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Intermittent Exercise in Response to Nicotine Cravings in the Context of an Internet-based Smoking Cessation Program

A dissertation submitted in partial satisfaction of the requirements for the degree
Doctor of Philosophy

in

Clinical Psychology

by

Sarah Elizabeth Linke

Committee in charge:

University of California, San Diego

Professor Thomas Rutledge, Chair
Professor Mark Myers, Co-Chair
Professor Karen Calfas
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Professor Elva Arredondo
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2011

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University of California, San Diego

San Diego State University

2011

DEDICATION

This dissertation is dedicated to my parents, who have supported me unconditionally throughout my entire education. From “Battle of Nations” to internship applications, my mom pulled all-nighters with me countless times to support my habit of perfecting scholastic endeavors down to the deadline. My dad prefers to sleep overnight, so he routinely checks in with me about deadlines and repeatedly reminds me to finish things much earlier than they are due. The balance of my parents’ disparate styles has proved beneficial for me. I appreciate their endless encouragement, assistance, and belief in me more than they can imagine.

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EPIGRAPH

Never give up on a dream just because of the time it will take
to achieve it. The time will pass anyway.

Earl Nightingale

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ABSTRACT OF THE DISSERTATION

Intermittent Exercise in Response to Nicotine Cravings in the Context of an Internet-based Smoking Cessation Program

by

Sarah Elizabeth Linke

Doctor of Philosophy in Clinical Psychology

University of California, San Diego, 2011
San Diego State University, 2011

Professor Thomas Rutledge, Chair
Professor Mark Myers, Co-Chair

Background: Interventions using sustained aerobic exercise programs to aid smoking cessation have resulted in modest, short-term cessation rates comparable to conventional cessation methods. No smoking cessation trial to date has prescribed intermittent bouts of exercise in response to nicotine cravings.

Objectives: This randomized controlled trial examined the feasibility and efficacy of an Internet-based smoking cessation program alone (CON) vs. the same Internet-based program + exercise (EX).

Study Population: Participants were generally healthy, inactive adult smokers (N = 38; mean age = 43.6 [SD = 11.5]; 60.5% women) who desired to quit.

Study Design: This pilot study added unique strategies to the methods employed in prior studies utilizing exercise as a smoking cessation strategy.

Results: Although retained participants ($n = 23$; 60.5%) achieved a higher cessation rate (26.1%) than all enrolled participants (15.8%), adjusted intent-to-treat and per-protocol binary logistic regression analyses revealed no significant cessation rate differences between EX and CON groups. A repeated measures general linear model (GLM) analysis examining between group and within subjects changes in smoking rate from baseline to post-intervention among all participants revealed a significant within subjects effect over time, $F(1, 35) = 11.45, p = .002$. However, neither the between group, $F(1, 35) = 1.08, p = .31$, nor the interaction, $F(1, 35) = 0.86, p = .36$, effect was statistically significant. Linear regression results indicated that additional days of self-reported exercise on the study website during the intervention phase predicted significantly higher reduction rates among EX group participants, $F(2, 18) = 31.08, p < .001$.

Conclusions: Outcomes from this pilot study were comparable to more resource- and time-consuming smoking cessation programs, suggesting that future iterations of this program may be promising. Results were mixed with regard to the incremental benefit of exercise in the presence of the apparently valuable Internet-based smoking cessation program. The results support findings from related research and underscore the need for additional investigation into both the mechanisms underlying the effect of exercise on cigarette cravings and the challenges of poor adherence in the context of exercise-based smoking cessation interventions.

Introduction

Tobacco use and physical inactivity are the leading causes of preventable death in the United States, accounting for approximately one-third of annual deaths (Centers for Disease Control and Prevention. Department of Health and Human Services. National Center for Chronic Disease Prevention and Health Promotion, 2007). They also tend to co-exist and apparently influence each other, as persistent smokers are more likely to remain inactive (Nagaya, Yoshida, Takahashi, & Kawai, 2007). The negative effects of these behaviors continue to prevail and even increase despite the declining age-standardized mortality rates from the diseases to which they contribute – namely, heart disease, stroke, and cancer (Centers for Disease Control and Prevention. Department of Health and Human Services. National Center for Chronic Disease Prevention and Health Promotion, 2007).

Despite the widespread dangers associated with tobacco use, the declining trend in the U.S. smoking rate appears to have stalled in recent years, consistently hovering around 20-21% of adults (Dube et al., 2010). The adult smoking rate in California was estimated at 11.6% in 2008, making it the state with the second lowest smoking rate (Al-Delaimy et al., 2010). Although an estimated 39.8% of adult everyday smokers attempt to quit each year (Centers for Disease Control and Prevention, 2008), only a small percentage succeeds (Fiore et al., 2008). These statistics suggest that mainstream cessation assistance options do not work well for many smokers, who may benefit from innovative, alternative cessation treatments.

Whereas smoking has been recognized as a leading behavioral risk factor for decades, inactivity has emerged relatively recently as an epidemic of Western society (Hedley et al., 2004). In 2008, only 30.7% of the adult population reportedly engaged in regular leisure-time physical activity (Pleis, Lucas, & Ward, 2009). Lead researchers predict that physical inactivity may be the biggest public health problem of the 21st century (Blair, 2009).

Smoking

Although a majority of smokers express a desire to quit at any given time, most of them attempt to quit without assistance (Chapman & MacKenzie, 2010). Smokers who seek assistance in their quit attempts tend to be more nicotine dependent and thus less likely to report successful smoking abstinence (Shiffman, Brockwell, Pillitteri, & Gitchell, 2008). Self-help approaches, single or combined pharmacotherapies, and psychological/counseling interventions with or without pharmacotherapies are the most common methods employed by those who seek assistance. Although these methods are associated with short-term cessation, results regarding their long-term utility are mixed or not even examined (Ranney, Melvin, Lux, McClain, & Lohr, 2006; Schroeder, Lawlor, Montaner, & Ebrahim, 2006).

Recent research suggests that telephone quitline counseling may be an effective cessation aid (Fiore, et al., 2008), an especially encouraging finding considering the convenience, relatively low resource, and potentially broad reach of this method. Nicotine replacement therapy (NRT) is perhaps the most frequently promoted method to assist smokers who desire to quit. However, evidence regarding

the safety of some NRT products is mixed. For example, an Institute of Medicine report found a lack of scientific evidence to support any degree of health protection bestowed by the allegedly “less risky” products, such as low-tar and low-nicotine cigarettes and cigarette-like devices that change the composition of the smoke inhaled, that are often promoted to replace cigarettes during quit attempts (Committee to assess the science base for tobacco harm reduction, Board on Health Promotion and Disease Prevention, & Institute of Medicine, 2001). On the other hand, nicotine replacement therapies such as the transdermal patch, gum, nasal spray, inhaler, and lozenge are considered safe because they lack the dangerous carcinogens contained in cigarettes and the aforementioned cigarette replacement products (Moore et al., 2009). Furthermore, two prescription medications that do not directly involve nicotine, Bupropion SR (a.k.a., Wellbutrin, Zyban) and Varenicline (a.k.a., Chantix), have relatively recently proven to be effective cessation aids (Jorenby et al., 2006). All of the currently available medications and nicotine replacement therapies are particularly effective when combined with smoking cessation counseling, consisting of a combination of problem-solving/skills training and social support components (Fiore, et al., 2008).

Although smoking cessation group therapy programs are associated with higher cessation rates compared to controls or self-help materials, potential drawbacks to these groups include time constraints and logistical considerations (Stead & Lancaster, 2005). Recent research has demonstrated that learning smoking cessation and relapse prevention information and techniques via convenient Internet-based

programs can increase cessation rates (Myung, McDonnell, Kazinets, Seo, & Moskowitz, 2009; Walters, Wright, & Shegog, 2006), particularly when the programs are tailored to the study population (Strecher et al., 2008). Likewise, self-monitoring of smoking may increase cessation and abstinence maintenance (van Achterberg et al., 2010). However, another recent review of Internet-based smoking cessation trials concluded that high attrition and low adherence rates may reduce the efficacy of web-based programs (Hutton et al., 2011).

Exercise

Just as a majority of smokers desire to quit but struggle to do so, most adults desire to exercise but struggle to maintain a regular exercise regimen (Barnes, 2007). Research indicates that a variety of factors contribute to this discrepancy, including a lack of motivation, time, access to facilities or equipment, energy, workout partner, and self-efficacy (Chinn, White M, Harland J, Drinkwater, & Raybould, 1999; King et al., 2000; Ryan, Frederick, Lipes, Rubio, & Sheldon, 1997; Sallis, 1997; Treiber et al., 1991; Trost, Owen, Bauman, Sallis, & Brown, 2002). Moreover, sedentary individuals often experience discomfort (e.g., pain, breathing difficulties, inflexibility, etc.) during initial exercise attempts, further discouraging them from making exercise part of their daily routine (Miller, Ogletree, & Welshimer, 2002).

Although recent exercise evaluations and guidelines have been modified to incorporate daily activities such as housework and gardening into the list of recognized modes of obtaining the regular physical activity recommended to maintain general health, purposeful exercise, such as leisure-time walking and sports, is

encouraged to help ensure adequate levels of activity in our increasingly sedentary world (Haskell et al., 2007).

Nonetheless, research has shown equal health benefits (Murphy, Blair, & Murtagh, 2009) regardless of whether exercise is obtained in one prolonged session (e.g., 30+ minutes of moderate or 20+ minutes of vigorous exercise) or multiple shorter sessions (e.g., 5-15 minutes each), with no evidence of consistent differences between adherence rates (Linke, Gallo, & Norman, Accepted). Following a home-based exercise routine obtained from web-based instructions that can be implemented within one's own schedule is more feasible than onsite or group-based exercise for many people and thus may increase adherence (B. H Marcus et al., 2007). Self-monitoring of daily exercise also significantly increases adherence (Donnelly et al., 2004) and is consistently one of the most effective health behavior change techniques (van Achterberg, et al., 2010). Finally, despite the frequent interest in and motivation to exercise in order to lose weight, research has demonstrated that the health benefits of increased fitness may be greater than those of weight loss (Janiszewski & Ross, 2009).

In addition to boosting physical health, exercise also improves mood and well-being (A. Daley, 2008). Indeed, research has shown that regular, moderate intensity exercise may alleviate symptoms of depression and anxiety and improve quality of life (Knubben et al., 2007; Penedo & Dahn, 2005). Randomized controlled trials have demonstrated that exercise may be as effective as anti-depressants at alleviating depression (Blumenthal et al., 2007).

Furthermore, exercise may be habit-forming for some individuals through brain reward pathways similar to those implicated in other forms of addiction (J Adams & Kirkby, 2002; H.A. Hausenblas & Symons Downs, 2002). Changes in these pathways may help individuals maintain regular exercise habits by increasing the physical, physiological, and psychological rewards associated with exercise. Conversely, habitual exercise may increase the likelihood of unwanted withdrawal symptoms during periods of exercise abstinence (Heather A. Hausenblas, Gauvin, Downs, & Duley, 2008). Research examining the processes behind exercise-induced euphoric feelings has determined that increased activity of certain neurotransmitters is at least partially responsible (Jeremy Adams, 2009). Beta-endorphins have been of particular interest to research in this area (Boecker et al., 2008; Heitkamp, 1993). Also, the neurotransmitters epinephrine, norepinephrine, and dopamine play verifiable roles in the innately rewarding aspects of exercise (Bortz et al., 1981; Mathes et al., 2010). These neurotransmitters, especially dopamine, have also been implicated in nicotine addiction (Ikemoto, 2007; Zhang et al., 2009).

Short-term effects of exercise on smoking

A recent review of 14 studies that examined the relationships among short bouts of exercise, nicotine withdrawal symptoms, cravings, affect, and subsequent smoking behavior found that exercise reduces cravings and improves mood among nicotine-dependent but temporarily abstinent (typically for 12-15 hours) smokers (Adrian H. Taylor, Ussher, & Faulkner, 2007). Other effects of exercise in these studies include increased positive affect and concentration and decreased negative

affect, stress levels, and depressive and anxiety symptoms. A few of these studies demonstrated that the effects are not likely due to distraction alone by comparing the effects of exercise to those of cognitive distraction tasks or video conditions (A. J. Daley, Oldham, & Townson, 2004; J. Z. Daniel, Cropley, & Fife-Schaw, 2006; M. Ussher, Nunziata, Cropley, & West, 2001).

