will go away within a few days. It should be noted, however, that this program provides you with tools that we believe will help counter these withdrawal symptoms. Specifically, moderate intensity exercise has been shown to reduce smoking withdrawal symptoms. The nicotine replacement therapy we provide you with should also eliminate or reduce the smoking withdrawal symptoms. Another common side effect of quitting smoking is that your "smoker's cough" gets worse for the first few days after you quit. This is your body's way of attempting to rid the lungs of excess toxins. This may not be alleviated by exercise or nicotine replacement therapy. Your smoker's cough will improve to a great extent after you have become smoke-free for a number of days.

Nicotine Replacement Therapy (NICODERM®): It is important to note that while this product does contain nicotine, it is considered safer and healthier than smoking. We are providing you with this medication as a tool to help you become completely free of your addiction to cigarettes. Some individuals who wear the patch experience redness, swelling, or a rash on their where the patch is placed. This is due to the adhesive material on the patch. Contact your family physician if this occurs. You should also contact your family physician if you develop an irregular heart beat, or if you get symptoms of nicotine overdose such as nausea, vomiting, dizziness, weakness and a rapid heartbeat. These are all potential side effects of taking nicotine replacement therapy; however, the chance of you developing one of these side effects is minimal.

Nicoderm should not be used by people who:

- Are allergic to nicotine
- Are non-smokers or occasional smokers
- Are under 18 years of age
- Are pregnant or breast-feeding
- Have just had a heart attack
- Have life-threatening abnormal heart rhythm
- Have severe or worsening chest pain
- Have recently had a stroke
- Have a generalized skin disorder

Electrocardiogram: The only potential side effect known is a rash that may develop due to the adhesive of the ECG electrodes. Should you develop this rash, it will disappear over the next 2-3 days.

Forearm Circulatory Occlusion: When blood flow to your hand is stopped, you may experience pins and needles or numbness in your forearm. These sensations will be followed by a sensation of warmth in the hand once the cuff is released and blood flow to the hand resumes. All of these sensations will resolve within 45 seconds of cuff release.

Blood Pressure Measures: The blood pressure monitoring cuffs used to measure blood pressure may cause some mild discomfort, bruising or red blood spots on the arm to which it is applied. There is some discomfort when the cuff is inflated around your arm but this feeling goes away when the cuff is deflated.

Dual-Energy X-Ray Absorptiometry (DXA; GE Lunar): This test uses a small dosage of radiation to conduct a non-invasive x-ray on your body. The amount of radiation is very minimal, and no known side effects are associated with this minimal amount of radiation. The amount of radiation used in one test is extremely small (0.01 mSv). Each day, you receive approximately 0.01 mSv of natural background radiation from the earth. In comparison, flying on a commercial airplane exposes humans to approximately 0.03 mSv per trip. The DXA machine used in the EHPL is tested and calibrated daily to ensure it is working optimally at all times. A trained and certified research technician will always perform this test on you.

R**isk to your foetus or baby:** If you are pregnant or breastfeeding, there are also side effects that could harm your foetus or baby. Use of nicotine replacement therapy is not recommended while pregnant or breastfeeding. Use of this product could cause harm to your foetus or baby. You are not eligible to participate in this study if you are pregnant or planning on becoming pregnant over the course of this study. If you become pregnant, it is important that you tell one of the study researchers immediately. It should be noted that pregnant women are advised to limit their exposure to radiation due to potential harm to the foetus. As such, women in this study who become pregnant, or who have any reason to believe they may be pregnant at all will **not** undergo DXA testing.

Do I have to take part?

Participation in this study is voluntary. You may refuse to participate, refuse to answer any questions or withdraw from the study at any time with no effect on your future care. If you decide to take part you will be given this Letter of Information to keep and be asked to sign the consent form. If you withdraw from the study, you maintain the right to request that any data collected from you not be used in the study. If you make such a request, all of the data collected from you will be destroyed. Please contact the Principal Investigator if you wish to withdraw from the study.

Participation in other studies

If you are participating in another study at this time, please inform the study researchers right away to determine if it is appropriate for you to participate in this study.

