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Are There any Relations Between Posture and Pelvic Floor Disorders? A Literature Review

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Abstract

Objective: Pelvic floor disorders (PFDs) include a wide variety of diseases. According to biomechanical theories, it can be suspected that there are relations between posture and PFDs. This review tries to find out if there are any postural, bony or muscular changes in patients with PFDs.

Methods: Relevant key words were used to search in different databases such as Medline, Cochrane, Elsevier and CINHAL. We found 22 related articles about postural change in patients with PFDs.

Results: The results showed increased thoracic kyphosis, decreased lumbar lordosis, wider transverse pelvic inlet and outlet, increased contraction of pelvic floor muscles (PFMs) with ankle in dorsiflexion, increasing protrusion in shoulders and decreasing in the angle of head in patients with PFDs compared to control group in different researches with different methodologies.

Conclusion: From this narrative review, it can be concluded that postural changes may be seen more often in women with PFDs so it should be considered in conservative treatment methods in these patients.

Keywords: Pelvic floor disorders, Posture, Ankle, Pelvic, Spine

Introduction

Pelvic floor disorders (PFD) are the most common gynecological disorders among women in reproductive and post-menopausal ages. PFD includes many varieties of clinical conditions such as urinary incontinence (UI), fecal incontinence (FI), pelvic organ prolapse (POP), chronic pelvic pain (CPP) etc (1).

It is estimated that 1 in every 10 women suffer from severe PFD that may lead to surgery (2).

It is remarkable that there are some links between human posture and PFDs. Although this relationship is not clear initially, poor posture can lead to many symptoms, including pain and dysfunction in the pelvic floor and pelvic floor muscle (PFM) dysfunction or CPP can alter posture in the same way; even there are many conditions affecting both posture and the pelvic floor at the same time and leading to pain and dysfunctions (3). There were also some evidences that showed indirect relationship between posture and PFDs like prevalence of PFD in patients suffered from low back pain (3- 5). These facts show possible relationship between pelvic floor structures and posture.

Previous studies have demonstrated that there are some postural changes in patients affected by PFDs. This review provides a brief summary of these postural changes in PFDs.

Methods

Search Strategy

Relevant key words were used to search in online databases such as Medline, Cochrane, Elsevier and CINHAL. Articles were limited from January 1990 to September 2016. These articles were reviewed by the specified criteria and key words as follows: pelvic floor muscle, ankle, pelvis, posture, spine, posturography, photogrammetry, x-ray, magnetic resonance imaging and computed tomography.

Inclusion and Exclusion Criteria

We considered these criteria in our selection:

- Articles included participants suffering at least from one type of PFD.
- Studies having control group only were added.
- There was no limitation in selecting specific language for articles.

Finally, 22 related articles in order to answer our questions about the aforementioned subject were used.

Data extraction

After studying and reviewing articles, authors categorized them into 4 main groups: Relationship between PFD and (*a*) spinal curvatures, (*b*) pelvis, (*c*) lower limb alignments, and (*d*) global postural change.

Results

Relations Between Pelvic Floor Disorder and Spinal Curvature

In 1996, Lind et al studied the relations between the degree of thoracic kyphosis and the prevalence of advanced POP in women by using a lateral chest x-ray and the Ferguson method (6). In this method, the angle between the 2 lines

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connecting the midpoints of the end vertebrae with the midpoint of the apical vertebra is measured (7). In this study, 48 cases were matched to 48 controls and the results showed the higher degree of thoracic kyphosis in patients with POP compared with healthy subjects (6). This study only evaluated thoracic curvature.

In 2000, Mattox et al studied the association of spinal curvature in POP. A total of 363 patients suffering from UI and POP were included and their spinal curvatures were measured with a flexi-curve malleable rod. The final results revealed that patients with an abnormal spinal curvature were 3.2 times more susceptible to develop POP and the most prevalent spinal abnormality in patients was decreased lumbar lordosis (8). In the same year, Nguyen et al also found that women with advanced POP have less lumbar lordosis compared with healthy subjects using lateral lumbosacral spine X-ray (9).

