Effects of Short-term Exercise Intervention on Metabolic Features and Bone Mineral Density in Patients with Serious Mental Illnesses

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Objectives: Epidemiologic evidence suggests that patients with serious mental illnesses are at higher risk for metabolic syndrome (MS) and osteoporosis. In this prospective study, we intended to examine the effectiveness of short-term exercise intervention program for patient with those disturbances. Methods: We examined the effects of a supervised 12-week aerobic exercise program on metabolic indices and bone mineral density in patients with serious mental illnesses. Results: Among 20 patients recruited, we found that the prevalences of MS, osteoporosis and osteopenia were 40%, 15.8%, and 42.1%, respectively, at baseline. Fourteen participants completed the program. There was no significant change in metabolic indices and bone mineral density after a short-term exercise intervention. Besides, the correlation between individual metabolic index and bone mineral density was not significant. Conclusion: The study results supported the necessity for close monitoring MS and osteoporosis as well as giving intervention in patients with serious mental illnesses. The effectiveness of exercise intervention warrants further evaluation.

Key words: aerobic exercise, metabolic syndrome, osteoporosis, severe/chronic psychiatric patients


Introduction

Metabolic syndrome (MS) and osteoporosis (OSP) are highly prevalent in patients with serious mental illnesses than those in the general population. In Taiwan, prevalence of metabolic syndrome in patients with schizophrenia and schizoaffective disorder has been estimated at about 35% [1], and that in patients with bipolar disorder at 33.9% [2]. Lower bone mass is noted in patients with schizophrenia [3].

Reported contributing factors for MS and OSP in patients with serious mental illnesses pa-
tients include shared pathophysiological mechanisms (e.g. endocrine dysfunction or hormone insufficiency), the use of psychotropic agents, and different life style (e.g. lack of exercise, smoking, drinking, and unhealthy diet). Whether shared pathophysiological mechanism exists is unclear. Although previous studies revealed contradictory and inconsistent findings [4], a recent study has suggested MS being a risk factor for developing OSP [5]. Since MS and OSP increase the incidence of cardiovascular disease, risk of fracture, compromise long-term health status, and quality of life, close supervision and effective intervention to improve the contributing factors are warranted. But the patients’ limited insight and poor self-awareness often make the intervention difficult.

Adequate exercise arrangement could improve severity of psychotic symptoms, cognitive function, quality of life, and general physical condition. The effectiveness of exercise intervention on metabolic disturbances has been investigated. Behavioral weight loss intervention has reduced weight remarkably in overweight or obese patients with serious mental illness [6, 7]. Aerobic exercises have been proven to improve physical indices including body weight, BMI, waist circumference, and lipid profile of overweight schizophrenic patients in two Taiwanese studies [8, 9]. But other studies have reported limited efficacy of exercise intervention on metabolic disturbance in patients with serious mental illnesses [10, 11]. The results were inconsistent.

In the general population, especially post-menopausal women and the elderly who have OSP, weight-bearing exercises, strength training exercises, and aerobic exercises are recommended for increasing bone density [12]. Whether such intervention is also helpful for osteoporotic patients with serious mental illnesses is unclear.

In this study, we intended to study the prevalence of MS and OSP and the impact of short-term exercise intervention on metabolic indices and bone mineral density (BMD) in patients with serious mental illnesses in Yun-Lin County, Taiwan. We further intended to analyze the correlation between the changes in the metabolic indices and BMD during the intervention period to identify possible linked or shared pathogenesis.

**Methods**

**Study subjects**

This prospectively-designed study was performed in the day hospital and chronic ward, psychiatric department in the Dou-Liou Branch of the National Cheng Kung University Hospital from March 1, 2012 to September 30, 2012. The institute review board at the National Cheng Kung University Hospital approved the study protocol, with the need of obtaining their informed consent before the study. The inclusion criteria included patients’ presence of serious mental illnesses (including schizophrenia, bipolar disorder, and schizoaffective disorder); age between 18 to 65 years old; history of continuous and concurrent psychotropic agent use for at least one year; as well as stable mental status. Excluded were those with their presence of severe physical illness that would show difficulty attending exercise program; history of neurocognitive illness; and history of substance abuse or dependence.

**The definition of metabolic syndrome and osteoporosis**

Metabolic syndrome is defined according to the IDF 2005 criteria for Asian people. It requires the presence of central obesity (waist circumference being greater than 90 cm in men or 80 cm in women), plus 2 of 4 following conditions: (A) TG
≥150 mg/dL or on medication; (B) HDL < 40 mg/dL in men or 50 mg/dL in women, or on medication; (C) ≥ 130 mm Hg systolic or ≥ 85 mm Hg diastolic blood pressure, or on medication; and (D) fasting serum glucose level ≥ 100 mg/dL or on medication. According to WHO diagnostic guideline, osteoporosis is defined when the bone mineral density ≤ 2.5 standard deviation below that of young, healthy adult women reference population. It is translated into T score: T score ≤ -2.5. Osteopenia is defined as -2.5 < T score < -1.

