

Thesis submitted for a Master of Science degree

Reykjavík, autumn 2009



**UNIVERSITY OF ICELAND
SCHOOL OF HEALTH SCIENCES
FACULTY OF MEDICINE**

**Pelvic floor muscle function before and after first childbirth
and women's perception of quality of the contraction**

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Ritgerð til meistaraþrófs

Reykjavík, haust 2009



**HÁSKÓLI ÍSLANDS
HEILBRIGÐISVÍSINDASVIÐ
LÆKNADEILD**

**Styrkur og úthald grindarbotnsvöðva
fyrir og eftir fyrstu fæðingu
og hvernig konur upplifa samdrátt vöðvanna**

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ÁGRIP

Bakgrunnur: Meðganga og fæðing um leggöng eru meðal helstu áhættuþátta í að veikja grindarbotnsvöðva og í þróun áreynsluþvagleka og sigs á líffærum grindarholshjá konum. Þessi þróun er talin stafa af skemmdum á bandvef, s.s. hinnum og liðböndum, grindarbotnsvöðvum og ítaugun þeirra. Allir þessir vefir, og samspil þeirra á milli, eru nauðsynlegir til að styðja við grindarholslíffærin og vegna þvag-og hægðaheldni.

Markmið: Meginmarkmið þessarrar rannsóknar var að meta styrk og úthald grindarbotnsvöðva fyrir og eftir fyrstu fæðingu og meta breytingar eftir tegund fæðinga (eðlilegra fæðinga um leggöng, inngripsfæðinga um leggöng og bráðakeisara). Einnig að fá fram lýsingar kvennanna sjálfra á upplifun þeirra á samdrætti grindarbotnsvöðva. Annað markmið var að kanna fylgni milli breytinga á starfsemi grindarbotnsvöðva, annars stigs fæðingar og annarra fæðingarbreyta.

Efni og aðferðir: Þessi rannsókn var framskyggn áhorfsathugun með endurteknum mælingum. Mælingar voru gerðar á styrk grindarbotnsvöðva hjá barnshafandi konum á 20.-26. viku meðgöngu og endurteknar 6-12 vikum eftir fæðingu. Úrtakið var þægindaúrtak. Fjörutíu og fjórar hraustar frumbyrjur sem gengu með einbura, staðfest með sönarrannsókn, voru sjálfboðaliðar í rannsókninni, 36 luku þátttöku. Meðalaldur þeirra var 26.6 ár (staðalfrávik 4.3), og BMI (líkamsþyngdarstuðull) fyrir meðgöngu var að meðaltali 24.1 (staðalfrávik 4.3). Rannsóknartækið var Myomed 932® (Enraf-Nonius, Delft, Netherland). Það var áreiðanleikaprófað fyrir aðalrannsóknina. Styrkur samdráttar grindarbotnsvöðva var mældur með nema í leggöngum sem nam þrýsting af samdrætti, mældur í hectoPascals (hPa) og úthald samdráttar var metið sem stöðugur samdráttur í sekúndum og sem endurteknir samdrættir. Eftir að hafa leiðbeint og frætt

konurnar um réttan samdrátt grindarbotnsvöðva sem var staðfestur með þreifingu í leggöngum, voru þær beðnar um að framkvæma; a) 3 hámarkssamdrætti, sá sterkasti notaður við tölfræðilega úrvinnslu, b) stöðugan samdrátt (jafnlengdar), tími í sekúndum notaður við úrvinnslu og c) endurtekna samdrætti, a.m.k. 15 samdrætti, fjöldi samdrátta notaður við úrvinnslu. Niðurstöður eru birtar sem meðaltöl með 95% öryggisbili. Einhliða dreifigreining var notuð til að bera saman breytingar á styrk og úthaldi grindarbotnsvöðva milli flokka mismundandi fæðinga. Spearman's raðfylgnistuðull var notaður til útreikninga á fylgni milli breytinga á styrk og úthaldi grindarbotnsvöðva vegna fæðingar og annars stigs fæðingar, og við aðrar breytur sem voru rað-og/eða flokkabreytur. Pearson's fylgnistuðull var notaður við útreikninga á samfelldum breytum. Marktækur munur var metinn nægur ef $p < 0.05$. SPSS v.16 (Chicago, Illinois) var notað við úrvinnslu.

Niðurstöður: Þegar hópar þátttakenda voru bornir saman, (eðlileg fæðing um leggöng ($n=26$), inngripsfæðing um leggöng (í öllum tilfellum með sogklukku) ($n=5$) og bráðakeisari ($n=5$)) kom í ljós marktækur munur á aldri og BMI eftir hópum, konur í bráðakeisarahópi voru að meðaltali, bæði eldri og með hærri BMI stuðul en konur í hinum hópunum. Ekki var marktækur munur eftir hópum m.t.t. meðalþyngdar-og ummáls höfuðs nýbura við fæðingu. Við upphaf rannsóknar, í fyrstu mælingu reyndist ekki marktækur munur á styrk og úthaldi grindarbotnsvöðva milli hópa. Hjá öllum hópnum varð marktæk styrk-og úthaldsminnkun (stöðugur samdráttur) eftir fæðingu miðað við ástand á meðgöngu ($p < 0.0001$). Hóparnir 3 sýndu mismunandi styrkminnkun: Eðlileg fæðing um leggöng, 20.1 hPa (95% öryggisbil: 16.2; 24.1), inngripsfæðing um leggöng, 31.4 hPa (95% öryggisbil: 7.4; 55.2) og bráðakeisari, 5.2 hPa (95% öryggisbil: -6.6; 17.0) minnkun í styrk.

Með einhliða dreifigreiningu var munurinn marktækur milli eðlilegra fæðinga um leggöng og bráðakeisara ($p=0.028$) og milli inngripsfæðinga og bráðakeisara ($p=0.003$). Ekki reyndist marktækur munur á styrkbreytingum hjá konum sem fóru í eðlilega fæðingu um leggöng eða inngripsfæðingu ($p=0.173$). Ekki fannst marktækur munur á breytingum í úthaldi grindarbotnsvöðva (mælt sem lengd samdráttar) vegna fæðingar, milli hópa ($p=0.212$). Úthaldsminnkunin mældist í sekúndum: Eðlileg fæðing um leggöng, 83.0 sek (95% öryggisbil: 44.4; 120.1), inngripsfæðingar um leggöng, 100.2 sek (95% öryggisbil: -39.7; 240.1), bráðakeisari, 2.4 sek (95% öryggisbil: 128.9; 255.3) minnkun. Allar konur gátu framkvæmt a.m.k. 15 endurtekna samdrætti, bæði á meðgöngu og eftir fæðingu fyrir utan eina, sem gat ekki spennt grindarbotnsvöðva 6 vikum eftir fæðingu. Lýsing flestra kvennanna á samdrætti grindarbotnsvöðva var skýr og virtist vera í samræmi við ástand vöðva á hverjum tíma. Engin fylgni fannst milli breytinga á styrk ($p=0.650$) og úthaldi ($p=0.810$) grindarbotnsvöðva annars vegar og lengdar á öðru stigi fæðingar hins vegar, né annarra fæðingarbreyta. Engin fylgni fannst milli breytinga á styrk og úthaldi grindarbotnsvöðva og fæðingarþyngdar eða höfuðummáls nýbura, fyrir allar konur sem fæddu um leggöng ($n=31$).

Ályktun: Miðað við þetta úrtak var styrkur grindarbotnsvöðva marktækt minnkaður eftir fæðingu um leggöng, bæði eftir eðlilega fæðingu og með inngripum, 6-12 vikum eftir fæðingu. Aðrir þættir vöðvavinnu, þ.e. úthald, mælt sem getan til að halda samdrætti stöðugt og endurteknir samdrættir, urðu fyrir minni áhrifum af tegund fæðingar. Engin marktæk fylgni fannst milli allra helstu fæðingarbreyta og breytinga á starfsemi grindarbotnsvöðva vegna fæðingar. Smæð úrtaksins gæti hafa haft áhrif á niðurstöðurnar, svo og há staðalfrávik og stór öryggisbil allra helstu gilda. Túlka ætti niðurstöður af varfærni.

ABSTRACT

Background: Pregnancy and vaginal delivery are considered to be the main risk factors for weakening the pelvic floor muscles (PFM) as well as for the development of stress urinary incontinence (SUI) and pelvic organ prolaps (POP) in women. This is considered to happen due to damage to fascias, ligaments, PFM and nerve supply. All this tissue and their interactions are necessary for pelvic organ support and for the control of the continence mechanism.

Aims: The main aim of this study was to evaluate pelvic floor muscle strength and endurance before and after a woman's first childbirth and compare these parameters with different types of births (normal vaginal, instrumentally assisted vaginal and acute cesarean births). The aim was also to gain qualitative information of women's perception of PFM contraction. The secondary aim was to correlate changes in pelvic floor muscle function due to childbirth with factors such as the length of the second stage of labor along with other delivery data.

