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Research paper

Effect of exercise augmentation of cognitive behavioural therapy for the treatment of suicidal ideation and depression

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ABSTRACT

Background: Suicidal ideation and depression are prevalent and costly conditions that reduce quality of life. This study was designed to determine the efficacy of exercise as an adjunct to cognitive behavioural therapy (CBT) for suicidal ideation and depression among depressed individuals.

Methods: In a randomized clinical trial, 54 mildly to moderately depressed patients (54% female, mean age = 48.25) were assigned to a combined CBT and exercise group or to a CBT only group. Both groups received one weekly session of therapy for 12 weeks, while the combined group also completed exercise three times weekly over the same period. Self-reported suicidal ideation, depression, and activities of daily living were measured at the beginning and the end of treatment.

Results: Multilevel modelling revealed greater improvements in suicidal ideation, depression, and activities of daily living in the combined CBT and exercise group, compared to the CBT only group.

Limitations: No follow-up data were collected, so the long-term effects (i.e., maintenance of gains) is unclear.

Conclusions: The findings revealed that exercise adjunct to CBT effectively decreases both depressive symptoms and suicidal ideation in mildly to moderately depressed individuals.

1. Introduction

Cognitive behavioural therapy (CBT) is one of the most widely used time-limited and effective interventions for treating depression and suicidal ideation (Brown et al., 2016; Charkhandeh et al., 2016; Cristea et al., 2015; Du et al., 2016; Hadjistavropoulos et al., 2016; Newby et al., 2016; Nyström et al., 2015). Depressive disorder is a serious and debilitating mental illness characterized by substantial impairment in functioning, including sleep disruption, reduced appetite, lack of self-care, poor concentration, loss of interest, sadness, decreased physical power, impaired motivation, and feeling of tiredness (World Health Organization, 2015). In Iran, the 12-month prevalence of the depressive disorder ranges from 15% to 25% (Aghakhani et al., 2011). The rate of suicide completion in depressive disorder is 2.1 times greater than that of the general population (Holma et al., 2010). Depression is an important predictor of suicidal ideation and suicide attempts (Walser et al., 2015), and research shows that reducing depression dramatically decreases the severity of suicidal ideation (Mann et al., 2005; Walser et al., 2015).

Suicide represents a global public health problem and contributes annually to 1.4% of the total burden of mental and physical diseases (World Health Organization, 2012). In Iran, suicidal behavior has increased dramatically over the past decades (Abdollahi and Abu Talib, 2015; Abdollahi and Talib, 2015b), with rates of suicide around 6.1/100,000 for Iranian males and 3/100,000 for females (Malakouti et al., 2009). Given that suicidal ideation is an important precursor to suicide (Abdollahi and Talib, 2015a), providing treatment to individuals suffering from suicidal ideation can play an important role in reducing suicide behavior.

CBT may alleviate suicidal ideation and depression by challenging

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and modifying maladaptive beliefs, increasing behavioural activation, and developing problem-solving skills (Beck and Dozois, 2011). Research suggests that CBT is most effective when delivered in 1–2 treatment sessions per week for 4–12 weeks (Huang et al., 2015; Strachowski et al., 2008).

Recently, exercise has been suggested as an effective means of alleviating a variety of mental health concerns (Asmundson et al., 2013; Nyström et al., 2015). Exercise is defined as planned, structured, and repetitive physical activities to increase the improvement and maintenance of physical fitness (Caspersen et al., 1985). Evidence suggests that while greater depression is associated with lower levels of physical activity, increasing physical activity can decrease depression (Mothes et al., 2014). This view is supported by Reed and Buck (2009), who highlighted the role of regular aerobic exercise in increasing feelings of well-being and suggested that its absence can have detrimental effects on physical and mental health. Exercise contributes to elevating the levels of serotonin, dopamine, and norepinephrine, which may alleviate depressive symptoms (Wright and Cattan, 2009). Recent studies have focused on the possible role of exercise in the management of depression (Harvey et al., 2010; Ström et al., 2013; Teychenne et al., 2008; Tulio et al., 2013) and have shown that it reduces symptoms of depression (Mota-Pereira et al., 2011) and anxiety (Powers et al., 2015). Although these results are promising, few studies have investigated the role of exercise in relation to suicidal ideation (Babiss and Gangwisch, 2009; Gartlehner et al., 2016) and additional studies regarding depression are warranted.

