



## Efficacy of resistance training as an aid to smoking cessation: Rationale and design of the Strength To Quit study



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### ABSTRACT

**Background:** Despite recent declines, cigarette smoking remains prevalent among individuals with lower income, less education, and those with mental illness or HIV. Exercise is promoted as a quitting aid; however, the evidence for this recommendation is equivocal. To date, the majority of studies have only examined aerobic exercise; there is a poor understanding of the mechanisms of action; and there is an under-representation of male smokers.

**Methods/Design:** 206 male and female smokers will receive a smoking cessation education session prior to being randomized into a 12-week Resistance Training (RT) or Wellness Contact Control group. Both groups will have the option of using nicotine replacement therapy (NRT), and both will meet on-site twice per week during the intervention (24 total sessions). Follow-up assessments will occur at the end of the 12-weeks (3-month), and at a 6-month and 12-month (post-randomization) visit. Participants will not receive any additional cessation treatment during follow-up; however, the RT group will receive a 9-month membership to a fitness center to encourage continued resistance training as a way to maintain cessation. The primary outcome is salivary-cotinine-verified 7-Day Point Prevalence Abstinence at the 3-month assessment, and at the 6 and 12-month follow-ups. Secondary outcomes include effects of resistance training on nicotine withdrawal, indicators of mental health, and markers of disease risk. **Discussion:** This study will produce new data on the efficacy of resistance training for smoking cessation, the potential mechanisms of action that may support its use, and the effects it has on markers of disease risk in smokers.

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### 1. Introduction

Each year, tobacco use kills nearly 6 million people and costs more than half a trillion dollars worldwide (WHO, 2013). In the United States (US), the primary method of tobacco use is cigarette smoking, and approximately 19.9% of men and 15.2% of women currently smoke (Schiller, Ward, & Freeman, 2013). These rates are

known to differ by other demographic variables such as race, education, and income level (CDC, 2012; Schoenborn, Adams, & Peregoy, 2013) and they differ by current health status. For example, the rate of cigarette smoking is estimated to be highest among persons living with human immunodeficiency virus (HIV; 59%–85%; Marshall et al., 2011; Tesoriero, Gieryic, Carrascal, & Lavigne, 2010) and those with a diagnosed mental illness (36.1%; CDC, 2013).

In the US, cigarette smoking and exposure to secondhand smoke is estimated to cause 480,000 deaths annually, or about one out of every five deaths (CDC, 2008; USDHHS, 2014). Lung cancer claims the most lives, followed by ischemic heart disease, and chronic obstructive pulmonary disease (COPD; CDC, 2008). In total, more deaths are caused by tobacco use in the US than by all deaths from

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illegal drug and alcohol use, HIV/AIDS, motor vehicle injuries, murders, and suicides combined (USDHHS, 2004). Fortunately, quitting smoking results in a number of short and long-term benefits. For example, the risk of developing heart disease drops by 50% within one year after quitting, and the risk for a stroke can fall to about the same as a nonsmoker's, 2–5 years after quitting (USDHHS, 2010). Other risks, such as cancer of the mouth or throat are cut in half five years after quitting, and the risk of dying from lung cancer drops by half 10 years after quitting (USDHHS, 2010). Smoking cessation can also improve mental health, as it is known to be associated with reduced depression, anxiety, and stress and improved mood and quality of life (Taylor et al., 2014).

Recent estimates indicate that the majority of US smokers would like to quit, with 45.8% having tried in the past year (Schoenborn et al., 2013). Unfortunately, less than 5% of those who attempt to quit are able to maintain long-term abstinence (Rafful et al., 2013), particularly greater than six months (Murthy & Subodh, 2010). There are several prescription and over-the-counter medications that have been shown to nearly double the success rate of smoking cessation when compared to a placebo (Herman & Sofuoglu, 2010); however, cost, access, and the perception of medication risk are well known barriers to use (Foulds et al., 2013). In addition, the weight gain associated with quitting can be problematic for both men and women, as current evidence indicates that post-cessation weight gain can range from 4 to 10 kg (Aubin, Farley, Lycett, Lahmek, & Aveyard, 2012). Notably, the increases in body weight following smoking cessation may be attributed to a lower metabolic rate and increased amount of body fat (Kleppinger, Litt, Kenny, & Oncken, 2010; Pistelli, Aquilini, & Carrozzi, 2009). Such changes can significantly diminish the positive health effects of smoking cessation via associated reductions in glucose metabolism (Yeh, Duncan, Schmidt, Wang, & Brancati, 2010), lung function (Chinn et al., 2005), and increases in the risk of developing type 2 diabetes (Luo et al., 2013) and hypertension (Gratziou, 2009).

