

Comparison of Postures According to Sitting Time with the Leg Crossed

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Abstract. [Purpose] The purpose of this study was to identify postural changes in adults who have adopted the habit of sitting with their legs crossed. [Subjects and Methods] The subjects were 232 adults in their 20s and 30s (84 males and 148 females). They were divided into 0-, 1-, 2-, and 3-hour or more groups by observing how much time per day they sat with their legs crossed while sitting on a chair. We measured the postural alignment of all the subjects in the sagittal plane and coronal plane. In the sagittal plane, distances from the line of gravity to the external auditory meatus, the shoulder joints, the knee joints, and the calcaneocuboid joint were measured. In the coronal plane, the shoulder inclination and the pelvic tilt were measured. [Results] The shoulder joints, the knee joints, and the calcaneocuboid joint did not show any significant differences, but the head was aligned further forward in the 3-hour group compared to the other groups. In the coronal plane, the acromion processes and the anterior superior iliac spines of the 3-hour group showed statistically significant differences than those of all of the other groups. [Conclusion] The results indicate that sitting with the legs crossed for longer than three hours per day may cause shoulder inclination, lateral pelvic tilt and forward head posture.

Key words: Cross legged position, Posture, Sitting time

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INTRODUCTION

Posture refers to the collective position of all the joints at a given moment. The term posture is also used to refer to the alignment of the body. When static postural alignment is maintained, the various joints can be described by body segments. In the standard position, the spine forms a normal curve and the skeleton of the lower half of the body is in a state of ideal alignment that is able to bear the weight of the body¹⁾. In psychology, there are several concepts that define an individual's permanent characteristics. Similarly, in physiology, certain habitual positions may reflect an individual's stable characteristics²⁾.

Proper alignment of the body segments not only maintains the correct postures of the upper and lower body but also prevents pain that may result from bad posture¹⁾. However, when bad posture becomes a long-term habit, poor postural alignment results in various musculoskeletal and nervous system diseases. Snijders et al.³⁾ state that the internal and external oblique abdominal muscle are less active in sitting postures than in standing postures, and that the external oblique abdominal muscle are less active in sitting

with the legs crossed. Variations in muscle activity in sitting with the legs crossed can be identified.

Currently, people spend more time sitting than standing due to the development of science and technology and automation. Dependence on automobiles, even for traveling short distances, and long periods spent working on computers, contribute to today's sedentary lifestyles⁴⁾. As the daily time spent in sitting postures increases, it is common to find people sitting with their legs crossed. The blood pressure of those with orthostatic hypotension rises when they sit with the legs crossed⁵⁾. Although the reasons why people sit with the legs crossed have not been clearly identified, several studies have proposed that it is because it gives stability to the lower extremities when sitting postures are maintained for an extended time, or for aesthetic reasons, for example, when a person is wearing a short skirt³⁾. However, a sitting with the legs crossed involves too many risk factors to be adopted for convenience or beauty. Studies have reported that sitting with the legs crossed may alter the weight-bearing or loads on soft tissues and muscles, resulting in unstable postures⁶⁾, and elicit negative effects, such as slower blood flow, varicose veins, and modified posture⁷⁾. If an individual habitually adopts such postures, part of the body will deviate from proper alignment, and deformation will be aggravated, to compensate for the unstable state⁸⁾, causing problems in the musculoskeletal system. Therefore, the purpose of this study was to identify postural changes in adults who have adopted the habit of sitting with legs crossed.

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Table 1. General characteristics of the subjects

	No leg-crossing (n=64)	1 (n=56)	2 (n=60)	3 (n=52)	Total (n=232)
Age (year)	22.6±2.9	21.7±2.0	22.2±3.4	22.1±1.9	22.2±2.0
Height (cm)	166.7±7.2	165.4±9.7	167.4±10.2	164.7±9.8	166.4±8.9
Weight (kg)	60.0±12.6	60.8±14.7	61.6±11.9	56.3±9.3	59.6±12.1

1, 1-hour group; 2, 2-hour group; 3, 3-hour group

SUBJECTS AND METHODS

Subjects

The subjects were 232 adults in their 20s and 30s (84 males and 148 females) who, through previous examination, were divided into two groups: those who habitually crossed their legs when sitting and those who did not. Those who crossed their legs were further divided into a one-hour group, a two-hour group, and a three-hour or more group by observing how much time per day they sat with their legs crossed while sitting on a chair. The subjects were selected from among those who had no disorders in their musculoskeletal or nervous/muscular systems, had not sustained any injuries or undergone surgery during the last six months, and had no posture-related problems.

