Is Physical Activity Associated with Improved Short-term Smoking Cessation?

by

Jill S. Schaefer

BA, CCRP, University of Pittsburgh, 2005

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This thesis was presented

by

Jill S. Schaefer

It was defended on

December 9, 2010

and approved by

Amy D. Otto, Ph.D., RD, LDN, School of Education

Alexandre R. Vieira, DDS, Ph.D. School of Dental Medicine

John M. Jakicic, Ph.D., School of Education
Thesis Director

IS PHYSICAL ACTIVITY ASSOCIATED WITH IMPROVED SHORT-TERM SMOKING CESSATION?

Jill S. Schaefer, BA, CCRP

University of Pittsburgh, 2010

PURPOSE: The purpose of this study was to determine if a correlation exists between the number of cigarettes smoked and the amount of exercise leisure-time activity performed in heavy adult smokers who were motivated to quit smoking.

METHODS: Twenty-seven adult smokers (smoking ≥ 15 cigarettes per day for a minimum of 5 years) participated in the study. The subjects enrolled were motivated (scored ≥ 120 on motivation/confidence 0—200 scale) to quit smoking. Participants received a brief behavioral stop-smoking intervention at baseline, and were instructed to quit smoking within the next 48 hours (over the weekend). Subjects were followed for a total of two weeks during which time smoking behavior and exercise habits were recorded.

The Godin Leisure-Time Exercise Questionnaire was administered at baseline and again at the end of weeks I and II (once a week for three weeks) to capture leisure time exercise habits. Smoking behavior was recorded (number of cigarettes smoked) daily.

RESULTS: It was hypothesized that individuals who smoke less cigarettes during a cessation attempt may tend to exercise more in their leisure time. It was also hypothesized that BMI and gender could play a role in the relationship between physical activity performed and number of cigarettes smoked. Baseline vigorous physical activity was not found to be statistically significant, but there was a trend towards decreased smoking rates at this intensity. No statistical significance was found for any other exercise intensity at baseline, week one or

week two. BMI and gender did not play a role in the relationship between physical activity performed and the number cigarettes smoked.

FUTURE DIRECTIONS: While an inverse relationship between amount of leisure time exercise performed and the number of cigarette smoked was not detected in the current study, future studies with a longer follow up period and larger sample sizes should be conducted. Should a negative correlation be found among these two variables, larger scale, statistically strong, causal studies should be conducted. Current smoking cessation programs may benefit from the inclusion of promoting healthy life style choices such as increasing the amount of leisure time activity performed.

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INTRODUCTION

1.1 PREVALENCE OF SMOKING

Despite the well-documented consequences of cigarette smoking since the time of the US Surgeon General's first major report in 1964, 45.3 million Americans currently smoke[9]. The majority (90%) of smokers start before the age of eighteen years of age allowing for an easy passage into a lifelong addiction[18]. Adolescents and young adults ages 18—24 are the fastest growing group of smokers, white females in particular[61]. Older adults account for a large percentage of smokers. In 2005, approximately 18.7 million Americans over the age of 45 smoked[2]. While slightly more men than women smoke across all ethnicities[9], about 200 million women in the world smoke[37]. Prevalence of cigarette smoking is highest among women who are American Indians or Alaska Natives (26.8%), followed by non-Hispanic whites (20%), African Americans (17.3%), Hispanics (11.1%), and Asians excluding Native Hawaiians and other Pacific Islanders (6.1%)[9].

1.2 HEALTH CONSEQUENCE OF SMOKING

Cigarette smoking remains the single leading cause of preventable death in the United States despite past and recent Surgeon General Reports (2004, 2007), enumerating the severe health

consequences of smoking. Approximately 443,000 deaths (or 1 of every 5 deaths each year) are attributed to smoking in the US[18]. Worldwide, smoking related deaths reach to an astounding three million[18]. The 2006 National Health Interview Survey (NHIS) found that approximately 20.8% of U.S. adults were current cigarette smokers, and this prevalence had not changed significantly since 2004. Data collected by the U.S. Centers for Disease Control and Prevention (CDC) estimated that adult male smokers lost an average of 13.2 years of life and female smokers lost 14.5 years of life due to smoking[18].

Smoking-related diseases claim more lives each year than illegal drug use, AIDS, automobile injuries, fires, homicide and suicide *combined*[30]. However, smoking-related diseases are highly preventable, as quitting smoking significantly reduces the mortality associated with these smoking related diseases. While most smokers want to quit[19], only about 5% are successful in doing so[26]. The Surgeon General Report notes that smoking harms nearly every organ in the body, and causes several diseases that further reduce overall health[4]. In conjunction with the dire health consequences of smoking, health care costs to the nation are reaching over $157.7 billion each year. The ramifications of smoking therefore include serious economic burdens in addition to health related diseases.

Smoking has been linked not only to cancer of the lung, but also to cancers of the larynx, pharynx, esophagus, kidney, oral cavity, pancreas, bladder, and cervix[10]. Cancer is the second leading cause of death within the US, second only to heart disease; smoking is related not to one, but *both* of these damaging, prevalent diseases. While smoking causes approximately 90% of all lung cancer deaths in men, and 80% of all lung cancer deaths in women, smoking also increases the risk of coronary heart disease (CHD) and stroke by two to four times[9].

Smoking alone increases the risk of coronary heart disease; it also raises blood pressure and decreases exercise tolerance. Women who smoke and use oral contraceptives are at an even higher risk of CHD and stroke compared to nonsmoking women who use oral contraceptives. Smoking also creates a higher risk for peripheral arterial disease and aortic aneurysm. For women, cigarette smoking also increases the risk for infertility, pre-term delivery, stillbirth, low birth weight, and sudden infant death syndrome. Postmenopausal women who smoke have lower bone density than women who never smoked[18].

1.3 SMOKING CESSATION

Quitting smoking is difficult because the nicotine in cigarettes is addictive, and causes pleasant feelings that make the smoker want to smoke more[3]. The nicotine withdrawal symptoms experienced while attempting to quit smoking are also extremely difficult to overcome for many individuals. Quitting smoking is the single best health change an individual can make as it greatly reduces the risk of developing any number of smoking related diseases, including cancer. After five years of quitting smoking, the risk of developing cancer is significantly decreased, and life expectancy is increased even in individuals who have been long-term smokers for many years[65]. After approximately ten years, the ex-smoker has nearly the same risk of developing cancer as a nonsmoker[65]. Heart rate and blood pressure begin to return to normal immediately after quitting smoking. Within a few hours, the level of carbon monoxide in the blood begins to decline[63].

To avoid an untimely death and the accompanying severe health consequences of smoking, many individuals attempt to stop smoking. Methods ranging from behavioral

interventions based on theory to pharmaceutical medications and nicotine fading have become common methods used to quit smoking. Nicotine gum, the skin patch, nasal spray, zyban, and even the "cold turkey" method are among the specific stop-smoking options available. While there is not monetary cost, the disadvantage of the "cold turkey" method includes the negative side effects experienced from nicotine withdrawal (such as irritability, headache, or difficulty sleeping). These withdrawal symptoms may be severe for some, especially if the cigarettes smoked contained high levels of nicotine.

Nicotine fading (using nicotine gum or the nicotine skin patch) minimizes physical side effects by decreasing the levels of nicotine over time, but many individuals find it hard to quit using nicotine replacement therapy all together as only the physical addiction is addressed with these methods [65]. Pharmaceutical medications such as zyban have side effects including dry mouth, agitation and insomnia. Methods such hypnosis and acupuncture have been proposed as possible stop smoking methods, though there is currently no clear data as to whether such interventions are effective. Though many smokers opt to utilize conventional stop-smoking methods, most are still not successful in their quit attempts[51]. Physical nicotine addiction and accompanying withdrawal symptoms often account for the low success rates of smokers who attempt to stop smoking[19].

While exercise has been proven to have many benefits for improving health such as weight loss, lowering blood pressure, and improvements in blood cholesterol levels, it is plausible that smokers may also find an added benefit of physical activity in diminishing side effects experienced when quitting smoking (including smoking lapses, irritability, increased hunger, sleep disturbances). Verkooijen reported that participation in leisure-time physical activity was inversely associated with adolescent smoking[65]. Coups found that women who

were current or former smokers and had high levels of physical activity were less likely to develop lung cancer than those who were more sedentary[17]. In both cases, physical activity proved to be a beneficial factor to the health of smokers. In a randomized controlled trial, Marcus[38] found that vigorous exercise facilitated both short and longer term smoking cessation in women when combined with a cognitive-behavioral smoking cessation program. Additional benefits included delayed weight gain following smoking cessation in subjects.

1.4 RATIONALE AND SIGNIFICANCE

State-of-the-art smoking cessation programs and nicotine replacement products have grown both in quality and popularity, but these conventional stop smoking methods exclude the forgotten aspect of improving overall health by increasing physical activity levels. If smokers who exercise more in their leisure time have the tendency to smoke less cigarettes than smokers who do not exercise in their leisure time, it may be highly beneficial to include physical activity interventions into future smoking cessation programs. This study focused on smokers during a quit attempt after a brief behavioral intervention and examine the relationship between the number of cigarettes smoked and the amount of leisure-time activity performed over a two week period. If an inverse correlation is found to exist between the amount of leisure-time activity and the number of cigarettes smoked, the next step will be to examine the mechanisms by which physical activity facilitates smoking cessation. Therefore, this study examined the following specific aims and hypotheses.

1.5 SPECIFIC AIMS AND HYPOTHESES

1. To examine the relationship between leisure-time physical activity and the frequency of cigarette smoking over a two-week period following a brief behavioral smoking cessation intervention.

   Hypothesis: It was hypothesized that there would be an inverse correlation between frequency of cigarette smoking, defined as number of days smoked and total cigarettes smoked, and the amount of leisure-time physical activity reported over a two-week period.

2. To examine the effect of body mass index (BMI) on the relationship between leisure-time physical activity and smoking frequency following a brief smoking cessation intervention.

   Hypothesis: It was hypothesized that BMI would moderate the relationship between leisure-time physical activity and smoking.

3. To examine the effect of gender on the relationship between physical activity and smoking, after receiving a brief stop-smoking intervention.

   Hypothesis: It was hypothesized that gender would moderate the relationship between leisure-time physical activity and smoking.

2.0 LITERATURE REVIEW

2.1 CIGARETTE SMOKING PREVALENCE

Globally, tobacco kills more than five million people each year, yet tobacco usage is currently rising. Approximately 1.3 billion people worldwide use tobacco and this number continues to grow, particularly in developing nations[52]. The World Health Organization estimates the tobacco global death toll will reach more than 8 million deaths per year by 2030[67]. While the overall percentage of smokers in the United States has decreased over the past 30 years, today approximately 20.8% (or 45.3 million) adults in the US still smoke cigarettes. (Figure 1 lists the prevalence of smoking among adults aged 18 years and older from 1997 to 2008)[63].

