The first reference equations for the 6-minute walk distance over a 10 m course

ABSTRACT

Rationale As primary care practice space is mostly limited to 10 m, the 6-minute walk test (6MWT) over a 10 m course is a frequently used alternative to evaluate patients’ performance in COPD. Considering that course length significantly affects distance walked in 6 minutes (6MWD), this study aims to develop appropriate reference equations for the 10 m 6MWT.

Methods 181 healthy subjects, aged 40–90 years, performed two standardised 6MWTs over a straight 10 m course in a cross-sectional study.

Results Average distance achieved was 578±108 m and differed between males and females (p<0.001). Resulting sex-specific reference equations from multiple regression analysis included age, body mass index and change in heart rate, explaining 62% of the variance in 6MWD for males and 71% for females.

Conclusions The presented reference equations are the first to evaluate 6MWD over a 10 m course and expand the usefulness of the 6MWT.

The 6-minute walk test (6MWT) is used to evaluate functional exercise capacity in patients with COPD.1 Reference equations for the 6MWT were established over courses ranging from 20 to 50 m,2 with 30 m being the recommended length by the American Thoracic Society (ATS).3 However, space limitations in primary care force professionals to execute the 6MWT over a 10 m course. Until now, no matching reference equations were established while current studies revealed a significant impact of course length on 6-minute walk distance (6MWD) and risk of clinical interpretation errors.2,4 We aimed to develop reference equations for the 10 m 6MWT.

A total of 184 healthy Caucasian subjects were recruited. After health screening, 181 remained. Subjects’ characteristics are summarised in online supplementary table S1 and S2. 6MWTs were performed in accordance with the ATS guidelines over a 10 m course.1 Univariate Pearson correlation coefficients and hierarchical/stepwise multiple regression analysis were used to evaluate variables explaining the variance in the 6MWD and to create a model predicting 6MWD. Included variables were sex, age, height, weight, body mass index, FVC, expiratory volume in one-second (FEV1), smoking pack-years, physical activity level, baseline heart rate (HR), change HR, baseline transcutaneous oxygen saturation (SpO2), change SpO2, baseline dyspnoea, change dyspnoea, baseline fatigue and change fatigue. A sex-specific lower limit of normal was calculated. Detailed information on methods is available in the online supplement.

We found that 6MWD in male and female was respectively 625±120 m and 554±94 m, with a significant difference (p<0.0001). 6MWD was significantly independently correlated with age, height, body mass index (BMI), FVC, FEV1, smoking, physical activity and changes in HR, experienced dyspnoea and fatigue (see online supplementary table S3). Based on a clear difference between the directions of the slopes for male versus female (see online supplementary figure S1), sex-specific reference equations were calculated (table 1). The amount of variation in 6MWD that was accounted for by the basic and extended model was respectively 52% and 62% for male and 59% and 71% for female. Assumptions of multiple regression analysis were met, and the models appeared to be reliable. Additional information on statistical analyses is available in the online supplement.

Our data provide healthcare professionals with suitable reference equations for the 10 m 6MWT. The significant association of 6MWD with age, gender and either BMI or ‘weight and height’ corresponds with previous studies.3 This is the first study to show a significant contribution of absolute HR values. However, HR is not always an adequate predictor for 6MWD due to lack of submaximal cardiac performance, other reasons for performance limitation, deviation of standardised HR measurement or use of β-adrenergic blocking agents. Although both models explained more variance than previous studies with Caucasian subjects (ranging from r²=0.20 to 0.66), other variables, such as psychological characteristics, may improve explained variance in 6MWD.4 Elaboration on the discussion is available in the online supplement. We conclude that unique reference equations for the 6MWT are essential when professionals use a 10 m course. The presented equations solve a practical problem and apply to subjects in various healthcare settings.