The studies' protocols incorporated various durations, intensities, and types of exercise. Results indicated that as little as 5-10 minutes of moderate aerobic or acute isometric exercise reduces cravings and improves mood (Everson, Daley, & Ussher, 2006; Thayer, Peters, Takahashi, & Birkhead-Flight, 1993; M. Ussher, West, Doshi, & Sampuran, 2006). Others demonstrated that brief but sustained aerobic exercise, including self-paced walking for one mile, also successfully reduces the desire to smoke during and after exercise (A.H Taylor & Katomeri, 2006; A.H Taylor, Katomeri, & Ussher, 2005, 2006). In contrast, light aerobic exercise (10-20% of heart rate reserve [HRR]) on a stationary bicycle did not produce significant reductions in cravings or improvements in mood compared to moderate (40-60% of HRR) cycling (J. Daniel, Cropley, Ussher, & West, 2004).

Studies reported mixed results in terms of ad-lib smoking post-exercise vs. no exercise control conditions. For example, Taylor and Katomeri (2007) found that time before the next ad-lib cigarette was 84 minutes among participants randomized to a self-paced one-mile walking condition compared to 27 minutes for those who were instructed to wait passively for a short amount of time. In contrast, Pomerleau et al. (1987) found that although self-reported nicotine cravings decreased following a bout

of high vs. light intensity exercise among healthy smokers, their subsequent smoking rates did not differ as soon as 35 minutes nor as late as 24 hours later. However, a non-exercise control condition was not included for comparison, and the duration and intensity of exercise (30 minutes on a bicycle at 80% vs. 30% VO_2 max) may have been too difficult or stressful for the typically inactive participants. Indeed, Daley et al. (2004) exposed inactive smokers to 30 minutes of cycling at 60-65% of age-predicted heart rate and failed to find a significant decline in their post-exercise cigarette cravings compared to those passively viewing a video. Altogether, these results suggest that short bouts of moderate to intense exercise decrease cigarette cravings among temporarily abstinent smokers, but a point of diminishing returns is reached when the exercise becomes too challenging for typically inactive smokers.

On the other hand, Bock and colleagues (1999) demonstrated that cardiorespiratory gains are rapid after smoking cessation and exercise initiation: female smokers experienced significant increases in VO_2 max (mean = 6.8%) during a standard bicycle fitness test after only 11 weeks of an exercise intervention program. Moreover, the women reported decreased cigarette craving levels and nicotine withdrawal symptoms after each exercise session (60 minutes, including 5 minute warm-up, 60-85% HRR for 30-40 minutes of aerobic activity, and 5 minute cool down) but not after 60-minute contact control, informational group sessions.

Despite the mixed and somewhat weak results of the studies included in their review, the authors concluded that exercise could be an effective method for reducing

cigarette cravings and, as a result, helping to maintain long-term smoking cessation (Adrian H. Taylor, et al., 2007).

Long-term effects of exercise on smoking cessation

Another recent systematic review summarized 13 unique randomized controlled smoking cessation trials that examined exercise as the primary or supplementary intervention (M. H. Ussher, Taylor, & Faulkner, 2008). Results of these trials, which focused primarily on short- and long-term smoking cessation rates, were somewhat discouraging compared to those examining changes in affect and cigarette craving levels in response to acute exercise among temporarily abstinent, physically inactive smokers not intending to quit smoking. Twelve of the 13 reviewed studies incorporated a multi-session cognitive-behavioral-based smoking cessation program that was also provided for the control group to ensure that any outcome differences could be attributed to the exercise component (M. H. Ussher, et al., 2008).

Overall, these exercise-based smoking cessation interventions resulted in modest, short-term success comparable to conventional cessation methods. The exercise intervention groups in only 3 of the 13 studies had higher post-treatment cessation rates than their counterpart control groups (Bess H. Marcus et al., 1999; B.H Marcus, Albrecht, Niaura, Abrams, & Thompson, 1991; Martin, Calfas, & Patten, 1997). Of those 3 studies, only one demonstrated a lasting benefit of exercise on cessation at 3- and 12-month follow-ups (Bess H. Marcus, et al., 1999). However, another study failed to show an immediate post-treatment or 12-month follow-up difference, but smokers in the exercise group were more likely to be abstinent at the 3-

month follow-up point (B.H Marcus et al., 2005). Furthermore, results of another 5 of the 13 studies revealed trends toward higher post-intervention cessation rates among exercise group participants (Hill, 1985; Kinnunen et al., 2008; Bess H. Marcus et al., 1995; Prapavessis et al., 2007; M. Ussher, West, McEwen, Taylor, & Steptoe, 2003).

Whereas most of the trials only compared exercise with a standard treatment control group, 4 of them also incorporated a nicotine replacement therapy (NRT) comparison group (Hill, 1985; Kinnunen, et al., 2008; Martin, et al., 1997; Prapavessis, et al., 2007). Results were mostly null in the NRT vs. exercise studies (Hill, 1985; Kinnunen, et al., 2008; Martin, et al., 1997) but favored the combination of exercise and NRT vs. exercise alone post-treatment and at the 12-month follow-up in one trial (Prapavessis, et al., 2007).

Intervention approaches varied widely on numerous variables, including but not limited to the following: exercise setting (home-based, group-based, or a combination of the two types); type of exercise prescribed (e.g., walk/jog, cardiovascular equipment); length of intervention (ranging from 5 to 15 weeks); timing of exercise initiation (before, after, or simultaneous with quit date); exercise intensity (e.g., mild, moderate, intense); and length of follow-up period (ranging from 23 weeks to 16 months). None of these characteristics was associated with unequivocally better results. In effect, specific types of components to include in future intervention efforts could not be ascertained.

The authors of the review paper concluded that exercise has the potential to be an effective smoking cessation intervention, despite the lack of convincing evidence

produced by the reviewed studies (M. H. Ussher, et al., 2008). They called for studies with improved designs, greater sample sizes, and sufficient exercise intensities. They also recommended that researchers explicitly explain to participants that exercise can be an effective smoking cessation aide, especially when used to help decrease cravings and improve mood/affect during the initial quitting phase and prevent relapse during the abstinence maintenance phase. To help the field better understand these processes, they encouraged future studies to track the effects of exercise on cravings and mood/affect among participants (M. H. Ussher, et al., 2008).

Limitations of existing research

Many of the aforementioned studies have included exclusively female samples, assuming that women may be more motivated than men to exercise during quit attempts to help prevent the weight gain that is often associated with smoking cessation. However, men may also benefit from exercise interventions. Also, despite generally positive findings of studies examining the acute effects of exercise on cravings and mood/affect after a period of smoking abstinence (Adrian H. Taylor, et al., 2007), no known exercise-based smoking cessation intervention trial has incorporated short bouts of exercise in response to acute cigarette cravings into the prescribed exercise routines. In addition, although self-monitoring of many health behaviors, including smoking (Manske, Miller, Moyer, Phaneuf, & Cameron, 2004), physical activity/exercise (Dishman & Buckworth, 1996), and mood (Febbaro & Clum, 1998), frequently increases overall efficacy when used in combination with other behavioral intervention techniques (van Achterberg, et al., 2010), it has been

underutilized in previous exercise-based smoking cessation trials. Moreover, most of the previous exercise-based smoking cessation studies also included extensive multi-component interventions that may not be feasible in real-world settings (Jonsdottir & Jonsdottir, 2001). Incorporating web-based interventions that align with evidence-based smoking cessation efforts (Walters, et al., 2006) and modern conveniences that allow individuals to participate according to their own schedules (Keefe & Blumenthal, 2004) may increase the effectiveness of future smoking cessation/exercise studies. Limitations of previous studies conducted on this topic and how they are addressed in the present study are summarized in Table 1.

Table 1. Study characteristics addressing limitations of previous smoking cessation intervention studies using exercise

Limitations of previous interventions	Strengths of “Walk Away” study
A lack of explanation to participants of how exercise can replace smoking behavior and reduce cravings.	This connection is made explicit throughout the study via verbal explanation at baseline and information on the study website.
Poor measurement of exercise adherence and its effect on cravings and withdrawal.	Multiple, yet quick and simple, assessments are completed daily to track these variables.
A lack of repeated collections of psychosocial measures post-intervention and at follow-up endpoints.	Assessments occur at regular intervals: baseline, post-intervention, and follow-up.
Failure to objectively track changes in fitness levels as an indicator of adherence to exercise regimens	Assesses five components of physical fitness at three in-person assessments: baseline, post-intervention, and follow-up

Table 1, continued

Limitations of previous interventions	Strengths of “Walk Away” study
Insufficient length of intervention	Intervention phase is 12 weeks, in line with well-designed studies
Time- and resource-demanding adjunctive supportive therapy (e.g., group meetings)	Includes a custom-designed study website with short, daily smoking cessation lessons and handouts that can be completed according to participants’ own schedules
Participants’ lack of ability/will to exercise alone after intervention ends, when exercise is no longer supervised and/or completed in a group format	Exercise program is externally valid (i.e., completed individually) throughout the intervention
Focus solely on aerobic exercise, despite equally positive results for strengthening and stretching exercises	Exercise regimen is multi-component, including aerobic activity, strengthening, and stretching/yoga
Continuous exercise interventions used, when shorter bouts effectively reduce cravings, increase fitness and promote weight loss, and may increase compliance and reduce attrition	Exercise program capitalizes on replacing smoking with exercise each time cravings occur in order to reduce cravings

Purpose

The “Walk Away from the Habit: Overcoming Nicotine Dependence through Exercise” randomized controlled trial was designed in attempt to replace an unhealthy, addictive behavior (smoking) with a healthy, yet still rewarding activity (exercise) among generally healthy, inactive adult smokers who desire to quit. The primary goals of the study were to examine the exercise intervention’s feasibility and efficacy.

Methods

Theoretical Foundation

The intervention was designed using Social Cognitive Theory (SCT) constructs (Bandura, 1986) with demonstrated ability to influence health behavior change (Glanz, Rimer, & Lewis, 2002). Behavioral capacity, which is defined as the knowledge and skills required to perform a given behavior and often advanced through skills training, is promoted through the study website-based smoking cessation tutorial. Outcome expectations, defined as anticipated outcomes of specific behaviors, are also promoted via the tutorial. Specifically, daily lessons on the website that describe the short- and long-term benefits of smoking cessation attempt to enhance participants' outcome expectations. The exercise information portion of the website and weekly exercise instruction emails (EX participants only) attempt to increase EX participants' exercise-related outcome expectations.

Reciprocal determinism is described as the dynamic interaction of the person, behavior, and environment in which the behavior is performed; it implies that multiple avenues to behavioral change, including environmental, skill, and personal change, should be addressed. Although the intervention primarily takes place online and therefore does not directly modify participants' environments, the smoking cessation tutorial encourages participants to modify their environments during the quit process (e.g., avoiding places they usually smoke). Furthermore, the intervention teaches them multiple skills to use in their smoking cessation efforts and advocates personal change via the website-based tutorial and daily emails.

Reinforcements, which are responses to behaviors that increase or decrease the likelihood of their reoccurrence, are offered via the daily emails and weekly check-in phone calls that occur throughout the intervention. Self-control, defined as personal regulation of goal-directed behavior or performance, is a primary feature of this intervention via daily self-monitoring of smoking, cigarette cravings, mood, and exercise (the latter for EX participants only). Self-efficacy, which is a key component of the SCT as well as many other behavior change theories, is defined as an individual's confidence in performing a particular behavior. Self-efficacy is promoted in this intervention in multiple ways, including encouraging participants to choose between gradually reducing their daily smoking rate or setting a "cold turkey" quit date and to celebrate all progress made toward their goals throughout the intervention. A brief summary of these SCT constructs and their integration into this study is provided in Table 2.