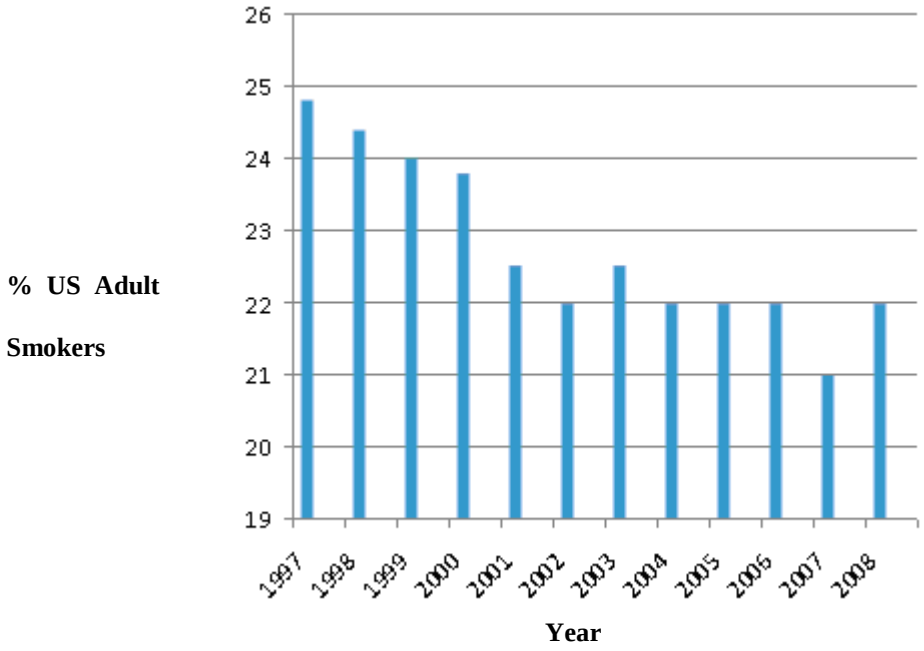

Figure 1 Prevalence of current smoking among adults aged 18 years and over: United States, 1997–June 2008

The percentage of adult smokers in the US declined from 42.4% in 1965 to 20.6% in 2008.[9] In 2008, an estimated 70.9 million Americans aged 12 or older were current users of tobacco. Among these, 59.8 million were current cigarette smokers, 13.1 million smoked cigars, 8.7 million used smokeless tobacco and 1.9 million smoked pipes[56].

An estimated 1 in 5 adults smoke cigarettes on a regular basis in the US[9]. Men's smoking rates are higher than women's at 23.5% and 18.3%, respectively. For both sexes combined, the percentage of adults who smoke is lower among adults aged 65 years and over (9.5%) than among adults aged 18–44 years (23.9%) and 45–64 years (21.9%). This pattern in current smoking by age group was observed in both men and women. For the age groups 18–44 years and 45–64 years, men are more likely than women to be current smokers[18].

The etiology of smoking in many instances begins at an early age, typically during adolescence. In fact, the majority of smokers began smoking in their early to mid teens, with some children beginning as early as third grade. The U.S. Surgeon General notes that of the adults who had tried a cigarette, 88% had done so by the age of 18 years, while 71% of daily smokers had become smokers before reaching 18 years[18]. Over 350,000 children under the age of 18 become regular, daily smokers each year[18]. Every day in the US approximately 4,000 youths age 12 to 17 smoke their first cigarette; of these, about 1,000 become daily cigarette smokers[56].

Cigarette advertising exposure in movies and video games, as well as peer pressure, attempting to be rebellious or mature, social bonding, and parental smoking all account for adolescent tobacco use. Surveys of children and adolescents found that young people ages 12 to 17 were more likely to smoke if they witnessed their favorite stars doing so in movies. Tobacco companies aggressively advertise to young people knowing that most individuals begin smoking regularly before the age of 18. Recent trends suggest that adolescent girls represent a particular risk, as they initiate smoking more frequently than in the past. While more adult men than women smoke, the gap is closing, and the prevalence of smoking rates for girls is already equal to that of boys[32]. Recent data also suggests that smoking among African-American and Hispanic adolescents has increased in the 1990s after several years of decline[9].

Among adults, the tobacco burden is distributed unequally in various ethnicities and geographies[15] and disparities are linked to several different factors such as environment and socioeconomic status. Smoking rates remain higher in Alaskan natives and American Indians. The age-sex-adjusted prevalence of current smoking was 14.5% for Hispanic persons, 22.8% for non-Hispanic white persons, and 21.9% for non-Hispanic black persons in 2008. Non-hispanic

white adults and non-Hispanic black adults were more likely than Hispanic adults to be current smokers. Smoking rates have been lower for minority women than for non-Hispanic whites, but minority women may still be at increased risk of developing smoking-related diseases. Individuals living below the poverty line, as well as in individuals with less than high school education[9] also represent a particular disparity because they have higher smoking rates. Smoking rates are also higher in individuals with psychiatric conditions and substance abuse issues[41].

2.2 RISKS ASSOCIATED WITH CIGARETTE SMOKING

Tobacco use causes many diseases and health conditions, such as cardiovascular and respiratory disease, which kill approximately 443,000 people every year in the US[10]. There is evidence to causally link tobacco usage to cancers at 18 different organ sites[2]. Active tobacco smoking causes cancers not only of the lung, but also of the lower urinary tract including the renal pelvis and bladder, upper aero-digestive tract including oral cavity, pharynx, larynx, esophagus and pancreas[65]. In the US, tobacco causes nearly 30% of all cancer deaths and 87% of all lung cancer deaths, which total approximately 169,000 lives lost in 2009[2]. Smoking is related to each of the four leading causes of death within the US: heart disease, cancer, stroke and chronic obstructive pulmonary disease[55].

Cigarette smoking contributes to almost half a million deaths annually in the United States (see Figure 2.1). The three leading specific causes of smoking-attributable death in 2009 were lung cancer (128,922 per year), ischemic heart disease (126,005 per year), and chronic obstructive pulmonary disease (92,900 per year).[9] Among adults aged $\geq$35 years, 160,848

(41.0%) smoking-attributable deaths were caused by cancer, 128,497 per year (32.7%) by cardiovascular diseases, and 103,338 (26.3%) by respiratory diseases (excluding deaths from secondhand smoking and from residential fires). Additionally, smoking is responsible for nearly all (90%) of the US deaths per year from chronic obstructive pulmonary disease, an irreversible condition blocking airways and obstructing breathing (See Figure 2)[9].

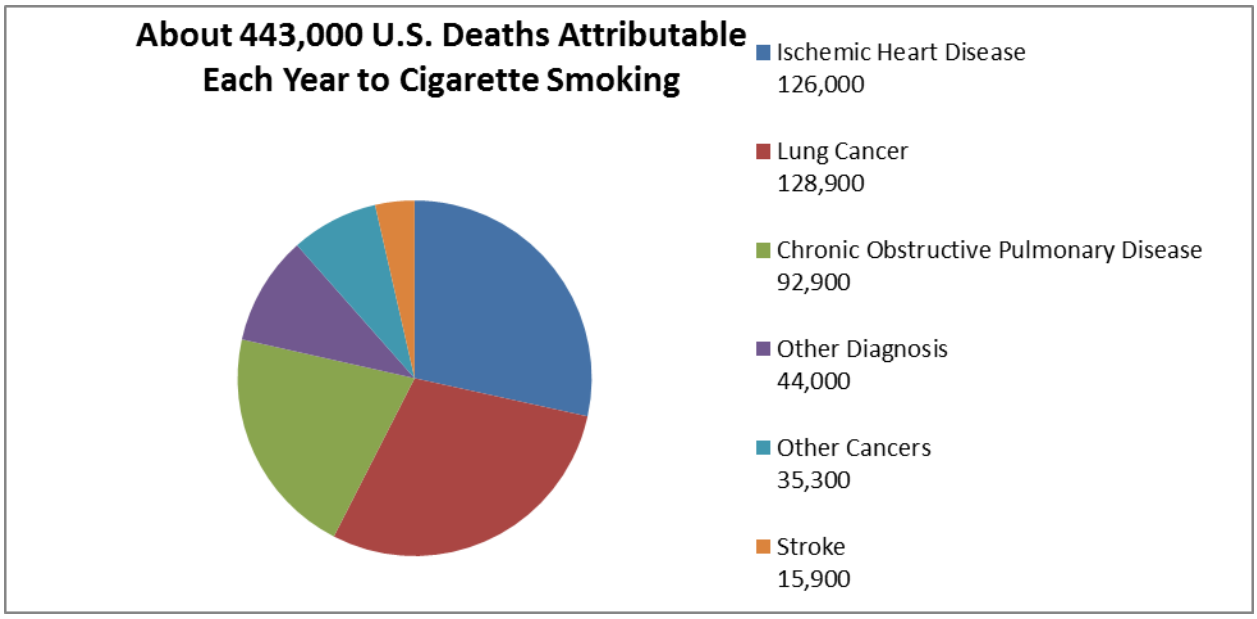

Figure 2 Deaths attributed to smoking each year

Smokers also experience higher levels of chronic inflammation, which is another damaging process that may result from oxidative stress[19]. For women, smoking increases the risk for infertility, preterm delivery, stillbirth, low birth weight, and sudden infant death syndrome (SIDS). Postmenopausal women who smoke have lower bone density than women who never smoked, which increases the risk of osteoporosis; women who smoke have an

increased risk for hip fracture than those who have never smoked[9]. Lung cancer has surpassed breast cancer as the leading cause of cancer death in women[2], and smoking has also been linked with cancer of the cervix when combined with oral contraceptives poses an even greater risk for heart disease in women. It is possible that smoking poses added risks for minority and disadvantaged women. Non-hispanic black women are disproportionately affected by several conditions that are exacerbated by smoking, including hypertension, diabetes, and delivery of low-birth weight infants[5].

2.3 SMOKING AND NICOTINE ADDICTION

Cigarettes make up the largest share of tobacco products in the world, but there are many forms of tobacco use including pipes, snuff/snus, dipping tobacco and powder tobacco for inhaling. Regardless of the form, all tobacco products exist to deliver nicotine, which is a very powerful and addictive drug. The 1988 Surgeon General's report on nicotine stated that pharmacologic and behavioral characteristics that determine tobacco addiction are similar to those that determine addiction to drugs such as heroin and cocaine. Of students who smoke at least once daily, 86.8% are chemically dependent under the DSM IV mental health standards[16]. Some studies have shown that tobacco can be more difficult to stop using than heroin or cocaine. Nicotine reserves in the body decline by about half every two hours; this determines mandatory nicotine "feeding" times, and if not met, the severe cravings begin[1].

2.4 TRADITIONAL METHODS USED TO QUIT SMOKING

Among the attempts that are made to quit smoking without the assistance of any type of NRT or behavioral therapy, only about 2% to 4% have a success rate of more than 12 months[57]. The known detrimental effects of cigarette smoking have created need for a variety of smoking cessation treatments and interventions. Today, individuals who wish to stop using tobacco have a wide variety of options, and can choose between pharmacological and behavioral treatments, or even a combination of the two. Cognitive behavioral techniques have focused on helping smokers to manage their reactions to lapses so that they can avoid relapses (a return to full blown smoking). However, cognitive behavioral relapse prevention has not been especially promising in doing so[39]. Formal smoking cessation programs of varying levels of intensity (minimal brief treatments to intensive, multi-session education and group participation) can be delivered through many different channels such as physician offices, hospitals, professional smoking cessation clinics and research studies.

Nicotine replacement therapy has become a popular stop-smoking option as it minimizes the harsh side effects often experience during nicotine withdrawal. Over the counter options such as the nicotine gum (Nicorette, Nicotrol) can be used as rescue medications or as part of gradual nicotine fading out over three months. The 2 mg dose is available for individuals who smoke less than 24 cigarettes per day, and the 4 mg dose is available for those who smoke more than 24 cigarettes a day. Common side effects can include minor mouth irritation or indigestion. The nicotine patch, marketed as Habitrol, Nicoderm, and CQ is a 24 hour patch which is applied in the morning. It is used once the individual stops smoking over a two month fading program. Side effects of the nicotine patch include skin irritation, sleep disruption, headache or nausea. The nicotine lozenge (Commit, other generic brands) is also available in two doses (2 mg, 4 mg),

and is used as a fading program over three months. Side effects include dizziness, sleep disruption, headache and nausea. The nicotine inhaler and nose spray, available by prescription only, offer a fading program over three to six months. Feelings of dependence, mouth/nose irritation, sleep disruption and nausea are common side effects[16].

Physicians can also prescription certain medications that have shown to help smoking cessation in clinical trials. Zyban (Wellburtrin SR, Bupriopion) can be used one week prior to quitting smoking and up to three months after quitting. Common side effects include sleep disruption, headache, nausea and dry mouth. Chantix received FDA approval in May of 2006, and has been available since August of 2006. This medication can be used while still smoking (up to one week) and up to 24 weeks after quitting smoking. Common side effects of Chantix include headache, nausea and flatulence[19]. Despite the many smoking cessation options and the fact that a majority of current smokers want to quit[47] only a small percentage are able to quit on their own[16]. Figure 3 shows the effectiveness of various cessation methods where cessation is defined as discontinuation of the habit of smoking, the inhaling and exhaling of tobacco smoke.

