

Table 1
Descriptive Data of Study Subjects

Variables	Women (n = 179)	Men (n = 181)	Total (n = 360)
Continuous			
Age	74.1 (8.2) ^a 60-94	73.3 (7.8) 60-90	73.9 (8.0) 60-94
Weight (kg)	60.8 (12.1) 31.5-113.7	75.0 (13.0) 44.5-107	68.2 (15.3) 31.5-113.7
Height (cm)	156.4 (6.8) 128-188	169.5 (5.8) 152-185	162.7 (10.3) 128-188
Hand size (cm)	17.2 (0.9) 14.4-21.0	18.9 (1.0) 16-23	18.0 (1.3) 14.4-23
Hand circumference (cm)	19.4 (1.1) 16.6-22.4	22.5 (1.5) 17.5-28	21.2 (3.8) 16.6-28
Categorical			
Dominance			
Right	169 (91.4) ^b	161 (89.0)	330 (91.7)
Left	8 (4.5)	14 (7.7)	22 (6.1)
Ambidextrous	2 (1.1)	6 (3.3)	8 (2.2)
Previous or current work characteristics			
Active	158 (88.8)	139 (76.8)	297 (82.7)
Sedentary	20 (11.2)	42 (23.2)	62 (17.3)
High upper extremity strength	60 (33.7)	74 (40.9)	134 (37.3)
Low upper extremity strength	118 (66.3)	107 (59.1)	225 (62.7)
High use of upper limb	167 (93.8)	134 (74.4)	301 (84.1)
Low use of upper limb	11 (6.2)	46 (25.6)	57 (15.9)
High fine dexterity	59 (33.1)	35 (19.4)	94 (26.3)
Low fine dexterity	119 (66.9)	145 (80.6)	264 (73.7)
Self-perceived health			
Excellent	57 (31.9)	66 (36.5)	123 (34.2)
Good	86 (48.0)	92 (50.8)	178 (49.5)
Fair	34 (19.0)	18 (9.9)	52 (14.4)
Poor	2 (1.1)	5 (2.8)	7 (1.9)
Current activity level			
Very active	45 (25.1)	41 (22.7)	86 (23.9)
Active	101 (56.4)	83 (45.8)	184 (51.1)
Slightly active	26 (14.6)	51 (28.2)	77 (21.4)
Sedentary	7 (3.9)	6 (3.3)	13 (3.6)
Frequency of current manual activities			
Very often	34 (19.0)	23 (12.7)	57 (15.8)
Often	48 (26.8)	41 (22.7)	89 (24.7)
Sometimes	29 (16.2)	31 (17.1)	60 (16.7)
Seldom/never	68 (38.0)	86 (47.5)	154 (42.8)

^aM (SD) Range

^bFrequency (%)

subjects, the majority of whom are right-handed, were stronger than the left hands ($p < 0.0001$ for the dynamometer and $p = 0.0004$ for the vigorimeter). On the Jamar™ dynamometer, these differences are 7.1% for the women and 3.3% for the men, with 5.1% and 2.1%, respectively, on the Martin vigorimeter.

The same results may be described by regression equations expressing strength as a function of age and their 95% confidence interval (see Table 3). The curvilinear relationship of strength with age required the trans-

Table 2
Grip Strength on the Jamar™ Dynamometer and the Martin Vigorimeter (Highest Score on Three Trials) According to Age and Gender

Subjects	Jamar™ Dynamometer		Martin Vigorimeter	
	Right Hand (kg)	Left Hand (kg)	Right Hand (kPa)	Left Hand (kPa)
Women				
60-69 years	25.3 (4.8) ^a 18-42	23.6 (4.7) 12-36	53.7 (10.2) 27-82	52.4 (9.9) 34-87
70-79 years	23.7 (5.1) 11-36	22.0 (4.7) 10-30	52.3 (12.0) 18-77	50.1 (11.2) 13-74
80 years and older	20.0 (4.3) 12-32	18.5 (4.4) 10-30	44.1 (9.4) 20-60	42.7 (10.9) 24-71
Men				
60-69 years	45.6 (8.6) 31-70	43.6 (8.7) 30-72	89.4 (16.7) 58-126	88.1 (17.2) 59-122
70-79 years	42.4 (9.1) 24-69	40.5 (8.5) 26-62	83.0 (18.2) 32-117	79.6 (16.2) 44-120
80 years and older	34.5 (7.2) 16.5-48	32.1 (7.0) 18-47	64.6 (14.5) 36-96	64.3 (14.7) 30-103

^aM (SD) Range

formation of the independent variable, namely age.²

The predictive equations for strength deduced from multiple regressions, where grip strength is the dependent variable and the personal variables of the subjects are the independent variables, are shown in Table 4. For the Jamar™ dynamometer, the variables that best predict grip strength are age,² hand circumference, and body height (or the size of the hand for women on the right side). For the Martin vigorimeter, age² is also the best predictor, but the other predictive variables differ according to gender and side. Residual analysis suggested that the assumptions underlying the regression analysis were satisfied. The studentized residuals appear normally distributed. Moreover, two-dimensional displays of residuals against predicted values and dependent variables did not suggest heterogeneity of variance or lack of linearity.

Discussion

The goal of this study was to develop grip strength norms applicable to persons aged 60 years and older. The sample used for this study was randomly recruited and the high participation rate suggests good representation of the population from which it was drawn. Moreover, statistical analyses revealed no difference between those who refused and those who agreed to participate in terms of specific variables, thus minimizing the possibility of a refusal bias.

The highest score on three trials was retained as the grip strength. Even though the reliability is slightly lower than that of the mean of the three measures (Mathiowetz et al., 1984), the highest score appears more valid because it corresponds to the real potential maximum