Combining Adapted Judo Training and pharmacological treatment to improve Bone Mineral Density on postmenopausal women: A two years study

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Manuscript Preparation
E Funds Collection

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Source of support: Departmental sources

Received: 29 January 2013; **Accepted:** 16 April 2013; **Published online:** 30 April 2013

ICID: 883889

Abstract

Background & Study Aim: Physical activity has been an important factor to increase bone mineral density (BMD) and, consequently, to prevent and treat osteoporosis. The study aimed the effects of adapted Judo training on BMD in postmenopausal women, during pharmacological treatment.

Material & Methods: Eighteen female volunteers participated in this study. They were separated into two groups: Adapted Judo training (AJT) (n=11; 52.2±5.3 years) and control group (CG) (n=7; 53.8±4.4 years). Lunar GE Dual Energy X-Ray Absorptiometry (DXA) measured BMD at lumbar L_2–L_4, femoral neck and trochanter sites. The training period for AJT was two years, comprised 12 mesocycles with different intensities. ANOVA compared 2 groups in 3 moments of testing and Scheffé Test allowed multiple comparisons between groups for the L_2–L_4 and femoral neck sites, but at trochanter was Fisher LSD.

Results: ANOVA showed significant differences in the AJT group ($F(2, 32)=15.187$, $p=0.000023$). Scheffé Test showed significant increase on lumbar BMD after one year of AJT ($\Delta\%=+8.9\%$, $p=0.000017$) and after two years this improvement stand still ($p=0.33$). The CG after one year presented significant decrease in BMD of femoral neck ($\Delta\%=-6.9\%$, $p=0.03$) and trochanter ($\Delta\%=-3.7\%$, $p=0.0084$). However, the CG recovered the loss of BMD of femoral neck ($\Delta\%=+7.6\%$, $p=0.02$) and trochanter ($\Delta\%=+3.8\%$, $p=0.0079$) after two years of study.

Conclusions: Drug therapy, without the physical activity practice, can aid the maintenance of BMD. AJT may be considered as an efficient physical activity for postmenopausal women with low BMD in pharmacological treatment.

Key words: adapted Judo training • bone density • bisphosphonate • physical activity • bone health

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Background

Adapted judo training (AJT) – Judo training with adapted methodology for older women.

Kuzushi – Training of the unbalancing.

Nage-ai – Throwing training.

Tai-sabaki – Training with turning of the body.

Ukemi – Breakfalls.

Uchi-komi – Repetition drill training of throwing techniques.

BMD – Bone Mineral Density.

Osteoporosis – Bone disease that causes bone fragility with increased risks of fractures.

INMETRO – National Institute of Metrology of Brazil.

Osteoporosis is a bone disease that causes bone fragility with increased risks of fractures and negative consequences on human mobility [1]. In the elderly, bone fragility, risk of falls and frequency of falls are the decisive factors [2]. These factors also affect the capacity for accomplishing daily activities which, consequently, determines the functional autonomy of elderly people [3].

Women are more likely to have the disease due to the endogenous release of sex hormones and the absorption of calcium (Ca) because estrogenic influences lead to decreased Ca absorption by bone tissue during postmenopause [4]. In addition to gender, other risk factors associated with osteoporosis and fractures include genetic inheritance, European descent, age, body mass index (BMI)<20, Ca deficiency, physical inactivity and excessive consumption of tobacco and alcohol [5,6].

In the present study, special attention was given to physical activity because it is thought to have beneficial effects related to bone mineral density (BMD) [7–9] and maintenance of body balance [10], a factor directly related to the risk of falls [11]. In addition, the use of sodium alendronate (bisphosphonate), which acts to control bone reabsorption caused by osteoclastic activity, contributes to fracture reduction [12,13].

Judo is a sport widely practiced in Brazil due to the strong results obtained by its national athletes in the World and Olympic Games [14]. Judo practice, however, does not appear in the literature for females with low BMD being controlled in advanced age. The existing studies indicate that Judo practice in children and in young and high-performance athletes has positive implications for playing a role in the protection of skeletal structure [15–17], suggesting that that Judo practice may also be effective for women with low BMD in advanced age. Borba-Pinheiro et al. [18] proved that AJT had significant impact on lumbar BMD, as well as resistance training and better than hydrogymnastics. It was the first time that any Martial Art was applied as an efficient treatment for BMD. This previous research led to some questions like: what would be the results after two years of AJT practice on BMD? Would lumbar BMD vary? Would BMD improve significantly at the other sites too?

