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Feasibility of a 12-month continuous and intermittent high-impact exercise intervention

A 12-month continuous and intermittent high-impact exercise intervention and its effects on bone mineral density in early postmenopausal women: a feasibility randomised controlled trial

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ABSTRACT

BACKGROUND: Intermittent mechanical loading generates greater bone adaptations than continuous mechanical loading in rodents but has never been evaluated in humans. This study aimed to evaluate the feasibility of a continuous and intermittent countermovement jump (CMJ) intervention for attenuating early postmenopausal BMD loss.

METHODS: 41 healthy early postmenopausal women (age = 54.6 ± 3.4 years) were randomly assigned to a continuous countermovement jumping group, an intermittent countermovement jumping group or a control group for 12 months. Adherence and dropout rates were recorded along with bone mineral density (BMD) at lumbar spine, femoral neck and trochanter sites at baseline, 6 months and 12 months.

RESULTS: 28 participants completed the study. Dropout rate during the intervention (from the initiation of exercise) was 36% from continuous and 38% from intermittent countermovement jumping groups. For the participants that completed the intervention, adherence was $60.0 \pm 46.8\%$ for continuous and $68.5 \pm 32.3\%$ for intermittent countermovement jumping. The control group lost significant lumbar spine BMD (% difference = -2.7 [95%CI: -3.9 to -1.4]) and femoral neck BMD (% difference = -3.0 [95%CI: -5.1 to -0.8]). There was no statistically significant change in BMD for either countermovement jumping group. There was no statistically significant difference in BMD change between continuous or intermittent countermovement jumping groups when compared with the control group.

CONCLUSIONS: Adherence and dropout rates were in line with previous similar interventions. To evaluate the effect of continuous and intermittent exercise on BMD, future studies should focus on maintaining participant engagement and adherence to the exercise intervention.

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Key words:

Bone mineral density; Postmenopausal women; Exercise; Osteoporosis prevention

TEXT

Introduction

Postmenopausal women experience rapid declines in bone mineral density (BMD) in the early years post-menopause which can increase the risk of developing osteoporosis and subsequent fractures (1,2). In the EU, 46% of women over the age of 50 will experience an osteoporotic fracture (3), with fracture treatments costing EU countries €37 billion each year (4).

High-impact exercise can reduce postmenopausal bone loss, has been demonstrated to be safe and can provide a cost-effective addition to pharmacological therapies (5). These exercise regimes are often comprised of high-strain magnitudes along with high levels of muscular force (6,7). In adult and aged animal models, the stimulus frequency is an important determining factor for mechanoadaptation with intermittent mechanical loading generating greater bone formation than continuous mechanical loading (8–10). The greater bone response may be due to the longer rest interval during the intermittent stimulus frequency creating a “resensitisation” effect on the mechanosensitivity of the bone (11). In support of this, repetitive continuous stimulus frequency loading has shown to desensitise bone tissue, as the anabolic response to bone loading becomes saturated after only 40 loading cycles (12). This highlights that there are potential benefits of performing very short durations of high-impact exercise with relatively few loading cycles at intermittent stimulus frequencies to stimulate bone adaptations (13). However, the comparative effects of long-term mechanical loading at continuous and intermittent stimulus frequencies, while controlling for loading variables (peak and gradient of loading); have not been evaluated in human populations.