Because it is effective, safe, easily accessible, inexpensive, requires less clinician training to deliver, and carries a low risk of negative side-effects (Wright and Cattan, 2009), exercise could complement conventional approaches to treating suicidal ideation and depression, such as CBT (Cuijpers et al., 2013). Nonetheless, little research has been conducted on assess the effects of exercise in addition to CBT for suicidal ideation as well as depression (Brosse et al., 2002; Huang et al., 2015; Ströhle, 2009). Therefore, the present study was designed to assess the efficacy of CBT augmented with exercise on suicidal ideation and depression in a sample of Iranian individuals.

2. Method

2.1. Participants

Participants included depressed individuals from two psychology clinics in Tehran, Iran. Of the 77 individuals to whom participation in this study was suggested, 70 agreed. Participants had mild ($n=29$; 41.4%) to moderate ($n=41$; 58.6%) depression. Demographic characteristics of the participants at pre-intervention are presented in Table 1.

Table 1
Participant demographics.

Variable	CBT only	Combined CBT and exercise	Overall sample
	M (*SD*)		
Age	48.43 (6.83)	50.91 (7.43)	49.67 (7.19)
	n (%)		
Gender			
Men	16 (45.7)	21 (60.0)	37 (52.9)
Women	19 (54.3)	14 (40.0)	33 (47.1)
Marital status			
Single	10 (28.6)	9 (25.7)	19 (27.1)
Married	25 (71.4)	26 (74.3)	51 (72.9)
Level of education			
Elementary and junior	15 (42.9)	12 (34.3)	27 (38.6)
High school	8 (22.9)	12 (34.3)	20 (28.6)
Diploma	8 (22.9)	5 (14.3)	13 (18.6)
Academic	4 (11.4)	6 (17.1)	10 (14.3)

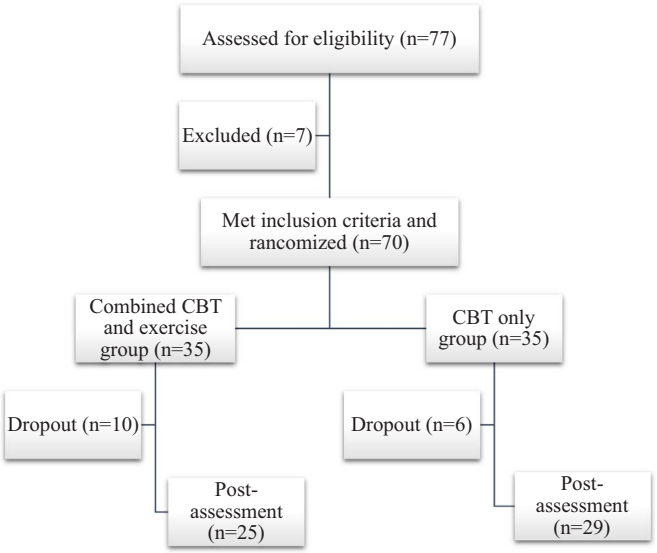

Fig. 1. Consort flow chart for the recruitment process.

We conducted *a priori* power analyses according to statistical formulae by Röhrig et al. (2010). An α level of 0.05 and β of 0.10 yielded a recruitment goal of 35 participants per group. The process of recruitment of participants is shown in Fig. 1.

Participants were randomly assigned using a permuted block randomization method to either a combined CBT and exercise group ($n=35$) or to a CBT only group ($n=35$), described below. Dropouts included 10 participants from the combined CBT and exercise group and 6 participants from the CBT only group (see Fig. 1). In the combined CBT and exercise group, reasons for dropout included muscle cramps (3 participants), traveling to different city (2 participants), and lack of interest in continuing with the exercise program (5 participants). In the CBT only group, reasons for dropout included declining to complete questionnaires (3 participants), travel (2 participants), and lack of interest in continuing participation (1 participant).

2.2. Inclusion and exclusion criteria

The inclusion criteria included being sedentary, defined as exercising less than three times per week for less than 20 min, being able to understand and sign the written informed consent, and having a formal diagnosis of a major depressive episode. The Barthel Index of Activities of Daily Living (BAIDL; Collin et al., 1988) was used by a trained exercise instructor to assess initial physical activity levels to certify that participants were at same physical activity levels at the time of study recruitment. Exclusion criteria included inability to do exercise due to medical problems, such as cardiovascular problems, lower-body neuropathy, stroke within the past year, Parkinson's disease, diagnosed vestibular disorders, severe poor vision, as well as severe depression based on the Beck Depression Inventory-II (i.e., scoring 30 or greater; Beck et al., 1996), bipolar disorder, schizoaffective disorder, and pregnancy or planned pregnancy. All participants were examined by an authorized physician and received medical clearance to exercise.

