

Sitting posture affects pelvic floor muscle activity in parous women: An observational study

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Question Do different sitting postures require different levels of pelvic floor and abdominal muscle activity in healthy women? **Design** Observational study. **Participants** Eight parous women with no pelvic floor dysfunction. **Outcome measures** Bilateral activity of pelvic floor muscles (assessed vaginally) and two abdominal muscles, obliquus internus abdominis and obliquus externus abdominis, during three sitting postures. **Results** There was a significant increase in pelvic floor muscle activity from slump supported sitting (mean 7.2% maximal voluntary contraction, SD 4.8) to both upright unsupported sitting (mean 12.6% maximal voluntary contraction, SD 7.8) ($p = 0.01$) and very tall unsupported sitting (mean 24.3% maximal voluntary contraction, SD 14.2) ($p = 0.004$). Activity in both abdominal muscles also increased but did not reach statistical significance. **Conclusion** Both unsupported sitting postures require greater pelvic floor muscle activity than the supported sitting posture. [Sapsford RR, Richardson CA and Stanton WR (2006) Sitting posture affects pelvic floor muscle activity in parous women: An observational study. *Australian Journal of Physiotherapy* 219–222]

Key words: Physical Therapy Modalities, Pelvic Floor Muscles, Abdominal Muscles, Sitting, EMG

Introduction

The pelvic floor is part of the musculoskeletal capsule surrounding the abdominal and pelvic organs. It contributes to continence, pelvic organ function, generation of intra-abdominal pressure, antigravity support, and lumbo-pelvic stability (Berglas and Rubin 1953, Cresswell et al 1992, Deindl et al 1993, Messelink et al 2005, O'Sullivan et al 2001). Ineffective functioning of the pelvic floor muscles can be a factor in urinary incontinence, vaginal prolapse, obstructed defaecation, and low back pain (Devreese et al 2004, Gilpin et al 1989, Markwell 1998, O'Sullivan et al 2002a).

It is well recognized that pelvic floor muscle activity is required to maintain continence and organ support during increases in intra-abdominal pressure during coughing and lifting (Deindl et al 1993, Hemborg et al 1985). Sustained pelvic floor muscle activity has been demonstrated in a variety of positions (Deindl et al 1993) and it is a contributing factor in maintaining continence as the bladder is filling (Vereecken and Verduyn 1970). It is an important factor in pelvic organ support against gravity (Shafik et al 2003). Abdominal muscle activity has also been demonstrated in standing (O'Sullivan et al 2002b). The relationship between pelvic floor and abdominal muscle activity (Neumann and Gill 2002, Sapsford et al 2001) is such that even low levels of pelvic floor muscle activity in standing are difficult to achieve without accompanying abdominal muscle activity (Neumann and Gill 2002).

Body position has a marked effect on pelvic floor muscle activity, which increases from lying to sitting and increases further still in standing (Vereecken et al 1975). Bo and

Finckenhagen (2003), Morgan et al (2005), and Shafik et al (2003) have investigated the changes in pelvic floor muscle activity from lying to standing. However, although changes in abdominal muscle activity have been demonstrated with changes in sitting posture (O'Sullivan et al 2002b), no study to date has examined pelvic floor muscle activity in different sitting postures. The aim of this study, therefore, was to investigate the effect of different sitting postures on pelvic floor and abdominal muscle activity in healthy women to examine whether some postures require higher levels of muscle activity.

Method

Participants Women were included in the study if: they had had one or more vaginal deliveries, their weight was within normal limits, they were aged between 18 and 70 years, and they had no pelvic floor dysfunction. They were excluded if they: were unable to comprehend English, were pregnant or had been pregnant within the last 12 months, had chronic or acute low back pain, had chronic constipation or a chronic or acute respiratory condition, had a neurological condition, had a previous history of surgical vaginal repair, or were currently or had recently been involved in intensive abdominal fitness training. Eight women with a mean age of 46 years (range 32–66), parity of 2.8 (range 1–4), and body mass index of 23.8 (range 19.6–26.3) were recruited. Informed consent was gained prior to data collection. The study was approved by the human research ethics committees of the University of Queensland and the Mater Health Services.