Sayyahmelli et al evaluated spinal curvature changes as a risk factor for POP. The results showed the higher stage of prolapse in cases with abnormal spinal curvature that represents excessive thoracic kyphosis and decreased lumbar lordosis in patients with POP (10).

Recently in 2016, Meyer et al (11) studied the relations between the thoracic and lumbar curvature with pelvic floor symptoms with Cobb angle method using spinal x-ray. This study revealed controversial results on previous studies that showed no association between pelvic floor symptoms and thoracic or lumbar spine angles and no statistically significant differences in the mean thoracic and lumbar curvature angles between women with and without pelvic floor symptoms (11).

Relations Between Pelvic Floor Disorder and Pelvis

Researchers had also identified a number of bony and soft tissue characteristics in pelvis that might be associated with the developing PFDs including:

1. Bony Pelvic

In 1999, Sze et al compared bony pelvis dimensions between 34 white women with POP and 34 matched white controls with no signs or symptoms of POP using CT pelvimetry. Their study demonstrated that women with advanced vaginal prolapse have larger transverse inlet diameters than women with normal pelvic floor (12).

In 2000, Nguyen et al (9) also studied about bony pelvic dimensions in patients with POP by using X-ray. They achieved the same results as Sze et al study (9).

Handa et al studied the architecture of bony pelvis in women with and without PFDs with MRI. The results showed a wider transverse inlet and a narrow obstetrical conjugate in patients with PFDs (13).

Stav et al examined anatomical features in the pelvic bones in women with UI by using CT. The results showed larger pelvic inlet & outlet diameters in PFD patients compared to healthy subjects (14).

In 2010, Hai-Nan et al investigated the same goal. They also used CT in their evaluations and the results showed larger transverse diameter of pelvic outlet. There was no significant difference in pelvic inlet diameter between healthy and PFD patients (15).

For other dimensions of pelvis, in 2002, Frudinger et al assessed the relationship between the subpubic arch angle and anal incontinence after child birth; so, the subpubic arch angle was calculated by the pelvic outlet measurements using standard trigonometry. In this study, 134 nulliparous women before and after deliveries were examined. The results showed a positive association between narrow subpubic arch and postpartum anal incontinence (16).

Handa et al in 2008, rearranged another study to compare pelvic dimensions using MRI between postpartum women with or without PFDs. The results were different compared to the previous study. This study showed a deeper sacral hollow in patients with FI, wider intertubrous diameter as well as a pelvic arch in patients with UI. They found no significant difference in patients with POP. The latter was a controversial result in relation to previous studies (17).

Stein et al compared pelvis dimensions at the level of pelvic floor in POP patients and healthy subjects in 2009. Pelvic floor dimensions of 42 white women with POP were compared with 42 matched healthy women by using MRI. The results revealed no significant differences in bony pelvic dimensions of both case and control groups (18).

Brown et al determined the differences of bony pelvic dimensions in women with and without PFDs by using MRI. This study demonstrated larger bispinous diameter and larger distance defining lateral displacement of ischia from pubis. Mediolateral enlargement of pelvic midplane and ischial eversion near subpubic arch also had been seen (19).

2. Soft Tissue

Stav et al examined the pelvic muscles cross sectional area of patients with UI comparing with healthy subjects. Smaller cross sectional diameters of levator ani, psoas major, transverse perineal muscles and lower density of the psoas major, transverse perineal muscles were reported in this study (14).

Handa et al studied pelvic soft tissue changes in 246 postpartum women using MRI. The results showed no meaningful differences in subjects with or without PFDs (17).

Ren et al evaluated pelvic soft tissue changes in patients with POP. The pelvic MRIs of patients showed narrower levator ani, cardinal and uterosacral ligaments compared to healthy subjects (20).