2.3. Ethics

Given that this study was part of the doctoral program of the first author at the Universiti Putra Malaysia, ethical approval was obtained from Universiti Putra Malaysia (UPM/TNCPI/1.418.1). Participants signed an informed consent form before starting the CBT and exercise programs and the right to withdraw at any time without any penalty or consequence was mentioned in the consent form.

2.4. Measures

2.4.1. Beck depression inventory-II

(BDI-II; Beck et al., 1996). The BDI-II is a 21-item measure of depressive symptoms over the past seven days. Items are rated on a four-point Likert scale from 0 to 3 and scores range from 0 to 63. Prior research suggests that the BDI-II has an acceptable reliability for Iranian sample (Abdollahi et al., 2015). Participants completed the BDI-II at pre- and post-treatment.

2.4.2. Beck Scale for Suicidal Ideation

(BSSI; Beck et al., 1988). Suicidal ideation was measured using the BSSI. The 21 items measure suicidal ideation, planning, and intent to commit suicide in the past week. Items are rated on a three-point Likert scale from 0 to 2 and scores range from 0 to 42 (Beck et al., 1988). Higher scores on the BSSI indicate higher suicide risk. Previous studies revealed concurrent validity between individuals with a high score in PSSI and experience of suicidal attempts (Beck et al., 1997). Prior research also suggests that the BSSI has an acceptable reliability for Iranian depressed sample (Abdollahi and Talib, 2015a). Participants completed the BSSI at pre- and post-treatment.

2.4.3. Barthel index of activities of daily living

(BIADL; Collin et al., 1988). Activities of daily living were measured using the BIADL. The 10 items measure actual rather than potential activities of daily living. Total possible scores range from 0 to 20, with lower scores indicating increased disability. Previous research suggests that BIADL has acceptable reliability for patients (Collin et al., 2009). Participants completed the BIADL at pre- and post-treatment.

2.5. CBT program

CBT was provided to both groups once a week for 12 weeks. Sessions were conducted by a researcher (who held a PhD in psychology and had completed a CBT course), lasted 90 min, and were delivered in groups of 4–6 participants. The groups were not mixed gender. The core of the CBT program was based on Beck's Cognitive Theory of Depression. Hence, the main goal of the treatment was to modify negative thinking patterns and underlying dysfunctional beliefs into more balanced thinking and adaptive behaviours. After one preparation session, CBT was implemented in three phases: I) weeks 1–3: familiarization with CBT and review of the negative effects of depressive symptoms and suicidal ideation on life; II) weeks 4–7: encouragement for participants to express their feelings and identification maladaptive beliefs and behaviours; and III) weeks 8–12: problem-solving skills, stress management, and relaxation training.

2.6. Exercise program

The exercise sessions were conducted under the supervision and guidance of a researcher and a qualified and trained exercise instructor (who held a PhD in sport science). CBT sessions were carried out by a therapist, and the exercise sessions were carried out by a trained exercise instructor. Participants completed the exercise sessions in a group setting. All exercise sessions were carried out indoors, and water and juice were provided to prevent dehydration. In accordance with the participants' preferences, evening time (7–7:40 p.m.) was chosen for the exercise sessions. Sessions consisted of a warm up (flexibility exercises; 5 min), cardiovascular exercises (clapping hands and some light movements; 5 min), walking (20 min), and cool-down (stretching exercises and deep breathing; 5 min) and were completed three times weekly over 12 weeks. The exercises were performed at moderate intensity (perceived exertion ratings between 12 and 14) as estimated by the Borg Scale (Borg, 1998).

2.7. Data preparation and analysis

Preliminary analyses were conducted using the Statistical Package for the Social Sciences (version 20). All data were checked for normality distribution using the Shapiro-Wilk test. The Shapiro-Wilk test is usually used for detecting normality for small sample size (Razali and Wah, 2011). The Shapiro-Wilk values for suicidal ideation, depression, and activities of daily living pre-test and post-test were not significant, meaning that the distributions did not deviate significantly from normality. The outliers were checked by box plot. A visual check showed the data were normally distributed.

