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Smoking and Cardiac Rehabilitation Participation: Associations with Referral, Attendance and Adherence

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Abstract

Objective—Continued smoking after a cardiac event greatly increases mortality risk. Smoking cessation and participation in cardiac rehabilitation (CR) are effective in reducing morbidity and mortality. However, these two behaviors may interact; those who smoke may be less likely to access or complete CR. This review explores the association between smoking status and CR referral, attendance, and adherence.

Methods—A systematic literature search was conducted examining associations between smoking status and CR referral, attendance and completion in peer-reviewed studies published through July 1st, 2014. For inclusion, studies had to report data on outpatient CR referral, attendance or completion rates and smoking status had to be considered as a variable associated with these outcomes.

Results—Fifty-six studies met inclusion criteria. In summary, a history of smoking was associated with an increased likelihood of referral to CR. However, smoking status also predicted not attending CR and was a strong predictor of CR dropout.

Conclusion—Continued smoking after a cardiac event predicts lack of attendance in, and completion of CR. The issue of smoking following a coronary event deserves renewed attention.

Keywords

cardiac rehabilitation; smoking; smoking cessation; referral; attendance; enrollment; participation; adherence; dropout

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Conflict of Interest Statement

The authors declare that there are no conflicts of interest.

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Smoking Prevalence in Cardiac Patients

Smoking prevalence in coronary heart disease (CHD) patients is higher than in the general population (Aguëro et al., 2013; Bellow et al., 2011). Multisite studies in the US report smoking prevalence of 27 to 36% in those hospitalized for an acute cardiac condition compared to a smoking rate of about 18% in the general adult population (LaBresh et al., 2007; Leifheit-Limson et al., 2013; Agaku et al., 2014). However, while smoking rates continue to decline in the general population, a similar decline has not been observed in cardiac populations (Richardson et al., 2000). This same pattern is also seen in Europe where smoking rates overall are slowly decreasing while smoking prevalence among cardiac patients remained at 20% over a 20 year period (Kotseva et al., 2009).

During hospitalization almost all cardiac patients in developed countries are required to abstain from smoking, with a preponderance receiving their care in smoke-free hospitals. Most of these hospitals offer cessation programs (e.g. Smith and Taylor, 2013), and self-reported smoking status does decline after a hospitalization for heart disease. Generally, cessation support services during hospitalization are strong but there is little systematic sustained support following discharge (Boggon et al., 2014). Not surprisingly, relapse following discharge is a problem. Rates of longer-term abstinence vary, but generally half or fewer of smokers who quit following their cardiac event are still abstinent at 6 to 12 months later (Berndt et al., 2013; Newsom et al., 2012; Larsen et al., 2011; Attebring et al., 2004). When smoking status is biochemically verified, allowing for an objective, rigorous measurement of smoking status, quit rates are even lower (e.g. 30%, Chouinard and Robichaud-Ekstrand, 2007; 22%, Johnston et al., 2004).

Smoking After an Acute Cardiovascular Event

Smoking status following an acute cardiac event is a powerful predictor of future morbidity and mortality. Among smokers hospitalized for acute coronary syndrome, those who quit have markedly lower rates of major adverse cardiac events (RR 0.61) and mortality (RR 0.49) compared to those who continue smoking (Boggon et al., 2014). In a large, multi-country study, quitting smoking was associated with a markedly reduced incidence of myocardial infarction (OR 0.57) over a 6-month period (Chow et al., 2010). In another rigorous study where smoking status was biochemically verified, the risk of recurrent cardiovascular disease events was reduced by 40% within one year of smoking cessation (Twardella et al., 2004). Meta-analyses show that in patients with CHD, smoking cessation is associated with significant decreases in mortality and recurrent myocardial infarction (OR 0.54; Wilson et al., 2000); those who quit benefit from a 36% reduction in crude relative risk of mortality regardless of age, sex, index cardiac event, country, or year of study (Critchley et al., 2003). Quitting smoking is considered the single most effective way to decrease risk of future morbidity and mortality following an acute cardiac event (Perk et al., 2012).

