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

Authors: D J Macfarlane¹, K L Chou², Y H Cheng², I Chi²

Affiliations:
1: Institute of Human Performance, The University of Hong Kong, Pokfulam, HONG KONG
2: Sau Po Centre on Aging, The University of Hong Kong, Pokfulam, HONG KONG

Corresponding author:
Dr Duncan Macfarlane
Institute of Human Performance
The University of Hong Kong
111-113 Pokfulam Road, Pokfulam, Hong Kong
Tel. (852) 28179451 Fax. (852) 28188042
E-mail: DJMAC@HKU.HK

Submitted for consideration as a Short Report:

Abstract: 132 words exactly
Full text (including abstract, but excluding references/tables): about 1840 words
Number of figures/tables = 2
Number of references = 13
ABSTRACT

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 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 completing isometric measures of maximal hip flexion and knee extension, plus a habitual physical activity questionnaire. The 30CST was significantly, yet only weakly, correlated with the isometric strength measures ($r \sim 0.3-0.4$), but accurately discriminated between levels of habitual physical activity and across ages in decades. The normative values generated provide useful data for health screening in this elderly Hong Kong population but do not compare well with their healthier US counterparts.

INTRODUCTION

Aging is frequently accompanied with a progressive deterioration in physiological function that can often be dependent upon lifestyle characteristics (McArdle et al. 2001). In 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 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 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. 2005).

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-
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
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-
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
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
adults in a field setting is unclear.

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

**SUBJECTS AND METHODS**

**Participants**

We recruited 1038 elderly volunteers aged 60 to 96 years from the Hong Kong Chinese
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
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)
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
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,
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 provided informed consent in accordance with the policies sanctioned by the institute’s ethics committee.

**Procedures**

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 participants into 3 levels of habitual physical activity (Low = < 25\textsuperscript{th} percentile; Medium = between 25\textsuperscript{th} – 75\textsuperscript{th} percentile; High = > 75\textsuperscript{th} percentile). A randomly selected sub-sample 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 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 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 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 the NMMT against the superficial hamstrings’ tendons during maximal contractions.

**Data analyses**

Standard descriptive statistics were first examined, then bivariate associations examined by 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 used to determine statistical significance, using StatView 5 software (SAS Inc., Cary, NY).
RESULTS

The results in Table 1 show that overall the 30CST was significantly, but only weakly, 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 ($r=0.39$, $p<0.0001$). 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 ($r=0.33$, $p<0.0001$ 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 ($r=0.32$, $p<0.0001$).

The ANOVA showed a significant decrease in the 30CST with increasing participant age 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 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 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 respectively, $p=0.0015$).

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 and the HK means values represented as a percentile from the USA norms (Rikli and Jones, 2001).

DISCUSSION

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
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 (NMNT), 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 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 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. 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 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 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 has shown that when using the same muscle group a significant and acceptably high correlation is found between isometric and isotonic strength ($r \approx 0.7$, Jameson et al. 1997).

The somewhat lower correlations of the 30CST v KE compared to HF were not 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 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 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 relatively higher fat mass (Vanderburgh and Katch, 1996), this cannot fully explain this finding and warrants further study that may involve allometric scaling.
The construct validity of the 30CST was more evident, with it discriminating between most 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 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 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 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 25\textsuperscript{th} 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 (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 facility, hence were quite active and independently mobile (Rikli and Jones, 1999b; Jones, personal communication, 2003). The US participants were also well educated (mean = 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 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 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 than their US counterparts.

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
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
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
measures.

Acknowledgement: This research was part of a larger study supported by the Hong Kong
Health Care & Promotion Fund (Grant #213025).

REFERENCES


Binder EF, Miller JP, Ball LJ. 2001. Development of a Test of Physical Performance for


strength and movement speed on the biomechanics of rising from a chair in healthy

Guralnik JM, Simonsick EM, Furrucci L, Glynn RJ, Berkmann LF, Blazer DG, Sherr PA,
Wallace RB. 1994. A short physical performance battery assessing lower extremity
function: Association with self-reported disability and prediction of mortality and


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).

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Group</th>
<th>Pearson r</th>
<th>p value</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>30CST v HF</td>
<td>Total n = 142</td>
<td>0.42</td>
<td>&lt;0.0001</td>
<td>0.27 - 0.54</td>
</tr>
<tr>
<td></td>
<td>Female, n = 86</td>
<td>0.36</td>
<td>0.0006</td>
<td>0.16 - 0.53</td>
</tr>
<tr>
<td></td>
<td>Male, n = 56</td>
<td>0.48</td>
<td>0.0001</td>
<td>0.25 - 0.66</td>
</tr>
<tr>
<td>30CST v KE</td>
<td>Total n = 142</td>
<td>0.29</td>
<td>0.0004</td>
<td>0.14 - 0.44</td>
</tr>
<tr>
<td></td>
<td>Female, n = 86</td>
<td>0.20</td>
<td>0.064</td>
<td>-0.01 - 0.40</td>
</tr>
<tr>
<td></td>
<td>Male, n = 56</td>
<td>0.37</td>
<td>0.004</td>
<td>0.12 - 0.58</td>
</tr>
<tr>
<td>30CST v (HF+KE)</td>
<td>Total n = 142</td>
<td>0.39</td>
<td>&lt;0.0001</td>
<td>0.24 - 0.52</td>
</tr>
<tr>
<td></td>
<td>Female, n = 86</td>
<td>0.31</td>
<td>0.0032</td>
<td>0.11 - 0.49</td>
</tr>
<tr>
<td></td>
<td>Male, n = 56</td>
<td>0.47</td>
<td>0.0002</td>
<td>0.24 - 0.65</td>
</tr>
<tr>
<td>30CST v HF/kg</td>
<td>Total n = 142</td>
<td>0.33</td>
<td>&lt;0.0001</td>
<td>0.17 - 0.47</td>
</tr>
<tr>
<td></td>
<td>Female, n = 86</td>
<td>0.19</td>
<td>0.073</td>
<td>-0.02 - 0.39</td>
</tr>
<tr>
<td></td>
<td>Male, n = 56</td>
<td>0.48</td>
<td>0.0001</td>
<td>0.25 - 0.66</td>
</tr>
<tr>
<td>30CST v KE/kg</td>
<td>Total n = 142</td>
<td>0.24</td>
<td>0.004</td>
<td>0.08 - 0.39</td>
</tr>
<tr>
<td></td>
<td>Female, n = 86</td>
<td>0.09</td>
<td>0.40</td>
<td>-0.12 - 0.30</td>
</tr>
<tr>
<td></td>
<td>Male, n = 56</td>
<td>0.46</td>
<td>0.0003</td>
<td>0.22 - 0.64</td>
</tr>
<tr>
<td>30CST v (HF+KE)/kg</td>
<td>Total n = 142</td>
<td>0.32</td>
<td>0.0001</td>
<td>0.16 - 0.46</td>
</tr>
<tr>
<td></td>
<td>Female, n = 86</td>
<td>0.16</td>
<td>0.15</td>
<td>-0.06 - 0.36</td>
</tr>
<tr>
<td></td>
<td>Male, n = 56</td>
<td>0.53</td>
<td>&lt;0.0001</td>
<td>0.31 - 0.69</td>
</tr>
</tbody>
</table>
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*.

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

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