Therefore, the objective of this study was effects of two years AJT on BMD in postmenopausal women in pharmacological treatment, trying to prove the effectiveness of a prolonged Adapted Judo Training (AJT) in osteoporosis therapy.

Material and Methods

Subjects

Eighteen women, all citizens of the Tucuruí municipal district in the State of Pará-Brazil, with low BMD, participated in this study. They were recruited through the systems of local communication (radio and television programs) and posters in December 2008. Eleven volunteers belonged to the Adapted Judo Training (**AJT**) group, and seven did not exercise regularly, control group (**CG**).

The study was started in February of 2009 and is designed as quasi-experimental. This research was approved by the Ethics Committee of the Castelo Branco University, study protocol: COMEP/PROCIMH 01171/2008 of Rio de Janeiro-Brazil, and the participants provided informed consent, and was conducted in adherence to the Declaration of Helsinki [19].

According to the following inclusion criteria, the subjects ought to:

1. Be classified within osteopenia and/or osteoporosis stages.
2. Be taking this medication: sodium alendronate (bisphosphonate, 70 mg/week) and/or Vitamin (Vit.) D^+.
3. Have no previous history of fractures and no history for at least 1 year of regular physical activity practice.
4. In addition, they ought to be in good mental and physical health, according to medical evaluation.

The group of patients was multi-ethnic; no pattern of dominance was observed, and the groups were randomly divided. It is important to point out that the studied region has a population that descends from miscegenation between Europeans, Brazilian Indians and Africans, because the Caucasians individuals have higher probability of developing osteoporosis than the blacks [20].

Protocols

Anthropometric measurement

To evaluate body mass, a National Institute of Metrology of Brazil (INMETRO) certified (precision of 100 g) Filizola scale (Brazil) was used. Height was measured using an INMETRO certified stadiometer (precision of 1 mm) Filizola brand [21].

Measurement of Bone Mineral Density

BMD was measured using a Dual-Energy X-Ray Absorptiometry DXA, GE Lunar® scan, type DPX, current (μA) 750 (USA). The exam was performed three

Table 1. Judo training.

12 Months					
Cycle 1	**Cycle 2**	**Cycle 3**	**Cycle 4**	**Cycle 5**	**Cycle 6**
Run – 5 min	Run – 8 min	Run – 8 min	Short Run – 3 Sprints/10m	Run – 8 min	Short Run – 4 Sprints/10 m
12 Exercises	12 Exercises	10 Exercises	10 Exercises	10 Exercises	10 Exercises
3 Sessions	3 Sessions	3 Sessions	3 Sessions	3 Sessions	3 Sessions
12 Repetitions	12 Repetitions	8 Repetitions	6 Repetitions	10 Repetitions	6-8 Repetitions
(Intensity/11–12)	(Intensity/11–12)	(Intensity/13–14)	(Intensity/15–16)	(Intensity/13-14)	(Intensity/15–16)
VME-Slow	VME-Slow	VME- Moderate	VME- Maximum	VME- Moderate	VME-Maximum
Time – 60 min	60 min	60 min	60 min	60 min	60 min

VME – Velocity of Movement Execution; Intensity – numbers are related to the Borg scale.

times by an orthopaedist physician. At the first data collection the subjects have not started the Judo practice yet. The subject posed in the supine position on the examination table his the legs were inclined (30°) and immobile. The scan was performed on the side right of the femur and lumbar spine. The variables supplied by the DXA were the measures of BMD (g/cm^2), and the *T-score* with negative values in the bone sites: lumbar L_2–L_4, neck of the femur and larger trochanter.

Pharmacological treatment

The medication bisphosphonate sodium alendronate (70 mg/week) and/or Vit. D^+ (day) were used to aid in treatment for reduced bone mass in the volunteers [12,13] in agreement with their personal doctors' prescriptions. The medicine was consumed in the form of tablets, one per week, by the volunteers from both groups during a two years period. In addition, the volunteers were not being treated with additional medicines for increasing bone mass.

Adapted Judo training

AJT was administered for two years, divided into 12 cycles of two months each. During the first year (2009), six cycles were used and repeated in year of 2010 [18]. The intensity of the training was measured by the subjective effort scale [22] and modified, with a growing progression at each cycle (Table 1). The traditional methodology for an adapted Judo class was used [14]. The adapted Judo class had the following sequence:

- **Initial Part:** greetings to the founder of Judo and to the teacher; muscle stretching;
- **Physical conditioning:** exercises of running, crawling, and short jumps;
- **Technique:** break falls 'ukemi', repetition drill training of throwing techniques (uchi-komi), training of the unbalancing 'kuzushi', training with turning of the body (tai-sabaki), and throwing training 'nage-ai', while the ladies did not fall. During the nage-ai, they have thrown the teacher or Judo athletes aging 15 to 20 years old;
- **Final Part:** Muscle stretching; final salutations to the teacher and the founder of Judo.

