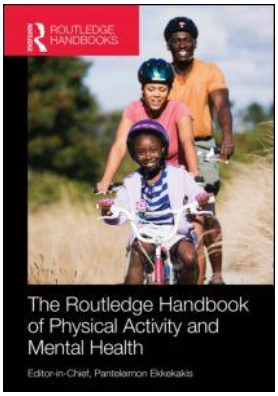

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31

PHYSICAL ACTIVITY AS AN AID IN SMOKING CESSATION

Adrian H. Taylor and Michael Ussher

Tobacco causes about five million deaths annually worldwide, and is the second leading cause of death (World Health Organization, 2011). Smoking cessation is a challenge due to the insidious nature of the addiction (American Psychiatric Association, 2000). Unaided quit attempts have a success rate (6–12 months abstinence) of around 3–5%, while aided quit attempts, particularly through a combination of behavioral counseling and nicotine replacement therapy (NRT), bupropion or varenicline, can improve success rates by around 7–9% (Cahill, Stead, & Lancaster, 2011; Hughes, Stead, & Lancaster, 2007; Stead, Perera, Bullen, Mant, & Lancaster, 2008). There is scope for new therapies. There is substantial research on why people relapse; notable reasons include cravings, low mood, and weight gain. Physical activity (PA) has the potential to influence all of these and has been recommended as an aid to smoking cessation by specialist smoking clinics (Everson-Hock, Taylor, & Ussher, 2010a; Everson-Hock, Taylor, Ussher, & Faulkner, 2010b), in self-help guides (Marcus, Hampl, & Fisher, 2004), and in national guidelines (US Department of Health & Human Services, 2008).

Many large-scale cross-sectional surveys have assessed associations between self-reported PA and smoking status. Kaczynski, Manske, Mannell, and Grewal (2008) identified 50 such studies, with almost 60% reporting a negative association, and the majority of the remaining studies had methodological issues. This evidence suggests that an increase in PA could help people to quit. It raises questions about how such an effect could occur and how PA interventions could be designed to maximize the effects on smoking.

Some randomized controlled trials, in a general primary care population, have shown increases in PA in a PA group relative to a control group but have shown no effect on smoking cessation (e.g., Taylor, Doust, & Webborn, 1998; Bull & Jamrozik, 1998). These studies are limited in that there is no information provided on whether smokers wish to quit. However, this research suggests that by simply increasing PA there is unlikely to be a spontaneous increase in smoking cessation. This raises the question of whether PA can aid smoking cessation when it is explicitly used for this purpose, and the remainder of the chapter will focus on this issue.

This chapter will provide an overview of research on:

- The chronic effects of PA on smoking cessation and dose-response issues.
- The acute effects of a single session of PA on smoking-related outcomes (e.g., cravings) and dose-response issues.

- Possible mechanisms underlying the effects of PA on smoking-related variables.
- Designing effective interventions that engage smokers.

The chronic effects of physical activity on smoking cessation

There have been a number of reviews of the chronic effects of exercise on smoking cessation (e.g., Nishi, Jenicek, & Tatara, 1998; Ussher, Taylor, West, & McEwen, 2000), but not all have clearly defined the research question, applied rigorous inclusion and exclusion criteria, or carefully considered the appropriateness of outcome measures (West, Hajek, Stead, & Stapleton, 2005). Ussher, Taylor, and Faulkner (2012) adopted a rigorous and conservative approach to understanding the effects of exercise. Their review identifies the excluded studies with a reason for their exclusion. The studies reviewed involved programs of supervised or unsupervised exercise alone or in addition to a smoking cessation intervention, compared with a smoking cessation program alone. Interventions involving exercise within a multiple component smoking cessation program were excluded because it would not be possible to attribute any effects solely to exercise. Studies involving interventions designed to target a number of health-related outcomes, including smoking, were excluded as, again, any effect could not be attributed to exercise. For example, a dietary intervention may hypothetically also enhance success at quitting by preventing weight gain, or it may reduce success at quitting due to elevated hunger during abstinence. Relapse in smoking cessation studies is notoriously high, so the review focused on trials with at least a 6-month follow-up (i.e., 6 months post quit or post treatment). Smoking cessation at the longest follow-up was reported as the main outcome.