Material and methods: This was a prospective repeated measures observational study. The women were evaluated at the 20th - 26 weeks of gestation and at the 6th – 12th week postpartum. The sample was a non-randomized, convenience sample. Forty-four healthy primiparas with a confirmed singleton pregnancy volunteered to participate in the study, 36 had both measurements. The mean age of the participants was 26.6 (SD 4.3) years and pre-pregnancy BMI was 24.1 (SD 4.3). The device used for measurements was Myomed 932® (Enraf-Nonius, Delft, Netherland). The device was tested for reliability before the study. Strength was measured as vaginal squeeze pressure in hectoPascals (hPa) along with the length of contractions in seconds and repeated contractions, by the number of times the contractions could be repeated. After

informing the women and teaching them how to contract the pelvic floor muscles by vaginal palpation, they were asked to perform; a) 3 maximum voluntary contractions (MVC), the strongest was used for statistical analysis, b) isometric contraction, time in seconds was used for analysis and c) repeated contractions, at least 15 of them, the amount of contractions each woman could do was used for analysis. Results are given as mean values with a 95% confidence interval (95% CI). One way analysis of variance (ANOVA) was used to compare changes in pelvic floor muscle function between divided groups of women going through different types of delivery. Spearman's correlation was used to correlate strength and endurance changes due to childbirth with the length of the second stage of labor and for other ranking - and categorical variables. For continuous variables, Pearson's correlations test was used. P values <0.05 were considered significant. SPSS v.16 (Chicago, Illinois) was used for analysis.

Results: For all three groups of primiparas, (normal vaginal birth (n=26), instrumental vaginal (in all cases vacuum extraction) birth (n=5) and acute cesarean birth (n=5)) we found a significant difference in the women's age and pre-pregnancy BMI. In both cases, women who had acute cesarean delivery were significantly older and had a higher BMI. Mean birth weight and infant head circumference was not significantly different between groups.

Before giving birth, there were no significant differences between groups in pelvic floor muscle strength or, endurance (ability to hold sustained contraction and repeat fast contractions).

For the group as a whole, there was a significant reduction in pelvic floor muscle strength and endurance when measured after childbirth compared with the women's performance during pregnancy (p=0.0001) with the exception of repeated contractions. The three groups showed different reductions in pelvic floor muscle strength: Normal

vaginal, 20.1 hPa (CI:16.2; 24.1), instrumental vaginal, 31.4 hPa (CI: 7.4; 55.2) and acute cesarean, 5.2 hPa (CI: -6.6; 17.0) reduction. Calculated with one way ANOVA, the difference was significant between normal vaginal birth and acute cesarean birth ($p=0.028$) as well as between instrumental vaginal birth and acute cesarean birth ($p=0.003$). The changes were not significant between normal vaginal and instrumental vaginal births ($p=0.173$).

There was no significant difference between the groups in their ability to hold isometric contraction ($p=0.212$). The reduction in seconds was: Normal vaginal, 83.0 sec (CI: 44.4; 120.1), instrumental vaginal, 100.2 sec (CI: -39.7; 240.1) and acute cesarean, 2.4 sec (CI: 128.9; 255.3).

All women were able to perform 15 repeated contractions both during pregnancy and after birth except for one woman who was not able to contract her pelvic floor muscles 6 weeks postpartum. The womens' descriptions of their perception of the PFM contraction was for most women clear and supportive of the muscle condition at each point in time.

No correlation was found between changes in pelvic floor muscle strength ($p=0.650$) and pelvic floor muscle endurance ($p=0.810$) due to delivery and the length of the second stage of labour and other delivery data. No correlation was found between changes in pelvic floor muscle strength and endurance as a consequence of delivery and the infants birth weight or head circumference in all women who delivered vaginally ($n=31$).

Conclusion: Based on this sample, pelvic floor muscle strength is significantly reduced after vaginal delivery, both normal and with instrumental assistance, 6-12 weeks postpartum. Other aspects of PFM function i.e. endurance measured as the ability to hold isometric contraction as well as the ability to repeat contractions are less

influenced by mode of delivery. No correlation was found between the delivery data mentioned before, and changes in PFM function. These results could be influenced by a relatively small sample size, high standard deviation and large confidence intervals, and should be interpreted with caution.

ACKNOWLEDGEMENTS

There are many people who I wish to thank. First of all I would like to thank my advisors. This work was guided with special expertise and friendship. My advisors Kari Bø, PhD, professor at the Department of Sports Medicine, Norwegian School of Sport Sciences, Oslo, Norway and Þóra Steingrímsdóttir, MD, PhD, Clinical associate Professor, University of Iceland, and Obstetrician, LSH and Head of the Centre for Antenatal Health Services, Reykjavík capital area, carefully followed my every step in this process, pushing me through all the barriers which, I thought I would never break. I thank them for faith, patience and support. I am very grateful for excellent help, support and professionalism from my supervisor, Árni Árnason, PhD, associate professor at the Department of Physiotherapy, University of Iceland. It has been a great privilege to have such a professional masters committee to guide me in my work.

I would like to extend my gratitude to Þórarinn Sveinsson, PhD, associate professor at the Department of Physiotherapy, University of Iceland for his advice on statistics as well as to Lilja Þorsteinsdóttir, project manager, IT-department, LSH for much help with information from the Icelandic birth registry. I am in debt to my good friend, Þóra Jenný Gunnarsdóttir, PhD, assistant professor at the Department of Nursing, University of Iceland, for her advice on interpretation of the qualitative part of the questionnaires in my study. I would also like to thank Helga Sólveig Gunnell for proofreading the manuscript for the English language.

I am grateful to all the women who participated in my study. In the reliability study which was the first part of this work, both colleagues and relatives helped me, both with their participation and in finding more women. I would like to give special thanks to all the women who participated in the study during this special time in their lives when

they were having their first baby. I also want to thank the midwives in the primary health care for their share in finding these women.

I am grateful to my colleagues in Táp, physiotherapy clinic, Kópavogur, Iceland for their interest in my work and support, especially Joost van Erven and Unnur Sandholt, my co-owners who gave me excellent facilities to meet my participants and for their patience during this period.

Last but not least I want to thank my family for patience and interest in this study, giving me freedom and all the time I needed to finish my work. My children, María, Kristín Eygló, Ingunn Lára and Sigurður and especially my husband Kristján Már Unnarsson, for believing in me and giving me endless support.

This study was financially supported by the Research Fund of the Association of Icelandic Physiotherapists and The Icelandic Association of University Women.

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ABBREVIATIONS

3D	Three dimensional
BMI	Body mass index
EMG	Electromyography
hPa	hectoPascals
ICIQ SF	International Consultation on Incontinence Questionnaire (Short form)
ICS	International Continence Society
LSH	Landspítali/Háskólasjúkrahús (University Hospital)
MRI	Magnetic resonance imaging
MVC	Maximal voluntary contraction
PFM	Pelvic floor muscles
POP	Pelvic organ prolaps
Q	Questionnaire
SUI	Stress urinary incontinence

LIST OF PAPERS

- I Sigurdardottir T, Steingrimsdottir T, Arnason A, Bo K. Test-retest intra-rater reliability of vaginal measurement of pelvic floor muscle strength using Myomed 932. Acta Obstet Gynecol Scand. 2009;88:939-43.

INTRODUCTION

Pregnancy and vaginal delivery are considered to be the main risk factors for weakening the pelvic floor muscles (PFM) as well as the development of stress urinary incontinence (SUI) and pelvic organ prolaps (POP) in women (1-6). This is considered to happen due to damages to fascias, ligaments, PFM and nerve supply (6, 7). All this tissue and its interaction is necessary for pelvic organ support and control of the continence mechanism (8).

Pelvic floor muscles and function.

The female pelvic floor anatomy.

Muscles and fascias.

The PFM form the floor of the pelvic cavity, and comprise of many individual muscles: In Gray's anatomy (9), they are categorized as follows: The deep layer of the PFM, consisting of pubococcygeus, iliococcygeus and ischiococcygeus; collectively known as levator ani muscle; and the superficial layer of the PFM, consisting of ischiocavernosus, bulbospongiosus and transversus perinei superficialis and profundus, collectively known as the perineal muscles; and the external sphincter ani, sphincter urethrae, urethrovaginal sphincter and compressor urethrae muscles. The pubococcygeus muscles are often subdivided into separate parts, according to the pelvic viscera to which they relate; in the female, puborectalis and pubovaginalis, the latter surrounding the vagina and urethra (Figure 1). Muscle fibers from individual muscles in the pelvic floor are often connected into adjacent muscles and fascias, e.g. fibers from puborectalis blend with fibers from the external anal sphincter muscle and fibers from pubovaginalis join the urethral sphincter mechanism which consists of the intrinsic

striated and smooth muscles of the urethra. Pubovaginalis forms a sling around the posterior wall of the vagina and blends into the perineal body, and some fibers also attach to the anorectal junction (9).

