Intra-Abdominal Pressure during Pilates: Unlikely to Cause Pelvic Floor Harm
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4506704/
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I. Introduction
a. 1/4 women has a symptomatic pelvic floor disorder (PFD)
b. 1/10 women undergoes surgery for PFD
   i. 30% return for surgical reoperation
c. In effort to minimize intra-abdominal pressure (IAP) or pelvic floor loading, clinicians often recommend short or long-term activity restrictions for women with PFDs or after surgical intervention.
   i. “While the relationship between IAP and progression or recurrence of PFDs is not clear, the fact remains that clinicians often restrict activity in hopes of minimizing the rise in IAP with strenuous activity, sometimes to the detriment of patients’ health and wellbeing.”
d. Authors of this study postulated that they could formulate an exercise routine that does not raise IAP beyond a given threshold
   i. To provide concrete advice or recommendations for patients and clinicians
e. Pilates was chosen as exercise mode (Pilates Method Alliance)
   i. Pilates Mat
   ii. Pilates Reformer

II. Aim/Primary Aim:
a. Describe IAPs generated during specific Pilates Mat and Reformer activities and determine whether these activities generated IAP above a sit-to-stand threshold
   i. Secondary aim
      1. Compare IAPs during selected Mat and Reformer activities

III. Study Design/Study Format:
a. Descriptive study

IV. Methods:
a. Participants
   i. Twenty healthy women, with median age 43 (age range 22-59 years)
      1. 30% nulliparous
      2. BMI 19-30 km/m^2
      3. Prior Pilates experience
b. IAP monitoring
   i. Wireless remote abdominal pressure system
      1. Intravaginal pressure sensor
         a. Participants were given written instructions of self-insertion after voiding
      2. Portable base station
         a. Secured at participant’s hip
   ii. Data was then analyzed for maximal and area under the curve (AUC) IAP
      1. Averaging the 10 maximal peaks in the waveform each separated by one second
         a. Mean maximum IAP statistics were calculated based upon the average of the subject population
         b. Each individual woman’s mean max IAP for each exercise compared against her mean max IAP during her sit-to-stand
      2. AUC
         a. Standardized repetitions, not duration of each exercise, as each woman competed it at her own rate
b. Calculated AUC over 40 cm H20 to highlight degree to which exercises elevated AUC over walking slowly

c. **Exercise Protocol**
   i. 22 Pilates exercises chosen to closely resemble an introductory Mat and Reformer class
      1. During class, instructor did not provide any cues to contract the PFM
      2. First performed 5 baseline activities and threshold activity (STS)
         a. Supine, sidelying, prone, quadruped, standing
         b. Sit-to-stand
            i. Hands crossed on chest, to metronome 40 bpm for 30 seconds
      3. Then, either performed 11 Mat or 11 Reformer exercises, with alternating study days
         a. Each exercises lasted approximately 1 minute
         b. 4-8 repetitions depending on the exercise, with repetition remaining consistent per exercise throughout the study
         c. Entire protocol lasted 1 hour and resembled class environment
            i. Rest periods variable
            ii. Completed at participant’s own rate
         d. If pressure sensor was displaced, it was readjusted in the restroom then activity was repeated

d. **History Information**
   i. Provided after protocol completion
      1. Age, weight, height, parity, number of Cesarean sections, number of vaginal deliveries, hysterectomy, length of Pilates experience, frequency in last 6 months using Pilates exercise, whether sensor fell out during study

e. **Data analysis**
   i. Wilcoxin signed-rank
      1. To determine if exercises were significantly different from STS activity
      2. Five comparisons between selected similar Reformer and Mat activities
   ii. Spearmann rank correlation
      1. Correlation between BMI, age, and Pilates experience with mean max peak IAP during Pilates Mat and Reformer exercises

V. **Results**
   a. All 20 women completed the exercise routine; two women were excluded due to device retention failure and abnormally low pressure data
   b. Mean average and range IAP during baseline activities are shown in Table 1
   c. Descriptive measures and comparisons of mean maximal IAP and AUC for sit-to-stand activity versus Pilates Mat and Reformer exercises are shown in Table 2 and Figures 1 and 2.
   d. **Group**
      i. There were no statistically significant differences in mean max IAP of the group between sit-to-stand and any of the Mat or Reformer exercises.
   e. **Individual**
      i. Six to twenty-five percent of women exceeded their individual STS thresholds for 10 of the 22 exercises (Figure 1, below the bars)
      1. Twenty-five percent of women exceeded their individual mean max IAP for the Reformer roll-up while thirteen percent did so during the Mat roll-up.
   f. **Figure 2**
      i. When measuring AUC from 0 cm H20, half the exercises exceeded the mean AUC of STS but only Pilates Reformer and Mat roll-ups exceeded the mean AUC of STS when calculated from a threshold of 40 cm H20 (consistent with walking, for example)

VI. **Discussion:**
   a. This study showed that mean max IAP for the population was not significantly higher during any of the exercises studied compared to a sit-to-stand.
b. “With few exception,” women did not exceed their own STS IAP threshold during neither Mat nor Reformer.
c. Researchers calculated an estimate of mean AUC during a typical post-operative day (sitting to standing before and after voiding and walking 5 mins 3x/day) (Figure 4)
   i. 31,694 cm H2O*sec
      1. Higher AUC than Mat and Reformer Pilates sessions combined
d. AUC not standardized for time represents the real-world situation of how women do a task
e. The Reformer roll-up produced a higher AUC compared to Mat
   i. Likely that participants were unable to fully relax during performance due to spring tension continuing to pull them upwards at the bottom of the exercise
f. 22 Pilates exercises chosen resemble an introductory class
   i. Many Pilates methodologies exist
      1. Cannot be extrapolated to other exercises
   ii. STS activity has substantial variability
      1. Chosen for clinical relevance and standardized with metronome bpm and time
g. Limitations
   i. Rest periods were not controlled between activities
   ii. Did not randomize the order of Mat vs Reformer Pilates
   iii. Did not randomize order of exercise activities
   iv. Breath control was cued by movement practitioner
   v. Indirect measurement of IAP rather than directly in the abdominal cavity
   vi. All women in this study were healthy and had previous Pilates experience

VII. Clinical Application
a. Results support recommending this series of introductory Pilates exercises including five Mat exercises and six Reformer exercises to women desiring a low IAP exercise routine

VIII. List discussion questions
a. Do any of you currently utilize these specific Pilates exercises with your patients? If so, do you use Mat or Reformer modes?
b. By this study, the following exercises that this study states does not raise IAP higher than STS that the study suggests “can be done in the post-operative period”:
   i. Mat
      1. Segmental bridges, Femur arc, Chest lift, Side-kick, Quadruped
   ii. Reformer
      1. Segmental bridging, Footwork, Supine arm work, Supine abdominals, Side-kick, Feet in straps
      a. Do you implement these exercises in treatments? What other Pilates-based exercises do you use?

IX. Other References:
a. Activity Restrictions after Gynecologic Surgery: Is There Evidence?
   i. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3774134/
b. The Effect of Commonly Performed Exercises on the Levator Hiatus Area and the Length and Strength of Pelvic Floor Muscles in Postpartum Women