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Abstract: OBJECTIVES Stair climbing (SC) as daily activity is assessed with different SC-tests, but none directly measures ground reaction force over several steps. The Leonardo Mechanograph Stair A has five steps and four force sensors. This study aimed at investigating the reliability of the Stair A test for force, power and time to SC. METHODS 55 healthy participants (age: 48±14 years) were five times tested during SC with self-chosen and fast speed. 30 participants were examined for test-retest-reliability, calculated with the intraclass correlation coefficient (ICC). The variability was examined with the coefficient of variation (CV). To determine potential associations between SC and jumping performance or daily activity, squat and countermovement jumps were additionally performed and the International physical activity questionnaire (IPAQ) was completed. RESULTS The inter-visit ICCs of self-chosen and fast SC were good to excellent 0.63-0.77. The intra-visit ICCs were excellent after three trials (0.78-0.88). The CVs for SC with self-chosen speed were lower (2.1-6.6%) than those for fast SC (4.9-10.8%). There were no significant correlations between SC and jump parameters and only moderate correlations with the IPAQ. CONCLUSION The Stair A is a reliable tool for the assessment of SC.

Original Article

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Abstract

Objectives: Stair climbing (SC) as daily activity is assessed with different SC-tests, but none directly measures ground reaction force over several steps. The Leonardo Mechanograph Stair A has five steps and four force sensors. This study aimed at investigating the reliability of the Stair A test for force, power and time to SC. **Methods:** 55 healthy participants (age: 48±14 years) were five times tested during SC with self-chosen and fast speed. 30 participants were examined for test-retest-reliability, calculated with the intraclass correlation coefficient (ICC). The variability was examined with the coefficient of variation (CV). To determine potential associations between SC and jumping performance or daily activity, squat and countermovement jumps were additionally performed and the International physical activity questionnaire (IPAQ) was completed. **Results:** The inter-visit ICCs of self-chosen and fast SC were good to excellent 0.63-0.77. The intra-visit ICCs were excellent after three trials (0.78-0.88). The CVs for SC with self-chosen speed were lower (2.1-6.6%) than those for fast SC (4.9-10.8%). There were no significant correlations between SC and jump parameters and only moderate correlations with the IPAQ. **Conclusion:** The Stair A is a reliable tool for the assessment of SC.

Keywords: Stair Climbing Test, Force, Power, Activity

Introduction

Stair climbing (SC) is a daily activity with an adaptable movement pattern, which produces greater ground reaction forces than walking and requires more energy[1]. The centre of gravity translates vertically, which is more challenging compared to walking[2]. The postural stability needs to be guaranteed in order to be able to SC, especially for the single stance phase to prevent falls[2]. It is known that many stair accidents occur, especially among elderly or frail people[3]. Not only the risk of falls is increased in elderly and frail people but also the ability for SC might get crucial

due to reduced force. It is thereby well known that increasing age leads to decreased physical activity, as well as to sensory and cognitive constraints[4,5]. Altogether, it has been shown that age can affect the vertical ground reaction force, especially during SC[6]. In addition, several medical diseases are related to reduced SC performance[7]. The inability for SC is a large limitation in everyday life that reduces independency. Measurement of ground reaction force during SC with SC tests (SCT) offers the option to investigate the actual condition of an individual and leafs room for an intervention if necessary. In this regard, SCT are widely used in patients with cardiopulmonary[8-10] and orthopaedic diseases[11] to test their skeletal muscle (dys-) function, which is often reduced, within a daily activity.

At the moment three different SCT exist. First, participants climb the steps of a normal stair and time is stopped manually[8,12-14]. Second, participants climb a stair construction (three steps) built on two force plates that are integrated into the floor[15]. Third, participants climb a staircase with an integrated force plate on single steps only[6,11,16,17]. The latter measurement tool is a construction of six steps, with an integrated force plate on the third and the fourth step. Studies have shown that the curve of the vertical ground reaction force during a single step stair ascent

Age (years)	48 ± 14
Sex (f/m)	30/25
BMI (kg/m^2)	23.8 ± 3.7
IPAQ (MET-minutes/week)	6664 ± 10083
$F_{max,rel}$ at self-chosen speed (N/kg)	1.43 ± 0.09
t_{tot} at self-chosen speed (s)	4.20 ± 0.40
$P_{max,rel}$ at self-chosen speed (W/kg)	5.90 ± 0.74
Fast $F_{max,rel}$ (N/kg)	1.39 ± 0.20
Fast t_{tot} (s)	3.11 ± 0.33
Fast $P_{max,rel}$ (W/kg)	8.03 ± 3.23

Note. Data are given as means ± standard deviations (SD). Abbreviations: BMI: body mass index; IPAQ: International physical activity questionnaire; $F_{max,rel}$: relative maximal force; t_{tot}: total time; $P_{max,rel}$: relative maximal power.

