Predictors of Timed “Up-and-Go” Test in Elderly with Knee Osteoarthritis

Priscila Marconcin, Margarida Espanha, Flávia Yázigi and Júlia Teles
Universidade de Lisboa, Faculdade de Motricidade Humana, CIPER, LBMF, 1499-002, Lisboa, Portugal

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Abstract: Knee Osteoarthritis (KOA) and aging are conditions that can compromise physical function and quality of life of human being. Thus, performance-based tests and specific self-reported measures related with KOA and general health-related quality of life (QoL) should be used in clinical intervention with elderlies. The study aim was to investigate which factors best predict the performance of the Timed “up-and-go” test in the elderly people with KOA. Eligibility criteria were age $\geq$ 60 years and uni or bilateral KOA. Subject performed physical tests [Timed “up-and-go” (TUG), Six Minutes Waking Test (6MWT), Five Repetition Sit-to-Stand Test (FRSTST)], Handgrip, 6 meters gait speed, Standing Balance], and filled self-reported questionnaires [Knee Injury and Osteoarthritis Outcome Score (KOOS), health-related quality of life (EQ-5D-5F) and International Physical Activity Questionnaire (IPAQ)]. Pearson and Spearman coefficients were used for correlation analysis and multiple linear regression analysis to identify the significant predictors of Timed “up-and-go”. Results: Final sample included 67 patients, 69±6 years of age. Timed “up-and-go” can be explained by two models. The best model (explained 80.7% of variance) included FRSTST, 6MWT, Gait Speed, KOOS ADL and EQ-5D-5F Self-Care variables. Conclusion: Functional strength, mobility, gait speed, and perceived limitation in activities of daily living influenced the TUG performance.

1 INTRODUCTION

Knee Osteoarthritis (KOA) is a joint disease that most often affects middle-age to elderly individuals, leading the cause of lower extremity disability and loss of functionality in this population (Johnson and Hunter, 2014).

The burden of KOA can be measured in terms of its signs and symptoms. Pain is the main symptom that incapacitates the individual to perform daily activities (Tanimura et al., 2011), which directly affects physical function. Several studies have shown the relationship between symptomatic KOA with physical disabilities (Davis et al., 1991; Machado et al., 2008; Wood et al., 2008). Furthermore, a 3-years cohort study with hip and KOA patients (van Dijk et al., 2010) refereed pain, reduced range of motion (ROM) and decreased muscle strength as good predictors of self-reported limitation in daily activities.

Controversially, a study with 2545 subjects with radiographic KOA shows no effects of physical activity (Physical Activity Scale for the Elderly) on knee pain (WOMAC) and a very small effect or no effect on functional performance (20-meters walk test) (Mansournia et al., 2012).

Results among studies may differ due to the use of different physical function outcome measures in people with KOA, which can be measured by self-report methods or performance-based tests, and a combination of both is recommended to provide additional information (Stratford and Kennedy, 2006).

Therefore, the Osteoarthritis Research International Society (OARSI), through an expert advisory group, recommended a set of five physical performance measures for hip and KOA: 30-s chair-stand test, 40 m fast paced walk test, a stair-climb test, 6MWT and Timed “up-and-go”, which was the most feasible of the performance-based tests (Dobson et al., 2013).

Elderly people with KOA have muscle weakness, which is attributed both to skeletal muscle wastage and sarcopenia (Wilhelm et al., 2014), and also to neural inhibition caused by pain which prevents the complete muscle activation, compromising physical function. An European study about sarcopenia suggested a set of measurements

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which can be used as an indicative of sarcopenia: the Short Physical Performance Battery (SPPB), that evaluates balance (side-by-side stand, tandem and semi-tandem position), gait speed (8 ft walk), lower strength (time to rise from a chair and return to the seated position five times) (Cruz-Jentoft et al., 2010). This battery is highly predictive of subsequent mobility-related disability, institutionalization, and mortality (Guralnik et al., 1994). Moreover, sarcopenia is strongly correlated to risk of fall, and Timed "up-and-go" test seems to be a sensitive and a specific measure for identifying community-dwelling adults who are at risk of falls (Shumway-Cook et al., 2000), and a good predictor of sarcopenia in hospitalized patients (Martinez et al., 2015).

The physical mobility is an essential component of the geriatric assessment of the frail elderly individual (Podsiadlo and Richardson, 1991), where the Timed "up-and-go" test is widely used for daily mobility skills assessment in this population (Podsiadlo and Richardson, 1991).

Thus, the aim of this study was to investigate which factors best predict the performance of elderly individuals with symptomatic KOA in the Timed "up-and-go" test.