The review identified 15 RCTs, seven of which had fewer than 25 people in each treatment arm, seven involved only females, and one, only males. The studies varied in the timing and intensity of the smoking cessation and exercise programs. In 13 studies a cognitive behavioral smoking cessation intervention was offered to both control and exercise groups, with six beginning before the quit date. In seven studies nicotine products were encouraged for all participants. Treatments lasted 5 to 15 weeks with the exception of one study with a single session, and another was undefined and involved an internet intervention. In terms of PA, nine, three, and two studies (with one not stating the timing) required participants to increase PA before, at the same time as, and after the quit date, respectively. Thus, in 12 studies the smokers set a quit date, and one study was unclear in its reporting.

Most studies involved a supervised group-based exercise program, with supplementary home-based exercises. A few studies also promoted free-living PA in addition to structured exercise, and one study exclusively focused on brief weekly counseling to increase PA (Ussher, West, McEwen, Taylor, & Steptoe, 2003, 2007). One study promoted resistance exercise (Ciccolo et al., 2011), but the others focused on cardiovascular-type exercise.

In terms of outcomes, three studies showed significantly higher abstinence rates in a physically active group versus a control group at end of treatment. One of these studies (Marcus et al., 1999) also showed a significant benefit for exercise versus control on abstinence at the 3-month follow-up (post-treatment) and a benefit for exercise of borderline significance ($p = 0.05$) at the 12-month follow-up (11.9% versus 5.4% abstinent). One study showed significantly higher abstinence rates for the exercise group versus a control group at the 3-month follow-up but not at the end of treatment or 12-month follow-up. The findings were reported using the most conservative outcomes for reporting smoking cessation. The other studies showed no significant effect for exercise on abstinence. The review concluded that only one study showed any long-term benefit of exercise on smoking cessation.

Most studies are efficacy studies with the recruitment of participants with an interest in exercise

and generally high adherence to the exercise intervention, and thus may not represent what happens in real life. The study showing the greatest benefits of exercise (Marcus et al., 1999) involved 30–40 minutes of vigorous structured exercise classes three times a week for 12 weeks, which may not appeal to most smokers (see below).

Do trained smoking advisors routinely promote physical activity as an aid to quitting?

There are mixed views about whether smoking advisors should be encouraged to promote PA. McEwen, Hajek, McRobbie, and West (2006) suggest that behaviors such as PA should be initiated after a period of successful abstinence since the demands of planning, goal setting, and initiating two or more behavior changes simultaneously may be too much for some, and could result in smoking relapse. On the other hand, Marcus, Hampl, and Fisher (2004) advocate a need to prevent weight gain after smoking cessation through simultaneously changing multiple health behaviors that may reinforce each other.

In a survey of 170 smoking cessation advisors in England and Scotland, 56% claimed to promote PA, and the average time spent promoting PA was less than 5 minutes in a typical 45-minute counseling session (Everson, Taylor, & Ussher, 2010). Those holding more positive beliefs regarding pros and cons, self-efficacy, outcome efficacy, and importance of PA within smoking cessation were more likely to promote PA, and this was supported in interviews with the advisors (Everson-Hock, Taylor, Ussher, & Faulkner, 2010b). The advisors noted that PA was a valuable coping strategy for cravings and withdrawal symptoms, it redirected the focus toward something positive rather than stopping smoking, and could help with weight management and emotional eating (in the absence of a cigarette).

Are smokers interested in physical activity as an explicit aid for smoking cessation?

In a UK survey of 181 smokers attempting to quit, 22% reported currently using PA to control their smoking and 35% had used it during a previous quit attempt (Everson-Hock, Taylor, & Ussher, 2010a). Those in later stages of readiness for using PA as a cessation aid (i.e., action and maintenance) held more positive beliefs regarding self-efficacy to do PA and outcome efficacy (or the belief that PA would be useful). The survey focused on smokers' views on "physical activity" (e.g., short bouts of brisk walking) rather than vigorous "exercise" sessions, which may be more valuable on a daily basis and may minimize barriers to participation.