Emmylou Beekman,1,2,3 Ilse Mesters,1,2 Rik Gosselink,4,5 Mariska P M Klazen,6 Erik J M Hendriks,7 Onno C P Van Schayck,8 Rob A de Bie1,2

1Department of Epidemiology, CAPHRI School for Public Health and Primary Care, Maastricht University, Maastricht, The Netherlands
2Centre for Evidence Based Physiotherapy, Maastricht University, Maastricht, The Netherlands
3Physical Therapy Section in Multidisciplinary Centre, ParaMedisch Centrum Sittard Zuid, Sittard, The Netherlands
4Department of Rehabilitation Sciences, KU Leuven, Leuven, Belgium
5Department of Respiratory Rehabilitation and Respiratory Division, University Hospital Leuven, Leuven, Belgium
6Department of Rehabilitation, University Centre for Chronic Diseases Dekkerswald (UCCZ), Groesbeek, The Netherlands
7Physical Therapy Practice, Fysiotherapie Maastraet, Druten, The Netherlands
8Department of Family Medicine, CAPHRI School for Public Health and Primary Care, Maastricht University, Maastricht, The Netherlands

Correspondence to Emmylou Beekman, Department of Epidemiology, Maastricht University, PO Box 616, Maastricht 6200 MD, The Netherlands; E.Beekm@maastrichtuniversity.nl

Acknowledgements The authors acknowledge the help of Tiny Wehrens, Melanie van der Vleke, Annie van der Woude, Toos Beekman and colleagues of the Epidemiology Department at Maastricht University for recruiting participants and providing course space for testing. The authors are grateful to all participants. The authors acknowledge Walter Zeller for his contribution to the conception of the study and his help in developing the study protocol.

Contributors EB and MPMK contributed to the conception of the study and developing the study protocol. EB screened, recruited and tested the study participants. IM and EJMH contributed to

Table 1 Reference equations for 6MWD over a 10 m course

<table>
<thead>
<tr>
<th>Equation Type</th>
<th>Equation</th>
<th>r²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic equation</td>
<td>6MWD = 1266 – (7.80 * age) – (5.92 * BMI)</td>
<td>0.52</td>
</tr>
<tr>
<td></td>
<td>LLN 6MWDpredicted = 163</td>
<td>0.59</td>
</tr>
<tr>
<td></td>
<td>6MWD = 1064 – (5.28 * age) – (6.55 * BMI)</td>
<td>0.52</td>
</tr>
<tr>
<td></td>
<td>LLN 6MWDpredicted = 119</td>
<td>0.59</td>
</tr>
<tr>
<td>Extended equation</td>
<td>6MWD = 1073 – (6.03 * age) – (5.79 * BMI) + (1.86 * HRchange)</td>
<td>0.62</td>
</tr>
<tr>
<td></td>
<td>LLN 6MWDpredicted = 146</td>
<td>0.71</td>
</tr>
<tr>
<td></td>
<td>6MWD = 878 – (3.60 * age) – (6.42 * BMI) + (1.95 * HRchange)</td>
<td>0.62</td>
</tr>
<tr>
<td></td>
<td>LLN 6MWDpredicted = 101</td>
<td>0.71</td>
</tr>
</tbody>
</table>

*The choice whether the extended model can be used should depend on the considerations of the healthcare provider. 6MWD, 6-minute walk distance in m; age in years; BMI, body mass index in kg/m²; HRchange, change in heart rate in beats per minute (heart rate measured directly after the test minus heart rate measured at rest before the test); LLN, lower limit of normal; r², the coefficient of determination, the proportion of variability in a dataset that is accounted for by a statistical model.
recruitment and testing of the participants. EB drafted the manuscript. IM, RG, MPMK, EJMH, OCPvS and RAdB revised the manuscript critically. All authors read and approved the final manuscript.

Funding The research was funded by the Dutch Scientific College of Physiotherapy (WCF) of the Royal Dutch Society for Physical Therapy (KNGF), within the research programme ‘Designing Optimal Interventions in physical Therapy’ (DO-IT), a national cooperation of four universities in The Netherlands.

Competing interests None.

Provenance and peer review Not commissioned; externally peer reviewed.

Additional material is published online only. To view please visit the journal online (http://dx.doi.org/10.1136/thoraxjnl-2014-205228).

REFERENCES


