Title: Validity and normative data for the 30-second chair stand test in elderly community-dwelling Hong Kong Chinese.

Running title: 30-second chair stand in Chinese elderly

Key Words: validity, normative data, isometric strength, chair stand test

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ABSTRACT

2   It is important to establish valid field measures of lower body strength in the elderly as well

as provide representative normative values that are culturally specific in order to help

4   health professionals in the risk assessment of this group. A sample of 1038 elderly Hong

Kong Chinese undertook a 30 s chair stand test (30CST), with a sub-sample of 143

6   completing isometric measures of maximal hip flexion and knee extension, plus a habitual

physical activity questionnaire. The 30CST was significantly, yet only weakly, correlated

8   with the isometric strength measures ($r \sim 0.3\text{-}0.4$), but accurately discriminated between

levels of habitual physical activity and across ages in decades. The normative values

10   generated provide useful data for health screening in this elderly Hong Kong population but

do not compare well with their healthier US counterparts.

12

INTRODUCTION

14   Aging is frequently accompanied with a progressive deterioration in physiological function

that can often be dependent upon lifestyle characteristics (McArdle et al. 2001). In

16   particular, the maintenance of lower body strength is seen as being an essential part of

independent daily living, as it is associated with important activities such as walking, stair

18   climbing, and rising from a seated position, as well as fall-prevention (Jones et al. 1999).

Having valid field tests that can be used to monitor community dwelling older adults is

20   important to our understanding of how lower body strength changes with age and to

identify those at potential risk of losing their independence or at risk of falling (Wang et al.

22   2005).

24   Field tests of lower body strength in the elderly have included the time taken to complete 5

repetitions (Guralnik et al. 1994) and 10 repetitions (Csuka and McCarty, 1985) of a sit-to-

26   stand test. Yet these tests have been criticized as being too difficult and failing to

discriminate accurately among the elderly (Rikli and Jones, 1999a), as many elderly

28   members of the population are incapable of completing even 5 repetitions (Binder et al.

2001). An alternative promoted by Rikli and Jones (2001) quantifies the maximum chair-

30   stands completed within 30 s (30CST), and is reliable (intraclass correlation coefficient =

0.84-0.92) and a valid measure of lower extremity strength (r = 0.71-0.78) in laboratory

32   settings (Rikli and Jones, 1999a). Yet its suitability as a valid field test and one that can

discriminate strength differences among a wide range of true community-dwelling older

34   adults in a field setting is unclear.

36   We aimed to (a) examine the validity of the 30CST in a true field setting, (b) obtain

normative data to serve as a benchmark for future Hong Kong studies, and (c) provide data

38   that could be compared with US data (Rikli and Jones, 1999b).

40   **SUBJECTS AND METHODS**

42   **Participants**

We recruited 1038 elderly volunteers aged 60 to 96 years from the Hong Kong Chinese

44   community, comprising 766 females (mean ± SD: 73.6 ± 7.1 yr; 150.6 ± 6.1 cm; 55.6 ±

11.2 kg); and 272 males (73.6 ± 6.7 yr; 162.7 ± 6.4 cm; 63.1 ± 11.1 kg). They were

46   recruited by: (a) random sampling from a list proportional to the total members in each of

22 Neighbourhood Elderly Centres across the 18 districts (about 60% of the total); and (b)

48   a multistage random sampling of elderly adults in residential complexes across the 18

districts. Each district was clustered and divided into randomly selected sub-districts with

50   floors randomly chosen from each selected residential complex. All households on each

selected floor were visited and an interview conducted if a respondent was willing,

52   resulting in an overall response rate of 64%. The inclusion criteria for our sample were

elderly persons aged at least 60 years and residing in the community. All participants

54   provided informed consent in accordance with the policies sanctioned by the institute's

ethics committee.

56

Procedures

58   Each participant completed a single 30CST in their own home (Rikli and Jones, 2001) and

a Modified Baecke Questionnaire for Older Adults (Voorrips et al. 1991) to separate the

60   participants into 3 levels of habitual physical activity (Low = < 25th percentile; Medium =

between 25th – 75th percentile; High = > 75th percentile). A randomly selected sub-sample

62   of 143 participants (113 females: 71.9 ± 7.6 yr, 155.5 ± 6.1 cm, 57.3 ± 10.8 kg, and 30

males: 71.7 ± 6.6 yr, 156.0 ± 8.8 cm, 57.5 ± 10.5 kg), also performed two maximal-effort

64   isometric tests of lower body strength: one of hip flexion (HF), and one of knee extension

(KE), using the Nicholas Manual Muscle Tester (NMMT: Model 01160: Lafayette

66   Instrument Company, USA), according to the manufacturers instructions and adapted from

(Kendall, 1983). Although a field test of hip extension would have been more ideal, we are

68   unaware of any publication using the NMMT to perform this in the field, presumably

reflecting to the practical difficulties of this manoeuvre and the potential pain of depressing

70   the NMMT against the superficial hamstrings' tendons during maximal contractions.