Table 1. Baseline characteristics of the participants (n=55).

is similar to the one of a gait cycle. These conventional SCT suffer from several weaknesses. Manual stoppage of time during SC lacks scientific accuracy and suffers from a large inter-tester variation. The other two SCT assess force, power and time but the assessment is limited to maximal two steps. Hence, the assessment of force and power is only possible for one step per leg. The progression of force and power during SC, which is mostly composed of more than two steps, are not possible.

A novel measurement device to determine force and power during SC is the Leonardo Mechanograph Stair A (Stair A). It works with four force sensors underneath the steps at the whole stair. Hence, this new instrument measures not only a single step, but also the performance during the whole SC with its five steps. The Stair A offers a promising option to investigate force and power values during SC. The measurement of force during SC is especially important in elderly and frail people as well as patients. In these population groups, muscle force might be reduced to such an extent that it is simply not possible to climb a stair. Timed SCT are questionable in these cohorts because these people are not interested in SC as fast as possible. They are rather interested in SC *per se*. Hence, it is important for these people to maintain a certain level of force to allow SC and maintain thereby their independency during everyday life. Repeated measurement of ground reaction force during SC represents a promising option to investigate the progression of muscle force during an important daily task. However, up to date, the reliability of the Stair A was not investigated so far.

Aim

The aim of the current study was to assess (absolute and relative) reliability of the Stair A in healthy participants. In addition, we aimed investigating whether the results of the Stair A differ as a function of age. Furthermore, to determine potential associations between SC and jumping performance or daily activity, the Stair A derived values were compared to the results of two-legged jumping manoeuvers and to the results of a questionnaire on daily physical activity.

Method

Design

Test-retest reliability was explored by executing the identical protocol of the SCT on two occasions within two to seven days. The study protocol was approved by the local Ethics Committee. The primary endpoint was the reliability of the maximal SC force relative to bodyweight ($F_{max,rel}$) with self-chosen speed. Exploratory endpoints were the reliability of the total time (t_{tot}), the relative maximal power ($P_{max,rel}$) and the $F_{max,rel}$ during SC with self-chosen and fast speed. Two-legged jumping manoeuvres and a physical activity questionnaire were completed to determine potential associations of these results with SC values.

Sample

Fifty-five subjects (Table 1) were recruited by placard in the University Hospital of Zurich. Having read the information leaflet, the participants signed the written informed consent form before being included in the study. Out of the fifty-five subjects, fifteen males and fifteen females, aged forty to fifty-nine years, were included to assess test-retest reliability analogously to Walter et al. (1998)[18]. Fourteen participants aged twenty to thirty-nine and eleven subjects aged sixty years or older were examined to investigate the influence of age during SC.

Assessment

Measurements were accomplished using the certified Stair A (adult version; Novotec Medical, Pforzheim, Germany). The staircase has a step height of 0.175 m and a step depth of 0.28 m. To guarantee the safety of the participants there is a handrail on both sides of the Stair A. Four integrated sensors enable measuring of force during SC. The manufacturer's software calculates the centre of mass related variables velocity and power. The sampling rate per sensor is 1000 Hz with a maximum force per sensor of 1.3 kN, using a 16 bit analogue-digital-converter. For analysis, the software Leonardo Mechanography v4.3 RES (Novotec Medical, Pforzheim, Germany) was used. The force platform was adjusted to zero (out of -0.03 kg and +0.03 kg) before any subject had stepped on the staircase.

Procedures

Stair climbing test

According to previous studies with Leonardo Mechanography, as well as other studies testing other kinds of stairs, the participants SC five times[16,17,19,20]. Participants were asked to SC five times with their self-chosen speed, since the variability of gait parameters is lowest with habitual speed[17], and five times as fast as possible without running. The participants had to wear anti-slippery socks provided by the researcher. At the beginning there was one sample measurement which was not included in the statistical calculations to reduce a possible familiarisation effect. Stair descent was not assessed due to its higher variability[17]. We included all five trials of the participants in the calculations.