Benefits of Cardiac Rehabilitation

Cardiac rehabilitation (CR) is a treatment model designed specifically for individuals who have had a major cardiac event or have an established history of chronic heart disease. It includes a structured exercise program, usually lasting several months, and is combined with educational and behavior-modifying interventions focused on improving dietary and lifestyle habits (Ades, 2001; Hamm et al., 2011). The American Heart Association and the American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR) recognize that CR is an integral part of comprehensive care for patients with CHD (Balady et al., 2007). CR programs vary in length but generally consist of 24–36 sessions held 2–3 times weekly over 3–4 months (Wenger, 2008). Perhaps the most important element of CR is an individualized, structured, progressive exercise program (preferably initially supervised) that needs to be continued long-term (Ades, 2001). Additional elements include counseling to help improve adherence to diet and medication recommendations while minimizing the psychological effects of coronary illness. Only occasionally do CR programs offer specific behavioral and pharmacological interventions for smoking cessation (Balady et al., 2007).

CR is highly effective at reducing morbidity and mortality rates following a myocardial infarction (MI) or coronary revascularization, while also reducing disability and promoting a healthy, active lifestyle (Clark et al., 2004; Taylor et al., 2004; Wenger, 2008). Participation in CR results in a 31% reduction in cardiac re-hospitalizations over a 12-month horizon and a 26% decrease in cardiac mortality over 3 years (Taylor et al., 2004; Heran et al., 2011). Thus benefits of participation accrue rapidly and limit rehospitalization costs (Heran et al., 2011). These effects of CR are also dose dependent, with reductions in mortality increasing with the number of sessions attended and with adherence to risk factor reduction strategies (Suaya et al., 2009; Hammill et al., 2010).

The benefits of CR reach beyond reduced risks for morbidity and mortality with measures of anxiety, depression, self-confidence, and patient-reported quality of life all improve after CR (Ades, 2001). Other benefits of CR with strong empirical support include improvements in symptoms, tolerance for exercise, psycho-social well-being and stress reduction (Wenger, 2008), all of which facilitate returning to work as well as resumption of active recreational activities (Dugmore et al., 1999).

Smoking Status and Cardiac Rehabilitation Participation

Given that smoking cessation and CR attendance are both effective at reducing morbidity and mortality, interactions between these types of behavior change are of great interest. Ideally patients would both attend CR and stop smoking. However, continued smoking following a cardiac event tends to co-exist with failure to change other unhealthy behavior patterns such as improving diet or exercise habits (Chow et al., 2010; Hahn et al., 2014; Kuhl et al., 2009). These same negative relationships between smoking and participating in healthy behavior change could also be present in how patients access CR.

Of interest is how smoking status affects the likelihood of accessing cardiac rehabilitation. The process of patient involvement in CR can be broken into three parts: 1. Referral: Was

the patient referred to CR by the health care-provider following their cardiac event? 2. Attendance: Did the patient attend even one session of CR? 3. Adherence: Did the patient complete their recommended course of CR? A systematic literature search was conducted to examine associations between smoking status and these three aspects of CR.