Relations Between Lower Limb Alignments

1. Ankle

Chen et al assessed the influence of ankle position on PFM activity in women with stress UI. They measured changes in PFM activity using electromyography (EMG). Each subject performed PFM contraction in 3 ankle position including horizontal standing with neutral, dorsiflexion (DF) and plantar-flexion (PF) ankle position. The results indicated that PFM activity was greater in neutral and DF ankle position compared to PF position (21).

Chen et al also considered the effect of ankle position on PFM contraction activity in women. Subjects were asked to perform PFM contractions while assuming 8 ankle positions with PFMs recorded by EMG for each position. Measurements were first done when the ankle was in active and passive horizontal, DF and PF position then they added arm movements in active ankle movements and once again they repeated the measurements while arms were up and the ankle was in DF and then PF position. The results showed all ankle positions resulted in greater PFM activity than the horizontal foot position against previously mentioned study. Significantly greater muscle activity was seen with ankles in the plantar position with raised arms (22).

With the same method and purpose, another study was designed by Cerruto et al in 2012. They measured PFM activity using EMG in 3 ankle positions: horizontal, 5, 10 and 15 degrees in both DF and PF. The results revealed that PFM activity was greater in 5 degrees plantar flexion and 10 degrees dorsiflexion (23).

Foot

Nygaard et al investigated the relations between foot arch flexibility and UI in elite athletes. Measurements were done on each subject using standardized foot arch height examination in 2 positions: with ankle in neutral and in maximal dorsiflexion position. Results showed significant association between decreased foot flexibility and UI, revealing potential etiology for stress UI.

Their study suggested that shock absorbing shoe may decrease force transmission to pelvic floor and may decrease UI (24).

Ansarian et al conducted a study to check the relationship between flat foot and stress UI. At first, they checked foot arch only by observation and then they measured it by using mechanical device (Metrecom) which was based on level of displacement of navicular tuberosity. The results of this study did not show any significant relations between flat foot and stress UI (25).

Global Postural Changes

Haugstad et al studied posture, movement patterns and body awareness in women with CPP. Subjective and objective evaluations were done on 60 patients with CPP and 35 healthy subjects. The results indicated that in standing position, area of support was smaller so pelvic was pushed forward and the shoulders and upper parts of back were pulled backward in CPP patients compared to healthy subjects (26).

In 2009, Miranda et al assessed postural changes of women with CPP using photogrammetry method. They evaluated 30 women complaining of CPP and 37 healthy subjects. The only significant differences between 2 groups were found in upper limbs including shoulder protrusion and decreased head angle (27).

In the same year Montenegro et al conducted a study similar to Miranda and colleagues'. They evaluated 67 patients with CPP and 37 healthy subjects using Kendall observational method. Their results also were similar to Miranda and colleagues'. Results showed significant shoulder protrusion and decreased head angle in patients compared to control group (28).

Discussion

In normal conditions, human body protects pelvic region from any dysfunctions. According to Delancey, there are 3 levels of supports for vagina: upper, mid and lower vagina that include ligaments, muscles and other supportive soft tissues (29). These soft tissues also play pivotal roles in supporting pelvic region with increasing intra-abdominal pressure. Accordingly, it is clear that any abnormality in them might cause POP as a result of decreasing control of intra-abdominal forces on the pelvic floor (9).

With regard to the role of intra-abdominal pressure in causing POP, it should be noted that changing in normal spinal curves might cause extra intra-abdominal pressure on to the pelvic floor. Anatomic studies showed a role of normal spinal curvatures in supporting pelvic floor from direct intra-abdominal pressures. Actually, these normal forward and backward curves of lumbar and thoracic might help in supporting abdominal viscera and absorbing downward intra-abdominal pressure before it reaches pelvic region (8-10).

Pelvic bone stops growing at the age of 17-20 years old. From that age, it gets more thickened up to the age of 26-30. So, it is not wrong to say that pelvic bone reaches steady state around the age of 30 (15). As discussed before, Nguyen et al studied both angles of lumbar lordosis and pelvic inlet. They suggested that pelvic inlet with more vertically orientation represents a better support for pelvic organs as it reduces downward intra-abdominal forces on to the pelvic floor (9).