	Test day 1	Test day 2	SEM	SDC
$F_{max,rel}$ at self-chosen speed (N/kg)	1.42 ± 0.08	1.42 ± 0.08	0.04	0.11
t_{tot} at self-chosen speed (s)	4.13 ± 0.36	4.02 ± 0.38	0.22	0.62
$P_{max,rel}$ at self-chosen speed (W/kg)	5.90 ± 0.72	5.88 ± 0.61	0.40	1.10
Fast $F_{max,rel}$ (N/kg)	1.35 ± 0.16	1.33 ± 0.13	0.09	0.25
Fast t_{tot} (s)	3.06 ± 0.25	3.09 ± 0.26	0.15	0.41
Fast $P_{max,rel}$ (W/kg)	7.42 ± 2.51	6.85 ± 1.96	1.36	3.79

Note. Data are given as means ± standard deviations (SD), n=30.
Abbreviations: $F_{max,rel}$: relative maximal force; t_{tot}: total time; $P_{max,rel}$: relative maximal power.

Table 2. Test-retest results, Standard error of measurement (SEM) and smallest detectable change (SDC) for stair climbing at self-chosen and fast speed.

	Inter-visit (n=30)			Intra-visit (first; n=55)			Intra-visit (second; n=30)		
	ICC	(95% CI)	CV (%)	ICC	(95% CI)	CV (%)	ICC	(95% CI)	CV (%)
Self-chosen speed									
$F_{max,rel}$	0.77	(0.67-0.86)	2.4	0.85	(0.79-0.90)	2.1	0.80	(0.69-0.88)	2.2
t_{tot}	0.63	(0.50-0.76)	4.5	0.86	(0.80-0.91)	3.5	0.84	(0.75-0.91)	3.8
$P_{max,rel}$	0.70	(0.58-0.81)	6.9	0.76	(0.67-0.83)	6.6	0.72	(0.59-0.83)	5.6
Fast									
$F_{max,rel}$	0.70	(0.58-0.82)	5.0	0.83	(0.76-0.89)	4.9	0.84	(0.74-0.91)	3.5
t_{tot}	0.65	(0.52-0.78)	5.8	0.70	(0.60-0.79)	5.7	0.81	(0.70-0.89)	3.7
$P_{max,rel}$	0.70	(0.59-0.81)	11.3	0.85	(0.79-0.90)	10.8	0.89	(0.83-0.94)	7.6

Abbreviations: $F_{max,rel}$: relative maximal force; t_{tot}: total time; $P_{max,rel}$: relative maximal power.

Table 3. Intraclass correlation coefficient (ICC (2,1)) and the coefficient of variation (CV) for Inter- and Intra-visit reliability.

International physical activity questionnaire

In addition to the measurement with the Stair A, all subjects received a questionnaire about their regular physical activity. For this assessment the International Physical Activity Questionnaire (IPAQ) was chosen, including several questions about daily activities such as sports and work[21].

Two-legged jumping manoeuvres

For the determination of jumping force and power during countermovement jumps (CMJ) and squat jumps (SJ), five vertical jumps (separated by 30 s of rest) were performed on a Leonardo Mechanograph force plate (Novotec Medical, Pforzheim, Germany). For the measurements, storage and analysis of data, we used the manufacturer's software (Leonardo Mechanography GRFP version 4.2, Novotec Medical, Pforzheim, Germany). CMJs were performed with freely moving arms, whereas the SJs were performed with the hands resting on the waist.

Statistics

Relative reliability (intra- and inter session) was calculated using the intraclass correlation coefficient (ICC) to explain the measurement error relative to total variance[22]. For the ICC, the consistency, two-way random mixed model was used. We calculated the ICC over two, three, four and five trials in one session. Values >0.75 are considered to be excellent, 0.6-0.74 good, 0.4-0.59 moderate and <0.4 poor[23]. Absolute reliability was expressed by the coefficient of variation (CV), calculated with the formula:

$$CV_{SDj} = \frac{SD_j}{\bar{x}_j} \cdot 100\%$$

where SD_j represents standard deviation (calculated for each participant of all five trials), and $\bar{x}_j$ is the mean of all x_{ij} [24]. To measure the within-subject standard deviation the standard error of measurement (SEM) was calculated[22,25]:

$$SEM = SD \sqrt{1 - ICC}$$

The smallest detectable change (SDC) of the measurement was calculated as[26]:

$$SDC = 1.96 \cdot SEM \cdot \sqrt{2}$$

To compare the Stair A results with the results of the jumping manoeuvres and the IPAQ scores (ordinal scale) with the Pearson correlations (r) and the Spearman correlations (r_s), were calculated, repsectively.

