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A comparison of spine ROM and physical fitness parameters in active females and sedentary females

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The aim of this study was to investigate the effect of physical activity on spine range of motion (ROM) and on some physical fitness parameters in young females. Ninety-nine female university students (45 physically active and 54 sedentary) between the ages of 18 and 24 years with no history of back pain (Age: 19.69±1.85years; Height: 158.61±7.1cm; Body weight: 55.34±6.13kg) voluntarily participated to this study. *Material and Method*. The anthropometric, strength, endurance and flexibility measurements of the all participants were made. After, spine ROM measurements from two different anatomic points were recorded. For data analysis, each parameters were calculated as mean±standart deviation (SD). Differences among the two groups were investigated by independent sample t testing. Pearson correlation coefficient was used to test relationships among the parameters. *Results:* The tests which resulted in signicant differences ($p < 0.00$) between the two groups included the back muscle strength (Active: 77.52±11.77kgf; Sedentary: 60.83±11.98kgf) and all the spine ROM variables except left lateral flexion (L5-S1 flexion: 71.08±11.52º, 58.81±10.16º; L5-S1 extension: 35.13±8.12º, 23.59±7.10º; T12-L1 flexion: 104.04±12.57º, 94.81±12.24º; T12-L1 extension: 53.20±9.01º, 42.61±10.22º; Right Lateral Flexion: 22.12±3.80cm, 19.75±3.56cm). Moreover, there were low and moderate significant relationship between spine ROM parameters with anthropometric and physical fitness parameters. These are: L5-S1 extension ROM with triceps SF (r=-0.266), suprailiac SF (r=-0.264), total fat (r=-0.284), FM(%) (r=-0.270), wrist circumference (r=-0.325), with frame size (r=0.318). L5-S1 flexion ROM with triceps SF (r=-0.250). T12-L1 extension ROM and wrist circumference (r=-0.208). According to these results, L5-S1 flexion and extension ROM were correlated positively with back muscle strength, the relative strength, and sit and reach score. T12-L1flexion and extension ROM only correlated with sit and reach score. *Conclusions.* It was demonstrated that there was a positive effect of physically active life-style on the back health. The results from this study will be helpful to know for individuals who have a physically active life-style will be able to improve their physical fitness parameters and spinal flexibility.
Key words*: anthropometry, spine flexibility, back muscle strength, back muscle endurance.*

Introduction

The spine and pelvis are referred to as the “core” of the body. Core muscles include the abdominal muscles, and spinal muscles which responsible for maintaining the stability of the spine and pelvis (1,2). Physical activities often require mobility of the pelvis and spine such as neck, trunk (3). The spine is a complex structure consisting of vertebrae, associated intervertebral discs and many attached ligaments and muscles. Each of these components is fundamental for stability and movement (4). Furthermore, the muscles of the trunk are active whether one is sitting, standing or lifting and so endurance of the trunk muscles is necessary to good health (5). Nevertheless, the weak spinal muscle function is often credited as a risk factor for low back pain (5-7). According to recent researches have been estimated that more than 80% of all low back pain cases are caused by weak spine muscles (6). Several studies have also examined the prevalence of back pain related to physical fitness (8,9). Furthermore, some results showed that adequate spinal flexibility is an important dimension of physical performance (3). Spinal flexibility like others joints in adulthood is affected age, gender (10), genotype, activities, body ratio, and body weight or BMI (3,11). The age and gender have been associated with lumbar spinal flexibility in adulthood by recent research (12, 13). Thus, spinal flexibility may decrease between 25% and 50% with age (3,12,14). Especially, spinal extension movement have the greatest decreased with age (15). Physical activity provides health benefits and the physical activity profile that is associated with enhanced health and quality of life (16). Most exercises perform targeting increased physical functioning focus on balance, strength, endurance, fitness and extremity flexibility. Whereas, spinal flexibility has received less attention, and is an important dimension of function (3,12, 14). For example sedentary life style may results

in reduced elasticity and loss of spinal mobility (17). But decreased spinal flexibility also may be a possible

source of decline in the physical capabilities.