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For human populations, mechanical loading is generated through high-impact exercises which can be challenging for postmenopausal women despite the known benefits of high-impact exercise on bone health (14). It is common to find adherence rates ranging from 52 to 100 % in exercise interventions with osteopenic and osteoporotic populations, for which the most commonly reported barriers to participating in exercise activity are lack of time and lack of transportation (15–17). For exercise interventions targeting bone health in adult populations, the average dropout rate is 21% [95% confidence intervals (CI): 17 to 26%] with 24% [95% CI: 20 to 28%] of the remaining participants not fully complying with the intervention (18,19). Furthermore, the longer the duration of the exercise intervention (from six months to two years), the higher the dropout rate and the higher the proportion of non-compliance within the intervention groups (18). There appears to be no meaningful difference in dropout rates or compliance rates when the exercise is supervised or unsupervised or when the exercise is completed in the home or at a designated facility (18). This presents a problem for the promotion of exercise interventions in order to benefit bone health and highlights the need for time-efficient and easily accessible exercise programmes aimed at improving or maintaining bone health in these adult populations. In light of the previous adherence issues highlighted with exercise interventions, the current study was designed so that exercise was; short in duration to reduce the time commitment, easily accessible to prevent transport issues, sufficient in duration to show changes in BMD but not excessively so and could be unsupervised if necessary.

Therefore, the aim of this study was to evaluate the feasibility of a 12-month home-based, self-administered, short duration, countermovement jump (CMJ) intervention performed at either continuous or intermittent stimulus frequencies for attenuating early postmenopausal BMD loss. The secondary aim was to evaluate the effect of a countermovement jump (CMJ) intervention performed at either continuous or intermittent stimulus frequencies on bone

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mineral density in early postmenopausal women.

Materials and Methods

Study design and participants

This feasibility study was a randomised controlled trial with two intervention and one control group. Participants performed either continuous CMJ (CTS), intermittent CMJ (INT) or a non-exercising control group (CON). The protocol was approved by Hull and East Yorkshire Hospitals NHS Trust ethics committee (HEY R&D Ref: R1723; REC Ref: 14/SW/1074; Chairperson: Dr Rhona Bratt; Approval given 16/10/14). Written informed consent was obtained on study enrolment. All procedures performed in studies involving human participants were in accordance with the ethical standards of the University of Hull, Hull and East Yorkshire Hospitals NHS Trust ethics committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

The study was publicised by local media between September 2014 – September 2015. Study participants were healthy early postmenopausal (1 – 5 years) women 48 to 59 years of age, white European origin and free from osteoporosis. Inclusion and exclusion criteria are detailed in the supplementary material.

Bone adaptations were based on a Cohen's d effect size of $d = 0.41$ using the mean group difference in lumbar spine BMD and three groups, with pre, mid and post intervention testing (20).

Feasibility of the two interventions were assessed against an adherence of 76% [95% CI: 72 to 80%] and a dropout rate of 21% [95% CI: 17 to 26%] in accordance with previous exercise

Feasibility of a 12-month continuous and intermittent high-impact exercise intervention interventions targeting bone mineral density (18).

Study procedures

Dual-energy x-ray absorptiometry (DXA) scans were performed at the lumbar spine (L1 – L4) and right proximal femur by the same technician at Hull Royal Infirmary on a GE Lunar Prodigy DXA scanner (GE Healthcare, Madison, WI, USA), whilst blinded to group allocation. Participants received DXA scans at baseline, 6 months and 12 months during the investigation to calculate BMD. DXA precision error was 0.9% and 1.4% for the lumbar spine and femoral neck respectively (root mean square % coefficient of variation) (21). The least significant change for lumbar spine and femoral neck BMD was 2.5% and 3.9% respectively (22).

Blood was sampled at baseline using venepuncture and analysed for serum 25-hydroxy vitamin D (25(OH)D), calcium and phosphate concentrations. Batch analysis occurred in the blood sciences laboratory at Hull Royal Infirmary. (25(OH)D) was measured using a Waters Quattro Premier XE mass spectrometer and Acuity UPLC System (Elstree, UK). The laboratory participates in external quality control (EQA) schemes with DEQAS and NEQAS on to ensure accuracy. Serum calcium ($\text{mmol}\cdot\text{L}^{-1}$) and inorganic phosphorus ($\text{mmol}\cdot\text{L}^{-1}$), were measured by standard photometric AU and UV methods using Beckman Coulter analysers (Beckman Coulter, CA, USA). The laboratory and tests are accredited under UKAS ISO 15189 for clinical diagnostics.