Acute effects of physical activity on smoking-related outcomes

Reviews have focused on the effects of a single session of PA on smoking-related outcomes (Taylor, Ussher, & Faulkner, 2007; Ussher et al., 2012), with studies involving either actual quitters or temporarily abstinent smokers.

Few studies have examined the acute effects from pre to post a single session of exercise among people receiving a smoking cessation intervention. Bock, Marcus, King, Borrelli, and Roberts (1999) reported significant reductions in cravings from pre to post exercise compared with a passive condition in weeks 5–10 of an 11-week trial, but the results reported for each session were not easy to disaggregate. Williams and colleagues (2010) reported that quitters who engaged in an 8-week smoking cessation program (i.e., counseling and NRT) plus three weekly 50-minute walks had no reduction in cravings compared with a passive control group. Finally,

Arbour-Nicitopoulos, Faulkner, Hsin, and Selby (2011) reported no acute effects on cravings among a sample of mental health patients receiving NRT to help with smoking cessation. Collectively, the results from these studies on the acute effects of exercise on cravings among those wishing to quit are unconvincing. This may be due to lower cravings at baseline, due to taking NRT, or because cravings tend to reduce over a few weeks after peaking within the first week of quitting.

Most acute studies have entailed a proof of concept approach in which cravings are initially exacerbated by a period of temporary nicotine abstinence (e.g., overnight) followed by either an exercise or control condition. Between- or within-subject crossover designs to compare pre to post exercise versus control changes in cravings and withdrawal symptoms have been used with smokers not receiving other smoking cessation aids.

Acute studies, following temporary abstinence, offer the opportunity to test the effects of a dose of exercise on smoking-related outcomes before promoting it within interventions. An example is the finding from an acute study that isometric exercises can reduce cravings (Ussher, West, Doshi, & Sampuran, 2006; Ussher, Cropley, Playle, Mohidin, & West, 2009), followed by the design of a study to test the feasibility and acceptability of offering isometric exercise within an NHS treatment (Al-Chalabi et al., 2008). Other research has looked at yoga in acute studies (Elibero, Janse van Rensburg, & Drobes, 2011) and as an intervention (Bock et al., 2010; Bock et al., 2012). Thus, acute studies allow us to examine what types of activity and what intensity and duration have the greatest effect on reducing cravings.

Two studies (Everson, Daley, & Ussher, 2008; Scerbo, Faulkner, Taylor, & Thomas, 2010) have shown that moderate and vigorous intensity exercise both reduce cravings, compared with a passive control group. Even short bouts (e.g., 5 minutes) of PA appear to temporarily reduce cravings, but the effects are more short-lived than for longer bouts. Together, these studies suggest that PA may be effective as a coping strategy for acutely reducing cravings and withdrawal symptoms.

Haasova and colleagues (2013) quantified the effects of a single bout of exercise on Strength of Desire to smoke (SoD; West, Hajek, & Belcher, 1989), which is a useful predictor of smoking cessation (Fidler, Shahab, & West, 2011). Using original individual patient data (IPD; Riley, Lambert, & Abo-Zaid, 2010) collated from 15 acute exercise studies, a linear regression was conducted with post-PA SoD as the main outcome and with various demographic and behavioral covariates added to the model, adjusting for study and baseline SoD. The pooled estimate for treatment effect (standardized mean difference) was -1.91 (95% CI -2.59; -1.22), with a high degree of between-study heterogeneity, as shown in Figure 31.1. In summary, these findings indicate a very strong acute effect of exercise on self-reported SoD.

Acute studies involving other measures of cravings and withdrawal symptoms (e.g., two-factor QSU-brief) have also shown reductions in cravings following exercise. Withdrawal symptoms include irritability, anger, poor concentration, depression, and hunger. Recent studies have begun to examine the acute effects of exercise on cue-elicited cravings. These studies are common in smoking cessation research and examine how a smoker responds to smoking triggers after exercise. Often such triggers elicit a craving, which may lead to smoking.

In terms of smoking topography, studies by Mikhail (1983), Reeser (1983), Thayer, Peters, Takahaski, and Birkhead-Flight (1993), Taylor and Katomeri (2007), and Faulkner, Arbour-Nicitopoulos, and Hsin (2010) have collectively shown that exercise acutely favorably influences time spent smoking and number of puffs smoking the next cigarette after exercise, and increases the time before smoking the next cigarette, compared with a passive control group.