Correlations (Spearman and Pearson) of 0-0.25 were considered to be little, 0.25-0.50 fair, 0.50-0.75 moderate to good and >0.75 very good to excellent[27]. To check for associations

n = 55	Trial 1, 2		Trial 1, 2, 3		Trial 1, 2, 3, 4		Trial 1, 2, 3, 4, 5	
	ICC	(95% CI)	ICC	(95% CI)	ICC	(95% CI)	ICC	(95% CI)
Self-chosen speed								
$F_{max,rel}$	0.83	(0.73-0.90)	0.85	(0.78-0.91)	0.87	(0.81-0.91)	0.85	(0.79-0.90)
t_{tot}	0.86	(0.77-0.92)	0.83	(0.75-0.89)	0.85	(0.78-0.90)	0.86	(0.80-0.91)
$P_{max,rel}$	0.84	(0.74-0.90)	0.79	(0.69-0.86)	0.77	(0.69-0.85)	0.76	(0.67-0.83)
Fast								
$F_{max,rel}$	0.82	(0.72-0.89)	0.82	(0.74-0.89)	0.81	(0.74-0.88)	0.83	(0.76-0.89)
t_{tot}	0.73	(0.57-0.83)	0.78	(0.69-0.86)	0.70	(0.60-0.80)	0.70	(0.60-0.79)
$P_{max,rel}$	0.90	(0.83-0.94)	0.88	(0.82-0.92)	0.85	(0.79-0.90)	0.85	(0.79-0.90)

Abbreviations: $F_{max,rel}$: relative maximal force; t_{tot}: total time; $P_{max,rel}$: relative maximal power.

Table 4. Intraclass correlation coefficient (ICC (2,1)) and 95% confidence interval (CI) of the first session over two, three, four and five trial.

	20-39 years (n=14)	40-59 years (n=30)	≥60 years (n=11)
Self-chosen speed			
$F_{max,rel}$ (N/kg)	1.47 ± 0.10	1.42 ± 0.08	1.42 ± 0.05
t_{tot} (s)	4.14 ± 0.35	4.13 ± 0.36	4.48 ± 0.48#
$P_{max,rel}$ (W/kg)	5.98 ± 0.89	5.90 ± 0.72	5.76 ± 0.62
Fast			
$F_{max,rel}$ (N/kg)	1.54 ± 0.27	1.35 ± 0.16°°	1.34 ± 0.08
t_{tot} (s)	2.96 ± 0.36	3.06 ± 0.25	3.44 ± 0.27**###
$P_{max,rel}$ (W/kg)	10.65 ± 4.13	7.42 ± 2.51°°	6.35 ± 1.49**

Note. Mean and Standard Deviations of the stair parameters classified by age. Group differences calculated with the non parametric Kruskal-Wallis Test and the Mann-Whitney Test.

Abbreviations: $F_{max,rel}$: relative maximal force; t_{tot}: total time; $P_{max,rel}$: relative maximal power. **p<0.01 significant differences between ≥60 years and 20-39 years. #p≤0.05 and ###p<0.001 significant differences between ≥60 years and 40-59 years. °°p<0.01 significant differences between 20-39 years and 40-59 years.

Table 5. Stair parameters of different age groups.

between age as well as physical activity measured by the IPAQ and the results of SC one-way ANOVAs were conducted. If the statistical preconditions (test of homogeneity and normal distribution) were not complied, the non-parametric Kruskal-Wallis-Test was used to analyse the variances by ranks.

To check whether there was potential learning or fatigue effect, a paired t-test or a Wilcoxon test (if parameters were not normally distributed) was calculated between trial 1 and 5 of test day 1, trial 1 of the first and the second test day, as well as trial 1 and 5 of test day 2, respectively.

Statistical calculations were performed with SPSS Statistics 21.0 (SPSS, Chicago, IL, USA). The level of significance was set at p≤0.05. Data are given in means ± SD.

Results

Reliability

The SEM and SDC had similar values in self-chosen and fast SC t_{tot} and $F_{max,rel}$ (Table 2). The SEM and SDC of $P_{max,rel}$ in fast SC were higher than in self-chosen SC (Table 2).

