Reliability and validity of Houghton scale of prosthesis use

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Abstract

Objectives
To adapt the Houghton scale into Finnish and to assess its psychometric properties.

Methods
The study used translation and backtranslation and repeated surveys. These were assessed: convergent validity (Spearman correlation), floor- and ceiling effects, reliability (intraclass correlation coefficient), and construct validity (exploratory factor analysis).

Results
Altogether 113 patients were included. Of these patients, 1.6% and 0.8% reached the minimum or maximum points, respectively, indicating a well-constructed scale and sufficient balance between easy and difficult items. The intraclass correlation coefficient and coefficient of repeatability were 0.90 (95% CI, 0.83-0.93) and 2.63 (95% CI, 2.10-3.14), respectively.

The Houghton scale had good convergent validity against the Prosthesis evaluation questionnaire and the 15D generic health-related quality of life instrument. The Houghton scale loaded on two factors (“Prosthesis use” and “Walking”).

Conclusions
The Houghton scale was successfully adapted into Finnish. The Finnish Houghton seems to be a reliable scale with good convergent validity. The Houghton scale showed a two-factor structure indicating that a total score may not be useful. Instead, the scale can be used as a profile with each item describing its own domain of functioning.

Keywords: prosthetics; psychometrics; validity; factor analysis

INTRODUCTION

Several patient-reported outcome scales (PROs) have been suggested to assess functioning, mobility, and health-related quality of life (HRQoL) after lower extremity amputation such as Prosthesis Evaluation Questionnaire (PEQ), Locomotor Capabilities Index, and Houghton Scale of Prosthesis Use (Houghton Scale) (1-3). The Houghton Scale has been found to be reliable, valid, and responsive to change (4). No validated scale to measuring prosthesis use have been translated in Finnish so far.

The objective of the study was to adapt the Houghton scale into Finnish and to assess its psychometric properties.

METHODS

This was a survey-based prospective study amongst adults (≥18 years) who had undergone major lower extremity amputation, were using prosthesis, and who were fully able to understand written Finnish. Altogether, 597 consecutive prosthesis users were invited to participate. The participants provided their signed informed consent according to the Helsinki Declaration (5). The hospital district’s ethics committee has approved the study protocol.

The participants who did not return the first questionnaire set within a week received a reminder letter. After the participants had completed the initial questionnaire, the Houghton scale was mailed to them twice more along with a survey on general health changes between the first and second questionnaires. The participants were included in the analyses if they had completed the Houghton scale twice within a two-week interval.

Scales used in the study
The Houghton scale is a four-item questionnaire. Three items contain graded response choices from 0 to 4. The last
fourth item is divided into three dichotomic (yes/no) responses (Appendix 1). It has been suggested that a total score (from 0 to 12 points) >9 points signals a successful prosthetic rehabilitation (6).

The PEQ measures ambulation, appearance, frustration, perceived response, social burden, utility, residual limb health, sounds, transfers, and well-being domains during the last four weeks using a visual analogue scale 0 to 100 (‘worst’ to ‘best’) (7,8). The PEQ total score is a mean of all 10 item scores.

The 15D evaluates moving, seeing, hearing, breathing, sleeping, eating, speech, excretion, usual activities, mental function, discomfort and symptoms, depression, distress, vitality, and sexual activity using a Likert-like scale 1 to 5 (‘best’ to ‘worst’) (9). It combines the advantages of a profile and a preference-based, single index measure. The single index score ranges from 0 to 1 (‘worst’ to ‘best’).

The data were also gathered on the participants’ age, gender, cause of amputation, comorbidities, amputation level (disarticulation amputation was considered to be included in the transfemoral amputation group), time since amputation in months, and the time of first application of prosthesis. The participants’ general health and pain during the preceding week were measured on a visual analogue scale ranging between 0 to 100 (‘best’ to ‘worst’) (10).

