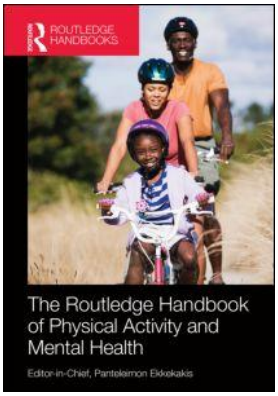

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Ana M. Abrantes, Stephen Matsko, Jessica Wolfe, Richard A. Brown
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32

PHYSICAL ACTIVITY AND ALCOHOL AND DRUG USE DISORDERS

Ana M. Abrantes, Stephen Matsko, Jessica Wolfe, and Richard A. Brown

Prevalence

Alcohol and drug use disorders are a major, global public health problem. Rates of use, abuse, and dependence are also high worldwide (Kessler et al., 2007). Approximately 8.9% of Americans aged 12 and older meet criteria for either substance abuse or dependence in the last year (Substance Abuse and Mental Health Services Administration, 2010). In Finland, 14.2% of young adults meet criteria for a lifetime substance use disorder (Latvala et al., 2009). In Japan, approximately 10.2% of the adult population has a lifetime alcohol use disorder (Orui, Kawakami, Iwata, Takeshima, & Fukao, 2011). Individuals with alcohol and drug use disorders experience significant mental health problems such as depression and anxiety as well as a number of negative health-related consequences, including health problems (Bloss, 2005), interpersonal violence (Stuart, 2005; Thompson & Kingree, 2006), risky sexual behavior (Justus, Finn, & Steinmetz, 2000), driving while under the influence (Cherpitel & Ye, 2008), and suicide (Wilcox, Conner, & Caine, 2004).

A number of treatment approaches for alcohol and drug use disorders have been shown to be effective, including cognitive behavioral therapies, 12-step programs, relapse prevention skills training, and pharmacotherapy (McGovern & Carroll, 2003). Despite the success of these approaches, relapse remains a major problem (Xie, McHugo, Fox, & Drake, 2005). Therefore, given the high prevalence of alcohol and drug use disorders as well as the associated economic impact, comorbidity, and mortality, it is crucial that accessible, affordable, and efficacious treatments to address drug and alcohol dependence continue to be developed.

The problem of relapse and the role of "lifestyle modification" in relapse prevention

In articulating their relapse model, Marlatt's (1985) primary focus was on the individual's ability to cope with situational factors that may precipitate relapse, and the need to deal with the negative cognitive-affective reactions following an initial lapse. An important aspect of this relapse model is the role of increasing lifestyle balance in preventing relapse (Marlatt & Witkiewitz, 2005). In the chapter on "Lifestyle Modification," Marlatt cites exercise as "a highly recommended lifestyle change activity" (Marlatt, 1985, p. 309) and discusses the advantages of physical activity as a

relapse prevention strategy. Other writers have agreed that lifestyle-enhancing factors such as exercise and fitness may play an important role in the prevention and treatment of addictive disorders (Taylor, Sallis, & Needle, 1985; Tkachuk & Martin, 1999). For example, Larimer and colleagues (1999) describe the importance of helping the client develop "positive addictions" such as increased physical activity and meditation. Although lifestyle modification was one of the main components in Marlatt's relapse prevention model (Marlatt & Witkiewitz, 2005), the treatment outcome literature suggests that this component has received the least emphasis in relapse prevention programs for alcohol and drug dependence. Despite this lack of attention in the empirical literature, methods that attempt to foster healthy lifestyle changes may contribute to long-term maintenance of recovery, and interventions targeting physical activity, in particular, may be especially valuable as an adjunct to alcohol and drug use treatment.

Epidemiology of the relationship between physical activity and alcohol and drug use

There is a strong body of evidence pointing toward the significant deleterious effects of physical inactivity with respect to morbidity and mortality (USDHHS, 1996). The association between alcohol and drug use in relation to physical activity has been examined among adults and adolescents with large representative samples both cross-sectionally and longitudinally. Across a number of studies, alcohol use appears to be positively correlated with physical activity among adults (French, Popovici, & Maclean, 2009; Smothers & Bertolucci, 2001). However, at hazardous levels of drinking, physical activity decreases (Liangpunsakul, Crabb, & Qi, 2010). Similarly, while adolescents involved in competitive sports may have higher rates of alcohol consumption, physical activity outside competitive sports is related to decreased alcohol use (Peretti-Watel, Beck, & Legleye, 2002; Tur, Puig, Pons, & Benito, 2003). Interestingly, young adults in college demonstrate a somewhat different relationship, where binge drinking is associated with greater levels of physical activity (Vickers et al., 2004) and those who exercise regularly drink alcohol at significantly higher quantities than infrequent exercisers (Moore & Werch, 2008). With respect to illicit drug use, while the relationship between drug use and physical activity has yet to be examined in adults, youth engaging in regular physical activity use drugs at much lower levels than their sedentary counterparts (Duncan, Duncan, Strycker, & Chaumeton, 2002; Pate, Trost, Levin, & Dowda, 2000; Peretti-Watel et al., 2002).