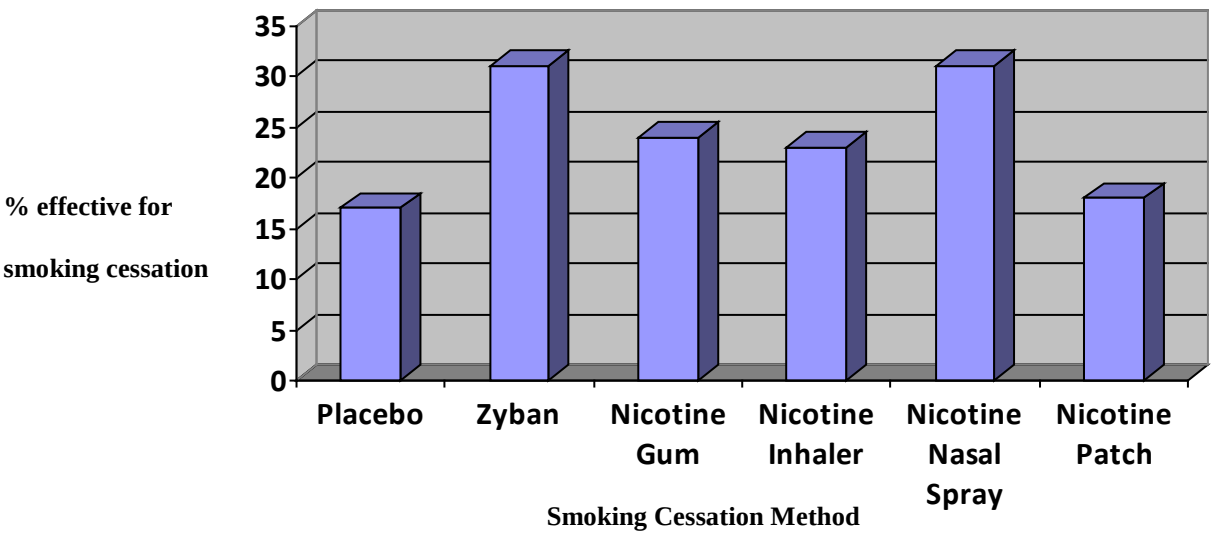

Figure 3 Effectiveness of Pharmacotherapy Smoking Cessation Methods

2.5 EFFECTS OF SMOKING CESSATION ON EXERCISE

Because smoking causes harm to nearly every organ in the body, it is not surprising that cigarette smoking hinders physical fitness even in young, fit people; smokers seem to present with lower physical endurance than nonsmokers overall[2]. Smoking's immediate health effects on the respiratory, cardiovascular, and immune and metabolic systems are particularly harmful to individuals who wish to remain or become physically fit. When the body performs physical activity it requires more oxygen to be delivered to the active muscles. Bronchospasms and increased phlegm production from smoking result in airway obstruction and decreased lung function, which leads to poor physical performance. Smoking has also been shown to stunt lung development in adolescent girls, limiting adult breathing capacity[56]. Smokers experience a

reduced performance when exercising, and adults experience a 4% decrease in oxygen uptake directly after smoking[20].

The benefits of physical activity have long been known to improve physical fitness and overall health. Exercise increases maximum oxygen consumption, capillary density and blood flow to active muscles. It also increases total blood volume, allows for maximal ventilation and increases lung diffusion capacity. Exercise has been proposed as a means to assist with smoking cessation by clinicians, and some research has been conducted to determine the efficacy of exercise on smoking cessation. Taylor et al.[59] conducted a systematic review of thirteen studies which focused on various exercise interventions for smoking cessation. Included in this review was a trial conducted by Marcus et al.[38]. Marcus et al. examined exercise as an aid for smoking cessation in women noting that smoking prevalence among women were declining at a slower rate than men[38]. Two hundred eighty-one healthy, sedentary smokers took part in the study. The exercise group participated in three supervised vigorous exercise sessions per week for 12 weeks. Smoking abstinence was based on self-report and verified by measuring saliva cotinine levels. The exercise group was found to have significantly higher levels of continuous abstinence at the end of the trial (19.4% vs 10.2%, P=.03) , at a 3 month follow-up (16.4% vs 8.2%, P=.03) and at a 12 month follow-up (11.9% vs 5.4%, P=.05).

Overall, Marcus et al.[38] found that vigorous exercise facilitated both short and long term smoking cessation for women. Marcus et al. also examined the effect of moderate intensity exercise as an aid for smoking cessation in women (N = 217)[36]. At the end of the trial, the exercise and control groups were equally likely to have achieved smoking cessation. However, at the three month follow-up, the exercise group was more likely to report smoking cessation. It was also noted that among exercise participants, those who more closely adhered to the exercise

prescription were significantly more likely to report cessation by the study's end. At a twelve month follow-up, however, no group differences were found.

A final study conducted by Taylor et al. found that the effects of a single session of exercise could help to control cigarette cravings, withdrawal symptoms and overall smoking behavior[59]. This finding suggests that even small doses of exercise could have a positive impact on smokers as they attempt to quit smoking and move toward a healthier lifestyle. Similarly, Taylor et al. also analyzed cravings and withdrawal symptoms in 60 regular smokers who were randomized to either a 15-minute brisk walking group or a passive group[59]. Results showed that absolute levels of the cravings and withdrawal symptoms were reduced both during and following exercise. Participants assigned to the walking group engaged in smoking almost an hour (57 minutes) later than participants who had been assigned to the passive condition.

The thirteen studies reviewed by Taylor et al. varied in length and in exercise intensity and type[59]. Some of the trials also included an educational stop-smoking component and/or nicotine replacement therapy. Because of these differences, a review and not a meta analysis was conducted. Many of the sample sizes were small with six of the studies having had less than 25 subjects per arm. Seven of the studies included women only; one of the trials focused only on men. Results showed that these three studies had significantly higher abstinence rates in the physically active groups versus the control groups at the end of the trials.

Among the studies that showed favorable results, they also showed favorable results for the exercise group over the control group at a 3 month follow-up, and a borderline significance ($P = 0.5$) at the 12 month follow-up[45]. Another one of the studies with favorable results showed significantly higher abstinence rates for the exercise group at the 3 month follow-up, but not at the 12 month follow-up. While ten of the studies reviewed in the Taylor et al. analysis did

not show a statistical significance for exercise as an effective aid to smoking cessation, five did show a trend for higher rates of abstinence in the exercise condition versus the controls[45].

Boutelle et al. examined associations between leisure-time exercise and various health behaviors including smoking[5]. The study had an adequate sample size of 4,907 females and 4,136 males, and focused adults (both male and female) in the work force; subjects completed surveys at 24 worksites in Minneapolis. Higher levels of leisure-time activity were inversely associated with smoking. Additionally, Boutelle et al. showed that associations between leisure-time exercise and positive health behaviors including smoking occurred at higher levels of exercise[5]. Similarly, Hu et al. found that leisure-time physical activity was inversely related to mean BMI and prevalence of smoking in both men and women in a large cross-sectional study (N = 3976) conducted in China[25]. Several other large cross-sectional surveys have pointed to an inverse relationship between smoking and physical activity[4][66][67]. Schroder et al. found that gender and intensity of exercise played a role in smoking status. Specifically, Schroder examined leisure-time physical activity and noted that among heavy smokers, only males showed an inverse relationship between smoking and physical activity.

While Taylor's et al. analysis of the thirteen studies did not yield overly favorable results for the efficacy of exercise as an aid to smoking cessation, a true comparison among the included studies was complicated due to the differences in study designs and cessation intervention specifics[45]. More research with larger sample sizes is needed to enhance the current literature. Future studies are needed to help establish whether exercise can provide additional benefits by enhancing abstinence compared to using NRT methods alone. One of the primary reasons smokers may face a relapse is due to the harsh withdrawal symptoms such as depression, irritability, restlessness, poor and concentration. If exercise could play an important role in the

acute management of such withdrawal symptoms, then the incorporation of a routine exercise program into traditional smoking cessation programs may have the ability to become an even more powerful aid than using NRT alone[59].

2.6 SUMMARY

Cigarette smoking is a pressing public health problem, which must be addressed in order to reduce morbidity and mortality in the US and worldwide. Unfortunately, the overwhelming majority of smokers who attempt to quit using *any* method or delivery channel are unsuccessful. While many smoking cessation efforts have focused on the psychological and physical effects of nicotine addiction, no significant, long-term research has been conducted focusing on the physical benefits of using exercise as a means to help smokers quit. Physical exercise may greatly assist smokers in quitting by diminishing the withdrawal effects of nicotine and increasing self-efficacy, and may have the ability to help reduce post-smoking cessation weight gain as demonstrated by Kawachi et al.[33]. While the Taylor et al. review demonstrated that only three of the thirteen studies showed physical activity as being statistically correlated with reductions in smoking, exercise as an effaceable aid to smoking cessation cannot be discounted[59]. More research is needed to determine the possibility and extent of the benefits that could be reached by incorporating regular physical activity into current quit-smoking interventions.

Effective, successful quit-smoking treatments are absolutely vital to limiting the number of future smoking related mortalities within the US and worldwide, and to expand the evidence base and improve treatment options for current smokers. Several of the studies reviewed in the

Taylor et al. analysis showed the favorable results of exercise as an aid to smoking cessation as having decreased over time[45]. It is important to understand why this may be the case in order to create effective interventions that work to achieve long-term smoking cessation to promote healthy lifestyles and curb premature death. Promoting higher levels of exercise as a life style change and not just as a temporary intervention component could prove to be a promising means for aiding in long-term smoking cessation.

3.0 METHODS

3.1 BRIEF DESCRIPTION OF MAIN STUDY PROVIDING DATA FOR SECONDARY ANALYSIS

The current study examines the impact of leisure-time physical activity on smoking rates in adult smokers after a short-term behavioral quit-smoking intervention. Data for this study are derived from a larger sample of subjects who participated in an NIH-funded study[51]. The main study from which these data are derived focused on relapse rates in adult cigarette smokers. Specifically, the study created a model of relapse in adult smokers to experimentally create a lapse (resumption in smoking) after a period of programmed abstinence; the study then measured time to relapse over a 14-day follow-up period. The primary aim of the main study was to determine whether lapse is causally related to relapse and what the mediating roles of self-efficacy and smoking outcome expectancies are in this relationship in order to improve upon current relapse prevention theory, and to ultimately create more effective smoking cessation programs.

The main study screened 931 subjects and of these, 222 were eligible participants. One hundred-sixty-one subjects attended the first session and were enrolled in the study, but 80 were not eligible to be randomized due to inadherance to the protocol (did not stop smoking for 48 hours). The 81 participants who were eligible for randomization were assigned to one of two

experimental conditions: 1) smoke condition or 2) non-smoke condition. (See Figure 4 Consort Diagram).