Methods

The online databases PubMed, PsychINFO and Web of Knowledge were systematically searched using the search terms smoking and cardiac rehabilitation. Additional potential reports were identified by using Google Scholar where the search terms were combined with terms indicative of participation in CR (referral, attendance, participation, adherence, and dropout). Publications were restricted to what is commonly known as “Phase 2” CR. These programs are distinct from “Phase 1” rehabilitation, which takes place in the hospital and “Phase 3 CR” which is a long-term maintenance program. Phase 2 CR begins shortly after hospital discharge and generally lasts 3 to 4 months. All publications prior to July 1st, 2014 were considered. Full texts of these articles were independently reviewed for inclusion by two authors (DEG, AYC) and any discrepancies resolved. Additionally, reference sections of relevant articles were reviewed for other relevant citations that were evaluated for possible inclusion. In total, 701 articles were identified as potentially relevant. Studies were included if the following criteria were met: results were published in a peer-reviewed journal in English, data were reported on CR referral, attendance or completion rates, smoking was included as a possible variable associated with these outcomes, the statistical significance of the effect of smoking status was reported, and the program being studied was “Phase 2” CR. With these criteria, 56 studies were rated eligible for inclusion. The significance of associations between smoking status and CR referral, attendance, or adherence was defined as the original author’s determination of statistical significance. A criterion of $p < .05$ was used across most studies; the few exceptions are noted in the tables.

Results

Effects of Current Smoking Status on Referral to CR

Ideally individuals who have experienced a qualifying cardiac event would be referred to CR while in the hospital. Referral rates are not optimal, however, and one quality improvement project increased referral rates from 16.9% to 41.7% (Zhang et al., 2005). While not all patients are appropriate for CR, these referral rates still leave room for improvement. Referrals that are not made systematically leave room for bias and those who get referred may differ significantly from those who do not. We assessed whether smoking status was associated with differences in CR referral rates.

Six studies were identified that provided data on smoking status and referral rates (Table 1). Three (50%) reported that current or recent smoking significantly increased a patient's chance of being referred to CR (Aragam et al., 2011; Brady et al., 2013; Brown et al., 2009). Two studies (33%) found no significant association between smoking status and referral (Bittner et al., 1999; Kotseva et al., 2013). Additionally, one study (17%) found a significant negative relationship between smoking status and referral (Barber et al., 2001). While more data on this issue are clearly needed, it appears that reporting current smoking may increase

a patient's probability of CR referral. This is in contrast to other risk factors such as obesity and diabetes that generally reduce the likelihood of a patient receiving all available therapies, including referral to CR (Motivala et al., 2011).

Effect of Smoking on CR Participation/Attendance

After a patient has been referred to CR, he or she must decide whether to attend. This is a potential point of self-selection as not all referred patients attend CR. One common metric for reporting attendance is determining whether a patient attends at least one CR session. Thirty-three studies provided data about the characteristics for those who did versus did not attend at least one CR session (see Table 2).

Thirteen studies (39%) provided evidence that smokers were significantly less likely to attend even one session (Ades, Huang et al., 1992; Deskur-Smielecka et al., 2009; Fontana et al., 1986; Goel et al., 2011; Kerins et al., 2011; Kotseva et al., 2004; 2013; Lindsay et al., 2003; Redfern et al., 2007; Taylor et al., 2001; Turk-Adawi et al., 2014; Tzou et al., 2004; Weingarten et al., 2011). In eighteen studies (55%) there was no significant association between smoking status and attendance (Beauchamp et al., 2012; Blackburn et al., 2000; CDC, 2003; Cooper et al., 1999; Dunlay et al., 2009; Evenson et al., 1998; Farley et al., 2003; Fridlund et al., 2000; Grace et al., 2007; 2008; Harlan et al., 1995; Higgins et al., 2008; King et al., 2001; Lane et al., 2001; Pasquali et al., 2003; Ramm et al., 2001; Salamonson et al., 2007; Whitmarsh et al., 2003). Lastly, in two additional studies (6%) smoking was a positive predictor of CR attendance (King et al., 1999; Witt et al., 2004).

In summary, most studies (55%, 18/33) did not find a significant association between smoking status and attendance. However in the 15 studies that found a significant positive or negative relationship between smoking and CR attendance 87% (13/15) found that smoking predicts CR non-participation. Variability could be due in part to how smoking was assessed in each study (Table 2). Smoking definitions varied from "current or former smoker" to "smoked in the last 12 months" to "current smoker". Quality of assessment also varied considerably, with some studies relying on hospital records, others on self-report, and with almost no studies biochemically verifying smoking status. Future studies looking at attendance and smoking might be improved by having very specific definitions of smoking status (i.e. differentiating between never smokers, former smokers, those who have recently quit, and current smokers) and, if possible, biochemically verifying smoking status.

