ORIGINAL ARTICLE

Effectiveness of Physiotherapeutic Group Education in Improving Quality of Life, Physical Performance and Back Extensor Muscle Strength among Postmenopausal Women with Osteoporosis

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ABSTRACT

Introduction: Menopause associated symptoms may interrupt daily activities and wellbeing among postmenopausal women. Decline in muscle strength and bone mineral density may lead to bone fragility, increase osteoporotic fracture risk, decrease functional performance and quality of life (QOL) among postmenopausal women. The aim of this study was to investigate the effectiveness of 8-weeks physiotherapeutic education (an education session and home-based exercise) on back extensor muscle (BEM) strength, physical performance, balance and QOL in postmenopausal women. Methods: A single blinded, two-arm pilot randomize clinical trial consisting of 30 postmenopausal women with mean age of 68.90 (SD = 8.44) years were randomly assigned to the experimental (n=15) and control (n=15) groups. Experimental group received a group education and performed 8-weeks of home-based exercises. Participants in experimental group recorded exercises performed in their exercise diaries and a physiotherapist monitored their progress through phone calls every two weeks. Control group maintained their daily routine. Assessments were performed at baseline and after eight weeks of intervention for quality of life (QOL), physical performance, BEM strength, handgrip muscle strength and balance using Euro-EQ5D Questionnaire, Short Physical Performance Battery (SPPB) test, prone trunk extension test with a load cell, hand-held dynamometer and Activities-specific Balance Confidence (ABC) scale, respectively. **Results:** The adherence of exercise in experimental group was 86.67%. Mixed model ANOVA analysis showed that there was an interaction effect for BEM strength ($p < 0.01$). Specifically, the self-perceived health status (EQVAS), EQ5D health Utility index, SPPB and ABC scale had more improvements from pre to post test (all $p < 0.05$) among experimental compared to control group. **Conclusion:** Physiotherapeutic education (a group education combined with 8-weeks of therapeutic home-based exercises) provides an effective means to improve BEM strength and physical performance in postmenopausal women.
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INTRODUCTION

Osteoporosis, a metabolic bone disease characterized by loss of bone mass is predicted to affect 200 million postmenopausal women globally (1). Prevalence of osteoporosis in Asian women ranged higher than those in Western countries (25% -38% versus 9% to 16 %) (2). Postmenopausal women exhibit reduced production of estradiol and increasing levels of follicle-stimulating hormone leading to higher bone remodeling (3-4). Bone remodeling increase two-fold at menopause, triple after 10 years, leading to increase age-related fragility fracture risk in postmenopausal women (5). Women with a lower bone mass have lower handgrip muscle strength in early menopausal as well as higher decline in bone mineral density and functional performance in late-menopausal (6). A greater bone loss in postmenopausal women with early menopause was found to be associated with reduced back muscle strength (7). Advancing age and post menopause may cause increase bone loss, reduced number and size of muscle fibers, thereby boosting the risk of osteoporotic fractures (8) and developing kyphosis that have long-term negative consequences, namely decreased back and lower limb function (9).

Management for individuals with increased risk of osteoporotic fractures includes nutrition, exercises, physical activity, falls prevention, secondary causes of osteoporosis management and pharmacotherapy (10). Physiotherapists have a vital role to play in the management of osteoporosis in terms of exercise prescription and client education to preserve bone mass, reduce risk of falls and pain, maintaining an ideal posture, improve mobility and function (11). Exercise programs have been shown to be effective in improving back muscle strength (12) and bone mineral density (13) among women with menopause.