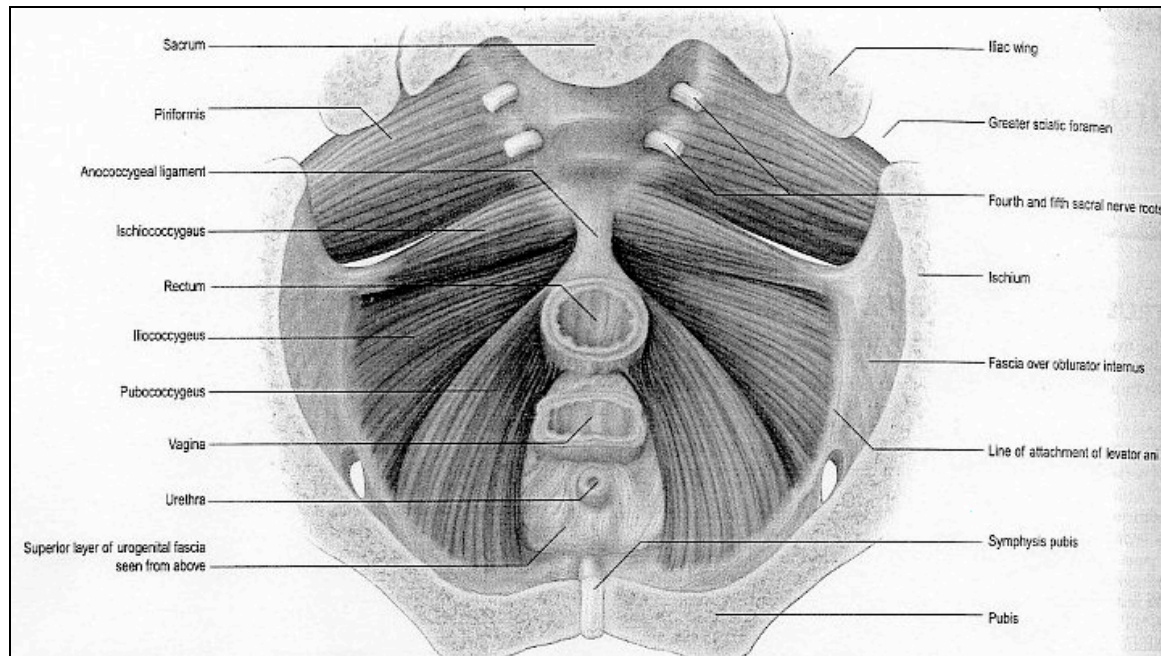


Figure 1. Muscles of the female pelvis viewed from above. The anorectal junction, vagina and urethra have been divided at the level of the pelvic floor (9).

The perineal body is an important landmark in the pelvic floor. It is defined as the area between the anus and the vagina in the midline and connects structures from both sides in the midline. It is made up of fibromuscular tissues, and is continuous with the perineal membrane. Many structures connect into the perineal body, such as fibers from external anal sphincter, pubococcygeus (pubovaginal and puborectal parts), transversus perinei profundus and superficialis, bulbospongiosus and fascias in the area. The superficial perineal fascia runs into the skin of the perineum, thus connecting the perineal body to the central perineal skin (9). Damage to the perineal body during childbirth can have consequences on the continence mechanism as well as possibly playing a role in the development of POP (10).

Fascias cover both surfaces of the deep and the superficial layers of PFM, vessels and nerves. One of the fascias of great clinical relevance is the endopelvic fascia which covers the upper surface of levator ani muscle and mixes with the visceral pelvic fascia. It also merges with other fascias in the area, e.g. piriformis and obturator internus fascias. These fascias contribute to the tendinous arch of levator ani and below it, within the endopelvic fascia is the tendinous arch of the pelvic fascia, and extends from the lower part of the symphysis pubis to the inferior margin of the spine of the ischium (9). According to the studies of DeLancey, these fascial structures together with the levator ani muscles, play a major part in urethral and vaginal support (8). The tendinous arch of the pelvic fascia is also the attachment of the lateral “true” ligament of the urinary bladder and anteriorly the same fascia forms thick bands, the paired pubourethral ligaments (9). Fritsch et al in 2006, conducted a large study on female fetuses and adult female cadavers as well as on healthy female volunteers. The results of this anatomical-radiological study was that there was no direct ligamentous fixation of the urethra to the pubic bone. They stated that “the most important and prominent support of the urethra and its sphincters comes from the dorsal connective tissue fixation at the ventral wall of the vagina” (11).

Innervation of the PFM

Levator ani receives nerve branches from second, third and fourth sacral spinal segments by various routes both from above and below the muscle plate; Pubococcygeus is most commonly innervated from the pudendal nerve (S2-3), while the ischiococcygeus and iliococcygeus are innervated by direct branches of the sacral plexus from the third and fourth sacral segments.

The superficial layer of the PFM with the sphincteric muscles is most commonly innervated by motor branches from the pudendal nerve and/or the perineal branch of the pudendal nerve. All the muscles receive innervation from both sides. All the nerves originate in S2-4 segments (9).

Function of the PFM

The pelvic floor muscles appear to have both tonic and phasic activity. Studies have shown that at rest, tonic activity is present in both sphincters and pubococcygeus muscles (12), even during sleep (13). This activity is necessary for maintaining tone over a long period of time, adding to urethral closure pressure and taking the weight of the pelvic organs off fascias and ligaments (12).

The normal function is that the muscles in the pelvic floor contract together as a functional unit, creating a squeeze around the pelvic openings and an inward and forward lift (7, 14). In a healthy individual, PFM activity is considered to be mainly an unconscious activity and preprogrammed before intra-abdominal pressure (IAP) arises, hence happening before and during increasing IAP (15, 16). Elevation of IAP is created by the shared action of the diaphragm, abdominal muscles and the PFM (17). Maximal voluntary PFM contraction seems to also be accompanied by a co-contraction of the deep abdominal muscles, i.e. transversus abdominis muscle and internal oblique muscle (18).

DeLancey states that, “The level of continence in the normal individual lies at the vesical neck, which in our observations occupies approximately the first 15% of the length of the urethral lumen” (19). Vesical neck support by connective tissues and muscles provides a resistance towards a downward displacement of the urethra during an increase in abdominal pressure (20). Contraction of the PFM elevates the vesical

neck but an increase in IAP (without PFM contraction) causes the vesical neck to descend (21). This function of the PFM helps to maintain both fecal and urinary continence with active and passive support to the pelvic organs (19). DeLancey also states that, “the urethra lies on a supportive layer that is composed of the endopelvic fascia and the anterior vaginal wall. This layer gains structural stability through its lateral attachment to the arcus tendineus fasciae pelvis and levator ani muscle. Pressure from above compresses the urethra against this hammock-like supportive layer, compressing its lumen closed. The stability of the suburethral layer depends on the connection of the vaginal wall that is intact and endopelvic fascia to the arcus tendineus fasciae pelvis and levator ani muscles” (8) .

The ability to contract the PFM -Perception

The fact that the PFM are situated at the floor of the pelvis as well as not being visible from the outside can make it difficult for women to voluntarily contract them (22). Peschers et al have suggested that there were physiological difficulties in activating (in isolation), deep-seated and proximal muscles such as the PFM because motor control is much less accessible than for limb muscles (21). Kegel reported in 1952 that approx. one third of his female patients were unable to voluntarily contract the pubococcygeus muscle without demonstration and facilitation through vaginal palpation (14). Similar findings showing that many women experience difficulties performing a correct voluntary contraction of the PFM, come from a number of other studies. Both Bump et al (23) and Bø et al (24) demonstrated a high number of women contracting incorrectly in their first attempt. Bump et al demonstrated that after verbal instructions, 28 women (60%) were able to contract their PFM but 49% had a significant increase in urethral closure pressure when contracting their PFM. In their study as many as 12 (26%) of the

women were straining/pushing down instead of lifting/squeezing (23). The results from Bø et al showed that 32% of women did not use their muscles correctly, even after individual verbal instructions. Of the women in the latter study, who claimed that they had exercised their PFM at home, 69% stated that they must have done it incorrectly. The most common misunderstanding was to exercise the gluteal muscles instead of the PFM (25). This high percentage of women, who were unable to voluntarily recruit their PFM on demand, has made vaginal palpation into a standard method for assessing the ability to contract, to teach and to give feedback on the PFM contraction (7, 22, 24, 26-28). Visual observation of the perineal area during PFM contraction can also give some information of a contraction (7, 14) although this is not as reliable as palpation, especially in obese people (22). The International Continence Society (ICS) concludes that PFM function (resting tone and strength) can be qualitatively determined by visual inspection, palpation, electromyography (EMG) and perineometry (29).

Pelvic floor muscle dysfunction

The ICS states in their standardization of the terminology of pelvic floor muscle function and dysfunction: “The pelvic floor is related to more than one organ system. Dysfunction of the pelvic floor therefore influences different functions at the same time” (30). They also state there is no existing international agreement on the terminology for PFM dysfunction. They list 5 groups of symptoms associated with PFM dysfunction:

1. Lower urinary tract symptoms.
 - a. urinary incontinence
 - b. urgency and frequency
 - c. slow or intermittent stream and straining

- d. feeling of incomplete emptying
- 2. Bowel symptoms
 - a. obstructed defecation
 - b. functional constipation
 - c. fecal incontinence
 - d. rectal/anal prolapse
- 3. Vaginal symptoms
 - a. pelvic organ prolapse
- 4. Sexual function
 - a. in women: dyspareunia
 - b. in men: erectile and ejaculatory dysfunction
 - c. in both: orgasmic dysfunction
- 5. Pain
 - a. chronic pelvic pain
 - b. pelvic pain syndrome (30).