Test-retest reliability

The values of the two different test days for self-chosen and fast SC are shown in Table 3. The ICC (2,1) for all stair variables (Table 3) assessed on two different days and within one test day ranged from 0.63 to 0.77 and from 0.70 to 0.89, respectively.

The ICCs of the first session calculated for two, three, four, and five trials were similar (Table 4). For most variables, the highest ICC was achieved with two or three trials.

Variability

The CV, overall stair parameters, ranged from 2.1% to 10.8% (Table 3). The mean CVs for the self-chosen SC (2.1-6.6%) were lower than those for fast SC (4.9-10.8%).

Learning and/or fatigue effect

There was a significant difference in the parameter t_{tot} at self-chosen speed between trial 1 and 5 in the first session (4.27 vs. 4.18 for the first vs. fifth trial, p=0.013). There was also a sig-

nificant difference in the parameter $P_{max,rel}$ at self-chosen speed between trial 1 and 5 in the second session (6.00 vs. 5.82 W·kg^{-1} body mass for the first vs. fifth trial, p=0.045). For most variables, the highest ICC was achieved with two or three trials.

Daily activity and jumping performance

There was a correlation between total IPAQ score and $P_{max,rel}$ at self-chosen speed (y=0.266·x+20.6, r_s=0.266, p=0.050). The active transportation part of the IPAQ correlated positively with $F_{max,rel}$ at self-chosen speed (y=0.300·x+19.6, r_s=0.300, p=0.026) and with $P_{max,rel}$ at self-chosen speed (y=0.424·x+16.1, r_s=0.424, p=0.001).

There was no significant correlation of the stair parameter means compared with the means of the variables determined during SJ or CMJ (r=-0.321-0.156, p>0.05).

Age differences

Age significantly influenced all stair parameters during fast SC and t_{tot} during SC at self-chosen (Table 5). In particular, elderly participants (≥60 years) showed significant differences in t_{tot} at self-chosen speed, fast t_{tot} and fast $P_{max,rel}$ compared to the younger two groups. Fast $F_{max,rel}$ and $P_{max,rel}$ were also significantly different comparing the youngest group (20-39 years) and the middle aged group (40-59 years).

Sex did not have a significant influence on the measured stair parameters (data not shown).

Discussion

In the current study we showed a moderate to high reliability of the Stair A during SC in all of the assessed parameters. The primary endpoint, i.e. the reliability of the SC $F_{max,rel}$, showed an excellent result at self-chosen speed. The ICCs (2,1) for $F_{max,rel}$, $P_{max,rel}$ and t_{tot} on two separate testing days were good to excellent for SC at self-chosen and good for fast SC. For all measured variables, an excellent reliability was already achieved after two or three trials within one session.

The ICCs (2,1) over one test day were better than over two test days. With respect to our ICCs (2,1) for $F_{max,rel}$ during SC at self-chosen speed, the ICCs of 0.65-0.84 measured with a force plate on two single steps described by Leitner et al. (2011)[16] are very similar. In addition, the ICC in t_{tot} at self-chosen during SC, which was 0.8-0.89 in their study, was comparable to our result[16]. However, in comparison with a study in chronic obstructive pulmonary disease (COPD) patients, in which participants had to ascend ten stairs as quickly and safely as possible[8], our correlations are lower. In the mentioned study, time was stopped manually and force as well as power, were then calculated. Patients with COPD showed lower power in the test than matched healthy people. The test-retest reliability was very high with an ICC (2,1) of 0.90[8]. Le-Brasseur et al. (2008) calculated higher ICCs of fast SC time (0.79-0.94), tested on 12 steps in different age categories of men, including also elderly men with mobility limitations, compared to the ICC (2,1) in fast SC t_{tot} of our study (0.65-

0.81)[28]. Overall the test-retest-reliability of the Stair A tended to be similar or only slightly lower than in previous studies[8,16,28]. Taken together, we can conclude that the current study is in line with previous SC assessments. Differences in ICC between the present study and previous studies can be explained by the determination methods (ground reaction force vs. manual hand stoppage of time) or the participant cohort (healthy participants vs. patients).