Translation and cross-cultural adaptation
The translation and adaptation were following the commonly accepted guidelines (11-13). First, two translators independently produced blinded forward translations. These translations were merged into one by a consensus between translators and a principal investigator. Third translator back-translated the obtained version into English. All the translations and the original scale were then compared with by all three translators and a principal investigator. The pre-final version was tested on 14 amputees asking whether there was any inaccurate content, problems in answering, or whether they would ask anything differently. The results and the cognitive debriefing reports were reviewed altering the text of one item. The final translation was proofread by a professional Finnish language expert (Appendix 2).

Statistical analysis
Data were presented as means and standard deviations (SDs), medians and interquartile ranges (IQRs), 95% confidence intervals (95% CI), or counts, ranges and percentages when appropriate. The missing responses were counted and displayed.

Relative reliability was estimated by an intraclass correlation coefficient (ICC) using a one-way random-effects model with absolute agreement. The ICC were categorized as follows: poor (<0.40), fair (0.40-0.59), good (0.60-0.74), or excellent (0.75-1.00) (14). To estimate the expected maximum size of 95% of absolute differences between paired observations, a coefficient of repeatability (CR) was used. For the ICCs and the CRs, the 95% CI were obtained by bias-corrected and accelerated bootstrapping (5000 replications). The internal consistency was assessed by a Cronbach’s alpha.

### Table 1. Sample characteristics.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>N=113</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men, n (%)</td>
<td>76 (63.7)</td>
</tr>
<tr>
<td>Age, years, mean (SD)</td>
<td>63.2 (14.0)</td>
</tr>
<tr>
<td>Time since amputation, years, median (IQR)</td>
<td>4.7 (6.0)</td>
</tr>
<tr>
<td>Amputation level, n (%)</td>
<td>80 (70.8)</td>
</tr>
<tr>
<td>Transtibial</td>
<td>30 (26.5)</td>
</tr>
<tr>
<td>Transemoral</td>
<td>3 (2.7)</td>
</tr>
<tr>
<td>Bilateral amputation, n (%)</td>
<td>11 (9.7)</td>
</tr>
<tr>
<td>Indication for amputation, n (%)</td>
<td>36 (32.1)</td>
</tr>
<tr>
<td>Vascular disease with or without diabetes</td>
<td>24 (21.2)</td>
</tr>
<tr>
<td>Trauma</td>
<td>21 (18.6)</td>
</tr>
<tr>
<td>Tumor</td>
<td>15 (13.3)</td>
</tr>
<tr>
<td>Diabetic vascular disease</td>
<td>7 (6.2)</td>
</tr>
<tr>
<td>Congenital foot disease</td>
<td>4 (3.5)</td>
</tr>
<tr>
<td>Chronic wound</td>
<td>4 (3.5)</td>
</tr>
<tr>
<td>Non-union</td>
<td>1 (0.9)</td>
</tr>
<tr>
<td>Talocrural joint destruction</td>
<td>1 (0.9)</td>
</tr>
<tr>
<td>Patient-reported comorbidities, n (%)</td>
<td>40 (35.4)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>36 (26.5)</td>
</tr>
<tr>
<td>Vascular disease</td>
<td>37 (32.7)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>29 (25.7)</td>
</tr>
<tr>
<td>Heart disease</td>
<td>10 (8.9)</td>
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<tr>
<td>Neurological disease</td>
<td>5 (4.4)</td>
</tr>
<tr>
<td>Respiratory disease</td>
<td>49 (43.4)</td>
</tr>
<tr>
<td>Other</td>
<td>35.0 (23.9)</td>
</tr>
<tr>
<td>General Health, VAS, mm, mean (SD)</td>
<td>33.3 (25.9)</td>
</tr>
<tr>
<td>General Pain, VAS, mm, mean (SD)</td>
<td>63.2 (14.0)</td>
</tr>
<tr>
<td>Ambulation</td>
<td>51.6 (28.3)</td>
</tr>
<tr>
<td>Appearance</td>
<td>62.1 (20.5)</td>
</tr>
<tr>
<td>Frustration</td>
<td>64.7 (30.3)</td>
</tr>
<tr>
<td>Perceived responses</td>
<td>83.3 (46.7)</td>
</tr>
<tr>
<td>Residual limb health</td>
<td>59.9 (22.2)</td>
</tr>
<tr>
<td>Social</td>
<td>67.5 (24.8)</td>
</tr>
<tr>
<td>Sounds</td>
<td>65.9 (26.9)</td>
</tr>
<tr>
<td>Utility</td>
<td>63.9 (19.0)</td>
</tr>
<tr>
<td>Well-being</td>
<td>66.1 (23.4)</td>
</tr>
<tr>
<td>Transfers</td>
<td>66.2 (24.8)</td>
</tr>
</tbody>
</table>