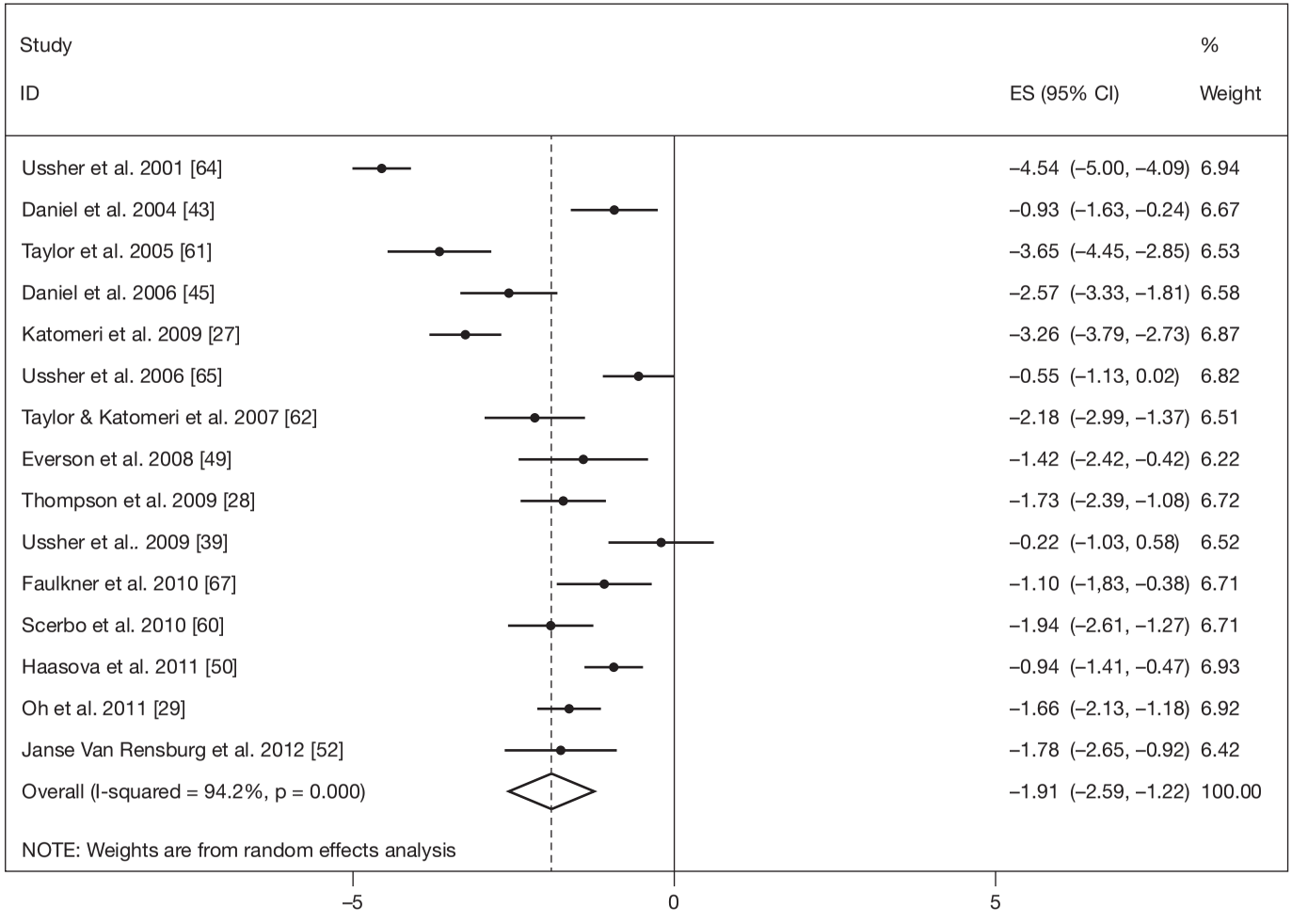

Figure 31.1
Acute effects of exercise on strength of desire to smoke (SoD). Individual participant data meta-analysis of all studies using two-stage random-effects regression of post SoD with baseline adjustment. Negative effect size (ES) favors intervention and positive ES favors control condition. CI: confidence interval (reproduced from Haasova et al., (2013), with permission of Addiction, Society for the Study of Addiction and Blackwell Publishing).