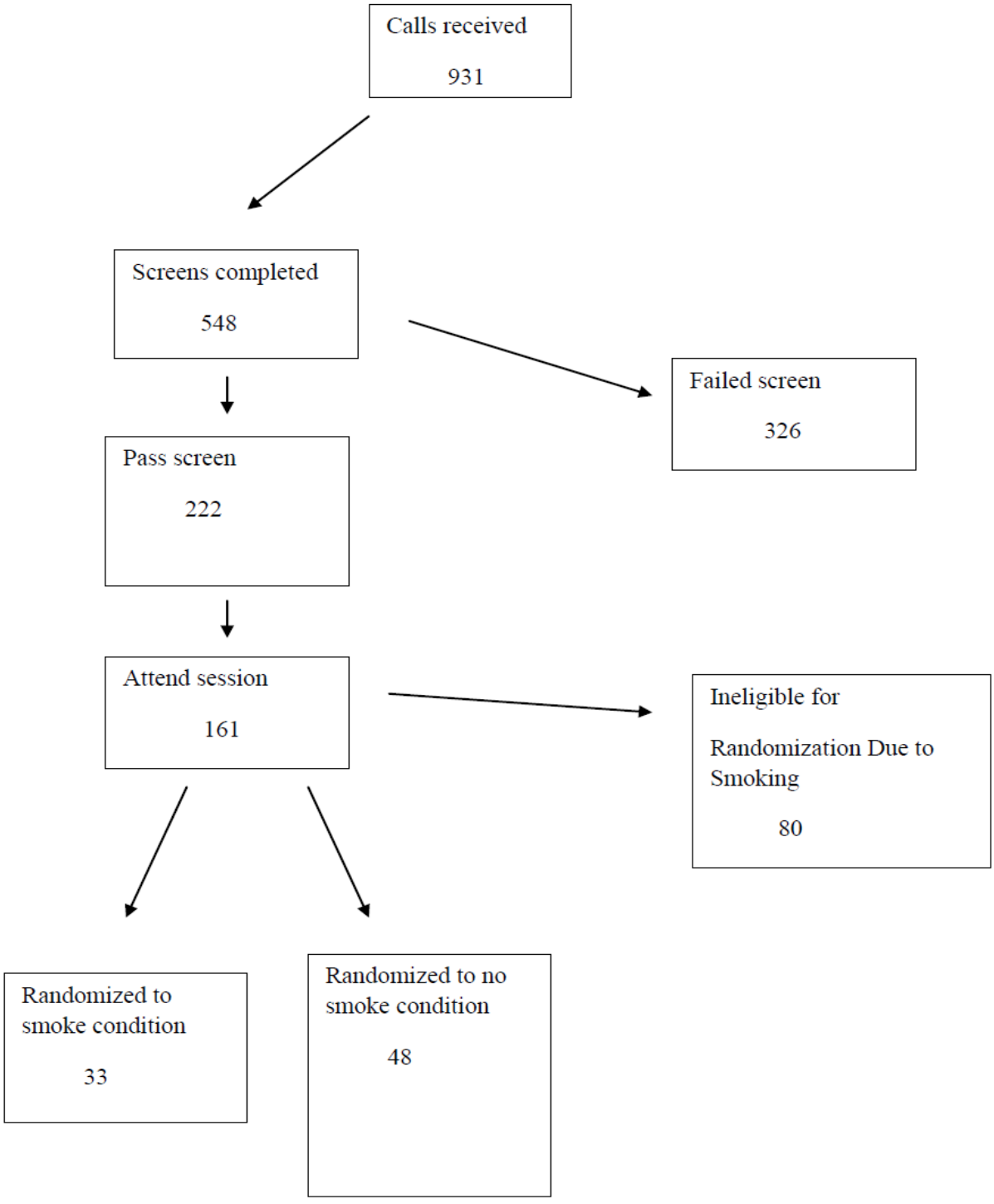

Figure 4 Consort Diagram

Subjects assigned to the non-smoke condition provided data for the secondary analysis as part of this proposed study. Forty-eight (N=48) subjects were assigned to the non-smoke experimental condition, with 21 subjects failing to provide complete data (dropped out or missed an experimental session), resulting in 27 subjects contributing data that is used in this study.

Subjects attended a 90-minute baseline session during which a carbon monoxide breath sample was taken and measured in parts per million (ppm). Multiple measures were administered including demographics, smoking history, nicotine dependence, other substance use, self-efficacy to quit smoking, smoking outcome expectancies, withdrawal symptoms, mood, and the Godin leisure-time physical activity questionnaire (see Appendix E for a detailed list of scales used in the main study). Subjects were provided a brief (30 minute) behavioral stop-smoking intervention (see Appendix C) and instructed to stay abstinent from smoking for the next 48 hours without using the assistance of any type of outside cessation program, nicotine replacement therapy or medication. Following this 48 hour period, subjects attended daily, in-person, individual appointments for a period of three weeks. The baseline session was 90 minutes while each follow-up session lasted approximately 15—20 minutes. On day three, subjects randomized to the non-smoke condition were instructed not to smoke for the duration of the study. All participants were offered a free clinical treatment after they exited the experimental portion of the study. The study flow is illustrated in Figure 5.

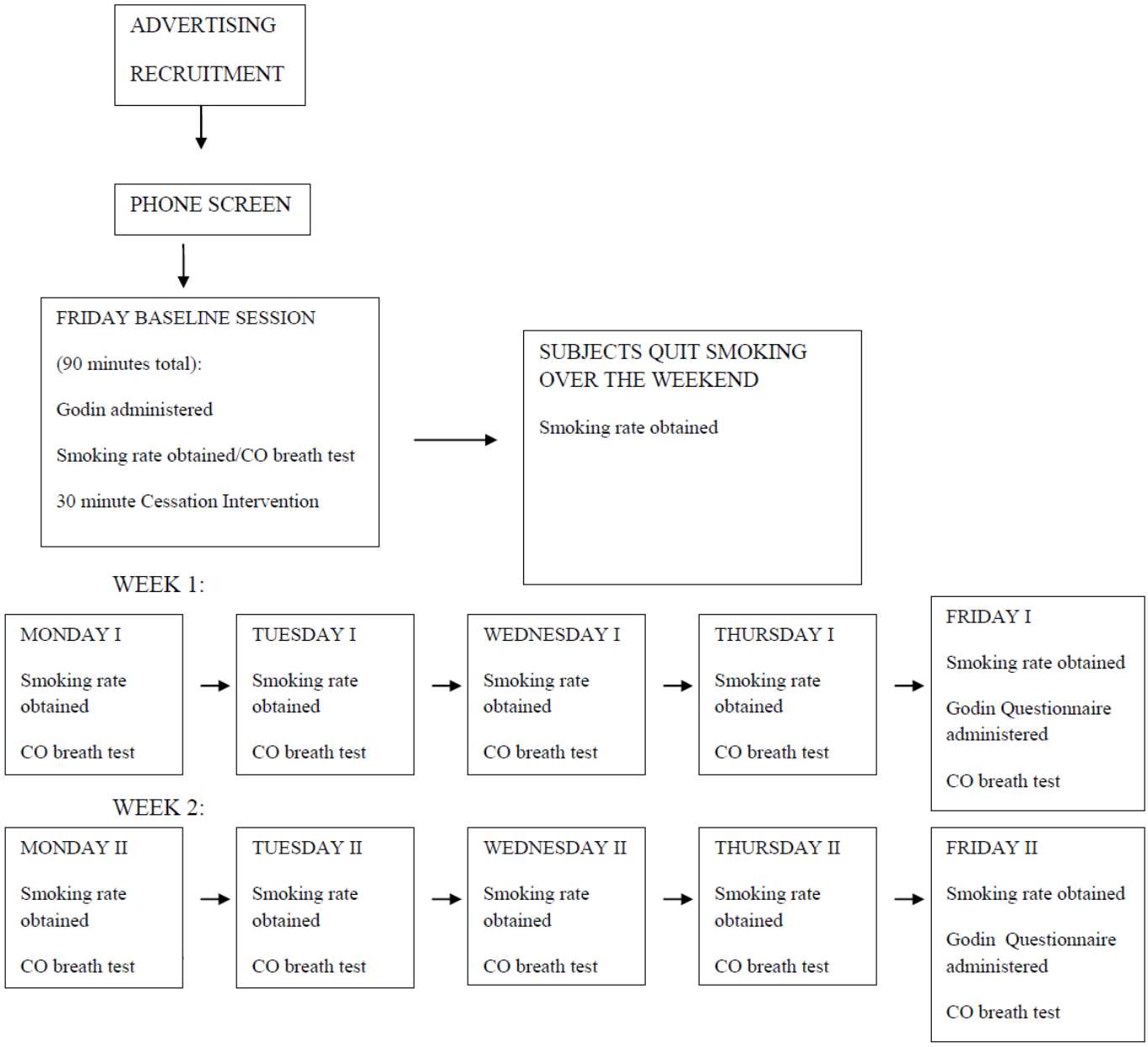

Figure 5 Conceptual Model for Flow of Study Participants

All intervention procedures, questionnaires and consent forms were approved by the Human Subject Protection Committee (HSPC) at the RAND Corporation in Pittsburgh. All baseline and follow up sessions were conducted at the RAND Corporation's Pittsburgh office. RAND is a private nonprofit research institution established in 1948 to conduct independent, objective research and analysis. Written informed consent was obtained from all participants prior to participation in the study (Appendix F). The study was also approved as exempt by the University of Pittsburgh Institutional Review Board.

3.2 SUBJECTS

Twenty-seven subjects who were randomly assigned to the non-smoke experimental condition in the main study will provide data for this study. To be eligible, subjects had to report smoking ≥ 15 cigarettes per day for a minimum of 5 years, and be between the ages of 18 and 65 years. To be eligible, the individual had to report a score of 7-10 on a 10-point Readiness to Quit Ladder, which corresponds to a response of "I definitely plan to quit smoking in the next 30 days." Additional exclusion criteria included the following:

1. Failure to quit smoking for 48 hours prior to randomization to the "smoke" or "non-smoke" condition.
2. Scores ≥ 120 on motivation/confidence readiness to quit smoking scale (0—200).
3. Currently being treated or receiving medication for bipolar disorder, dementia, schizophrenia

4. A serious psychological condition that would make it difficult to complete the procedures of the main study.
5. A history of heart attack or stroke.
6. Is pregnant or planning to become pregnant within the next 30 days
7. Reports the presence of any of the following within the previous 12 months:
    a. Arrhythmia/heart palpitations/heart or atria afibrulation
    b. Atherosclerosis/hardening of the arteries
    c. Coronary Heart Disease
    d. Congestive Heart Failure (CHF)/Congestive heart disease
    e. Chest pain/Angina Pectoris
    f. Cancer of any type
    g. Diabetes
    h. Chronic bronchitis, emphysema/chronic obstructive pulmonary disease, or severe asthma
    i. Hypertension
    j. Any other medical condition requiring ongoing treatment

3.3 RECRUITMENT

The subjects in this study were recruited through various media sources including print advertisements in daily and weekly newspapers as well as flyers in order to cover a diverse population base. Recruitment advertisements stated that smokers who were motivated to quit smoking were being recruited to participate in the study (see text for recruitment

flyer/advertisement Appendix D). Potential participants were directed to contact the Research Assistants at the RAND Corporation at the phone number provided. A brief phone interview and screening via an HSPC-approved script was conducted in order to determine eligibility. Eligible individuals were invited to participate in the study, and were scheduled for a baseline session. Interested participants who provided written informed consent completed demographic information including height, weight, age, ethnicity, education, number of years smoked, current daily smoking rate (Appendix A), the Godin Leisure-time exercise questionnaire (Appendix B), and number of cigarettes smoked at their heaviest (smoking history; Appendix E)

3.4 ASSESSMENT PROCEDURES

The following procedures were used to assess the outcomes of this study.

1. Smoking Status: Smoking status was determined in two ways. Subjects self-reported number of cigarettes smoked (if any) at baseline and at each daily visit. A carbon monoxide breath test was also administered at baseline and at all follow up visits as an objective measure used to confirm whether or not the subject had smoked within the last 24 hours. If a subject had a reading of 10 parts per million (ppm), he or she was determined to have smoked within the previous 24 hours regardless of self-report.

2. Physical Activity: The Godin Leisure-Time Exercise Questionnaire was used to assess physical activity. This questionnaire was completed weekly on every Friday at (1) baseline, (2) week one and (3) week two, and provides information about light, moderate and vigorous exercise. Reliability studies of the Godin questionnaire show that it is a

simple and reliable method to assess exercise behavior in the community[22]. Subjects completed a brief four item query of usual leisure-time exercise habits and gave verbal descriptors of these categories reporting how many times on average that they participated in: (1) vigorous (2) moderate and (3) mild exercise for more than 15 minutes in the previous 7 days. The last item asks subject to indicate how often they engage in any regular activity long enough to work up a sweat where the heart beats rapidly (see Appendix B for scoring mechanism).

