International Journal of
Clinical Case Studies
Case Study Open Access

Standing Postural Control during Twin Pregnancy: Case Study

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Abstract

Background: Alterations in anatomical and physiological conditions during pregnancy expose women to changes in balance control, which may be further exacerbated with a twin pregnancy. The purpose of the current study was to describe the changes in postural stability during twin pregnancy.

Methods: Evaluation of postural control in static standing of one participant with a twin pregnancy was carried out,by using a Tetrax device measuring stabilometry in eyes open and closed conditions. A non pregnant control was used measure retest variability. Scores of Falling Index, General Stability, weight distribution pattern and center of pressure's path were measured during each month of pregnancy and twice following delivery for the pregnant participant, and during three assessments – one each month, for the control participant.

Results: The Falling Index score rose mainly during the third trimester with the change larger than the variability shown with retesting, and didnot return to baseline even three months after delivery. In addition, the location of center of pressure moved in accordance with the changes of the fetuses' weight.

Conclusion: As postural balance strategy changes, particularly in the third trimester, and does not recover in the following few months after delivery, particular caution should be taken to prevent falling during these periods. Further research comparing singleton to multiple pregnancies should be conducted.

Publication History:

Received: May 05, 2017
Accepted: June 25, 2017
Published: June 27, 2017

Keywords:

Balance, Case report,Falls,Postural stability,Twin pregnancy

Introduction

During pregnancy, women undergo physiological, anatomical, and biomechanical changes affecting possible adaptations in her standing balance control [1-3]. Such changes progress and vary throughout the pregnancy period and include weight gain (between 16%-23% of body weight and much of the weight gain is located in the anterior torso), mental state changes such as anxiety and mood changes as well as morning sickness (50%-90% of pregnant women) consisting of nausea and vomiting [4-6]. Typically, the abdominal muscle wall during pregnancy under goes elongation and reduced ability to function [7]. During their second and third trimesters, women experience changes including, increased lumbar lordosis, increased joint mobility, decreased neuromuscular control, a decrease in kinesthetic and coordination abilities, increased reaction time and changes in the foot biomechanics and walking pattern [1-3,6,8-10].

Additional adjustments such as head elevation, hyperextension of the neck, extension of the knee and ankle joints and anterior pelvic tilt, might lead to unsteadiness [1,8]. Such unsteadiness is expected to increase postural sway during upright standing, as evidenced by the increased path length of the center of pressure (COP) as well as increased anterior–posterior and radial deviation of COP, and a larger preferred stance width in pregnant women during quiet stance when compared to non-pregnant women [1,3,10].

Comparing to singleton pregnancy, women carrying twins are at higher risk for greater gestational weight gain particularly in the anterior lower torso and greater hemodynamic changes [11]. These two factors may further affect balance maintenance ability. Hence, it can be assumed that during twin pregnancy balance controlis disturbed even more than in singleton pregnancy.

As there is a paucity of literature regarding standing postural stability during twin pregnancy, the purpose of this study was to investigate using a n-of -1 design [12] the changes in standing postural stability during twin pregnancy in comparison to a control non-pregnant woman.

Based on the known changes in postural balance of single child pregnancy [1,3,4], our hypothesis was that twin pregnancy would be accompanied by additional changes in postural control of COP's sway, mainly during the third trimester, asthe presence of two fetuses may cause greater diversifications of weight distribution and larger inertial issues to be resolved and consequent balance reactions.

Materials and Methods

The study was approved by the local ethical committee of the Academic College at Wingate, Israel.

Participants

A naturalistic single system design was used as the intervention (pregnancy) was not controlled by the investigator [12]. One biparous woman (aged 31.5 years, height 1.77 meter, mass 64 kilograms prior to pregnancy), carrying twins, participated as the case to be studied. During the pregnancy period, she maintained herroutine daily activities and her (non-sedentary) work, and was monitored by ultrasound each month for size and movements of the fetuses. Data

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Citation: Vardi S, Hellerstein D, Gilleard W, Dunsky A(2017) Standing Postural Control during Twin Pregnancy: Case Study. Int J Clin Case Stud 3: 119. doi: https://doi.org/10.15344/2455-2356/2017/119

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collection of postural stability began on the ninth week of pregnancy, and was repeated each month. In total, eight assessments were conducted during the pregnancy, one assessment three weeks after delivery and a final assessment, 12 weeks after delivery.