Group client education is advocated to be effective in increasing knowledge and adherence towards treatment among older adults with osteoporosis (14). In addition, function, balance and quality of life among sedentary postmenopausal women with idiopathic osteoporosis improved with self-management (15). Home-based exercises (16-18) or client education in addition to group exercise programs (19) resulted in increased back muscle strength, mobility, balance, and quality of life, among women with a history of vertebral fractures. Moreover, combination of client education about osteoporosis and peer-led exercise programs had positive outcomes in term of knowledge, muscle strength and flexibility, balance, overall function and reduced risk of falls and fractures among older adults with osteoporosis (20). This suggests that physiotherapeutic intervention that consists of client empowerment through education about the condition and self-management using exercises are effective as part of the management for osteoporosis.

In a Malaysian study, it was found that knowledge about osteoporosis was mainly obtained from printed materials or general practitioners and the awareness was generally greater in women with higher education level and income (21). Brief written education materials facilitated changes in knowledge and beliefs related to osteoporosis, calcium intake and exercises among women (22). Generally, a successful home rehabilitation program depends on adhering to regular exercise routine that is strongly influenced by intrinsic motivation, biophysical issues, psychosocial commitments, environmental factors and resources (23). It is important to understand the basics of osteoporosis prevention and regular exercise which are essential to build and maintain healthy bones among postmenopausal women.

Hence, the aim of present study was to investigate the effects of physiotherapeutic group education (a group education combined with home-based exercise program) on quality of life, physical performance, and back extensor muscle (BEM) strength for postmenopausal women with eight weeks of intervention. We hypothesized that physiotherapeutic education (a group education combined with home-based exercise program) may improve quality of life, physical performance, and BEM strength in postmenopausal women with low bone mass.

MATERIALS AND METHODS

Participants and Study Design

This single blinded pilot randomized controlled of 8-weeks trial enrolled 30 postmenopausal women who were diagnosed with low bone mass from January 2017 to April 2017 at the Orthopedics Clinic, Hospital Canselor Tuanku Muhriz, Universiti Kebangsaan Malaysia. Bone density was measured using dual energy X-ray absorptiometry, T score less than -1 indicate low bone mass. Sample size was based on recommendation for pilot RCT, whereby ten to thirty subjects were deemed as an adequate sample size for a pilot RCT, to test the hypothesis (24). Inclusion criteria were postmenopausal women aged 55 years and above, who were not on physiotherapy rehabilitation currently and able to walk more than 4 meters without the use of an assistive device. Participants were excluded if they (1) had chronic back pain with Visual Analogue Scale (VAS) more than 5; (2) had prior surgery or acute fracture at the back and lower limbs; (3) experienced serious trauma that led to fractures and dislocations at the spine; (4) had any known underlying pathologies such as tumour, spinal infections, tuberculosis, inflammatory joint diseases and other rheumatological conditions; (5) had unstable cardiovascular and respiratory conditions that limit participation in the intervention. The flow of study is displayed in Figure 1.

This trial was registered with Australia and New Zealand Clinical Trials Register (ACTRN12618000532202.). Ethical approval was obtained from Research Ethics Committee, Universiti Kebangsaan Malaysia (Ref. No. UKM PPI/118/JEP-2016-6580).

Participants were screened by a physiotherapist (musculoskeletal specialized) who had five years'

