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Evaluation of a Physical Activity Program for Pathological Gamblers in Treatment

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Abstract It has been demonstrated that craving for gambling is associated with anxiety and depression in pathological gamblers. Exercise has been shown to reduce anxiety and depression, as well as positively influence abstinence rates in individuals with substance use disorders. In this study, we examined the impact of a physical activity program in 33 pathological gamblers. We also analyzed the association between craving and plasmatic levels of stress hormones (adrenocorticotropic hormone, cortisol, and prolactin). The program involved eight 50-min sessions. Craving was assessed 24 h before, immediately before, and immediately after each session, as well as on a weekly basis. Before and after the program, we evaluated gambling behavior, depressive symptoms, anxiety, and plasma levels of stress hormones. We identified a significant reduction in craving following each session and at the end of the program. There was improvement in anxiety, depressive symptoms, and gambling behavior. The post-session reduction in craving was accompanied by post-program reductions in craving and anxiety but not by a post-program reduction in depressive symptoms. The craving reduction was associated with a variation in prolactin levels but not with variations in levels of cortisol or adrenocorticotropic hormone.

Keywords Gambling · Addiction · Impulse control disorders · Exercise · Physical activity

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Introduction

Pathological gambling is characterized by loss of control over gambling behavior, which persists despite significant losses. The diagnostic criteria for pathological gambling were inspired by the criteria for substance dependence (Weinstock et al. 2008). Some authors suggest that pathological gamblers are addicted to a euphoric feeling similar to that induced by drugs (Crockford and el-Guebaly 1998). According to Potenza et al. (2002), pathological gambling is a natural model for research in addictive behaviors.

One of the central features of gambling behavior is the craving to gamble in order to avoid adverse emotional states. Anxiety and depression have been shown to be significantly associated with the intensity of craving among pathological gamblers (Potenza 2001). Therefore, it is possible that the treatment of depression and anxiety would indirectly reduce gambling behavior by reducing craving. Treatment strategies for pathological gambler include individual and group psychotherapy in association with pharmacological treatment with antidepressants and/or mood stabilizers (Tavares et al. 1999). It is well known that physical exercise can have a positive influence on mental health, by reducing levels of anxiety and depression and improving stress control (Dunn et al. 2005; Blumenthal et al. 2007; Martinsen 2008 Carter et al. 2012).

A small number of studies have examined the application of physical activity programs in the treatment of alcohol and nicotine dependence. The results of these studies suggest that it is a promising strategy, although interventions involving physical activity have been poorly implemented (Ussher et al. 2008). Consequently, a physical activity program could help individuals overcome addiction, which has been shown to be strongly associated with mood regulation (Tordeurs et al. 2011). In the case of pathological gambling, there is only one study with a small sample conducted by our group that suggests that physical exercise may be associated with a significant reduction in gambling craving, specifically related to the reduction of gambling behavior (Angelo et al. 2009).

Hypotheses indicating the relationship of pathological gambling with addictive disorders often suggest the involvement of the dopaminergic pathways in the brain, the so-called dopamine reward deficiency syndrome (Ibáñez et al. 2003). Studies have demonstrated that cortisol levels increase significantly during gambling and that gambling induces hypothalamic–pituitary–adrenal axis (HPA) activation, increasing autonomic nervous system activity (Meyer et al. 2000; Krueger et al. 2005). An analogous increase of HPA axis activity can be observed during psychological stress in gamblers (Meyer et al. 2004), thus indicating that gambling elicits stress responses with increased levels of plasma cortisol. On the other hand, there is a relationship between dopamine and physical activity, e.g., exercise elicits an increase in synthesis and release of dopamine, promoting well-being (Ribeiro et al. 2011). Along time, exercise could have positive effects on mental health, possibly mediated by neuroendocrine changes, such as changes in the secretion of adrenocorticotropic hormone (ACTH), cortisol and prolactin (Luger et al. 1987; Kiive et al. 2004).