Table 2. Social Cognitive Theory constructs guiding the intervention design

Construct	Definition	Application
Behavioral capacity	Knowledge and skills to influence behavior	1) Educational material about the benefits of smoking cessation; 2) Written information about and handouts with smoking cessation tips; 3) *Literature about exercise
Outcome expectations	Beliefs about likely results of action	Increase/enhance expectations about the positive health effects of smoking cessation *and exercise as a smoking cessation tool
Reciprocal determinism	Behavior changes result from interaction between person and environment; change is bidirectional	Encourage participants to: 1) enlist friends and family members to help them stay on track; and 2) change their routines and environments (e.g., avoid places associated with smoking) to break behavior chains and contextual associations
Reinforcement	Responses to a person's behavior that increase or decrease the chances of recurrence	Daily emails and weekly phone calls with positive messages and feedback, encouraging participants to continue working toward smoking cessation/maintenance and/or *exercise program
Self-control	Personal regulation of goal-directed behavior or performance	Daily, study website-based self-monitoring of: # of cigarettes, cigarette cravings, mood, and *exercise
Self-efficacy	Confidence in one's own ability to take and persist in action in the context of a specific area	Increase smoking cessation self-efficacy via recognition and reinforcement of progress (e.g., daily cigarette reductions) and communication of knowledge about cessation strategies

*Exercise (EX) Group only

Overview of Procedures

An outline of the timing of the multiple assessments incorporated into the study is located in Table 3. The entire study, including recruitment, assessment, and intervention delivery components, is described in detail in the following sections.

Table 3. Overview of assessments schedule

Assessment Components & Timeline	Base	Daily	Post	F/U
Psychiatric History (Diagnostic Interview Schedule)	X			
Fitness Testing	X		X	X
Body weight/BMI measurement	X		X	X
Self-reported daily smoking		X		
Self-reported daily cigarette cravings		X		
Self-reported daily mood		X		
Self-reported daily exercise		X		
Center for Epidemiological Studies – Depression (CES-D)	X		X	X
Exercise Self-efficacy Scale	X		X	X
Fagerstrom Test for Nicotine Dependence (FTND)	X		X	X
Leisure Time Exercise Questionnaire (LTEQ)	X		X	X
Mood & Physical Symptoms Scale (MPSS)	X		X	X
Positive & Negative Affect Scale (PANAS)	X		X	X
Smoking Cessation Self-efficacy Scale	X		X	X

Recruitment

Recruitment primarily took place via online advertisements in attempt to enroll individuals who were already using the Internet. Ads were listed on the Craigslist website, the online version of the San Diego Reader, various targeted web pages via Google AdWords, and UCSD Student Flyers. One announcement about the study was sent to UCSD staff via email. Paper flyers were posted on approved announcement boards at two main university campuses – University of California, San Diego (UCSD) and San Diego State University (SDSU) – as well as at UCSD’s Hillcrest campus and at the San Diego Veterans Affairs Medical Center (VAMC). The advertisements and flyers announced a study examining the effects of exercise on quitting smoking. They also specified that current adult smokers who desire to quit, do not currently exercise regularly, and are otherwise generally healthy might qualify as participants.

In addition to the advertisements, approximately 300 questionnaires completed by female veterans about smoking (for an unrelated study conducted through the VAMC) were screened for potential participants. Approximately 50 individuals who appeared eligible and had provided consent to be contacted in the future about other research studies were screened further by medical chart review. Of those, 20 individuals appeared to meet eligibility criteria and were called to inquire about study participation interest and to further evaluate for eligibility.

All advertisements and recruitment methods were pre-approved by the Institutional Review Boards (IRB) at each academic institution (UCSD and SDSU) as well as by the Research & Development Committee (R&D) at the VAMC San Diego.

Eligibility/Screening

Potential participants were screened extensively to ensure that they met all inclusion/exclusion criteria. A scripted initial phone screen (Appendix A) determined whether each individual met basic eligibility criteria; each person who appeared to meet criteria based on this initial screening was scheduled for an in-person visit. In the meantime, s/he was required to obtain medical clearance to participate in the study by asking his/her primary care provider to sign a standardized document (Appendix B) stating that s/he was medically stable enough to engage in moderate intensity exercise and sub-maximal fitness testing. Individuals who could not obtain clearance because of a lack of insurance/financial hardship were given the option of meeting with one of two study physicians to complete a physical examination at no cost to them.

Potential participants reported to the Clinical Research Center (CRC) at UCSD for the in-person screening. After providing informed consent, individuals were screened with selected modules of the DSM-IV (American Psychiatric Association (APA), 1994) for untreated or uncontrolled psychiatric disorders that could contraindicate their participation, including the following: current major depressive episode; bipolar disorder or other major mood/affective disorder; current psychotic symptoms or chronic psychotic disorders; current or recent (past six months) substance use disorder; current eating disorder; and/or other psychiatric disorders that

currently interfere with daily functioning in one or more domains (e.g., responsibilities at home, work, or other area). Individuals who met criteria for any psychiatric disorders that deemed them ineligible for the study were encouraged to seek treatment and provided with a list of referrals to local treatment facilities (if they were not already currently in treatment).

All other inclusion/exclusion criteria (listed in Table 4) were briefly reviewed again with each participant at the in-person visit. If all criteria were met and the individual was still interested in the study, the baseline visit was conducted immediately following the in-person screening to minimize participant travel and scheduling burdens.

Table 4. Inclusion/exclusion criteria for study participation eligibility

✓	18-64 years old
✓	Nicotine dependent
✓	Regularly smoking for at least 3 years
✓	Currently smoke at least 10 cigarettes per day
✓	Current desire to quit smoking
✓	Body Mass Index (BMI) < 35
✓	No current suicidal ideation or untreated psychiatric disorders (current major depressive episode, actively psychotic, bipolar disorder, substance abuse or dependence, eating disorder)
✓	No untreated medical problems that would prevent or limit training (cardiovascular disease, chronic obstructive pulmonary disease, severe arthritis, certain disabilities)
✓	Cleared by physician to exercise moderately and complete exercise testing
✓	Sedentary: does not meet ACSM criteria for regular aerobic, strengthening, or stretching activity per week
✓	Must report daily dosages if concurrently using NRT or pharmacotherapy
✓	Cannot be or plan to become pregnant within six months of enrollment
✓	Must speak, read, and write fluently in English
✓	Must have daily Internet access readily available
✓	Must be technology-literate enough to use the website after receiving brief training

Baseline Visit

The baseline visit, comprised of a battery of questionnaires, a physical fitness assessment, randomization, and study orientation, was conducted at the UCSD CRC, immediately following the screening. The individual questionnaires and physical fitness assessment components are listed and briefly described in Table 5.

Table 5. Descriptions of measures/evaluations completed at baseline, post-intervention, and follow-up assessment visits

Measure	Description
Center for Epidemiological Studies Depression Scale (CES-D)	20-item inventory comprised depressive symptoms
Exercise Self-efficacy Scale	Degree of confidence in one's ability to exercise on a regular basis, even when faced with each of 18 different situations that may make exercise challenging (e.g., weather)
Fagerstrom Test for Nicotine Dependence (FTND)	Severity of nicotine dependence based on 6 indicative items
Leisure Time Exercise Questionnaire	Typical amounts of mild, moderate, and strenuous exercise completed during one's leisure time
Mood and Physical Symptoms Scale (MPSS)	Smoking withdrawal symptoms: depressed, irritable, restless, hungry, poor concentration; frequency and intensity of urges to smoke in the previous 24 hours
Positive and Negative Affect Schedule (PANAS)	Level of experiences of 10 positive and 10 negative emotions
Smoking Cessation Self-efficacy Questionnaire	Degree of confidence in one's ability to avoid smoking in twelve different situations commonly associated with smoking

Table 5, continued

Measure	Description
Aerobic capacity	5-minute step test, assessing recovery heart rate for 1 minute immediately following completion of test
Abdominal strength	Partial curl-up test, assessing number of curl-ups completed until failure to maintain proper form or decision to stop
Upper body strength	Push-up test, assessing number of push-ups completed until failure to maintain proper form or decision to stop
Flexibility	Sit-and-reach test, assessing the furthest distances reached toward toes in three trials with each leg, keeping leg straight ahead of body in a seated position
Body composition	Body mass index (height/weight), calculated as kilograms/meters ²

Following the assessments, participants were randomly assigned to the Internet + Exercise (EX) or the Internet-only Control (CON) group. They were then enrolled on the study website and provided with secure login information. All participants were guided through the website and given opportunities to practice completing the daily records and ask questions about study procedures. Additional information about the following topics was explained to EX group participants in lay language via verbal summary and written information on the study website: exercise may temporarily reduce cigarette cravings and boost smoking cessation efforts; exercise may help ease the depressed mood and negative affect that often accompany quit attempts; and exercise may help to prevent or assuage weight gain during quit attempts. Information about these topics was reiterated in weekly exercise instruction emails and check-in

phone calls. All enrolled participants received \$20 upon completion of the baseline visit.

Study Website Design/Creation

With the help of information technology (IT) and web-design consultants, a secure website was built for the study. Only the researchers, IT consultant, and participants had access to the internal website. Each participant was assigned log-in information, which was emailed to them upon enrollment, to use throughout the study.

Web-based Tutorial

Material comprising the smoking cessation tutorial was gathered and adapted with permission from two efficacious quit assist websites sponsored by the American Lung Association (<http://www.ffsonline.org>) and the University of California San Francisco (<https://www.stopsmoking.ucsf.edu>). The tutorial consisted of twelve modules (one for each week of the intervention phase), which were divided into daily lessons and handouts. Participants were prompted on their homepage to click on the next sequential lesson or handout after viewing each daily lesson/handout, but all lessons and handouts were available to participants at any given time to allow them to be viewed multiple times. SCT constructs guided the tutorial's content. Particular focus was placed on education about smoking's deleterious effects, increasing and maintaining motivation, increasing self-efficacy, avoiding tempting situations, coping with nicotine withdrawal symptoms, and rebounding after relapses. See Appendix C for a sample of the daily lessons and handouts.

Daily Smoking Records

All participants were instructed to complete the smoking self-report section of the website on a daily basis. This section served as an assessment tool for changes in smoking rates over time as well as a form of self-monitoring. They were asked to honestly and accurately report the number of cigarettes they smoked each day and reminded that they would not be penalized or reprimanded in any way by reporting that they continued to smoke and/or relapsed after quitting. They were first asked to indicate whether or not they smoked at all that day in a dichotomous question (yes/no). “Yes” responses were followed-up with a prompt to report the total number of cigarettes smoked. See Appendix D for a sample smoking record.

Daily Cigarette Craving Records

All participants were instructed to rate their average daily cigarette craving levels on the study website using a scale ranging from “-5” (“Cigarettes seemed absolutely disgusting”) to “+5” (“My craving for cigarettes was unbearably high”), where “0” was neutral (“Cigarettes seemed neither disgusting nor desirable”). They were also asked to separately rate the highest level of craving experienced each day using the same scale. Tracking cigarette cravings served as a form of self-monitoring. See Appendix E for a sample.

Daily Mood Records

All participants were also instructed to complete a web-based daily mood rating. They were asked to rate their average daily mood on a scale from -5 to +5, on which “0” represented neutral and the extreme values reflect the most depressing or happiest days imaginable, respectively. Tracking how variations in mood coincide

with cravings, smoking, and exercise served as a form of self-monitoring. Tracking mood was intended to help participants recognize their patterns of smoking and, coupled with the lessons/handouts from the study website's tutorial that cover mood, depression, and coping skills, learn to regulate their mood in alternative ways. See Appendix F for a sample daily mood record.

Daily Emails

All participants received a daily email reminding them to login to the website in order to complete their daily records and read their daily lesson/handout. The emails also always contained an encouraging message (e.g., "You're doing great!" or "Keep up your hard work!" or "You can quit smoking for good!"). The emails were uniquely written every day throughout the program, but the same email was sent to all currently enrolled participants each day. A sample daily email is provided in Appendix G.

Weekly Phone Calls

All participants received a weekly phone call consisting of checking in, addressing questions or concerns about the study, and encouraging them to continue their smoking cessation efforts. Although the themes of the phone calls were consistent, the conversations allowed for flexibility in order to best address individual questions and concerns.