Exercise intervention

Following adaptive randomisation, CTS and INT groups completed identical exercise programmes in their own homes for 12 months, which only differed in the rest interval duration between jumps (stimulus frequency). Countermovement jumping (CMJ) has shown to remain consistent and similar in key mechanical loading parameters (peak acceleration and

Feasibility of a 12-month continuous and intermittent high-impact exercise intervention acceleration gradient) when performed at continuous or intermittent stimulus frequencies (23). Both groups performed 30 CMJ on three separate occasions per week that were at least 48 hours apart to reduce the desensitisation effect (12). Participants were told to complete the exercises barefoot on a hard surface and to “jump as high as possible using the arms and land on the balls of the feet with bent knees” to reduce the risk of injury. Participants were familiarised with the CMJ technique prior to the start of the intervention, each participant’s technique was checked to ensure safe jumping technique was practiced. CTS participants performed 30 CMJs at a stimulus frequency of 15 jumps per minute (totalling two minutes of exercise), INT participants performed 30 CMJs at a stimulus frequency of 4 jumps per minute (totalling seven minutes and thirty seconds of exercise). Rest intervals were counted using a metronome. Intervention participants kept monthly exercise logs and were regularly contacted via email or telephone every 3 to 4 weeks to assess adherence. Control participants were instructed to maintain their habitual physical activity during the trial.

Statistical analysis

Participants were adaptively randomised by the lead researcher (after DXA and blood measures) to groups using their baseline femoral neck T-score and (25(OH)D) to standardise the group baseline femoral neck and (25(OH)D) values to control for bias arising from regression to the mean (24). The primary outcome measure was BMD (g/cm^2).

Data were deemed to be normally distributed following visual interpretation of Q-Q plots, and histograms and via the Shapiro-Wilk tests. Log transformations were applied to satisfy assumptions of normality and reduce non-uniformity of error. Absolute changes in BMD pre and post intervention are presented as mean difference (g/cm^2) and 95%CI. The mean between-group differences were divided by the pooled between-subject SD (following adjustment for small sample bias) of the baseline data, to quantify the magnitude of the standardised effect

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size (Cohens d). Cohen's d effect size was reported and evaluated using the following scale: 0-0.19 trivial, 0.2-0.59 small, 0.6-1.19 moderate, 1.2-1.99 large (25). Uncertainty in the population estimates are expressed as 95% CI.

Using R (R Foundation for Statistical Computing 3.2.1, Vienna, Austria), between-group baseline variables were analysed with Welch's t-tests due to unequal group variances. A two-way (3 group x 3 time points) repeated measures ANOVA with a type 3 correction for unequal sample sizes was used to examine the effect of the intervention for group (CTS, INT and CON), time (pre, mid and post) and group \times time interaction. Post-hoc within-group pairwise comparisons were completed with paired t-tests adjusted for multiple comparisons using the Holm-Sidak method (26). Main effects for group (CTS, INT and CON) are presented, as are main effects for time (pre, mid and post) and group \times time interaction. Significance was set at $P < 0.05$. This study was not powered to detect differences in participant centred outcomes and therefore the results should be interpreted with caution.

Results

Feasibility and process outcomes

There were 49 participants were initially recruited of which 41 were randomly assigned to exercise and control groups. Of those, 28 completed the study and were included in the intention to treat analysis, following adherence checks, 17 participants were included in per-protocol analysis. During the intervention, four participants dropped out due to undisclosed prior conditions. One participant experienced a hip fracture due to an unrelated fall and was excluded from the analyses (Fig.1). The dropout rate during the intervention (from the initiation of exercise) was 36% from the CTS group, 38% from the INT group and 8% from

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the control group.

Of the participants that completed the study (9 CTS group, 8 INT group), exercise adherence was $60.0 \pm 46.8\%$ and $68.5 \pm 32.3\%$ respectively.

