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Power training improves bone mineral density and fall risk for a postmenopausal woman with a history of osteoporosis and increased risk of falling: A case report

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ABSTRACT

The purpose of this case study was to assess the degree to which a 12-month power-based resistance-training program improved bone mineral density (BMD) and fall risk for a 70-year-old postmenopausal woman with osteoporosis and increased risk of falling. After an eight-week strength-development phase, we had the patient perform 44 weeks of resistance training with maximal force mobilization by instructing her to complete as many repetitions as possible during each 60-s set. We used dual-energy X-ray absorptiometry (DEXA) to assess BMD and Dynamic Gait Index (DGI) to assess fall risk before and after the intervention. Post compared to pre-training testing indicated an increase in BMD in the lumbar spine (24%) and femoral neck (29%) resulting in changes in T-score of 0.7 and 0.4 SD, respectively. Testing also revealed a seven-point change in DGI which improved her status to "safe ambulator." After a 12-month period of power training, BMD was increased and fall risk was reduced for a postmenopausal woman with osteoporosis and increased risk of falling.

1. Introduction

Osteoporosis is a condition characterized by an imbalance between bone formation and resorption. The resultant loss of bone mineral density (BMD) exerts its most debilitating effect by increasing fracture risk; for example, by 2.3 and 2.6 fold for every standard-deviation reduction at the lumbar spine and hip, respectively (Marshall et al., 1996). Osteoporotic fractures are associated with considerable disability and osteoporotic vertebral and hip fractures in particular convey a marked increase in mortality (Sattui and Saag, 2014). Despite a lower incidence compared to other fractures, osteoporotic hip fractures present the greatest risk of morbidity and mortality for older women (Sattui and Saag, 2014).

In addition to an increased risk of bone fracture, individuals with osteoporosis possess psychological (e.g., greater fear of falling) and physical (e.g., postural abnormalities) characteristics that increase their likelihood for falling (Arnold et al., 2005; Sinaki et al., 2005). Females over the age of 70 have the greatest risk of suffering at least one fall (Shumway-Cook et al., 2009) and older females are also more susceptible to osteoporosis. Hence, osteoporosis and fall susceptibility conspire to dramatically increase the risk of bone fracture for these individuals. Exercise and weight-bearing activities are important treatment options because they provide a way to improve bone health without the potential side effects associated with pharmacological interventions (McClung et al., 2013). Indeed, even high-intensity resistance training with impact loading has proven to be a safe way to increase BMD and enhance physical function for postmenopausal women with osteoporosis (Watson et al., 2015). The mechanistic basis of this effect appears to be rooted in the activity of sensor cells of osteoblasts and osteoclasts, which are stimulated by a threshold level of mechanical strain (Rubin and Lanyon, 1985).

Intense exercise improves BMD thereby decreasing the likelihood of fractures related to falling. However, to further protect susceptible individuals, training should also include physical activity designed to reduce the likelihood that falls will occur. Preventing a fall requires muscle force production to counteract the forces associated with the fall (i.e., strength); however, requisite

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force must be applied rapidly (i.e., strength per *unit time* or power). In this regard, it is interesting to note that a decline in muscle power production occurs with aging and the reduction exceeds the concurrent decline in strength (Izquierdo et al., 1999). It is, therefore, power that might be the most important attribute to train to reduce susceptibility to falling.

The distinction between the development of strength per se and the development of power is important because some forms of strength training increase strength while not increasing (and possibly decreasing) the rate at which it can be developed (Duchateau and Hainaut, 1984). Consequently, compared to conventional strength training, power training (e.g., resistance training with the concentric phase of each repetition performed with maximal force mobilization) might be the superior form of training for increasing the capacity for power production and, by extension, reducing fall risk in vulnerable individuals (Fielding et al., 2002). In this regard, Chen et al. found that while both slow- and high-velocity sit-and-stand exercises increased strength, only the high-velocity training improved muscle power production (Chen et al., 2012). Importantly, this type of training elicited greater improvement in clinical assessments designed to assess balance, mobility and self confidence (Chen et al., 2012). Miszko et al. also compared strength and power training for older adults and found that power training was more effective for improving whole-body physical function (Miszko et al., 2003). Furthermore, Stengel et al. compared periodized progressive resistance training that required slow performance of the concentric phase of the lift with one that involved the lift being initiated explosively and found that only the explosive training maintained BMD in postmenopausal women over a two-year period (Stengel et al., 2005). This raises the intriguing possibility that power training might represent an intervention that concomitantly reduces the likelihood of falls and the repercussions of falls if/when they do occur.