Exercise Information

An additional section of the website with information about exercise (e.g., starting an exercise program, exercising safely, exercise examples) was accessible only to EX group participants. They were encouraged to read this section during the

first week of the intervention phase, prior to beginning the exercise program, which started in Week 2. A sample exercise information web page is located in Appendix H.

Weekly Exercise Emails

CON participants were not given any explicit exercise instructions throughout the intervention. EX participants were instructed to exercise intermittently throughout the day in response to their cigarette cravings. In other words, EX participants were instructed to engage in a short bout of exercise each time they experienced a craving for a cigarette and would otherwise have smoked. EX participants were instructed when and how to increase their exercise during the intervention phase via weekly emails, which were individually tailored for each participant on a week-by-week basis depending on his/her adherence and feedback. Participants were encouraged to remain on track with the standard exercise protocol, which increased the number of minutes per bout and decreased the bouts per day each week. This standard protocol assumed three inter-related things: 1) participants quit and abstained from smoking or consistently reduced their smoking rate each week; 2) their daily cigarette cravings decreased in frequency as time passed; and 3) their exercise tolerance increased as time passed. However, the nature of this type of exercise (relatively short, intermittent bouts) allowed them to comfortably re-start the exercise program following missed days or weeks, if necessary. It also allowed for flexibility and individual tailoring (e.g., not increasing the dose of exercise as intended for participants who struggled to keep up with the program).

Participants were strongly encouraged to engage in a variety of different types of exercise and to incorporate a balance of aerobic, strengthening, and stretching exercises each day in order to prevent boredom and burnout as well as to increase overall physical fitness. The exercise instructions provided general guidance in terms of total exercise time per day (approximately 60 minutes per day throughout the program); duration per bout (starting with 5 minutes per bout and gradually increasing to a maximum of 15 minutes per bout); intensity (moderate intensity, approximated by a “moderately difficult” rating of 12-14 on the rating of perceived exertion [RPE] scale, throughout the entire program); and type (a combination of aerobic, strengthening, and stretching exercises). However, participants selected their own daily frequency of exercise throughout the program, allowing them the flexibility of engaging in the frequency of exercise bouts personally needed to align with the number of cigarette cravings they experienced on a day-to-day basis. A sample weekly exercise instruction email is located in Appendix I.

Daily Exercise Records

A daily exercise record section of the website was accessible only to EX participants in order to avoid the possibility of exercise self-monitoring unintentionally influencing exercise levels among CON participants. The daily exercise records were more involved and time-consuming than the other daily records. They queried for the following details: number of daily exercise bouts completed (i.e., frequency); time of day each exercise bout was completed; length of each exercise bout (i.e., duration); type(s) of each exercise bout (aerobic, strengthening, and/or

stretching); RPE for each exercise bout; mood (-5 to +5) immediately before and after the most recent exercise bout; and cigarette craving level (-5 to +5) immediately before and after the most recent exercise bout. See Appendix J for a sample record.

Subsequent Assessments

At two additional time points (post-intervention three months after baseline and follow-up six months after baseline), participants reported to the CRC at UCSD for additional assessments. They completed the same battery of questionnaires and physical fitness assessments that they had completed at the baseline visit (Table 5). They also reported their current daily smoking rate and described any and all changes in their daily smoking rate since their previous assessment (baseline or post-intervention), using a calendar to anchor their memories. Participants were paid \$30 for completing the post-intervention assessment and \$25 for completing the follow-up assessment.

A relatively high attrition rate was expected because of the typically high attrition characteristic of smoking cessation and exercise initiation research, let alone the two in combination. However, participants were encouraged to remain in the study even if they were not able to quit and/or relapsed after quitting. They were not penalized for continuing to smoke or relapsing, and they were encouraged to try quitting again immediately after relapsing if they still desired to quit. Likewise, EX group participants were encouraged to remain in the study and to continue to try exercising even if they were unable to meet their exercise goals.

Hypotheses

Smoking Cessation/Reduction. We hypothesized that EX participants would achieve significantly greater mean smoking cessation and reduction rates than CON participants, measured by self-reported point prevalence cessation and daily smoking rate reductions from baseline to post-intervention assessment.

Exercise. We hypothesized that more frequent exercise, as determined by self-reported exercise ≥ 1 time per day on the study website's daily exercise records, would predict greater mean smoking reduction rates among EX participants.

Statistics

Power Analysis. To determine the sample sizes necessary to detect statistically significant differences in within subjects, between groups, and/or interaction variables in the repeated measures general linear model, power analyses using G-power software (Faul, Erdfelder, Lang, & Buchner, 2007) were conducted. Based on a design with 2 groups, 2 time points (baseline, post-intervention), a medium effect size of .25, a power level of .80, an alpha value of .05, and 2 tails, analyses indicated that between 34 (for repeated measures, within subjects and interactions) and 98 (for repeated measures, between factors) participants would be necessary to detect statistically significant differences. Considering time and resource related limitations, the initial goal was to recruit 60 individuals, which would surpass the requirements for within subjects and interaction effects but fall short of those for between factors effects.

Additional power analyses indicated that the project was grossly underpowered to find between group differences in the binary logistic regression analysis examining smoking cessation rates. However, 55 participants would be sufficient to detect group

differences in daily smoking rate (i.e., mean number of cigarettes per day) changes from baseline to post-intervention in a linear regression analysis with an effect size of .15, a power level of .80, an alpha value of .05, and one predictor variable.

Baseline Characteristics. One-way analysis of variance (ANOVA) was used to test for any group (EX vs. CON) differences on baseline characteristics. ANOVA was also used to test for any differences on baseline characteristics according to retention status (retained vs. not retained at the post-intervention assessment).

Smoking Cessation/Reduction. Binary logistic regression was used to test the effect of group (EX vs. CON) on smoking cessation, with self-reported point prevalence abstinence at the post-intervention assessment as the dependent variable. A conservative approach was taken to handle missing data: participants who did not complete the post-intervention assessment were counted as smokers, which assumes that they were current smokers at the time that their post-intervention assessments should have happened. Baseline daily smoking rate was included as a covariate.

Paired *t*-tests were conducted to examine individual changes in smoking rates from baseline to post-intervention among all enrolled participants (intent-to-treat), retained participants only (per protocol), and each group (EX and CON, both intent-to-treat and per protocol). A repeated measures general linear model (GLM) analysis was conducted to examine the effect of group (EX vs. CON; between subjects factor) on individual changes in self-reported daily smoking rate over time (within subjects factor). Again, a conservative approach was taken to handle missing data: baseline smoking rates were carried over for participants who did not complete the post-

intervention assessment, which assumes that their smoking rate had not decreased at all at that time. The model was adjusted for quit status to control for the potentially strong impact of 100% rate reductions among participants who had quit.

Exercise. Linear regression was used to test the effect of exercise dose on smoking reduction rates. The total number of days during the intervention phase with any self-reported exercise, extracted from the study website's daily exercise records, served as the independent variable. Specifically, all days with 1+ exercise bouts recorded were counted as exercise compliant days. Days with missing exercise record data were conservatively treated as exercise non-compliant days. Point prevalence self-reported daily smoking rate ("0" for participants who were quit) at the post-intervention assessment served as the dependent variable. To account for missing data, participants who did not complete a post-intervention assessment were conservatively assumed to be smoking at their baseline rate (i.e., baseline rate carried forward) at the time that their post-intervention assessment should have occurred. Baseline daily smoking rate was included as a covariate in this model.

All statistical analyses were conducted using SPSS, Version 19.0. Tests were conducted with two tails, and significance levels were set at $p < 0.05$ for all analyses. Other potentially confounding variables were examined as potential covariates in all models; however, because these variables were significantly correlated with one another, the fewest number possible were selected to avoid over-fitting models with few degrees of freedom.

Results

Recruitment/Screening Process

A diagram of the recruitment and screening process is provided in Figure 1. A total of 99 individuals called to inquire about the study. Of those, 14 were unable to be reached upon attempt to return their voicemail inquiry, 14 were not interested in participating after hearing the study description, and 14 were deemed ineligible based upon the phone screening. The reasons for ineligibility based upon the phone screening included the following: physical disability limiting ability to exercise (2); uncontrolled, serious medical problems (1); lack of access to a medical provider for medical clearance (1); lack of daily access to Internet (2); non-proficient English skills (1); daily smoking less than three years (1); already quit/not currently smoking (2); currently engaging in regular exercise meeting or exceeding ACSM recommendations (2); psychiatric reasons (1); and body mass index > 35 (1).

A total of 57 individuals who were deemed potentially eligible based upon the phone screening and expressed interest in participating were scheduled for an in-person screening/baseline visit. Of those, 17 did not show and were unable to be reached to reschedule, 1 was deemed ineligible based upon the in-person screening (for uncontrolled, serious psychiatric problems), and 1 was no longer interested after attending the in-person screening. A total of 38 eligible and interested individuals were randomized to either the EX (n = 19) or CON (n = 19) group.

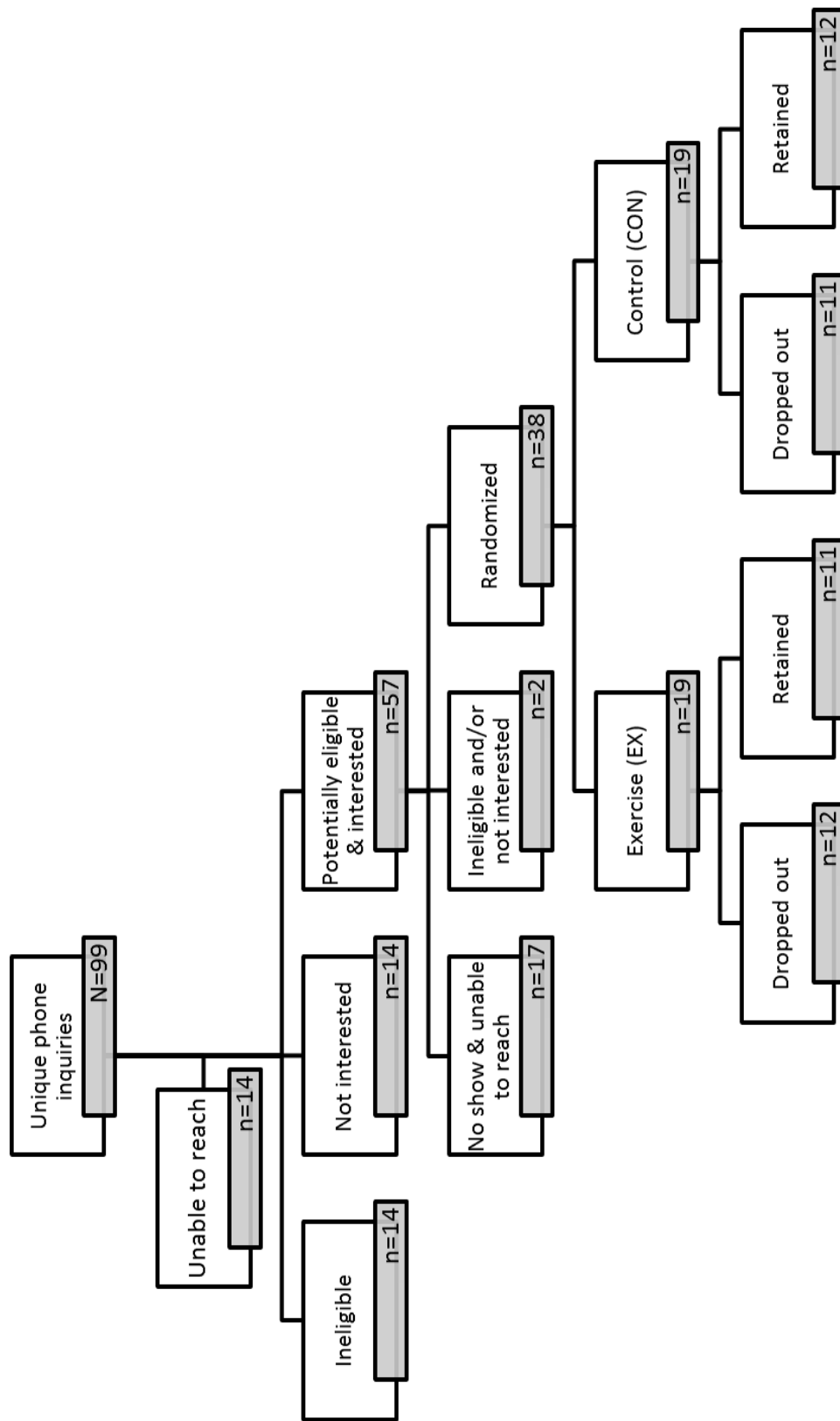


Figure 1. Diagram of recruitment/enrollment procedure.