Height, and Weight, and BMI: Subjects self-reported height in feet/inches and weight in pounds respectively. While direct measurement is preferred, self-reported height and weight has been shown to be valid. Spencer et al. found that self-reported height and weight data are valid for identifying relationships in epidemiological studies. These data were used to compute BMI (kg/m^2) as weight represented in kilograms divided by height represented in meters squared, and used to calculate Body Mass Index[55]. While directly measure height and weight is preferable and more precise, self-reported data is very easy to obtain and assess at no cost.

3.5 DATA ANALYSIS

Data were analyzed using SPSS statistical software version 17.0. Descriptive data are presented as mean ± standard deviation. Difference between men and women for baseline demographic were analyzed using independent t-tests. Change in physical activity and smoking from baseline to week 1 and week 2 along with potential differences by gender were analyzed using a series of two-factor (Gender X Time) repeated measures analysis of variance. Correlations between

smoking and physical activity variables were computed using Pearson Correlation Coefficients and Spearman Rank Order Coefficients. Because there was no difference in the pattern of the findings only the Pearson Correlation Coefficients are presented in the Results section of this document. Linear regression was used to further examine the relationship between smoking and physical activity variables controlling for gender and body mass index.

3.6 POWER ANALYSIS

The primary hypotheses in this study were examined using linear regression and represented as correlation coefficients. The power analysis was conducted based on the sample size available for this study for examination of the relationships of interested in this investigation. The power analysis was conducted to determine if the 27 subjects available for this study would provide adequate statistical power to examine the primary hypotheses in this study. Statistically significant correlations of 0.50 are able to be detected with at least 0.80 statistical power at a two-tailed alpha of 0.05 with a sample of 27 subjects. Statistically significant correlations of 0.60 are able to be detected with at least 0.80 statistical power at a two-tailed alpha of 0.05 with 17 subjects. Statistically significant correlations of 0.70 are able to be detected with at least 0.80 statistical power at a two-tailed alpha of 0.05 with 11 subjects.

4.0 RESULTS

The purpose of this study was to examine the association between leisure-time activity levels and frequency of cigarette smoking over a two week period of a smoking cessation program. Body mass index (BMI) and gender were also examined to the influence that the variables may have on the association between leisure-time physical activity and smoking frequency in this study. Activity level was measured at baseline, during week one and week two. Smoking was assessed for week one and week two.

4.1 SUBJECT CHARACTERISTICS

Data from 27 adult subjects (10 men, 17 women) provided complete data at baseline. Average age of the subjects was 45.13years (SD= 0.22), with a mean BMI of 25.89 kg/m^2. Sixty percent of the subjects were women. Baseline descriptive statistics are presented in Table 1 for the 27 individuals who have complete data for all of these variables. Data are presented by gender in Table 2. As shown in the table, men were significantly ($p<0.05$) taller and weighed more than women. However, there were no difference between men and women for age, BMI, cigarettes smoked per day, or physical activity as measured by the Godin Questionnaire at baseline.

Table 1 Characteristics of Subjects at Baseline (N=27)

Variable	Mean ± Standard Deviation	Range
Age (years)	44.4±10.6	23.0-60.0
Height (cm)	172.5±10.7	154.9-193.0
Body Weight (kg)	81.1±15.0	54.0-108.9
BMI (kg/m^2)	27.2±4.3	19.8-35.5
Cigarettes (per day)	23.6±10.8	10-60
Physical Activity		
Vigorous Activity (episodes per week)	2.8±2.0	1-7
Moderate Activity (episodes per week)	4.0±2.5	1-8
Sweat Episodes (Often/Sometimes/Never)	2.0±0.5	1-3

Table 2 Comparison of baseline characteristics between women and men

Variable	Women (N=17)	Men (N=10)	P-Value for Difference Between Women and Men
Age (years)	44.2±11.0	44.9±10.4	0.868
Height (cm)	165.8±5.6	183.9±6.9	<0.001*
Body Weight (kg)	76.8±15.3	88.5±12.0	0.050*
BMI (kg/m^2)	27.8±4.9	26.1±2.6	0.242
Cigarettes (per day)	25.2±12.3	20.7±7.1	0.299
Physical Activity			
Vigorous Activity (episodes per week)	2.4±2.0	3.4±1.8	0.214
Moderate Activity (episodes per week)	4.4±2.8	3.3±2.1	0.309
Sweat Episodes (Often/Sometimes/Never)	2.1±0.6	2.0±0.5	0.782

4.2 CHANGE IN PHYSICAL ACTIVITY AND SMOKING

Data were analyzed to examine the change in physical activity by gender across the 2 week period using a two-factor (Time X Gender) repeated measures analysis of variance (RANOVA). Data analysis was performed on 25 subjects who provided physical activity data at the three collection periods for this study, with results presented in Table 3. Results showed no significant change in physical activity for episodes of vigorous activity or for sweat episodes, and this did not differ by gender. There was a significant change ($p=0.009$) in episodes of moderate activity with this increasing from 3.9±2.4 episodes per week at baseline to 4.7±2.5 episodes per week in week 1 and then decreasing to 3.3±2.4 episodes per week in week 2. There was also a significant decrease in number of days of sweat episodes from baseline (2.0±0.5) to week 2 (1.7±0.7) ($p=0.022$). The patterns observed for episodes of moderate activity or days of sweat episodes did not differ by gender.

Data were analyzed to examine the change in physical activity by gender across the 2 week period using a two-factor (Time X Gender) RANOVA. Data analysis was performed on 20 subjects who provided smoking data at the three collection periods for this study, with results presented in Table 3. Results showed significant time effect for smoking with reported cigarettes smoked per day being 24.0±12.3 at baseline, 3.1±4.6 during week 1, and 6.0±7.7 during week 2. There was no significant effect of gender on rates of cigarette smoking.

Table 3 Change in physical activity and smoking across the two week study period.

Variable	Gender	Baseline	Week 1	Week 2	Gender Effect	Time Effect	Gender X Time Effect
Physical Activity – Vigorous Episodes per week	Men (N=10)	3.4±1.8	2.6±1.7	2.8±1.8	0.590	0.878	0.322
	Women (N=15)	2.3±2.0	2.8±2.3	2.5±2.4			
Physical Activity – Moderate Episodes per week	Men (N=10)	3.3±2.1	4.7±2.5	3.0±1.3	0.544	0.009*	0.551
	Women (N=15)	4.3±2.6	4.7±2.7	3.5±2.9			
Physical Activity – Sweat Episodes (Often/Sometimes /Never)	Men (N=10)	2..0±0.5	1.8±0.8	1.7±0.7	0.723	0.022	0.907
	Women (N=15)	2.1±0.6	1.9±0.7	1.8±0.7			
Cigarettes Smoked per Day	Men (N=7)	21.4±8.5	4.3±5.9	8.4±9.7	0.835	<0.001	0.363
	Women (N=13)	25.4±14.1	2.4±3.8	4.7±6.5			

4.3 CORRELATIONS BETWEEN BASELINE PHYSICALACTIVITY AND SMOKING

The correlations between baseline physical activity and smoking are presented in Table 4. To maximize the amount of data available, subjects with the data for the variables of interest were included for each of the computed correlations, which accounts for the varying samples sizes for each of the correlations presented. Data were analyzed using Baseline total physical activity

level, which was not associated with smoking for week one. When analyzed by physical activity category, vigorous physical activity revealed a trend towards being associated with cigarettes smoked during week one (r=-0.350, p=0.080). Moderate activity was not significantly associated with cigarettes smoked during week one. Total and categories of baseline leisure-time physical activity was not significantly associated with smoking during week two. Moreover, total and categories of baseline physical activity were not significantly associated with total smoking over the two week period of this study. Because of a data collection error at baseline, data on mild activity were not available and therefore have been excluded from these analyses.

Table 4 . Correlations between baseline physical activity and smoking.

	Sweat Activity	**Episodes of Vigorous Activity**	**Episodes of Moderate Activity**
Cigarettes Smoked in Week 1	-0.093 (p= 0.651) N = 26	-0.350 (p= .080) N = 26	-0.246 (p= 0.226) N = 26
Cigarettes Smoked in Week 2	-0.069 (p= 0.765) N = 21	-0.206 (p= 0.370) N = 21	-0.193 (p= 0.403) N = 21
Cigarettes Smoked in Weeks 1 and 2	-0.064 (p= 0.790) N = 20	-0.290 (p= 0.215) N = 20	-0.254 (p= 0.279) N = 20

4.4 CORRELATIONS BETWEEN WEEK ONE PHYSICAL ACTIVITY AND SMOKING

The correlations between week one physical activity and smoking are presented in Table 5. To maximize the amount of data available, subjects with the data for the variables of interest were included for each of the computed correlations, which accounts for the varying samples sizes for each of the correlations presented. Baseline total physical activity level was not associated with smoking for week one. When analyzed by physical activity category, the correlation between vigorous physical activity and cigarettes smoked in week one was (r=-0.303, p=0.133). Moderate activity and mild activity were not significantly associated with cigarettes smoked during week one, week 2, or combined smoking for weeks one and two. Frequency of sweat episodes for week 1 was not significantly correlated with cigarettes smoked during week 1, week 2, or combined cigarettes smoked for weeks one and two.

Table 5 Correlations between physical activity during week 1 and smoking.

	Sweat Activity	**Episodes of Vigorous Activity**	**Episodes of Moderate Activity**	**Episodes of Mild Activity**
Cigarettes Smoked in Week 1	0.004 (p= 0.984) N = 26	-0.303 (p= 0.133) N = 26	0.025 (p= 0.905) N =25	-0.220 (p= 0.352) N = 20
Cigarettes Smoked in Week 2	-0.080 (p= 0.731) N = 21	-0.273 (p= 0.232) N = 21	0.062 (p= 0.759) N = 20	-0.148 (p= 0.586) N = 16
Cigarettes Smoked in Weeks 1 and 2	-0.046 (p= 0.848) N = 20	-0.329 (p= 0.157) N = 20	0.031 (p= 0.898) N = 19	-0.197 (p= 0.481) N = 15

4.5 CORRELATIONS BETWEEN WEEK TWO ACTIVITY AND SMOKING

The correlations between week two physical activity and smoking are presented in Table 6. To maximize the amount of data available, subjects with the data for the variables of interest were included for each of the computed correlations, which accounts for the varying samples sizes for each of the correlations presented. Baseline total physical activity level was not associated with smoking for week two. When analyzed by physical activity category, vigorous physical activity was not associated with cigarettes smoked during week two. Moderate activity and mild activity were not significantly associated with cigarettes smoked during week two. Total and categories of baseline leisure-time physical activity were not significantly associated with smoking during week two. Total and categories of baseline physical activity were not significantly associated with total smoking over the two week period of this study.

Table 6 Correlations between physical activity during week 2 and smoking.

	Sweat Activity	**Episodes of Vigorous Activity**	**Episodes of Moderate Activity**	**Episodes of Mild Activity**
Cigarettes Smoked in Week 1	-0.175 (p= 0.404) N = 25	-0.276 (p= 0.192) N = 24	-0.112 (p= 0.602) N = 24	0.077 (p= 0.749) N = 20
Cigarettes Smoked in Week 2	-0.204 (p= 0.389) N = 20	-0.240 (p= 0.323) N = 19	-0.108 (p= 0.659) N = 19	0.101 (p= 0.709) N = 16
Cigarettes Smoked in Weeks 1 and 2	-0.179 (p= 0.465) N = 19	-0.286 (p= 0.251) N = 18	-0.144 (p= 0.569) N = 18	0.057 (p= 0.841) N = 15

4.6 EFFECT OF BMI ON THE ASSOCIATION BETWEEN PHYSICAL ACTIVITY AND SMOKING

The BMI for each of the subjects included in this study are shown in Figure 6. Based on these data 29.6% of the subjects were classified as normal weight (BMI ranging from 18.5 to <25.0 kg/m^2), 40.7% were classified as overweight (BMI ranging from 25.0 to <30.0 kg/m^2), 25.9% were classified as Class I obese (BMI ranging from 30.0 to <35.0 kg/m^2), and 3.7% were classified as Class II obese (BMI ranging from 35.0 to <40 kg/m^2).