Pregnancy and delivery

Pregnancy

Many studies have focused on the effects of childbirth on PFM function and symptoms related to the pelvic floor organs, such as incontinence and POP. Dietz et al (2003) mentioned that “The effect of pregnancy on the pelvic floor muscle is unknown and may well be significant, given the fact that progesterone is a muscle relaxant” (31). The hormone relaxin is known to affect the condition of connective tissue during pregnancy (32) and as such it can possibly influence the urethral continence mechanism. In their study from 1998, Meyer et al stated that the growing uterus stretches fascias and

ligaments and modifies the relationship between the bladder and the enlarged uterus thus changing the urethrovesical angle with a decreased tensile strength of the fascia and the bladder-neck anchoring system (33). They, on the other hand, did not find significant changes in PFM strength measured as intra-vaginal and intra-anal pressures with advancing pregnancy or between non-pregnant and pregnant state (33). Mørkved et al (2004) found that continence status during pregnancy was strongly related to PFM strength and muscle thickness by using ultrasound and perineometer (34). Dietz et al (2004) found an increase in bladder and urethral mobility during pregnancy compared to non-pregnant controls using ultrasound, they hypothesized that it was most likely due to a hormonal influence on connective tissue (35). In a study on the effects of PFM exercises on transient incontinence during pregnancy and after birth, Sampsel et al (1998) reported a reduction in PFM strength with advancing pregnancy both for the PFM exercise group and the control group. They used a vaginal speculum, which had been adapted from a gynecologic speculum, but had strain gauges (36). In the latter study the sample was small and the findings did not reach significance. For symptoms related to pregnancy; In a prevalence study Iosif and Ingemarsson (1982) reported, a permanent SUI in 9% of women after elective cesarean section and hypothesized that pregnancy and hereditary factors were more decisive in the development of SUI than delivery in itself (37). McKinnie et al (2005) concluded also in a prevalence study, that pregnancy increased the risk of urinary and fecal incontinence and that cesarean section did not decrease the risk compared to pregnancy with a vaginal delivery (38). In a review from 2002, Chaliha and Stanton suggest that inherent abnormalities in collagenous component of the connective tissue of bladder-neck support, can render some women more vulnerable to SUI during pregnancy (39). After searching the

databases Pubmed and ISI Web of KnowledgeSM it seems that only a few studies have focused on comparing PFM strength in pregnant and non-pregnant women (33, 35, 36). Stress urinary incontinence is known to increase during pregnancy (2, 40, 41). Whether this is due to an increase in bladder and urethral mobility because of connective tissue laxity as well as the influence of the growing uterus or because of changes in PFM strength during pregnancy remains uncertain.

Delivery

There is a general consensus that PFM strength is reduced after vaginal delivery, however, results differ regarding how long PFM strength remains reduced. Both muscular and nerve damages have been reported (3-6, 40, 42-52). Findings come regardless of the techniques used for measuring the PFM, e.g. strength evaluation with vaginal palpation (43), perineometers measuring vaginal squeeze pressure (3, 6, 43, 46), ultrasonography (40, 44, 49), EMG (3, 6, 47) or magnetic resonance imaging (MRI) (50-52). Peschers et al (1997) measured PFM strength with perineometer and ultrasound. PFM strength was still significantly reduced 6-10 weeks postpartum for primiparas after vaginal delivery, compared to strength during the last month of pregnancy. However vesical neck elevation on ultrasound had returned to antepartum values (43). Meyer et al (1998) had similar findings. They found a significant decrease in intra-vaginal and intra-anal pressures during PFM contraction for women who delivered vaginally, 9 weeks postpartum, compared to levels during pregnancy. This was more severe after forceps delivery (40). Allen et al (1990) measured PFM strength with perineometer. They also measured nerve damages. Measurements took place late into the pregnancy, as well as 2-5 days and 2 months postpartum. PFM strength as a vaginal squeeze pressure was still significantly reduced 2 months postpartum compared

with antepartum values. They also found evidence of partial denervation of the pelvic floor in 80% of women delivered vaginally. Forceps delivery and perineal tear did not affect the degree of nerve damage found in this study (6).

Peschers et al (1996), using perineal ultrasound, found that the bladder neck was significantly lower at rest, 6-10 weeks after vaginal delivery compared to nulligravids or women after elective cesarean delivery. They also found that the bladder neck mobility was greater on the Valsalva manoeuvre in a majority of women after vaginal delivery. On the other hand, only the minority of primiparas and multiparas had decreased ability to elevate the bladder neck during PFM contraction (49).

Also using translabial (perineal) ultrasound, Dietz (2004) found that the capacity of the PFM to elevate the bladder neck was significantly reduced 2-5 months after the first delivery (44). Dietz and Lanzarone (2005) using translabial ultrasound, discovered injuries to the muscular attachments of the levator ani to the sidewalls of the pelvis in one third of the women who delivered vaginally 2-6 months postpartum, and associated those findings with postpartum SUI (53). In a MRI study, Tunn et al (1999) found that the levator ani muscles returned to normal geometry 2 weeks postpartum, but there was a delayed recovery in connective tissue and smooth muscles in their study of only 6 women (50). DeLancey et al (2003) investigated the pelvic floor in both nulliparous and primiparous women (examined 9-12 months after delivery) with MRI. Only after vaginal delivery did they find abnormalities in the levator ani muscles, this was not the case with nulliparas. The nature of the muscle defects varied greatly (51). Yousuf et al (2009) investigated the location and movement of the pelvic floor structures with MRI, one and 7 months postpartum (52). They found that the location of both perineal body and the anal verge were significantly higher 7 months postpartum compared to one month postpartum. Urogenital and levator hiatal dimensions had decreased significantly

in size but displacement of the PFM both during valsalva and maximal Kegel (PFM contraction) did not change between one and 7 months postpartum (52). Damages to nerve supply and its role in PFM dysfunction has been discussed by many authors (5, 48, 54, 55). Jozwik and Jozwik (48) underline the relationship between the period of maximal distension or overstretching of the soft tissue of the birth canal, (including the PFM) and denervation. They point out the fact that the pudendal nerve can be injured throughout its course: “ 1) denervation at the neuromuscular junction; 2) overstretching of the nerve trunk; 3) compromise of the lumbo-sacral plexus; 4) temporary pressure effect; and 5) compression of the nerve inside the pudendal (Alcock’s) canal.” (48). According to a textbook on work physiology, the nerves of the PFM can elongate 6-22% of their initial length before damage occurs but skeletal muscles are known to tolerate a distension of up to 200% of their initial length (56). This supports the theory, that nerve damage is likely to occur before muscular damage in childbirth. In 1989, Smith et al using single-fibre electromyography, discovered that partial denervation with subsequent reinnervation of the pubococcygeus muscle was found in women with SUI and POP and increased by parity as well as being a normal accompaniment to aging (5). They also reported in another article that women with genuine SUI had a delayed conduction to both the striated urethral muscle and the PFM, indicative of denervation injury. However, when POP was present and urinary control was normal, only a sign of denervation damage was noticable to the pelvic floor but not to the urethral striated muscle (54). Snooks et al (1985) discovered that SUI in parous women was associated with nerve damages to the most distal part of nerves to the periurethral striated sphincter muscle (55). Sultan et al (1994) found nerve damages after vaginal delivery for both primiparas and multiparas when measured 6-8 weeks postpartum.

They also found nerve damages in women after acute cesarean section, after obstructed labor (57).

Effects of various obstetric factors on PFM

Many studies have reported the effects of the second stage of labor and other obstetric factors, on PFM function. The second stage of labor is divided into a passive and active phase, where the passive phase is “prior to or in the absence of involuntary expulsive contractions” (58). The duration of second stage of labor is usually longer for primiparas than multiparas but references differ in, what is a normal time period (58-60). According to Friedman (1978), the mean length of the stage is 33 minutes for primiparas and 8.5 minutes for multiparas in spontaneous labor at term (59), from british recommendations for intrapartum care (2007), a summary of 3 studies gave the length for primiparas a mean of 54 minutes and a mean of 18 minutes for multiparas, all without epidural analgesia (58). In a textbook of obstetric and gynecology, the length of the second stage of labor, a time period of up to 2-3 hours is considered normal for primiparas and for multiparas it is half to one hour (60).

Allen et al (1990) found, that a long active second stage of labor and delivering heavier babies resulted in nerve damage to the pelvic floor. Allen et al did not find an association between forceps delivery and perineal tear or a higher degree of nerve damage in primiparas (6). Sultan et al (1994) found that the longer the second stage of labor and delivery of heavier babies were associated with pudendal nerve damage (57). Dietz (2004) found a weak correlation between a reduction in the cranioventral elevation of the bladder neck and the length of the second stage of labor in his study using ultrasound (44).