It is possible that changes seen over the pregnancy may have been variability associated with retesting. One nulliparous control participant (aged 34, 1.63 meters, 62.3 kilograms), was tested three times 4 weeks apart, in order to investigate the natural variability associated with retesting.

Measures

The assessment ofpostural control was carried out by the Tetrax©posterography stabilometry system (BeamMed Ltd [Sunlight], PetachTikva, Israel) sampling at 32 HZ. The Tetrax analysis is based on the vertical pressure applied via the heels and the toes during standing in an upright position on four plates.Data collection was documented in eight different conditions. At each time, the participant was instructed to maintain upright position without moving for 30 seconds. The weight of the participant is automatically accounted for by the software, while height does not interfere with the Tetrax parameters [13]. Previous studies demonstrated reliability of the Tetrax device (ICC2,1) with fall index and stability indexreported to be 0.858 and 0.850 respectively [14].

In the current study, the following factors, computed by the Tetrax program were evaluated: 1) Stability Index (ST): Representing the general stability. The total amount of sway of COP from the four footplates is totaled and then divided by the participant's weight. A higher score indicates greater sway and higher instability; 2) COP's path and location: graphical illustration of COP path and mean location relative to the four footplates; 3) Weight Distribution Index (WDI): Describing the amount of unevenness anddiscrepancy of weight distribution. The score of this measure reflects the percentage of weight placed on each platform (4 different values); 4) Falling Index (FI): Calculation ofnumber of standard deviations the performance of the examinee deviates from the mean of the normative database (for matched age and gender) at each condition.The higher the FI the higher the risk of a fall. In general the ranges 0 to 36, 37 to 40, and >41, indicate low, moderate or high risk of falling, respectively, among young population [13,14].

The postural control was measured in eight conditions: (a) normal open position (NO): standing straight with eyes open; (b) normal closed position (NC): standing straight with eyes closed; (c) pillows open: standing on pillows, with eyes open; (d) pillows closed: standing on pillows, with eyes closed; (e) head right: standing with the head turned right and eyes closed; (f) head left: standing with the head turned left and eyes closed; (g) head back: standing with head tilted backward at a 30-degree angle, with eyes closed; and (h) head forward: standing with head tilted forward about 30 degrees, with eyes closed. In each condition, one trial was performed [13]. FI was calculated based on all positions, however for ST and WDI measures in the current report only the two conditions of NO and NC are discussed.

Data analysis

The pregnant participant data was graphed [12]. The natural variability with re-testing was established by calculating the mean ± 2 SE of the control particpant data. Results are based on visual interpretation of the graphs and a change was considered significant if it was larger than the established variability.

Results

Weight, FI scores and ST scores for standing with eyes open and eyes closed position, from 10 assessment sessions of the pregnant participant are presented in Table 1. During the pregnancy, mass increased by 14.8 kg,and then decreased after deliveryto near pre pregnancy levels (Table 1). These mass changes are considered to be similar to the weight gain for a underweight/normal twin pregnancy [15]. The increased mass was accompanied with an increase in size of both fetuses, as measured by ultrasound. In addition, monitoring showed that the bigger fetus was present on the right side of the womb. The birth weight of the fetuses were 2.860 and 2.370 kg.

NC-ST score***	NO-ST score***	FI score**	mass- kg	Week of pregnancy*	test No
11.86	8.96	12	65.6	9	1
13.84	8.46	12	66.4	13	2
14.15	8.07	12	69.2	17	3
15.84	8.95	8	71.5	21	4
12.30	8.56	14	73.2	25	5
14.30	8.72	8	76.1	29	6
12.81	8.33	32	76.5	33	7
15.20	8.88	26	78.8	37	8
10.18	8.99	22	63.9	3 weeks post birth	9
13.95	9.59	24	65.7	12 weeks post birth	10

Table 1: Detailed weight, FI and ST scores for each assessment (1-10) of the pregnant participant.

* Mass prior to pregnancy was 64 kg
**Numerical ranges 0 to 100, the higher the score the higher the risk of falling.
*** Normative value ranges between 10 to 20, and between 15-25 for NO-ST and NC-ST respectively.The higher the score the greater the instability [13,14].