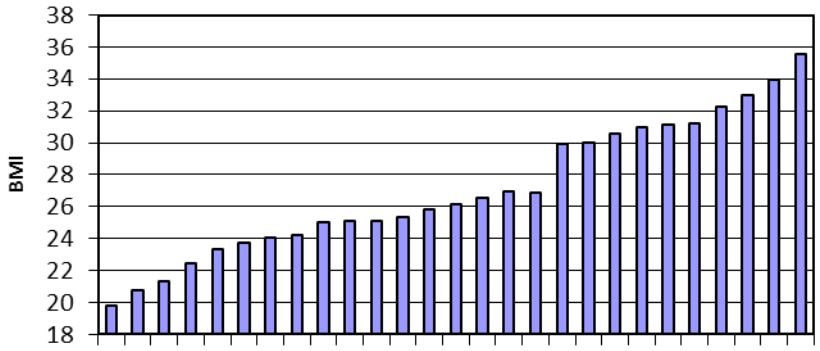

Figure 6 Body Mass Index for each participant (N=27).

Correlations between physical activity and smoking were computed controlling for baseline BMI. Compared to the results presented above in Tables 7, 8, and 9, controlling for baseline BMI did not influence the pattern of the associations observed. Correlations between baseline physical activity and smoking controlling for BMI are presented in Table 7. Correlations between physical activity during week 1 and smoking controlling for BMI are

presented in Table 8. Correlations between physical activity during week 2 and smoking controlling for BMI are presented in Table 9.

Table 7 Correlations between baseline physical activity and smoking controlling for body mass index.

	Sweat Activity	**Episodes of Vigorous Activity**	**Episodes of Moderate Activity**
Cigarettes Smoked in Week 1	-0.106 (p=0.621) N=22	-0.335 (p=0.110) N=22	-0.290 (p=0.169) N=22
Cigarettes Smoked in Week 2	-0.075 (p=0.755) N=18	-0.188 (p=0.426) N=18	-0.209 (p=0.377) N=18
Cigarettes Smoked in Weeks 1 and 2	-0.071 (p=0.773) N=17	-0.269 (p=0.265) N=17	-0.279 (p=0.247) N=17

Table 8 Correlations between physical activity during week 1 and smoking controlling for body mass index.

	Sweat Activity	**Episodes of Vigorous Activity**	**Episodes of Moderate Activity**	**Episodes of Mild Activity**
Cigarettes Smoked in Week 1	0.047 (p=0.826) N=22	-0.303 (p=0.150) N=22	-0.015 (p=0.946) N=21	-0.239 (p=0.340) N=16
Cigarettes Smoked in Week 2	-0.060 (p=0.802) N=18	-0.267 (p=0.255) N=18	0.043 (p=0.863) N=17	-0.154 (p=0.585) N=13
Cigarettes Smoked in Weeks 1 and 2	-0.018 (p=0.943) N=17	-0.324 (p=0.176) N=17	0.004 (p=0.989) N=16	-0.208 (p=0.476) N=12

Table 9 . Correlations between physical activity during week 2 and smoking controlling for body mass index.

	Sweat Activity	Episodes of Vigorous Activity	Episodes of Moderate Activity	Episodes of Mild Activity
Cigarettes Smoked in Week 1	-0.171 (p=0.434) N=21	-0.274 (p=0.218) N=20	-0.157 (p=0.485) N=20	0.026 (p=0.917) N=16
Cigarettes Smoked in Week 2	-0.197 (p=0.419) N=17	-0.232 (p=0.355) N=16	-0.130 (p=0.607) N=15	0.072 (p=0.800) N=13
Cigarettes Smoked in Weeks 1 and 2	-0.170 (p=0.500) N=16	-0.277 (p=0.282) N=15	-0.175 (p=0.501) N=15	0.013 (p=0.964) N=12

4.7 EFFECT OF GENDER ON ASSOCIATION BETWEEN PHYSICAL ACTIVITY AND SMOKING

Correlations between physical activity and smoking were computed controlling for gender. Compare to the results presented above in Tables 4., 5, and 6, controlling for gender did not influence the pattern of the associations observed. Correlations between baseline physical activity and smoking controlling for gender are presented in Table 10. Correlations between physical activity during week 1 and smoking controlling for gender are presented in Table 11. Correlations between physical activity during week 2 and smoking controlling for gender are presented in Table 12.

Table 10 Correlations between baseline physical activity and smoking controlling for gender.

	Sweat Activity	**Episodes of Vigorous Activity**	**Episodes of Moderate Activity**
Cigarettes Smoked in Week 1	-0.090 (p=0.674) N=22	-0.385 (p=0.063) N=22	-0.245 (p=0.249) N=22
Cigarettes Smoked in Week 2	-0.058 (p=0.808) N=18	-0.279 (p=0.233) N=18	-0.153 (p=0.520) N=18
Cigarettes Smoked in Weeks 1 and 2	-0.052 (p=0.832) N=17	-0.367 (p=0.122) N=17	-0.218 (p=0.370) N=17

Table 11 Correlations between physical activity during week 1 and smoking controlling for gender.

	Sweat Activity	**Episodes of Vigorous Activity**	**Episodes of Moderate Activity**	**Episodes of Mild Activity**
Cigarettes Smoked in Week 1	0.010 (p=0.963) N=22	-0.307 (p=0.144) N=22	0.023 (p=0.916) N=21	-0.227 (p=0.366) N=16
Cigarettes Smoked in Week 2	-0.058 (p=0.807) N=18	-0.281 (p=0.230) N=18	0.055 (p=0.824) N=17	-0.176 (p=0.531) N=13
Cigarettes Smoked in Weeks 1 and 2	-0.024 (p=0.923) N=17	-0.338 (p=0.156) N=17	0.023 (p=0.927) N=16	-0.226 (p=0.437) N=12

Table 12 Correlations between physical activity during week 2 and smoking controlling for gender.

	Sweat Activity	**Episodes of Vigorous Activity**	**Episodes of Moderate Activity**	**Episodes of Mild Activity**
Cigarettes Smoked in Week 1	-0.180 (p=0.412) N=21	-0.287 (p=0.195) N=20	-0.107 (p=0.637) N=20	0.090 (p=0.723) N=16
Cigarettes Smoked in Week 2	-0.201 (p=0.410) N=17	-0.262 (p=0.294) N=16	-0.085 (p=0.738) N=16	0.117 (p=0.679) N=13
Cigarettes Smoked in Weeks 1 and 2	-0.175 (p=0.488) N=16	-0.309 (p=0.228) N=15	-0.122 (p=0.640) N=15	0.070 (p=0.811) N=12

5.0 DISCUSSION

5.1 INTRODUCTION

The prevalence of smoking and resulting health consequences in the US has led to the development of various quit-smoking methods including cognitive behavioral programs as well as nicotine replacement therapies in order to better assist smokers in quitting. However, there are limited studies conducted to examine potential benefits exercise as an effaceable aid for smoking cessation. Therefore, the primary purpose of the current investigation was to determine if leisure-time physical activity is associated with reductions in smoking rates during a two week period following and quit smoking attempt.

5.2 DISCUSSION

Baseline physical activity data show that the subjects participating in this study do not appear to be physically activity at a level that is consistent with the consensus public health recommendation for physical activity[45]. For example, the public health guidelines recommend moderate-to-vigorous activity on most days of the week. However, subjects in this study reported participating in a sufficient dose of physical activity to resulting in sweating 1 to 3 days per week, which is less than the recommended dose. Thus, the physical activity characteristics

of subjects in this study appear to be consistent with the physical activity patterns of the majority of adults in the United States, which reflects less activity than is recommended to improve health outcomes and reduce risk of chronic disease.

The analysis of baseline physical activity data (episodes of vigorous activity, episodes of moderate activity, sweat episodes) did not show statistically significant correlations with smoking across the two week study period (see Table 3). However, while not examined statistically, the strongest correlations with smoking were with vigorous episodes of physical activity, suggesting that individuals with higher levels of vigorous physical activity had lower smoking rates across the study period. The strength of the correlations appeared to be consistent when physical activity reported during week 1 or 2 were considered in the analyses (see Table 5 and 6).

The results of these correlation analyses appear to be consistent with the findings of Marcus et al.[38] who reported that vigorous activity conducted within the context of a smoking cessation intervention study was associated with improved cessation rates compare to a non-exercise comparison condition. However, within the context of a separate study, Marcus [36] did not find that moderate-intensity physical activity influenced smoking cessation rates.

Of interest is that Marcus et al. examined only women, whereas in this current study both men and women were included in the analysis and similar findings were observed with regard to vigorous versus moderate physical activity[38]. This is further supported by the results presented in Tables 10, 11, and 12 which show that the pattern of results were not affected when gender was controlled for in the analyses. However, these results are not consistent with the findings of Schroeder et al. or Helmert et al.[53][23]. In a cross-sectional study, Schroder[41] reported that the relationship between leisure-time physical activity in heavy smokers was

inversely related to physical activity in men but not women. Helmert et al. reported that sports were negatively associated with smoking in men, but not in women[23]. Thus, there are inconsistencies with regard to the potential moderating effect of gender on the relationship between smoking and physical activity. Future research efforts focusing on the relationship between physical activity and smoking would benefit from observing what gender differences, if any, may exist within the context of a substantially larger sample size with the inclusion of an adequate number of both men and women.

This study did not involve an intervention, yet the results with regard to the potential stronger association between vigorous activity and reductions in smoking appear to be consistent with the results of an intervention study conducted by Marcus et al.[38]. There is additional support in the scientific literature to suggest that physical activity may be important to reduce smoking and improve smoking cessation outcomes. However, few of these studies have been prospective longitudinal studies, which may support the need for these studies to be conducted to better understand the long-term influence of physical activity on smoking cessation.

This study found no influence of BMI on the association between physical activity and smoking (see Table 4.7, 4.8, 4.9). Participants in the current study ranged from normal weight to Class I obese (see Figure 4.1). The importance of understanding the effect of BMI on the relationship between physical activity and smoking may reach beyond the behavior of smoking. For example, there is a common belief that individuals who smoke cigarettes are concerned about potential weight gain that may occur if they were to stop smoking. However, data actually support the use of physical activity as a potential lifestyle method of preventing weight gain during smoking cessation. Marcus et al.[38] reported that subjects participating in vigorous physical activity gained less weight by the end of treatment a smoking cessation

treatment compared to individuals not participating in this level of physical activity (3.05 ±3.45 vs 5.40 ±6.94 kg, P = .03). Kawachi et al.[33] has shown that weight gain during smoking cessation can be can be minimized (by 2.4 kg) when participating in a moderate dose of physical activity. Thus, appropriately designed longer-term prospective studies are needed to confirm the prevention of weight resulting from physical activity during smoking cessation, and whether this contributes to long-term smoking cessation efforts.

5.3 LIMITATIONS AND FUTURE RESEARCH

The current study posed several limitations which should be addressed in future research:

1. The current study had a small sample size due to the high attrition rate. Data is not available for all 27 subjects for many of the variables used in the analysis. Thus, the current study may have been under powered to identify statistically significant findings that were present in this study. Therefore, these data should be used as pilot data for future studies that are have adequate sample size and are appropriately designed to examine these research questions.
2. More females than males participated in the study thus limiting the ability to determine conclusively the effect of gender. Moreover, this study was not originally designed to examine gender differences. Therefore, future research seeking examine potential gender differences in the effect of physical activity on smoking should be conducted within the context of appropriately designed studies that are adequately powered to test gender-specific hypotheses.