The U.S. Department of Health and Human Services currently advocates the use of exercise as an aid to quitting (USDHHS, 2008), as do researchers, tobacco treatment specialists and former smokers (Everson, Taylor, & Ussher, 2010; Haasova et al., 2014). However, the overall evidence for using exercise as an aid is equivocal. Specifically, a 2012 Cochrane review determined that larger, adequately powered, sufficiently intense interventions with equal contact control conditions are needed (Ussher, Taylor, & Faulkner, 2012). The authors identified a number of limitations of previous research that included a lack of testing potential mechanisms of action (e.g., reduction in nicotine withdrawal symptoms), a female-only sample, and a strict focus on using aerobic exercise. As such, newer, rigorous research is needed to elucidate the role exercise can play in aiding smoking cessation, particularly for male smokers and anyone who would prefer to engage in various different physical activity modalities. This could potentially enhance compliance and ultimately prevent relapse.

In a prior pilot study, we explored the feasibility of resistance training (i.e., weight training) as an aid to smoking cessation (Ciccolo et al., 2011). Briefly, 12 male and 13 female smokers received a 20-min smoking cessation counseling session and Nicotine Replacement Therapy (NRT). Participants were then randomized into a two-session per week, 12-week resistance training or contact control program (i.e., 24 total sessions). At the end of treatment, carbon-monoxide (CO)-verified 7-day point prevalence abstinence (PPA) rates were 46% for the resistance training group and 17% for contact control (OR 4.3, 95% CI = 0.7–27.8). Additionally, participants in the resistance training group had more favorable changes in body weight (Cohen's  $d = -0.7$ ) and body fat ( $d = -0.8$ ) when compared to the control.

These pilot results warrant additional research, as the data suggest that resistance training could (1) be a potential aid for smoking cessation and (2) provide smokers with a method to reduce other health risks when trying to quit. More specifically, the potential mechanisms supporting resistance training as an aid for smoking cessation are that it could beneficially affect some of the most well known predictors of relapse, such as negative affect (Leventhal et al., 2013) and sleep disturbance (Hamidovic & de Wit, 2009), as well as barriers to quitting, such as weight gain (Pistelli et al., 2009). For example, studies have shown that resistance training can reduce many of the same negative affective states frequently reported during nicotine withdrawal, such as tension, anxiety, and depression (Arent, Landers, Matt, & Etnier, 2005; Singh et al., 2005). Other research has shown that there is a significant association between resistance training and increased quality of sleep (Yang, Ho, Chen, & Chien, 2012); and the effects of resistance training on metabolism and body composition have been rigorously tested and are well established (Strasser, Siebert, & Schobersberger, 2010). In addition to these potential positive effects, the health benefits gained from resistance training could also be particularly helpful for smokers, as resistance training has been shown to improve lung function (Singh, Jani, John, Singh, & Joseley, 2011), blood lipids (Kelley & Kelley, 2009), and blood glucose control (Strasser et al., 2010). All of these factors are known indicators of disease risk that are also significantly associated with smoking (USDHHS, 2014).

As such, the purpose of this paper is to outline the rationale and design of *Strength To Quit*, a large, laboratory-based, randomized controlled trial (RCT) testing the use of resistance training as an aid to smoking cessation. *Strength To Quit* was specifically designed to examine the following three questions: (a) What is the efficacy of resistance training as an aid to smoking cessation for male and female smokers? (b) What are the psychological and physiological mechanisms of the effects of resistance training on smoking cessation? and (c) Does resistance training attenuate detrimental changes in markers of disease risk associated with quitting (e.g., body fat gain)?

## 1.1. Study methods

### 1.1.1. Study design

*Strength To Quit* uses a 2-group design in which 206 participants will be randomized into 12-week Resistance Training ( $n = 103$ ) or Wellness Contact Control ( $n = 103$ ) conditions. A stratified block randomization procedure is used to achieve balance between the two groups on gender and intention to use the nicotine patch. All participants receive a brief smoking cessation education session prior to being randomized. Both groups meet on-site twice per week during the 12-week program (24 total sessions), and follow-up assessments occur at the end of the 12-weeks (3-month) and at a 6-month and 12-month (post-randomization) follow-up (See Fig. 1). The primary outcome is salivary-cotinine-verified 7-Day PPA measured at each of the follow-up assessments.

### 1.1.2. Participants and eligibility

Eligible participants are male and female smokers, age  $\geq 18$ , who have a desire to quit smoking and have regularly smoked five or more cigarettes a day for at least the past 12 months. Potential participants are excluded if they currently engage in any combination of aerobic exercise or resistance training for  $>60$  min/week or have over the past 3 months, currently use smokeless tobacco, are taking medication to quit smoking, or are participating in an ongoing smoking cessation treatment. Women who are pregnant or planning to become pregnant are excluded. Anyone with cardiovascular or pulmonary disease (e.g., coronary artery disease, emphysema), and

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