In sum, regular physical activity is associated with effects that may be compensatory of the neurobiological changes observed in pathological gambling, e.g., ameliorating the above mentioned reward deficiency syndrome. Therefore, the objective of the present study was to determine whether a physical activity program can be useful as an adjuvant therapy in the treatment of pathological gambling. In addition, we investigated the association between potential reductions in gambling craving with physical activity and alterations in plasma levels of ACTH, cortisol and prolactin (as an indirect measure of dopaminergic activity).

Methods

Participants

Subjects were recruited from among patients seeking treatment for pathological gambling between October 2008 and January 2011 at the Outpatient Clinic for Gambling and Other Impulse Control Disorders of the Institute of Psychiatry at the University of São Paulo School of Medicine in Brazil. All patients met DSM-IV criteria for a diagnosis of pathological gambling. Treatment consists of an initial psychiatric assessment, followed by weekly group sessions of cognitive-behavioral therapy (for 12–15 weeks), and an educational program, in which patients are given general and specific information regarding the nature of pathological gambling. Patients with psychiatric comorbidities are treated, if necessary, with the appropriate pharmacological regimens.

Selection

Inclusion criteria were being over 18 years of age; having had at least 4 years of schooling and being physically fit enough to engage in exercise of moderate intensity. We excluded patients with intellectual disability, those who were unable to exercise due to a medical condition, those with serious injuries, and those with psychotic symptoms or cognitive impairment that could compromise their ability to complete the research questionnaires.

A total of 137 patients were invited to participate in the study. Of those, 64 declined to engage in physical activity, 14 were excluded on the basis of the study criteria, and 26 dropped out before the end of the study. Therefore, we evaluated a study sample comprising 33 patients, designated the physical activity group (PA), and a non-physical activity group (NPA) comprising 30 patients (recruited from among those who refused to participate in physical activity). The study was approved by the Institutional Research Ethics Committee, and all subjects gave written informed consent.

Procedure

The program of physical activity comprised eight sessions, conducted over a period of 4 weeks (two sessions/week) or 8 weeks (one session/week). The proposed activity consisted of 50-min sessions—10-min of stretching plus 40-min of running, aiming at 65–70 % of the maximum heart rate for age—as recommended by the American College of Sports Medicine (ACSM 1991). The activity was monitored by physical educators using individual heart rate monitors.

We evaluated the intensity of symptoms of anxiety and depression, as well as gambling behavior, in the PA and the NPA groups. We also analyzed four PA subgroups: those attending sessions once a week (PA/1, $n = 15$); those attending sessions twice a week (PA/2, $n = 18$); those receiving some kind of pharmacological therapy (PA/PT, $n = 14$); and those receiving no pharmacological therapy (PA/NPT, $n = 19$).

Measurements

Psychiatric comorbidities were investigated with the Portuguese-language version of the Mini International Neuropsychiatric Interview (MINI), which has been validated for use in Brazil. At baseline and at the end of the physical activity program, clinical status was

evaluated by the self-report 10-item version of the Gambling Follow-up Scale (Castro et al. 2005). On the GFS, scores <29 are suggestive of active pathological gambling, scores of 29–33 are suggestive of partial remission, and scores >33 are suggestive of complete remission. The GFS comprises three subfactors: FGAMBLING (related to specific gambling behaviors); FSTRESS (related to debts, emotional distress, and autonomy); and FSOCIAL (related to family relationships, leisure activities, and socialization).

Depression was assessed by the Beck Depression Inventory (BDI; Beck et al. 1961). The BDI is a self-administered 21-item questionnaire, with responses scored from 0 (least intense) to 3 (most intense), and assesses depressive symptoms in the last 7 days. Anxiety was assessed by the Beck Anxiety Inventory (BAI; Beck 1988). The BAI is also a self-administered 21-item questionnaire, with responses ranging from "not at all" to "severely", and assesses anxiety symptoms in the last 7 days. The BDI and BAI were applied at baseline and at the end of the physical activity program.