Primary analyses were conducted with R (version 3.2.4) (R.C.Team, 2016) using the RStudio integrated development environment (version 0.99.893) (RsTeam, 2015). Multilevel models were computed using the lmerTest package (Kuznetsova et al., 2015). In order to provide robust estimates, models were bootstrapped using 1000 samples. As suggested by Hesser (2015), all models were estimated using restricted maximum likelihood. We included fixed effects of intercept, group, time, and group-by-time interaction, as well as main effects. The time variable was coded as 0 (pre-intervention) or 1 (post-intervention). The group variable was coded as 0 (CBT only) or 1 (combined CBT and exercise). For each of the three multilevel models, we also included fixed main effects of the other two variables of interest (e.g., suicidal ideation and activities of daily living were included in the model predicting depression). These variables were included as time-varying covariates, thereby controlling for their effect both at baseline and post-treatment. In order to control for differences between completers and dropouts, we followed recommendations outlined by Tabachnick and Fidell (2013). We included a dummy-coded fixed-effect parameter representing individuals with complete and incomplete data. This method provides adjusted estimates while quantifying and controlling for potential differences in outcomes between completers and dropouts. For each participant, this variable was coded as 0 (incomplete data) or 1 (complete data). Finally, all models included a random effect of intercept. To provide a measure of effect size, we computed the percentage of variance accounted for by the multilevel models (r^2) according to Xu (2003).

3. Results

3.1. Preliminary analyses

Of the 70 individuals who were randomized, 54 (77.1%) completed the intervention and provided complete data (see Fig. 1). Individuals who completed the intervention reported greater baseline levels of depression ($M_{diff} = 2.77$, t (41.58) = 3.16, $p = 0.003$) and activities of daily living ($M_{diff} = 1.38$, t (68) = 3.49, $p = 0.001$), but there were no significant differences in suicidal ideation ($M_{diff} = 0.84$, t (68) = 1.31, $p = 0.194$) or age ($M_{diff} = -0.91$, t (68) = −0.44, $p = 0.659$). Fisher's exact tests revealed that individuals with high school education or less were more likely to complete the intervention than those with greater than high school education ($p = 0.034$), but no significant differences were observed for gender ($p = 0.051$) or marital status ($p = 0.529$).

3.2. Depression, suicidal ideation, and activities of daily living

Dependent variable scores at pre- and post-treatment are presented in Table 2 and results of the multilevel models are presented in Table 3. For the model predicting depression, we controlled for suicidal ideation and activities of daily living. There was a significant main effect of time and a group-by-time interaction, suggesting that there were overall reductions in symptoms over time, but that these reductions were of greater magnitude (approximately 3.30 points on the BDI-II) in the combined CBT and exercise group. For the model predicting suicidal ideation, we controlled for depression and activities of daily living. There was a significant main effect of time and a group-by-time

Table 2
Dependent variable scores at pre- and post-treatment.

Variable	CBT only	Combined CBT and exercise	Overall sample
	M (*SD*)		
BDI-II			
Pre-treatment	20.51 (4.39)	20.89 (3.95)	20.70 (4.15)
Post-treatment	14.48 (2.16)	9.68 (2.91)	12.26 (3.49)
BSSI			
Pre-treatment	14.77 (1.83)	14.29 (2.66)	14.53 (2.28)
Post-treatment	12.72 (1.56)	7.08 (1.26)	10.11 (3.17)
ADL			
Pre-treatment	15.03 (1.44)	14.60 (1.54)	14.81 (1.50)
Post-treatment	15.21 (1.47)	17.12 (0.97)	16.09 (1.58)

interaction, with the combined CBT and exercise group reporting greater reductions in symptoms (approximately 6.54 points on the BSSI) over time. Finally, for the model predicting activities of daily living, we controlled for depression and suicidal ideation. There was no main effect of condition or time, but there was a significant group-by-time interaction, such that individuals in the combined CBT and exercise group, but not the CBT group, reported increases in activity (approximately 3.21 points on the BAIDL) over time. These results indicate that the combined CBT and exercise intervention increased activity levels to a greater degree than the CBT only group. Overall, the models explained a large proportion of the variance in outcomes.

4. Discussion

Considering the findings of the present study, both a combination of exercise and CBT and CBT alone were effective strategies for reducing depression and suicidal ideation. However, the effects of an exercise program adjunct to a CBT program in reducing depressive symptoms and suicidal ideation were greater than the CBT program alone. The results from this study are consistent with previous studies that have demonstrated the effectiveness of exercise as an adjunct to CBT in reducing symptoms of depression (Babiss and Gangwisch, 2009; Gartlehner et al., 2016; Huang et al., 2015). A unique contribution of the current study is the finding that the addition of exercise to CBT also reduces suicidal ideation to a greater degree that CBT alone. Our results are bolstered by controlling for other variables of interest in the analyses (e.g., controlling for suicidal ideation and activities of daily living when predicting changes in depression), thus highlighting the robustness of the interventions in reducing depression and suicidal ideation independently. One possible explanation for effectiveness of exercises adjunct to CBT is that exercise is remarkably effective when it is enjoyable for individuals and is integrated into social communication (Berger and Motl, 2000). As individuals engage in an exercise program, self-esteem may be increased, sense of control may be enhanced, and the experience depression and suicidal ideation may diminish as a result. Additionally, various biological mechanisms have been proposed to explain the antidepressant effects of regular exercise, These include the simultaneous reduction in net cortisol and increase the brain neurotransmitters (e.g., serotonin, dopamine, norepinephrine Vythilingam et al., 2004), which have a positive effect on decreasing depression and suicidal ideation (Sims et al., 2009). Therefore, regular exercise can improve physical and biological functions and ultimately contribute to decreased suicidal ideation and depression remission.