3. This study examined the effect of leisure-time exercise on short-term smoking cessation rates over a two week period. Due to the limited duration of the observation period, this study does not provide information with regard to the effect of physical activity on smoking status beyond this two week period. Future investigations may benefit from a longitudinal study design that allows for a longer observational period.
4. This study permitted the examination of relationships between physical activity and smoking. However, this does not allow for examination of causal relationships, nor does this permit the examination of casual behavioral or physiological pathways that may provide an understanding of how physical activity can affect smoking behavior. Future studies should be designed to examine these research questions, which may include randomized controlled research designs.
5. Data collection relied primarily on self-reported smoking, physical activity, weight and height. Some studies in the literature have shown that self-report can result in significant error with regard to physical activity, weight, and height. This may have influenced the results of the current study. Future research studies should include objective assessment of these outcome variables to minimize the influence of measurement error on the results of these studies. Future investigations unable to objectively assess these measures could overcome this limitation by making adjustments to BMI thresholds based on the self-report bias in the literature.
6. The current study employed a one-time behavioral stop smoking intervention administered at baseline, which constituted the only difference in the study design from week to week. Future designs may benefit from the inclusion of a continued motivational behavioral intervention administered throughout the duration of the study, for example, at

baseline, week one and at week two; this may serve to heighten motivation and improve overall cessation rates.

5.4 SUMMARY

This study showed no statistically significant association between physical activity and smoking across a two week smoking cessation attempt. However, while not statistically significant, the strength of the relationship between physical activity and lower smoking during this period appears to be greatest for vigorous physical activity. The lack of a significant finding may be a result of the small sample size which limited statistical power. This study also showed no noticeable influence of gender or BMI on the association between physical activity and smoking during the study period. However, because this study was a secondary analysis of an existing dataset that was not originally designed to examine the association between physical activity and smoking, or the influence of gender or BMI on this relationship, additional studies are warranted in this area of research. In particular, there is a need for appropriately designed and powered longer-term prospective studies that also include measure of physiological and behavioral mechanism, which may provide an enhanced understanding of the importance of physical activity during periods of smoking cessation.

5.5 CONCLUSIONS

1. The current study examined the relationship between leisure-time physical activity and the frequency of cigarette smoking over a two-week period following a brief behavioral smoking cessation intervention. It was hypothesized that there would be an inverse correlation between frequency of cigarette smoking, defined as number of days smoked and total cigarettes smoked, and the amount of leisure-time physical activity reported over a two-week period. Though no statistically significant associations were noted, there was a trend for vigorous exercise intensity to the strength of the relationship between physical activity and lower smoking during this period appears to be greatest for vigorous physical activity.
2. The current study examined the effect of body mass index (BMI) on the relationship between leisure-time physical activity and smoking frequency following a brief smoking cessation intervention, and it was hypothesized that BMI would affect the relationship between leisure-time physical activity and smoking. When controlling for baseline, however, BMI did not influence the pattern of the associations observed.
3. The current study examined the effect of gender on the relationship between physical activity and smoking, after the administration of a brief stop-smoking intervention. It was hypothesized that gender would affect the relationship between leisure-time physical activity and smoking. Controlling for gender did not influence the pattern of the associations observed.

APPENDIX A

DEMOGRAPHICS

1. What is your birth date?

MM DD YYYY

2. What is your gender?

Male

Female

3. How do you describe yourself? (Choose one)

Hispanic or Latino (a person of Cuban, Mexican, Puerto Rican, South or Central American or other Spanish culture)

Not Hispanic or Latino

4a. Are you an American Indian or Alaska native?

No

Yes

4b. Are you African American?

No

Yes

4c. Are you Native Hawaiian or a Pacific Islander?

No

Yes

4d. Are you White or Caucasian?

No

Yes

4e. Are you from some other ethnic background not yet described?

No

Yes

5. Select the option which best describes your job:

Not working

Retired

Full-time Student

Professional/Business Owner/Manager/Executive

Sales/Clerical

Service

Skilled Laborer

Unskilled Laborer

Some other paid job

6. What is the highest educational level you completed?

Some high school

Graduated from high school

GED

Some college

Graduated technical, community, professional, or nursing college

Bachelor's degree

Master's degree or Juris Doctorate

Ph.D. or M.D.

7. Please enter your weight in pounds.

Weight in pounds:

8. Please enter your height in feet and inches.

Feet Inches

9. How many cigarettes a day do you smoke?

a.) 10 or less

b.) 11-20

c.) 21-30

d.) 31 or more

APPENDIX B

GODIN LEISURE-TIME EXERCISE QUESTIONNAIRE

1. During a typical **7-Day period** (a week), how many times on the average do you do the following kinds of exercise for **more than 15 minutes** during your free time (write on each line the appropriate number).

Times Per Week

a) VIGOROUS EXERCISE
(HEART
BEATS
RAPIDLY)

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

b) MODERATE EXERCISE
(NOT EXHAUSTING)

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

c) MILD EXERCISE
(MINIMAL EFFORT)

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

2. During a typical **7-Day period** (a week), in your leisure time, how often do you engage in any regular activity **long enough to work up a sweat** (heart beats rapidly)?

OFTEN	SOMETIMES	NEVER/RARELY
1. □	2. □	3. □

Godin Leisure-Time Exercise Questionnaire

INSTRUCTIONS

In this excerpt from the Godin Leisure-Time Exercise Questionnaire, the individual is asked to complete a self-explanatory, brief four-item query of usual leisure-time exercise habits.

CALCULATIONS

For the first question, weekly frequencies of vigorous, moderate, and light activities are multiplied by nine, five, and three, respectively. Total weekly leisure activity is calculated in arbitrary units by summing the products of the separate components, as shown in the following formula:

Weekly leisure activity score = (9 × Vigorous) + (5 × Moderate) + (3 × Light)

The second question is used to calculate the frequency of weekly leisure-time activities pursued “long enough to work up a sweat“ (see questionnaire).

EXAMPLE

Vigorous = 3 times/wk
Moderate = 6 times/wk
Light = 14 times/wk
Total leisure activity score = (9 × 3) + (5 × 6) + (3 × 14) = 27 + 30 + 42 = 99

APPENDIX C

SMOKING CESSATION INTERVENTION: TO BE DELIVERED AT THE END OF SESSION 1

Quitting smoking is one of the most important things you can do for yourself. It will improve your current health because you will feel better and have more energy. Not smoking will also protect you from developing any number of health problems like cancer and lung diseases in the future. What are your personal reasons for quitting smoking?

Your quit day in this study as part of the practice quit attempt will be tomorrow. As part of preparing for quitting, before you go to bed tonight, you should get rid of all your remaining cigarettes and ashtrays in your house or apartment. You should also strive to make your house and car smoke free. This will make it easier to quit and to stay quit. Here are several other things you can do:

1) Read about quitting. There are a number of different materials you can read. Here is something to get you started. (The 2004 Surgeon General's Report: The Health Consequences of Smoking.= and What it Means to You.")

2) Manage withdrawal symptoms. Common withdrawal symptoms smokers experience after quitting include irritability, increased tension and frustration, trouble concentrating, cravings, trouble sleeping, and increased hunger. Not everybody will have the same withdrawal symptoms for the same amount of time. Generally speaking, though, your

symptoms will gradually decrease over the next two to three weeks once you're quit. Many people feel better within 2—3 days. You may find that you hit some peaks and valleys along the way. Many people report their withdrawal symptoms get worse during the evening hours. In any case, you may not feel like yourself for a few days and that's OK. This will not be a permanent change.

3) High risk situations. High risk situations are those situations where you are most at risk for going back to smoking. Usually smokers can predict when these situations are; they are usually situations that made you want to smoke before, for example, like when you're feeling bad or stressed or after a meal. That knowledge is, again, power because it allows you to plan a coping plan for those high risk times.

4) Coping skills. Smoking doesn't just come out of thin air, though it might seem like it sometimes. There are usually triggers or events that cause you to have an urge and then to smoke. These triggers can be feelings, thoughts, or situations. There are three types of behavioral or habit changing strategies you can use to cope with these triggers, to break up this chain of events that lead to smoking:

   - Avoid the trigger. Avoiding the trigger obviously can be the most powerful strategy: If you are not around the trigger, you will not have an urge and you will not smoke. However, sometimes avoiding a trigger is not always the most practical strategy. That's why there are additional types of strategies to help you manage your smoking triggers.

   - Alter the trigger situation. Think of your triggers to smoke as very fixed parts of your daily routine—anything that you can do to alter that routine, can help you to manage your smoking urges. What you're doing is essentially taking control of your environment so that you can control your smoking. For example, let's take that cup of coffee as a trigger. If you always drink that cup of coffee in the same place using the same cup at the same time of the day, change any one of or all of those parts of the routine: change the cup you use, drink your coffee in a different chair or part of the house. The key with altering a trigger is to be creative. Use it as an opportunity to challenge yourself to outsmart the environment to give you control of your smoking.

   - Substitute something else for the cigarette when you encounter the trigger. This can be as simple as putting a piece of gum or hard candy in your mouth when you want a cigarette. Again, think of it as an opportunity to be creative.

   - Another type of coping strategy is a thought strategy or telling yourself things so that you will not want to smoke. These thoughts can include:

     - Reasons you want to quit

- Benefits of quitting
- Statements of determination (e.g., “I can do it”, or
- Delay statements (e.g., “only five more minutes”).

With strategies in mind, I’d like to review your visit schedule with you for the next few weeks.

APPENDIX D

RECRUITMENT FLYER

Are You Planning to Quit Smoking?

The RAND Corporation in Pittsburgh is conducting a research study with adults (age 18 and older) who are motivated to quit smoking. Individuals will participate in a practice quit smoking attempt and then receive **free** behavioral treatment to help them quit smoking.

Participation requires attending several in person sessions at the RAND offices over a two month period. Participants can receive up to $350.00 for their time and effort in completing the study procedures. If you are interested, please call: 412-683-2300, ext. 4965.

RAND 412-683-2300	RAND 412-683-2300	RAND 412-683-2300	RAND 412-683-2300	RAND 412-683-2300	RAND 412-683-2300	RAND 412-683-2300	RAND 412-683-2300

APPENDIX E

MEASURES USED IN SHADEL ET AL STUDY

Demographics and smoking history: Gender, age, marital status, ethnicity, education and number and length of prior quit attempts, number of years smoked, current daily smoking rate, and current brand of cigarettes smoked.

Nicotine dependence: Fagerstrom Test for Nicotine Dependence (FTND; Heatherton et al., 1991)

Other substance use: Time-Line Follow-Back TLFB (Sobell & Sobell, 1992)

Self-efficacy to quit smoking: Confidence Questionnaire (Condiotte & Lichtenstein, 1981)

Smoking outcome expectancies: Smoking Consequences Questionnaire (Brandon & Baker, 1991; Wetter et al., 1994)

Expired Air Carbon Monoxide (CO): Bedford micro smokerlyzer device

APPENDIX F

PROTOCOL FOR CARBON MONOXIDE TESTING

Materials Needed: Carbon Monoxide Detector and Mouthpieces

Explanation of the Test:

Carbon Monoxide is a colorless, odorless gas and is a byproduct from cigarette smoke. Carbon Monoxide is measured in relation to Oxygen and is measured in parts per million. This machine will detect carbon monoxide in your breath sample within the past twenty-four hours and will be relative to your last cigarette.

Procedure:

1. Put a clean mouthpiece in the detector and turn the machine on.
2. If the patient has any chewing gum or hard candy in his/her mouth, ask him/her to throw it out.
3. Press the red "Zero" button on the detector; the screen will read "Set" and then within a few seconds, it will read "Go."
4. Ask the patient to take three deep breaths. Ask the patient to hold their breath on the third inhalation.
5. Press the green "Go" button as the patient is holding their breath. The detector will count down from 15 seconds.
6. Ask the patient to make a tight seal with their mouth on the white mouthpiece and fully exhale once the detector has counted down to zero. It is important that the patient exhales slowly and gently, emptying the lungs as far as possible. (A powerful exhalation may dislodge the valve and will not necessarily provide the desired air sample.)
7. The Carbon Monoxide reading is the highest number recorded.
8. Remove and discard the white mouthpiece.

Press the green “Go” button before shutting off the machine in order to clear the reading. This is important for the longevity of the monitor. Once the reading has returned to zero, it is safe to turn the machine off.