Peripheral venous blood samples were collected for determination of baseline concentrations of ACTH, cortisol and prolactin. Blood was drawn at baseline (2 days before) and at the end (2 days after) of the physical activity program (both at 8:00 pm), and collected into EDTA tubes (Sarstedt, Nümbrecht, Germany). Blood samples were immediately centrifuged at 4 °C and plasma stored on dry ice during the experiment and later stored at −70 °C until endocrine analysis could be done. ACTH, prolactin and cortisol levels were detected by immunofluorometric, Immunochemiluminometric and chemiluminescence immunoassay, respectively, using "kits" Delfia.

At baseline and at the end of every week, patients completed an adapted version of the self-administered, dimensional Pennsylvania Craving Scale (PCS; Flannery et al. 1999), which is a 5-item scale, with responses ranging from 0 (never, none, not at all) to 6 (nearly all, strong, all the time), which assesses the craving to gamble during the last 7 days. At baseline and at the end of every week, patients completed an adapted version of the self-administered Craving Questionnaire (CQ; Weiss et al. 1997), which is a 5-item measure, with responses ranging from 0 (no) to 9 (extremely), which assesses the craving to gamble, the ability to resist urges, and the intensity of craving within the last 24 h. Before and immediately after each exercise session, the craving to gamble was further evaluated by a Likert-type scale, the Visual Craving Scale, which is a self-administered one-item measure, with responses scored from 0 (no) to 10 (extremely).

Statistical Analyses

Categorical variables were compared by the Chi-square (χ^2) test. Regarding continuous variables, when the assumption of data normality was met by the Kolmogorov–Smirnov test, the comparison of pre- and post-means was performed by analysis of variance (paired t test). For variables without normal distribution, we used the nonparametric Wilcoxon (Z) test. For repeated measures, we used the nonparametric Friedman test. Deltas were calculated for the variables change after treatment parameters; that is, the post-program means for the variables PCS, CQ, FGAMBLING, FSTRESS, FSOCIAL, BDI, BAI, ACTH, cortisol, and prolactin were subtracted from the baseline means. We also calculated the pre- and post-session deltas for craving. We then performed correlation analyses of the obtained deltas. We used Spearman correlation tests for nonparametric variables, with a significance level of $p < 0.05$.

We also compared the PA/1 group with the PA/2 group, the PA/PT group with the PA/NPT group, and the PA group with the NPA group, in terms of the variables means, using

t tests for independent samples for normally distributed variables and the Mann–Whitney (*U*) test for non-normally distributed variables.

We evaluated the frequency of anxiety, depression and gambling behavior symptoms, in PA and NPA groups. Unfortunately, data on craving were not available for the NPA group.

Results

At baseline, there were no statistically significant differences between the PA and NPA groups in terms of sociodemographic or clinical characteristics (Table 1). At the end of the program, the PA group patients scored significantly better on the BAI, BDI, and GFS than did the NPA group patients. The difference between the initial and final mean scores on the BAI in the PA group was −10 (SD = 9.8), compared with −5 (SD = 8.5) in the NPA group ($t = 2.282$, $p = .026$); on the BDI, it was −11 (SD = 7.9) in the PA group, compared with −6 (SD = 8.9) in the NPA group ($t = 2.504$, $p = .015$); and, on the GFS, it was 10 (SD = 6.7) in the PA group, compared with 7 (SD = 3.9) in the NPA group ($t = -2.073$, $p = .042$) (Table 2).

PA Group

The 33 patients in the PA group were considered sedentary (defined as exercising less than three times per week and for not more than 20 min on each occasion) for the last 6 months (Dunn et al. 2005). Of the 33 PA group patients, 15 (45.5 %) were in the PA/1 subgroup and 18 (54.5 %) were in the PA/2 subgroup. Comparing the two subgroups in terms of the mean scores on the PCS, CQ, BAI, BDI, and GFS, we found no statistically significant differences. Because the *t* test and Mann–Whitney (*U*) test showed that both subgroups had a similar behavior, it was possible to analyze them as a single group.