2 METHODS

2.1 Sample

The recruitment and sample selection were done in the Lisbon area and, to avoid convenience sampling, different strategies for announcement by communication channels were use: social networks, newspapers, magazines, contacts with senior universities, health centers, churches and community centers.

Community-dwelling elderly with persistent knee pain, age over than or equal to 60 years, with KOA diagnosed according clinical and radiological criteria of the American College of Rheumatology (ACR) (Altman et al., 1986), independently mobile and literate were selected to participate in the study. The exclusion criteria were: (1) having undergone surgery for knee replacement; or go to perform surgery to place knee(s) prosthesis in the next eight months; (2) have made applications (injections) of corticosteroids or hyaluronic acid in the last 6 months. The eligible subjects, according to the aforesaid eligibility criteria, were invited to an interview for explanation of the study and gave their written informed consent.

2.2 Measures and Instruments

The measures and instruments used were: (1) socio demographic questionnaire (sex, age, educational level, body index mass (BMI) and marital status); (2) performance-based tests (physical mobility, aerobic capacity, lower limb strength, hand grip strength, gait speed and balance); (3) specific self-reported measures related with KOA (pain, other symptoms, daily living activities, sports and recreations activities and quality of life), general health-related quality of life (QoL) (mobility, self-care, usual activities, pain/discomfort and anxiety/depression) and (4) level of physical activity.

Physical mobility was assessed by Timed "up-and-go", a test that incorporates multiple activities including sit-to-stand, walking short distance, changing direction during walking, and transitions between them, allowing evaluation of strength, agility and dynamic balance (Podsiadlo and Richardson, 1991).

Aerobic capacity and mobility was measured by the Six Minutes' Walk Test (6MWT), that was a valid measure for older adults (Rikli, 1998), and it has been used in studies with KOA (Escalante et al., 2011; Schlenk et al., 2011).

Lower limb strength was measured by the Five Repetitions Sit to Stand Test (FRSTST) that is a widely used measure of functional strength. ICC values demonstrated from good to high test-retest reliability for adults and subjects with osteoarthritis (Bohannon, 1995; 2011; Schlenk et al., 2011).

For hand grip strength a dynamometer was used to evaluate maximal isometric force of the hand and forearm muscles. This test has been used in elderly as an indicator of sarcopenia and/or disability (Alley et al., 2014; Giampaoli et al., 1999).

Gait speed was assessed with a 6 meters test, measuring the ability of linear walking since acceleration and deceleration were excluded (Cesari et al., 2009). This variable is also a primary outcome of algorithm for sarcopenia in older individuals (Cruz-Jentoft et al., 2010).

Balance was assessed by Standing Balance Test (Rose, 2003), and both most painful and least painful leg were assessed. For analysis, only the most painful one was used.

Pain and other symptoms, function in daily living (ADL), sports and recreations activities and quality of life, related with the pathology, were evaluated by the Knee Injury and Osteoarthritis Outcome Score (KOOS). This questionnaire includes five dimensions, a score in each of the five dimensions is calculated as the sum of the items included and then converted to a 0-100 scale, with 0 representing extreme knee problems and 100 representing no knee problems. The KOOS is validated for patients with knee injury or with knee OA and is a reliable and responsive self-administered instrument for short-term follow-up (Roos and Lohmander, 2003). The Portuguese validation was done by Gonçalves et al., (2009).

The EQ-5D-5L is a generic instrument for measuring health-related quality of life in five dimensions: mobility, self-care, usual activities, pain/discomfort and anxiety/depression. Each of these dimensions has five levels of severity (no, light, moderate and severe problems, and unable). This instrument has similar psychometric techniques as the EQ-5D (Pickard et al., 2007) and is validated to the Portuguese population (Ferreira et al., 2013).

Level of physical activity was measured by short form of the International Physical Activity Questionnaire (IPAQ). Its reliability was verified in many countries and with different populations (Craig et al., 2003; Rutten and Abu-Omar, 2004).

2.3 Statistical Analysis

Prior to performing multiple linear regression analysis to identify the significant predictors of TUG, correlation analyses and independent samples *t*-test were conducted to gain a better understanding of how predictors are associated with TUG.

Pearson correlation coefficient (r) was used to evaluate the correlation between continuous variables, and Spearman correlation coefficient (r_S) was used in the case of ordinal variables. Some rough guidelines were employed for designating the strength of correlation: if $|r| \geq 0.7$, the correlation is considered strong; if $0.3 \leq |r| < 0.7$, is classified as moderate; and if $|r| < 0.3$, the correlation is weak. These guidelines were also used to classify Spearman correlation coefficients (Sheskin, 2007).