Meyer et al (1998) measured intra-vaginal and intra-anal pressures during PFM contraction, along with other variables during pregnancy and again about 9 weeks postpartum. Their results were that pressure (strength) reduction was significant in women who delivered with the aid of forceps and women who delivered spontaneously, but not in the cesarean section group, which consisted of women who had both elective and acute cesarean delivery. Almost all the variables measured in this study, such as urinary and fecal incontinence, PFM strength reduction and bladder neck mobility were most severely influenced in the forceps assisted delivery group (40). Pretlove et al (2008), in a comparative systematic review, found an increased risk for any type of anal incontinence (flatus, liquid and solid) in the first year postpartum for any type of vaginal delivery compared to cesarean section. The greatest risk was for forceps assisted delivery but no significant difference was found between spontaneous vaginal and ventouse (vacuum) delivery (61). Samuelsson et al (2000) studied risk factors for an anal sphincter tear in a large prospective observational study. They found that mediolateral episiotomy increased the risk of an anal sphincter tear more than twofold. Other high risk factors included vacuum extraction, perineal oedema, epidural analgesia and a prolonged second stage of labor along with high birth weight. However, after stepwise logistic regression analysis of risk factors, only high birth weight remained an independent risk factor. Their results did not mention forceps assisted delivery (62). Peschers et al (2003) conducted a case-control study 6-24 weeks postpartum, comparing women after spontaneous and vacuum deliveries. Although showing more sonographic defects, the vacuum assisted delivery group did not have more urinary and anal incontinence than the spontaneous delivery group (63). Groutz et al (2004) found that vacuum extraction was a risk factor for voiding difficulties in the early postpartum

period together with a prolonged first and second stage of labor and a birth weight of ≥ 3800 g (64).

Handa et al (1996), in a review article identified the main risk factors for muscular and neurologic damage to the pelvic floor as being; midline episiotomy, the use of forceps, third or fourth degree lacerations, high birth weight and a prolonged active second stage of labor. They recognized that the use of forceps could possibly be associated with other risk factors and not causative in it self. The use of vacuum extraction seemed to be less traumatic to the pelvic floor than the use of forceps.

The use of midline episiotomy appeared to have no protective effect on the pelvic floor musculature and did not prevent laceration to the anal sphincter. In contrast, mediolateral episiotomy could possibly protect against sphincter lacerations but did not prevent a decrease in PFM strength. A prolonged active second stage of labor (with active maternal straining) was associated with neuromuscular injury, however, that was not the case in the passive part of the second stage. They suggested that allowing a passive second stage for longer, without maternal pushing, could protect the pelvic floor (65). Several other review articles and randomized controlled trials suggest that the use of episiotomy and forceps should be minimized as much as possible because it does not have any advantages with regard to PFM function and does not protect against anal sphincter tearing. Further, it does not seem to protect the infant either (66-69).

The effect of epidural analgesia during labor on PFM function after childbirth has been studied by several authors. Sartore et al (2003) compared groups of primiparas who had and did not have epidural analgesia during labor, at 3 months postpartum. They found no significant differences in PFM strength, SUI or anal incontinence between the groups (70). Meyer et al (2002) had similar findings, 2 groups of women, with and without epidural analgesia were measured during pregnancy and 2-10 months

postpartum. There were no statistical differences regarding pelvic floor parameters (vaginal and anal pressures during PFM contraction) between groups (71). Schiessl et al (2005) studied obstetrical parameters influencing the duration of the second stage of labor and found that the use of epidural analgesia was significantly associated with a prolonged second stage of labor (72).

Cesarean section

Many studies have shown that elective cesarean section provides some protection for the PFM when compared to acute cesarean section performed for obstructed labor and vaginal delivery (6, 43, 46). Despite this, Iosif and Ingemarsson (1982) reported a relatively high prevalence of stress urinary incontinence (which is often considered a sign of weak PFM or connective tissue damage) among women after elective cesarean delivery (37).

Peschers et al (1997) compared primiparas, multiparas and women undergoing elective cesarean section both during pregnancy and after delivery. They found no changes in PFM function for the cesarean section group from pregnancy to after delivery when measured with perineometry, perineal ultrasound and palpation (43). Similar findings came from Meyer et al (1998). A group of women who had cesarean section (44% elective and 56% acute) showed no significant changes in PFM strength due to childbirth when measured with a perineometer (40). Baytur et al (2005) compared PFM strength using a perineometer in groups of women who had delivered vaginally and with elective, pre labor cesarean section. A group of nulliparas were recruited as controls. None of the women in the study group had given birth in the last 2 years. They found that the elective cesarean delivered women had significantly stronger PFM than the vaginally delivered women (46).

Cesarean section performed for obstructed labor or after the onset of labor has been reported by some researchers, ineffective in protecting the pelvic floor, especially after a long second stage of labor (6, 44, 73, 74). Sultan et al (1994) found that women who had a cesarean section during labor might also suffer pudendal nerve damage (and as a consequence, weaknesses in their PFM) (57).

Dietz (2004) using ultrasound, concluded that the full engagement of the fetal head upon the pelvic floor, rather than the actual passage of the fetal head seemed to impair levator function (44). Dietz et al in 2005, concluded in another study, that genetic factors regarding the connective tissue type, influenced bladder neck mobility more than the mode of delivery (75). Tooze-Hobson et al published a study in 2008 where they investigated the effects of different modes of delivery on the volume of the urethral sphincter, bladder neck mobility and changes in levator hiatus distensibility using ultrasound. They compared women with vaginal delivery and cesarean section (not categorized in details). The results of their study was that increased bladder neck mobility and a more distensible levator hiatus was associated with vaginal delivery, both antenatally and postpartum. In accordance with that, they asked whether tissue type predisposes women towards one mode of delivery or the other (76).

Childbirths in Iceland

During the year 2007, 4498 women gave birth in Iceland. The rate of elective cesarean section was 7% (77). Of all the mothers, 3126 (70%) gave birth in the University Hospital (Landspítali-Háskólasjúkrahús (LSH)) and of them, 1336 (43%) were primiparas (78). The age of all primiparas giving birth in LSH during the year 2007, ranged from 16 to 55 years. (78).

Over 99% of pregnant women in Iceland attend the available antenatal care, which is provided by the primary health care for healthy women with normal pregnancies. A service for high risk pregnancies is provided by the LSH (77).

The rate of urinary incontinence among women in Iceland is high (79), as in other countries (1). In an Icelandic postal survey from 2002, sent to 10.000 women (75% responded), 38% of women between 30 and 75 years of age, had experienced urinary incontinence in the last month. Nineteen percent suffered from incontinence 2-3 times per week or more often (79). Urinary incontinence in women is often considered to occur after childbirth (1, 80). It was therefore of interest to take a closer look at the development of the PFM function during pregnancy to postpartum period in Icelandic women to see if the results were similar to other studies.

To the author's knowledge, no studies have been published on women's perception of the quality of PFM contraction. This has been of special interest to the author, based on many years, working in the field of physiotherapy for incontinence and pelvic floor dysfunction. Many clients have, complained of "not being able to feel the muscles in the pelvic floor or knowing how to contract them". Therefore it was decided to ask participants in this study to report their own perception at the time periods pinpointed for the study and to try and find associations or trends between measured muscle strength and the description of perception of the quality of PFM contraction.

The present study will focus on functional (strength and endurance) changes in PFM, due to the modes of delivery in primiparas, as many studies mentioned above have done. In addition, this study will focus on the women's perception of the quality of their PFM contractions.

AIMS OF THE STUDY

The primary aim of the present study was to compare PFM strength and endurance changes in primiparas, from mid-pregnancy to 6 weeks postpartum and between different modes of delivery: normal vaginal, instrumental vaginal deliveries and acute cesarean section. Also to get qualitative information about women's perception of PFM contraction.

The secondary aim was to correlate changes in PFM strength and endurance due to delivery with the length of the second stage of labor and other delivery data.

The tertiary aim was to compare information from questionnaires, such as symptoms from pelvic organs and PFM exercises, from before pregnancy to postpartum.

Four null-hypotheses were established:

1. PFM strength and endurance are not influenced by childbirth.
2. Changes in PFM strength (a) and endurance (b), are not influenced by the mode of delivery (normal vaginal, instrumental vaginal and acute cesarean section).
3. There is no correlation between changes in PFM strength and endurance due to childbirth and the duration of the second stage of labor.
4. There is no correlation between changes in PFM strength and endurance due to childbirth and:
 - infants birth weight,
 - infants head circumference,
 - the use of episiotomy (yes or no),
 - the degree of perineal tear (first to fourth degree),

the use of perineal analgesia (yes or no) and,
the use of epidural analgesia (yes or no).