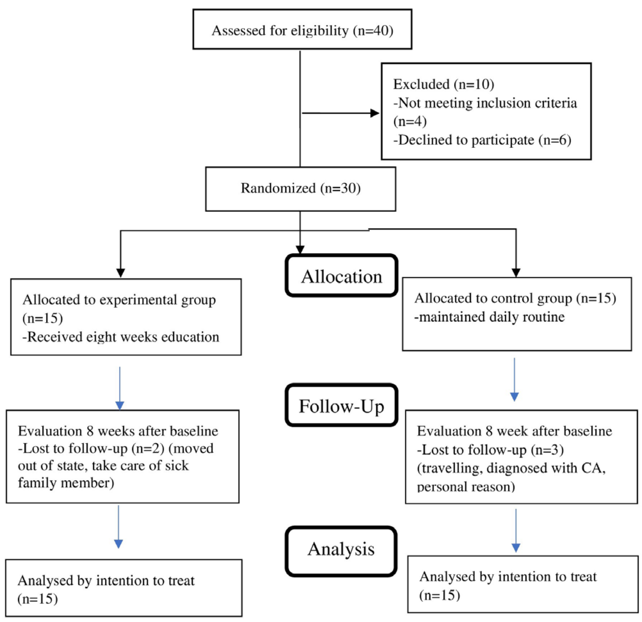


Figure 1: Flow chart of the study

experience using Osteoporosis Fracture Screening Questions. The random allocation was generated using computer after the baseline assessments. Participants were randomly assigned into experimental group (a group education and home-based exercise program) or control (continue usual care and activities). Another physiotherapist who was blinded to allocation of participants, assessed the outcome measurements at baseline and post 8 weeks of intervention.

Experimental group (EG)
Participants in this group attended one occasion of group education regarding facts about osteoporosis, falls prevention and home-based exercises. An education booklet was provided as a reference for self-management (Figure 2). One session of home-based exercises was conducted face to face in a group by a trainee physiotherapist (CYY) and supervised by senior physiotherapist (CSK) with more than 10 years' experience in musculoskeletal physiotherapy. The home-based exercise program included resisted strength training using elastic resistance bands 1-RM aimed to increase muscle strength with an emphasis on good-quality movements (25). Participants were advised to perform 5 to 8 repetitions per set for 3 sets, at least 60 minutes per session, 3 times per week for 8 weeks. The targeted muscles included back extensors, knee extensors and hip muscles known to be associated with spinal extensor muscle weakness and poor balance. The balance exercises comprised of tandem standing, support standing with one leg lift backwards, followed by sideways and repeated for the other leg. Whereas, lower limb strengthening exercises were performed in sitting with an elastic band tied to the bottom of the chair. BEM strengthening exercises were also performed in sitting. With one end of elastic band end attached to side of the chair, right hand pulling upwards, followed by outwards to shoulder abduction to about 120 degrees. Similar movements were repeated using left hand. These exercises are depicted in Figure 2 and Figure 3. Participants were supervised and monitored by a physiotherapist.

Participants were required to record exercises done in their exercise diaries. Participants were contacted at least once every 2 weeks by the trainee physiotherapist (CYY) to provide motivation for adherence and monitoring any adverse events. Program adherence was measured by the proportion of participants completing exercise at the recommended intensity on each day through the records in participants' exercise diaries.

Control group (CG)
Control group continued their usual care and daily activities such as brisk walking, jogging, cycling and others without any restriction up to the end of the study (8 weeks). After which, the participants were provided with the physiotherapeutic group education and home-based exercise program that was received by the experimental group.

Figure 2: Booklet-Home-based exercises training

Figure 3: Physiotherapeutic group education and one occasion of home-based exercises training

Back Extensor Muscle Strength
Back extensor muscle strength (BEM) was measured using load cell (LC501-200/N sensor, Load cell, 200lb, 3MV/V, Newport Electronic, Inc, US), connected to the upper trunk of participants lying prone on a plinth. This procedure has been reported in Chua et al. (26). The participants were required to lift up their upper back and sustained maximum voluntary contraction for five seconds. The same technique was repeated twice with a 60-second rest in between the tests. This test is believed to induce less spine loading and limit the risk of excessive lordosis with good reliability (ICCs of 0.97) for both sexes (27).

Dominant Handgrip Strength
Dominant handgrip strength was measured with three

attempts and a rest in between tests, using a hand-held dynamometer (Jamar, White Plains NY 10602, USA). Details of the procedures were as presented in our earlier study (26). Good reliability of this test was demonstrated with ICCs of 0.97 to 0.98 among nursing home and community-dwelling older adults (28).

Physical Performance
Short Physical Performance Battery (SPBB) (29) was employed to measure physical function that comprised of combined scores of balances, gait speed and chair-stand test. The score ranged from 0: the worst to 12: the best performance. SPPB have been shown to have predictive validity in terms of disability, nursing home admission and risk of mortality (30).