Independent samples *t*-test was used to test if there were significant differences in the mean values of TUG between males and females. The candidate predictors that were considered for the linear regression model were the following: (i) age, sex, BMI a risk or related factors; (ii) pain, others symptoms; (iii) health related physical fitness measures (aerobic capacity, lower limb strength, hand grip strength); (iv) skill related fitness measures (gait speed and balance); (v) general and specific self-reported health-related QoL measures, and (vi) physical activity. Multiple regression analysis, using the backward elimination stepwise method, was done to identify the significant predictors of TUG. Residual analysis was conducted to ensure no violation of the assumptions of normality, homoscedasticity, linearity; Variance Inflation Factor (VIF) and Durbin-Watson statistics was used to verify if multicollinearity is present and if errors were independent, respectively. All statistical analyses were performed with the software SPSS v.22 and a significance level of 5% was considered.

3 RESULTS

Study sample included 67 participants, 47 female and 20 male, with mean (SD) age of 69.1 (5.8) years, Body Mass Index (BMI) of 31.2 (5.2) Kg/m^2, with 38.8% having obesity grade 1 and 94.0% having bilateral KOA. The participants were mostly retired (91.0%) and married (59.7%).

Independent samples *t*-test revealed that there were significant differences in the mean values of TUG between males and females (males: $M = 6.19$, $SD = 1.29$; females: $M = 7.19$, $SD = 1.84$; $t(65) = 2.193$, $p = .032$). Among the other socio-demographic variables, Timed "up-and-go" was positively correlated with age ($r = .285$, $p = .020$; weak correlation), education level ($r_S = -.331$, $p = .006$; moderate association), and BMI ($r = .379$, $p = .002$; moderate correlation). Relatively to performance-based tests, Timed "up-and-go" was strongly negatively correlated with 6MWT test ($r = -.709$, $p < .001$) and gait speed ($r = -.734$, $p < .001$); FRSTST showed a moderate positive correlation with Timed "up-and-go" ($r = .635$, $p < .001$); Balance showed a moderate negative correlation with Timed "up-and-go" ($r_S = -.347$, $p = .004$). Concerning KOOS dimensions, all of them showed moderate negative correlations with Timed "up-and-go" (Pain: $r = -.504$, $p < .001$; Symptom: $r = -.451$, $p < .001$; ADL: $r = -.663$, $p < .001$; Sport/Rec: $r = -.562$, $p < .001$; QoL: $r = -.521$, $p < .001$). Among EQ-5D-5L dimensions, Timed "up-and-go" had moderate positive correlations with Mobility ($r_S = .481$, $p < .001$), Self-care ($r_S = .566$, $p < .001$), Usual activities ($r_S = .651$, $p < .001$), and Pain/Discomfort ($r_S = .311$, $p = .010$). Timed "up-and-go" showed no significant correlations with the level of physical activity (IPAQ).

Multiple regression analysis, using the backward elimination stepwise method, allowed identifying two models to predict Timed "up-and-go". The variables FRSTST, 6MWT, Gait Speed, and KOOS ADL were included in both models. The Model 1 contained also the variable EQ-5D-5F Self Care and the Model 2, EQ-5D-5F Usual Activities instead of EQ-5D-5F Self Care. The results indicated that in Model 1 the five predictors explained 80.7% of the variance of Timed “up-and-go” ($R^2 = .807$, $adj.\ R^2 = .787$, $F(6,60) = 41.719$, $p < .001$) and 78.7% of the variance ($R^2 = .787$, $adj.\ R^2 = .766$, $F(6,60) = 37.057$, $p < .001$) in case of Model 2. The regression coefficients and standard error estimates for both models are presented in Table 1.

Table 1: Predictor´s variables of TIMED “UP-AND-GO”.

Predictors - Model 1	*B (SE)*	*t*	*p*
Intercept	11.400 (0.921)	12.376	<.001
FRSTST (s)	0.145 (0.037)	3.940	<.001
6MWT	–0.006 (0.002)	–3.443	.001
Gait Speed	–1.027 (0.359)	–2.862	.006
KOOS ADL	–0.016 (0.006)	–2.487	.016
EQ-5D-5F Self Care(1)[a]	–0.930 (0.330)	–2.816	.007
EQ-5D-5F Self Care(2)[a]	–1.181 (0.314)	–3.755	<.001
Predictors - Model 2	***B (SE)***	***t***	***p***
Intercept	10.767 (0.958)	11.241	<.001
FRSTST (s)	0.151 (0.038)	4.003	<.001
6MWT	–0.005 (0.002)	–2.826	.006
Gait Speed	–1.119 (0.373)	–3.001	.004
KOOS ADL	–0.017 (0.007)	–2.448	.017
EQ-5D-5F Usual Act(1)[a]	–0.795 (0.323)	–2.462	.007
EQ-5D-5F Usual Act (2)[a]	–0.706 (0.290)	–2.437	.018