Definations/terms used in this thesis:

1. PFM strength is measured as vaginal squeeze pressure in hPa.
2. PFM endurance is measured as;
 - the length of a sustained contraction in seconds and
 - the number of repeated contractions, at least 15 repetitions.
3. Birth weight of the infant is measured in grams.
4. Circumference of the infants head is measured in cm.
5. Mode of delivery is defined as:
 - normal vaginal birth,
 - instrumental vaginal birth (with forceps or vacuum extraction) and
 - acute cesarean birth (cesarean section after the onset of labor).
6. Second stage of labor is defined as the time from fully dilated cervix to the birth of the infant and is measured in minutes (58, 60).
7. Mid-pregnancy is defined as the time from 20th to 26th week of gestation (after routine ultrasound scan, most women attend).
8. Postpartum is defined as from 6th to 12 th week after the delivery.
9. Perineal tears (lacerations) are defined as:
 - First degree tear involve the fourchet, the perineal skin and vaginal mucous membrane but not the underlying fascia and muscle.
 - Second degree tear involve, in addition to skin and mucous membrane, the fascia and muscles of the perineal body but not the rectal sphincter. These

tears usually extend upward on one or both sides of the vagina, forming an irregular triangular injury.

- Third degree tears are defined as laceration extending into the anal sphincter without involvement of the anorectal mucosa.
 - Fourth degree lacerations are defined as: laceration extending into the anal sphincter involving the anorectal mucosa (74, 81).
10. Episiotomy is an incision of the perineum, made to widen the outlet of the birth canal. Includes the fascia and muscles of the perineal body in addition to the skin and mucosa. In this study group always made mediolaterally on right hand side.
 11. Perineal analgesia is a local injection of lidocain in the perineum for pain relief.
 12. Epidural analgesia is an injection of anaesthetic (bupivacain) and the opioid Sufenta into the epidural space usually at the level of the lumbar space L2-3 or L3-4. For pain relief.

MATERIAL AND METHODS

Design

This was a prospective repeated measures observational study assessing changes in PFM function due to first childbirth. The women were measured for the first time as near mid-pregnancy as possible and for the second time, around the 6th week postpartum. The women answered 4 questionnaires; two when they came for PFM measurements during their pregnancy (q.1a and q.1b), the third questionnaire (q.2) in the first days after delivery, and the fourth questionnaire (q.3), during the second PFM measurement postpartum (appendixes 1-4 for Icelandic version and appendixes 5-8 for English).

The measurements took place in an outpatient physiotherapy clinic from April 2007 until March 2008 and they were followed up with second measurements until July 2008.

Power estimation

The Center of Statistics in the University of Iceland helped to estimate the sample size. The question was, how many participants were going to be needed to reach 80% power as well as having only 20% chance to make a type II error, which is the probability of failing to reject a false null-hypothesis, not finding a significant difference when it really exists (82). At that time, values for strength changes in the PFM from the present study were not available. Measurements of PFM strength for 20 participants from the reliability study of the measurement device was available, they had been measured twice, in all 40 measurements with no intervention between tests (see Paper I). The values had large range and were normally distributed. The study of Peschers et al from

1997 was used, to see changes in the effect size due to childbirth. The study had similarities with the present study (43). According to those data, the following was given:

If a correlation of 0.8 existed between PFM strength during pregnancy and strength postpartum, 8 participants were needed to detect changes due to childbirth. If no correlation was found between the 2 measurements, 32 participants were needed (83). From all the measurements in this study, correlation was found for each delivery group: Normal vaginal delivery; 0.78, instrumental vaginal delivery; 0.80 and acute cesarean section; 0.85.

Recruitment and inclusion/exclusion criteria

The sample was a non-randomized, convenience sample. Women in their first pregnancy were recruited through the antenatal care in the Primary Health Care centers in the capital area of Reykjavík, Iceland. The area includes 7 communities and about 63% of the Icelandic population (84).

Of 17 centers, 11 centers agreed to participate. Nine of them recruited women. Midwives in the centers invited women to participate, during their routine antenatal care at 13th to 16th week of pregnancy.

Inclusion criteria were:

- First pregnancy
- Healthy
- Eighteen years or older
- One live fetus confirmed by ultrasound scan
- Being able to understand Icelandic or English

Exclusion criteria were:

- High risk and multiple pregnancies
- Elective cesarean section
- Ongoing urinary infections or having other diseases that could interfere with the participation

After acquiring a verbal agreement from the women, the midwives sent a list to the MSc. student's advisor, with the names of women willing to participate. After an ultrasound scan in the 20th week of pregnancy, where a singleton pregnancy was confirmed without any major anomalies or factors that could interfere with pregnancy or normal vaginal birth being found, the MSc. student, contacted the women. Of the 58 women agreeing to be contacted, 3 women were excluded due to exclusion criteria. The remaining 55 women were contacted by phone and a total of 44 women agreed to participate, 11 refused.

Of the 44 women who gave their informed signed consent and came to the first appointment, 36 women completed both measurements. The flow of participants is shown in Figure 2.

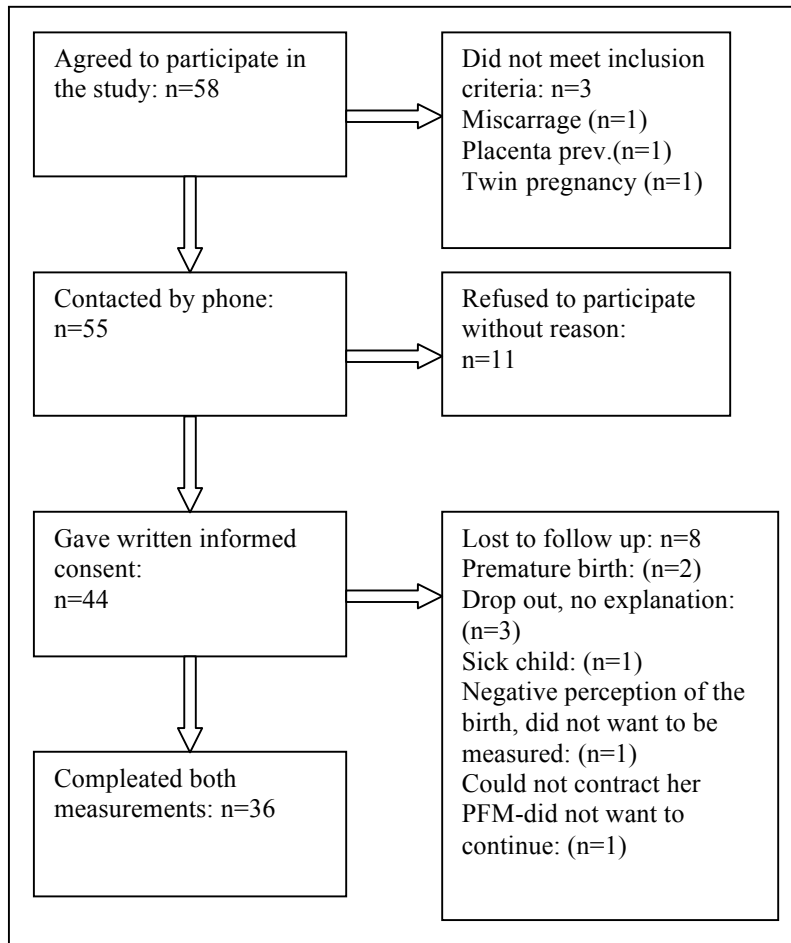


Figure 2. Flow of participants throughout the study and reasons for withdrawal.

Participants

The age of the participants ranged from 19 to 39. Pre-pregnancy body mass index (BMI) (kg/m^2) ranged from 19 to 39. Background variables and comparison to primiparas in Reykjavík, Iceland are given in Table 1.

Table 1. Background variables for the participants and comparison to primiparas in Reykjavík, Iceland when available. Means with standard deviations (SD) and numbers (n).

	Participants (n=36)		Primiparas in Reykjavík (n=1336)	p value
Maternal age in years	26.6	(4.3)	26.5 (5.1)*	NS
Pre-pregnancy BMI	24.1	(4.3)	NA	
Gestational length in weeks, days	40.2	(1)	NA	
Infants birth weight in g	3564	(422)	3620 (30.9)**	NS
Infants head circumference in cm	35.3	(1.5)	35.4 (0.2)**	NS
Smoking (n):			NA	
yes	5			
no	31			
Marital status (n):			NA	
Married	6			
co-habiting	29			
single	1			
Occupational status (n):			NA	
in a paid job	24			
in school	11			
not answering	1			
Educational level (n):			NA	
Elementary school	9			
upper secondary school	9			
university or another further education	18			

NS: Non significant

NA: Data not available

*Data from Landspítali/Landlæknir, all primiparas giving birth in LSH 2007 (N=1336) (78).

** Data from Landspítali/Landlæknir, SD are based on mean birth weight and mean head circumference each year for the years 1982 to 2009 but not actual values (85).

Outcome measures

Strength changes

Strength as maximal voluntary contraction (MVC) of the PFM, was measured as vaginal squeeze pressure in hPa, both during pregnancy and postpartum.

Endurance changes

Endurance of the PFM was measured as the length of a sustained contraction in seconds as well as the ability to contract repeatedly at least 15 times, both during pregnancy and postpartum

Perception of quality of the PFM contraction- Questionnaires

To obtain information about how the women perceived their PFM contraction, they answered questions with open and closed responses. In the open response questions, they were asked to describe their own perception in their own words in all questionnaires. They were asked the following questions:

Q.1a. Explain in your own words what you felt when you tried to contract your pelvic floor muscles (before pregnancy).