The purpose of this case study was to investigate the effectiveness of a 12-month power-based resistance-training program for a 70-year-old postmenopausal woman with osteoporosis and increased risk of falling. The patient was referred to a physical-therapy clinic after being diagnosed with osteoporosis with a referral for "gait and balance" due to a self-reported fear of falling and unsteadiness on her feet. After an initial eight-week strength-development phase, we had the patient perform 44 weeks of power training which required her to perform lifts as rapidly as possible. Unlike Chen et al. who used unloaded sit-to-stand exercise with progression based on changing feedback from a video game, we employed a program comprising conventional movements that are used in physical therapy which can also be performed in an unsupervised environment outside the clinic. We also assessed fall risk by using the Dynamic Gait Index (DGI) which has proven to be a valid assessment tool for populations that are susceptible to balance-related deficits (Hall et al., 2004; Romero et al., 2011). We hypothesized that power training would improve DGI score and increase BMD (assessed using dual X-ray absorptiometry; DEXA) in the lumbar spine and femur of this patient.

2. Methods

2.1. Case description

The patient was a 70-year-old postmenopausal female (stature, 1.65 m; body mass, 70.3 kg) with no history of cancer, diabetes, myocardial infarction, cardiac surgery or cerebrovascular accident. The patient was independent in all activities of daily living and instrumental activities of daily living and was independent in ambulation without an assistive device at home and within the community. However, she required handrail support during stair negotiation for both ascending and descending. Furthermore, she reported that she possessed coronary artery disease that she was managing with pharmacological agents (Lipitor, 40 mg; Norvasc, 5 mg; Hyzaar, 100 mg; and Lexapro, 5 mg). The patient was initially diagnosed with osteopenia and a recent DEXA scan confirmed that the disease had progressed to osteoporosis with a high risk of fracture (T-score < -2.4). Prior to initiation of the intervention, she was prescribed 70 mg of Fosamax (bisphosphonate) one time per week and also ingested calcium and vitamin D daily as nutritional supplements. The patient denied having experienced any "real falls" although she did reveal that she had tripped and caught herself without falling on many occasions. She also explained that she has a fear of falling and often feels off balance and unsteady on her feet.

Table 1
Pre- and Post-intervention Scores and Assessments using the Dynamic Gait Index to Assess Fall Risk for a Postmenopausal Woman with Osteoporosis.

Classification	Pre-intervention score/ assessment	Post-intervention score/ assessment
Gait level surface	2	3
Change in gait speed	2	3
Gait with horizontal head turns	1	2
Gait with vertical head turns	1	2
Gait and pivot turn	1	2
Step over obstacle	2	3
Step around obstacles	3	3
Steps	2	3
Total	14	21
	Increased risk of falling	Safe ambulator

Note. 1 = moderate impairment; 2 = mild impairment; 3 = normal; Total = sum of individual-category scores.

2.2. Examination

The patient demonstrated excessive forward head posture with increased thoracic kyphosis along with lumbar lordosis. She also presented with a barrel chest, which she stated she has had since childhood. Range of motion and flexibility were assessed. Limitations were noted in thoracic rotation in either direction measured at 30°. Evidence of decreased hamstring length bilaterally was observed with a measurement of 35° from full extension when utilizing a 90/90 hamstring length test. Furthermore, there was evidence of decreased gastrocnemius length bilaterally with zero degrees of dorsiflexion with the knee extended and 10 degrees of dorsiflexion with the knee in flexion. The patient was unable to perform single leg stance without handheld support; however, she was able to perform tandem stance bilaterally for 15 s before losing balance. She was also able to sustain tandem stanc foam pad bilaterally for 5 s, standing posture on foam pad with eyes open for 60 s and standing posture on foam pad with eyes closed for 5 s. The DGI testing revealed a score of 14, which categorized her as being at an "increased risk of falling" (see Table 1).

2.3. Evaluation

We noted that the patient had decreased lower-extremity and upper-extremity strength, decreased static balance, decreased dynamic gait strategies and decreased BMD. With this in mind in association with her DGI score (see above), we concluded that her history of osteoporosis coupled with balance deficits placed her at a significantly increased risk of fall-related fractures. Consequently, our objective was to create an intervention that would address each of these deficits. We developed an initial program that focused on strengthening major muscle groups and improving static balance by honing technique in preparation for the novel power-based training program that we would subsequently implement. The power-based program was designed to target the hip musculature with a stimulus derived from prioritizing movement speed during each repetition.