The Friedman test for repeated measures showed a significant reduction in the Visual Craving Scale score after each physical activity session (pre-session: $\chi^2 = 20.22$, $df = 7$, $p = .005$; post-session: $\chi^2 = 21.19$, $df = 7$, $p = .003$), as can be seen in Fig. 1. At the end of the program, we also observed a reduction in the craving to gamble in the previous 24 h ($\chi^2 = 59.75$, $df = 7$, $p < .001$) and over the previous 7 days ($\chi^2 = 64.86$, $df = 7$, $p < .001$).

In the PA group, there was significant post-program improvement not only in total GFS score but also in all GFS subfactors. We also observed post-program improvements in the symptoms of depression and anxiety, as assessed by the BDI and BAI, respectively. Of the 33 PA group patients, only 18 (54.5 %) agreed to undergo the blood tests for the determination of plasma levels of ACTH, cortisol, and prolactin. Among those 18 patients, there was no significant variation between pre- and post-program plasma levels of stress hormones (Table 3).

Spearman correlation analyses of the deltas for PCS, CQ, FGAMBLING, FSTRESS, FSOCIAL, BDI, BAI, ACTH, cortisol, and prolactin in relation to the mean variation of the pre- and post-session craving to gamble (Δcraving) showed that Δcraving was significantly associated with the ΔPCS ($r = .565$, $p < .001$) and the ΔCQ ($r = .632$, $p < .001$). We also observed a significant correlation between the Δcraving and the ΔBAI ($r = .490$, $p = .004$) but not between the Δcraving and the ΔBDI ($r = .195$, $p = .277$).

We found that the Δcraving was significantly associated with the Δprolactin level ($r = .655$, $p = .002$) but not with the ΔACTH level ($r = .017$, $p = .945$) or the Δcortisol level ($r = .027$, $p = .912$).

Table 1 Baseline sociodemographic and clinical characteristics of the physical activity group (PA) and no-physical activity group (NPA) of pathological gamblers

Characteristic	PA (n = 33)	NPA (n = 30)	Coefficient	*p*
Gender			$\chi^2 = .012$	.912
Male, n (%)	20 (60.6)	18 (60)		
Female, n (%)	13 (39.4)	12 (40)		
Ethnicity (self-declared)			$\chi^2 = 5.763$	.124
White, n (%)	19 (57.6)	21 (70)		
Black, n (%)	3 (9.1)	3 (10)		
Asian, n (%)	2 (6.1)	–		
Other, n (%)	9 (27.3)	6 (20)		
Marital status			$\chi^2 = 2.010$	.366
Married, n (%)	21 (63.6)	20 (66.7)		
Single, n (%)	12 (36.4)	10 (33.3)		
Age (years), mean (SD)	47.5 (11.6)	45.4 (12.3)	$U = 398.500$	.337
Monthly salary (US$), mean (SD)	2.983 (5.21)	2.600 (3.84)	$U = 447.000$	.965
Professional status			$\chi^2 = .627$	.960
Employed, n (%)	23 (69.6)	22 (73.3)		
Unemployed, n (%)	1 (3)	3 (10)		
On mental disability leave, n (%)	3 (9.1)	1 (3.3)		
On physical disability leave, n (%)	6 (18.2)	4 (18.2)		
Years of education, mean (SD)	11.5 (5.5)	10.3 (4.0)	$U = 377.500$	.379
Religion			$\chi^2 = 3.064$	.547
Catholic, n (%)	28 (84.8)	24 (80)		
Evangelical, n (%)	2 (6.1)	2 (6.7)		
Other, n (%)	3 (9.1)	4 (13.3)		
Age (years) at gambling onset, mean (SD)	30 (14.6)	30 (14.8)	$U = 429.000$	.927
Maximum withdrawal time (days), mean (SD)	14.5 (15.9)	11.6 (12.5)	$U = 392.500$	.518
Type of gambling abused			$\chi^2 = 4.825$	.476
Bingo, n (%)	16 (48.5)	18 (60)		
Video bingo, video poker, other, n (%)	30 (90.9)	27 (90)		
Concern over gambling in the last month?			$\chi^2 = 4.162$	.533
None/little, n (%)	3 (9.1)	4 (13.3)		
Moderate/considerable, n (%)	9 (27.3)	7 (23.3)		
Great, n (%)	21 (63.6)	19 (63.6)		
Current importance of treatment for gambling problems?			$\chi^2 = 3.883$	.274
Not at all/slightly, n (%)	0	2 (6.7)		
Moderately/considerably, n (%)	7 (21.2)	6 (20)		
Extremely, n (%)	26 (78.8)	22 (73.3)		
DSM-IV criteria, mean (SD)	7.3 (2.3)	7.4 (2.1)	U = 435.000	.822
Pharmacologic treatment			$\chi^2 = 0.115$	.074
Yes, n (%)	14 (42.4)	14 (46.7)		
No, n (%)	19 (56.6)	16 (53.3)		
Cognitive-behavioral therapy group, n (%)	33 (100)	30 (100)		