Several studies have attempted to examine the directionality of the relationship between physical activity and substance use. For example, data collected from 11,741 high school seniors followed until 26 years of age showed that the extent of exercise participation in high school was associated with lower substance use frequency in high school and into early adulthood (Terry-McElrath & O'Malley, 2011). Similarly, in a sample of 4,240 twins in Finland, low levels of physical activity at ages 16–18 years were predictive of greater alcohol and illicit drug use at later timepoints (ages 22–27 years), even when controlling for familial factors (Korhonen, Kujala, Rose, & Kaprio, 2009). Further, in a 4-year prospective, longitudinal community study of 2,548 adolescents and young adults (ages 14–24), regular physical activity was significantly associated with decreased risk of substance use disorders (Strohle et al., 2007).

With respect to the extent that individuals with alcohol and drug use disorders engage in physical activity, information is limited. Data examined from the National Comorbidity Survey in the United States (n=5,877) showed that 63.5% of the alcohol-dependent respondents and 58.5% of the substance-dependent respondents reported regular physical activity (Goodwin, 2003), which did not significantly differ from the rates found among the general population without a mental disorder (60.3%). However, among substance abusing patients in addiction

treatment, the rates of regular physical activity have been reported to be much lower (24% in Weinstock, Barry, & Petry, 2008, and 25% in Read & Brown, 2003).

In summary, alcohol (at problematic levels) and drug use are associated with lower levels of physical activity. Physical inactivity during adolescence has also been found to be predictive of higher levels of alcohol and drug use in adulthood. As such, alcohol- and drug-dependent patients in substance abuse treatment may benefit from increasing their levels of physical activity during and following treatment.

The role of exercise in addiction recovery: what has been done?

Alcohol use

There have been a small number of studies that have examined the effects of exercise in individuals with alcohol and drug use problems or disorders. In one of the first studies, Sinyor and colleagues (1982) engaged patients receiving inpatient alcohol rehabilitation treatment in 6 weeks of "tailored" exercise, consisting of progressively more rigorous physical exercise including stretching, calisthenics, and walking/running. Exercise participants demonstrated better abstinence outcomes post treatment than did non-exercising participants. Significant differences between exercisers and non-exercisers continued at 3-month and 18-month follow-up.

A later study by Murphy and colleagues (1986) randomly assigned heavy-drinking college students to running, meditation, or no treatment control. At post-intervention, participants assigned to either of the intervention conditions (running or meditation) demonstrated significant decreases in quantity of alcohol consumption compared with control participants. A number of exercise intervention studies have also been conducted with problem drinkers, and while drinking outcomes were not examined or reported, reductions in depression and anxiety as well as increases in fitness levels were observed (Donaghy, Ralston, & Mutrie, 1991; Ermalinski, Hanson, Lubin, Thornby, & Nahormek, 1997; Frankel & Murphy, 1974; Gary & Guthrie, 1972; Palmer, Vacc, & Epstein, 1988; Tsukue & Shohoji, 1981).

In our own work (R. A. Brown et al., 2009), we explored the efficacy of an aerobic exercise intervention as an adjunct to addiction treatment for alcohol-dependent patients. The 12-week exercise intervention involved attending our fitness facility once a week to participate in moderate-intensity aerobic exercise supervised by an exercise physiologist, with the expectation that participants exercise independently an additional two to three other times during the week. The results of this pilot study (n=19) suggest that, compared with the mean pretreatment percent days abstinent (PDA), significant increases in PDA were observed at the end of the 12-week exercise intervention and at the 3-month post-intervention follow-up. In addition, participants demonstrated good adherence to the intervention.

