Muscular Strength and Whole-Body Bone Mineral Density in Older Adults With and Without Artificial Joints

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ABSTRACT

PURPOSE: Artificial joints (AJ) are prevalent in older adults, yet commonly ignored in bone related studies. We examined the effect of AJ on the association between muscular strength (MS) and whole-body bone mineral density (BMD) in older adults. **METHODS**: This cross-sectional study included 303 older adults (58% women) ≥65 years old from the Physical Activity and Aging Study (PAAS). MS (peak torque at 60°/sec) was assessed by leg extension (LE), leg flexion (LF), elbow extension (EE), and elbow flexion (EF) on the dominant limbs using isokinetic dynamometry (Biodex). Whole-body BMD (t-score) was assessed by dual-energy X-ray absorptiometry (DXA). Low BMD was defined as t-score < -1.0. AJ status was identified via medical history questionnaire. Linear and logistic regression were conducted in stratified samples of AJ status (yes/no) and sex including MS, age, hormone therapy (women only), smoking, cardiorespiratory fitness (400-meter walk test), physical activity, and body mass index (BMI). Odds ratios (ORs) of low BMD by sex-specific tertiles of MS were calculated in each stratum. **RESULTS**: Forty-five (15%) older adults had AJ. T-scores were higher in individuals with AJ compared with individuals without AJ in both men (-0.6 vs. 1.9) and women (-1.4 vs. 0.6) (both p<0.01) since most materials in AJ (e.g., metals) are considered as bone tissues by DXA. LF, EE, and EF were positively associated with BMD in men without AJ (all p<0.05), but not in men with AJ after adjusting for the possible confounders including BMI. There were no associations between MS variables and BMD in women, regardless of AJ status (all p>0.05). Compared with the lowest (weakest) third of LF, ORs (95% confidence intervals) of low BMD for the middle and upper thirds of LF were 0.40 (0.15-1.08) and 0.27 (0.09-0.85) among men without AJ after adjusting for the possible confounders without BMI. We found similar results in LE. However, no associations were observed after further adjustment for BMI, possibly due to the confounding effects of BMI on both MS and BMD. **CONCLUSION**: Higher MS appears to be associated with higher BMD and lower odds of having low BMD in men without AJ, but not in men with AJ. These results indicate that AJ status should be considered in studies of muscular strength and bone health in older men.

INTRODUCTION

To our knowledge, there was no study on the influence of artificial joints on the association of MS with BMD in older adults.

METHODS

Participants:

• 303 older adults aged 65 years or older (mean age 72±6) free of cancer treatment in past five years and major medical issues (e.g., stroke) that would interfere physical activity.

Muscular Strength (MS) and Artificial Joints (AJs):

• MS (peak torque at 60º/sec) was assessed by knee extension, knee flexion, elbow extension, and elbow flexion on the dominant limbs using isokinetic dynamometry (Biodex). Thus, the higher number, the stronger muscular strength.
• Participants were classified into sex-specific MS tertiles (Reference: lower tertile).
• Artificial joint status was identified by self-report before BMD measurement.

Bone Mineral Density (BMD):

• Bone mineral density was measured by DXA.
• Low BMD was defined as t-score < -1.0.
  ✓ Among 258 participants without AJs, 124 (48.1%) had low BMD.
  ✓ Among 45 participants with AJs, 5 (11.1%) had low BMD.



Statistical Analysis:

• Linear regression was used to investigate the associations between MS and BMD in subsamples with and without AJs, adjusting for age, hormone therapy (women only), smoking, cardiorespiratory fitness, physical activity, and body mass index (BMI).
• Logistic regression was used to investigate the associations between MS and low BMD prevalence in subsamples with and without AJs, adjusting for the same potential confounders in linear regression.