Effect of Smoking on Adherence/Dropout

The number of CR sessions attended is also of interest. As noted above, the benefits of CR appear to accrue in a dose-dependent fashion (Hammill et al., 2010; Suaya et al., 2009), with those dropping out early not benefiting as much from CR as those who complete the whole program. Twenty-one studies provided data on smoking status and CR completion (see Table 3). In all studies reviewed number of sessions completed was examined only in those who had at least entered the CR program.

In thirteen of the 21 studies (62%), smoking significantly predicted early dropout (Beauchamp et al., 2012; Beckie et al., 2010; Digenio et al., 1992; Dorn et al., 2001; Kerins et al., 2011; Marzolini et al., 2008; Oldridge et al., 1978; Oldridge et al., 1983; Oldridge and

Streiner, 1990; Sanderson et al., 2003; Sarrafzadegan et al., 2007; Waites et al., 1983; Wittmer et al., 2012). In two other studies (10%), results also suggested a negative association of smoking and CR completion, but differences were not definitive. In one study the proportion of smokers did not differ between completers and dropouts, but smokers who dropped out were heavier smokers than those who did not (Eyherabide and Yates, 1985) and in the other smoking was only a significant predictor of dropout among men but not women (Worcester et al., 2004). In six of the 21 studies (29%) smoking status did not significantly predict dropout (Fontana et al., 1986; Oldridge et al., 1992; Sanderson and Bittner, 2005; Soleimani et al., 2009; Taylor et al., 1988; Yohannes et al., 2007. Overall, most studies (62%) demonstrated a significant association between smoking status and CR dropout and in no study was smoking a positive predictor of completion.

Discussion

Smoking status is robustly associated with how people access CR. While reporting smoking on hospital admission may make referral to CR more likely, those who smoke appear to be less likely to attend even a single CR session and are much more likely to drop out if they do attend.

The process underlying the association between smoking status and accessing CR likely differs at these different time points. During referral, an increase in referral for smokers would be logical, as those with greater risk factor burdens seem high priority targets for additional services. The association between smoking and CR attendance and CR dropout is likely different than CR referral, as accessing CR is dependent on the patient's behavior rather than the physician's. While smoking status may directly affect how patients access CR there is likely a third variable that underlies these associations. Smoking is much more prevalent among those with lower educational attainment and those living below the poverty line (Garrett et al., 2013). As such, smoking may be serving as a marker of other patient characteristics that may limit CR attendance such as limited education, lack of financial resources, or transportation issues. As clinical databases rarely include characteristics such as financial standing or educational attainment, smoking may be serving as a reasonable proxy for these other variables.

Another characteristic potentially influencing CR attendance is gender. While more males than females have diagnoses that qualify them for CR, women do appear to access CR at lower rates than men. Studies have demonstrated that women appear to have lower referral rates (Colella et al., 2015), are less likely to attend CR (Samayoa et al., 2014), and are potentially less likely to complete CR (Colbert et al., 2014; but see Turk-Adawai, et al., 2013). Given that women are underrepresented in these studies, drawing conclusions about the relationship between smoking and CR participation in women should be done cautiously.

While other variables are likely responsible for the association between smoking and CR attendance there is reason to think that at least in regards to early dropout there may be a partial direct contribution of smoking to these outcomes. The relationship between smoking and dropping out of CR seems particularly strong, even in studies examining multiple possible predictors of dropout in multivariate analyses (Oldridge et al., 1983; Wittmer et al.,

2012) and considering the physiological effects of continued smoking on exercise capacity (e.g. Smarz et al., 2012), smoking status may indeed directly increase dropout rates.