Although most of the research focused on gender and age for spine flexibility, only a few studies noted physically active life style or sedentary life style. The aims of this investigation were. Firstly, to determine the effect of physical activity on spine ROM and on some physical fitness parameters such as back muscle strength, back extensor endurance, and sit and reach in young female. Secondly, to determine whether a relationship between the spine ROM with physical fitness parameters and physical structure.

Material and method

Participants. Ninety-nine female university students (45 physically active and 54 sedentary) between the ages of 18 and 24 years with no history of back pain were recruited. Participants were volunteers and signed an institutionally approved informed consent statement. No warm-up or stretching exercises were performed by the participants prior to the measurements.

Anthropometric Measurement. Height, sitting height and body weight (BW) were measured to the nearest 0.1 cm and 0.1kg, respectively. BMI was calculated as body weight (kg) divided by squared height (m^2). Waist circumference was measured midway between the lower rib margin and the superior anterior iliac spine. Hip circumference was taken at the widest point over the greater trochanters with a tapemeter. Waist/hip (W/H) ratio as waist circumference (cm) divided by hip circumference (cm). Using the anthropometric set (Holtain), and tapemeter, measured chest breadth, and frame size (height (cm)/wrist circumference (cm) from determined standart points.

Fat mass (FM) Measurement. Skinfold measurements were taken from three sites (triceps, thigh, and suprailiac) to the nearest 0.1mm using skinfold caliper (Harpenden, England) and standard methods.

Estimates of percentage body fat were calculated according to the method suggested by Jackson et al. (18).

Body density = 1.0994921 - (0.0009929 x (sum of triceps SF + thigh SF + suprailiac SF) + (0.0000023 x (sum of triceps SF + thigh SF + suprailiac SF)^2) - (0.0001392 x age);

Fat% = (4.95/Body Density)-4.5) x100

The Sit and Reach Test. This test was utilized to assess flexibility of the lower back and hamstrings. Standard procedures for this test were followed. The participants were instructed to maintain their legs extended and to reach forward as far as possible. The best result out of two efforts was recorded (19).

Maximum Back Strength Measurement. This test was assessed with the use of a dynamometer (Takei, Japan). The participants standing on the platform with the knees fully extended and the head and trunk erected. The handbar was positioned across the thighs and without leaning backward, the participants pulled it straight upward using the back muscle. Two trials were administered with a 1 minute rest between the trials (18).

Back Extensor Endurance Test (Biering-Sorensen Test). The participants lied prone over the end of a treatment couch with anterior superior iliac spine supported on the bench edge. Their ankles were fixed by the research. They maintained the horizontal position for as long as possible, beginning timing when the horizontal unsupported position was achieved and ending when they dropped below the horizontal plane. The duration of holding was measured in seconds (7,20).

Inclinometric Measurement. Thoracic and lumbar spine ROM for flexion and extension were measured using inclinometer (bubble inclinometer, enterprises inc. USA). The spinous processes at T12-L1 and L5-S1 were located and marked by palpation with the participants standing upright. The inclinometer was placed on the landmark and "zeroed" before motion occurred. The participants performed flexion by bending forward as far as they could. They were instructed to keep their knees extended throughout the movement. Once full flexion was achieved and each inclinometer was read, the participants returned to the starting position. During the extension movement, the inclinometer was placed on at T12-L1 and L5-S1 were "zeroed" prior to performance of the extension movement.

The participants were asked to bend backward as far as they could. Once full extension movement was completed, inclinometer was read and the participant returned to the starting position (21)

Lateral Bending Measurements. The distance between the tip of the middle finger and the floor was measured (in centimeters) in standing (start position) and in fully attained lateral bending using a tape measure. The difference between these two measurements was the lateral bending ROM measurement for that side. Right lateral bending and left lateral bending were measured (22).