Table 1 continued

Characteristic	PA (n = 33)	NPA (n = 30)	Coefficient	*p*
Mean initial scores				
BAI, mean (SD)	21 (12.8)	20 (8.6)	$t = .326$	.746
BDI, mean (SD)	24 (10.0)	21 (9.8)	$t = 1.321$	.192
GFS, mean (SD)	28 (5.7)	26 (6.9)	$t = -1.040$	.284

PA physical activity group, *NPA* non-physical activity group, χ^2 Chi-square, *U* Mann–Whitney, *t* *t* test for independent samples

Of the 33 PA group patients, 14 (42.4 %) were in the PA/PT group. The medications most commonly used were topiramate (in 24.3 %), sertraline (in 12.2 %), quetiapine (in 9.1 %) and fluoxetine (in 9.1 %). In the PA/PT group, the most common comorbidities were major depression (in 69.7 %), major depression with melancholic features (in 48.5 %), and dysthymia (in 42.4 %). Mean baseline scores on the PCS, CQ and BAI were significant higher in the PA/PT group than in the PA/NPT group. Baseline scores on the GFS and BDI were no statistically significant differences. The difference between baseline scores on the PCS in the PA/PT group was 16 (SD = 5.3) compared with 8 (SD = 6.3) in the PA/NPT group ($t = -3.880$, $p = .001$); on the CQ, it was 23 (SD = 9.7) in the PA/PT group, compared with 11 (SD = 10.3) in the PA/NPT group ($t = -3.114$ $p = .004$); on the BAI, it was 26 (SD = 12.5) in the PA/PT group, compared with 17 (SD = 11.9) in the PA/NPT group ($t = -2.085$, $p = .045$); on the GFS, it was 29 (SD = 4.5) in the PA/PT group, compared with 27 (SD = 6.5) in the PA/NPT group ($t = -1.040$, $p = .306$); and, on the BDI, it was 27 (SD = 10.4) in the PA/PT group, compared with 22 (SD = 9.4) in the PA/NPT group ($t = -1.461$, $p = .154$). There were no differences between initial and final mean scores on the CQ, PCS, BAI, BDI and GFS (Table 4).

Discussion

Comparing the physical activity group (PA) with the non-physical activity group (NPA), we observed reductions in the levels of anxiety, depression, and gambling behavior in both groups. However, those improvements were more consistent and more pronounced in the PA than in the NPA group. This suggests that the addition of a physical activity program to the treatment of individuals diagnosed with pathological gambling can be beneficial.

The main problem of this study is that the NPA group does not represent a similar comparison group, so it does not qualify as a control group. The study had a small sample size so it would have been difficult to divide the volunteers into two groups, thus further reducing the statistical power. We can not rule out that the lack of random assignment to groups might have influenced differences in outcome. The NPA group at baseline was clearly less motivated to engage in physical activity, and this difference needs to taken into consideration when interpreting the results.