<< **Figure 1 Here** >>

Participant baseline characteristics

Participant baseline characteristics are presented in Table 1.

<< **Table 1 Here** >>

There were no statistically significant changes in mass or body mass index during the intervention across all groups.

Intention to treat analysis

Lumbar spine bone mineral density (L1 – L4)

From baseline to final testing after 12 months, for lumbar spine BMD there was no statistically significant main effect for group, time, or interaction term ($P = 0.672$; $P = 0.792$; $P = 0.922$).

Femoral neck bone mineral density

From baseline to final testing after 12 months, for femoral neck BMD there was no statistically significant main effect for group, time, or interaction term ($P = 0.394$; $P = 0.840$; $P = 0.764$).

Trochanter bone mineral density

From baseline to final testing after 12 months, for trochanter BMD there was no statistically significant main effect for group, time, or interaction term ($P = 0.320$; $P = 0.933$; $P = 0.983$),
(Table 2).

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<< Table 2 Here >>

*Per-protocol analysis**Lumbar spine bone mineral density (L1 – L4)*

From baseline to final testing after 12 months, for lumbar spine BMD there was no statistically significant main effect for group ($P = 0.750$), but there was a statistically significant main effect for time, showing a reduction across groups ($P = 0.006$), the group-time interaction term was not statistically significant ($P = 0.307$), (Table 3).

Only the CON group experienced a statistically significant within-group loss in lumbar spine BMD over 12 months (Fig. 2). When compared to the least significant change, which was 2.5%, it was apparent that 20% of the CTS, 60% of the INT participants and 57% of the CON participants experienced clinically detectable reductions in lumbar spine BMD.

<< Figure 2 Here >>

Femoral neck bone mineral density

From baseline to final testing after 12 months, for femoral neck BMD there was no statistically significant main effect for group ($P = 0.307$), but there was a statistically significant main effect for time, showing a reduction across groups ($P < 0.001$), the group-time interaction term was not statistically significant ($P = 0.970$), (Table 3).

Only the CON group experienced a statistically significant within-group loss in femoral neck BMD over 12 months (Fig. 3). When compared to the least significant change, which was 3.9%, it was apparent that 20% of the CTS participants, 20% of the INT participants and 57% of the CON participants experienced clinically detectable reductions in femoral neck BMD.

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<< **Figure 3 Here** >>*Trochanter bone mineral density*

No statistically significant main effect on trochanter BMD was found for group, time or interaction ($P = 0.530$; $P = 0.091$; $P = 0.090$), (Table 3).

<< **Table 3 Here** >>**Discussion***Main Findings*

Of the 17 intervention participants (9 CTS group, 8 INT group) that completed the study, adherence was $60.0 \pm 46.8\%$ and $68.5 \pm 32.3\%$ respectively, with four of those participants not returning exercise logs and therefore counting as 0%. The current adherence would be deemed as poor in comparison to previous exercise interventions targeting bone mineral density (76% [95% CI: 72 to 80%]), but within the expected range for unsupervised exercise interventions (82% [95% CI: 59 to 93%]) (17,18,27), and exercise adherence rates from patients with osteopenia or osteoporosis, albeit at the lower end of the observed adherence rates (52% to 100%) (15,16) For the 10 participants that completed the exercise protocol and were included in the final statistical analysis, adherence to sessions was good (5 CTS group, 5 INT group), ($98.2 \pm 5.9\%$ and $87.3 \pm 8.7\%$). However, the dropout rate of 36% from the CTS group and 38% from the INT group was much higher than previously reported for other bone health interventions (21% [95% CI: 17 to 26%]), but within the expected range for unsupervised exercise interventions (32% [95% CI: 19 to 48%]) (18,19). The adherence and dropout rates raises questions over the feasibility of a time-efficient, home-based CMJ programme for early

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postmenopausal women, which would require a much greater initial cohort to ensure a larger final number of participants. Some control participants (36%) undertook extra exercise training during the study, which consequently meant elimination from the per-protocol analysis, as can commonly occur with a randomised control trial design (28). Despite frequent checks, future programmes may benefit from individual or group training sessions with an instructor, where adherence can be objectively recorded and a group environment could potentially increase quality of life and bolster adherence (29). Other factors such as exercise variation may improve adherence to the intervention as participants may find the programme more interesting, although the addition of multiple exercises would incorporate confounding variables into the exercise stimulus and makes standardising the exercise stimulus more complicated.