Biological specimens given by you for use in this study
The sample we are asking of you during the course of this study is saliva. This saliva sample will be used for the current study only. Specifically, this saliva will be frozen in our laboratory freezer, then shipped and analyzed at the Salimetrics® Laboratory in the United States of America for markers of smoking abstinence (cotinine). The saliva taken at the baseline measurement time point only will be frozen in our laboratory freezer, then shipped and analyzed at the University of Toronto in Canada for an indication of how quickly you metabolize (break down) nicotine in your body (3-hydroxycotinine: cotinine ratio). Bar codes will be used to label your saliva samples, so the laboratory technicians analyzing your saliva will have no information as to who provided the saliva sample. The samples will be stored for a minimum of 3 years. Usage and potential research value will be reviewed annually thereafter. It is typical to keep the samples collected from a research study for 6 years after the study has been conducted. Once the research value is deemed lower than sufficient to justify storage costs, the samples will be destroyed by standard disposal of biohazardous waste laboratory policies and procedures.

Any specimen(s) obtained for the purposes of this study will become the property of the study researchers and once you have provided the specimens you will not have access to them. The specimen(s) will be discarded or destroyed once they have been used for the purposes described in the protocol. The specimen(s) will be used for research and such use may result in inventions or discoveries that could become the basis for new products or diagnostic or therapeutic agents. In some instances, these inventions and discoveries may be of potential commercial value and may be patented and licensed by the researcher. It is not the purpose of this study to use specimens for any inventions or patents, so it is very unlikely that this will occur as an outcome of a sample you provide us with. You will not receive any money or other benefits derived from any commercial or other products that may be developed form use of the specimens.

New findings
If, during the course of this study, new information becomes available that may relate to your willingness to continue to participate, this information will be provided to you by the investigator.

What are the benefits of my involvement?
Involvement in this study could help you to increase your levels of physical activity in a safe and supportive setting, and may assist you in remaining smoke free. It may also help you manage your weight and ease weight concerns, and teach you how to maintain your levels of physical activity. Ultimately, to be physically active and to quit smoking is good for your health, and may prevent you from developing co morbidities associated with long-term smoking and from an inactive lifestyle (e.g., cardiovascular disease). Furthermore, your participation will help to inform the development of other programs in the future.

Are there any costs associated with participation?
The study medication (NICODERM ®) will be given to you at no cost. You will not be paid to take part in the study; however, you will be reimbursed for your expenses such as parking for visits required as part of this study.

If you have private medical or life insurance, you should check with your insurance company before you agree to take part in the study to confirm your participation in this study will not affect your insurance coverage and/or access to benefits.

This study is covered by an insurance policy and if during the course of the study any injury should occur to you as a result of the administration of the study medication, not due to your fault or negligence, all medical expenses necessary to treat such injury will be paid provided: a) you comply at all times with the study researcher's instructions b) you promptly report any such injury to the study researchers conducting the study, and c) the expenses are not otherwise covered by your provincial health care. Financial compensation for such things as lost wages, disability or discomfort due to this type of injury is not routinely available. You do not waive any legal rights by signing the consent form.

Will information obtained in the study be confidential?

All the information you provide to the researcher will be kept in the strictest confidence. You will be assigned an identification number and all data collected from you will be recorded and stored under this number only, so study researchers will have any way of connecting your data to you. All data will be stored in coded form on computers accessible only to research staff in a secure office. You will not be identified in any documents relating to the research. No information obtained during the study will be discussed with anyone outside of the research team. If the results of the study are published, your name will not be used.

Representatives of the University of Western Ontario Health Sciences Research Ethics Board and regulatory bodies (Health Canada) may contact you or require access to your study-related records to monitor the conduct of the research. If we find information we are required by law to disclose, we cannot guarantee confidentiality. We will strive to ensure the confidentiality of your research-related records. Absolute confidentiality cannot be guaranteed as we may have to disclose certain information under certain laws.

Alternative treatments

An alternative to participating in this study would be to see your family physician for advice on how to quit smoking. You could also choose to not participate in the study and continue on just as you do now.