2.4. Intervention

The patient underwent physical-therapy treatment two times per week for eight weeks after which she continued to receive treatment one time per week for the remainder of the year. However, she performed physical activity 2–3 days per week by supplementing her activities in the clinic with an unsupervised "home exercise program" which consisted of the same exercises she was completing during her physical therapy sessions at our clinic. She performed this unsupervised training at a local commercial gym. The home program consisted of 10 min of treadmill walking each day along with all of the exercises performed in the clinic. The patient reported "fair" compliance with her home program (e.g., average participation of one day per week during the 12-month intervention). Information regarding the exercises that were performed during the various phases of the program and the volume and load that were applied is presented in Table 2.

During the initial eight weeks of training, the patient started her session by performing 10 min of treadmill walking at a self-selected speed ranging from 2.5 to 3.5 mph. Following this warm-up, she performed hamstring and gastrocnemius stretching for her posterior chain, which tested as limited during evaluation. The initial exercise program consisted of conventional resistance training, which required lift repetitions to be initiated in a controlled manner (3-s concentric/3-s eccentric cadence; i.e., without maximal force mobilization). This eight-week training phase was designed to improve baseline strength and hone technique in preparation for the introduction of the power training that would follow for the subsequent 44 weeks. During the preparatory phase, three sets were performed to momentary muscular failure (MMF) for side-lying "clamshells" (hip external rotation), leg press, resisted elbow flexion and extension, seated rows, seated shoulder extension, bridging and heel raises. The load for these exercises was initially determined as one that would allow for a range of 8–15 repetitions to MMF and this load was progressed on a weekly basis to maintain repetitions within that range. During this initial phase of training, the patient also performed static balance activities designed to challenge sensory integration. Activities performed for this type of training included Romberg stance (3 sets x 60 s each), which was progressed to one-half and then full tandem stance (also 3 sets x 60 s each) and, finally, to single-leg stance (3 sets x 5–15 s each).

Following the initial eight weeks of training, the patient participated in the power-based program for the duration of the 12-month intervention. The patient began sessions with the same warm-up (see above) after which she performed sit to stands, forward step-ups and lateral step-downs (8-in step in each case) with upper extremity support, weighted standing hip abduction, weighted standing hip extension, lat pulldowns and leg presses. For each of these exercises, emphasis was placed on maximally mobilizing force for each concentric repetition. This was accomplished by instructing the patient to initiate the lift explosively while attempting to complete as many repetitions as possible during each 60-s set. Each exercise was performed for three sets with load increased every six weeks to progress the stimulus. During this power-based phase of training, we also trained the patient eccentrically with a reactive-stepping challenge requiring her to maintain her balance with her center of gravity positioned outside her base of support.

Table 2
Volume and Load Information for the Exercises Comprising the 12-month Training Intervention Performed by our Patient.

Exercise	Sets	Time (s)	Load (lbs)
Week 1 (beginning of preparatory training phase)			
Treadmill (2.5–3.5 mph)		600	
Hamstring and Calf Stretch	3	30 per set	
Side-lying Hip External Rotation	3		0
Leg Press	3		95
Elbow Flexion	3		3
Elbow Extension (Cable)	3		5
Seated Rows (Cable)	3		15
Seated Shoulder Extension (Cable)	3		5
Supine Bridges	3		0
Heel Raises	3		0
Romberg Stance	3	60	
Week 8 (completion of preparatory training phase)			
Treadmill (2.5–3.5 mph)		600	
Hamstring and Calf Stretch	3	30 per set	
Side-lying Hip External Rotation	3		5
Leg Press	3		125
Elbow Flexion	3		5
Elbow Extension (Cable)	3		7
Seated Rows (Cable)	3		30
Seated Shoulder Extension (Cable)	3		15
Supine Bridges	3		10
Heel Raises	3		10
Single-leg Stance	3	5–15	
Week 9 (beginning of power-based training phase)			
Treadmill (2.5–3.5 mph)		10	
Hamstring and Calf Stretch	3	30 per set	
Sit to Stands (18-in chair)	3	60	10
Forward Step-ups (8-inch step)	3	60	5
Lateral Step-downs (8-inch step)	3	60	5
Standing Hip Abduction	3	60	2
Standing Hip Extension	3	60	2
Lat Pulldown	3	60	25
Leg Press	3	60	130
Reactive-stepping Activity	10		
Week 52 (completion of power-based training phase)			
Treadmill (2.5–3.5 mph)		10	
Hamstring and Calf Stretch	3	30 per set	
Sit to Stands (18-in chair)	3	60	40
Forward Step-ups (8-inch step)	3	60	20
Lateral Step-downs (8-inch step)	3	60	15
Standing Hip Abduction	3	60	8
Standing Hip Extension	3	60	8
Lat Pulldown	3	60	65
Leg Press	3	60	175
Reactive-stepping Activity	10		