The findings showed that the CTS and INT groups showed no statistically significant change in lumbar spine and femoral neck BMD levels whereas the control group experienced a statistically significant loss in both lumbar spine BMD (% difference = -2.7 [95%CI: -3.9 to -1.4]) and femoral neck BMD (% difference = -3.0% [95%CI: -5.1 to -0.8]). When comparing the magnitude of change between groups findings were either trivial or confidence intervals spanned substantially negative and substantially positive effect sizes. Therefore, more data are required to clarify whether there are beneficial effects of CTS or INT exercise programmes on reducing early postmenopausal BMD loss. To the authors' knowledge, this is the first study to directly evaluate the effect of stimulus frequency on human bone. It is also the first study to compare continuous and intermittent CMJ interventions for attenuating early postmenopausal BMD loss. Interestingly, the percentage of CON participants experiencing clinically meaningful reductions in both lumbar spine and femoral neck BMD was almost three times higher than that of the CTS and INT groups. The CON group displayed a 2.4 times higher level of postmenopausal bone loss when compared to a 47 to 63 year old population (30), this may be due to participants being in closer proximity to the menopause where rates of bone loss are

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known to be higher (31). The present study showed comparable lumbar spine postmenopausal BMD loss when compared to a similar population of early postmenopausal women (2). Our study supports the rapid BMD loss in close proximity to the menopause.

Current findings are supported by previous studies that also found no effect of counter-movement jumping programmes on postmenopausal BMD loss (35–37). The most likely explanation for the current study is that the focus was on the feasibility of the intervention and that the study was not powered to detect these potential changes in BMD. This could ~~result~~ ~~from~~ also be affected by a decreased oestrogen bioavailability, which increases bone demineralisation (38). However, a variety of exercise programmes have found positive bone adaptations despite participants being oestrogen-depleted postmenopausal women (5,39–43). Furthermore, with a known osteogenic exercise stimulus in premenopausal women, the addition of oestrogen via hormone replacement therapy for postmenopausal women has not had any effect on BMD, which could suggest the influence of factors other than oestrogen that may contribute to a blunted BMD response (35).

It is unclear if the exercise programmes had any beneficial effects on skeletal parameters in the current population of early postmenopausal women. Therefore, the question of whether intermittent stimulus frequency exercise could provide a greater osteogenic stimulus than continuous stimulus frequency exercise for early postmenopausal women as has been previously demonstrated in animals, remains unanswered and highlights the need for higher powered future intervention studies (8).

Strengths and Limitations

The programme was designed to be; easy to complete, accessible to all and minimise time commitment. Judging by the high dropout rate, this programme was not easy to adhere to however. Successful interventions with the current population have involved either resistance

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exercise or mixed loading protocols and could indicate that adherence is improved with an increased exercise variety (5,41,43). Anecdotally participants, particularly in the INT group, sometimes expressed boredom during the longer rest intervals, which could have affected dropout rate.

It was not possible to determine the effect of CTS or INT exercise on early postmenopausal BMD loss, any future study in this area would require a greater number of participants in order to evaluate this concept more thoroughly. DXA scans are limited in determining geometric bone adaptations. It is possible that bone adaptation had occurred but was undetectable with DXA scans. DXA and the addition of MRI or CT scans have been advocated for combined use in determining bone strength parameters and geometrical bone shape (44–46).

