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RESEARCH ARTICLE

RELATIONSHIP OF THE STANDING, STOOPING AND CROUCHING PERFORMANCES WITH THE LOWER BODY AND LOWER EXTREMITY FLEXIBILITY AND STRENGTH

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ABSTRACT

Introduction: The aim of this study was to evaluate the relationship of the standing, stooping and crouching performances with the lower body and lower extremity flexibility and strength.
Material and Methods: Over the age of 18 years, 97 volunteer sedentary young adults were included in this cross-sectional study. Valpar 9 Whole Body Range of Motion test was used to evaluate standing, stooping and crouching performances. In addition, modified sit-and-reach and isometric back-leg strength tests were applied to the participants. Pearson correlation analysis was used to analyze the relationship between standing, stooping and crouching performances, and flexibility and muscular strength.
Results: The mean age of the participants was 23.5±1.4 (20-31) years. The body mass index of the participants was 22.3±3.2 (16.6-31.8) kg/m2. In this study, no relationship was found between standing, stooping and crouching performances, and flexibility of hamstring-lumbar extensor muscles and isometric back-leg muscle strength in sedentary young adults (p>0.05).
Conclusion: Standing, stooping and crouching performances have a low level of necessity for lower body and lower extremity flexibility and isometric muscle strength. In further studies, it would be appropriate to examine these activities for other parameters of physical fitness such as muscular endurance.

Key Words: Physical fitness, pliability, task performance, young adult

INTRODUCTION

Standing, stooping and crouching are considered important physical demands of the work, which are among the 20 physical work demands defined in the Dictionary of Occupational Titles (1,2). Agricultural workers, underground miners, aircraft baggage handlers, plumbers, mechanics and many other workers adopt these postures (3-7). These postures are also used in daily activities such as gardening, shopping and cleaning, as well as in activities such as reaching to low shelves and picking things up from the floor (8,9).

Standing describes an upright position without moving (2). Maintaining this position requires sustained muscle activity in various muscles of the body known as the antigravity muscles (10). Stooping consists of bending the torso forward and down with the legs in a relatively straight position. Crouching is an activity performed with the flexion of the hip, knee, and ankle while the trunk is in a vertical position. During stooping, the lower back and posterior leg muscles are stretched. Crouching involves similar length changes, particularly in the quadriceps and ankle plantar flexor muscles, because of significant flexion in the knee and ankle joints. Unlike standing, as the hip and knee joints are fully flexed during crouching, activation of the quadriceps and calf muscles is potentially required to support lower extremities and weight transfer between limbs (11).

During the interpretation of the work or daily activities, consideration of the flexibility defined as the maximum range of motion, and the muscular strength associated with the amount of external force a muscle can exert (12,13), may provide a different perspective to the healthcare professionals. Analyzes of activities in the context of physical fitness will provide an understanding of the physical requirements for performing functional task performances without difficulty. Since activities that include standing, stooping and crouching performances which are frequently used in daily routine require significant strength and flexibility (9), knowing the relationship of these performances with the direct measurement methods may help to make a more accurate decision during the health care assessments and guiding individuals who have difficulties in these activities to the appropriate rehabilitation program. Starting from this point of view, in this study, we aimed to evaluate the relationship of the standing, stooping and crouching performances with the flexibility and muscular strength tests with in sedentary young adults.

MATERIAL AND METHODS

Study design

This cross-sectional study was carried out at Pamukkale University School of Physical Therapy and Rehabilitation. The study protocol was approved by Pamukkale University Medical Ethics Committee (Date: 11.12.2018, Number: 60116787-020/85229). Written informed consent was obtained from all participants before the study. The study was conducted in accordance with the principles in the Declaration of Helsinki. This study protocol was registered in Clinical Trials.gov PRS.

Participants

Ninety-seven sedentary young adults aged between 18 and 31 (23.5±1.4) years old studying at university were included in this cross-sectional study by convenience sampling. Announcement about the study was made via e-mail and social media. Individuals who volunteered to participate in the study and met the inclusion criteria were enrolled. Inclusion criteria were age between 18 and 35 years, the absence of any orthopedic, neurological, rheumatologic, or metabolic diseases that cause musculoskeletal involvement, and the absence of a history of surgery on the related extremities. Individuals who had acquired the skills to practice these tests before the study and who had regular physical activity or sports participation (exercising at least 150 minutes per week) were excluded from the study (14).

Assessment

After questioning the age, gender, weight, height and exercise habits of the participants, Valpar 9 Whole Body Range of Motion (WBROM), modified sit-and-reach (MSR) and isometric back-leg strength (IBLS) tests were completed with the participants who met the eligibility criteria. After detailed explanation, the tests were applied to the participants under the supervision of the same physiotherapist, on the same day and the same room temperatures in a bright and well-ventilated room. Firstly WBROM, then IBLS and MSR tests were performed. After each test, participants were given a rest period of 10 minutes in a sitting position. All assessments took approximately 45 minutes for each participant.