Sze et al hypothesized that pelvis with larger dimensions might lessen the risk of damaging soft tissues and nerves in pelvic region during parturition. Surprisingly, they found that women with genital prolapse have larger transverse diameter of pelvic inlet. One explanation for it was that women with larger dimensions of pelvic allowed heavier and larger infants that result in more soft tissues and neurological damages, plus larger hiatus also results in more abdominal pressure transmission to pelvic (12). It is believed that narrow subpubic arch, that could also estimate pelvic outlet, is more likely to posterior displacement of fetal head. This condition has a stretching influence in nervous innervations of pelvic floor and possibly results in more nervous damages in women with narrow subpubic arch, which can lead to incontinency or any other PFDs (16).

Handa et al in 2003 found that in women with transverse outlet more than 13.9 cm, developing PFD is 7.2 times more possible. They also found a relationship between the shorter obstetrical conjugate and PFD. They suggested that this variation in obstetrical conjugate might result in more damages in soft tissues including levator ani, uterosacral ligaments and hypogastric nerve along anterior sacrum. As a result, women with platypelloid pelvic type have a greater risk for developing any kind of PFD. They also investigated this issue in different type of race and found that black women have narrower obstetrical conjugate, intertuberous diameters, anterior-posterior conjugate plus wider anterior-posterior outlet compared to others (17).

The size and shape of bony pelvic also have effect on soft tissues attached to this region. Hai-Nan et al concluded that oversized transverse pelvic outlet diameter plays a vital role in developing PFD than diameters at pelvic inlet as it results in more gravitational strain on PFMs. They suggested that pelvic outlet greater than 9.5 cm is more likely to develop PFD (15).

It is recommended to perform PFM exercises with ankle in dorsiflexion (21,22). Chen et al suggested to do PFM exercises in passive dorsiflexion of ankle as they believed that in this position pelvic tends to tilt anteriorly and leads to more PFM activity. They explained that posterior tilt makes iliac bones apart and makes vaginal region weaker. They also reported that in posterior pelvic tilt, foot flexibility reduced and it resulted in abnormality in providing information which is transmitted from foot to pelvic region (21). Chen et al did not found any significant differences in PFM activity with passive ankle dorsiflexion or plantar-flexion. They concluded that ankle movements could affect PFM activity. The clinical point of this finding was that ankle dorsiflexion might lead to PFM facilitation (22).

It should be highlighted that although the aforementioned studies show some postural changes in women with PFD, global postural evaluations only show changes in head and neck posture. The significant difference regarding the position of the head and shoulders protrusion observed in patients with PFD especially CPP, can be related to women's emotional state with CPP. However, only one of the studies used quantitative method such as photography for its evaluations and the other used observational method that was less reliable (27,28).

There are some important limitations in the reviewed literature. First, although these studies evaluated an association of spinal curvatures and PFDs, it should be noted that they only reported this relationship in women suffering from POP. The findings of studies reporting bony pelvis in women with PFDs suggested that the risk for developing PFDs was higher in women with a platypelloid pelvic shape (wide, ovoid inlet) and it was lower in women with anthropoid (heart-shaped) pelvis type. The heart-shaped pelvis is more prevalent in black women who were not included in most of these studies (13). None of the studies examined the bone mass density in a standard way to check osteoporosis. Unfortunately race was not considered in the mentioned studies as osteoporosis is less common in black women.

These studies were limited in evaluation of obese subjects and most of them needed greater sample size to be more reliable. The major part of these studies used one- or two-dimensional measurements which might not be the ideal method for evaluation of bony pelvic structure.

Conclusion

From this narrative review (Table 1), It can be concluded that postural changes may be seen more often in women with PFDs. This review also concluded that some muscular and bony characteristics may be associated with PFDs. However, it is not clear to confirm a direct relation between PFDs and postural changes. Therefore, more studies are needed to answer this question.