Baseline Characteristics

Participants' (N = 38) mean age was 43.6 (SD = 11.5) years, ranging from 20 to 60 years, and 60.5% (n = 23) of all participants were women. At baseline, the mean smoking rate was 15.9 (SD = 7.2) cigarettes per day, and the mean FTND score was 5.2 (SD = 2.3), together suggesting that participants were moderate to heavy smokers with substantial nicotine dependence. Participants' mean weighted score on the Leisure Time Exercise Questionnaire (LTEQ; 29.6 [SD = 18.7]) suggested that they led relatively inactive lives, and their mean body mass index (BMI; 28.8 [SD = 5.0]) indicated that they were moderately overweight. These and other baseline characteristics, broken down according to group (EX vs. CON), are listed in Table 6. No significant group differences were found on any baseline characteristics.

Table 6. Baseline characteristics

Variable* **	EX N=19	CON N=19	Total N=38
Female (%)	52.6%	68.4%	60.5%
Age	45.7 (9.8)	41.4 (12.9)	43.6 (11.5)
Body mass index (BMI)	28.7 (5.0)	29.0 (5.1)	28.8 (5.0)
Number of cigarettes per day	16.8 (8.6)	15 (5.5)	15.9 (7.2)
FTND score	5.6 (2.5)	4.7 (2.2)	5.2 (2.3)
LTEQ weighted score	33.8 (15.1)	25.3 (20.3)	29.6 (18.7)
Smoking cessation self-efficacy score	29.3 (8.9)	31.2 (8.7)	30.3 (8.7)
Exercise self-efficacy score	949 (370)	1073 (301)	1013 (337)
CES-D score	15.4 (10.4)	11.0 (8.5)	13.1 (9.6)

Abbreviations: EX = Internet + Exercise Group; CON = Internet-only Group; FTND = Fagerstrom Test of Nicotine Dependence; LTEQ = Leisure Time Exercise Questionnaire; CES-D = Center for Epidemiological Studies – Depression Scale

*Results are reported as mean (standard deviation) unless otherwise noted.

**No significant differences observed between groups on any baseline variables.

General Study Outcomes

General study outcomes, broken down according to group, are presented in Table 7. The overall retention rate (i.e., percentage of enrolled participants who completed a post-intervention assessment after the three-month intervention phase) was 60.5% (n = 23), and no significant retention rate differences were found between groups (EX vs. CON). A sex difference in retention rate barely reached statistical

significance, indicating that men were more likely than women to complete a post-intervention assessment, $F(1, 36) = 4.2, p = 0.05$. No other significant differences in participant characteristics were found according to retention status.

Throughout the intervention phase, participants clicked on an average of 16.7 (SD = 12.4) of the 36 available daily lesson website pages (median = 15, range = 1-36) at least once. Clicks on the 24 action-oriented handouts that comprised the rest of the smoking cessation tutorial were not tracked due to technological limitations. EX participants reported 1+ bouts of exercise on the exercise daily records less than 25% of the days they were enrolled in the intervention phase of the study (mean = 21 [SD = 21.4]).

Table 7. General study outcomes.

Variable	EX (n=19)	CON (n=19)	Total (N=38)
Retention Rate (%)	57.9%	63.2%	60.5%
Female Retention Rate (%)	40%	53.8%	48%
Male Retention Rate (%)	77.8%	83.3%	80%
Mean number of unique lessons viewed (SD)	16.6 (11.3)	16.8 (13.7)	16.7 (12.4)
Mean number of exercise days recorded (SD)	21.0 (21.4)	n/a	n/a

Smoking Cessation/Reduction

The adjusted intent-to-treat binary logistic regression analysis revealed that the EX and CON groups' post-intervention point prevalence smoking cessation rates were identical at 15.8% each, $\beta = -0.07$, S.E. = 0.90, $p = .93$. Although retained participants ($n = 23$) achieved a higher cessation rate (26.1%) than all enrolled participants (15.8%), an adjusted per-protocol binary logistic regression analysis revealed no significant cessation rate difference between the EX (27.3%) and CON (25%) groups, $\beta = -0.50$, S.E. = 1.02, $p = .62$. These results are depicted in Figure 2.

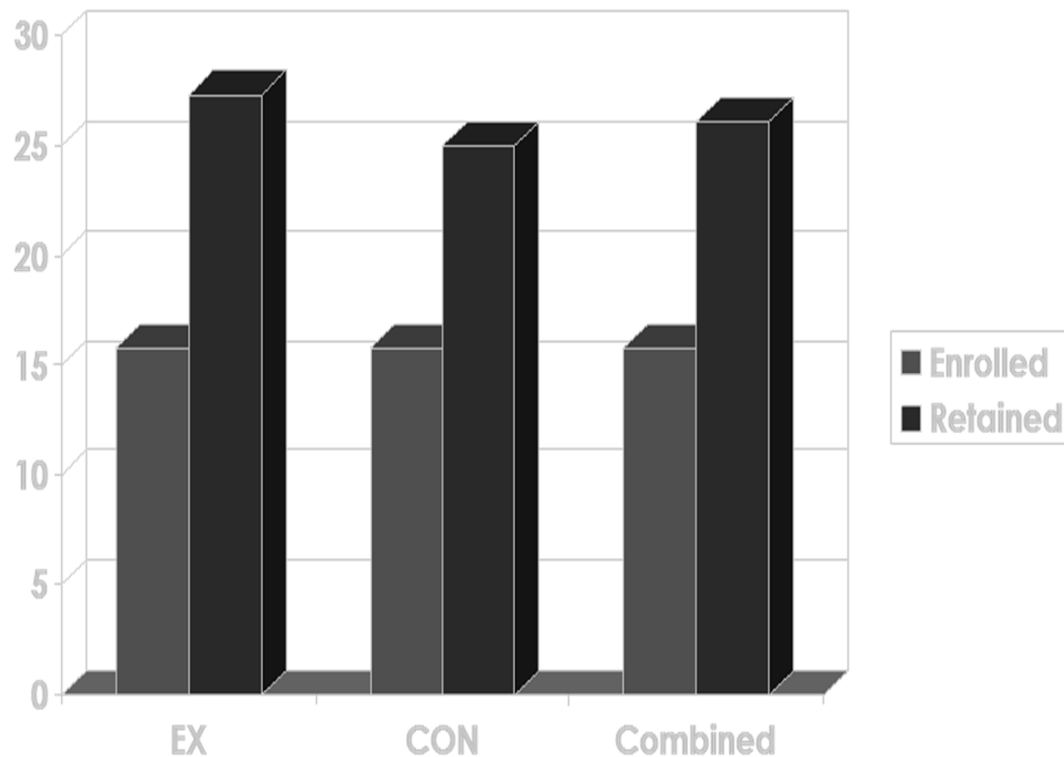


Figure 2. Point prevalence smoking cessation rates at the post-intervention assessment according to group and retention status.

Paired *t*-tests examining individual changes in daily cigarettes smoked from baseline to post-intervention resulted in statistically significant changes among all sub-groups of participants examined, including: all enrolled participants ($t = 4.6, p < 0.001$), all retained participants ($t = 5.7, p < 0.001$), all enrolled CON group participants ($t = 3.5, p = 0.002$), all retained CON group participants ($t = 4.5, p = 0.001$), all enrolled EX group participants ($t = 2.9, p = 0.011$), and all retained EX group participants ($t = 3.4, p = 0.007$). Mean numbers of cigarettes at baseline and post-intervention associated with these analyses are presented in Table 8.

Table 8. Mean self-reported daily smoking rates among participant sub-groups

	Participant Sub-Group	Exercise	Control	All Participants
Baseline	All Enrolled	16.8 [8.6]	15 [5.5]	15.9 [7.2]
Post-Intervention		13 [10.8]	9.7 [8.5]	11.4 [9.7]
Percent Change		26.7% [40.0]	38% [41.3]	32.4% [40.4]
Baseline	Retained Only	19.5 [10.3]	14.8 [6.1]	17.1 [8.5]
Post-Intervention		13 [14.2]	6.5 [8.6]	9.6 [11.8]
Percent Change		46.2% [43.0]	60.2% [36.5]	53.5% [39.5]

The repeated measures GLM analysis, adjusted for quit status at post-intervention, revealed a significant within subjects effect over time, $F(1, 35) = 11.45$, $p = .002$. From baseline to post-intervention, mean daily cigarettes fell from 16.8 (SD = 8.6) to 13 (SD = 10.8) among EX group participants and from 15 (SD = 5.5) to 9.7 (SD = 8.5) among CON group participants. However, neither the between group, $F(1, 35) = 1.08$, $p = .31$, nor the interaction, $F(1, 35) = 0.86$, $p = .36$, effect was statistically significant. Results of the GLM are depicted in Figure 3, which clearly illustrates the within subjects effect but lack of interactive and group effects.

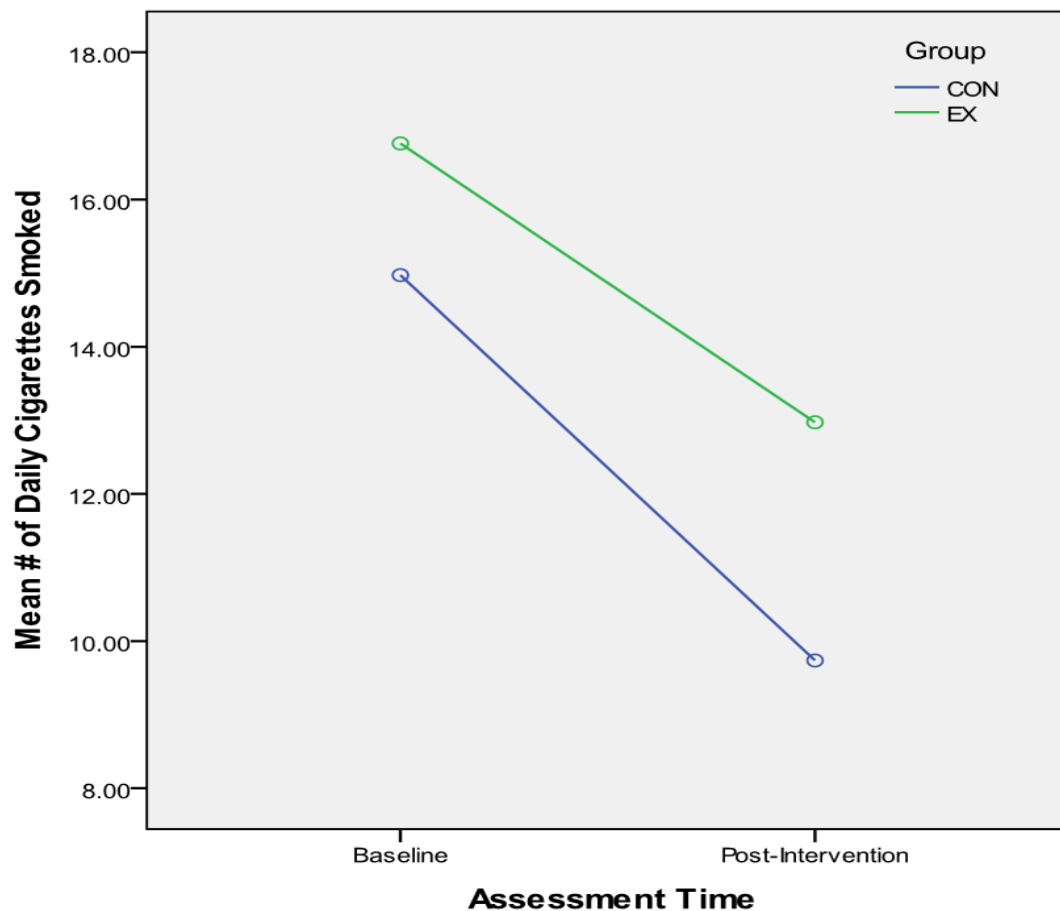


Figure 3. Depiction of results from the general linear model, demonstrating significant within subjects effect but no interaction or between subjects effects

Exercise

Linear regression results, adjusted for baseline daily smoking rate, indicated that additional days of self-reported exercise on the study website during the intervention phase predicted significantly higher reduction rates at the post-intervention assessment among EX group participants, $F(2, 18) = 31.08, p < .001$. Specifically, each additional day of at least one bout of exercise recorded on the study website was associated with a 1.6% greater reduction rate from baseline to post-intervention. Results of the linear regression are depicted in a scatterplot with a superimposed mean regression line in Figure 4.