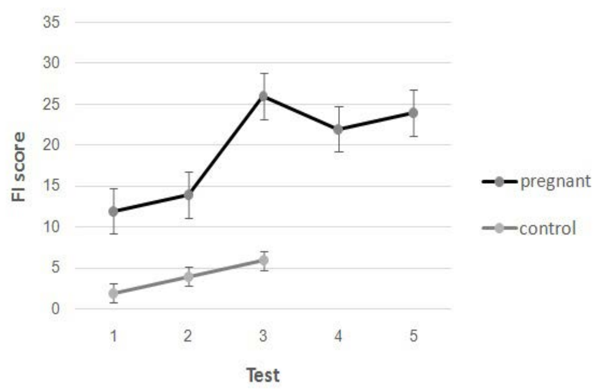

Figure 1: FI (Fall Index) scores ± SE of the pregnant participant at the end of each trimester (1-3) and 3 weeks (4) and 12 weeks (5) after delivery, and of the control participant at each test (1-3). FI score is calculated from all 8 positions tested and represents the performance of the examinee comparing to population. FI is better when the score is lower.

The scores ±SE of NO-ST, and NC-STat the end of each trimester of pregnancy and after delivery, and three assessments of the control participant are presented on Figure 2a and Figure 2b, respectively.

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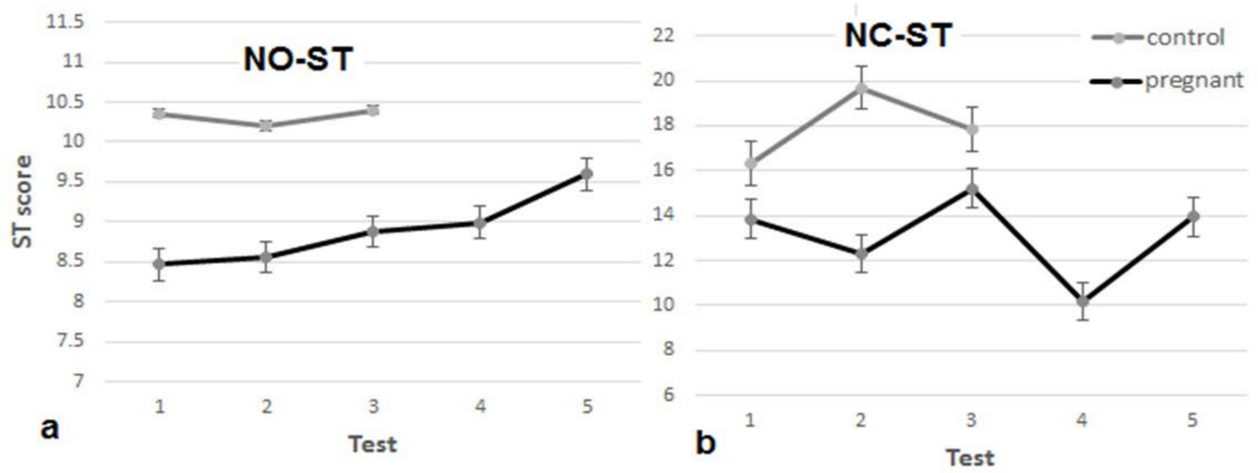

Figure 2: (a). NO-ST (general stability with eyes open) scores ± SE of the pregnant participant at the end of each trimester (1-3) and 3 weeks (4) and 12 weeks (5) after delivery, and of the of the control participant at each test (1-3). ST is better when the score is lower. (b). NC-ST (general stability with eyes closed) scores ± SE of the pregnant participant at the end of each trimester (1-3) and 3 weeks (4) and 12 weeks (5) after delivery, and of the of the control participant at each test (1-3). ST is better when the score is lower.

As can be seen, for both conditions, the pregnant participant had lower ST scores in comparison to the control participant during all assessment sessions. In addition, NO-ST was very similar over all test session during pregnancy and post birth.As can be seen in Figure 2b, NC-ST had a slight rise between second and third trimesters (2.9 points), however this was smaller than the variability shown with the retest sessions of the control participant (3.4 points).