Conflict of Interests

The authors declare that they have no conflicts of interest.

Ethical Issues

Not applicable.

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References

1. Weber AM, Abrams P, Brubaker L, et al. The standardization of terminology for researchers in female pelvic floor disorders. Int Urogynecol J Pelvic Floor Dysfunc. 2001;12(3):178-186. doi:10.1007/PL00004033.
2. DeLancey JO. The hidden epidemic of pelvic floor dysfunction: achievable goals for improved prevention and treatment. Am J Obstet Gynecol. 2005;192(5):1488-1495.
3. Carrière B, Feldt CM. The Pelvic Floor. New York: Thieme; 2006:68-78.
4. Pool-Goudzwaard AL, ten Hove MCS, Vierhout ME, et al. Relations between pregnancy-related low back pain, pelvic floor activity and pelvic floor dysfunction. Int Urogynecol J. 2005;16(6):468-474.
5. Ghaderi F, Mohammadi K, Sasan RA, Kheslat SN, Oskouei AE. Effects of Stabilization exercises focusing on pelvic floor muscles on low back pain and urinary incontinence in women. Urology. 2016;93:50-4.
6. Lind LR, Lucente V, Kohn N. Thoracic kyphosis and the prevalence of advanced uterine prolapse. Obstet Gynecol. 1996;87(4):605-609.
7. Vrtovec T, Pernuš F, Likar B. A review of methods for quantitative evaluation of spinal curvature. Eur Spine J. 2009;18(5):593-607.
8. Mattox TF, Lucente V, McIntyre P, Miklos JR, Tomezsko J. Abnormal spinal curvature and its relationship to pelvic organ prolapse. Am J Obstet Gynecol. 2000;183(6):1381-1384.
9. Nguyen JK, Lind LR, Choe JY, McKindsey F, Sinow R, Bhatia NN. Lumbosacral spine and pelvic inlet changes associated with pelvic organ prolapse. Obstet Gynecol. 2000;95(3):332-336.
10. Melli MS, Alizadeh M. Abnormal spinal curvature as a risk factor for pelvic organ prolapse. PJBS. 2007;10(23):4218-4223.
11. Meyer I, McArthur TA, Tang Y, McKinney JL, Morgan SL, Richter HE. Pelvic floor symptoms and spinal curvature in women. Female Pelvic Med Reconstr Surg. 2016;22(4):219-223.

Table 1. Review of Posture and Pelvic Floor Disorders

Main Category	Subtitles	First Author/Year	Sample Size	Outcome	Results
Spinal curvature	Thoracic	Lind et al (1996)	48 POP, 48 controls	Radiography	Higher degree of thoracic kyphosis in cases ($P < 0.001$).
		Mattox et al (2000)	363 POP & UI	Flexi ruler	Excessive thoracic kyphosis & Loss of lumbar lordosis ($P = 0.02$).
	Lumbar	Nguyen et al (2000)	20 POP, 20 controls	Radiography	Loss of lumbar lordosis ($P < 0.003$).
		Sayyahmelli et al (2007)	100 abnormal spine, 100 normal spine	Flexi ruler	Excessive thoracic kyphosis & loss of lumbar lordosis($P = 0.035$).
		Meyer et al (2016)	1126 subjects with X-ray images	Radiography	No differences in the mean angles of the thoracic and lumbar curvatures($P \geq 0.05$).
Pelvic	Bony pelvic	Sze et al (1999)	34POP, 34 controls	CT	Greater mean transverse diameter of pelvic inlet ($P = 0.006$).
		Nguyen et al (2000)	20 POP, 20 controls	Radiography	Wider transverse inlet ($P < 0.001$).
		Frudinger et al (2002)	134 Nulliparous	Obstetric calipers	Narrow sub pubic arch ($P < 0.001$).
		Handa et al (2003)	59 PFD, 39 controls	MRI	Wider transverse inlet ($P = 0.006$) plus narrow obstetrical conjugate ($P = 0.026$).
		Stav et al (2006)	93 UI, 107 controls	CT	Larger pelvic inlet ($P < 0.0001$)& outlet diameters ($P = 0.011$).
		Handa et al (2008)	246 UI, POP, FI	MRI	Deeper sacral hollow in patients with FI ($P = 0.005$), wider intertubrous diameter ($P = 0.017$)& pelvic arch ($P = 0.017$) in patients with UI, no significant difference in patient with POP ($P \geq 0.05$).
		Stein et al (2009)	42 POP, 42 controls	MRI	No significant difference in bony dimensions ($P \geq 0.05$).
		Hai-nan et al (2010)	298 UI & POP, 508 controls	CT	Larger transverse diameter of pelvic outlet ($P < 0.01$).
		Brown et al (2012)	19 PFD, 16 controls	MRI	Larger bispinous diameter ($P = 0.05$),mediolateral enlargement of pelvic midplane and ischial eversion near subpubic arch.