RESULTS

Table 1. Participant characteristics by sex

Characteristic	Men	Women
N	126	177
Age (year)	72.5 (6.0)	72.1 (5.7)
Bone Mineral Density (t-score)	-0.31 (1.44)	-1.01 (1.51)
Low Bone Mineral Density, n (%)*	37 (29)	92 (52)
Knee Extension (N-M, 60°/sec)	132.0 (40.1)	87.7 (25.2)
Knee Flexion (N-M, 60°/sec)	67.1 (23.5)	42.1 (11.0)
Elbow Extension (N-M, 60°/sec)	42.0 (12.5)	24.8 (8.2)
Elbow Flexion (N-M, 60°/sec)	45.4 (11.0)	25.2 (6.8)
Hormone Therapy, n (%)	-	6 (3)
400-Meter Walk (completion time in minutes)	4.3 (0.8)	4.6 (0.8)
Leisure-time Physical Activity (MET-hours/week)†	31.5 (25.1)	24.1 (21.3)
Previous/Current Smoker, n (%)	45 (35)	59 (33)
Body Mass Index (kg/m²)	27.6 (4.1)	26.6 (5.3)
Artificial Joint, n (%)	14 (11)	31 (18)

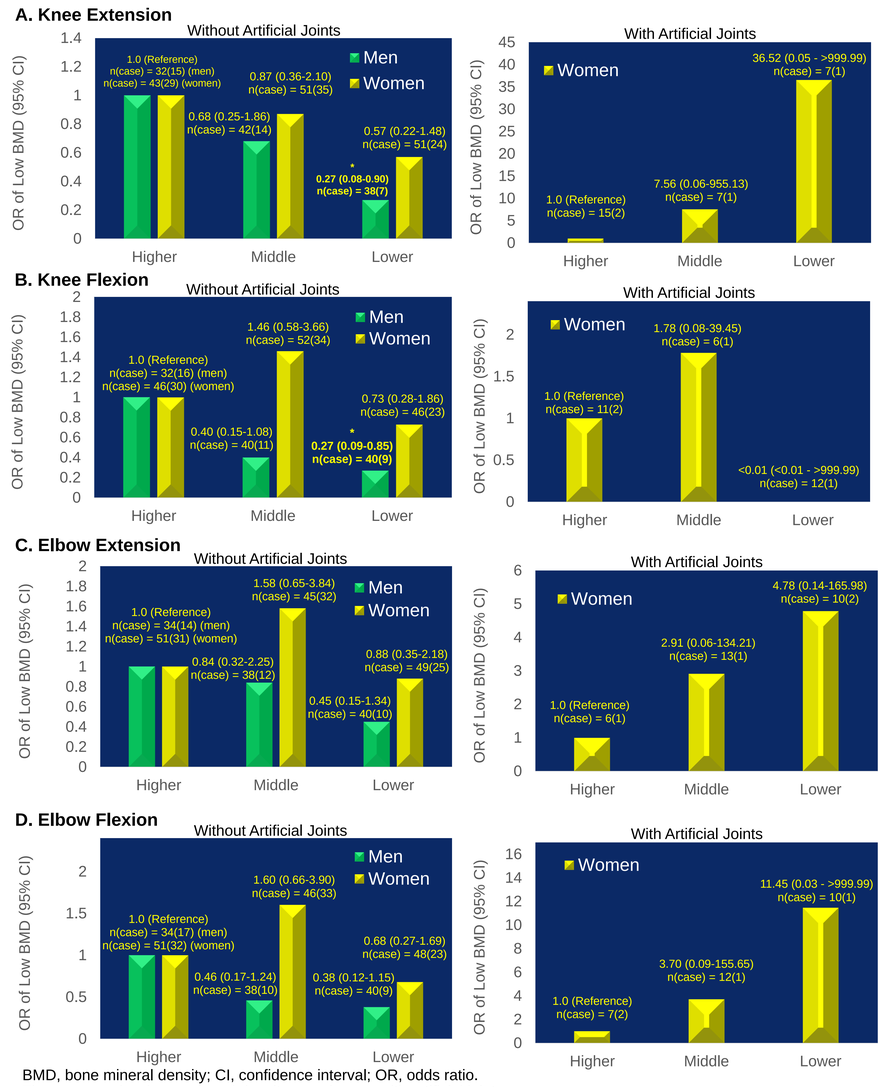
N-M, Newton-meter.
Data are mean (SD) or %. MET denotes metabolic equivalent.
* Low bone mineral density is defined as t-score < -1.0.
†Total amount of moderate or vigorous physical activities such as running, golfing, dancing, and etc.