Our study is subject to a number of limitations. First, there was no control group and the exercise component was not studied in isolation; thus, we cannot account for regression to the mean. Second, no follow-up data were collected and it is unclear whether physical exercise is sustained, so the long-term effects (i.e., maintenance of gains) remain unclear. Third, we did not examine relationships with variables such as increased fitness level, gender, economic status, family structure, and educational levels, which may be associated with depression and suicidal ideation. It is recommended that further research investigate the effect of these variables on the efficacy of exercise-based interventions for depression and suicidal ideation. Fourth, the exercise program and CBT program were performed in groups of four to six individuals, which may have partly reduced depression and suicidal ideation by

Table 3
Final multilevel models.

	Fixed effects				Random effects		
Predictor	*b*		95% CI	*SE*	*SD*	95% CI	r^2
Depression							0.84
Intercept	26.93	***	[19.61, 34.47]	3.77	2.25	[1.43, 2.83]	
Suicidal ideation	0.12		[−0.18, 0.41]	0.15			
Activities of daily living	−0.75	**	[−1.24, −0.27]	0.25			
Complete data	3.79	***	[1.98, 5.68]	0.98			
Group	0.54		[−1.00, 1.99]	0.78			
Time	−6.29	***	[−7.57, −4.99]	0.66			
Group*time	−3.30	*	[−6.00, −0.50]	1.39			
Suicidal ideation							0.89
Intercept	6.22	*	[0.93, 11.26]	2.55	1.60	[1.16, 1.92]	
Depression	0.06		[−0.05, 0.16]	0.05			
Activities of daily living	0.50	**	[0.19, 0.80]	0.15			
Complete data	−0.04		[−1.24, 1.23]	0.63			
Group	−0.3		[−1.28, 0.65]	0.48			
Time	−1.56	**	[−2.44, −0.67]	0.45			
Group*time	−6.54	***	[−7.68, −5.37]	0.58			
Activities of daily living							0.87
Intercept	11.57	***	[10.03, 13.09]	0.77	1.25	[0.98, 1.44]	
Depression	−0.06	*	[−0.10, −0.01]	0.02			
Suicidal ideation	0.24	***	[0.16, 0.32]	0.04			
Complete data	1.31	**	[0.55, 2.06]	0.39			
Group	−0.14		[−0.77, 0.49]	0.32			
Time	0.07		[−0.32, 0.44]	0.19			
Group*time	3.21	***	[2.60, 3.83]	0.31			

Note. Confidence intervals were bootstrapped using 1000 samples.
* $p \leq .05$.
** $p \leq .01$.
*** $p \leq .001$.

facilitating social interaction and bonding between participants. Future studies should evaluate the extent and effect of social interaction in group settings, as well as attempt to replicate our findings with individually-administered CBT and exercise programs. Fifth, our study only included mildly to moderately depressed participants; nonetheless, our results show promise for investigating our interventions in more severely depressed and suicidal individuals. Finally, other individual factors, such as dietary habits, were not examined in our study and should be considered for investigation in future research.

Despite the aforementioned limitations, our study utilized a robust randomized controlled design and, to our knowledge, is the first to investigate the additive effect of exercise to CBT for both depression and suicidal ideation. Our results provide evidence that regular exercise combined with CBT leads to superior short-term outcomes in treating depression and suicidal ideation when compared to CBT alone; consequently, where possible, structured exercise should be added to CBT programs delivered to individuals seeking treatment for suicidal ideation and depression. These positive effects of exercise as an adjunct to CBT have the potential to play an important role for increasing both physical and mental health in depressed individuals.

Ethical standard

The research was conducted in accordance with ethical standards outlined by the Universiti Putra Malaysia.

Human rights and informed consent

All procedures performed with human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards, and informed consent procedures were completed prior to participation.

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