As for the WDI, during the first and second trimesters, weight bearing at NO position was higher on the toes in comparison to the heels in both RT and LT legs. In the third trimester, weight bearing shifted towards the heels and was higher on the LT leg, as shown in Figure 3a. Regarding NC position (Figure 3b), at all times weight bearing was higher on the toes in comparison to the heels and higher on the LT foot comparing to the RT.In the third trimester, in this

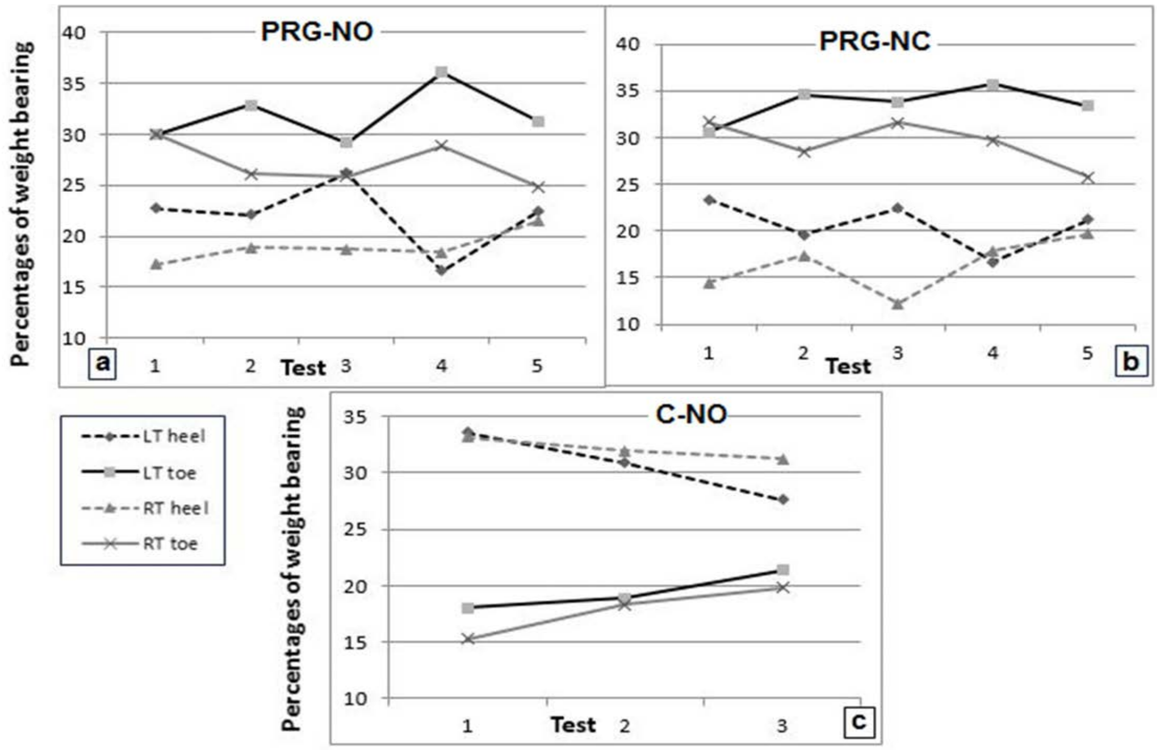

Figure 3: (a).PRG-NO. The percentage of weight bearing (WDI) on each one of the 4 platforms (LT heel, LT toes, RT heel, RT toes), of pregnant participant at the end of each trimester (1-3) and 3 weeks (4) and 3 months (5) after delivery, in eyes open position. During pregnancy weight bearing shifts backwards and to the left.(b).PRG-NC. The WDI on each one of the 4 platforms (LT heel, LT toes, RT heel, RT toes) of pregnant participant at the end of each trimester (1-3) and 3 weeks (4) and 3 months (5) after delivery, in eyes closed position. At all times weight bearing is higher on the toes comparing to heels and during pregnancy is higher on the LT foot comparing to the RT.(c). C-NO - The WDI on each one of the 4 platforms (LT heel, LT toes, RT heel, RT toes) of the control participant at each test (1-3), in eyes open position. Throughout tests, weight bearing remains similar and higher on the heels comparing to toes.

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condition we see the lowest record of weight bearing on the RT heel and similar weight bearing (about 33%) on the toes of both legs.As can be seen in Figure 3c, the weight bearing of the control participant was higher on the heels in comparison to the toes, with almost no changes between assessment sessions.

Figure 4 presents the COP location and path during the NO condition, in the first assessment (during the first trimester) in comparison to the eighth assessment (during the third trimester). COP location underwent changes during pregnancy, and moved backwards and slightly left,while increasinganterior-posterior path length. No changes were shown in the COP sway patterns of the control participant.