Risk and Fear of Falls
Activities-Specific Balance Confidence (ABC) scale is a 16-item self-administered questionnaire used to determine the risk and fear of falls among participants (31). The score for each item was recorded in percentage, ranging from 0 and 100% with no and completely confident respectively. The total score was obtained by calculating the average of all 16-items in which higher score indicates greater balance, and confidence level. Lower ABC score was significantly related with more falls among older women with construct validity of $r = 0.20$, $p < .001$ (32). ABC scale has high internal consistency with Cronbach's alpha of 0.96 (33).

Risk of osteoporotic fracture
Risk of osteoporotic fracture was measured using fracture calculator World Health Organization's (WHO) FRAX® (www.shef.ac.uk/FRAX) with age, sex, weight, height, clinical risk factors and the result of femoral neck bone mineral density. T-score was based on the WHO diagnostic categories, where individuals with T-score within 1 standard deviation (SD) of the norm are considered to have normal bone mineral density. Scores below this norm are indicated in negative numbers. T-score between -2.5 to -1 and below -2.5 are categorized as osteopenia and osteoporosis, respectively (https://www.bones.nih.gov, Oct 2018). The detail description is as in the study by Chua et al. (26). The Singapore model was used as FRAX has not been calibrated in Malaysia (1).

Quality of life
Euro-EQ5D Questionnaire consisted of self-perceived health status (EQVAS) and EQ-5D profile (34): Malay, Tamil and Mandarin versions were employed to evaluate the quality of life (QOL). EQ-5D profile comprised of self-reported measures of mobility, self-care, usual activities, pain/discomfort and anxiety/depression with 5 levels ranging from no, slight, moderate, severe problem and unable to perform. Participants also rated their perceived health (EQVAS) by using a visual analogue scale (VAS) with the perfect and worst possible health score of 100 and 0 respectively (35). Details of the procedures were as presented in our earlier study (36). Quality of life domains are correlated with health utility index with a scale of 0 (being death) to 1 (being the best state of health) among postmenopausal women (37).

Statistical Analysis
The obtained data was analyzed by using SPSS (Statistical Products and Service Solution) version 22. For baseline measurements, Shapiro-Wilk test was used to determine the normality of sample distribution. Independent t-test and Mann-Whitney test were utilized to compare the intervention and control groups at baseline for continuous data, while Chi-square test was used for nominal data. Data was analyzed using intention-to-treat analysis, where the baseline data was used irrespective of the lost to follow up after the intervention. A mixed model ANOVA was used to examine the effectiveness of physiotherapeutic group education post 8th weeks in terms of time, group and interaction effect. The significant level was set at $p < 0.05$ for each statistical analysis.

RESULTS

A total of 30 postmenopausal women with mean age of 68.90 years old (SD = 8.44) participated in this study. Participants' baseline characters are as in Table 1. 73% and 53% of participants in Experimental (EG) and control (CG) groups had chronic low back pain. Four in EG and one in CG had history of falls in the past one year. One in EG had a history of wrist fracture while two in CG had wrist and clavicle fractures. The mean FRAX 10-year probability of major osteoporotic fracture for all participants was 11.95% (SD = 5.92). Out of the 22 participants, 10 in EG and 12 in CG claimed that they did exercises three times per week (brisk walking, jogging, cycling and others). There were no significant differences between experimental and control groups with regards to demographic variables and baseline measurements.

Thirteen participants in the experimental group completed 8 weeks home-based exercise
program with an adherence rate of 86.67%. BEM strength, dominant grip strength,
SPPB, ABC scale, EQVAS, and EQ5D Health Utility Index post 8 weeks of interventions are displayed in Table 2. Percentage changes post intervention for all measures are as depicted in Fig.4.