Q.1b. Explain in your own words what you feel when you try to contract your pelvic floor muscles now (during pregnancy).

Q.2. Explain in your own words what you feel when you try to contract your pelvic floor muscles now directly after birth.

Q.3. Explain in your own words what you feel when you try to contract your pelvic floor muscles (approx. six weeks postpartum).

Urine stream interruption and symptoms from the pelvic organs

In all 4 questionnaires, women were asked about their ability to stop the midstream while urinating. They were asked: “Are you able to stop midstream while voiding”. This has been considered by some authors, a useful method to evaluate PFM function (86).

Questions about urinary symptoms used in this study were taken from the ICIQ SF questionnaire (appendix 9) and consists of 4 questions about urinary symptoms which were all used in the questionnaires in this study. The questions are based on a subjective assessment about type, amount, frequency and bother from symptoms, the latter on a visual analogue scale (VAS). However, they were taken from a recommended questionnaire from the International Consultation on Incontinence, ICIQ

SF (short form) which has been fully validated (87). The first 3 questions give scores for each possibility of answers, the higher the score, more severe were the symptoms. These scores are then added and the sum of them give the ICIQ score: 1. How often do you leak urine? (0-5 scores), 2. How much urine do you usually leak (whether you wear protection or not)? (0, 2, 4 and 6 scores) and 3. Overall, how much does leaking urine interfere with your everyday life? (VAS scale zero to 10). ICIQ score can therefore range from zero to 21. The fourth question is about the type of incontinence (see appendixes 1-8 for questionnaires and 9 for ICIQ SF).

Correlation between delivery data and changes in PFM strength and endurance

In order to calculate the correlation between changes in PFM strength and endurance as well as various obstetric factors, the following delivery data was collected: Length of the of second stage of labor in minutes, birth weight in grams, infants head circumference in cm, episiotomy (yes or no), degree of perineal tear (first to fourth degree), perineal analgesia (yes or no) and epidural analgesia (yes or no) as well as mode of delivery (normal vaginal birth, vaginal instrumental and acute cesarean section).

Assessment of ability to contract the PFM

The participating women were first informed of the function of the PFM and taught to contract the muscles. They were instructed to focus on the PFM during the tests and to try and avoid co-contraction of other muscles as much as possible. However, a small contraction of the abdominal wall was allowed if no movement of the pelvic girdle was visible (27). They were also asked to breath normally during the measurements. They were first tested for correct PFM contraction which includes contraction around pelvic

openings, inward (cranial) and forward (ventral) lift of the muscle plate (7). This was done with vaginal palpation with one finger and observation of the perineal area during a contraction (26-28).

Device for assessment of PFM strength and endurance

The device used for assessment of PFM strength and endurance was Myomed 932® (Enraf-Nonius, Delft, Netherland). It measures pressure changes vaginally by means of a cavity probe, with auditive and visual feedback, displayed on a LCD-screen. Pressure signals can be graphically reproduced with adjustable sensibility and time scales. The pressure probe is 9 cm in length and 3 cm in diameter. The middle third of the probe is soft, allowing sensitivity for pressure changes during contraction and relaxation and is aimed at corresponding to the localization of the PFM in the middle third of the vagina (88). A silicone ring is located at the end of the probe to provide control for standardized depth of insertion as it stopped at the vaginal introitus. The probe is connected to the apparatus with an airfilled tube. A picture of the device is displayed in paper I. The readings are given in hectoPascals (hPa). Lowest, highest and mean pressures are displayed. After insertion of the probe into the vagina, the LCD-screen shows the vaginal resting pressure which can be set to zero before measurements. The device was tested for reliability before the main study (See paper I).

Perineometers similar to this have been found to be valid and reliable in measuring PFM function (27, 29, 89-91).

Procedure

In their first appointment, the women answered 2 questionnaires (q.1a and q.1b), the first with questions about background variables. All 4 questionnaires had questions

about physical activity including PFM exercises, and symptoms related to the pelvic organs. The first questionnaire (q.1a) addressed health before pregnancy, and the second questionnaire (q.1b), the same questions for mid-pregnancy. They were asked to take home the third questionnaire (q.2), and to answer it as soon as possible after delivery. This questionnaire contained questions about health during last month of pregnancy and the first days after the delivery. The fourth questionnaire (q.3). was answered approx. 6 weeks postpartum, when the women came back for their second measurements.

The measurements took place during the 20th to the 26th week of gestation, on average during the 22nd week, and then during the 6th to the 12th weeks postpartum, on average during the 7th week postpartum (only one woman came during the 12th week postpartum).

The women were tested in a supine position with knees bent and legs slightly apart. A condom was put over the pressure probe of the measurement device before insertion into the vagina to ensure hygiene for each participant. The examiner supported the end of the probe manually during the tests.

The PFM function was tested in three ways:

- 1) Maximal voluntary contraction (MVC). The women were asked to contract the PFM 3 times as hard as possible and try to hold for 5 seconds. Ten seconds interval was provided between each contraction. The strongest contraction measured in hPa was used for statistical analysis.

- 2) Endurance of PFM contraction. The women were asked to hold a PFM contraction as long as they could and were not interrupted unless the pressure measurements reached zero or they reported they could not hold the contraction longer. The holding time of the contraction in seconds was used for analysis.
- 3) Repeated contractions. The women were asked to repeat contractions of the PFM continuously, at least 15 times. Number of contractions used for analysis.

Adequate rest (approximately 3-5 minutes) was given between the tests.

Statistical methods

Statistical analysis of the data was performed using SPSS v.16 software (SPSS inc. Chicago, Illinois, USA). Raw data was documented in an excel document (microsoft office 2003, Microsoft Corporation©, USA,).

Descriptive statistics were applied to background variables:

Maternal age (years), BMI (kg/m^2), gestational length (weeks and days), infants birth weight (grams) and head circumference (cm); as a mean with standard deviation (SD). Smoking status, marital status, occupational status and educational status were given as numbers/frequencies.

PFM strength and endurance are presented as a mean with a 95% confidence interval (95% CI). Repeated contractions are presented as number of repetitions. Normality of the data was checked with Shapiro-Wilks' test. Changes in PFM function from mid-pregnancy to postpartum were calculated with a paired t-test. One way ANOVA was used to compare changes in PFM strength and endurance in relation to different modes of delivery. Multiple comparisons between groups was done with Bonferroni post-hoc tests. Correlation was tested using Pearson's correlation coefficient (r) for data with

normal distribution and with sufficiently high number. Spearman's rank correlation coefficient (r) was used for ordinal and categorical data and for the length of the second stage of labor, which was not normally distributed. P values <0.05 were considered statistically significant.

Ethics

The study was approved by the Icelandic National Bioethics Committee (ref.number 06-070) on August 21st, 2006

The Protection of Privacy gave permission on July 10th, 2007 for use of delivery data from the LSH medical records.

Authorities in LSH, maternity ward also gave their permission, on January 26th, 2006. Delivery data were collected by the advisor, Dr. Þóra Steingrimsdóttir.

Authorities in the Primary Health Care in the capital area of Iceland gave their permission for the midwives from the maternity care to invite the women to the study, on February 20th, 2007.

The study procedure was in accordance with the Helsinki declaration on human experimentation. All women participating in this study gave their written informed consent (appendix 10 for Icelandic version and appendix 11 for English).

RESULTS

A total of 36 women did both measurements, 8 women withdrew from the study. (Figure 2). At the time of the second measurement, 33 women were still breastfeeding. All instrumental deliveries were performed with vacuum extraction. All episiotomies were performed as a mediolateral dexter episiotomy.

No significant difference was found between the participants in the present study and in all primiparas in Reykjavík, Iceland giving birth in 2007, regarding mean age, mean infants birth weight or head circumference (Table 1). Delivery information for the study group and a comparison to all women giving birth 2007 in Iceland (Icelandic birth registry) is given in Table 2 because information about primiparas and their delivery data was not exclusively available (77).

No significant differences were found between the three study groups (normal vaginal, instrumental vaginal and acute cesarean section), regarding birth weight or infants head circumference. We found a significant difference in the mean age of women, women in the cesarean section group were significantly older than women in the other groups ($p=0.002$). This same group also had a significantly higher pre-pregnancy BMI ($p=0.044$). Maternal and infant variables are shown in Table 3.

Table 2. Mode of delivery and other maternal and delivery data. Comparison between participants and the Icelandic birth registry 2007. Values are number of women, with percentages (%)

	Participants		Icelandic birth registry 2007*	
	n=36	(%)	n=4498	(%)
Delivery mode:				
normal vaginal	26	(72.2)	3376	(75.1)
instrumental vaginal (vacuum)	5	(13.9)	298	(6.6)
intstr. vaginal (forceps)	0	(0)	25	(0.6)
acute cesarean section	5	(13.9)	487	(10.1)
elective cesarean section**	0	(0)	312	(6.9)
Perineal tear:				
All perineal tear	26	(72.2)	2634	(58.6)
1° tear	5	(13.9)	955	(21.2)
2° tear	16	(44.4)	1485	(33.0)
3° tear	5	(13.9)	173	(3.8)
4° tear	0	(0.0)	21	(0.5)
Episiotomy:	5	(13.9)	364	(8.1)
Perineal analgesia:	4	(11.1)	1542	(34.3)
Epidural/spinal analgesia:	16	(44.4)	1931	(42.9)
Breastfeeding during second measurement (approx.6 weeks postpartum):			NA	
yes	33	(91.7)		
no	3***	(8.3)		

*Data from Landspítali/Landlæknir, The Icelandic birth registry (77).