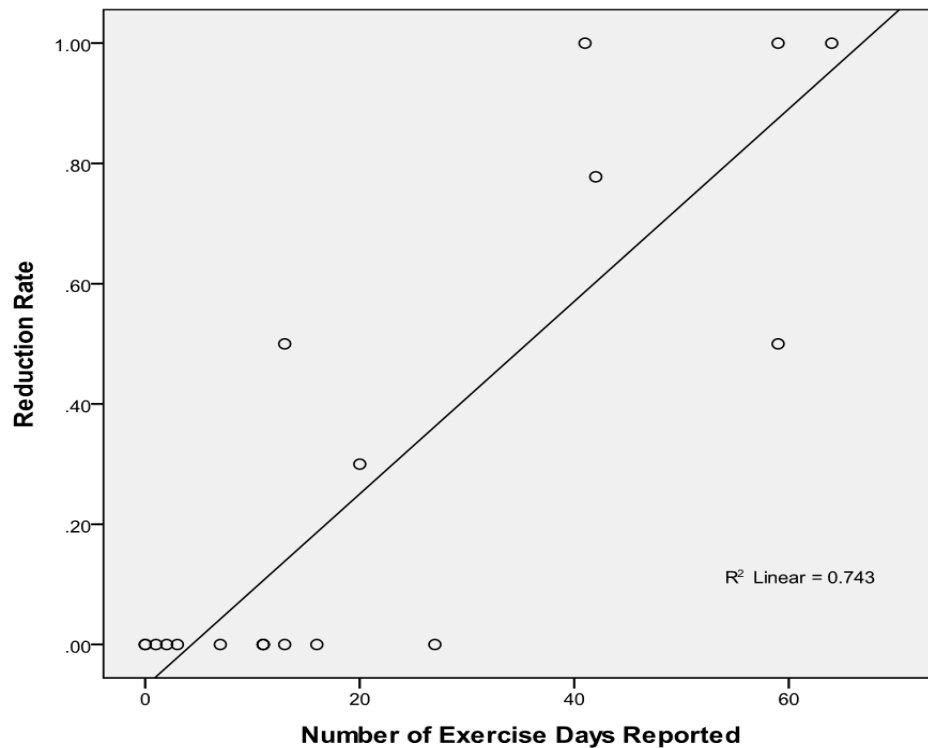


Figure 4. Relationship between exercise frequency (number of days of reported exercise on the study website) and smoking reduction rates (in terms of daily cigarette smoking rate from baseline to post-intervention) among EX participants

Discussion

This randomized controlled trial examined the feasibility and efficacy of an Internet-based smoking cessation program alone (CON) vs. the same Internet-based program + exercise (EX) among generally healthy, sedentary adult smokers who desire to quit. The smoking cessation program, guided by SCT constructs, was delivered primarily over the Internet, via email and a study website that included extensive self-monitoring as well as daily lessons/handouts with smoking cessation related information. Feasibility was established, and participant satisfaction was high. Results were mixed with regard to the incremental benefit of exercise in the presence of the apparently valuable smoking cessation program offered to CON and EX participants alike. Although no group differences were found in terms of post-intervention smoking cessation and reduction rates according to random group assignment, EX group participants who recorded more exercise days on the study website throughout the intervention phase experienced greater reduction rates at the post-intervention assessment. Furthermore, the mean daily smoking rate among all participants decreased significantly from baseline to post-intervention, with even greater reductions apparent among retained compared to all enrolled participants.

Results of this pilot study supported those reported in the exercise-based smoking cessation intervention literature, which has consistently found significant within participant smoking cessation and reduction rates but a lack of group differences between exercise and control groups (M. H. Ussher, et al., 2008). Only three of these types of studies found statistically significant effects of exercise

compared to controls (Bess H. Marcus, et al., 1999; B.H Marcus, et al., 1991), and five others reported similar statistical trends (Hill, 1985; Kinnunen, et al., 2008; Bess H. Marcus, et al., 1995; Prapavessis, et al., 2007; M. Ussher, et al., 2003). Null results generally lead to an abandonment of a research hypothesis; however, the few studies with significant and promising effects, combined with a solid theoretical foundation that exercise is a beneficial substitute for smoking and other addictive behaviors, have kept this scientific inquiry alive. Although the current pilot study's results do not add to the short list of encouraging findings, perhaps its unique methods bring a fresh perspective and a sense of renewal to a field that is growing somewhat weary and disheartened.

General Study Outcomes

The overall retention rate of 60.5% was slightly lower than the expected 65% but not entirely surprising considering the difficulties associated with behavior change in general, let alone the specific health behavior changes addressed in this study. Cigarette smoking is widely recognized as one of the most difficult habits to quit. Participants in the EX group faced the additional challenge of attempting to exercise, a difficult health behavior to adopt, in the face of cigarette cravings. Motivation to change these two behaviors is challenging to maintain, and many participants may have decided to cease participation if/when their motivation waned. The Internet-based intervention may have made dropping out especially convenient because of the sense of anonymity associated with the Internet. Furthermore, participant burden for EX participants, who were asked not only to exercise but also to record their exercise

in detail every day on the study website, may have been excessive. This high level of burden may have counteracted the otherwise engaging exercise-enhanced intervention. Future iterations of this study should attempt to reduce this burden by streamlining the exercise records. Efforts should also be made to balance intervention-related time requirements between groups to control for the potential confounding effects of contact time.

Feedback about the study was quite positive, and participants provided helpful suggestions for improvements. However, feedback was obviously not obtained from participants who did not complete a post-intervention assessment. These individuals may have discontinued their participation because of disappointment or negative experiences with the study, among other personal reasons unrelated to the study.

Smoking Cessation/Reduction

The *t*-test and GLM analyses provided solid evidence that many participants successfully quit or reduced their daily smoking rate from baseline to post-intervention. Cessation and reduction rates were comparable to those reported in the general smoking cessation intervention literature. The mean daily smoking rate among all enrolled participants, as well as among all sub-groups examined, significantly declined even though a conservative approach to handling missing data was taken. Moreover, cessation and reduction rates were considerably higher in analyses that only included participants who completed post-intervention assessments. Of course, only by incorporating a true control or wait-list group would the results have definitively demonstrated that the intervention was more efficacious than no treatment at all.

Exercise

Based on the number of days of 1+ bouts of exercise reported on the study website, adherence to the exercise prescription appeared poor. However, because the daily exercise records were quite time-consuming, many EX participants may not have completed them every day they exercised. Exercise intervention studies that require participants to complete exercise assessments regardless of whether or not they exercised typically assume that participants actually engage in *less* exercise than they report (i.e., participants over-report exercise completed). Although the daily exercise records on the study website allowed participants to complete them even if they did not exercise on any given day (i.e., by selecting “0” bouts of exercise for that day), completion of daily exercise records on non-exercise days was not emphasized in the intervention. Thus, we surmise that participants *under*-reported rather than *over*-reported the number of days they exercised on the daily exercise records. Moreover, some EX participants who quit or significantly reduced their smoking rate reported at the post-intervention assessment that they had stopped recording their exercise on the study website at some point during the intervention phase because they had developed a regular exercise routine and felt that they no longer needed to self-monitor their exercise. Future studies should utilize objective measures of physical activity (e.g., pedometers or accelerometers) and/or ecological momentary assessment methods of exercise data collection (e.g., smart phones) to increase the validity and reliability of self-reported exercise.

Regardless, the linear regression analysis revealed that participants who reported more exercise days also reported greater reductions in daily smoking rates. The effect was small but statistically significant, and we suspect it may have been substantially larger if adherence to exercise self-monitoring had been better.

Other exercise variables collected will enable us to examine the data in additional ways to help determine the actual dose of exercise necessary to produce a significant effect. For example, we will examine numbers of total bouts, bouts per day, and types of bouts (i.e., aerobic, strengthening, and stretching) recorded on the website, as well as changes in LTEQ scores from baseline to post-intervention, in relation to cessation and reduction rates. Moreover, changes in performance on the physical fitness assessments from baseline to post-intervention may be used to validate self-reported exercise.

Planned Exploratory Analyses

Even though this pilot study's sample size was small, its dataset is rich. Likewise, the daily records contain a large amount of information despite the abundance of missing data. This rich dataset will facilitate a variety of exploratory analyses on the potential roles of many variables in the smoking cessation and reduction rates associated with this program, including but not limited to the following: self-monitoring adherence; mood; cigarette cravings; nicotine dependence; smoking cessation self-efficacy; exercise self-efficacy; depressive symptoms; weight gain/loss; and other psychosocial variables gathered via the questionnaires completed

at the in-person assessments. Analyses examining these and other relevant variables will undoubtedly lead to future publications.

Future Directions

Exercise. Although research in the area of exercise-based smoking cessation is still relatively young, the literature has grown substantially in the past 20 years. Unfortunately, few studies have produced significant effects (M. H. Ussher, et al., 2008), suggesting that exercise may not work as well in real-world settings as it does in laboratory-based research on the acute effects of exercise on cigarette cravings and mood/affect (Adrian H. Taylor, et al., 2007). On the other hand, the relatively promising exercise dose response results found in many of the intervention studies, including this one, are encouraging enough to incite further research into this area. Therefore, two topically related but systematically distinct domains may continue to guide research in this area: 1) the efficacy of exercise in the reduction of cigarette cravings and withdrawal symptoms among temporarily abstinent smokers; and 2) the application of habitual exercise to smoking cessation interventions. Many specific questions within each of these general domains may be pursued. In addition, these two domains may begin to merge.

This pilot study was the first that we are aware of to combine the two related but disparate domains of research in the smoking and exercise literature. It applied the type of exercise (short bouts) that has effectively reduced cigarette cravings and improved affect among temporarily abstinent smokers in the acute exercise experiments to a smoking cessation intervention trial. Replications of this type of

intervention, with improvements in the design and implementation, will help to clarify whether or not it may be efficacious for some smokers.

Interestingly, although the intermittent exercise prescription in this study differed in many ways from the sustained exercise prescriptions in previous studies, the results were similar, providing further evidence that the actual dose of exercise completed matters more than mere group assignment. In other words, exercise – perhaps regardless of whether it is intermittent or sustained – works well for those who do it. Much like medications only work if taken as directed, exercise may only aid cessation efforts only if it is completed as directed. Likewise, much like the premise of personalized medicine, different types of exercise prescriptions (e.g., sustained vs. intermittent, aerobic vs. strength training vs. stretching) may not work equally well for all individuals. Systematically experimenting with different types of exercise prescriptions tailored to individuals may help clarify the potential role of exercise in smoking cessation. Identifying patterns of individual participants' unique exercise participation and smoking cessation trajectories in previous studies may help guide the tailoring process.

In addition, randomized controlled trials directly comparing groups with equivalent smoking cessation programs but different exercise prescriptions may be warranted. Potential types of exercise prescriptions to compare include but are not limited to the following: 1) regular, sustained exercise (e.g., 30+ minutes, 5 days per week); 2) intermittent, short bouts of exercise (e.g., 5-15 minutes multiple times per day); 3) a combination of sustained and intermittent exercise, beginning

simultaneously and continuing as such throughout the program; 4) a combination of sustained and intermittent exercise, beginning with intermittent and progressing to sustained by the end of the program; and 5) either sustained or intermittent, allowing participants to choose their preferred type.