2.5. Outcome measures

We used the DGI as a valid tool to assess the patient's overall likelihood of falling (Matsuda et al., 2014). This index is designed to test eight facets of gait. It is scored on a four-point ordinal scale ranging from 0 to 3 with 0 indicating the lowest level of function and 3 indicating the highest. The DGI demonstrates good reliability, sensitivity and specificity. Intra-rater and inter-rater reliability have been reported to be 0.89 and 0.82, respectively (Jønsson et al., 2011). The minimal detectable change for DGI score in community dwelling adults is 1.9 (Pardasaney et al., 2012).

We used DEXA as a quantitative radiological procedure to measure BMD which is a major determinant of bone strength (Bouxsein et al., 2009). The validity and reliability of DEXA is well established and it represents the standard of care and best practice for measuring BMD in the field (Lewiecki et al., 2016). We also used the changes observed for Romberg stance and tandem stance during the training sessions as the intervention period progressed as an outcome measurement to assess the influence of this training intervention.

Table 3
Pre- and post-intervention DEXA scan results for a postmenopausal woman with osteoporosis.

	Pre-intervention	Post-intervention
Lumbar spine (L1–L4)		
BMD ($g \cdot cm^{-2}$)	0.807	1.003
T-score (SD)	−2.2	−1.5
Femoral neck		
BMD ($g \cdot cm^{-2}$)	0.572	0.742
T-score (SD)	−2.5	−2.1

Note. BMD = bone mineral density; SD = standard-deviation difference compared to normative BMD for healthy young adults.

2.6. Outcomes

Pre/post scores for the DGI assessment and DEXA scan are provided in Tables 1 and 3, respectively. A 24% and 29% increase in BMD was observed for the patient's lumbar spine and femoral neck, respectively. Compared to normative data for healthy young adults, the patient's deficit in T-score was reduced by 0.7 (lumbar spine) and 0.4 (femoral neck) SD. Post-intervention improvement in the duration for which static balance challenges could be maintained were observed for tandem stance on ground (eyes open, ~300%; eyes closed ~500%), tandem stance on foam pad (~550%) and Romberg stance on foam pad with eyes closed (~620%). The patient also achieved the capacity for single-leg stance for both the left (11 s) and right (13 s) leg during the 12-month intervention.

3. Discussion

The main finding from this case study is that a 12-month program comprising strength-training performed with maximal force mobilization (i.e., "power training") may have reduced the risk of falling for a 70-year-old postmenopausal woman. Specifically, DGI revealed improvement from "moderate impairment" to "mild impairment" or from "mild impairment" to "normal" for all classifications that were not deemed "normal" at intervention onset. Consequently, in support of our first hypothesis, the program caused a change in DGI classification from "increased risk of falling" to "safe ambulator." Furthermore, in support of our second hypothesis, BMD in the lumbar spine and femoral neck was increased with the latter change advancing our patient's status from "osteoporosis" to "osteopenia." Importantly, no adverse effects were observed or reported during the intervention. These results suggest that power training might have the potential to be a safe, effective way to reduce fracture susceptibility for at-risk individuals both by reducing the likelihood of falls and the possibility of fractures consequent to falls if/when they do occur.

The DGI possesses a relatively low sensitivity to change, the 7.0-point improvement we observed exceeds the minimal detectable change of 1.9 points by a considerable margin (Pardasaney et al., 2012). Accordingly, we believe that the change in DGI score demonstrated by our patient reflects improvement in fall risk that is both valid and clinically significant.

