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Research

What are the Endurance Times of the Trunk Muscle Endurance Tests on the Roman Chair: A Preliminary Normative Study

Petrič Maja^{1,*}

- 1. Faculty of Health Sciences, Department of Physiotherapy, University of Ljubljana, Ljubljana, Slovenia
- * Correspondence: Maja Petrič; maja.petric@zf.uni-lj.si

Abstract:

Sufficient trunk muscle endurance and an appropriate ratio between endurances of the major trunk muscle groups are important factors in the prevention of low back pain. Trunk muscle endurance tests on the 45° Roman chair can be used as an alternative to the standard tests, but there is a need to collect normative data for these tests.

The aim of this preliminary normative study was to assess the endurance times of the trunk muscles and the ratio between endurances of these trunk muscles during endurance tests on the Roman chair.

One hundred and six healthy participants aged 16-76 years (mean age: 36.9±11.7 years) without recent injuries or musculoskeletal disorders participated in our study. Trunk muscle endurance was tested on the Roman chair in four test positions: an endurance test for the trunk extensors, the trunk flexors and the lateral trunk muscles on the right and left side. For each test, the endurance time was recorded in seconds and the four trunk muscle endurance ratios were calculated for each participant.

The mean endurance time in the trunk extensors endurance test was significantly (p = 0.03) longer in women than in men. In addition, the ratios between the lateral trunk muscles and the extensors also differed significantly between women and men (p < 0.05).

The preliminary results on the normative endurance times for the trunk muscles in the Roman chair tests indicate some differences in muscle endurance between the genders. A larger sample of participants is required to determine normative values.

Keywords: Endurance tests; Roman chair; Physical performance; Spine stabilisation; Core muscles

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1. Introduction

Back and abdominal muscle endurance is one of the key elements of physical performance that can affect spinal health by providing good/poor stability of the lower back and thus preventing injury (Panjabi, 1992; Kisner & Thorp, 2018). Therefore, sufficient trunk muscle endurance and an appropriate ratio between endurances of the major trunk muscle groups, i.e. the trunk extensors, trunk flexors and lateral trunk muscles, are important factors in the prevention of low back pain (Panjabi, 1992; McGill et al., 1999; McGill, 2016).

As McGill (2016) has already emphasised, optimal tests that isolate the trunk extensors, flexors and lateral trunk muscles are difficult to find. The endurance tests proposed by this author are 1) the extensor endurance test - a modification of the Biering-Sorensen test (Biering-Sørensen, 1984), 2) the flexor endurance test - sitting posture with a 60° angle to the floor and 3) the side bridge test (McGill, 2016). However, many authors emphasised that the endurance of other muscles (e.g. hip and shoulder muscles, etc.) (Pagé et al., 2011; Juan-Recio et al., 2022), shoulder pain or weakness (Ledoux et al., 2012; Pagé & Descarreaux, 2012) and the different type of kinetic chain (Tuff et al., 2020) may contribute to the performance of the above test positions.

The trunk muscle endurance tests on the 45° Roman chair showed some comparable characteristics and some potentially more feasible characteristics than the standard tests, i.e. the McGill tests (Petrič et al., 2022). Considering the characteristics and usefulness found in our previous study (Petrič et al., 2022), the Roman chair endurance tests can be used as an alternative to the standard tests mentioned above: All four trunk muscle groups are tested in a unified body position, a unified inclination angle and in an open kinetic chain. They have been shown to be easier and quicker for the evaluator to perform (no additional preparation or stabilisation is required, etc.), and in terms of perceived exertion by the participants, these tests are slightly easier to perform compared to the McGill tests (Petrič et al., 2022).

As the test positions of the Roman chair tests have only been used in a few studies so far (Ledoux et al., 2012; Pagé & Descarreaux, 2012; Petrič et al., 2024), there is a need to develop a normative database for these tests. The aim of this preliminary normative study was to assess the endurance times and the ratio between endurances of the major trunk muscle groups during the Roman chair tests.

2. Material and Methods

The study was designed as a preliminary normative study with a simple measurement of endurance times in four trunk muscle endurance tests on the Roman chair. The measurements were performed at the Faculty of Health Sciences of the University of Ljubljana (Slovenia). This study was approved by the National Medical Ethics Committee of the Republic of Slovenia (0120-220/2019/6).

2.1. Study sample

One hundred and six participants aged 16 to 76 years without current musculoskeletal injuries or diseases participated in our study. They were invited via electronic media and chain referral sampling in various research projects (PhD research, HUD 2024 project of the Faculty of Health Sciences, University of Ljubljana etc.). The inclusion criteria were a) healthy participants without musculoskeletal injuries or other conditions, that could be a contraindication for the muscle endurance test, b) and without low back pain at the time of enrolment in the study. All participants were volunteers and provided written informed consent prior to participation in this study.

2.2. Study instruments and procedures

All participants completed questionnaires regarding their demographic data and health status (Jakovljević et al., 2017).