Statistical Analysis. SPSS 11.0 statistical software was used to perform all the analysis. Each parameters were calculated as mean±standart deviation (SD). Differences among the two groups were investigated by indepented samples t test. A Pearson r correlation was calculated to describe the association between spine ROM and anthropometric parameters and fitness parameters; $p<0.05$ was considered significant.

Results

The means and standard deviations on physical characteristics and anthropometric measurements according to groups were presented in Table I. The two groups were similar with regard to most of the baseline characteristics. The average age of the participants was 19,6years. The results of some parameters, such as BMI, W/H ratio and FM (%) demonstrated that the participants have normal weight range and normal body fat. Furthermore, the sedentary female group was slightly heavier, taller and fatter than the active female group. However, differences were not significant.

The means and standard deviations on fitness parameters according to groups were presented in Table II. There was significant differences ($p >0.05$) back muscle strength, but there were no significant differences sit and reach scores and back extensor endurance scores between two groups.

Table I. Characteristics of active and sedentary female groups (mean ± SD)

Parameters	Active female (n= 45)	Sedentary female (n=54)	Total (n= 99)
Age (year)	21.17±1,74	18.46±0.63	19.69±1.85
Height (cm)	157.97±9.04	159.14±4.99	158.61±7.11
BW (kg)	54.61±5.39	55.95±6.66	55.34±6.13
BMI (kg / m^2)	22.12±4.21	22.10±2.53	22.11±3.38
Sitting Height (cm)	85.72±2.62	85.06±2.69	85.37±2.66
Sitting Height / Height Ratio	0.54±0.04	0.53±0.12	0.53±0.03
Waist Circumference (cm)	67.67±3.98	70.29±5.41	69.10±4.97
Hip Circumference (cm)	92.94±4.21	94.47±6.22	93.77±5.43
W/H Ratio	0.72±0.03	0.74±0.03	0.73±0.03
Wrist Circumference (cm)	14.73±0.61	15.84±0.82	15.39±0.90
Frame Size	10.64±0.66	10.06±0.50	10.32±0.65
Chest breadth (cm)	24.48±1.07	24.36±1.34	24.42±1.22
Thigh SF (mm)	31.95±6.70	33,99±6.84	33.06±6.82
Triceps SF (mm)	18.09±4.98	21.09±6.57	19.73±6.06
Suprailiac SF (mm)	12.77±6.15	15.69±7,99	14.36±7.33
Sum of skin fold thickness (mm)	62.82±14,39	70.78±18.88	67.16±17.36
FM (%)	24.31±4.60	26.50±5.74	25.50±5.34
Fat Free Mass (FFM) (kg)	41.17±3.04	40.87±3.50	41.00±3.29

Table II. The values of fitness parameters of the participants (mean ± SD)

Fitness Parameters	Active female (n=45)	Sedentary female (n=54)	Total (n= 99)	p
Sit and Reach (cm)	28,03±6,61	25,17±8,12	26,50±7,56	
Back Muscle Strength (kgf)	77,52±11,77	60,83±11,98	68,41±14,47	0,00
Back Extensor Endurance Test (sec)	231,06±101,09	209,74±91,68	219,01±96,16	

Table III. The Measurement of spine ROM of the participants (mean ± SD)

Spine ROM Parameters	Active female (n=45) Mean ± SD	Sedentary female (n=54) Mean ± SD	Total (n= 99) Mean ± SD	p
L5 - S1 Flexion (º)	71.08±11.52	58.81±10.16	64.39±12.37	0.00
L5 - S1 Extension (º)	35.13±8.12	23.59±7.10	28.83±9.50	0.00
T12 - L1 Flexion (º)	104.04±12.57	94.81±12.24	99.01±13.16	0.00
T12 - L1 Extension (º)	53.20±9.01	42.61±10.22	47.42±11.00	0.00
Right Lateral Flexion (cm)	22.12±3.80	19.75±3.56	20.84±3.84	0.00
Left Lateral Flexion (cm)	21.95±3.81	20.49±3.6	21.16±3.88	0.00

There were significant differences between two groups for all the spine ROM variables except left lateral flexion (Table III). All spine ROM parameters of the active group were higher than those of the sedentary group. While the sagittal plane movements of the spine are higher in the active groups, the coronal plane movements of the spine were similar in the two groups.