Results show a reduction in the craving to gamble, together with improvements in the symptoms of anxiety, in depressive symptoms, and in all factors related to gambling behavior, at the end of the physical activity program. The post-program improvements in the symptoms of depression and anxiety are similar to those reported after psychotherapy or pharmacological therapy (Blumenthal et al. 2007; Martinsen 2008). Comparing the PA/

Table 2 Comparisons of the changes in the baseline and final scores on GSF, BDI and BAI in the physical activity group (PA) and in the non-physical activity group (NPA)

Variable	Physical activity group (PA)				Non-physical activity group (NPA)				Comparison		
	Baseline Mean(SD)	Final Mean(SD)	Test	*p*	Baseline Mean(SD)	Final Mean(SD)	Test	*p*	△PA Mean(SD)	△NPA Mean(SD)	△*p**
GFS	28 (5.7)	38 (6.2)	$z = -4.98$	<.001	26 (6.9)	33 (4.4)	$z = -4.35$	<.001	10 (6.7)	7 (3.9)	<.001
BDI	24 (10)	13 (10.3)	$t = 7.863$	<.001	21 (9.8)	15 (7.3)	$t = -3.210$	.003	−11 (7.9)	−6 (8.9)	.015
BAI	21(12.8)	11 (9.1)	$t = 6.091$	<.001	20 (8.6)	15 (6.8)	$t = -.031$	.005	−10 (9.8)	−5 (8.5)	.026

GFS Gambling Follow-up Scale, *BDI* beck depression inventory, *BAI* beck anxiety inventory, *z* wilcoxon test, *t* paired *t* test, *SD* standard deviation

* *p* values unpaired *t* test for differences in final scores between the Physical Activity and Non-Physical Activity groups, adjusting for baseline scores

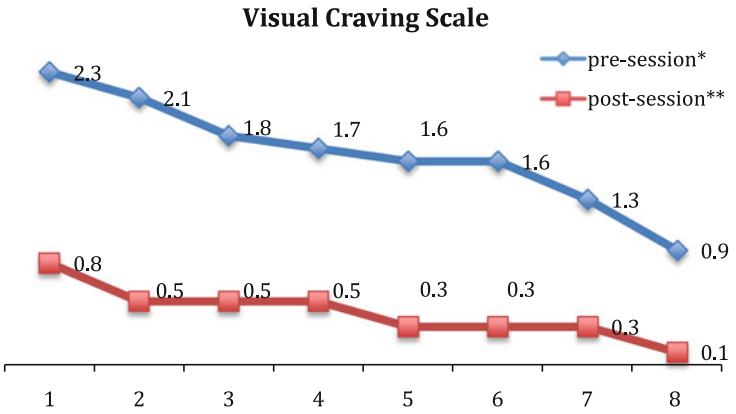

Fig. 1 The Friedman test for repeated measures showed a significant reduction in the Visual Craving Scale score after each physical activity session. Friedman test: *($\chi^2 = 20.22$, $df = 7$, $p = .005$); **($\chi^2 = 21.19$, $df = 7$, $p = .003$)

Table 3 Gambling behavior, depression, anxiety and plasma levels of ACTH, cortisol, and prolactin at the baseline and at the end of the physical activity program

Variable	Baseline Mean (SD)	Final Mean (SD)	Test	*p*
GFS	28 (5.7)	38 (6.2)	$z = -4.98$	<.001
FGAMBLING	13 (3.9)	17 (3.2)	$z = -4.48$	<.001
FSOCIAL	9 (2.1)	11 (2.1)	$z = -4.04$	<.001
FSTRESS	6 (2.9)	10 (2.9)	$z = -4.75$	<.001
BDI	24 (10)	13 (10.3)	$t = 7.863$	<.001
BAI	21 (12.8)	11 (9.1)	$t = 6.091$	<.001
ACTH	23.6 (12.3)	23.2 (11,4)	$t = .241$	.812
Cortisol	10.0 (3.1)	9.7 (2.8)	$t = .400$	.694
Prolactin	5.4 (3.3)	6.3 (3.9)	$t = -1.409$	.179