To evaluate standing, stooping, and crouching performances, WBROM test was used. This test provides information on range of motion, agility, and endurance. In this test, which took approximately 30 minutes, the participant was positioned in front of the test panel with the upper frame 6 inches above the head. The participant unscrewed the 22 nuts to release and transfer three different shapes in the standing position in the first transfer, in the standing and stooping positions in the second, in the stooping and crouching positions in the third and in the crouching and standing positions in the last transfer and retightened the nuts to fix the shapes. This test assesses participants' ability to stand, stoop and crouch while performing a manual task. The completion time of each transfer and total time were recorded as seconds (15-17).

MSR test was performed using Baseline™ modified sit and reach box with adjustable measuring bar. It has been reported in the literature that the standard SR test does not take into account differences in limb lengths or proportional differences between legs and arms, which is an important limitation of the test. MSR test that eliminates the possibility of error by creating a relative zero point for each case has been developed due to potential errors that may arise from differences in limb-length ratio between individuals (18). At the beginning of this test, while the head, back and hips were against the wall and the soles of the feet were against the block, hands were placed on top of each other, and the arms were extended to the front. In this position, only scapular abduction was performed while the head and back were in contact with the wall. The point where the fingertip touches the sliding measuring apparatus was determined as the individual relative zero point. After the determination of the initial position, the SR test was performed as standard. The participant was asked to reach out slowly with hands on top of each other and to advance the movable part of the test device with fingertips. The mean value of three trials was recorded in centimeters (cm).

Isometric back and leg muscle strengths were assessed using a Baseline dynamometer. The dynamometer was connected via a hook to a platform with an adjustable chain. For isometric leg muscle strength assessment, participants were asked to spread their feet at shoulder width on the dynamometer platform and hold the dynamometer bars in forearm pronation position with both hands. After the participant was positioned with the knees slightly flexed, the head and back straight and the projection of the hip joint passing through the ankle, isometric leg strength was evaluated by asking the participant to extend the knees with maximum force vertically. A similar procedure was used for back muscle strength assessment. For this test, the participants were positioned with knees extended, trunk slightly flexed, arms straight and palms facing themselves. In this position, isometric back strength was evaluated by asking the participant to do back extension with maximum force. Leg and back muscle strength measurements were performed three times with one minute pause after each measurement and the mean value in kilograms (kg) was recorded (19).

Due to the lack of data on the use of the WBROM test in the literature, an a priori power analysis could not be performed to determine the sample size. The data obtained from the participants were recorded in SPSS 18.0 statistical analysis program. Mean and standard deviation were calculated for descriptive data determined by measurement, and number and percentage (%) values were presented for descriptive data determined by counting. The suitability of the data for the normal distribution was analyzed with the Kolmogorov-Smirnov test. Since parametric conditions were met, Pearson Correlation Analysis was used to analyze the relationship of the standing, stooping and crouching performance with the flexibility and muscular strength. Significance level was accepted as $p < 0.05$.

RESULTS

A total of 97 participants (52 female, 45 male) with a mean age of 23.5±1.4 years participated in the study. The body mass index of the participants was 22.3±3.2 (16.6-31.8) kg/m2 (Table 1). Results of the MSR, IBLS and WBROM tests are shown in Table 2. In the WBROM test, it was seen that the third transfer performed in the stooping and crouching position was completed in the longest time compared to the others. The relationship between WBROM, MSR, IBLS tests is shown in Table 3. Flexibility and isometric back-leg

Table 1. Demographic Characteristics of the Participants

	mean±sd	min.-max.	median
Age (year)	23.5±1.4	20-31	23.0
Weight (kg)	67.0±14.0	45-107	67.0
Length (cm)	170.8±9.1	155-193	170.8
BMI (kg/m^2)	22.3±3.2	16.6-31.8	22.3
	n (%)		
Gender			
Female	52 (53.6)		
Male	45 (46.4)		

kg: kilogram, cm: centimeter, m: meter, UE: upper extremity, sd: standart deviation, min: minimum, max: maximum, BMI: Body mass index

Table 2. Tests Results of the Participants

	mean±sd	min.-max.	median
MSR test (cm)	30.9±9.8	8.8-64.2	31.9
IBLS test (kg)			
Back strength	71.0±35.3	19.3-147.3	61.3
Leg strength	93.3±43.4	21.3-195.7	85.0
WBROM test			
Transfer 1 (seconds)	447.4±63.0	305-691	436.0
Transfer 2 (seconds)	398.2±62.7	270-674	91.0
Transfer 3 (seconds)	462.1±68.5	305-657	462.0
Transfer 4 (seconds)	402.9±64.9	259-691	392.0
Total transfer time (seconds)	1703.9±236.1	1177-2594	1666.0

cm: centimeter, kg: kilogram, sd: standart deviation, min: minimum, max: maximum, MSR: Modified Sit and Reach, IBLS: Isometric Back and Leg Strength, WBROM: Whole Body Range of Motion