Table 1. Continued

	Soft tissues	Stav et al (2006)	93 UI, 107 controls	CT	Smaller cross sectional diameters of levator ani ($P = 0.04$),Psos major ($P = 0.001$), transverse perineal muscles ($P < 0.0001$) and lower density of the psoas major ($P = 0.02$),Transverse perineal muscles ($P = 0.01$).
		Handa et al (2008)	246 UI, POP, FI	MRI	No significant differences ($P \geq 0.05$).
		Ren et al (2015)	1 POP,1 controls	MRI	Thicker levator an, cardinal ligaments, uterosacral ligaments.
Lower limb	**Ankle joint**	Chen C-H et al (2005)	39 UI	EMG	Greater resting PFM activity with ankle in dorsiflexion than with ankle plantar-flexion ($P<0.01$), Greater maximal PFM activity in DF and horizontal standing ($P = 0.011$).
		Chen H-L et al (2009)	31 UI	EMG	Greater muscle activity was seen with ankles in the plantar position with raised arms ($P = 0.0051$).
		Cerruto et al (2012)	20 UI	EMG	Higher PFM activity in PF than in both 5 DF ($P = 0.006$) and 15 DF ($P = 0.01$), no significant EMG difference was found between 5 PF and 10 DF ($P \geq 0.05$).
	Foot	Nygaard et al (1996)	47 UI	Standardized foot arch height examination	Decreased foot flexibility ($P = 0.03$).
		Ansarian et al (2014)	28 SUI, 57 UI	Observation, Mechanical, Metrecom device	No association between flat foot and UIby method of Metrocom ($P = 0.071$) and method of observing ($P = 0.486$).
Global postural changes		Hausgstad et al (2006)	60 CPP, 35 controls	Subjective & objective evaluations	Patients area of support was minimal($P = 0.011$), feet being posed close together ($P = 0.003$), pelvic area pushed forward ($P = 0.004$), shoulders ($P = 0.001$) and upper parts of back pulled backward ($P = 0.006$).
		Martins et al (2009)	30 CPP, 37 controls	Photogrammetry	Differences in head protrusion ($P < 0.0001$)and protrusion in shoulders ($P = 0.03$).
		Montenegro et al (2009)	67 CPP, 37 controls	Kendal observation	Increasing protrusion in shoulders ($P < 0.05$) and decreasing the angle of head ($P < 0.01$).

Abbreviations: PFD, pelvic floor disorders; UI, urinary incontinence; FI, fecal incontinence; POP, pelvic organ prolapse, CPP, chronic pelvic pain, MRI, magnetic resonance imaging; CT, computed tomography, EMG, electromyography; PFM, pelvic floor muscle; DF, dorsiflextion; PF, plantar-flextion; SUI, stress Urinary Incontinence.