Combat training '*randori*' was excluded due to the possible risk of fractures from this activity. Classes were held in a 103 m^2 room with a tatami of synthetic rubber (2×1 m and 40 mm of thickness). The frequency was three weekly sessions on alternate days with 60 min/class.

Statistical methods

Initially, the descriptive analysis of the groups was accomplished with measures of central tendency and of dispersion. Shapiro-Wilk tested the distributions normality. The Levene's and Mauchly's tests were performed to confirm proximity with a normal distribution. Factorial ANOVA 2x3 (between-within) compared the BMD of 2 groups, in 3 moments of testing, complementing with Scheffé and Fisher LSD post - hoc tests. In addition, the equation $\Delta\% = ((PostTest–Test)/Test)*100$ was used to determine the percent of improvement [23]. The software Statistica® (version 7.0) was used for the analysis of the data.

Results

Table 2 shows the volunteers' input data; in addition to descriptive measurements of the variables, the values of *T-Scores* and time since menopause, which served as the inclusion criteria for volunteers and confirmed the low BMD in the groups studied. In addition, it is demonstrated that the age, mass, height and time since menopause did not present significant differences between groups. However, significant differences ($p<0.05$) are also presented for the following variables: *T-scores*

Table 2. Descriptive analysis.

Variables	AJT Group; n=11	Control Group; n=7
	Mean±SD	Mean±SD
Age (year)	52.2±5.3	53.8±4.4
Weight (kg)	58.1±12.8	61.78±12.2
Height (cm)	155.6±6.6	153.1±7.05
Years since onset of menopause (year)	2.7±1.2	3±1.08
T-score, Lumbar L_2–L_4 (SD)	–2.6±0.7***	–1.44±1.2**
T-score, Neck Femur (SD)	–1.8±0.9**	–0.97±0.84*
T-score, Trochanter (SD)	–1.2±0.8**	–0.18±1.14*
BMD, L_2–L_4 (g/cm^2)	0.883±0.07	1.003±0.15
BMD, Neck Femur (g/cm^2)	0.766±0.10	0.870±0.10
BMD, Trochanter (g/cm^2)	0.672±0.10	0.778±0.13

* Normal; ** osteopenia; *** osteoporosis.

L_2–L_4 and trochanter, besides the BMD L_2–L_4 between the two groups (Table 2).

Lumbar L_2–L_4 analysis

While analysing the assumptions for ANOVA application, the Shapiro-Wilk test proved that the distributions were all normal (p>0.05), less during the third evaluation of BMD at L_2–L_4 site, for the CG (p=0.03). Due to the small sample size and the lack of normality at the third evaluation of the CG, we controlled α error occurrence during the statistical analyses accepting a more conservative p-critical value of 0.01 during the ANOVA, as recommended by Vincent [23]. The Levene's test have shown the equality of Error Variances for all distributions (p>0.05). The Mauchly's test was not either significant (p=0.40), so ANOVA could be used without any correction factor.

The Figure 1 presents the evolution of the BMD L_2–L_4 after two years of Judo training. In addition, there was a significant difference when the BMD L_2–L_4 was compared between tests *vs.* groups (F(2, 32)=15.187; p=0.00002).

In the Tests*Group analysis, the eta square showed that 49% of the data variability explains the difference found and that this analysis has enough power to support the results (power=0.998). Scheffé Test proved that the subjects from AJT group increased significantly their BMD after one year of practice (Δ=+8.9%; p=0.00002). The AJT maintained their increased BMD after the second year of practice, showing no significant variation (p=0.33), when comparing the second evaluation with the third. The subjects from Control Group did not change significantly their BMD along the 2 years.