Effects of smoking on CR benefits

It is certainly reasonable to think that smoking may undermine CR participation in that smoking may make exercise more difficult, or interfere with improvements in fitness such that smokers do not feel like they are benefiting from CR or become frustrated with their progress and thus stop attending. As suggested above, there is evidence to support this view. First, smoking has known effects on cardiopulmonary function that make aerobic activities more difficult. For example, current smokers have decreased oxygen uptake at peak exercise (Smarz et al., 2012) and impaired ventilatory efficiency and lower peak heart rates (Sven et al., 2010). Also, the gains from CR may not be apparent to smokers. At least one study reported that current smokers perceive that their current cardiac health did not significantly improve during CR (Tzou et al., 2004). Also important to consider is that smoking cessation is viewed as especially challenging by CR patients. For example, cardiac patients are more optimistic about their ability to begin regular exercise than their ability to quit smoking (Johnston et al., 2004) and their inability to quit is a source of frustration, which they report interferes with completion of their other health-related behavior-change goals (Grace et al., 2005).

There is a literature that suggests that indeed smokers do not benefit as much from CR as non-smokers. Short-term intensive CR can improve metabolic syndrome parameters, but only in non-smokers (Mlakar et al., 2013). This lack of gains could be a result of a variety of factors, for example, smokers spend fewer minutes exercising per session in CR than non-smokers (Digenio et al., 1992). Regardless of the proximal cause, current smokers are less likely to reach maximal capacity exercise goals at the end of CR (Weinberger et al., 2014) and current smoking is associated with less gain in health-related quality of life (Oldridge et al., 1998). There is also compelling evidence that smoking directly inhibits fitness gains. One study examined the effects of continued smoking versus abstinence in 600 smokers enrolled in smoking-cessation trials (Asthana et al., 2012). Even after controlling for possible covariates, smokers had lower fitness scores than abstainers. Only abstainers had measurable improvement in fitness suggestive of an improved CVD profile (lower exercise capacity, lower HR reserve, and a blunted exercise HR response).

Health Risks of Continued Smoking

Regardless of the nature of the association between smoking status and CR attendance, smoking during CR is of significant concern. Compared to nonsmokers, smokers are more likely to suffer medical events during and following completion of CR. In one study on risks of serious complications during CR, the only significant predictor of complications was current cigarette smoking (17% of complication group vs. 1% of the non-complication group; Paul-Labrador et al., 1999). Smoking is also a strong predictor of recurrent CV events following CR (Griffo et al., 2013) and eventual mortality (Kavanagh et al., 2002). Considering the robust negative associations of smoking and CR completion, together with the unequivocal health benefits of smoking cessation, an increased focus on smoking-cessation in CR patients is warranted.

Implications for Supporting Cardiac Patients who Smoke

Given the negative health effects of continued smoking and the potential negative effects of smoking on CR attendance and adherence, increased attention should be paid to cardiac patients who report smoking, even before they are entered into a CR program. If a patient reports smoking while in hospital that could trigger a flag that the patient may need additional support achieving secondary prevention goals in general. Patients could be queried about potential areas needing support, are they in need of transportation vouchers to make follow-up visits, home nurse visits, or reduced cost medications? Patients who smoke may have greater needs and stronger support in hospital could help them achieve more secondary prevention goals upon returning home.

Smoking cessation should, of course, be a focus during hospitalization. Several approaches could be taken in the hospital to provide additional support. Patients could be offered prescriptions for smoking cessation medication, provided with nicotine replacement therapy, or referred to smoking cessation programs. However, while cessation support is generally offered to hospitalized patients, support following discharge is rare (Boggon et al., 2014). Ideally hospitals would provide an intensive smoking cessation program that built off the initial abstinence achieved by being hospitalized. This program would then be continued in the months following discharge and would help bridge the transition of returning home and promote maintained cessation.