BEM strength doubled in experimental group post intervention. The ANOVA analysis showed a significant effect of time and interaction for BEM strength ($F = 16.575$, $p < 0.001$) and ($F = 9.829$, $p < 0.01$) respectively. Also, significant effect of time for dominant grip strength in both groups ($F = 9.867$, $p < 0.01$) was demonstrated. EQVAS, EQ5D Health Utility index, SPPB and ABC scale increased with greater improvements in experimental compared to control group ($p < 0.01$).

Table I:Baseline characteristics of all participants

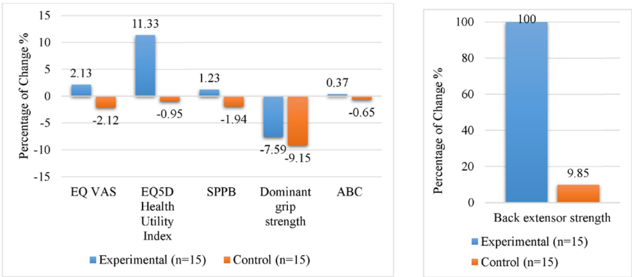
Variables	Total Participants N=30	Experimental n=15	Control n=15	*P* value
Age (years)	68.90 (8.44)	69.07 (9.29)	68.73 (7.82)	0.92[b]
BMI (kg/m²)	23.59 (3.59)	24.14 (4.34)	23.05 (2.69)	0.42[b]
Race				0.64[c]
Malay	8 (26.67)	5 (33.33)	3 (20)	
Chinese	19 (63.33)	9 (60)	10 (66.67)	
Indian	3 (10)	1 (6.67)	2 (13.33)	
Employment status				0.56[c]
Retired/ Unemployed	28 (93.33)	14 (93.33)	14 (93.33)	
Employed	2 (6.67)	1 (6.67)	1 (6.67)	
Level of education				0.86[c]
None/ Primary	9 (30.00)	5 (33.33)	4 (26.66)	
Secondary	13 (43.33)	7 (46.67)	6 (40)	
Higher	8 (26.67)	3 (20)	5 (33.33)	
Chronic low back pain	19 (63.33)	11 (73.33)	8 (53.33)	0.26[c]
Pain score (VAS)	4 (0-5)	4 (1.5-4)	4 (0-5)	0.91[d]
Dominant hand, Right	28 (93.33)	13 (86.67)	15 (100)	0.14[c]
Exercise (30 min, 3 times/ week)	22 (73.33)	10 (66.67)	12 (80)	0.41[c]
Years of menopause	21.5 (9-26.25)	20 (11-27)	22 (8-25.5)	0.51[d]
Had previous falls in past one year	5 (16.67)	4 (26.67)	1 (6.67)	0.22[c]
Had previous fractures	3 (10)	1 (6.67)	2 (13.33)	0.54[c]
Major osteoporotic fracture (%)	11.95 (5.92)	12.03 (6.97)	11.86 (4.90)	0.94[b]
Hip fracture (%)	3.6 (1.15-5.6)	2.5 (1.05-5.3)	3.7 (1.45-5.8)	0.74[d]
EQ VAS (0-100)	80 (70-90)	80 (70-90)	80 (75-90)	0.67[d]
EQ 5D Health utility index, range	0.60-0.78	0.59-0.78	0.62-0.78	0.48[d]
SPPB score (Total=12)	12 (9.75-12)	11 (10.5-12)	12 (9-12)	0.91[d]
Dominant grip strength (kg)	12.65(5.08)	13.73 (5.04)	11.57 (5.06)	0.25[b]
BEM strength (Newton/sec)	14.27	14.19	14.36	0.82[d]
ABC Scale (%)	73.57 (19.91)	73.40 (17.56)	73.73 (22.65)	0.96[b]