The endurance time (in seconds) of the four major trunk muscle groups was measured: trunk extensors (EX), trunk flexors (FL), right lateral trunk muscles (R-LM) and left lateral trunk muscles (L-LM). All four tests were performed on the 45° Roman chair, with the test positions, test procedures and calculation of trunk muscle endurance ratios following the protocols previously described in Petrič et al. (2022) (referred to as "B tests" in this article).







2.3. *Study statistics*

The statistical analysis consisted of calculating mean endurance times (in seconds) and ratio between endurances of the major trunk muscle groups with standard deviations. The endurance times in each trunk muscle group were compared between women and men (t-test for unrelated samples or Mann-Whitney U-Test for unrelated samples). Statistical significance was set at $p \le 0.05$ for all analyses. Data analysis was performed using an Excel programme (Microsoft Corporation, Washington, United States) and IBM SPSS Statistics 29 (IBM, New York, United States).

3. Results

One hundred and six participants aged 16-76 years (mean age: 36.9 ± 11.7 years) took part in a study. In terms of gender, participants differed significantly in mean body height and mass (p < 0.001; **Table 1**).

	n	Age (years)	Body height (m)	Body mass (kg)	BMI (kg/m²)
Women	86	37.1 ± 12.5	1.67 ± 0.05	64.1 ± 10.3	23.0 ± 3.7
Men	20	36.3 ± 7.1	1.80 ± 0.06	78.8 ± 11.1	24.3 ± 2.7
р		0.79	< 0.001*	< 0.001*	0.10
All	106	36.9 ± 11.7	1.69 ± 0.07	66.9 ± 12.0	23.3 ± 3.6

Table 1. Demographic data of participants by gender (mean ± standard deviation).

n, number of participants; BMI, body mass index; p, Asymptotic sig. (2-sided test); *, statistically significant differences

The mean endurance time in the EX endurance test was significantly (p = 0.03) longer in women than in men (**Table 2**). The ratios between each side LM and EX also differed significantly between women and men (p < 0.05) (**Table 2**).

Table 2. Preliminary results of endurance times (in seconds) and endurance ratios for women, men and all participants together (mean ± standard deviation).

	Endurance	times (s)			Endurance ratios				
	mean \pm SD				mean \pm SD				
Gender	EX	FL	L-LM	R-LM	FL:EX	R-LM:	L-LM:	R-LM:	
						L-LM	EX	EX	
Women	$362.7 \pm$	$193.6 \pm$	$145.5 \pm$	$127.4 \pm$	0.(2 + 0.50)	0.91 ± 0.26	0.47 ± 0.20	0.42 ± 0.19	
(n = 86)	247.9	181.9	71.0	60.3	0.63 ± 0.50				
Men	$248.4 \pm$	$202.9~\pm$	$140.9 \pm$	$131.3 \pm$	0.78 ± 0.44	0.94 ± 0.23	0.58 ± 0.15	0.53 ± 0.13	
(n = 20)	70.4	154.9	55.2	57.6	0.78 ± 0.44				
р	0.03*	0.76	0.99	0.62	0.06	0.61	0.02*	0.01*	
All	$341.1 \pm$	195.3 ±	$144.7 \pm$	$128.1\pm$	0.66 + 0.40	0.92 ± 0.25	0.49 ± 0.20	0.44 ± 0.19	
(n = 106)	229.5	176.4	68.1	59.6	0.66 ± 0.49				

SD, standard deviation; n, number of participants; EX, endurance of trunk extensors; FL, endurance of trunk flexors; L-LM, endurance of lateral trunk muscles (left side); R-LM, endurance of lateral trunk muscles (right side); p, Asymptotic sig. (2-sided test); *, statistically significant differences







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Mean endurance times and endurance ratios by age group are listed for women in **Table 3** and for men in **Table 4**.

Table 3. Preliminary results of endurance times (in seconds) and endurance ratios for women (n = 86) by age group (mean ± standard deviation).

WOMEN		Enduran	ce times (s)			Endurance ratios			
(n = 86)		mean \pm SD			mean \pm SD				
Age group	n	EX	FL	L-LM	R-LM	FL:EX	R-LM:	L-LM:	R-LM:
(years)							L-LM	EX	EX
16-25	1($466.9 \pm$	$172.3 \pm$	$148.5 \pm$	$117.8 \pm$	0.48 ± 0.33	0.83 ± 0.26	0.40 ± 0.19	0.32 ± 0.14
	16	325.4	105.1	50.9	41.1				
26-35	29	$357.2 \pm$	$209.4 \pm$	$135.1 \pm$	$125.3 \pm$	0.60 ± 0.44	0.95 ± 0.22	0.45 ± 0.18	0.42 ± 0.19
		260.0	254.5	65.2	54.2				
36-45	18	$285.1 \pm$	$201.7 \pm$	$120.6~\pm$	$110.7 \pm$	0.87 ± 0.69	0.94 ± 0.23	0.47 ± 0.21	0.44 ± 0.21
		112.0	110.6	41.5	43.0				
46-55	13	$436.9 \pm$	$193.1\pm$	$215.2 \pm$	$180.9~\pm$	0.55 ± 0.46	0.89 ± 0.29	0.57 ± 0.22	0.47 ± 0.19
		238.1	168.5	96.8	78.5				
> 56	10	$254.8 \pm$	$167.6 \pm$	125,4 ±	$108.9\pm$	0.65 ± 0.31	0.00 + 0.22	0.55 ± 0.20	0.46 ± 0.20
		116.5	120.1	53.9	60.2		0.88 ± 0.32		

n, number of participants; SD, standard deviation; EX, endurance of trunk extensors; FL, endurance of trunk flexors; L-LM, endurance of lateral trunk muscles (left side); R-LM, endurance of lateral trunk muscles (right side)