Mechanisms

There are a number of ways in which PA may help smokers to reduce or quit smoking, which are shown in Table 31.1. Some of these are discussed below.

Distraction: There is increasing interest in low-intensity "mindful" exercise (e.g., yoga, Tai Chi, isometrics, stretching) that may demand a greater cognitive focus (i.e., distraction from smoking) than walking, for example. Similarly, at a high intensity, above the ventilatory threshold, exercise may induce greater attentional demand or provide more introspective feedback associated with displeasure than at moderate intensities (Ekkekakis, Parfitt, & Petruzzello, 2011). In studies that have compared exercise with a distracting task (as a control condition) there was a greater reduction in cravings and withdrawal symptoms during and following moderate intensity exercise (e.g., Daniel, Cropley, & Fife-Schaw, 2006; Ussher, Nunziata, Cropley, & West, 2001), suggesting distraction is not the key mechanism. However, exercise appears to reduce attentional bias to smoking images (Janse van Rensburg, Taylor, & Hodgson, 2009; Oh & Taylor, in press), which may be an important indicator of addictive processes and inhibitory control (Field, Munafò, & Franken, 2009). Further research is needed to determine the role of exercise in building self-control and inhibitory strength as key elements of self-regulation (see Prime Theory by West, 2007; Baumeister & Vohs, 2011).

Affective changes: Another mechanism by which exercise may influence cigarette cravings is through changes in affect. Several studies have reported simultaneous changes in affective activation and feelings and cravings while exercising (e.g., Taylor, Katomeri, & Ussher, 2006). It may be that a single bout of moderate-intensity exercise provides a sense of pleasure or positively activated affective, and this replaces the hedonic expectancy from smoking a cigarette, thereby reducing the desire to smoke. Audrain-McGovern and colleagues (2011) suggested that the alternative reinforcement value from sport may prevent progression to smoking among adolescents.

Neuro-cognitive-affective effects: Two studies (Janse Van Rensburg, Taylor, Hodgson, & Benattayallah, 2009; Janse van Rensburg, 2010) have shown among abstinent smokers, using

Table 31.1 Possible mechanisms by which PA may help someone to reduce or quit smoking, and prevent relapse

- It may provide a useful distraction from smoking and reduce the frequency and intensity of tobacco cravings.
- Nicotine abstinence is associated with increased withdrawal symptoms such as anger, low mood, irritability, and hunger. PA may reduce these symptoms. The acute effects of exercise on mood and affect are widely recognized.
- Smokers experiencing depression have lower success in quitting. PA can have chronic positive effects on depression through a range of possible neurobiological and psychosocial mechanisms discussed elsewhere in this book.
- Doing some PA can remind a smoker just how breathless they have become, and this could prompt a desire to reduce or quit.
- Engaging in PA may displace certain behaviors and time spent in selected environments previously associated with smoking and could lead to a shift in identity away from that of a smoker.
- Weight gain and fear of weight gain can impact on whether a smoker quits and/or relapses. PA can help to prevent weight gain.
- PA may help to increase control capacity, and self-regulation of addiction to cigarettes has been described as a failure to self-regulate a habitual behavior in Prime Theory (West, 2007). Self-control involves overriding or inhibiting smoking, urges, or desire to smoke that would otherwise interfere with an attempt to cut down or quit smoking (Baumeister & Vohs, 2011).

functional magnetic resonance imagery (fMRI) while viewing smoking images, that after being passive, significant regional brain activations were identified in areas of the brain associated with visuospatial attention (e.g., parietal lobe, parahippocampal gyrus, and fusiform gyrus), drug use motivation (e.g., orbitofrontal cortex), and reward (e.g., caudate nucleus). Following a 10-minute bout of moderate-intensity exercise, none of these brain regions were activated. This suggests that exercise may implicitly regulate neuro-cognitive-affective processes that may lead from cues to developing an urge to smoke.