Questions?

If you have any questions about your rights as a research participant or the conduct of the study you may contact the Office of Research Ethics (Phone: 519-xxx-xxxx; Email:).

If you have any questions about the study, please contact the principal investigator, Dr. Harry Prapavessis (Phone: 519-xxx-xxxx ext. xxxxx; Email:.

This letter is for you to keep. You will be given a copy of this letter of information and consent form once it has been signed. If you have any concerns, please feel free to contact one of the researchers below. You may request the general findings of this research study from the researchers after the study is complete. Again, if you have any questions about the conduct of this study, or your rights as a participant, you may contact the Office of Research Ethics, The University of Western Ontario, 519-xxx-xxxx.

Dr. Lyndsay Fitzgeorge	Dr. Harry Prapavessis	Therese Harper
Postdoctoral Fellow	Professor	Ph.D. Student
School of Kinesiology	School of Kinesiology	School of Kinesiology
UWO	UWO	UWO

Informed Consent

Study Title: Getting Physical on Cigarettes

I have read the Letter of Information, had the nature of the study explained to me and I agree to participate. All questions have been answered to my satisfaction. I will be given a copy of the Letter of Information and consent form once it has been signed.

Consenting Signature:

Participant: _____
Please Print Name

Participant: _____
Please Sign Name

Date: _____

Please send me the overall conclusions from this trial: Yes □ No □

Researcher Signature:

Person obtaining informed consent: _____
Please Print Name

Person obtaining informed consent: _____
Please Sign Name

Date: _____

Appendix 19. Ethics approval forms

Office of Research Ethics
The University of Western Ontario
Room 4180 Support Services Building, London, ON, Canada N6A 5C1
Telephone: (519) 661-3036 Fax: (519) 850-2466 Email: ethics@uwo.ca
Website: www.uwo.ca/research/ethics

Use of Human Subjects - Ethics Approval Notice

Principal Investigator: Dr. H. Prapavessis
Review Number: 16306 **Review Level:** Full Board
Review Date: July 07, 2009
Protocol Title: Getting physical on cigarettes
Department and Institution: Kinesiology, University of Western Ontario
Sponsor: NCIC-NATIONAL CANCER INSTITUTE OF CANADA
Ethics Approval Date: October 01, 2009 **Expiry Date:** March 31, 2013
Documents Reviewed and Approved: UWO Protocol, Letter of information & consent form, advertisement, & recruitment script
Documents Received for Information:

This is to notify you that The University of Western Ontario Research Ethics Board for Health Sciences Research Involving Human Subjects (HSREB) which is organized and operates according to the Tri-Council Policy Statement: Ethical Conduct of Research Involving Humans and the Health Canada/ICH Good Clinical Practice Practices: Consolidated Guidelines; and the applicable laws and regulations of Ontario has reviewed and granted approval to the above referenced study on the approval date noted above. The membership of this REB also complies with the membership requirements for REB's as defined in Division 5 of the Food and Drug Regulations.

The ethics approval for this study shall remain valid until the expiry date noted above assuming timely and acceptable responses to the HSREB's periodic requests for surveillance and monitoring information. If you require an updated approval notice prior to that time you must request it using the UWO Updated Approval Request Form.

During the course of the research, no deviations from, or changes to, the protocol or consent form may be initiated without prior written approval from the HSREB except when necessary to eliminate immediate hazards to the subject or when the change(s) involve only logistical or administrative aspects of the study (e.g. change of monitor, telephone number). Expedited review of minor change(s) in ongoing studies will be considered. Subjects must receive a copy of the signed information/consent documentation.

Investigators must promptly also report to the HSREB:

a) changes increasing the risk to the participant(s) and/or affecting significantly the conduct of the study;
b) all adverse and unexpected experiences or events that are both serious and unexpected;
c) new information that may adversely affect the safety of the subjects or the conduct of the study.

If these changes/adverse events require a change to the information/consent documentation, and/or recruitment advertisement, the newly revised information/consent documentation, and/or advertisement, must be submitted to this office for approval.