Table 2. Associations between regional muscular strength and bone mineral density (t-score) in men and women (linear regression)

	Men				Women			
Muscular Strength	**Without Artificial Joint**		**With Artificial Joint**		**Without Artificial Joint**		**With Artificial Joint**	
	Model 1							
	β (SE)	P-value	β (SE)	P-value	β (SE)	P-value	β (SE)	P-value
Knee Extension	0.007 (0.003)	**0.04**	0.010 (0.014)	0.49	0.004 (0.004)	0.35	0.007 (0.017)	0.70
Knee Flexion	0.014 (0.005)	**<0.01**	0.025 (0.026)	0.35	0.007 (0.010)	0.49	-0.004 (0.029)	0.89
Elbow Extension	0.029 (0.009)	**<0.01**	0.055 (0.046)	0.26	0.011 (0.013)	0.41	-0.024 (0.055)	0.66
Elbow Flexion	0.041 (0.011)	**<0.01**	0.054 (0.046)	0.27	0.001 (0.016)	0.93	-0.034 (0.083)	0.69
	Model 2							
Knee Extension	0.008 (0.004)	**0.03**	0.017 (0.019)	0.39	0.006 (0.005)	0.22	0.011 (0.018)	0.54
Knee Flexion	0.015 (0.005)	**<0.01**	0.023 (0.029)	0.45	0.011 (0.011)	0.29	-0.016 (0.033)	0.64
Elbow Extension	0.030 (0.009)	**<0.01**	0.096 (0.046)	0.07	0.012 (0.013)	0.36	-0.022 (0.064)	0.74
Elbow Flexion	0.043 (0.012)	**<0.01**	0.106 (0.046)	0.05	0.006 (0.016)	0.70	-0.065 (0.126)	0.61
	Model 3							
Knee Extension	0.006 (0.004)	0.12	0.013 (0.023)	0.59	0.003 (0.005)	0.60	0.012 (0.018)	0.51
Knee Flexion	0.012 (0.005)	**0.03**	0.015 (0.070)	0.83	0.006 (0.011)	0.60	-0.012 (0.035)	0.72
Elbow Extension	0.023 (0.010)	**0.02**	0.134 (0.068)	0.09	0.007 (0.013)	0.60	-0.022 (0.065)	0.74
Elbow Flexion	0.033 (0.013)	**0.01**	0.127 (0.061)	0.08	-0.005 (0.017)	0.76	-0.053 (0.132)	0.69

MET, metabolic equivalent; SE, standard error. Muscular strength were measured using an isokinetic dynamometry at 60º/sec. Model 1: adjusted for age (years). Model 2: model 1 further adjusted for smoking, cardiorespiratory fitness (minutes to complete 400-meter walking), leisure-time physical activity (MET-hours/week), and hormone therapy (women only). Model 3: model 2 further adjusted for body mass index (kg/m²).

Figure 1. Odds ratios of low bone mineral density by muscular strength without and with artificial joints



BMD, bone mineral density; CI, confidence interval; OR, odds ratio.
There was no low bone mineral density case in men with artificial joints.
All models (A-D) adjusted for age (years), smoking, cardiorespiratory fitness (minutes to complete 400-meter walking), leisure-time physical activity (MET-hours/week), and hormone therapy (women only).

CONCLUSIONS

1. Higher muscular strength, independent of cardiorespiratory fitness, appeared to be associated with higher bone mineral density and lower odds of having low bone mineral density in men without artificial joints, but not in men with artificial joints. No significant results were found in women.
2. These results suggest that artificial joint status should be considered in studies of muscular strength and bone health in older men.