Weight gain prevention: A meta-analysis of 62 studies revealed that there was a mean increase of 4–5kg in body weight after 12 months of abstinence, with the greatest gain occurring within 3 months of quitting (Aubin, Farley, Lycett, Lahmek, & Aveyard, 2012). Untreated and pharmacologically treated quitters had similar weight gain but variation was large, with about 16% losing weight and 13% gaining more than 10kg.

Within 4–8 years, quitters gain about 9kg, compared with 2kg among continuing smokers, with 38% gaining over 10kg in weight (Lycett, Munafò, Johnstone, Murphy, & Aveyard, 2011). Weight gain concerns are often grounds for initiation of smoking behavior, reluctance to quit smoking, and smoking relapse (Klesges, Meyers, Klesges, & La Vasque, 1989), but not all studies support fear of weight gain as a reason for relapse (e.g., Xhou et al., 2009). In one study, just prior to quitting, 52% feared gaining weight, 84% were unwilling to accept a gain of more than 5kg in body weight, and 28% were not prepared to accept any weight gain (Tùnnesen et al., 1999). To account for this weight gain the basal metabolic rate reduces by the equivalent of 150–300kcals per day or about 10% of daily energy expenditure, partly explained by the fall in sympathetic drive. Also, some studies report an increased energy intake of about 250kcals/day at 3 months after smoking cessation, particularly among those prone to emotional or comfort eating (Perkins, 1993). Not surprisingly then, exercise has been recommended for preventing weight gain, both to address energy balance and also help self-regulate emotional eating (e.g., high-energy snacks) (Oh & Taylor, 2012; Taylor & Oliver, 2009; Thayer et al., 1993). In a laboratory study, temporarily abstinent smokers, who were also regular high-calorie snackers, showed reduced attentional bias to both smoking and snacking images, compared with neutral images, following 15 minutes of moderate-intensity exercise, relative to a passive control condition (Oh & Taylor, in press). Thus, short bouts of physical activity, compared with being sedentary, may reduce both cravings and salience of cues associated with reward.

The evidence for whether exercise prevents weight gain after quitting is mixed. When pooling the studies, Parsons and colleagues (2009) found no reduced gain at end of treatment, but did at 12 months' follow-up in a meta-analysis of three studies (Bize et al., 2010; Marcus et al., 1999; Ussher et al., 2003). In another meta-analysis of 10 studies (Spring et al., 2009) there was a significant reduction in weight gain from the exercise intervention in the short term (< 3 months), but not in the long term (> 6 months).

Practical and theoretical implications

Several pilot studies involving counseling, with detailed descriptions of behavioral change techniques, and novel exercise interventions (e.g., isometric exercise, yoga, resistance exercise; Al-Chalabi et al., 2008; Bock et al., 2010; Ciccolo et al., 2011) have been reported. Nevertheless, it is a challenge to determine how best to integrate exercise or PA into conventional pharmacological and behavioral support without overloading smokers (Jung, Fitzgeorge, Prapavessis, Faulkner, & Maddison, 2010; Maddison et al., 2010; Williams et al., 2010), and when to integrate any PA in relation to quitting. Most trials in the Cochrane review (Ussher et al., 2012) focused on increasing PA before quitting, but Taylor and colleagues (Taylor, Everson-Hock, & Ussher,

2010) described the development and piloting of a pragmatic "Walk to Quit" counseling intervention that incorporated a range of behavior change techniques, use of a pedometer, and a self-help guide at the same time as quitting. The focus was on building confidence to increase PA and also develop an expectation that PA would be a valuable cessation aid among smokers attempting to quit. In contrast, Prochaska and colleagues (2008) reported that a pedometer intervention helped to prevent relapse several months after quitting. Finally, it is important to note that our Cochrane review focused on trials in which smoking outcomes could clearly be attributed to PA. In contrast, more pragmatic trials have focused on more complex interventions to change multiple risk factors (e.g., McClure et al., 2011) with the focus on changing smoking, diet, and PA simultaneously.