Patients who report smoking will likely also need support in attending CR. Patients who smoke should be given strong recommendations to attend CR. They could be told that continued smoking puts them at increased risk of a future event making it is even more important that they attend CR. Strong physician referrals are a powerful predictor of CR attendance (Balady et al., 2011) and an increased emphasis on referral could get more smokers at CR. Additionally, CR programs should have intensive ongoing support available for smoking cessation. This could be provided as group educational sessions focused on cessation support with individualized counseling available as needed, pharmacologic support when indicated, and frequent monitoring with long-term follow up and support in place in case of relapse. The provision of an intensive cessation support program in CR could have multiple benefits: the presence of such a program could entice more smokers to attend CR and the increased support for cessation they receive could encourage them to remain in the CR program generally.

Conclusion

Smoking status is robustly associated with how people access cardiac rehabilitation. While reporting smoking on hospital admission may increase the rate of referral to CR, those who smoke are less likely to attend even a single session of CR and are much more likely to drop out prior to completion if they do attend. The issue of smoking following a coronary event deserves renewed attention.

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Highlights

Those who smoke may be more likely to be referred to CR but less likely to attend.

Those who smoke are much more likely to drop out of CR.

Smoking in patients following a coronary event deserves increased attention.

Table 1

The effects of reported smoking status on likelihood of referral to a cardiac rehabilitation program.

Author	Year	Location	*n*	sex	Effect Direction	Size of Effect
Brady et al.	2013	Ontario, Canada	3,739	76% M	*+	Smokers more likely to be referred (AOR 1.53)
Brown et al.	2009	156 hospitals in USA	72,817	68% M	*+	Smokers more likely to be referred (AOR 1.10)
Aragam et al.	2011	Michigan, USA	145,661	66% M	+	Within those referred 27.4% were smokers vs. 24.9% within those not referred
Bittner et al.	1999	Alabama, USA	995	65% M	=	13.8% smokers referred vs. 10.2% of nonsmokers
Kotseva et al.	2013	76 centres in Europe	8,845	76% M	=	31.6 % smokers referred vs. 29.0% of nonsmokers
Barber et al.	2001	Michigan, USA	347	64% M	−	9.4% of smokers referred compared to 13.9% of nonsmokers

Note: Significance is defined as the original author's determination of statistical significance. A criterion of $p < .05$ was used across all studies. A + denotes a significant positive association, an = denotes no significant relationship and a – denotes a significant negative association. An * denotes studies using multivariate analyses that accounted for other common predictors of attendance such as age, gender and qualifying diagnoses.

Table 2

The effects of reported smoking status on likelihood of attending even one session at a cardiac rehabilitation program.