Members of the HSREB who are named as investigators in research studies, or declare a conflict of interest, do not participate in discussion related to, nor vote on, such studies when they are presented to the HSREB.

Chair of HSREB: Dr. Joseph Gilbert

Ethics Officer to Contact for Further Information			
☑ Janice Sutherland (jsutherl@uwo.ca)	☐ Elizabeth Wambolt (ewambolt@uwo.ca)	☐ Grace Kelly (grace.kelly@uwo.ca)	☐ Denise Grafton (dgrafton@uwo.ca)

This is an official document. Please retain the original in your files.

cc: ORE File

Office of Research Ethics
The University of Western Ontario
Room 4180 Support Services Building, London, ON, Canada N6A 5C1
Telephone: (519) 661-3036 Fax: (519) 850-2466 Email: ethics@uwo.ca
Website: www.uwo.ca/research/ethics

Use of Human Subjects - Ethics Approval Notice

Principal Investigator: Dr. H. Prapavessis
Review Level: Expedited
Review Number: 16306
Revision Number: 3
Review Date: November 26, 2010
Approved Local # of Participants: 420
Protocol Title: Getting physical on cigarettes
Department and Institution: Kinesiology, University of Western Ontario
Sponsor: NCIC-NATIONAL CANCER INSTITUTE OF CANADA
Ethics Approval Date: November 29, 2010
Expiry Date: March 31, 2013
Documents Reviewed and Approved: Deletion of 3 questionnaires & Addition of 2 questionnaires on coping with daily hassles, revised letter of information & consent form
Documents Received for Information:

This is to notify you that The University of Western Ontario Research Ethics Board for Health Sciences Research Involving Human Subjects (HSREB) which is organized and operates according to the Tri-Council Policy Statement: Ethical Conduct of Research Involving Humans and the Health Canada/ICH Good Clinical Practice Practices: Consolidated Guidelines; and the applicable laws and regulations of Ontario has reviewed and granted approval to the above referenced revision(s) or amendment(s) on the approval date noted above. The membership of this REB also complies with the membership requirements for REB's as defined in Division 5 of the Food and Drug Regulations.

The ethics approval for this study shall remain valid until the expiry date noted above assuming timely and acceptable responses to the HSREB's periodic requests for surveillance and monitoring information. If you require an updated approval notice prior to that time you must request it using the UWO Updated Approval Request Form.

During the course of the research, no deviations from, or changes to, the protocol or consent form may be initiated without prior written approval from the HSREB except when necessary to eliminate immediate hazards to the subject or when the change(s) involve only logistical or administrative aspects of the study (e.g. change of monitor, telephone number). Expedited review of minor change(s) in ongoing studies will be considered. Subjects must receive a copy of the signed information/consent documentation.

Investigators must promptly also report to the HSREB:

a) changes increasing the risk to the participant(s) and/or affecting significantly the conduct of the study;
b) all adverse and unexpected experiences or events that are both serious and unexpected;
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Members of the HSREB who are named as investigators in research studies, or declare a conflict of interest, do not participate in discussion related to, nor vote on, such studies when they are presented to the HSREB.

Chair of HSREB: Dr. Joseph Gilbert
FDA Ref. #: IRB 00000940

Ethics Officer to Contact for Further Information			
☑ Janice Sutherland (jsuther@uwo.ca)	☐ Elizabeth Wambolt (ewambolt@uwo.ca)	☐ Grace Kelly (grace.kelly@uwo.ca)	

This is an official document. Please retain the original in your files.

cc: ORE File

CURRICULUM VITAE – THERESE HARPER

EDUCATION

Sep 08 – Present	PhD Candidate in Kinesiology, Faculty of Health Science University of Western Ontario, Canada
Mar 04 – Mar 06	Master of Science (MSc), First Class Honours, Sport and Exercise Science, Faculty of Health Science University of Auckland, New Zealand
Mar 01 – Mar 04	Bachelor of Science (BSc), Major in Physiology and Psychology, Faculty of Health Science University of Auckland, New Zealand