It was difficult to determine the intensity of the home-based programme when participants were unsupervised. It is possible that exercise intensity could have been reduced and therefore may have reduced the bone stimulus (i.e. submaximal CMJ).

Many participants were (25(OH)D) deficient at baseline. Seasonal fluctuations in (25(OH)D) status could have further reduced bioavailability, which could have blunted the osteogenic potential of the exercise programmes through reductions in calcium absorption and bone mineral accrual (47). The average T-score of the femoral neck for an age-matched population to the current study is -1.0 (48). Participants for the current study had higher T-scores at baseline of -0.4 ± 0.6 , -0.7 ± 0.7 and -0.2 ± 0.4 for the CTS, INT and CON groups respectively. Participants with higher BMD potentially require greater mechanical stimulation to initiate an adaptive response. The current exercise volume was relatively low at 30 CMJ, performed three times per week. Despite more than 36 loading cycles having shown little extra benefit for bone adaptation in animal populations, human bone potentially requires a greater number of loading cycles (12,49). This necessitates further research to establish potential thresholds for human

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bone adaptation.

Conclusions

This study demonstrates that the time-efficient and easily accessible home-based exercise intervention was feasible for a small number of participants, although the adherence and dropout rates suggested that this intervention was less effective than other similar interventions. The low participant number meant that it was not possible to determine if there was an effect of the exercise interventions on BMD. CTS and INT groups maintained lumbar spine and femoral neck BMD whereas the control group experienced a statistically significant loss in both lumbar spine and femoral neck BMD. A definitive inference cannot be made from the observed effects of CTS and INT CMJ on reducing early postmenopausal BMD loss, at the lumbar spine and femoral neck, when compared to the control group. Future studies should focus on maintaining participant engagement and adherence to the exercise intervention in the evaluation of continuous and intermittent exercise on BMD.

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NOTES

Conflicts of interest

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Authors' contribution statement

GM, GA, CD, WE, MA and MD conceived the research idea and constructed the research protocol; GM performed the data analyses and initial interpretations; GM, GA, CD and MD drafted the manuscript; all authors reviewed and provided intellectual feedback on subsequent drafts of the manuscript.

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TABLES

Table 1. - Descriptive participant parameters at baseline

	Mean \pm SD		
	Continuous (n = 15)	Intermittent (n = 14)	Control (n = 12)
BMD			
Lumbar Spine	1.133 \pm 0.161	1.153 \pm 0.174	1.137 \pm 0.130
BMD (g/cm ²)			
Femoral Neck	0.947 \pm 0.086	0.956 \pm 0.120	0.960 \pm 0.091
BMD (g/cm ²)			
Trochanter BMD	0.793 \pm 0.091	0.757 \pm 0.120	0.786 \pm 0.092
(g/cm ²)			
Blood			
25-hydroxy	53.2 \pm 19.8	50.4 \pm 17.5	54.8 \pm 18.5
vitamin D			
(25(OH)D)			
(nmol·l ⁻¹)			
Calcium	2.3 \pm 0.1	2.4 \pm 0.1	2.3 \pm 0.1
(mmol·l ⁻¹)			
Phosphate	1.2 \pm 0.1	1.2 \pm 0.1	1.2 \pm 0.1
(mmol·l ⁻¹)			
Age (y)	56.0 \pm 3.0	53.3 \pm 3.2	54.3 \pm 3.8
Height (m)	1.63 \pm 0.07	1.65 \pm 0.06	1.64 \pm 0.05
Mass (kg)	67.2 \pm 6.6	67.7 \pm 13.6	68.1 \pm 9.7
Body Mass	25.4 \pm 2.0	25.0 \pm 4.7	25.2 \pm 2.6
Index (kg·m ⁻²)			
BMD, bone mineral density			

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Table 2. – **Intention to treat analysis** - Descriptive statistics for bone mineral density (BMD) parameters pre, mid and post intervention