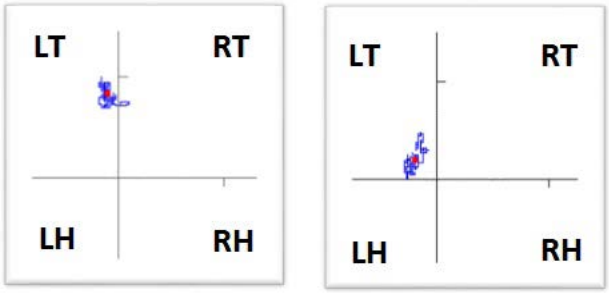

Figure 4: COP's path and location on the 1st testsession (left) and the 8th test session (right), standing with eyes open position. Quarters match a neutral standing.

Discussion

The purpose of the current study was to evaluate standing postural control changes during twin pregnancy. A non pregnant participant was investigated to establish test retest variability. The main results imply a general higher instability accompanied by higher COP sway while eyes closed and by changes in the weight distribution during the third trimester. These changes were more than test retest variability [14]. According to Oliveira et al. [16], changes and asymmetric distribution of body mass may be the main cause of the changes inbody sway during pregnancy. As two fetuses generally weigh more than one, these changes in body mass distribution, as well as COP swayare expected to be higher than in a single fetus pregnancy. In the current study, changes of COP swayand body mass distribution of the twinpregnant participantwas compared to a non-pregnant participant. As can be seen in Figure 1, the change in FI between the second and third trimesters (12 points) of the pregnant participant were three times higher in comparison to the changes found in that index over the three assessments of the non-pregnant participant (4 points). Although the pregnant participant showed much higher FI scores (indicating more pronounced deviations and oscillations of the postugraphic wave), they remained below 36 at all times, reaching a maximal score of 32 during the third trimester, indicating a low risk of falling respective to the population [13].These results are in line with the results of Inanir et al [4] who found the greatest instability during standing with eyes open in the third trimester of 80 singleton pregnant women.

The pregnant participant was relatively unstable in the third trimester in comparison to her matched age population and to her own balance ability at the early stage of pregnancy. This result is in agreement with the results of McCrory et al. [3] who assessed the influence of the progress inpregnancy on the dynamic stability, and found greater changes in the last stage of pregnancy. The differences found in the current study, as well as in the other studies, are probably the results of changes in the COP sway pattern during pregnancy. It is suggested that both fetus weight and fetus degree of activity may influence the COP sway pattern, by changing the amount of sway orits velocities [11,17].

In the current study, the general stability (which was calculated by the change in total amount of COP sway divided by weight) among assessments during the eyes open condition (NO-ST) was very limited for both participants. For the eyes closed condition (NC-ST), a slight increase in swaywas found between second and third trimesters in the pregnant participant. These results are not consistent with those found by McCrory et al[3]who found a significant decrease in the length of COP sway of 41 singleton pregnant women from the middle of the second trimester to the third trimester.

McCrory et al. [17] found that fallers showed shorter as well as slower paths of COP sway, in comparison to non-fallers. The researchers suggested that it is possible that the decrease in COP movement implies greater stiffness that might cause a fall.In this matter, in the current study it was found that the pregnant participant had lower ST scores than the control participant in both conditions (NO and NC, see Figure 2a-b), which implies a shorter COP movement. In addition, her FI score were higher in comparison to the control participant (Figure 1). Therefore, two factors support that the twin pregnancy participant may be at a higher risk of falling.

One noticeable result found in the current study, mainly during the third trimester of pregnancy, is the change in weight distribution (which was not shown in the control participant). As can be seen in Figure 4, which illustrates COP path during NO condition,between first assessment and the eighth assessment (during thethird trimester) the COP moved backwards and to the left, withthe sway pattern changing from medio-lateral to more anterior-posterior movements. This trend is in line with Oliveira et al. [16] who found an increase in the anterior-posterior sway as a reaction to increasing body weight in the sagittal plane during pregnancy. The shifting of COP to the left found in the current study is suggested to occur as a compensation reaction to the presence of the bigger fetus on the right side. This suggestion is based on ultrasound tests that the pregnant participant performed during the pregnancy, which revealed a larger fetus located at the right side of the womb. In addition, according to the participant's reports, the bigger fetus was significantly more active compared to the smaller one. Therefore, it is possible that this uneven weight distribution and inner movements of the fetuses challenged the postural stability systems and forced the participant to adopt a matching reaction, which led her shifting weight towards the left heel.