This study was also the first to our knowledge to integrate a combination of aerobic, strength training, and stretching into the exercise intervention. Although we have not yet examined the quantitative breakdown of the three types of exercise reported on the study website, informal data obtained from EX participants during the weekly check-in phone calls and at the post-intervention assessment suggested that walking (i.e., aerobic exercise) was the most common type of exercise completed. Many participants stated that walking was more convenient and required less thought than other types of exercise – two important factors to consider in any situation, let alone in the face of an urge to smoke. Many also informally reported that exercise helped them resist the urge to smoke; however, other participants reported that their cigarette cravings actually *increased* after exercise and/or that they desired to reward themselves for exercising with a cigarette, thus defeating the purpose of the exercise.

Previous exercise-based smoking cessation interventions have prescribed aerobic exercise alone despite evidence that isometric exercise also reduces cigarette cravings and improves mood/affect among temporarily abstinent smokers (M. Ussher, et al., 2006). A recent pilot study incorporated strength training into the later stages of the primarily aerobic exercise based program (Whiteley et al., 2007). The pilot study formed the foundation for a randomized controlled trial that also incorporated strength

training into a primarily aerobic exercise based program; the results of the latter study (not yet published) may pave the way for future studies to integrate strength training into typical aerobic exercise based protocols. Smoking cessation trials utilizing strength training and yoga are currently being conducted; results from these studies will also help guide the field in this largely unexplored area. Eventually, randomized controlled trials directly comparing smoking cessation rates among groups exposed to aerobic exercise, strength training, stretching, or a combination of any or all of these types of exercise may be warranted.

Technology. Although participants attended three in-person assessment visits over the course of the six months in which they were enrolled and received weekly check-in phone calls during the first three months of the study, most of the intervention was delivered on the Internet via the study website and email. The smoking cessation tutorial, consisting of daily lessons and handouts with smoking cessation tips and information, was provided on the study website for all participants. Exercise instructions were sent via email, and general exercise information (e.g., exercise safety, beginning an exercise program) was provided on the study website for EX group participants. Participant feedback from this study suggested that participants were highly satisfied with the Internet-based intervention. Of course, this feedback should be interpreted in light of the fact that participants self-selected into this type of intervention.

As personal computers and home Internet service become increasingly available to individuals from all socioeconomic backgrounds, Internet-based health

behavior intervention research is becoming more abundant. Evidence suggests that smoking cessation (Myung, et al., 2009; Walters, et al., 2006) and exercise (van den Berg, Schoones, & Vliet Vlieland, 2007; Vandelanotte, Spathonis, Eakin, & Owen, 2007) interventions delivered via the Internet work well for many individuals. Because technology-based health behavior intervention research is in its infancy, methodological improvements are inevitable. One of the biggest struggles may prove to be keeping up with rapid technological advances in order to maintain individuals' attention and interest in an increasingly stimulating and distracting world. Moreover, factors such as lack of access, low literacy, and language or cultural barriers may prevent many individuals from participating in web-based research. Therefore, results from studies that utilize technology-based methods should only be extrapolated to other populations with tremendous caution.

Challenges

A wide variety of factors made this study challenging to complete. Like most health behavior intervention research, recruiting enough participants was challenging. Initial goal sample size was pared down after the first few months suggested that the goal was unrealistic given time and resource constraints. Furthermore, enrollment was difficult for many individuals interested in participating because of the medical clearance requirement; many individuals did not have health insurance and had not undergone a physical examination within the past year, which prevented them from obtaining clearance. Fortunately, two UCSD physicians volunteered their time to complete basic physicals for some of these individuals. However, the physicians were

not able to see individuals who reported complicated medical histories because of the inherent risk in clearing them to participate without medical monitoring throughout the study to ensure their safety. Other challenges that arose, such as no-shows, attrition, adherence, motivation, and missing data, are typical of this type of research. Although these challenges undoubtedly influenced the results, they reflect real world issues and thus may increase its external validity. Moreover, these challenges brought to the surface issues that could be minimized when designing future iterations of this study.

Limitations

Numerous limitations prevented this pilot study from reaching its full potential. Budget constraints, inherent with dissertation research, posed the biggest challenge. A larger budget would have facilitated a more visually appealing, technologically advanced study website with additional features, such as an online forum for participants to interact with each other and/or the researchers in real time, individual feedback in written and graphical formats, and automated intervention tailoring based on each participant's progress, to name a few. The materials comprising the website were adapted from publicly available smoking cessation websites. The backend and graphics of the website were designed by a computer science undergraduate student with relatively little experience in website design. Nevertheless, a functional study website was created, suggesting that a web-based program can be implemented on a limited budget.

Recruitment methods were also limited by budget constraints. Many studies utilize more costly recruitment strategies such as television commercials, radio

advertisements, and mainstream newspaper advertisements. These types of recruitment strategies may have increased the sample size substantially. The relatively small sample limited the study's power to detect group differences. It also limited our ability to adjust for potential confounding variables because of the high risk of over-fitting statistical models. Nevertheless, results from this study may provide adequate pilot data for grant applications to conduct future iterations of this study.

In addition to budgetary and sample size limitations, potential researcher and participant biases may have reduced internal validity. Although every effort to maintain objectivity was made, a certain degree of researcher bias was almost inevitable because the principal researcher was responsible for every aspect of the study, including design, attainment of funding and institutional approval, recruitment, randomization, intervention delivery, data collection and analyses, and interpretation of results. Because of this combination of responsibilities, researcher blinding was impossible. Likewise, participant bias may have occurred because of the unavoidable lack of blinding to study condition.

A related limitation was an over-reliance on self-report data. Participants were strongly encouraged to honestly report their smoking and exercise behaviors in order to increase the accuracy of study findings, and they were reassured that their responses had no bearing on their receipt of incentives. However, participants notoriously attempt to present themselves in a positive light and to "please" researchers by reporting the behaviors they believe are desired and/or expected of them. The lack of blinding on both ends of the study may have increased the likelihood that these

demand characteristics came into play. Objective measures, such as breath carbon monoxide (CO) level monitors and/or saliva or urine cotinine levels to verify self-reported smoking status and pedometers or actigraphs to verify self-reported exercise, would have served as useful markers of criterion validity.

Finally, because participants were required to have daily access to the Internet and the ability to read, write, and understand English fluently, the study sample was limited to individuals with relatively higher socioeconomic status; therefore, the results may not accurately reflect a large percentage of current smokers, who tend to have lower socioeconomic status. Likewise, other eligibility criteria limit the generalizability of the study's results to individuals with few medical and psychiatric problems, among other characteristics.

Conclusions

Outcomes from this pilot study were comparable to more resource- and time-consuming smoking cessation programs, suggesting that future iterations of this program may be promising. Results were mixed with regard to the incremental benefit of exercise in the presence of the apparently valuable study website. Although no group differences were found in terms of post-intervention smoking cessation and reduction rates according to random assignment, reduction rates were statistically significant among all enrolled participants and comparatively greater among retained participants. Furthermore, EX group participants who recorded exercise on the study website more frequently experienced higher reduction rates than those who recorded exercise less frequently. Results from this study support findings from previous

research and underscore the need for additional investigation into both the mechanisms behind exercise-based smoking cessation interventions and the challenges of poor exercise adherence.

Appendices

Appendix A: Phone Screen

Walk Away from the Habit Phone Screener

*Researchers at UCSD have received funding from the National Institutes of Health to test a smoking cessation program, **Walk Away from the Habit: Overcoming Nicotine Dependence through Exercise**, in the Greater San Diego area. If you are eligible and choose to participate, you will receive a 12-week Internet-based smoking cessation program. You may also be randomly assigned to receive an exercise program in addition to the smoking cessation program. Thirty smokers will be recruited over a nine-month time span to participate in the 12-week program. For your participation in the program, we will provide the program at no charge, and you can earn up to \$75 for completing our questionnaires at your baseline visit, after completing the program, and again three months later. If you are eligible, we will ask you to obtain physician clearance to participate, attend a baseline visit, and login to the study website every day throughout the 12-week program to read a daily smoking cessation lesson and complete daily self-monitoring records. At each of your three in-person visits, you will also be asked to complete a brief physical fitness assessment. We will ask you questions during and after the program about your smoking, nicotine cravings, exercise, and mood that help us determine if the program was effective.*

If you think you are interested, we will ask you to answer a few screening questions to determine if you are eligible. The only known risk to you for completing the screener is that it will take a few minutes of your time. You will not incur any cost nor will you receive any payment for participating in this screener. Your participation in this screener is voluntary. You may refuse to answer any of the questions asked, and your responses to these questions are confidential.

May we continue with this screen now that you have heard the description of it?

If declining: I understand your decision and that's fine. For our records, so that we can understand what appeals to people and what doesn't, could you tell me something about why you've decided to not pursue participating in the study?

If accepting: Okay, then I will ask you a few questions to help determine whether or not you would be eligible for the study if you decide you would like to participate.

- Are you between the ages of 18 and 64 years?
- Do you have any severe, untreated medical problems that may limit your ability to exercise moderately? (e.g., untreated CVD, pulmonary disease, severe arthritis, severely limiting physical disabilities)
- Have you been smoking regularly for at least 3 years?
- Do you currently smoke at least 10 cigarettes per day?
- What are your current height and weight? (calculate BMI to ensure it is < 35)
- Do you wish to quit smoking at this time?
- Do you wish to increase your exercise levels?
- How many times per week do you currently exercise? How much total time do you spend exercising each week? What types of exercise do you currently do? (Make sure individual does not meet ACSM criteria for aerobic activity [150 min moderate aerobic exercise or 110 min vigorous aerobic exercise per week]; strength training [$>2X/week$]; and stretching/yoga routine [$>2X/week$])
- Are you currently pregnant or do you plan to become pregnant in the next six months?
- Do you speak, read, & write fluently in English?
- Do you have daily Internet access readily available at home or work?

If eligible: Thank you for your time. Based on your responses you seem to be eligible for the study. Do you have additional questions about the study before deciding whether or not you are interesting in participating? Would you like to schedule a baseline visit to enroll in the study?

If yes: Great. You will just need to obtain physician clearance to participate in moderate exercise, and then we can get you enrolled. If you have seen a physician in the past year s/he will usually clear you without a separate visit. I can email you the form s/he will sign and either fax directly to me or send with you to bring to our baseline visit. When are you available to come in to our laboratory for a baseline visit? It will require approximately 1.5 hours of your time.

If no: I understand your decision and that's fine. For our records, so that we can understand what appeals to people and what doesn't, could you tell me something about why you've decided to not pursue participation in the study?

If ineligible: Thank you for your time. Unfortunately, based on your responses you are not eligible for the study at this time. (Provide feedback about which criterion/criteria s/he does not meet.) I hope that you will seek another smoking cessation program to assist you. Please let me know if you would like a list of other available smoking cessation programs/resources.

Appendix B: Medical Clearance Form

**Walk Away from the Habit:
Overcoming Nicotine Dependence through Exercise****Statement of Medical Clearance for Exercise**

Patient Name: _____

Address: _____

Date of Birth: _____ Phone Number: _____

Your patient (named above) would like to participate in Walk Away from the Habit: Overcoming Nicotine Dependence through Exercise, a research study designed to help sedentary smokers who desire to quit smoking achieve their goal. This study is supported by a training grant from the National Institutes of Health/National Institute on Drug Abuse (NIH/NIDA) and is approved by the Institutional Review Board (IRB) at both University of California San Diego (UCSD) and San Diego State University (SDSU), as well as by the Research and Development (R&D) Committee at the Veterans Affairs (VA) Medical Center.

Half of the qualified, enrolled participants will be randomly assigned to receive the exercise intervention, while the other half will not receive any exercise instructions. The exercise program will consist of multiple, brief bouts (5-15 minutes each) of daily exercise, including aerobic, strength training, and stretching components. The exercise bouts will be completed independently by the participants, without professional supervision. In addition, all participants, regardless of randomization, will complete a supervised, basic fitness assessment (5-minute step, sit-and-reach, sit-up, and push-up tests) at baseline and 12 weeks after enrollment in the study.