A novel aspect of the resistance-training intervention we employed was that exercises were performed with maximal force mobilization. This distinction is important because "conventional strength training" (i.e., performing resistance exercise against relatively heavy loads without "ballistic intent") can slow the contractile mechanism resulting in a more forceful contraction (i.e., greater strength) that takes longer to develop (Duchateau and Hainaut, 1984). This appears to be the case because there is a different motor unit activation pattern when there is the intention to move explosively compared to the "ramp" activation pattern that is in effect under normal circumstances (Behm and Sale, 1993). With respect to strength training, this means that a distinction can be made between exercise that is specific for increasing "strength" (i.e., maximal force) compared to that which increases "power" (i.e., the product of force and velocity) and this resonates with respect to fall prevention because when balance is disturbed and the potential for a fall exists, contractile force and the rate at which it can be developed conspire to dictate the ability for avoidance. It is, therefore, not surprising that the capacity to produce muscle power represents a critical determinant of fall risk for older adults (Thelen et al., 1996). Moreover, a deficit in the ability to produce muscle power has been implicated along with asymmetry between limbs as factors that are more predictive of future falls than "traditional strength" per se (Skelton et al., 2002).

If muscle power is indeed a key attribute for reducing the likelihood for falls, it would stand to reason that power training would result in improvement in DGI score similar to what we found. The DGI contains tasks in which a subject is asked to perform the required actions as quickly as possible and, therefore, rewards subjects who are able to move quickly (Mayson et al., 2008). With this in mind, the emphasis we placed on movement speed and maximizing the number of repetitions performed per unit time appears to have provided a stimulus that is specific for DGI performance and, by extension, decreasing fall risk as indicated by such.

Although beyond the scope of this case study, it is interesting to speculate potential reasons why velocity-specific training might improve DGI score and, by extension, fall risk. It stands to reason that performing resistance exercise at a high movement speed requires a different form of coordination compared to more controlled movement patterns (e.g., what is typically encountered during "conventional strength training" where the speed at which repetitions are performed is controlled at a submaximal movement cadence). Emphasis on speed of movement might be specific for eliciting positive adaptations in proprioceptive feedback and cerebellar processing. Moreover, vestibulocerebellar and vestibulospinal tract adaptations may contribute to gait improvements following a high-speed training intervention. In this regard, the DGI requires gait tasks that challenge vestibular and proprioceptive systems (e.g., walking with head turns, stepping over an obstacle, etc.) along with spinal mediated systems. Another potential reason for changes in DGI score from high-speed training might be related to the "Central Benefit Model" (Liu-Ambrose et al., 2013). Specifically, exposure to activities requiring high-speed movement might result in enhanced executive function and improved confidence for such movement. This can be an important asset during recovery after balance is lost.

To ensure that our patient performed her resistance training with maximal force mobilization, we instructed her to complete as many repetitions as possible during each 60-s set. However, we stressed that she maintain proper form despite the emphasis on movement rapidity. We also did not introduce this power-specific component until an initial eight-week period of conventional strength training consisting of the same movements had been completed. In addition to developing "baseline strength," this preparatory phase provided an opportunity for her to learn and practice proper form so that movement patterns were ingrained once the additional challenge of maximum movement velocity was introduced.

Despite the fact that our training program resulted in a change of DGI classification from "increased risk of falling" to "safe ambulator," it is likely that our patient is still more susceptible to falling compared to younger counterparts because falls in the elderly are multi-factorial (Herman et al., 2009). Moreover, her sex (Herman et al., 2009) and osteoporotic status (Arnold et al., 2005;

