LOAD-SPECIFIC RELATIONSHIPS BETWEEN MUSCULAR POWER AND BONE MINERAL DENSITY

[1]Brandi Row and [2]Peter Cavanagh
[1]The Centre for Studies in Aging, Sunnybrook and Women's College Health Sciences Centre, Toronto, Canada, [2]Cleveland Clinic Foundation, email: Brandi.Row@sw.ca

INTRODUCTION

Lower extremity muscular strength (STR) influences bone mineral density (BMD) of the proximal femur (PF) and lumbar spine (LS) in older adults [1]. However, when body size is taken into account, STR is not independently associated with BMD of the PF in older adults [2]. In various lower extremity muscle groups, normalized STR and power (PWR) contributed to the best predictive models of BMD in older adults [3]. Further, PWR of lower extremity muscles contributed uniquely to BMD, even when taking sex, age, BMI, and STR into account [3]. The purpose of this study was to determine 1) which factors of PWR (force and velocity) are most predictive of BMD, and 2) at which loads relative to maximal STR is the relationship between PWR and BMD optimized in older adults.

METHODS

Pre-intervention STR, PWR and BMD data were collected for 48 healthy older adults (28 females, 20 males; ages 65-82 yrs) who were accepted into an exercise intervention study previously described [4]. Subjects with osteoporosis, joint replacements and those already participating in resistance-training programs were excluded. Dual X-Ray Absorptiometry (DXA) scans (Hologic, Inc., Bedford, MA) were used to assess whole body lean body mass (LBM) and BMD at the PF and LS. Subjects performed STR tests (one-repetition maximum, 1RM) for Leg Press (LP), Hip Abduction (AB), Hip Adduction (AD) and Hip Flexion (HF) using resistance-training machines. PWR was determined for each exercise: the concentric motion was completed 'as fast as possible' at loads of 30, 50 and 70% of 1RM (except for LP, where 30% 1RM is too light to perform safely). PWR (force*velocity during the PWR test), and STR (in kg and Watts, respectively) were normalized by dividing by the lean body mass of the total leg in kg. Regression analyses were conducted using statistical software (Minitab, State College, PA). The 'best subsets' feature was used in order to determine the combination of variables (lowest bias, highest adjusted R^2) accounting for the most variance in BMD. Systematic variations of the regressions were conducted in order to determine the optimal relationship between the load (% 1RM) used during the PWR tests and BMD, and to determine which component of PWR (force or velocity, VEL) was the most influential for BMD.

RESULTS AND DISCUSSION

While sex was the leading predictor of BMD (women < men), the VEL component of PWR was also an important predictor of PF BMD, while the normalized force component was not. For LS BMD, however, *both* VEL and force parameters were important predictors (Table 1). Regression models for Proximal Femur BMD were optimized with PWR tested at a load of 50% 1RM (Figure 1). Conversely, models for Lumbar Spine BMD were optimized at a load of 70% 1RM.

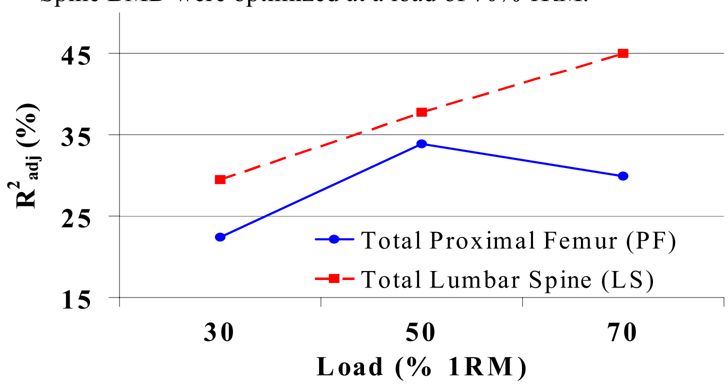

Figure 1: R^2_{adj} for PF and LS BMD for models as in Table 1.

CONCLUSIONS

This study revealed that PWR tests at moderate loads (50% 1RM) produced the best relationship between PWR parameters and PF BMD. A load of at least 70% 1RM was required to optimize this relationship with LS BMD. Given the predominance of VEL as a predictor of BMD, particularly for PF BMD, high velocity resistance training should be evaluated as a method for improving BMD in older adults. Further, investigations should focus on whether such load-specific relationships optimize training outcomes for PF and LS BMD.

REFERENCES

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Table 1: P-values and R^2_{adj} for the best model for each BMD parameter at loads of *50% 1RM, and $^{+}$70% 1RM (Force (F)/ leg LBM). Blank cells indicate that the indicated parameter was not a part of the best model.

BMD	Sex	Age	BMI	AD VEL	AB VEL	HF VEL	LP F	AD F	AB F	HF F	R^2_{adj} (%)
Femoral Neck	0.000		0.039		0.113	0.164					27.7^{+}
Greater Trochanter	0.000	0.037	0.157	0.012	0.006						43.9*
Inter-Trochanteric Crest	0.000		0.077	0.026	0.090						34.4*
L1	0.000		0.060	0.056	0.027					0.283	48.7^{+}
L2	0.000		0.183	0.009			0.017		0.181		43.8^{+}
L3	0.003			0.004	0.312	0.197	0.147	0.127			37.6^{+}
L4		0.019		0.035			0.101	0.019	0.042		30.8^{+}