_____ YES, my patient has no current unstable medical problems that are a contraindication to participating in this exercise program. I approve and support her/his participation in this progressive exercise intervention for smoking cessation.

Comments/Special Considerations/Restrictions:

_____ NO, my patient is not eligible to participate in this exercise program due to his/her current medical status.

Physician Signature

Date

Physician Information:

Print Name: _____

Address: _____

Telephone: _____ Fax: _____

If you would like to know more about the Walk Away from the Habit: Overcoming Nicotine Dependence through Exercise study, please contact Sarah Linke, M.S., Principal Investigator, at 858-552-8585, Extension 5979, or Thomas Rutledge, Ph.D., Supervisor, at 858-552-8585, Extension 7273.

Appendix C: Sample Daily Lesson & Handout

How Can I Stop Smoking?

In addition to participating in this research study by completing the daily modules and records, you can do several things to help make the quitting process a little easier.

Learn to resist the desire to smoke:

- **Don't buy cigarettes**
By not having cigarettes readily available, you will be less tempted and likely to smoke.
- **When you feel the desire to smoke, wait five minutes before deciding whether or not to light a cigarette.**
As time goes by, the desire to smoke gradually lessens, so you might change your mind about lighting up if you wait a few minutes.
- **Keep your mouth and hands busy.**
For example, put something like a toothpick, breath mints, gum, or carrots in your mouth, and keep your hands busy with a pencil or a coin.
- **Do not smoke in your favorite places.**
Stop smoking in your favorite places, and do not smoke in the same place for more than 4 or 5 days.
- **Do not smoke in your home.**
Decide not to smoke inside of your home. If you feel a desire to smoke while you are at home, go out to the street or to the garden before lighting the cigarette.
- **Do not go places where many other people are smoking.**
Keep away from places where many people frequently smoke (e.g., bars, dances, or parties).
- **Talk to persons who have quit smoking.**
Ask your friends who have quit smoking how they did it, and ask them to help you to quit smoking.

Consider the negative effects of cigarettes:

- **Be aware of the bad physical effects produced by cigarettes.**
Every time that you smoke a cigarette, be aware of the burning in your throat and eyes and the irritation of your lungs. Smoking is not as pleasurable as you might think.

- **Collect cigarette butts in a bottle.**
Place all of the cigarettes and cigarette butts you can find in a bottle. Add water and cover it. Every time you have a desire to smoke, look at the bottle and open it so you can smell the bad odor of the cigarette poisons.
- **Remember how cigarettes affect your health.**
If you have desires to smoke, remember the adverse effects that cigarettes have on your health.

Obtain the help of your friends and relatives:

- **Tell your friends and relatives that you want to quit smoking.**
Tell your friends and relatives that you are quitting so that they will neither offer you cigarettes nor smoke in your presence.

My Reasons to Stop Smoking

The following is a list of reasons why I, _____, want to stop smoking.

Example: I want to stop smoking to save \$2,700.00 a year. This amount is the approximate cost of smoking 1-1/2 packs of cigarettes a day.

1. _____

2. _____

3. _____

4. _____

5. _____

Appendix D: Daily Smoking Record

Daily Smoking Record

If you did not smoke today, great job! If you did smoke, remember that tomorrow is a new day, and you can always try to quit again then!

Using the form below, please honesty and accurately report the number of cigarettes you smoked today, if any. Remember, you will not be penalized or reprimanded in any way by reporting that you smoked. You are encouraged to remain in the study even if you are having trouble quitting or if you have relapsed after initially quitting. Also, your self-reported smoking will not be individually identified. It will be combined with the other participants' reports and used for research purposes only.

Did you smoke any cigarettes today?

- ☐ Yes
- ☐ No

If yes, how many cigarettes did you smoke?

Appendix E: Daily Cigarette Craving Record

Daily Cigarette Craving Record

Keeping track of daily cigarette cravings and noticing the circumstances that happen before the intense ones can help you to understand your pattern of relapsing (smoking again after quitting). Also, recording your cravings and the tough times that you resist them can help motivate you to resist cravings again in the future.

Please rate the **average intensity of your craving for cigarettes** today:

-5	-4	-3	-2	-1	0	1	2	3	4	5
The thought of cigarettes was absolutely disgusting					Neutral (cigarettes didn't seem disgusting nor desirable)					My craving for cigarettes was almost unbearably high

Please rate the **intensity of your highest craving for cigarettes at one particular time** today:

-5	-4	-3	-2	-1	0	1	2	3	4	5
The thought of cigarettes was absolutely disgusting					Neutral (cigarettes didn't seem disgusting nor desirable)					My craving for cigarettes was almost unbearably high

In the space below, please comment on the circumstances **immediately preceding** the **highest intensity of craving** you experienced today:

Appendix F: Daily Mood Record

Daily Mood Record

Your mood is often related to your craving for cigarettes and to your smoking and exercise behaviors. Keeping track of your fluctuations in mood can help you to better understand your patterns of cravings and relapses (smoking again after quitting). Please use the scale below to rate your mood today.

Please rate your **average mood** for the day:

-5	-4	-3	-2	-1	0	1	2	3	4	5
Extremely down/ upset					Neutral (neither sad nor happy)					Extremely happy/ upbeat

Appendix G: Sample Daily Email

Hi Participant Name,

How was your day? Were you able to refrain from smoking today? I hope so! If you didn't smoke, great job!! If you did smoke, try not to dwell on it because tomorrow is a new day. You can make the decision to NOT smoke tomorrow whether or not you smoked today.

Make sure you login to the walkawayucsd.org website to read your daily lesson and complete your daily records. Remember that doing these will help you keep track of how your mood is related to your cigarette cravings and numbers of cigarettes you smoke each day. It also helps you to feel accountable, which decreases the chances that you will smoke even when you have high cravings levels.

Keep up the good work! 😊

Best,
Sarah

Appendix H: Sample Exercise Information Website Page

Benefits of Exercise

Regular exercise makes the heart stronger and the lungs fitter, enabling the cardiovascular system to deliver more oxygen to the body with every heartbeat and the pulmonary system to increase the maximum amount of oxygen that the lungs can take in. Exercise lowers blood pressure, somewhat decreases the levels of total and low density lipoprotein (LDL) cholesterol (the bad cholesterol), and increases the level of high density lipoprotein (HDL) cholesterol (the good cholesterol). These beneficial effects in turn decrease the risk of heart attack, stroke, and coronary artery disease. In addition, colon cancer and some forms of diabetes are less likely to occur in people who exercise regularly.

Exercise makes muscles stronger, allowing people to do tasks that they otherwise might not be able to do or to do them more easily. Every physical task requires muscle strength and some degree of range of motion in joints. Regular exercise can improve both.

Exercising stretches muscles and joints, which in turn can increase flexibility and help prevent injuries. Weight-bearing exercise, such as brisk walking and weight training, strengthens bones and helps prevent osteoporosis. Exercise can improve function and reduce pain in people with osteoarthritis, although exercises that put undue strain on joints, such as jumping and running, may need to be avoided.

Exercise increases the body's level of endorphins, chemicals in the brain that reduce pain and induce a sense of well-being. Thus, exercise appears to help improve mood and energy levels and may even help relieve depression. Exercise may also help boost self-esteem by improving a person's overall health and appearance.

In addition to all its other benefits, regular exercise helps older people remain independent by improving functional ability and by preventing falls and fractures. It can strengthen the muscles of even the frailest older person living in a nursing or retirement home. It tends to increase appetite, reduce constipation, and promote sleep.

The benefits of exercise diminish within months after a person stops exercising. Heart strength, muscle strength, and the level of high density lipoprotein (HDL) cholesterol (the good cholesterol) decrease, whereas blood pressure and body fat increase. Even former athletes who stop exercising do not retain measurable long-term benefits. However, people who were physically active in the past regain fitness faster.

Appendix I: Sample Weekly Exercise Instructions Email

Hi Exercise Participant Name,

Starting today, you should focus on exercising instead of smoking when you're craving cigarettes. For example, if you get a craving while you're watching TV and you really want a cigarette to go with your favorite show, go for a walk or do some stretching or strengthening exercises while you watch instead. You'll be amazed at how much less you'll want to smoke after you exercise!

Exercise when you start to feel stressed, tired, sad, anxious, irritable, hungry, or angry. And don't forget to login to the website to record your exercise, mood, and craving levels after you exercise. Here's a sample of what your day might look like, but you don't have to follow this exactly.

7:30 AM: Push-ups and sit-ups at home before getting ready for work – 5 minutes.

10:30 AM: Stretching at the office to take a break from the computer – 5 minutes.

12:30 PM: Walking around office building during lunch break – 5 minutes.

3:00 PM: Stretching at the office to take a break from the computer – 5 minutes.

5:00 PM: Walking around office building before getting in car to go home – 5 minutes.

7:30 PM: Squats and lunges at home while watching TV – 5 minutes.

10:00 PM: Stretching at home to relax before going to bed – 5 minutes.

Good luck!

Best,

Sarah

Appendix J: Daily Exercise Record

Daily Exercise Record

Select the day this record is for:

How many times did you exercise instead of smoking today? *(Drop down menu with options 0-10)*

(Page expands depending on how many times the person reported exercising)

Please answer the following questions about **each bout of exercise** you did today.

Exercise #1. What time did you exercise? Please be specific!

What type of exercise did you do? Check all that apply.

- ☐ Aerobic (e.g., walking, bicycling, swimming, etc.)
- ☐ Strength (e.g., weights, calisthenics, etc.)
- ☐ Stretch/yoga

How long did you exercise? minutes

How hard did you feel this bout of exercise was for you? Use the following scale to estimate the intensity (rate of perceived exertion or RPE) of this bout of exercise:

6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
No exertion at all	Extremely light (7.5)		Very light		Light		Somewhat hard		Hard (heavy)		Very hard		Extremely hard	Maximal exertion

Exercise #2. What time did you exercise? Please be specific!

What type of exercise did you do? Check all that apply.

- ☐ Aerobic (e.g., walking, bicycling, swimming, etc.)
- ☐ Strength (e.g., weights, calisthenics, etc.)
- ☐ Stretch/yoga

How long did you exercise?

minutes

How hard did you feel this bout of exercise was for you? Use the following scale to estimate the intensity (rate of perceived exertion or RPE) of this bout of exercise:

6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
No exertion at all	Extremely light (7.5)		Very light		Light		Somewhat hard		Hard (heavy)		Very hard		Extremely hard	Maximal exertion

Exercise #3. What time did you exercise? Please be specific!

What type of exercise did you do? Check all that apply.

- ☐ Aerobic (e.g., walking, bicycling, swimming, etc.)
- ☐ Strength (e.g., weights, calisthenics, etc.)
- ☐ Stretch/yoga

How long did you exercise?

minutes

How hard did you feel this bout of exercise was for you? Use the following scale to estimate the intensity (rate of perceived exertion or RPE) of this bout of exercise:

6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
No exertion at all	Extremely light (7.5)		Very light		Light		Somewhat hard		Hard (heavy)		Very hard		Extremely hard	Maximal exertion

Please answer the following questions about the **most recent time you exercised** today.

Remember: Recognizing how your mood, cravings, and exercise are connected will help you to stay “quit”!

Please rate your **mood immediately before** you exercised:

-5	-4	-3	-2	-1	0	1	2	3	4	5
Extremely down/ upset					Neutral (neither sad nor happy)					Extremely happy/ upbeat

Please rate the **intensity of your craving for cigarettes immediately before** you exercised:

-5	-4	-3	-2	-1	0	1	2	3	4	5
The thought of cigarettes was absolutely disgusting					Neutral (cigarettes didn't seem disgusting nor desirable)					My craving for cigarettes was almost unbearably high

Please rate your **mood immediately after** you exercised on the following scale:

-5	-4	-3	-2	-1	0	1	2	3	4	5
Extremely down/ upset					Neutral (neither sad nor happy)					Extremely happy/ upbeat

Please rate the **intensity of your craving for cigarettes immediately after** you exercised:

-5	-4	-3	-2	-1	0	1	2	3	4	5
The thought of cigarettes was absolutely disgusting					Neutral (cigarettes didn't seem disgusting nor desirable)					My craving for cigarettes was almost unbearably high

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