Table 4. Preliminary results of endurance times (in seconds) and endurance ratios for men (n = 20) by age group (mean \pm standard deviation).

MEN	MEN Endurance times (s)				Endurance ratios				
(n = 20)	= 20) mean (SD)			mean (SD)					
Age group	n	EX	FL	L-LM	R-LM	FL:EX	R-LM:	L-LM:	R-LM:
(years)							L-LM	EX	EX
16-25	1	$269.0 \pm$	$68.0 \pm$	$103.0 \pm$	$84.0 \pm$	0.25 + 0.0	0.82 ± 0.0	0.20 ± 0.0	0.21 + 0.0
		0.0	0.0	0.0	0.0	0.23 ± 0.0	0.62 ± 0.0	0.30 ± 0.0	0.31 ± 0.0
26-35	8	$243.4 \pm$	$194.6 \pm$	$135.8 \pm$	$130.3 \pm$	0.77 ± 0.41	0.06 ± 0.20	0.56 ± 0.12	0.52 ± 0.12
		63.5	137.4	44.1	56.0	0.77 ± 0.41	0.90 ± 0.20	0.30 ± 0.12	0.55 ± 0.12
36-45	9	$255.1 \pm$	$248.8 \pm$	$157.4 \pm$	$144.1 \pm$	0.91 ± 0.43	0.94 ± 0.26	0.63 ± 0.16	0.55 ± 0.10
		72.3	164.8	62.7	60.1				
46-55	2	$227.5 \pm$	$96.5 \pm$	$106.0 \pm$	$101.0 \pm$	0.50 ± 0.22	0.98 ± 0.18	0.51 ± 0.11	0.51 ± 0.20
		80.5	10.5	15.0	4.0				
> 56	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

n, number of participants; SD, standard deviation; EX, endurance of trunk extensors; FL, endurance of trunk flexors; L-LM, endurance of lateral trunk muscles (left side); R-LM, endurance of lateral trunk muscles (right side); N/A, results not yet available







4. Discussion

The results of a preliminary normative study on the endurance times of trunk muscle endurance tests on the Roman chair indicated that, with the exception of the EX endurance test, women and men have a comparable mean endurance time. Therefore, the endurance ratios of the trunk muscle groups also differed between men and women for LM and EX (the ratios L-LM:EX and R-LM:EX), but not for the other two ratios. The lower number of male participants must be taken into account.

There are only a few data sets that can be compared with the data from this study. Pagé & Descarreaux (2012) reported slightly shorter mean endurance times in the L-LM endurance test (96.7 (24.9) s) and R-LM endurance test (97.2 (21.5) s) in healthy participants (n = 22; mean age: 24.55 (5.00) years). Compared to the results of Ledoux et al. (2012), in which healthy older adults participated (n = 32; mean age: 67.25 (5.13) years), the participants in our study (> 56 years old women) achieved a longer mean endurance time in the EX endurance test (mean endurance time in their study: 221.61 (108.6) s) and a similar mean endurance time in the LM endurance test (mean endurance test could be found in the available literature.

The results of our study show some similar findings to the results of another preliminary normative study by McGill et al. (1999), in which they strive to assess endurance times in the tests proposed by McGill (McGill, 2016). Despite different body positions in both groups of endurance tests, we all found that women had longer endurance times than men in EX (p = 0.03), and that men were able to maintain LM tests for a longer period (p < 0.05) of their EX endurance times (i. e., LM:EX ratios) than women (e. g., for the LM test in the left side: 58% vs. 47% of their EX test). As reported in our previous study (Petrič et al., 2022), longer endurance times are generally observed for at least three out of four Roman chair tests compared to the McGill tests (McGill et al., 1999).

The study has some limitations. The first limitation of this preliminary normative study is the small and unevenly gender distributed sample of participants. In our study, there were more female than male participants. In addition, the sample of participants was unevenly distributed with respect to age, with most participants being between 20 and 45 years old. A larger and more homogeneous sample of participants with respect to gender and age is needed to continue this normative study.

This is the first study to collect normative data on Roman chair endurance testing.

5. Conclusions

The preliminary results on the normative endurance times for the trunk muscles in Roman chair tests show some differences between the sexes (especially in the trunk EX endurance). A larger sample of participants is required to determine normative values, particularly a larger sample of male participants and participants under 20 and over 45 years of age.

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Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki (0120-220/2019/6).

Conflicts of Interest: The authors declare no conflict of interest.

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