BIBLIOGRAPHY

1. Abrams DR, Niaura, et al. The tobacco dependence treatment handbook: A guide to best practices. 2003; The Guilford Press.

2. American Lung Association. Smoking Among Older Adults Fact Sheet. June 2007. http://www.lungusa.org.

3. American Cancer Society. Cancer Prevention and Early Detection Facts and Figures. Atlanta, GA. 2009; American Cancer Society.

4. Blum AE, Solberg, et al. The Surgeon General's report on smoking and health 40 years later: still wandering in the desert. *The Lancet*. 2004; 363.

5. Boutelle KN, Murray DM, Jeffery RW, Hennrikus DJ, Lando HA. Associations between exercise and health behaviors in a community sample of working adults. *Preventive Medicine*. 2000; 30:217-24.

6. Boyle RP, O'Connor, et al. Health behaviors of smokers, ex-smokers, and never smokers in an HMO. *Preventive Medicine*. 2000; 177-182.

7. Brown ER, Wyn R, Cumberland WG, et al. Women's Health-Related Behaviors and Use of Clinical Preventive Services: A Report to the Commonwealth Fund. 1995; Los Angeles, Calif: UCLA Center for Health Policy Research.

8. Centers for Disease Control and Prevention. Cigarette smoking among adults and trends in smoking cessation-United States, 2008; *Morbidity Mortal Wkly Rep* 2009; 1227–32.

9. Centers for Disease Control and Prevention. Tobacco Use Among Adults—United States. *Morbidity Mortal Wkly Rep*. 2006; 1145–1148.

10. Centers for Disease Control and Prevention. Reducing the health consequences of smoking: 25 years of progress—a report of the Surgeon General. Rockville, MD: US Department of Health and Human Services, Public Health Service, CDC, 1989; DHHS 89-8411.

11. Centers for Disease Control and Prevention. *Morbidity Mortal Wkly Rep,* Smoking-attributable mortality and years of potential life lost. United States: 2008; 1226-1228.

12. Centers for Disease Control and Prevention. National Health Interview Survey (NHIS), 2008; National Center for Health Statistics.

13. Centers for Disease Control and Prevention. National Center for Health Statistics: National Vital Statistics Reports: March, 2005.

14. Centers for Disease Control and Prevention. Youth and Tobacco Use: Current Estimates. 2010; http://www.cdc.gov/tobacco/data_statistics/fact_sheets/youth_data/tobacco_use/index.htm.

15. Centers for Disease Control and Prevention. Summary Health Statistics for U.S. Adults: National Health Interview Survey. 2006, 2000; Atlanta (GA): CDC.

16. Charlesworth A, Glantz, Stanton, A. *Pediatrics*. Smoking in the Movies Increases Adolescent Smoking: A Review. 2005; 1516-1528.

17. Coups EJ, et. al, Physical Activity among Lung Cancer Survivors: Changes across the Cancer Trajectory and Associations with Quality of Life. *Cancer Epidemiology Biomarkers Prevention*. 2009; 664–72.

18. Elders, MJ, Perry C. Preventing tobacco use among young people: A report of the Surgeon General. MMWR 43 1994; 2–10.

19. Fiore MW, Bailey, et. al. Treating tobacco use and dependence. Clinical practice guideline. 2000; 00-032.

20. Gan WG, Man SFP, Senthilselvan A, Sin DD, Association Between Chronic Obstructive Pulmonary Disease and Systematic Inflammation: a Systematic Review and a Meta-analysis. *Thorax*. 2004;574-580.

21. Godin, G, Shephard RJ, Godin leisure-time exercise questionnaire. Medicine Science Sports Exercise 1997; 29.

22. Godin G, Shephard RJ, A simple method to assess exercise behavior in the community. Can. *Journal Appl. Sport Science* 1985; 141-146.

23. Helmert U, Herman B, Shea S. Moderate and vigorous leisure-time physical activity and cardiovascular disease risk factors in West Germany, 1984-1991. *International Journal of Epidemiology*. 1994; 23: 285-92.

24. Hirsch GL, et al., Immediate effects of smoking on cardiorespiratory response to exercise. *Journal of Applied Physiology*, 1985; 58:1975-81.

25. Hu G, Pekkarinen H, Hanninen O, Yu Z, Guo Z, Tian H. Commuting, leisure-time physical activity and cardiovascular risk factors in China. Medicine and Science of Sports and Exercise. 2002; 34: 234-8.

26. Hughes, JR, Motivating and helping smokers to stop smoking. *Journal of General Internal Medicine*. 2007; 1053-1057.

27. Hughes, JR et al, Smoking Cessation Among Self-Quitters. *Health Psychology*. 1992; 331-4.

28. International Agency for Research on Cancer (IARC): World Cancer Report 2008; Lyon France.

29. Illinois Department of Public Health. Arnold Damon P, Division of Oral health Fact Sheet. http://www.idph.state.il.us/HealthWellness/oralhlth/oraltobacco.htm.

30. Institute of Medicine Report, Ending the Tobacco Problem: A Blueprint for the Nation. 2007; http://www.iom.edu/Reports/2007/Ending-the-Tobacco-Problem-A-Blueprint-for-theNation.aspx

31. International Agency for Research on Cancer working Group on the Evaluation of Carcinogenic Risks to Humans. IARC Monographs on the Evaluation of Carcinogenic on the Evaluation of Carcinogenic Risks to Humans, 2004; 83: Tobacco smoke and involuntary smoking. Lyon France: IARC.

32. Johnston LP, O'malley, J, Bachman, National Survey Results on Drug Use From the Monitoring the Future Study, 1975-1994; Vol I, Secondary School Students. No: NIH 95-4026, 1995; 341.

33. Kawachi I, Troisi RJ, Rotnitzky AG, Coakley EH, Colditz MS, Colditz MD. Can exercise minimize weight gain in women after smoking cessation? American *Journal of Public Health*. 1996; 86: 999-1004.

34. Lancaster T,L, Stead. Individual behavioral counseling for smoking cessation. *Cochrane Database Systematic Review*. 2005; 2: 1–23.

35. Louie D, "The effects of cigarette smoking on cardiopulmonary function and exercise tolerance in teenagers," Canadian Respiratory*: Journal of the Canadian Thoracic Society*, July-August, 2001; 289-91.

36. Marcus, B et al. The Efficacy of Moderate-Intensity Exercise as an Aid for Smoking Cessation in Women: A Randomized Controlled Trial. *Nicotine and Tobacco Research*. 2004.

37. Mackay J, Amos A, Invited Review Series: Tobacco and Lung Health: Women and Tobacco. *Respirology*. 2003; 123-130.

38. Marcus, B et al. The Efficacy of Exercise as an Aid for Smoking Cessation in Women: a randomized controlled trial. *Internal Medicine*. 1999; 1229-1234.

39. Marcus, B et al. The Efficacy of Moderate-Intensity Exercise as an Aid for Smoking Cessation in Women: A Randomized Controlled Trial. *Nicotine and Tobacco Research*. 2004.

40. Myers J. Exercise and cardiovascular health. *Circulation*. 2003; 107.

41. National Household Survey on Drug Abuse Population Estimates, 1996; Rockville, MD: US.

42. National Institute on Drug Abuse, Department of Health and Human Services, 1996; *Treating Tobacco Use and Dependence: Clinical Practice Guideline*.

43. Niaura RD, et al. Cue exposure treatment for smoking relapse prevention: a controlled clinical trial. *Addiction* 1999; 685-695.

44. Nissen SE, Wolski K. Effect of rosiglitazone on the risk of myocardial infarction and death from cardiovascular causes. *New England Journal Med.* 2007; 2457-2471.

45. Physical Activity Guidelines for Americans Report. 2008; http://www.health.gov/PAGuidelines/pdf/paguide.pdf

46. Piasecki T, Niaura R, et al. Smoking withdrawal dynamics in unaided quitters. *Journal of Abnormal Psychology*. 2000; 74-86.

47. Prochaska JW, Velicer, et al. Evaluating a population-based recruitment approach and a stage-based expert system intervention for smoking cessation. *Addictive Behaviors* 2001; 583-602.

48. Report of the National Institutes of Health: Opportunities for Research on Women's Health.Hunt Valley, Md: US Department of Health and Human Services, National Institutes of Health, Office of Research on Women's Health; 1992; NIH Publication no 92-3457.

49. Rodgman A, Perfetti, TA. The Chemical Components of Tobacco and Tobacco Smoke. Boca Raton (FL): CRC Press, 2009; Taylor and Francis Group.

50. Secretan B. Straifk, Baan R. et al. A review of human carcinogens—Part E: tobacco, areca nut, alcohol, coal smoke, and salted fish. *Lancet Oncology*. 2009; 10:1033-4.

51. Shadel, William G, et al. 2008; Evaluating the Causal Pathways from Lapse to Relapse in Smokers.

52. Shafey O, Eriksen M, Ross H, Mackay J. The Tobacco Atlas. 2009; Atlanta (GA): American Cancer Society.

53. Schroeder SA, et al. We Can Do Better—Improving the Health of the American People. *New Eng Journal of Med.* 2010; 1221-1228.

54. Schuman A, Hapke U, Rumpf HJ, Meyer C, John U. The association between degree of nicotine dependence and other health behaviors. Findings from a German general population study. *European Journal of Public Health*. 2001; 11:450-2.

55. Spencer, EA, PN Applebya1, GK Daveya1, TJ Keya1, et a1. Imperial Cancer Research Fund Cancer Epidemiology Unit, University of Oxford Gibson Building, Validity of self-reported height and weight in 4808 EPIC–Oxford participants. The Radcliffe Infirmary, Oxford OX2 6HE, UK.

56. Substance Abuse and Mental Health Services Administration (SAMHSA). Results from the 2008 National Survey on Drug Use and Health: National Findings. Rockville MD.

57. Substance Abuse and Mental Health Services Administration (SAMHSA). Results from the 2008 National Survey on Drug Use and Health:Detailed Tables. 2009. http://www.oas.samhsa.gov/NSDUH/2K8NSDUH/tabs/Sect4peTabs10to11.pdf.

58. Takemura Y. SakuraiY. Inaba Y, Kugai N. A cross-sectional study on the relationship between leisure or recreational physical activity and coronary risk factors. *Tohoku Journal of Experimental Medicine.* 2000; 192: 227-37.

59. Taylor, AM, Ussher, et al. The acute effects of exercise on cigarette cravings, withdrawal symptoms, affect and smoking behavior: a systematic review. *Addiction* 2007; 534-543.

60. Tobacco Use Among US Racial/Ethnic Minority Groups: A Report of the Surgeon General.Atlanta, Ga: US Department of Health and Human Services, Centers for Disease Controland Prevention, Office on Smoking and Health; 1998.

61. U.S. Department of Health and Human Services. Women and Smoking: A Report of the Surgeon General. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service, CDC, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2001.

62. US Department of Health and Human Services. The Health Consequences of Smoking: A Report of the Surgeon General. Atlanta GA: Office of Public Health and Science; 2004.

63. U.S. Department of Health and Human Services. The Health Consequences of Involuntary Exposure to Tobacco Smoke: A Report of the Surgeon General. Atlanta: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, Coordinating Center for Health Promotion, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2006.

64. Velicer, W., J. Fava, et al. Distribution of smokers by stage in three representative samples. *Preventative Medicine*. 1995; 401-411.

65. Verkooijen, Kristen, T. Gert A. Nielsen, Stef P. J. Kremers. The association between leisure time physical activity and smoking in adolescence: An examination of potential mediating and moderating factors. *International Journal of Behavioral Medicine.* 2008; 157-163.

66. Vineis P, Alavanja M, Buffler, E. Fontham, S. Franceschi, Y. T. Gao, et al. Journal of the National Cancer Institute. 2004; Tobacco and Cancer: *Recent Epidemiological Evidence,* 99-06, Oxford University Press.

67. World Health Organization. Tobacco key facts. http://www.who.int/topics/tobacco/facts/en/index.html. March 29, 2010.