Other drug use

There are also few published studies examining the efficacy of exercise in adults with drug dependence. In an early study of softball team participation among homeless veteran substance abusers, compared with controls those in the exercise condition demonstrated higher abstinence rates 3 months post-discharge (Burling, Seidner, Robbins-Sisco, Krinsky, & Hanser, 1992). In one small uncontrolled pilot study of an exercise intervention conducted with substance-abusing offenders in outpatient treatment (Williams, 2000), a 12-week intervention consisting of once-weekly strength training groups plus recommendations for exercise during the rest of the week was examined. While substance abuse outcomes were not presented in the results, the authors

reported that the 11 out of 20 participants who completed the intervention reported that exercise was helpful in maintaining abstinence. Other studies (Li, Chen, & Mo, 2002; Palmer, Palmer, Michiels, & Thigpen, 1995) have also demonstrated ancillary benefits related to improved anxiety and depression among substance abusers engaging in exercise. In addition, Li and colleagues (2002) found that, compared with pharmacotherapy, qigong therapy (a type of Chinese exercise involving slow, repetitive fluid movements) was associated with a more rapid detoxification of heroin.

In our own study (Brown et al., 2010) examining aerobic exercise as an adjunctive treatment for drug dependence, we found that following participation in a 12-week moderate-intensity aerobic exercise intervention, participants who attended at least 75% of the exercise sessions had significantly better substance use outcomes than those who did not. In terms of PDA for drug use, there was a significant increase and a trend towards increased PDA 3 months post-intervention. In addition, participants showed a significant increase in their cardiorespiratory fitness by the end of treatment.

A recent pilot study conducted in Denmark, in which participants took part in exercise groups three times a week for 2 to 6 months, found similar results (Roessler, 2010). Following the exercise intervention, which included both aerobic and group exercises (volleyball and badminton), participants reported a decrease in the urge to use substances from 65% to 47% as assessed by the Europe Addiction Severity Index. In addition, of the 20 participants who completed the intervention, when assessed "more than a year" following the exercise intervention, five reported no substance use and 10 reported reduced intake.

Another study examining cannabis use and aerobic exercise training reported decreases in daily cannabis use following the exercise intervention (Buchowski et al., 2011). In this pilot study, participants with cannabis dependence attended 10 exercise sessions over 2 weeks, during which they completed a 30-minute treadmill session. Significant changes in both cannabis craving and use were observed pre- to post-exercise.

Lastly, Weinstock and colleagues (2008) examined the extent to which exercise-related behaviors (e.g., buying a pair of sneakers) during a contingency management treatment for substance use disorders was related to abstinence outcomes in 187 outpatients. The results of the study revealed longer durations of abstinence for those who engaged in at least one exercise-related behavior during the 12-week contingency management intervention.

Adolescents

There exists scant research in the area of exercise interventions for adolescent populations with alcohol and drug use disorders. While Werch and colleagues (2003, 2005) have developed brief exercise interventions implemented in schools for the prevention of substance problems, much of the work in the area of introducing structured health promotion to adolescent substance abuse treatment has been conducted by Collingwood and colleagues (1991, 1994). Collingwood and colleagues (1991) conducted a study of a structured fitness program with adolescent substance abusers. The fitness program involved one to two meetings per week with an assignment to engage in two exercise sessions outside the meetings. Overall, participants showed improved physical fitness, reduced polysubstance use, and increased abstinence rates. In a larger-scale study, Collingwood, Sunderlin, and Kohl (1994) evaluated the effects of a fitness skills training program on substance use in a sample of approximately 1,500 "at-risk" adolescents. Although pre-post-data were available for only a subset of the sample, outcome data revealed general improvements in fitness and self-concept and in reduced substance use. Therefore, promising results have begun to emerge from these efforts to deliver exercise interventions to adolescent substance abusers.

Potential mechanisms

Exercise may benefit alcohol- and drug-dependent patients attempting recovery from substance problems through a number of different mechanisms of action. While none of the proposed mechanisms have been formally empirically tested, below is a description of some promising areas for further investigation. Possible neurobiological mechanisms are discussed in Chapter 33 by Smith and Lynch (this volume).

Reduced depressive symptoms

Although the relationship between substance use and depression is complex, studies in recent years have found an association between depressive symptomology and poor treatment outcome among patients with alcohol and drug use disorders (Brown et al., 1998; Nunes & Levin, 2004; Ouimette, Gima, Moos, & Finney, 1999; Poling, Kosten, & Sofuoglu, 2007). Physical activity has consistently been shown to have a positive impact on depressive symptoms across a broad array of populations (Dunn, Trivedi, & O'Neal, 2001; Doyne et al., 1987; Fremont & Craighead, 1987; Babyak et al., 2000).