GFS Gambling Follow-up Scale, *FGAMBLING*: GFS subfactor related to specific gambling behaviors, *FSOCIAL* GFS subfactor related to family relationships, leisure activities, and socialization, *FSTRESS* GFS subfactor related to debts, emotional distress, and autonomy, *BDI* beck depression inventory, *BAI* beck anxiety inventory, *ACTH* adrenocorticotropic hormone, *z* Wilcoxon test, *t* paired *t* test

PT and PA/NPT group patients, we found that the baseline scores on the BAI and craving scales were higher in the PA/PT group, although there were no differences in relation to the other variables. This suggests that patients who received pharmacological therapy presented to treatment with more intense symptomatology than those who did not receive pharmacological therapy.

McNeil et al. (1991) demonstrated that social contact could result in a reduction in depressive symptoms equivalent to that achieved through exercise. In the present study, the physical activity was performed in group sessions. Therefore, we cannot rule out the possibility that the positive effects resulted from socialization rather than from the physical activity itself. We could only clarify this point if a control group with pathological gamblers engaged in other types of group activities (for instance, psychoeducational interventions related to quality of life) was included.

Table 4 The difference between baseline and final scores on PCS, CQ, GSF, BDI and BAI in the physical activity subgroups: those receiving some kind of pharmacological therapy (PA/PT group) and those receiving no pharmacological therapy (PA/NPT group)

Variable	PA/PT group (n = 14)		PA/NPT group (n = 19)		Comparison		
	Baseline Mean (SD)	Final Mean (SD)	Baseline Mean (SD)	Final Mean (SD)	△PA/PT Mean (SD)	△PA/NPT Mean (SD)	△p*
PCS	16 (5.3)	9 (5.6)	8 (6.3)	6 (6.0)	−7 (5.4)	−2 (9.5)	.087
CQ	23 (9.7)	13 (11.6)	11 (10.3)	6 (7.8)	−10 (10.6)	−5 (8.9)	.151
GFS	29 (4.5)	37 (4.4)	27 (6.5)	39 (7.3)	8 (5.2)	12 (7.1)	.122
BDI	27 (10.4)	17 (12.2)	22 (9.4)	11 (8.1)	−10 (8.6)	−11 (7.5)	.680
BAI	26 (12.5)	14 (10.6)	17 (11.9)	8 (7.0)	−12 (10)	−9 (9.3)	.408

GFS Gambling Follow-up Scale, *BDI* beck depression inventory, *BAI* beck anxiety inventory, *SD* standard deviation

* p values unpaired t test for differences in final scores between the Physical Activity and Non-Physical Activity groups, adjusting for baseline scores

Contrary to our expectations, we found no significant variations in stress hormone levels following the physical activity program. Some authors claim that one acute session of exercise can increase cortisol and ACTH levels and after a training period, a decrease in these hormones represents an adaptive change to the stress of exercise. However, much controversy exists about the actual response of these hormones, which can vary due to the volume or intensity of exercise, and other factors such as blood glucose levels, circadian rhythm, heat, and cold (Luger et al. 1987; Kiive et al. 2004).

We observed a significant positive association between the Δcraving and the ΔBAI. Therefore, the greater the reduction in craving after an individual exercise session, the greater was the reduction in anxiety at the end of the physical activity program.

The small sample size can reduce the generalizability of on results. Although we invited 137 patients to participate in the program of physical activity, only 33 patients completed the eight sessions and were included in the analysis. The low participation of patients with depressive symptoms in physical activity programs has long been considered as a limiting factor for the effectiveness of these programs (Singh and Fiatarone 2000; Dishman et al. 2006).

This study suffers from multiple comparisons. Thus, it is possible that some associations were due to chance and should be seen as preliminary. This is an exploratory study and results have to be tested in further confirmatory studies.

We conclude that a physical activity program can be a useful complement to the treatment of pathological gamblers. Our results show a reduction in the craving to gamble, as well as improvements in the symptoms of anxiety, depressive symptoms, and all factors related to gambling behavior. Studies involving larger samples, with random assignment of subjects and control for motivation to exercise are needed in order to confirm these results.

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