Author	Year	Location	*n*	sex	Effect Direction	Size of Effect	Smoking Definition
Turk-Adawi et al.	2014	Wisconsin, USA	6,874	69% M	*−	Smokers less likely to attend (AOR) 0.59	Smoked in last 12 months
Kotseva et al.	2013	76 centres in Europe	3,950	77% M	* −	33.3% of non-attenders smoked vs. 28.1% of attenders	Smoked in month prior to event
Goel et al.	2011	Minnesota, USA	2,395	68% M	* −	Current smokers less likely to attend (OR 0.68)	Current smoker, no definition, but distinct from former
Weingarten et al.	2011	Minnesota, USA	450	66% M	* −	Current smoking predictive of failure to enroll (AOR 3.38)	Current smoker based on hospital record
Taylor et al.	2001	Bristol, UK	187	79% M	* −	Current smokers less likely to attend (AOR 0.39)	Still smoking at discharge
Kotseva et al.	2004	47 centres in Europe	2,382	78% M	−	22.4% of non-attenders smoked vs. 18.7% of attenders	Smoked in month prior to event
Ades, Huang et al.	1992	Vermont, USA	580	87% M	−	38% of non-attenders smoked vs. 14% of attenders	Reported current smoking while in hospital
Tzou et al.	2004	Wisconsin, USA	630	Unknown	−	30.5% of non-attenders smoked vs. 13.6% of attenders	Smoked in last 12 months
Deskur-Smielecka et al.	2009	Poland	70	73% M	−, p = .052	None of those who continued smoking attended	Continued smoking after event
Redfern et al.	2007	Sydney, Australia	446	76% M	−	21% non-attenders smoked vs. 1% of attenders	Current, self-report confirmed by CO
Kerins et al.	2011	Dublin, Ireland	268	72% M	−	37% non-attenders smoked vs. 10% of attenders	Self-reported "smoker"
Fontana et al.	1986	Connecticut, USA	95	100% M	−	Smokers half as likely to attend	Smoked in last 6 months
Lindsay et al.	2003	Glasgow, UK	183	Unknown	−	43% non-attenders smoked vs. 14% of attenders	Current smoker at time of event
Lane et al.	2001	London, UK	263	75% M	*=	Current smoking not significantly associated with attendance (OR 0.80)	Current at time of hospitalization
Harlan et al.	1995	North Carolina, USA	393	76% M	*=	Only non-attenders reported any daily smoking	Current cigarettes per day
Higgins et al.	2008	Melbourne, Australia	184	78% M	*=	13% non-attenders smoked vs. 8% of attenders	Current smoker, no definition but distinct from former
Ayala et al.	2003	19 states and DC, USA	720	63% M	*=	24.5% non-attenders smoked vs. 19.3% of attenders	Current smoker, no definition but distinct from former
Blackburn et al.	2000	Ohio, USA	3,331	70% M	*=	19% non-attenders smoked vs. 16% of attenders	Current smoker, from clinical record

Author	Year	Location	*n*	sex	Effect Direction	Size of Effect	Smoking Definition
Pasquali et al.	2003	North Carolina, USA	700	64% M	*=	61.1% non-attenders smoked vs. 57.0% of attenders	"History of smoking"
Cooper et al.	1999	London, UK	137	77% M	*=	Equal percent of never smokers in attenders and non-attenders (27%)	Past, present or never smoker
Dunlay et al.	2009	Minnesota, USA	179	66% M	*=	17.2% non-attenders smoked vs. 21.7% of attenders	Current smoking from hospital record
Grace et al.	2007	Ontario, Canada	506	77% M	*=	Current smoking not significantly associated with attendance (OR 1.36)	Current smoking after event
Grace et al.	2008	Ontario, Canada	1,490	72% M	*=	7.8% non-attenders smoked vs. 8.6% of attenders	Smoking in last 3 months
Farley et al.	2003	Adelaide, Australia	165	71% M	*=	No difference in attendance for smokers (OR 0.96)	Combined current and former smokers
King et al.	2001	Western Canada	304	76% M	*=	Smoking status not significantly associated with attendance (OR 0.67)	Smoked in last 3 months
Whitmarsh et al.	2003	UK	93	80% M	*=	58% of non-attenders smoked vs. 65% of attenders	Smoked prior to MI - may combine recent quitters with distant quitters
Evenson et al.	1998	Minnesota, USA	2,150	63% M	*=	Smoking rates similar in attenders (35%) and non-attenders (34%)	Current smoker, no definition but distinct from former
Salamonson et al.	2007	New South Wales, Australia	106	73% M	=	16% non-attenders smoked vs. 6% of attenders	Current at time of hospitalization
Ramm et al.	2001	Auckland, NZ	324	74% M	=	Data not provided	Smoking status at admission to hospital
Fridlund et al.	2000	Sweden	240	0% M	=	23% non-attenders smoked vs. 24% of attenders	Smoking: yes/no? Not defined
Beauchamp et al.	2013	Melbourne, Australia	544	73% M	=	Smoking rates similar in attenders (23%) and non-attenders (22%)	Currently smokes at least the occasional cigarette
King et al.	1999	Western Canada	1,245	77% M	*+, criterion not specified	Current smokers more likely to attend (OR 1.51)	Smoked in last 3 months
Witt et al.	2004	Minnesota, USA	1,821	58% M	*+	Current smokers more likely to attend (OR 2.22)	"Current smoker" - no definition

Note: Significance is defined as the original author's determination of statistical significance. A criterion of $p < .05$ was used across all studies unless specifically noted otherwise. A + denotes a significant positive association, an = denotes no significant relationship and a − denotes a significant negative association. An * denotes studies using multivariate analyses that accounted for other common predictors of attendance such as age, gender and qualifying diagnoses.