### Table 2. Factor loadings and uniqueness.

<table>
<thead>
<tr>
<th>Houghton scale items</th>
<th>Factor 1: “Prosthesis use”</th>
<th>Factor 2: “Walking”</th>
<th>Uniqueness</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.70</td>
<td>0.51</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0.81</td>
<td>0.16</td>
<td>0.31</td>
</tr>
<tr>
<td>3</td>
<td>0.64</td>
<td>0.17</td>
<td>0.57</td>
</tr>
<tr>
<td>4a</td>
<td>0.48</td>
<td>0.50</td>
<td>0.53</td>
</tr>
<tr>
<td>4b</td>
<td>0.82</td>
<td>0.38</td>
<td>0.85</td>
</tr>
</tbody>
</table>

IQR, interquartile range; PEQ, Prosthesis evaluation questionnaire; SD, standard deviation; VAS, visual analogue scale.
The Spearman correlations were accompanied by two-tailed \( p \)-values test considering \( \leq 0.05 \) to be significant. Linear regression analyses were applied to identify the appropriate predictors of the 15D and PEQ age-standardized and gender-standardized regression coefficients considering values 0.10, 0.30, and 0.50 small, moderate, and strong correlations, respectively.

The exploratory factor analysis with varimax rotation was used to investigate the construct validity of Houghton scale. The items were standardized into the same scale. Statistical and illustrative analyses were used to identify factor loadings. A factor retained if its eigenvalue was \( \geq 1 \). The parallel analysis was also applied (15).

The statistical analyses were performed using IBM SPSS Statistics version 24.0 and R version 3.4.1. Reporting adheres to the COSMIN checklist (16).

RESULTS

Altogether, 167 patients responded to a first questionnaire. Of these patients, 113 (68%) responded to a second questionnaire and were included in the analysis. The sociodemographic characteristics are presented in Table 1. The majority of the patients were men (63.7%). The age ranged from 19 to 93 years. Most of the patients had undergone a transtibial amputation (70.8%). Peripheral artery disease with or without diabetes (26.6%) was the most frequent indication for amputation while trauma (21.2%) was a secondly frequent reason.

Convergent and discriminant validity

The Houghton scale showed a strong and statistically significant relationship with such items of 15D as “Mobility”, “Usual activities”, “Sleeping”, “Excretion”, and “Distress” and, as well, with a 15D total score (Figure 1). The Houghton scale demonstrated a significant association such items of PEQ as “Ambulation”, “Utility”, “Well-Being”, “Transfers”, and “Social Burden”. The Houghton scale displayed poor negative correlations with general health (\( \rho = -0.30; \ p < .01 \)) and general pain (\( \rho = -0.29; \ p < .01 \)). All relationships with the 15D and the PEQ are illustrated in Figures 1 and Table 2.

The Houghton scale had a weak negative correlation with a cause for amputation (Spearman \( \rho = -0.26; \ p < .01 \)). Amputation level (\( \rho = -0.12 \)), gender (\( \rho = 0.05 \)), and whether the patient was amputated bilaterally (\( \rho = -0.01 \)) showed no correlations.

Exploratory factor analysis

The Houghton scale loaded on two retained factors with eigenvalues 2.5 and 1.3 (Figure 1). These two factors were named here as “Prosthesis use” and “Walking” (Table 2).