Positive effects of exercise on psychological health have also been shown in individuals with alcohol and drug use disorders. For example, in studies where alcohol and drug use outcomes were not assessed, both aerobic and strength training exercise programs during the course of alcohol treatment have resulted in decreased depressive and anxiety symptoms (Frankel & Murphy, 1974; Palmer, Vacc, & Epstein, 1988; Palmer et al., 1995). Just as it has been found that improved drinking outcomes in alcohol-dependent patients receiving cognitive–behavioral treatment for depression were mediated by reduction of depressive symptoms (Brown, Evans, Miller, Burgess, & Mueller, 1997), so may exercise lead to improved drinking outcomes as a result of reductions in depressive and anxiety symptoms.

Positive mood states without use of alcohol or drugs

Through a pattern of escalating alcohol and drug use, dysregulation of brain reward pathways occurs (Froelich, 1997; Koob & Kreek, 2007; O'Malley et al., 1996). The brain attempts to compensate by producing less dopamine or reducing the number of dopamine receptors (e.g., Volkow et al., 2001). This, in turn, results in limited capacity of dependent individuals to experience pleasure in early recovery. Exercise has positive reinforcing properties that may be mediated by its effects on the endogenous opioid system and on dopaminergic reinforcement mechanisms (Meeusen, 2005). Further, more recent exercise intervention studies have shown that while decreases in negative affect are not always observed, significant increases in positive affect are consistently demonstrated (Brown, Liu-Ambrose, Tate, & Lord, 2009; Hoffman & Hoffman, 2008; Mutrie et al., 2007; Stroth, Hille, Spitzer, & Reinhardt, 2009). Therefore, alcohol- and drug-dependent patients in early recovery may find engaging in physical activity to be a viable means of experiencing pleasurable mood states and a positively reinforcing alternative to alcohol and drug use.

Decreased urges and coping-oriented motives

Urges to drink alcohol have been identified as an important relapse trigger for abstinent alcoholics (Monti, Rohsenow, & Hutchison, 2000). More recently it has been proposed that moderate-intensity exercise may provide short-term relief from urges to drink alcohol (Ussher, Sampuran,

Doshi, West, & Drummond, 2004). Therefore, decreases in urges to drink may mediate the effect of aerobic exercise on decreased likelihood for relapse.

In addition, recent studies have also examined the association between exercise and coping-oriented motives for alcohol and marijuana (Medina et al., 2011; Smits, Bonn-Miller, Tart, Irons, & Zvolensky, 2011). In one study, Medina and colleagues (2011) found that among trauma-exposed adults, vigorous-intensity exercise was inversely associated with their motivation toward using alcohol to cope. Similarly, Smits and colleagues (2011) found that, among young adult marijuana users, moderate-intensity exercise decreased anxiety sensitivity, which in turn decreased using marijuana as a coping strategy.

Improved cognitive functioning

Deficits in executive functioning, learning/memory, psychomotor speed, and visuospatial abilities (Ersche & Sahakian, 2007; Gruber, Silveri, & Yurgelun-Todd, 2007; Hildebrandt, Brokate, Eling, & Lanz, 2004; Jovanovski, Erb, & Zakzanis, 2005; Noel et al., 2007; Scott et al., 2007) are common neurocognitive consequences of chronic alcohol and drug use, and deficits in executive functioning may contribute to relapse in alcohol and drug use, especially given well-documented disinhibition and decision-making impairments that accompany early recovery (Baicy & London, 2007; Bowden-Jones, McPhillips, Rogers, Hutton, & Joyce, 2005). Regular physical activity is associated with both acute and sustained improvements in cognitive functioning (Stein, Collins, Daniels, Noakes, & Zigmond, 2007), particularly executive functioning (Coles & Tomporowski, 2008; Kramer & Erickson, 2007; Scisco, Leynes, & Kang, 2008; Sibley, Etnier, & LeMasurier, 2006). Therefore, increasing physical activity may result in critical improvements in regulation of attention, controlled information processing, and capacity for learning during early recovery for alcohol- and drug-dependent patients.

Improved sleep

Sleep disturbance is ubiquitous among those in early recovery (Brower, 2001; Stein et al., 2004). Indices of sleep disturbance have been found to be predictive of relapse to alcohol and drug use (Conroy et al., 2006; Liu, Xiaoping, Wei, & Zeng, 2000). Most often, sleep disturbances in early recovery are managed with pharmacotherapy. However, there has been reluctance among addiction experts to prescribe medication to patients in early recovery who are experiencing sleep disturbance (Friedmann et al., 2003). Exercise, on the other hand, has been considered an effective non-pharmacological treatment for sleep disturbance (Youngstedt, 2005) and it is feasible that it would have this benefit among those experiencing substance misuse.