There is little research on behavioral support to support smoking reduction among those who do not wish to quit immediately. In a pilot RCT with 99 disadvantaged smokers, an Exercise Assisted Reduction then Stop intervention, compared with a brief advice condition, resulted in 22% vs 6% making a quit attempt, 14% vs 4% with expired carbon monoxide confirmed 4–8 weeks' abstinence, and 10% vs 4% with CO confirmed abstinence at 16 weeks post baseline (Thompson et al., in press). A larger trial is needed to provide greater confidence in these findings, and further exploration of the value of physical activity as an aid for different smoking reduction strategies.

Exercise and smoking cessation for special populations

Adolescents, sport, and smoking

Research suggests there are complex relationships between type of sport, gender, and progression to smoking among adolescents (Larson, Story, Perry, Neumark-Sztainer, & Hannan, 2007; Audrain-McGovern, Rodriguez, & Moss, 2003), with competency beliefs and mood appearing to mediate an apparent protective effect of engaging in PA (Rodriguez, Duton, Tscherne, & Sass, 2008; Verkooijen, Nielsen, & Kremers, 2008). In contrast to adult research, only one study has looked at PA as an adolescent smoking cessation aid. Horn et al. (2011) conducted a cluster RCT to examine the effects of PA counseling in addition to a standard smoking cessation program. There was an increased likelihood of cessation at 6-month follow-up in the PA arm but mostly limited to male adolescents. Everson, Daley, and Ussher (2006) reported that, unlike research involving adult populations, 10 minutes of moderate-intensity cycle ergometry did not reduce desire to smoke in adolescents.

Mental illness, physical activity, and smoking

There is a much higher incidence of smoking among people with mental health problems (Williams & Ziedonis, 2004) and lower levels of PA (Janney et al., 2008). Depression is also associated with less success at smoking cessation (Berlin & Covey, 2006). As other chapters in this book will identify, it can be challenging to devise interventions that effectively increase PA among people with mental health problems. Faulkner and colleagues (2007) reported from survey data that 63% (n=109) of current or recently quit smokers receiving treatment for mental health disorders (e.g., schizophrenia or depression) were interested in becoming more physically active within the context of their smoking cessation efforts. PA was regarded as a useful behavioral strategy for coping with cravings and withdrawal symptoms. A pilot trial on the effects of exercise counseling among 44 female smokers with depression suggested the intervention was acceptable and feasible (Vickers et al., 2009). In the only acute study involving participants with severe

mental illness, Arbour-Nicitopoulos and colleagues (2011) reported no effect of exercise on cravings and withdrawal symptoms. The use of NRT by all participants may have minimized baseline cravings, and hence created a floor effect.

Pregnancy, physical activity, and smoking

During pregnancy, smokers may be less inclined to use pharmaco-therapies, but appear interested in PA as an aid to quitting (Ussher, West, & Hibbs, 2004; Ussher, Ah-Yoon, West, & Straus, 2007). An ongoing trial is assessing the effects of an exercise intervention in this population (Ussher et al., 2008; Ussher et al., 2012).

Summary

This chapter has reviewed a wide range of literature that has considered the relationship between exercise, physical activity, and smoking, including cross-sectional studies, RCTs of exercise, or physical activity counseling interventions to aid smoking cessation, and acute studies to determine the temporary utility of physical activity for reducing cravings and withdrawal symptoms. In terms of the most rigorously conducted studies, there is some evidence that exercise may increase smoking cessation when used as an adjunctive treatment to usual care. Many previous studies have been too small-scale or had limitations that ongoing studies are currently addressing, so more definitive findings are expected in the coming years about the effectiveness of exercise as a smoking cessation aid.

In terms of acute exercise, there has been an exponential growth in the past decade in the number of studies designed to examine the effects on smoking-related outcomes. This research strongly suggests that, during temporary abstinence (when cravings and withdrawal symptoms are elevated), exercise reduces desire and strength of desire to smoke, withdrawal symptoms, attentional bias to smoking-related cues, and ad libitum smoking.

A variety of mechanisms for how exercise may have both acute and chronic effects have been considered and further research is required. Chronically, exercise may reduce weight gain following cessation and provide a useful behavioral coping strategy to manage cravings and withdrawal symptoms. Rather than just structured supervised exercise, a variety of approaches are being examined to help smokers to use physical activity as an aid to smoking reduction and cessation.

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