Abbreviations: 6MWT= six Minutes Walking Test; FRSTST= Five Repetitions Sit to Stand Test; EQ-5D-5L= EuroQol 5-dimensions 5- level; KOOS ADL=Knee injury and Osteoarthritis Outcomes, Score Function in daily living (ADL)
[a] The reference level for the predictors EQ-5D-5L Usual Act and EQ-5D-5L Self Care was “At least moderate problems”, and (1) represents “No problem” and (2) represents “Slight problems”.

4 DISCUSSION

Osteoarthritis is a highly disabling disease, and pain and physical function are the core domains recommended to be measured in people diagnosed with KOA. Outcome measures, both self-reported questionnaires and performance-based tests, should be used for these assessments (Sabirli et al., 2013). Performance measure and self-reported measure are complementary, since they not measure the same construct: self-report tests can show disability which is the social side of the functional limitation (Hoeymans et al., 1996), therefore, they cannot substitute each other. Moreover, as this study involved older adults that may underestimate or overestimate their functional status, the use of these two types of measures is advocate.

The Timed “up-and-go” test is one of the most widely used tests of functional mobility, being similar to many daily activities. In this study, involving elderly individuals with KOA, we found that Timed “up-and-go” was significantly associated with pain and other OA symptoms, physical function, and subjective general and specific health-related quality of life factors. The strongest predictors of this test were: FRSTST, 6MWT, Gait Speed, KOOS ADL and EQ-5D-5F self-care and usual activities dimensions.

It is understandable that FRSTST and gait speed were predictors, as they are parts of the Timed “up-and-go” test (Reid and Fielding, 2012). Although 6MWT is not incorporated in the Timed “up-and-go” test, it reflects overall physical functional performance and mobility, (Rikli, 1998), being strongly associated with others functional tests like Timed “up-and-go”.

Considering the self-reported measures, only the EQ-5D-5F (self-care and usual activity dimension), and KOOS ADL were included in the regression models. Both questionnaires assess similar domains, but in different ways, as EQ-5D-5F includes 5 levels of severity, that only one should be reported, in each of the dimensions, and in the KOOS ADL subscale a final score is obtained from seventeen daily activities performed in the previous week, assessing therefore a wider range of activities.

It has previously been found in others studies that health status (self-reported) is a predictor of functional tests, namely the FRSTST (Lord et al., 2002) and 6MWT (Lord and Menz, 2002).

In a related study, involving subjects with knee and hip osteoarthritis, all dimensions/subscales of KOOS and WOMAC had a moderate and inverse relationship with Timed “up-and-go” (Juhakoski et al., 2008; Sabirli et al., 2013), as occurred in this study. However, it is important to highlight that all KOOS’s subscales were correlated with each other, therefore in the final multiple regression models only ADL dimension was included.

In a study with 163 KOA patients, self-reported measure of function (SF-36) was more influenced by pain (WOMAC pain) than a performance-based physical functioning test (Terwee et al., 2006), and in a similar study, pain severity, obesity and helplessness were the most important determinants of physical function (Creamer et al., 2000). Interestingly, in the present study Time “up-and-go” performance was not influenced by self-reported pain and other symptoms. One possible explanation is because the test involves a quick activity [mean (SD), 6.9s (0.2)] and therefore stimulus duration was not sufficient to cause mechanical pain. It seems that only when knee pain is severe, is significantly associated with limited mobility (Lamb et al., 2000).

Pain and other OA symptoms probably has influenced the Timed “up-and-go” that leads the individual to exert less physical work and thereby decreasing lower limb strength and power, indirectly affecting Timed “up-and-go” performance.

It is challenging to select the best physical function tests, especially in people with KOA that might complain of mechanical pain if exposed to overloading due to performance of several tests. Thus, for this population, the Timed “up-and-go” test may be most suitable than 6 meters test and FRSTST.

5 CONCLUSIONS

In conclusion, the findings of this study indicate that in older individuals with KOA, Timed “up-and-go” performance is influenced by lower limb strength, gait speed, mobility, and the perceived limitation in performing activities of daily living.

Pain and other OA symptoms seem not to be as relevant to the functionality, as strength and gait speed, since they are associated with daily living activities that seem to influence the functionality.

In a further study will be interesting to investigate which physical fitness component the Timed “up-and-go” test can predict.

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