Procedures Pelvic floor and abdominal muscle activity was recorded via surface electromyography (EMG). Pelvic floor muscle activity was collected using a vaginal Periform

probe^(a). The probe was inserted with the two opposing electrodes on the probe in contact with the lateral vaginal walls. The probe had a flange that fitted firmly against the vaginal introitus (Figure 1). Pairs of silver/silver chloride electrodes were positioned on the abdominal wall to record obliquus externus abdominis and obliquus internus abdominis bilaterally. The position of the electrodes was determined with participants in standing to account for skin movement in parous women. Electrodes were positioned according to Ng et al (1998) with an inter-electrode distance of 1–1.5 cm. Electrodes to record obliquus externus abdominis were positioned just inferior to the 10th rib in a line joining the most inferior point of the costal margin of the ribs and the contralateral pubic tubercle. Electrodes to record obliquus internus abdominis were positioned immediately medial to the anterior superior iliac spine along a line joining both spines. Reference electrodes were positioned either over the tibial tuberosity or on the ulna just inferior to the olecranon. The skin was cleaned to reduce electrical impedance (Turker 1993). EMG data were recorded on AMLAB^(b) and stored on computer for later analysis. The EMG signal was sampled at 2000 Hz and band pass filtered between 20 and 2000 Hz.

It was confirmed that all participants were able to achieve a pelvic floor muscle contraction, with perineal movement in a cephalad direction with contraction, and in a caudal direction with relaxation (Bo et al 1990). Participants emptied the bladder to standardise bladder volume. Then maximal voluntary contractions (MVC) of the abdominal and pelvic floor muscles were performed in upright unsupported sitting to act as a reference. A rapid maximal expiratory effort from a full inspiration, blowing through a filtered mouthpiece into a spirometer with a sustained breath hold at the end of the airflow, was used to produce maximal abdominal muscle activity (Richardson et al 2002). A maximal voluntary contraction of pelvic floor muscles was also recorded for 3 s.

Pelvic floor and abdominal muscle activity was then recorded in three sitting postures – slump supported, upright unsupported, and very tall unsupported sitting (Figure 2). Participants were seated on a broad-topped stool, with feet well supported on the floor. The seat height was adjusted for comfort as necessary. The non compressible surface of the seat featured a cut out area to prevent pressure on the vaginal probe. The back support, required for the slumped posture, was provided by a padded curved band, 19 cm deep, attached to an adjustable wall support and positioned at the level of the mid-thoracic spine. Participants were asked to assume sitting postures supported against the back support and upright without support. In the very tall unsupported sitting position, participants were asked to sit tall 'like a dancer'. Muscle activity was recorded for 10 s while participants were asked to remain looking directly ahead without moving or talking, and breathing normally. Two to three trials were recorded of each posture. The order of postures was randomised for each participant. After recording in each posture, participants were asked to provide an assessment of the activity in their abdominal and pelvic floor muscles.

Data analysis The root mean square of a 400 ms segment of EMG data between heart beats was determined for pelvic floor and abdominal muscles. The mean of right and left abdominal muscles was used. Data from three trials were averaged for the slump supported and upright unsupported

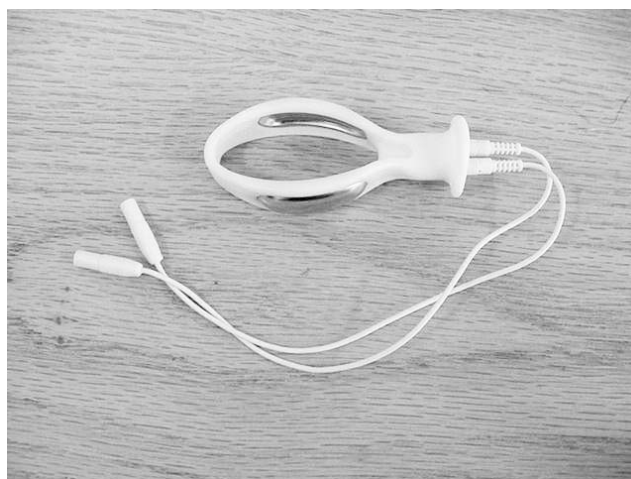


Figure 1. A Periform probe, used intravaginally, to monitor pelvic floor muscle EMG activity. The electrodes, seen as the metal strips on each side of the probe, make firm contact with the lateral vaginal walls and the flange remains external against the vaginal introitus.