12. Sze EH, Kohli N, Miklos JR, Roat T, Karram MM. Computed tomography comparison of bony pelvis dimensions between women with and without genital prolapse. Obstet Gynecol. 1999;93(2):229-232.
13. Handa VL, Pannu HK, Siddique S, Gutman R, Van Rooyen J, Cundiff G. Architectural differences in the bony pelvis of women with and without pelvic floor disorders. Obstet Gynecol. 2003;102(6):1283-1290.
14. Stav K, Alcalay M, Peleg S, Lindner A, Gayer G, Hershkovitz I. Pelvis architecture and urinary incontinence in women. Eur Urol. 2007;52(1):239-244.
15. Hai-Nan X, Zhi-Jun X, Bao-Xiang L, et al. Investigation of correlation between diameters of pelvic inlet and outlet planes and female pelvic floor dysfunction. Eur J Obstet Gynecol Reprod Biol. 2011;159(2):461-464. doi: 10.1016/j.ejogrb.2011.07.034.
16. Frudinger A, Halligan S, Spencer JA, Bartram CI, Kamm MA, Winter R. Influence of the subpubic arch angle on anal sphincter trauma and anal incontinence following childbirth. BJOG. 2002;109(11):1207-1212.
17. Handa VL, Lockhart ME, Kenton KS, et al. Magnetic resonance assessment of pelvic anatomy and pelvic floor disorders after childbirth. Int Urogynecol J. 2009;20(2):133-139.
18. Stein TA, Kaur G, Summers A, Larson KA, DeLancey JO. Comparison of bony dimensions at the level of the pelvic floor in women with and without pelvic organ prolapse. Am J Obstet Gynecol. 2009;200(3):241.e1-e5.
19. Brown KM, Handa VL, Macura KJ, DeLeon VB. Three-dimensional shape differences in the bony pelvis of women with pelvic floor disorders. Int Urogynecol J. 2013;24(3):431-439. doi: 10.1007/s00192-012-1876-y.
20. Ren S, Xie B, Wang J, Rong Q. Three-dimensional modeling of the pelvic floor support systems of subjects with and without pelvic organ prolapse. Biomed Res Int. 2015;2015:845985. doi: 10.1155/2015/845985.
21. Chen C-H, Huang M-H, Chen T-W, Weng M-C, Lee C-L, Wang G-J. Relationship between ankle position and pelvic floor muscle activity in female stress urinary incontinence. Urology. 2005;66(2):288-92.
22. Chen H-L, Lin Y-C, Chien W-J, Huang W-C, Lin H-Y, Chen P-L. The effect of ankle position on pelvic floor muscle contraction activity in women. The J Urol. 2009;181(3):1217-1223.
23. Cerruto M, Vedovi E, Mantovani W, D'Elia C, Artibani W. Effects of ankle position on pelvic floor muscle electromyographic activity in female stress urinary incontinence: preliminary results from a pilot study. Arch Ital Urol Androl. 2012;84(4):184-188.
24. Nygaard IE, Wacki CG, Saltzman CL. Relationship between foot flexibility and urinary incontinence in nulliparous varsity athletes. Obstet Gynecol. 1996;87(6):1049-1051.
25. Ansarian M, Eivazi Gharamaleki M, Ghaderi F, Ghafari ME, Asaadi N. The relationship between stress urinary incontinence in women and flat foot by using two methods. Adv Environ Biol. 2014;8(11):377-386.
26. Haugstad GK, Haugstad TS, Kirste UM, et al. Posture, movement patterns, and body awareness in women with chronic pelvic pain. J Psychosom Res. 2006;61(5):637-644.
27. Miranda R, Schor E, Girão MJ. Postural evaluation in women with chronic pelvic pain. Rev Bras Ginecol Obstet. 2009;31(7):353-560.
28. Montenegro ML, Mateus-Vasconcelos EC, Rosa E Silva JC, Dos Reis FJ, Nogueira AA, Poli-Neto OB. Postural changes in women with chronic pelvic pain: a case control study. BMC Musculoskelet Disord. 2009;10:82. doi: 10.1186/1471-2474-10-82.
29. DeLancey JO. Anatomie aspects of vaginal eversion after hysterectomy. Am J Obstet Gynecol. 1992;166(6):1717-1728.