The relationship between the spine ROM in two planes and anthropometric measurements were presented in Table IV. There were weak and moderate correlations between spine ROM parameters and anthropometric parameters. L5-S1 extension ROM was correlated negatively with triceps SF (r=-0.266), suprailiac SF (r=-0.264), total fat (r=-0.284), FM (%) (r=-0.270), wrist circumference (r=-0.325), and correlated positively with frame size (r=0.318). L5-S1 flexion ROM was correlated negatively with only triceps SF (r=-0.250). Moreover, there was relationship between T12-L1 extension ROM and wrist circumference (r=-0.208), but T12-L1 flexion not relate to any anthropometric parameters. When the frontal plane was examined, the right lateral flexion was found relations with sitting height (r=0.409), waist circumference (r=-0.229), W/H ratio (r=-0.249), triceps SF (r=-0.244), total fat (r=-0.242), FM (%) (r=-0.233). And left lateral flexion relations with sitting height (r=0.261) and FFM (r=0.227) were found. Furthermore, there were no correlation between spine ROM and some anthropometric parameters such as height, BMI and chest breadth.

The results of relationship between the spine ROM parameters and fitness parameters were given in Table V. According to these results, L5-S1 flexion and extension ROM were correlated positively with back muscle strength (r=0.220 and r=0.411), the relative strength (r=0.251 and r=0.483), and sit and reach score (r=0.620). T12-L1flexion and extension ROM only correlated with sit and reach score (r=0.623 and r=0.257). Furthermore, coronal plane movements only significantly correlated with T12 - L1 flexion and extension movements.

Table IV. Relationship between spine ROM parameters and anthropometric parameters for young females

Spine ROM	Sitting Height	Waist Circumf	W/H Ratio	Wrist Circumf	Frame Size	Suprailiac SF	Triceps SF	Total Fat	FM (%)	FFM
L5-S1 Flexion (º)							-.250 [b]			
L5-S1 Extension (º)				-.325[a]	.318[a]	-.264[a]	-.266[a]	-.284[a]	-.270[a]	
T12 -L1 Flexion (º)										
T12-L1 Extension (º)				-.208 [a]						
Right Lateral Flexion (cm)	.409[a]	-.229[c]	.249[b]				-.244[b]	-.242[b]	-.233	
Left Lateral Flexion (cm)	.261[b]									0.227[c]

a=p<0.00 , b=p<0.01, c=p<0.02, d=p<0.03

Table V. Relationship between spine ROM parameters and fitness parameters for young females

Spine ROM	Back Muscle Strength	Relative Strength	Sit and Reach	Right Lateral Flexion	Left Lateral Flexion
L5 - S1 Flexion (º)	.220 [c]	.251[b]	.620 [a]	.230 [c]	
L5 - S1 Extension (º)	.411[a]	.483[a]		.271 [a]	
T12 - L1 Flexion (º)		.224 [d]	.623 [a]	.252[b]	.265 [a]
T12 - L1 Extension (º)			.257 [b]	.314 [a]	.304[a]

a=p<0.00 , b=p<0.01, c=p<0.02, d=p<0.03

Discussion

In this study, it was assessed to determine the effects of physical activity on spine ROM and on some physical fitness parameters in young females and also determine the relationship between spinal flexibility and body structure. There was no group difference in baseline data, except in age and skinfold thickness. But it is not very likely that the group differences would have had a major influence on the main outcome of the study.