Table 3

The effects of reported smoking status on likelihood of dropping out of a cardiac rehabilitation program.

Author	Year	Location	*n*	sex	Effect Direction	Size of Effect
Oldridge & Streiner	1990	Canada	120	100% M	*+	15.5% of completers were current smokers vs.
Oldridge et al.	1983	Canada	733	100% M	*+	37.1% of dropouts Smokers more likely to drop out (AOR 2.46)
Dorn et al.	2001	6 states and DC, USA	931	100% M	*+	r −0.21 between current smoking and program compliance (completing 50% or more sessions)
Beckie et al.	2010	Southeastern US	252	0% M	*+	Smokers attend 4 fewer sessions on average
Sarrafzadegan et al.	2007	Iran	1,115	77% M	*+	Nonsmokers more likely to complete (AOR 1.779)
Wittmer et al.	2011	Switzerland	2,371	85% M	*+	Smokers more likely to drop out (AOR 2.338)
Marzolini et al.	2008	Toronto, Canada	5,922	82% M	*+	Smokers more likely to drop out (AOR 2.307)
Sanderson et al.	2003	Alabama	526	65% M	*+	Smokers more likely to drop out (AOR 2.1)

Author	Year	Location	*n*	sex	Effect Direction	Size of Effect
Digenio et al.	1992	South Africa	711	Unknown	*+	Percent attendance current smoker (45.96%) lower than non and former (57.84–59.76%)
Beauchamp	2013	Melbourne, Australia	281	73% M	+	More low attenders were current smokers (40%), than were high attenders (18%)
Kerins et al.	2011	Ireland	187	71% M	+	9.6% of completers smokers vs. 31.4% of dropouts
Oldridge et al.	1978	Hamilton, Canada	163	100% M	+	43% of compliers and 58% of noncomplier s were smokers
Waites et al.	1983	Atlanta, Georgia	22	86% M	+, criterion not specified	No smokers completed the program
Eyherabide and Yates	1985	Wisconsin	236	81% M	*+/=	Smokers in best attending group smoked 12.2 cigs per day vs 35 in worst attending
Worcestor et al.	2004	Melbourne, Australia	573	70% M	*+/=	Current smoking predicts drop out in men (AOR 3.33), but not in small sample of women

Author	Year	Location	*n*	sex	Effect Direction	Size of Effect
Sanderson and Bittner	2005	Alabama	228	0% M	* =	Smokers less likely to complete program (AOR 0.4)
Taylor et al.	1988	California	97	100% M	* =	Adherence lower in current smokers (80%) than in non and former smokers (88–89%)
Yohannes et al.	2007	Manchester, UK	189	74% M	* =	26.2% of drop-out patients were smokers vs. 16.3% of completers
Oldridge et al.	1992	Wisconsin	492	68% M	* =	Both smokers and nonsmokers completed about 75% of sessions
Soleimani et al.	2009	Iran	1,986	73% M	=	23.9% of dropouts smoke compared to 21.6% of completers
Fontana et al.	1986	Connecticut	95	100% M	=	Raw data not provided

Note: Significance is defined as the original author's determination of statistical significance. A criterion of $p < .05$ was used across all studies unless specifically noted otherwise. A + denotes a significant positive association, an = denotes no significant relationship and a +/= denotes that significant effects were found in one subset of a population but not another. An * denotes studies using multivariate analyses that accounted for other common predictors of completion such as age, gender and qualifying diagnoses.