DISCUSSION

To assess the psychometric properties of the Houghton Scale, this study recruited a heterogeneous sample of patients with prostheses after major lower extremity amputation. The Houghton Scale had a two-factor structure that raises a question if the scale is able to produce a reliable total score. The results suggested that the Houghton Scale might probably better be used as a profile for prosthesis users.

The study sample might be too small to detect the exact structure of the scale. Additionally, the heterogeneity of reasons for amputation may affect the generalizability of the results.

CONCLUSIONS

The Houghton scale was successfully adapted into Finnish. The Finnish Houghton seems to be a reliable scale with good convergent validity. The Houghton scale showed a two-factor structure indicating that a total score may not be useful. Instead, the scale can be used as a profile with each item describing its own domain of functioning.

No previous studies employed a factor analysis to evaluate the Houghton scale. Of the observed factors, one was related to prosthesis use (items 1, 2 and 3) and another one to an effort needing to walk (item 4). While previous study has reported ICC values of 0.96 for the total score (6), smaller ICC of 0.90 was seen in the present study, probably due to differences between studied populations. In a convergent validity analysis, a prosthesis use was associated with mobility, subjective well-being, and a general HRQoL. This was in line with a previous report on the Houghton Scale having a strong correlation with the 2-Minute Test (6).

Further research on the Houghton scale psychometrics is needed. The Rasch analysis or item response theory may produce more insights into the scale’s construct validity.
REFERENCES


ACKNOWLEDGMENTS

The authors would like to thank Heli Sarpila and Paju Becker for their contribution in data collection.
Appendix 1. Original Houghton score.

1. Do you wear your prosthesis:
   0 – Less than 25% of waking hours (1-3 hours)
   1 – Between 25% and 50% of waking hours (4-8 hours)
   2 – More than 50% of waking hours (more than 8 hours)
   3 – All waking hours (12-16 hours)

2. Do you use your prosthesis to walk:
   0 – Just when visiting the doctor or limb-fitting centre
   1 – At home but not to go outside
   2 – Outside the home on occasion
   3 – Inside and outside all the time

3. When going outside wearing your prosthesis, do you:
   0 – Use a wheelchair
   1 – Use two crutches, two canes, or a walker
   2 – Use one cane
   3 – Use nothing

4. When walking with your prosthesis outside, do you feel unstable when:
   4a. Walking on flat surface  0 – Yes  1 – No
   4b. Walking on slopes  0 – Yes  1 – No
   4c. Walking on rough ground  0 – Yes  1 – No
Appendix 2. Finnish translation of Houghton score [Houghtonin kysely alaraajaproteesin käyttäjille]

1. Käytätkö proteesiasi:
   0 - Vähemmän kuin 25 % valveillaoloajasta (1–3 tuntia)
   1 - Valveillaoloajasta 25–50 % (4–8 tuntia)
   2 - Enemmän kuin 50 % valveillaoloajasta (yli 8 tuntia)
   3 - Koko valveillaoloajan (12–16 tuntia)

2. Käytätkö proteesiasi kävelyyn:
   0 - Vain käydessäni lääkäriissä tai proteesin sovituksessa
   1 - Kotona vain sisätiloissa
   2 - Satunnaisesti kodin ulkopuolella
   3 - Sisällä ja ulkona koko ajan

3. Kun menet ulos proteesia käyttäen,
   0 - Käytän pyörätuolia
   1 - Käytän kahta kynärsauvaa, keppiä tai kävelytelinettä
   2 - Käytän keppiä tai kynärsauvaa
   3 - En käytä mitään apuvälineitä

4. Kun kävelet ulkona proteesia käyttäen, tunnetko tasapainosi epävarmaksi
   4a. Tasaisella kävellessä 0 – Kyllä 1 – En
   4b. Kaltevalla alustalla kävellessä 0 – Kyllä 1 – En
   4c. Epätasaisella kävellessä 0 – Kyllä 1 – En