The subjects were selected from among those who understood the purpose of this study and were capable of understanding and complying with the tester's instructions. All subjects understood the purpose of this study, agreed to participate in this research, and signed an informed consent form approved by the Institutional Review Board.

Methods

To compare changes in postures relative to the length of time spent sitting with the legs crossed, subjects were surveyed by questionnaire about the habit of crossing their legs, and the length of time spent with their legs crossed, than they were measured. Photos were taken in the sagittal and coronal planes using a digital camera, and the subjects' postures were measured using a global posture system (GPS, Chinesport, Udine, Italy). Thereafter, the subjects were divided into four groups: those without the habit of crossing their legs, and groups of those with the habit of crossing their legs for one hour per day, two hours per day, or at least three hours per day. The postures of the subjects in these groups were comparatively analyzed. For this study, a cross-legged posture was defined as placing one leg over the thigh of the other leg.

To measure the subjects' postural alignment, the subjects were instructed to take off their top, wear shorts, and stand in a natural posture with their feet placed in the footmarks on the GPS examination stand. Thereafter, the subjects' images were taken in the sagittal and coronal planes using a digital camera. The images were subsequently analyzed using proprietary software. In the sagittal plane, distances from the line of gravity to the external auditory meatus, the shoulder joints, the knee joints, and the calcaneocuboid joint were measured. The unit used was (mm). In the coronal plane, the shoulder inclination and the pelvic tilt were

measured. The shoulder gradient was calculated as the difference between the heights of the acromion processes on the two sides, and the pelvic tilt was measured using the difference between the heights of the anterior superior iliac spines (ASIS) on the two sides. The unit used was (mm). Larger values indicate greater incline of the shoulders and pelvis.

Statistical analyses were performed using SPSS version 14 for Windows (SPSS Institute Korea, Seoul, Republic of Korea). All results are presented as mean±SD. In order to analyze the postural changes in the sagittal and coronal planes according to cross-legged sitting time. One-way ANOVA was used to compare differences among the values for each group, and multiple analyses of three groups were performed using Turkey's test. Statistical significance was accepted for values of $p < 0.05$.

RESULTS

The characteristics of the 232 participants in this study are shown Table 1. According to the results of the comparison of postures in the sagittal plane relative to the time spent sitting with the legs crossed, the distance from the line of gravity to the external auditory meatus, indicative of forward head posture, was the largest in the three-hour group, but the differences were not statistically significant. The shoulder joints, the knee joints, and the calcaneocuboid joint did not show any statistically significant differences. Postures in the coronal plane relative to the leg-crossing times were also compared. The results showed statistically significant differences for both the acromion process and the ASIS ($p < 0.05$). In post hoc comparisons among the groups, the acromion process showed statistically significant differences in comparisons between the three-hour group and the non-leg-crossing group and between the three-hour group and the one-hour group ($p < 0.05$). The ASIS showed statistically significant differences in comparisons between the three-hour group and all of the other groups ($p < 0.05$), indicating that the subjects in the group with the habit of crossing their legs for at least three hours per day had significantly inclined shoulders and pelvis between the two sides (Table 2). Regarding the preferred leg when sitting with legs crossed: 152 subjects preferred to cross their right leg over their left, and 80 subjects preferred to cross their left leg over their right. In the comparison of the preferred legs no statistically significant difference (Table 3).

DISCUSSION

This study was conducted to investigate whether normal

Table 2. Comparison of the postural measures in the sagittal plane and coronal plane (unit: mm)

		No leg-crossing	1	2	3
Sagittal plane	External auditory meatus	52.19±2.79	59.64±7.50	56.67±3.41	62.15±3.29
	Shoulder joint	39.00±5.30	38.14±8.71	39.80±8.30	39.75±7.34
	Knee joint	36.44±9.45	37.86±3.77	39.33±8.34	39.62±5.76
	Calcaneocuboid joint	13.31±1.29	14.86±3.04	15.13±4.45	14.96±7.16
Coronal plane	Acromion process	5.94±3.06	5.29±1.72	6.27±1.07	10.92±3.58* ⁺
	ASIS	5.75±2.26	5.00±2.75	8.27±2.66* ⁺	13.25±5.58* ⁺ ‡

ASIS: anterior superior iliac spine; 1, 1-hour group; 2, 2-hour group; 3, 3-hour group

*p<0.05 significant difference form the no leg crossing group

⁺p<0.05 significant difference form the legs crossing for 1-hour group

[‡]p<0.05 significant difference form the legs crossing for 2-hour group

Table 3. Comparison of the posture between the preferred leg for leg-crossing (unit: mm)