The sit and reach test measures mainly hamstring flexibility, but is dependent on hip and back mobility too (23). In the present study, although the sit and reach test and back muscle endurance measurements, which increases with an active daily life style were higher in the active female, there was no significant differences between the two groups. However, isometric back muscle strength measurement was determined 77,52kgf in active females and 60,83kgf in sedentary females, this result showed a statistically significant difference between both groups. Participation in aerobic and muscle strengthening physical activities provide additional health benefits and results in higher levels of physical fitness (16,23). Lindgren et al found that powerful back extensor muscles in elite hockey players (24). Mikkelson et al. also determined lower the risk of low back pain in women who had physical activity1–4 times a week (23).

Moreover, significant differences were found in the spine ROM except the left lateral flexion between the groups. The physically active females have increased range of sagittal and coronal planes movement than sedentary females. Physically inactivity that results in neurological and physiological changes in the spine. And these changes include weakness of the paraspinal musculature, and shortening of muscles and connective tissues of the spinal region (25). Recent studies have shown that spinal flexibility is associated with physical performance (3). Grabara et al reported that the boys training football and Lindgren et al reported that hockey players had significantly better the thoracic spine mobility than untrained participants (10, 24). A similar pattern of association with back pain was reported Videman et al. They found that low back pain occurred less commonly among former elite athletes compared with controls (26).

The strength and endurance of the back extensor muscles play a significant role in back health such as back pain (27, 28, 29).

While lack of spine ROM has been associated with low back pain (13,27), on the contrary, low back pain may be caused by lack of spine ROM. Because low back pain is related to soft tissue damage and insufficient muscle strength (29). Several studies have shown that relation on spine ROM between in low back pain subjects and in healthy subjects (30) and between male and female subjects (15).

In this study, the significant enhancement of the back muscles strength and spine ROM in active female may reflect the fitness benefits of a physically active lifestyle. The strength and flexibility might be probably increased by this life style, even without a special exercise. It seems that benefits of the physically active life style are more important indicator of back health.

The significant relationship between the spine ROM and some physical fitness and some anthropometric parameters found in this study was generally slightly weak. An interesting result is the significant negatively relationship between subject wrist circumference and spinal extension ROM. This correlation suggests that females with larger bone have a larger range of spinal extension than females with thin bone. Biomechanically this appears feasible if one assumes that larger vertebrae is a limiting factor in spinal extension, but not flexion. Furthermore, Gatton et al. reported that taller subjects have a larger range of spinal flexion than shorter subjects (4). But in this study no found any relationship between height, sitting height and spine ROM on the sagittal plane. Whereas correlations were found between sitting height with right and left lateral flexion. This finding is similar to the findings of Batti'e et al (13).

The results also showed that sitting height has a significant and positive relation to lateral bending, while fat mass especially waist circumference has a negative relation to lateral bending. It was determined that anterior bending was not significantly related to body structure. Whereas, especially lumbar extension ROM was significant relation with body structure such as waist circumference, frame size, fat mass. These results showed that large frame size or increased fat mass may be negative effect on the backward bending of the lumbar spine. This result is in agreement with the results reported by Suni et al. and Mikkelsson et al. (8,23).

It is also interesting that only forward and backward bending of the lumbar spine were effected by back muscle strength. Whereas, no relationship between toracal spine and back muscle strength was found. And also no correlation was found in the relationship between back muscle endurance and spine ROM. This result supports the results reported by Odebiyi et al (31). Several studies have examined the prevalence of back pain related to physical fitness (8,31). The healthy adults in the study by Suni et al. showed a correlation between the high fitness and positive back health (8).

The analysis in this study indicate that physical activity probable role is to back health. And physical structure measurements help to explain the flexibility of spine in young female.

Conclusion

It was demonstrated that there was a positive effect of a physically active life-style on the back health. The results from this study will be helpful to know for individuals who have a physically active life-style tend to improve their physical fitness parameters and spinal flexibility.

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