In the matter of gaining postural balance following delivery, Butler et al. [1]has shown that stability recovers six-eight weeks after delivery, and Opala-Berdzik et al. [10] showed that the changing location of COG following pregnancy is temporary and returns to its original place two months after delivery.In the current study, general stability (FI and ST) scores did not return to baseline as far as three months after delivery. Rapid weight decrease, abdominal muscles which are still not able to work effectively [7] and slow adaptation of the postural control systems may cause instability during the first months following delivery. It is possible that immediately after delivery, balance control systems are not yet synchronized with the body's new dimensions and will not react appropriately to changing balance events.

Conclusions

The major periods of instability that were found in the current study occurred during the third trimester and three months following delivery, thus we advise to take extra caution for fall prevention during these periods.

It was shown that twin pregnancy leads to special standing postural control strategies. This effect may lead to the development of a strategy for weight distribution as a way to adjust to the differences in mass and locations of the fetuses. It might be assumed that twin pregnancy has an additional effect on balance control, in comparison to a singleton pregnancy. In the current study, the postural control of a twin pregnant subject was compared to a non-pregnant subject. The differences in postural strategies between twin pregnant and singleton pregnant women should be explored in future studies.

Competing Interests

The authors declare that they have no competing interests.

Acknowledgments

We thank the participants in the study for their cooperation.

References

1. Butler EE, Colón I, Druzin ML, Rose J (2006) Postural equilibrium during pregnancy: decreased stability with an increased reliance on visual cues. Am J Obstet Gynecol 195:1104-1108.
2. Dunning K, LeMasters G, Levin L, Bhattacharya A, Alterman T, et al. (2003) Falls in workers during pregnancy: risk factors, job hazards, and high risk occupations. Am J Ind Med 44:664-672.
3. McCrory JL, Chambers AJ, Daftary A, Redfern MS (2010) Dynamic postural stability during advancing pregnancy. J Biomech 43:2434-2439.
4. Inanir A, Cakmak B, Hisim Y, Demirturk F (2014) Evaluation of postural equilibrium and fall risk during pregnancy. Gait Posture 39: 1122-1125.
5. Niebyl JR(2010) Nausea and vomiting in pregnancy. The New England Journal ofMedicine 363:1544-1550.
6. Yu Y, Chung HC, Hemingway L, Stoffregen TA (2013)Standing body sway in women with and without morning sickness in pregnancy. Gait Posture 37: 103-107.
7. Gilleard WL, Brown JM (1996) Structure and function of the abdominal muscles in primigravid subjects during pregnancy and the immediate postbirth period. Phys Ther 76: 750-762.
8. Nagai M, Isida M, Saitoh J, Hirata Y, Natori H, et al. (2009) Characteristics of the control of standing posture during pregnancy. Neurosci Lett 462: 130-134.
9. Whitcome KK, Shapiro LJ, Lieberman DE (2007) Fetal load and the evolution of lumbar lordosis in bipedal hominins. Nature 450: 1075-1078.
10. Opala-Berdzik A, Bacik B, Cieślińska-Świder J, Plewa M, Gajewska M (2011) The influence of pregnancy on the location of the center of gravity in standing position. J Hum Kinet 26:5-11.
11. Rao A, Sairam S, Shehata H (2004) Obstetric complications of twin pregnancies. Best Pract Res Clin Obstet Gynaecol 18: 557-576.
12. Kravitz RL,Duan N (Eds.) (2014) Design and implementation of N-of-1 Trials: A User's Guide. Rockville, MD: Agency for Healthcare Research and Quality.
13. Kohen-Raz R (1991) Application of tetra-ataxiametric posturography in clinical and developmental diagnosis. Percept Mot Skills 73:635-656.
14. Akkaya N, Doğanlar N, Çelik E, Aysşe SE, Akkaya S, et al.(2015) Test-retest reliability of Tetrax ® Static Posturography System in young adults with low physical activity level. Inter JSports Phys Ther10: 893-900.
15. Lal AK, Kominiarek MA (2015) Weight gain in twin gestations: are the Institute of Medicine guidelines optimal for neonatal outcomes? J Perinatol 35:405-410.
16. Oliveira LF, Vieira TMM, Macedo AR, Simpson DM, Nadal J (2009) Postural sway changes during pregnancy: a descriptive study using stabilometry. Eur J Obstet Gynecol Reprod Biol 147: 25-28.
17. McCrory JL, Chambers AJ, Daftary A, Redfern MS (2010) Dynamic postural stability in pregnant fallers and non-fallers. BJOG 117:954-962.