The individual calculations for the ICC (2,1) for two, three, four and five trials of the first session demonstrated a good repeatability already after two and three trials, which were even better than after five trials. Moreover, the intra-visit ICCs for all variables were already excellent after three trials in the first session (0.78-0.88). These results indicate that two trials would be sufficient to receive reliable measurement results with the Stair A. In addition to the increase in time efficiency, this result would also have an important practical benefit. The Stair A will mainly be applied in patients with a reduced exercise capacity. In these population groups, a fatigue effect might occur already after few trials, which would negatively influence test outcomes. Such a fatigue effect manifested itself already in our participants with a reduced $P_{max,rel}$ in trial 5 compared to trial 1 of the second testing day. Hence, especially in patients fewer trials represent a large benefit. However, one result might impair our proposal. For t_{tot} at self-chosen speed during testing day 1, there was a significant better result for trial 5 compared to trial 1. Therefore, the sample measurement at the beginning of the testing procedure, which was not included in the analysis, seemed not sufficient to eliminate the potential learning/familiarisation effect for all assessed variables. Based on our data, we suggest therefore that two familiarisation trials should be conducted in advance of two measurement trials to achieve reliable results with optimal time efficiency.

The CVs were higher during fast SC compared to SC at self-chosen speed. This can be explained by the higher variability for the assessment of ground reaction force during fast SC compared to SC at self chosen[29]. Considering the fact that Stacoff et al. (2005) reported CVs of 5-10% for ground reaction force during stair ascent, our results are promising[6]. Our CVs for SC at self-chosen are also lower than the CVs of Leitner et al. (2011) who calculated CVs of 2.52-3.87% for force variables, and 5.72-11.82% for time variables during SC[16]. The CV of the SC t_{tot} at self-chosen speed is similar to Galvao and Taaffe (2005), who calculated a CV of 4.8% in community-dwelling older people tested on a flight of stairs consisting of eleven steps[30].

To decrypt a potential association between SC and muscle function or daily physical activity, SC parameters were comapred with $F_{max,rel}$, $P_{max,rel}$ and height of two different two-legged jumping manoeuvres or the IPAQ. No correlations were present between the variables of the SCT ($F_{max,rel}$, $P_{max,rel}$ and t_{tot}) and the variables of the two-legged jumping manoeuvers and only minor correlations with the scores of the IPAQ. These results stand in contrast to previously published data. Bean et al. (2007) showed a significant correlation between SC power and leg press power (r=0.47-0.52) in community-dwelling

older adults with mobility limitations[13]. In another study, SC time correlated ($r>0.6$) with one repetition maximum and total strength of leg press, leg curl, and leg extension, respectively, but not with leg press endurance in older adults (≥ 60 years old)[31]. In this study, the SCT consisted of climbing 23 steps without using handrails, while time was recorded with a stopwatch[31]. In addition, Roig et al. (2010) showed a moderate correlation between the SCT and eccentric and isometric knee extension torque as well as for eccentric knee flexion torque in COPD patients[8]. Furthermore, SC power in COPD patients had a good correlation ($r=0.68$) with the 6 minute walking distance (6 MWD). A possible explanation for the discrepancy between our result and these previously published results might be the fact that we investigated healthy people and the other studies were on elderly people or patients. This difference in participant characteristic leads to at least two explanations. First, a ceiling effect might occur especially in measurements of activities in daily life[23]. In particular, we assume that patients or elderly participants approach their exercise limit already during fast SC, while this is not the case in healthy participants. Second, a potential explanation is the fact that healthy people jump as high as possible during two-legged jumping, while during SC, they only use the minimal force necessary to successfully climb the stair. This explanation is supported by the lower variances in $F_{max,rel}$ during SC (1.27-1.57 N·kg body mass^{-1}) compared to $F_{max,rel}$ during CMJ (18.5-30.2 N·kg body mass^{-1}).

The oldest age group needed significantly more time to SC as fast as possible, than the younger groups. This is in line with a previous study, which demonstrated that age influences SC especially between young (34 years) to middle-aged (64 years) people, as well as between young people and old (77 years) people. In contrast, there was no difference between middle-aged and older subjects[6]. The clinical relevance of this result is presented by Oh-Park et al. (2011) who stated that people who are slower in SC show a higher number of medical diseases, depressive symptoms and disability scores and lower gait velocity (in women those with fear of falling)[7].

Conclusion

The SCT on the Stair A is reliable, especially during SC with self-chosen speed. Reliable results can be achieved with two familiarisation trials followed by two measurement trials. The Stair A has only a small association with parts of the IPAQ survey, but not with maximal values of two-legged jumping manoeuvres. Elderly (≥ 60 years) need significantly more time to SC than younger subjects.

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