Table 3. The Relationship Between WBROM Test and, Flexibility and Back-Leg Isometric Muscle Strength

WBROM test (seconds)	Parameters	r	p*
Transfer 1 (standing position)	Modified sit and reach flexibility (cm)	-0.096	0.348
	Back isometric muscle strength (kg)	-0.066	0.518
	Leg isometric muscle strength (kg)	0.023	0.823
Transfer 2 (standing-stooping positions)	Modified sit and reach flexibility (cm)	-0.004	0.972
	Back isometric muscle strength (kg)	-0.014	0.893
	Leg isometric muscle strength (kg)	0.011	0.918
Transfer 3 (stooping-crouching positions)	Modified sit and reach flexibility (cm)	-0.002	0.981
	Back isometric muscle strength (kg)	0.021	0.841
	Leg isometric muscle strength (kg)	-0.002	0.984
Transfer 4 (crouching-standing positions)	Modified sit and reach flexibility (cm)	-0.122	0.232
	Back isometric muscle strength (kg)	-0.163	0.110
	Leg isometric muscle strength (kg)	-0.104	0.308
Total time	Modified sit and reach flexibility (cm)	-0.091	0.373
	Back isometric muscle strength (kg)	-0.067	0.515
	Leg isometric muscle strength (kg)	-0.032	0.755

*Pearson correlation analysis, cm: centimeter, kg: kilogram, WBROM: Whole Body Range of Motion

strength was not associated with 4 transfers and total test time in the WBROM test.

DISCUSSION

If we consider the physical requirements of the standing, stooping and crouching activities, we can say that these are the lower body and lower limb flexibility and, back and leg strength. The WBROM test required a certain amount of time in standing, stooping, and crouching positions, as well as allowing transitions between these postures. However, we found that the performances including standing, stooping and crouching positions in this test, which we have chosen considering that it may simulate daily activities well, since it allows to stay fixed in a certain position and position transitions, were not related to the back-leg flexibility and strength.

Scapular abduction, spinal flexion and hip flexion have been shown to be the factors that affect forward reach in sit and reach test (20). When the physical requirements of stooping and crouching activities are examined, flexion and extension movements are performed in the trunk, hip and knee, and these movements require muscular flexibility. In a study, it was stated that the greatest factor that determines the flexibility range belongs to the hamstring muscle group (21). Considering the transfers in the WBROM test, it can be considered that the need for hamstring flexibility is relatively at the forefront in transfer 2 and 3, one of the components of which is the stooping activity, performed with the knees in extension and trunk in flexion. Therefore, we believe that the reason why WBROM test was not related to flexibility in our study is that the flexibility assessment in the MSR test was not specific to isolated hamstring muscle. This suggests that the WBROM test may be associated with a result of a test that evaluates hamstring flexibility in isolation. In addition we think that only static flexibility is not relevant for this test, since transfers include a dynamic component as well as a static posture.

According to the results obtained in this study, standing, stooping and crouching performances were not correlated with back and leg isometric muscle strength. We think that the result of the evaluation, which was made considering that these performances require strength, may be related to the method used. Although we assumed that the WBROM test requires a certain level of muscle strength, this requirement may be considerably lower than the maximum isometric force limits achieved by the dynamometer. In addition, the WBROM test, in which the upper extremity activity is performed in standing, stooping and crouching positions, can be said to necessitate muscular endurance rather than muscle strength. Therefore, this result revealed that the muscular endurance parameter was more prominent in these evaluations. However, since we did not assess muscular endurance, it is not possible to make a detailed comment on this parameter. In addition, the fact that the flexibility and strength values of the participants in our study were similar to the results of previous studies on sedentary individuals suggests that the strength and flexibility levels of the participants were at an acceptable level (22, 23). This supports the idea that physical fitness parameters other than strength and flexibility should be taken into account.

The strengths of our study were that it was performed in a homogeneous study group and that the test used simulates activities in daily life well. One of the limitations of the study was that other parameters of physical fitness, such as endurance, were not evaluated. In addition, the lack of an a priori power analysis restricted our ability to interpret the results.

CONCLUSION

In conclusion, in this study, no relationship was found between the standing, stooping and crouching performances, and flexibility of hamstring-lumbar extensor muscles and isometric back-leg muscle strength in sedentary young adults. This result suggests that the transfer activities in this test have a low level of necessity for physical fitness parameters such as isometric muscle strength and flexibility. We believe that in further studies, examination of different positions or activities in different age and occupational groups with regard to parameters related to physical fitness will provide clearer information on the requirements of frequent work and daily living activities.

Author contributions: UE: Conception and design, data collection, literature review, writing, critical review. AK: Conception and design, data analysis, critical review. SCI: data analysis, literature review, writing.

Conflict of interests: The authors declare no conflict of interest.

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