Future directions

Relative to other areas of research, the role of exercise in alcohol and drug use recovery is still in its infancy. There is clearly much more research needed. Specifically, there is a critical need for well-designed, randomized controlled trials of clearly delineated exercise interventions, with objective measures of physical activity and biochemical verification of alcohol and drug use. In doing so, challenges related to recruitment and retention of patients in the exercise interventions (R. A. Brown et al., 2009, 2010; Roessler, 2010; Weinstock, 2010) must be addressed.

Weinstock (2010) identified factors that were associated with successfully initiating and maintaining an exercise program and these included social support, self-efficacy, motivation, having physical activity choices, goal setting and behavioral contracts, positive reinforcement,

and feedback. Another important consideration in addressing recruitment and retention issues involves the "fit" of the exercise intervention to the patient population. For example, substance-dependent patients in early recovery may be in a sensitive period of transition that can include attending numerous outpatient treatment sessions as well as 12-step meetings, rebuilding strained familial and personal relationships, finding new jobs, and addressing physical health problems that may have resulted from prolonged periods of substance use. They may have specific preferences regarding the timing, type, and structure of an exercise intervention that would influence adoption and maintenance of regular physical activity (Abrantes et al., in press). As a result, focusing future research efforts on identifying exercise preferences among substance-abusing populations may contribute to the development of exercise interventions that are not only effective but also more feasible to administer.

In addition, considering barriers, particularly lack of motivation, in the development of exercise interventions will be important for adherence and retention issues. Alcohol- and drug-dependent patients may benefit from the use of tools to help bolster motivation. For example, pedometers have been used to improve self-monitoring, facilitate goal setting, and enhance motivation in numerous exercise intervention studies (Croteau, 2004; Merom et al., 2007; Murphy, Nevill, Murtagh, & Holder, 2007). In addition, monetary incentives have been utilized in previous exercise intervention studies as a means of increasing motivation and adherence (Jeffery, Wing, Thorson, & Burton, 1998; Robison et al., 1992). Given that contingency management approaches have been efficacious in substance-abusing populations (Higgins & Petry, 1999), utilizing a similar approach within exercise interventions for patients in substance abuse treatment may be an effective strategy for increasing motivation in this population.

Consideration may need to be given to gender differences when developing intervention programs for alcohol- and drug-dependent patients. Gender differences often emerge with regard to the type of exercise that appeals to women versus men, as well as the perceived benefits of engaging in an exercise-based intervention (Abrantes et al., in press). For example, women typically find walking and aerobics more appealing than men, whereas men endorse greater interest in sports, strength training, and running (Booth, Bauman, Owen, & Gore, 1997). These patterns may be important to consider given that interventions may be most successful if they are either tailored directly for women versus men, or if they are flexibly designed so that appealing options are available for both gender groups.

Conclusion

Relapse continues to pose a major problem to the substance abuse treatment field as a whole and to individuals attempting recovery from alcohol and drug use disorders. Studies evaluating strategies to enhance maintenance of treatment gains have devoted relatively little attention to lifestyle modification, and research in the area of exercise and recovery from alcohol and drug use disorders is still scant. Many patients in substance abuse programs express interest in incorporating exercise into their recovery (Read et al., 2001). In light of the promising findings from these studies, more research is clearly needed in this area.

A physical activity intervention with demonstrated generalizability and the potential for dissemination would have important clinical and public health implications for the treatment of alcohol and drug use disorders and would provide some definite advantages. Exercise offers the potential for improved health and wellness, as the physiological (e.g., USDHHS, 1996) and psychological (e.g., Tkachuk & Martin, 1999) health benefits of exercise have been well documented. Exercise also has the potential to be cost-effective, flexible, and accessible; many forms of exercise may be conducted independently, and associated costs are likely to be minimal.

Finally, exercise has minimal side effects compared with pharmacological treatment (Broocks et al., 1998), and carries with it far less risk of adverse events than does the use of psychotropic medication. Given each of these benefits, alcohol- and drug-dependent individuals may be afforded a valuable adjunct to traditional addiction treatment that could enhance alcohol and drug use outcomes, improve psychological well-being, and increase fitness and the overall health of patients.

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