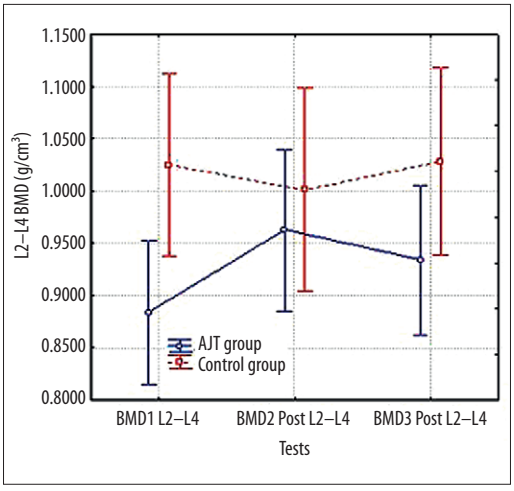

Figure 1. Development of BMD L_2–L_4 among the groups, after two years of study.

Neck of the femur analysis

While analysing the BMD from the femoral neck site, preliminary tests have guaranteed assumptions for ANOVA use. Shapiro-Wilk's test proved that the distributions were normal (p>0.05), Levene's Test was not significant (p>0.05), and neither Mauchly's test (p=0.06). These results have guaranteed the assumptions for ANOVA application.

ANOVA Tests*Group analysis has shown significant difference (F(2, 32)=8.7037, p=0.00096). The eta square showed that 35% of the data variability explains the found difference and that this analysis has enough power to support the results (power=0.95). Scheffé test proved that the subjects from AJT group did not vary significantly their BMD (p>0.05) during the two years of practice. Surprisingly, BMD from the Control Group

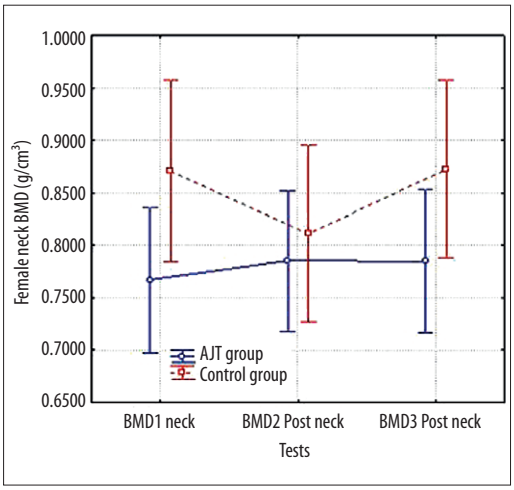

Figure 2. Development of BMD femoral neck among the groups, after two years of study.

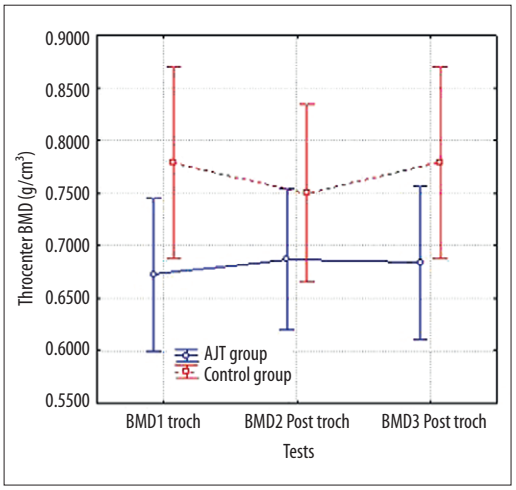

Figure 3. Development of trochanter BMD among the groups after two years of intervention.

decreased significantly (Δ=–6.9%; p=0.03) at the second DEXA evaluation, but increased significantly at the third (Δ=+7.6%; p=0.02), reaching the same level of the first evaluation (p=0.999).

Trochanter analysis

Assumptions for ANOVA application were assured by Shapiro-Wilk test (p>0.05), Levene's (p>0.05) and Mauchly tests (p=0.26). ANOVA showed significant differences during the Group*Tests analysis (F(2, 32)=5.9013; p=0.00658).

Despite of the difference presented by ANOVA, Scheffé could not present which groups were significantly different from each other, however Fisher LSD test could. BMD at trochanter site have not varied significantly within the two years of AJT. Similarly to femoral neck analysis, the CG presented significant decrease in BMD (Δ%=–3.7%; p=0.0084), after the first year, followed by a significant increase in the second year (Δ%=+3.8%; p=0.0079). So BMD reached the same level as in the first evaluation (p=0.977).

Discussion

Our results contribute to and are based on earlier work in this field [24–26]. Although they verify many of the earlier findings, the study was conducted in a population with a context that has not been previously studied: the members of the AJT in our study had never previously practiced Judo. Their improved BMDs for the lumbar spine L_2–L_4 may have been influenced by the crawl exercises and the impact caused by the exercises relating to fall reduction.