**Metabolic indices and exercise intervention**

The subjects received the intervention of one-hour aerobic dance program three times per week, for 12 weeks. The program was held three times per week in weekday afternoon. DVD of aerobic dance was played as teaching material, and at least two workers would attend and supervise the whole program, and gave assistance to these patients if needed. The compliance to the intervention was good, since those who had difficulty attending the program regularly were excluded. Metabolic indices (included body weight, waist circumference, blood pressure, serum fasting sugar, cholesterol, triglyceride, and high-density lipoprotein, or HDL) were measured at week 0, 4, 8, and 12 after starting the intervention. The severity of psychotic symptoms was evaluated by an experienced psychiatrist using the Brief Psychiatric Rating Scale (BPRS) at the time of the metabolic indices measurement. In addition, we used dual-energy X-ray absorptiometry (DXA) (GE Healthcare, Fairfield, Connecticut, USA) to assess the BMD of lumbar spine and bilateral femur bones at baseline and 12 weeks after starting the intervention. The combined prevalences of MS and OSP were calculated for the subjects and compared with previous statistical data of Taiwanese general population, those who live in Yun-Lin County, and patients with serious mental illnesses. We evaluated effects of short-term exercise intervention on the metabolic indices and BMD. We also examined the correlation between the severity of the psychotic symptoms and the metabolic indices and BMD.

**Statistical analyses**

We analyzed the effects of exercise intervention on individual metabolic index, BPRS, and BMD scores with within-subjects analysis of variance (ANOVA), as well as prevalence of MS with McNemar test. The correlation between the change of individual metabolic index and BMD was measured using Pearson’s r test. Differences between groups were considered significant if p-value were smaller than 0.05 for all of these tests. The data were analyzed using Statistical Package for Social Science software 17 for Windows (SPSS Inc., Chicago, Illinios, USA).

**Results**

We recruited 20 patients initially. The mean age ± standard deviation was 40.40 ± 11.98 years. Fourteen were male, and six were female. Thirteen patients had schizophrenia, three patients bipolar I disorder, and the other four patients schizoaffective disorder. The prevalence of MS before intervention was 40%. Among the 19 patients who had received DXA, the prevalence of OSP and osteopenia were 15.8% and 42.1%, respectively. Thirteen patients completed a 12-week exercise program as well as measurements of metabolic indices and BMD. One patient completed the exercise program and metabolic indices measurements only.

Table 1 lists baseline demographic data of completers and non-completers. Table 2 lists metabolic indices, BMD and severity of psychotic
symptoms at week 0, 4, 8 and 12 during a 12-week exercise intervention.

**Discussions**

This study provides clinical evidence about the prevalence of MS and OSP in patients with serious mental illnesses in Yun-Lin County, Taiwan. According to the survey of the Nutrition and Health Survey in Taiwan (NAHSIT, http://nahr.org.tw/), the prevalences of MS in males and females aged 31 to 44 years are 22.7% and 7.7%, respectively. Our results show higher prevalence when compared to that in general population. The prevalences of OSP and osteopenia are close to those in the elderly reported in NAHSIT, which ranged from 25%-40%, and survey done in our hospital, which was around 28% and 45.7%, respectively.

These results support the necessity of regular follow-up of these indices, and integration of appropriate intervention focusing on these disturbances into treatment for patients with serious mental illnesses. The content of exercise program should be safe, simple and interesting for those patients, since they often revealed little motivation or patience in attending the exercise programs compared to those in general population based on our experience, which was also mentioned in a previous study [13]. In addition, the exercise program needs be individualized and modified, and intensive supervision may be required.

The intervention of a 12-week exercise program did not prove effective in this study (Table 1). Nor did the exercise program significantly change the metabolic indices or the BMD (Table 2). The result may be attributable to the inadequate intensity or length of the exercise program.