Sinaki et al., 2005) further increase her likelihood of falling regardless of DGI score. Consequently, a training program for this patient should also be designed to induce anatomical adaptations which reduce the likelihood of fractures secondary to falls if/when they do occur. The increase in BMD we observed for lumbar spine (24%) and femoral neck (29%) reflect such positive changes. For example, using the Fracture Risk Assessment Tool (FRAX) (Black et al., 2001), we documented a reduction in the risk of hip fracture from 3.7 to 2.4%. Reducing this risk is important because individuals who experience a hip fracture demonstrate a rate of mortality that is at least two-fold greater than age-matched counterparts who have not fractured their hip (Abrahamsen et al., 2009). Furthermore, after experiencing a fragility-related hip fracture, the risk of subsequent fracture is markedly increased (Berry et al., 2007) particularly for women with low BMD (Chapurlat et al., 2003). Consequently, hip fractures often initiate a pathological progression that can have dire consequences. It is well established that exercise training can have a positive effect on bone health; however, the type of exercise that best elicits this effect (e.g., weight-bearing aerobic exercise, high-impact activity, resistance training, etc.) continues to be investigated (Moreira et al., 2014). Bone remodeling appears to occur primarily due to forceful pulling of muscle on bone; hence, movements should be chosen based on the origins/insertions of muscles associated with the bony sites being targeted (Zehnacker et al., 2007). Being that osteoporotic hip fractures present the greatest risk of morbidity and mortality for postmenopausal women (Sattui and Saag, 2014), we chose movements that required the contraction of muscles pulling on the hip/femur (e.g., standing hip abduction, standing hip extension and leg press) in an attempt to improve BMD in these areas. Due to safety concerns, we did not directly measure 1 RM; however, as previously mentioned, the load was likely ≥60% 1 RM (Reynolds et al., 2006), which is in line with guidelines suggesting that high loading provides the optimal stimulus for increasing BMD in women with osteopenia/osteoporosis (Zehnacker and Bemis-Dougherty, 2007).

While the mode, intensity and duration of the resistance training we had our patient perform was similar to what is typically employed to induce bone remodeling (Moreira et al., 2014; Zehnacker and Bemis-Dougherty, 2007), our program was different because repetitions were performed with maximal force mobilization. While this was done primarily to create a velocity-specific training effect that might be more effective for reducing fall risk (see above), there is mounting evidence which suggests that loading rate (as opposed to magnitude per se) might also be an important stimulus for inducing bone adaptation. For example, Stengel et al. compared progressive resistance training with 70–90% of the 1 RM performed with either slow (4-s controlled cadence) or explosive concentric repetitions and found that only the explosive training prevented the loss in BMD at the spine and hip that occurred for post-menopausal women over the course of the 12-month intervention (Stengel et al., 2005). The authors concluded that power training is superior for stimulating osteogenesis presumably due to the greater loading magnitudes/amplitudes and/or strain rates/frequencies that are present. A number of more recent studies confirm that resistance training with rapid performance of the concentric repetition phase provides a potent stimulus for bone remodeling for post-menopausal women with reduced bone mass regardless of whether it is performed using a heavy (Mosti et al., 2013) or light (Hamaguchi et al., 2017) load. However, the percent change of BMD in the spine and hip that we observed is greater than what has been reported in these studies (Hamaguchi et al. Stengel et al.). Furthermore, the improvements in our patient exceeded those which are typically reported for interventions involving exercise coupled with pharmacological management or pharmacological management alone (Howe et al., 2011; Uusi-Rasi et al., 2003; Chilibeck et al., 2002; Cummings et al., 1998). Being that these researchers did not assess any parameters indicative of fall risk, we believe that our findings that both bone health and functional adaptations that contribute to the maintenance of bone health can be gleaned from this singular form of training provide a foundation for validation by future randomized controlled trials.

A limitation of the present study is that our contention that the program our patient performed improved measures of fall risk by increasing muscle power cannot be confirmed because we did not directly assess her capacity for power production before and after the intervention. Furthermore, owing to the design of this investigation (i.e., case study), we could not compare the improvement in DGI score after 12 months of power training with that which might have been achieved if a volume-matched program comprising the same exercises was performed with cadence controlled at a submaximal force-mobilization rate (i.e., as conventional strength training). Finally, the program we had our patient perform also included basic strengthening and balance exercises and unsupervised power-based training at the gym where direct patient care was lacking. However, the unsupervised program we prescribed was consistent with what was performed in the clinic and the balance and general strengthening activities were only performed for the initial eight weeks of the 52-week intervention. We believe it is therefore likely that the training adaptations we observed were predominantly the result of the power-based form of training. The patient was also under pharmacologic care for osteoporosis during the intervention so when considering our findings on BMD, one must consider the possibility of a combined effect.

4. Conclusions

A 12-month resistance-training intervention comprising movements performed with maximal force mobilization (i.e., power training) improved DGI score and BMD for a 70-year-old postmenopausal woman with osteoporosis. The former is consistent with a classification change indicating a reduced risk of falling. Power training might therefore represent a viable form of training for reducing fracture risk for postmenopausal women with osteoporosis by reducing the likelihood of falls and the repercussions associated with falls if/when they do occur.

Declaration of competing interest

There are no known conflicts of interest.

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