[a] continuous variables are expressed in mean (SD) or median (IQR); categorical variables are expressed in number %; [b] independent t test; [c] Chi square test; [d] Mann-Whitney test
ABC: Activities-specific Balance Confidence; BEM: back extensor muscle strength;
EQ 5D: Euro Quality of Life five-domains; FRAX- WHO Fracture Risk Assessment tool; SPPB: Short Physical Performance Battery; VAS: Visual Analogue Scale

Table II: Measurements mean (SD) and within-between-interaction effects of study groups

Outcomes	Experimental (n=15) mean (SD)	Control (n=15)	*P* value (partial eta square) Group effect (hp²)	Time effect (hp²)	Interaction effect (hp²)
EQ VAS (0-100)					
Week 0	78.33 (12.49)	78.33 (17.29)	0.73(0.004)	1.008(<0.001)	0.49(0.02)
Week 8	80 (12.54)	76.67 (14.96)			
Euro HU Index (0-1)					
Week 0	0.697 (0.16)	0.736 (0.16)	0.94(<0.001)	0.188 (0.06)	0.11 (0.09)
Week 8	0.776 (0.18)	0.729 (0.149)			
SPPB (Total=12)					
Week 0	10.6 (2.20)	10.33 (2.38)	0.61(0.009)	0.88(0.001)	0.44(0.02)
Week 8	10.73 (2.25)	10.13 (2.70)			
Dominant grip strength (kg)					
Week 0	13.73 (5.04)	11.57 (5.06)	0.26(0.045)	0.004 (0.26)	0.98(<0.001)
Week 8	12.69 (5.35)	10.5171 (5.46)			
BEM (Newton/sec)					
Week 0	15.08 (4.91)	19.92 (25.79)	0.80 (0.002)	<0.001 (0.37)	0.004(0.26)
Week 8	30.20 (16.27)	21.88 (23.54)			
ABC (0-100%)					
Week 0	73.40 (17.56)	73.73 (22.65)	0.995 (<0.001)	0.96 (<0.001)	0.87 (0.001)
Week 8	73.67 (17.76)	73.25 (23.32)			

EQ VAS: Euro Quality of Life Visual Analogue Scale; Euro HU: Euro Health Utility; SPPB: Short Physical Performance Battery;BES: Back extensor muscle strength; ABC: Activities-specific Balance Confidence Scale
**p<0.05; **p<0.01, ***p<0.001*



EQ VAS: Euro Quality of Life Visual Analogue Scale;
EQ 5D: Euro Quality of Life five-domains;
SPPB: Short Physical Performance Battery;
ABC: Activities-specific Balance Confidence Scale

Figure 4: Percentage changes for the outcome measurements of intervention and control groups after 8 weeks

DISCUSSION

We aimed to investigate the effectiveness of 8-weeks physiotherapeutic group education (a group education combined with home-based exercise program) on back extensor muscle (BEM) strength, physical performance, balance, and QOL in postmenopausal women. Our results demonstrated that physiotherapeutic group education improved BEM strength among postmenopausal women. The BEM strength increased significantly from baseline. This may be explained by the fact that the baseline BEM strength was poor as compared to other measures. The resisted training for back strengthening exercises in the present study with moderate intensity and higher repetitions (5-8 repetitions for 3 sets; 3 times per week) may have exceeded the typical loading patterns of the muscle forces encountered during everyday activities. In sitting, using an elastic band pulling upwards and sideways beyond 90 degree of shoulder level may induce more loading at lumbar spinal vertebras and indirectly targeted via the action of BEM contraction. It is noteworthy that the physiotherapeutic group education was found to be safe as no incidents of injury was reported throughout the study. Moreover, regular monitoring via phone calls may have motivated participants to adhere to the exercises.