72   **Data analyses**

Standard descriptive statistics were first examined, then bivariate associations examined by

74   Pearson correlations, with ANOVA used to examine differences between group means and

Scheffe post hoc pair-wise comparisons where appropriate. An alpha-level of 0.05 was

76   used to determine statistical significance, using StatView 5 software (SAS Inc., Cary, NY).

78   **RESULTS**

The results in Table 1 show that overall the 30CST was significantly, but only weakly,

80   correlated with individual values of HF (r=0.42, p<0.0001) and KE (r=0.29, p=0.0004),

whilst no net improvement occurred when the HF and KE scores were combined (r=0.39,

82   p<0.0001). When the NMMT scores were mass-adjusted, both HF/kg and KE/kg were still

statistically significant but even more weakly correlated to the 30CST scores (r=0.33,

84   p<0.0001 and r=0.24, p<0.004 respectively), whilst combining the HF/kg and KE/kg scores

together again had little effect on changing the correlation (r=0.32, p<0.0001).

86

The ANOVA showed a significant decrease in the 30CST with increasing participant age

88   when grouped into 60, 70, 80 and 90's decades (overall means of 12.1, 10.3, 9.4, and 7.2

respectively). The only pair-wise comparison between each decade that was not

90   significantly different was the 80's v 90's. The elderly with high levels of habitual physical

activity performed significantly more chair stands than the low activity group (11.5 ± 4.1

92   and 9.7 ± 3.5 respectively, p<0.0001); the moderately active group also performed

significantly more chair stands than the low activity group (10.9 ± 3.9 and 9.7 ± 3.5

94   respectively, p=0.0015).

96   Normative values from the 30CST for the Hong Kong elderly across 5 yr age ranges were

calculated and shown in Table 2, together with a comparison with the USA mean values

98   and the HK means values represented as a percentile from the USA norms (Rikli and Jones,

2001).

100

DISCUSSION

102   The validity results presented here from the NMMT give limited support to the criterion-

related validity of the 30CST shown by (Jones et al. 1999). The Pearson correlation

104 coefficients are significant but weak, and are lower than the 0.47-0.60 correlations reported

by Csuka and McCarty (1985). The criterion measure used here was an isometric field test

106 (NMMT), unlike the isotonic laboratory test (1-repetition maximum leg extension) used by

Jones et al. (1999) that produced higher correlations of 0.71-0.78. By necessity, our

108 community-based study not only relied on a field measure of criterion strength, but was

also unable to standardize perfectly the chair height. These limitations may have

110 contributed to greater variation in our data, resulting in the lower correlations found in

current study when compared to the rigorous laboratory studies mentioned above.

112 Furthermore, the criterion test should be highly specific and follow a similar speed and

movement pattern as the test procedure (Schell and Leelarthaepin, 1994). Therefore, the

114 isometric NMMT hip flexion test is not ideal, as the chair stand requires strong isotonic hip

extension, although during fast chair stands good strength in the hip flexors has been

116 shown to be very important in the elderly (Gross et al. 1998). Chair stands also involve

strong knee extension, albeit isotonically rather than isometrically, yet previous research

118 has shown that when using the same muscle group a significant and acceptably high

correlation is found between isometric and isotonic strength ($r \sim 0.7$, Jameson et al. 1997).

120

The somewhat lower correlations of the 30CST v KE compared to HF were not

122 unexpected, as prior research has reported that hip strength is more important than knee

extensor strength in the elderly during a chair stand test (Gross et al, 1998). A more

124 surprising result was the slightly lower overall correlations found when the 30CST scores

were compared to the mass-adjusted NMMT values. This unexpected effect (as a chair

126 stand is a mass-dependent task), was entirely due to the influence of the female group and

although simple ratio scaling can disadvantage females in power events due to their

128 relatively higher fat mass (Vanderburgh and Katch, 1996), this cannot fully explain this

finding and warrants further study that may involve allometric scaling.