Prouteau et al. [27] corroborated these results in a study of Judo athletes undergoing circuit and weight training concomitant with judo training. The results indicated that there were significant increases in total BMDs, the lumbar spines and the neck of the femur in judoists compared to the controls.

Recent study, of Borba-Pinheiro et al. [18] examined the effects of judo training, aquatic exercise, resistance training and control group on the BMD in postmenopausal women and found that Judo caused a significant BMD difference (p<0.05) of the lumbar L_2–L_4 compared to the control group. In addition, the Judo group caused a significant balance difference (p<0.05) compared to the group that practiced aquatic exercise and the control group, in a period of 12 months. However, it is worth noting that the resistance training had the best results, including in relation to the Judo group.

Although the postmenopausal women in the present study have not shown a significant increase in BMD in all parameters, it was shown that at least in one aspect (lumbar spine) there was an improvement, which may indicate that AJT can be beneficial, regardless of previous experience in Judo.

These findings suggest that regular practice of Judo may exert osteogenic effects that are helpful in preventing loss of BMD with advanced age, reducing the risk for developing osteoporosis. Such a protective role has previously been ascribed to physical exercise [28].

It was also observed, as can be seen in (Table 3) that bone variables significant differences in CG group, possibly as a consequence of the medication consumption, especially, after two year of study. In addition, there were significant differences in BMD L_2–L_4 had better outcomes in the AJT. The results suggest that AJT exerts strong osteogenic effects and, as an alternative for

other physical activity, can be recommended for postmenopausal women with low BMD. However, the consumption of alendronate, without the Judo physical activity can aid the maintenance of BMD.

The discoveries in the current work appear to highlight a role for Judo practice in the regulation of healthy advanced age bone metabolism and, ultimately, a potential role for Judo practice in osteoporosis prevention. Its role may be influenced by Judo's natural biomechanics, offering protection against a negative bone metabolic balance.

The literature shows that physical activity develops balance, improves strolling, and minimizes the risk of falls significantly, which, consequently, reduces the risk of fractures [29,30]. The present study corroborates other data found in literature, such as [18,31].

There has been no research that examines the impact of Judo on BMD in older women, except the study of [18]. There are similar studies with Tai Chi's apprentices [8] and multiple other exercises including force training, coordination movements and balance [11].

The exercises of displacement and steep turns in all directions (kuzushi), turns of the body (tai-sabaki) and force of the inferior member developed by jumps, along with the activities involved in judogi grabbing, force participants to seek out a position of dynamic and recovered balance and may have contributed to the measured benefits. This analysis suggests that Judo may be another alternative physical activity that is useful for minimizing the risk of falls.

Silva and Pellegrini [32] suggest that the practice of Judo improves the technique for fall reduction that tends to be used whenever the individual meets a fall situation out of the Judo context. Our results reinforce that statement. They demonstrate a significant improvement in the fear of falls, which may be related to break fall techniques (ukemi) that protect the spine and the cervical region, arms and legs.

The combination of physical activity and medication has also been shown to have a positive effect on BMD and other risk factors for osteoporosis according to the results of [33], which indicate that the interaction between medications and physical activity has been shown to be more effective than only physical activity or only medications for women in menopause. This study found that the consumption of alendronate and/or Vit. D^+, without the physical activity practice can aid the maintenance of BMD.

The results of the present study also revealed that the combination of Judo and pharmacological treatment might have a significant effect on increasing the BMD of the lumbar spine and stabilizing the BMD of the larger trochanter and femoral neck.

This two years study indicate that AJT with alendronate and/or Vit. D^+ was an effective treatment to improve lumbar BMD and maintain this improvement in postmenopausal women. A JT may be an alternative practice of physical activity to be offered at gyms, Sport associations and university programs for the community by a qualified professional can help in osteoporosis prevention and treatment.

Conclusions

Drug therapy, without the physical activity practice, can aid the maintenance of BMD. AJT may be considered as an efficient physical activity for postmenopausal women with low BMD in pharmacological treatment.

So, Physical Education, Kinesiology and Exercise Science courses should provide this knowledge on AJT to their students, enabling them to work with prevention of lumbar spine fractures. We recommend further research dealing with variations on AJT methods and its intensity, volume and recovery time to better understand the benefits of this practice on BMD within a prospective and longitudinal design.

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Cite this article as: Borba-Pinheiro CJ, Carvalho MCGA, Drigo AJ et al.: Combining Adapted Judo Training and pharmacological treatment to improve Bone Mineral Density on postmenopausal women: A two years study. Arch Budo, 2013; 2: 93–99.