<p>| Table 1. Baseline demographic data of study completers and non-completers |
|---------------------------------|---------------------------------|</p>
<table>
<thead>
<tr>
<th></th>
<th>Completers (n = 14)</th>
<th>Non-completers (n = 6)</th>
</tr>
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<tbody>
<tr>
<td>Age (years)</td>
<td>40.57 ± 13.11</td>
<td>40.00 ± 9.92</td>
</tr>
<tr>
<td>Gender (M/F)</td>
<td>8/6</td>
<td>6/0</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>27.10 ± 4.87</td>
<td>27.97 ± 4.65</td>
</tr>
<tr>
<td>Mean arterial pressure (mmHg)</td>
<td>86.68 ± 10.82</td>
<td>95.39 ± 7.28</td>
</tr>
<tr>
<td>Cholesterol (mg/dL)</td>
<td>164.14 ± 39.33</td>
<td>175.33 ± 36.51</td>
</tr>
<tr>
<td>Triglyceride (mg/dL)</td>
<td>161.36 ± 98.74</td>
<td>134.00 ± 59.9</td>
</tr>
<tr>
<td>High-density lipoprotein (mg/dL)</td>
<td>43.71 ± 18.48</td>
<td>43.83 ± 15.45</td>
</tr>
<tr>
<td>Glucose A.C. (mg/dL)</td>
<td>94.43 ± 8.54</td>
<td>99.83 ± 16.09</td>
</tr>
<tr>
<td>Metabolic syndrome (Y/N)</td>
<td>6/8</td>
<td>2/4</td>
</tr>
<tr>
<td>Brief psychotic rating scale</td>
<td>20.29 ± 5.65</td>
<td>19.5 ± 8.12</td>
</tr>
<tr>
<td>Bone mineral density-LS</td>
<td>1.18 ± 0.17</td>
<td>1.11 ± 0.15</td>
</tr>
<tr>
<td>Bone mineral density-LFN</td>
<td>0.93 ± 0.13</td>
<td>0.93 ± 0.16</td>
</tr>
<tr>
<td>Bone mineral density-LTH</td>
<td>0.99 ± 0.13</td>
<td>0.98 ± 0.14</td>
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<tr>
<td>Bone mineral density-RFN</td>
<td>0.93 ± 0.13</td>
<td>0.92 ± 0.21</td>
</tr>
<tr>
<td>Bone mineral density-RTH</td>
<td>0.99 ± 0.13</td>
<td>0.96 ± 0.16</td>
</tr>
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Nonsignificantly different between completers and non-completers (N = 20).

LS, lumbar spine; LFN, left femur neck; LTH, left total hip; RFN, right femur neck; RTH, right total hip
since the effect of exercise on metabolic indices may take as long as three months to show the benefits, especially for those with serious mental illness [6]. Since the severity of metabolic disturbances and bone loss tend to fluctuate, extension of follow-up period is needed for confirming the long-term trend. Moreover, the influences of confounding factors such as diet, nutrition status, hormone levels, gender, age, and types of medication should also be considered in a more comprehensive study. A previous study has mentioned about the importance of incorporating of multiple programs (for example, weight management class, nutrition intervention, plus cognitive adaptation for achieving better life style) to reduce body weight [14]. This finding suggests that only exercise intervention might show limited effect for metabolic disturbance or bone density. In addition, baseline characters of metabolic index and bone mass should be considered also, since previous studies that has reported marked efficacy of exercise intervention for those with pre-existing metabolic disturbances. The effect of exercise on metabolic index and bone mass may vary across healthy groups and those with MS or OSP. Randomized controlled trial or crossover design for evaluating the effectiveness of exercise intervention more accurately in this population is warranted in future studies.

Previous studies have investigated the correlation between lipid profile and BMD, but the results are inconclusive. In this study, we did not observe any correlation between changes in individual metabolic index and BMD after exercise intervention (Table 2). Based on this observation, we suggest that interaction deserves more investi-
gation. Further studies targeting patients with serious mental illnesses which lead to the identification of the underlying physiological mechanism and the development of effective intervention are warranted.

**Limitations of the study**

While the findings are interesting and potentially useful, we still caution not to over-interpret the study results because this study has three limitations:

- The sample size is small, and the dropout rate of study subjects is high. The primary reason for the dropout is the fluctuating course of the illnesses.
- Confounding factors such as gender, age, intake of calcium and vitamin D, types of medication, and diet, were not controlled due to the small sample size.
- We could not determine whether maintaining the status quo in the indices that would represent improved medical outcome compared to a control group since control group was absent in this study. Future studies should have a larger sample size and incorporate a control group.

**Summary of the study**

The results supported the necessity for close monitoring metabolic indices and BMD considering the high prevalences of both MS and OSP in patients with serious mental illnesses. The effectiveness of exercise intervention in this population warrants further evaluation.

**Acknowledgements**

This study was supported by the National Cheng Kung University Hospital (NCKUH-10102005). This research also received funding (D102-35001 and D103-35A09) from the Main Campus of University Advancement at the National Cheng Kung University, which is sponsored by the Ministry of Education, Taiwan. The funding institutions of this study had no further rôle in the study design, the collection, analysis, and interpretation of data, the writing of this paper, or the decision to submit it for publication. All the authors declare that they do not have any competing interests.

**References**