PROFESSIONAL EXPERIENCE

Research Officer
Auckland Bone and Joint Surgery – Ascot Hospital
Jan 2005 - Sep 2008

Report Writer
The Health Planner
Sep 2007 – Sep 2008

Tutor
Exercise Psychology (third year course)
University of Auckland
Mar 2004 – Mar 2006

Researcher
Sport and Exercise Science Department
University of Auckland
Jan 2003 – Dec 2005

Note Taker
University of Auckland
Mar 2001 – Mar 2003

AWARDS

2008-2011	Graduate Research Scholarship – University of Western Ontario
2008-2011	Top Achievers Doctoral Scholarship – Tertiary Education Commission of New Zealand
2008	Deans Entrance Scholarship – University of Western Ontario
2005	Sport and Exercise Science Postgraduate Award

2004 Faculty of Science Fees Bursary Award
2004 Health Research Council Summer Studentship
2004 Sport and Exercise Science Postgraduate Award
2003 Senior Prize in Physiology

PROFESSIONAL DEVELOPMENT

2010 Tobacco Treatment Specialist – University of Massachusetts Medical School, Core Certification Training
2010 Protecting Human Research Participants – National Institutes of Health (NIH) web based training course
2010 Basic Skills for Working with Smokers – University of Massachusetts Medical School

PUBLICATIONS

Harper, T. & Prapavessis, H. (under review). Physical inactivity information as a source of exercise motivation during adolescence. *Health Psychology*.

Maddison, R., Prapavessis, H., Clatworthy, M., Hall, C., Foley, L., **Harper, T.**, Cupal, D., & Brewer, B. (in press). Guided imagery to improve functional outcomes post anterior cruciate ligament repair: randomized controlled pilot trial. *Scandinavian Journal of Medicine and Science in Sports*.

Prapavessis, H., Cameron, L., Baldi, J., Robinson, S, Borrie, K., **Harper, T.**, & Grove, J. R. (2007). The effects of exercise and nicotine replacement therapy on smoking rates in women. *Addictive Behaviors.*

Prapavessis, H., Maddison, R., Ruygrok, P., Bassett, S., Gillanders, L., & **Harper, T**. (2005). Using Theory of Planned Behavior to understand exercise motivation in patients with congenital heart disease. *Psychology, Health and Medicine*, 10, 335-343.

PUBLISHED ABSTRACTS

Harper, T., Fitzgeorge, L., & Prapavessis, H. (2011). The magnitude of craving and withdrawal relief experienced following exercise during a quit smoking attempt using nicotine replacement therapy. *Annals of Behavioral Medicine*, *41*(S1), s157.

Clatworthy, M., Young, S., Deverall, H., & **Harper, T.** (2006). Treatment of full thickness articular cartilage defects with microfracture. *Journal of Bone and Joint Surgery, 88(Suppl II)*, 316.

Clatworthy, M., **Harper, T.**, & Maddison, R. (2006). The effect of tibial slope on anterior tibial translation in the ACL deficient knee and outcome of the ACL reconstructed knee. *Journal of Bone and Joint Surgery, 88(Suppl II)*, 317.

CONFERENCE PRESENTATIONS

Fitzgeorge, L., **Harper, T.**, & Prapavessis, H. (2011). *'Getting Physical on Cigarettes' preliminary findings.* Poster presented at the Society for Research on Nicotine and Tobacco, Toronto, Canada.

Harper, T., Fitzgeorge, L., & Prapavessis, H. (2011). *Do acute exercise effects predict success in a 14 week exercise-aided smoking cessation programme?* Poster presented at The Society of Behavioral Medicine, Washington, DC, United States of America.

Harper, T. & Prapavessis, H. (2007). *Is physical inactivity information an effective source of exercise motivation?* Lecture presented at The Society of Behavioral Medicine, Washington DC, United States of America.

MEMBERSHIPS / AFFILIATIONS

Canadian Centre for Addiction and Mental Health
Society for Research on Nicotine and Tobacco
Society of Behavioral Medicine