		Left (n=80)	Right (n=152)
Sagittal plane	External auditory meatus	56.6±7.91	57.9±5.96
	Shoulder joint	38.36±11.84	39.10±13.26
	Knee joint	37.71±10.34	39.38±8.84
	Calcaneocuboid joint	14.41±5.12	14.97±10.23
Coronal plane	Acromion process	8.93±4.06	10.04±5.52
	ASIS	7.29±12.97	8.57±10.0

adults in their 20s and 30s experience changes in posture relative to the length of time that they sit with their legs crossed. The results show that subjects with the habit of sitting with their legs crossed for at least three hours per day had statistically significant differences in the heights of the acromion processes and the ASISs between the two sides. Subjects preferred to cross the right leg over the left, but this had no effect on the postural change.

Currently, people spend more time in sitting than in standing postures due to developments in science, technology and automation. Dependence on automobiles, even for traveling short distances, and extended periods spent on working computers contribute to today's sedentary lifestyles. Stationary, cross-legged sitting postures are assumed quite frequently and are perceived as comfortable by all age groups, and by both males and females³). If an individual works for an extended period of time in a sitting position, maintaining a proper posture may become difficult⁹), and muscle fatigue increases. Previous studies have indicated that people prefer sitting with the legs crossed because it change the weight or load on soft tissues and muscles; and provides stability to the lower extremities or because of social situations or for aesthetic reasons¹⁰). Cross-legged postures are useful when sitting positions are maintained for a long time because crossing the legs reduces trunk muscle fatigue³).

However, crossing the legs may cause rotation of the pelvis¹¹), thereby causing problems in the lumbar region. Studies report that lateral pelvic tilt might result when the hip abductors are weakened¹²). When sitting with the legs crossed, one leg is placed over the supporting leg, and the

leg placed on top is in a state of abduction. Therefore, the gluteus medius, which is related to abduction, is stretched for an extended period and thereby weakened, resulting in lateral tilt of the pelvis. In the present study, a statistically significant lateral pelvic tilt was identified in the group that sat with their legs crossed for at least three hours per day, indicating that sitting with the legs crossed for three hours or longer may result in lateral pelvic tilt related to weakening of the gluteus medius.

Previous studies have also suggested that when the legs are crossed, an insufficient range of hip flexion is compensated by lumbar bending, which might increase the rotational moment of the lumbar spine¹¹). When the pelvis is tilted laterally, the lumbar spine may be bent due to lateral instability and impaired movements¹³). Lateral spinal flexion is called scoliosis. Scoliosis caused by habitual postures is called postural scoliosis, and may cause pain and problems in muscles and joints due to abnormal force distribution¹⁴). In this study, although scoliosis was not measured, the group sitting with their legs crossed for at least 3 hours a day showed lateral tilt of the pelvis and the acromion processes showed significant differences, indicating the possibility of lateral flexion of the spine. Therefore, sitting cross-legged for an extended period can be considered a factor that may cause not only lateral pelvic tilt but also changes in spinal posture.

Previous studies have reported that a 6.3-mm or greater difference between the ASISs of the two sides might result in pelvic lateral tilt¹⁵), a 9-mm or greater difference might cause pain and changes in joints¹⁶), and a 15 mm or greater difference might lead to pelvic torsion¹⁷). In the present

study, the three-hour group showed a mean difference of 13.25-mm between the ASIS of the two sides, indicating that pelvic pain and changes in the joints might occur. When sitting with the legs crossed, weight bearing on the supporting leg tends to increase, further leading to unstable postures⁶⁾. Such excessive weight bearing would bring about gradual changes in the musculoskeletal system due to static postures, thereby causing secondary problems.

Lumbar flexion is greater when sitting with the legs crossed¹⁸⁾. A flexed trunk may affect the maintenance of proper support of the trunk and the position of the head in a sitting posture¹⁹⁾. In the present study, although subjects in the three-hour group did not show significantly larger distance from the external auditory meatus, their heads were aligned further forward than in the other groups. Therefore, sitting with their legs crossed for longer than three hours influenced their trunk posture, and the position of their heads.

As reviewed above, sitting cross-legged for longer than three hours per day may cause shoulder and pelvic lateral tilts, and aligned the head further forward. These are factors that can cause pain and changes in joints, or result in spinal lateral flexion and forward head posture. This study measured postural changes relative to time spent sitting with the legs crossed, and we consider, further studies that include spinal postures and the kinetics of the musculoskeletal system are necessary.

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