	Continuous (n =9)			Intermittent (n = 8)			Control (n = 11)		
	Mean ± SD								
	PRE	MID	POST	PRE	MID	POST	PRE	MID	POST
BMD									
Lumbar	1.144 ±	1.142 ±	1.123 ±	1.097 ±	1.089 ±	1.078 ±	1.127 ±	1.141 ±	1.107 ±
Spine L1- L4 (g/cm²)	0.182	0.182	0.187	0.148	0.146	0.170	0.130	0.128	0.126
Femoral	0.931 ±	0.929 ±	0.923 ±	0.892 ±	0.879 ±	0.871 ±	0.955 ±	0.935 ±	0.938 ±
Neck (g/cm²)	0.097	0.104	0.107	0.112	0.107	0.109	0.093	0.065	0.095
Trochanter	0.806 ±	0.808 ±	0.788 ±	0.716 ±	0.728 ±	0.728 ±	0.780 ±	0.779 ±	0.771 ±
(g/cm²)	0.111	0.097	0.106	0.134	0.111	0.122	0.094	0.097	0.087
BMD, bone mineral density									

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Table 3. – **Per-protocol analysis** - Descriptive statistics for bone mineral density (BMD) parameters pre, mid and post intervention

	Continuous (n =5)			Intermittent (n = 5)			Control (n = 7)			Cohen's <i>d</i> [95% confidence intervals] PRE – POST		
	Mean ± SD											
	PRE	MID	POST	PRE	MID	POST	PRE	MID	POST	Continuous - Control	Intermittent - Control	Continuous - Intermittent
BMD												
Lumbar	1.105 ±	1.112 ±	1.105 ±	1.061 ±	1.044 ±	1.028 ±	1.117 ±	1.112 ±	1.088 ±	<i>d</i> = 0.16 [-0.04 to	<i>d</i> = -0.05 [-0.47 to	<i>d</i> = 0.19 [-0.13 to 0.51]; <i>P</i>
Spine L1- L4 (g/cm²)	0.168	0.165	0.179	0.095	0.090	0.115	0.116	0.125	0.118	0.37]; <i>P</i> = 0.085	0.37]; <i>P</i> = 0.766	= 0.189
Femoral	0.936 ±	0.922 ±	0.916 ±	0.889 ±	0.875 ±	0.867 ±	0.959 ±	0.944 ±	0.930 ±	<i>d</i> = 0.10 [-0.61 to	<i>d</i> = 0.06 [-0.21 to	<i>d</i> = 0.01 [-0.46 to 0.47]; <i>P</i>
Neck (g/cm²)	0.075	0.088	0.092	0.087	0.081	0.074	0.049	0.038	0.043	0.80]; <i>P</i> = 0.743	0.33]; <i>P</i> = 0.607	= 0.965
Trochanter	0.801 ±	0.820 ±	0.792 ±	0.722 ±	0.735 ±	0.743 ±	0.789 ±	0.791 ±	0.787 ±	<i>d</i> = -0.08 [-0.28 to	<i>d</i> = 0.18 [-0.10 to	<i>d</i> = -0.20 [-0.43 to 0.03];
(g/cm²)	0.106	0.094	0.109	0.141	0.114	0.121	0.083	0.080	0.075	0.12]; <i>P</i> = 0.459	0.45]; <i>P</i> = 0.104	<i>P</i> = 0.072
BMD, bone mineral density												

TITLES OF FIGURES

Figure. 1 - Participant inclusion flow diagram

Figure. 2 - Changes in lumbar spine (L1 – L4) bone mineral density (BMD) after 12 months.

Data are mean differences \pm 95% CI; continuous group (CTS) n = 5, intermittent group (INT) n = 5, control group (CON) n = 7

Figure. 3 - Changes in femoral neck bone mineral density (BMD) after 12 months. Data are mean differences \pm 95% CI; continuous group (CTS) n = 5, intermittent group (INT) n = 5, control group (CON) n = 7