positions while data from two trials were averaged for the very tall unsupported position. Muscle activity is reported as a percentage of MVC, averaged from two trials. Data from the abdominal muscles were not available from two participants due to technical difficulties.

Repeated measures ANOVA was conducted to examine differences across sitting postures (slump supported, upright unsupported, and very tall unsupported) for each muscle (pelvic floor muscle, obliquus internus abdominis, and obliquus externus abdominis). A priori simple contrasts were used to test for statistically significant differences between upright unsupported, very tall unsupported, and the slump supported sitting posture.

Results

Muscle activity of the pelvic floor muscles, obliquus internus abdominis and obliquus externus abdominis during three sitting postures (slump supported, upright unsupported, and very tall unsupported sitting) are shown in Table 1. Analysis of variance showed a significant overall effect across sitting postures for the pelvic floor muscles ($p < 0.001$), obliquus internus abdominis ($p = 0.02$), and obliquus externus abdominis ($p = 0.05$). Significantly greater muscle activity was required by the pelvic floor muscles in upright unsupported ($p = 0.01$) and very tall unsupported ($p = 0.004$) sitting compared to slump supported sitting. This was not the case for obliquus internus abdominis in upright unsupported ($p = 0.08$) and very tall unsupported ($p = 0.06$) sitting compared to slump supported sitting. Neither was it the case for obliquus externus abdominis in upright unsupported ($p = 0.54$) and very tall unsupported ($p = 0.09$) sitting compared to slump supported sitting.

Six out of eight participants reported the sensation of most pelvic floor muscle activity in the very tall unsupported posture, followed by the upright unsupported posture, followed by the slump supported sitting posture.