130

The construct validity of the 30CST was more evident, with it discriminating between most

132   groups differing in their levels of HPA and producing differences with increasing age, as

have been reported by (Jones et al. 1999). Although our 1038 participants represent only

134   0.1% of the elderly Hong Kong population, it compares favourably to the estimated 0.02%

of the US elderly sampled by (Rikli and Jones, 1999b), and provides reasonably normative

136   data for this population. However, it may not be representative for every age and gender

group, especially males, who at 36% were under-represented, but is not dissimilar to the

138   42% of males reported in the Rikli and Jones (1999) study. The Hong Kong elderly

produced normative values for the 30CST that were considerably lower (i.e., about 25th

140   percentile) than their US counterparts. This may reflect factors such as the high-density

living conditions and the relatively little opportunity for outdoor exercise in Hong Kong

142   (Adab and Macfarlane, 1998), but may also reflect a non-random US cohort. The US

participants were predominantly self-selected volunteers capable of attending a central test

144   facility, hence were quite active and independently mobile (Rikli and Jones, 1999b; Jones,

personal communication, 2003). The US participants were also well educated (mean =

146   14.5 yr), very healthy (91% rating their health as Good or Very Good), and reported an

average of 1.7 chronic illnesses (Rikli and Jones, 1999).   In contrast, the Hong Kong

148   sample was randomly selected and less independently mobile since they were monitored in

their own dwelling. The Hong Kong cohort was also less educated (mean = 3.4 yr), with

150   only 53% rating their health as Good or Very Good, and averaged 2.3 chronic illnesses.

Thus it was not unexpected that the Hong Kong normative values are reasonably lower

152   than their US counterparts.

154   Despite the limitations of the collection techniques, the results suggest the 30CST is likely

to be a moderately weak measure of lower body strength in the elderly, although it

156   adequately discriminates between groups of different age and activity levels. The tabulated

data therefore remain useful in providing some normative data for health screening in this

158   population. Further research is needed to devise field tests with greater criterion validity

for this population, or to re-evaluate the validity of the 30CST using superior criterion

160   measures.

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TABLES

Table 1. Pearson correlations, p-value and its 95% confidence interval (CI), for the 30-sec Chair Stand Test (30CST) and the maximal values of Hip Flexion (HF), Knee Extension (KE), the combined total (HF+KE), plus the mass-adjusted values of Hip Flexion (HF/kg), Knee Extension (KE/kg), and the combined total (HF+KE)/kg, as measured isometrically using the Nicholas Manual Muscle Tester (NMMT).

Comparison	Group	Pearson r	p value	95% CI
30CST v HF	Total n = 142	0.42	<0.0001	0.27 - 0.54
	Female, n = 86	0.36	0.0006	0.16 - 0.53
	Male, n = 56	0.48	0.0001	0.25 - 0.66
30CST v KE	Total n = 142	0.29	0.0004	0.14 - 0.44
	Female, n = 86	0.20	0.064	-0.01 - 0.40
	Male, n = 56	0.37	0.004	0.12 - 0.58
30CST v (HF+KE)	Total n = 142	0.39	<0.0001	0.24 - 0.52
	Female, n = 86	0.31	0.0032	0.11 - 0.49
	Male, n = 56	0.47	0.0002	0.24 - 0.65
30CST v HF/kg	Total n = 142	0.33	<0.0001	0.17 - 0.47
	Female, n = 86	0.19	0.073	-.02 - 0.39
	Male, n = 56	0.48	0.0001	0.25 - 0.66
30CST v KE/kg	Total n = 142	0.24	0.004	0.08 - 0.39
	Female, n = 86	0.09	0.40	-0.12 - 0.30
	Male, n = 56	0.46	0.0003	0.22 - 0.64
30CST v (HF+KE)/kg	Total n = 142	0.32	0.0001	0.16- 0.46
	Female, n = 86	0.16	0.15	-0.06 - 0.36
	Male, n = 56	0.53	<0.0001	0.31 - 0.69

Table 2. Normative values of the 1038 Hong Kong (HK) elderly in 5-year age ranges for the 30-s Chair Stand Test (30CST: mean ± SD), compared to USA norms and the HK mean ranked against the USA percentile*.

30CST across age span (yr)	HK mean ± SD	USA norm n	HK mean as USA percentile
Female 60-64	12.3 ± 4.2	15	25
Female 65-69	11.3 ± 3.5	14	25
Female 70-74	10.1 ± 3.8	13	25
Female 75-79	9.4 ± 3.4	12	20
Female 80-84	9.3 ± 3.1	11	25
Female 85-89	8.3 ± 2.4	10	25
Female 90+	7.9 ± 2.7	8	50
Male 60-64	14.0 ± 4.3	16	25
Male 65-69	12.9 ± 4.6	15	30
Male 70-74	11.6 ± 3.3	14	25
Male 75-79	11.3 ± 4.4	14	25
Male 80-84	11.1 ± 4.2	12	35
Male 85-89	8.1 ± 4.0	11	25
Male 90+	5.8 ± 2.6	10	15

* USA mean data and percentiles taken from Rikli and Jones (2001)