Resistance training is reported to increase muscle strength and preserve bone density among postmenopausal women (38-39). In addition, weighted exercises slowed down the rate of loss and increased BMD of the spine among women with osteoporosis (39). Our study finding is consistent with a pilot study that had 10-weeks of back strengthening exercises in improving back muscle endurance, measured using time load standing test among adults with vertebral fractures (11). Furthermore, in a 2-year progressive resisted back strengthening exercise program among postmenopausal women in the study by Sinaki et al. (10) demonstrated increased BEM strength and reduced bone loss and reduced incidence of vertebral fractures 8 years later in comparison to those without exercises.

Concomitant reduction of hand grip muscle strength was observed in both groups post intervention in our study. This result in present study may be explained by the fact that no specific upper limb strength exercises were included in the intervention. This was in contrast to the findings in a previous study that employed specific handgrip strengthening therapy (40), suggesting that handgrip muscle strength might not be an appropriate measurement to evaluate back muscle strength change. It was also deduced that effectiveness of exercise intervention programs for older adults with frailty cannot be evaluated using the change in grip strength as it does not provide a valid mean to determine change of muscle strength and muscle mass compared to leg muscle strength and physical performance (41). Furthermore, a simple exercise intervention for 6 months brought about increased upper and lower limbs muscle strength and balance among women with osteoporosis (42). Also, in a 12-months of daily home-based strength training program, hand grip muscle strength among osteoporotic women improved (43).

The home exercises prescribed in our study included two balance exercises that were tandem and single leg stand. However, from the findings of our study, there was a very small (< 0.5 unit) improvement in ABC scale post 8 weeks of intervention in the experimental group. This could be due to the fact that the participants already had high balance confidence at baseline. Static balance training with only narrow base of support and less intensive strength training on quadricep muscles may not have improved their balance confidence. In contrast, 4-weeks of balance exercises that included dynamic movements to challenge the center of gravity, stress the postural muscle groups and reduce sensory input significantly improved balance confidence among adults with osteoporosis (44).

Osteoporosis may limit functional performance leading to depression or anxiety, reduced social activities, frustration and consequently decline in quality of life (QOL). Although not significant, an improvement in QOL (EQVAS and EQ5D Health Utility Index) among the experimental group was shown. The present study results are supported by previous studies showing that postmenopausal women who have no previous osteoporotic fracture, with lower pain intensity experience (45) and had exercise training (46) showed better QOL compared to those with osteoporotic hip or vertebral fracture mainly due to limitation in social activities (45, 47).

An 8 weeks of specific BEM strengthening exercises program among women with osteoporosis has been demonstrated to have a positive impact on QOL (48). Even short specific 3-weeks of 5 day per week therapy with both physical agent and non-specific exercises or exercises on its own improved QOL, namely in pain domain (46). However, this is not the case in our present study. This may likely be due to ceiling effect in the outcome measure (49). The other reason may be attributed to EQ5D VAS not been a sensitive tool to observe change in postmenopausal women with no osteoporotic fracture (50). In addition, women with no history of previous osteoporotic fracture with lower pain scores and being active in exercise programs were shown to have better QOL (45). The nonsignificant and small change could also be due to QOL being affected by other factors such as having better socioeconomic and social support among postmenopausal women (48).

The intervention in our study that can be considered as low intensity home-based exercise program was found to be safe and effective in improving BEM strength and QOL among postmenopausal women with osteoporosis. Similar results were reported in a 6 months long exercise program in post-menopausal women previously (16). One to the limitation in our study was the small sample size in each group and participants were postmenopausal women aged 55 years old and above. Thus, the findings cannot be generalized to men or the general population. Also, the participants were recruited from only a single urban hospital and so the results may not be applicable to other rural areas. Future studies should involve both males and females from both the rural and urban areas. Determining the cost benefits and effectiveness of such programs will also be beneficial.

CONCLUSION

In conclusion, our study findings indicate that physiotherapeutic group education that consisted of a group education and home-based exercises were effective in improving BEM strength among postmenopausal women. Such programs may improve targeted outcomes among postmenopausal women with risk of osteoporotic fractures.

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