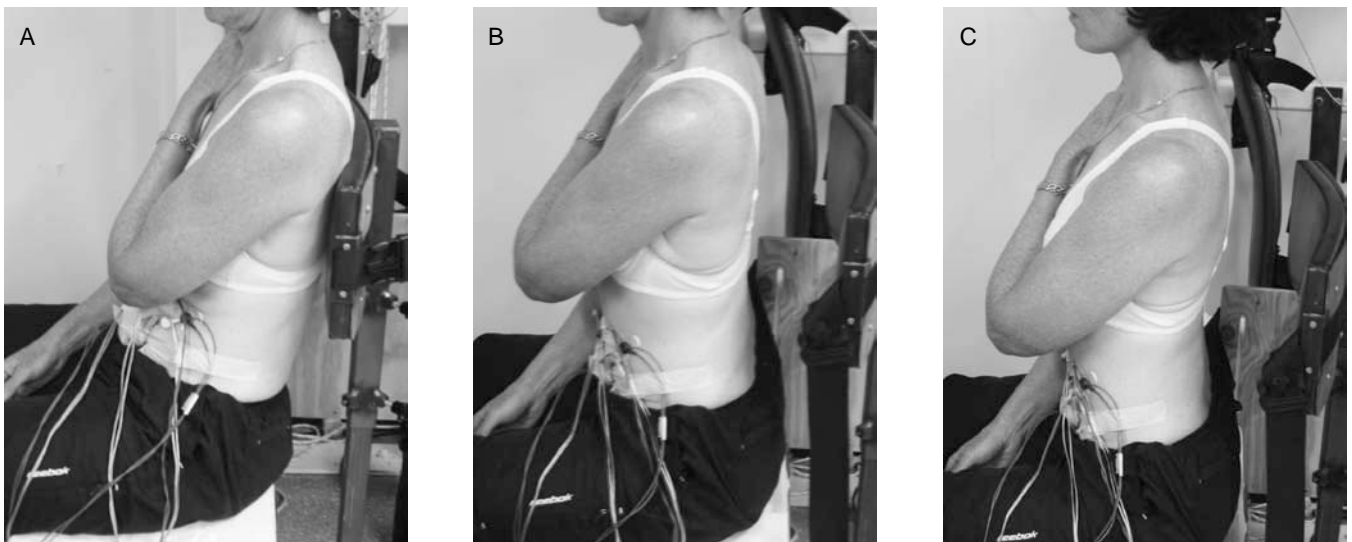


Figure 2. Sitting postures (a) slump supported, (b) upright unsupported, and (c) very tall unsupported showing placement of electrodes recording abdominal muscle activity.

Table 1. Mean (SD) pelvic floor and abdominal muscle activity as %MVC during different sitting postures.

Sitting postures	Pelvic floor muscles n = 8	Obliquus internus abdominis n = 6	Obliquus externus abdominis n = 6
Slump supported	7.20 (4.78)	6.46 (3.45)	7.86 (6.70)
Upright unsupported	12.61 (7.80)	10.12 (6.91)	9.82 (5.16)
Very tall unsupported	24.25 (14.19)	22.25 (19.30)	20.18 (15.54)

Discussion

This is the first study to record pelvic floor muscle activity in different sitting postures. It has shown that pelvic floor muscle activity increases with more upright postures. More pelvic floor muscle activity was found in upright unsupported compared to slump supported sitting, and in very tall unsupported compared to slump supported sitting. These results provide information on the importance of pelvic floor function in sitting posture. Although there was also an increase in abdominal muscle activity with more upright postures, the changes did not reach significant levels. This differed from the results of O'Sullivan et al (2002b) who found that activity in obliquus internus abdominis was significantly greater in the upright sitting posture. However, O'Sullivan et al (2002b) recorded from 20 people, in comparison with six women in this study. In addition, the submaximal standardised action they chose for abdominal muscle standardisation was a crook lying bilateral leg raise with heels held 5 cm above the bed. Compared with the supported position in our study, O'Sullivan and colleagues chose an unsupported posture which was maintained for only three seconds. In unsupported slumped sitting it is likely that the posture would be maintained by spinal ligamentous structures with minimal abdominal muscles activity. In our study the back rest provided trunk support in the slump supported sitting position, supposedly relieving the abdominal muscles of the need to contribute to antigravity support.

A limitation of this study has been the monitoring of activity only in the superficial abdominal muscles. However, surface electrodes monitoring activity in obliquus internus abdominis may have recorded activity from the underlying transversus abdominis. It is known that transversus abdominis acts in synergy with the pelvic floor muscles so that an increase in pelvic floor muscle activity is accompanied by an increase in transversus abdominis activity (Sapsford et al 2001). In addition, the pelvic floor muscles arise partially from fascia overlying obturator internus, which externally rotate the hip. Cross talk from these muscles could have affected the pelvic floor muscle EMG activity. However, the fact that there was no hip movement during testing would have reduced this likelihood. As well, other variables such as intra-abdominal pressure and breathing patterns that may affect pelvic floor muscle function have not been considered in this study. Investigation of intra-abdominal pressure and transversus abdominis, as well as pelvic floor and superficial abdominal muscles, would increase our understanding of the muscle activity associated with different sitting postures.

This study has examined pelvic floor and abdominal muscle activity in healthy women. Urinary incontinence is a major health problem (MacLennan et al 2000) and most of those with symptoms have weak pelvic floor muscles with less endurance than their continent counterparts (Morkved et al 2004, Gunnarsson and Mattiasson 1999). Investigation of the muscle activity associated with different sitting postures should be conducted in women suffering from urinary

incontinence to point the way to optimal positions to use in pelvic floor muscle rehabilitation.

Footnotes ^(a)Neen Healthcare, UK ^(b)AMLAB Technologies, Australia

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