** Women having elective cesarean section were excluded from the study

***Stopped breastfeeding during, third, fourth and sixth week postpartum

NA: Data not available.

Table 3. Maternal and infant variables by groups of normal vaginal, instrumental vaginal and acute cesarean birth. Values are presented as mean (SD)

	Normal vaginal birth (n=26)	Vaginal instrumental birth (n=5)	Acute cesarean section (n=5)	p value
Maternal age	25.5 (3.6)	26.2 (1.6)	32.6 (5.3)*	0.002
Pre-preg. BMI	23.7 (4.2)	22.2 (2.5)	28.3 (3.6)*	0.044
Birth weight (grams)	3533 (434)	3384 (278)	3907 (331)	0.112
Infants head circumference (cm)	35.1 (1.5)	35.8 (1.5)	35.8 (1.0)	0.423

* p<0.05, significantly different compared with the two other groups

PFM function

No statistically significant difference existed between the groups in PFM strength or PFM endurance, the latter measured as the ability to hold a sustained contraction and repeat contractions during pregnancy.

The mean PFM strength at mid-pregnancy for the 8 women who withdrew from the study was similar to the group who continued and finished the study.

Results of changes in PFM strength and endurance for all participants

A statistically significant reduction was found in PFM strength and endurance, the latter, measured as the holding time of a sustained contraction, for the whole group of women ($p < 0.0001$) from mid-pregnancy to after childbirth. No significant difference was measured regarding endurance, measured as repeated contractions, at least 15 of them. All women were able to repeat 15 contractions during their pregnancy. All but one were able to do the same postpartum (Table 4).

Table 4. Development of PFM function from mid-pregnancy (20-26 weeks of gestation) to after childbirth (6-12 weeks postpartum) for all participants ($n=36$). PFM strength presented as mean with 95% CI of MVC of vaginal squeeze pressure (hPa), PFM endurance, mean with 95% CI of holding time in seconds and repeated contractions (number of women doing at least 15 contractions).

	Mid-pregnancy	Postpartum	p value
MVC (hPa)	42.1 (36.3; 47.9)	21.9 (17.8; 26.1)	<0.0001
Endurance (sec)	146.1 (104.8; 187.4)	71.9 (47.5; 96.4)	<0.0001
Endurance (at least 15 repeated contractions) (n)	36	35*	

* One woman was not able to contract her PFM 6 weeks postpartum

Results of changes in PFM strength and endurance due to mode of delivery

The results for the 3 groups of women (normal vaginal, instrumental vaginal and acute cesarean section) are summarized in Table 5.

Table 5. Development of PFM function from mid-pregnancy (20-26 weeks of gestation) to after childbirth (6-12 weeks postpartum) for different deliveries. Mean with 95% CI of vaginal squeeze pressure (hPa) PFM endurance as mean with 95% CI of holding time in seconds and number of women (n) able to do at least 15 repeated contractions.

	Normal vag. (n=26)	Instr. vag. (n=5)	Acute ces. sect. (n=5)	p value
MVC during mid-pregnancy (hPa)	41.6 (35.1; 48.2)	48.4 (18.8; 78.0)	38.2 (16.7; 59.7)	0.637
MVC after childbirth (hPa)	20.8 (16.2; 25.3)	17.0 (9.3; 24.6)	33.0 (10.8; 55.2)	0.069
Difference in MVC (hPa)	20.5 (16.5; 24.5)	31.4 (7.4; 55.4)	5.2 (-6.6; 17.0)*	0.003
Endurance during mid-pregnancy (sec)	154.3 (103.4; 205.3)	150.2 (-48.1; 348.5)	99.2 (41.9; 156.5)	0.662
Endurance after childbirth (sec)	71.4 (45.5; 97.3)	50.0 (-9.1; 109.1)	96.8 (-61.7; 255.3)	0.600
Difference in endurance (sec)	83.0 (45.0; 120.9)	100.2 (-39.7; 240.1)	2.4 (-128.9; 133.7)	0.212
15 rep. contr. during mid-pregnancy (n)	26	5	5	
15 rep. contr. after childbirth (n)	25**	5	5	

* $p < 0.05$, significantly different compared with the two other groups

** One woman was not able to contract her PFM post-partum

1. PFM strength changes

The three groups showed significantly different changes in PFM strength, ($p=0.003$).

With multiple comparisons, the difference was significant between normal vaginal birth vs. acute cesarean section ($p=0.028$) and between instrumental vaginal birth and acute cesarean section ($p=0.003$). The changes were not significant between normal vaginal and instrumental vaginal births ($p=0.173$). The women giving birth with instrumental assistance (in all cases, vacuum extraction) showed the most marked reduction in strength, second were the women who gave normal vaginal birth and the least changes occurred in the acute cesarean section group. Figure 3 shows an example of pressure curves during MVC of the pelvic floor for one participant.

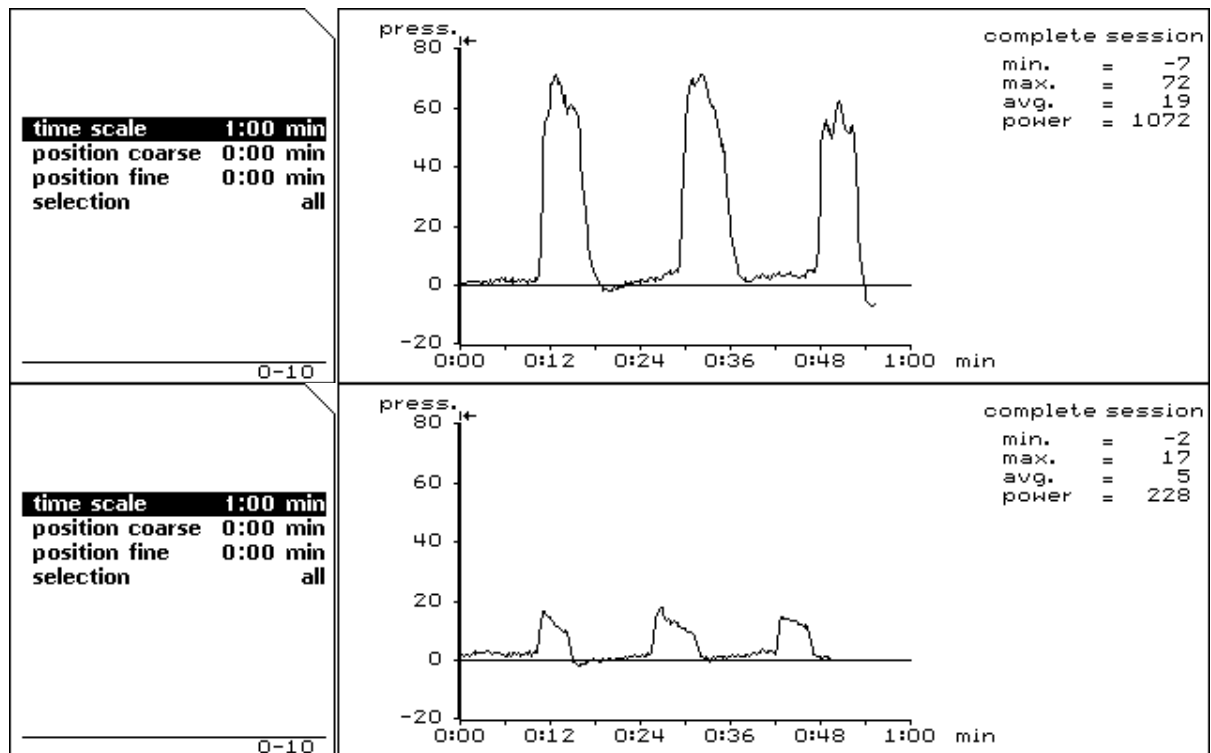


Figure 3. Examples of readings from Myomed 932, showing pressure curves of vaginal squeeze pressure during MVC of PFM, during mid-pregnancy above and 6 weeks after childbirth below. This woman had an instrumental delivery with vacuum extraction, 19 minutes of second stage of labor, episiotomy with perineal analgesia. Birth weight 3275 g and infant's head circumference was 35 cm.

2. Endurance changes (sustained contraction)

The three groups did not show significant differences regarding reduction in the ability to sustain a PFM contraction (in seconds), from mid-pregnancy to postpartum ($p=0.212$).

3. Endurance changes (repeated contractions)

No major changes were measured regarding repeated PFM contractions. All women were able to perform at least 15 contractions both during pregnancy and after birth, with the exception of one woman who was not able to contract her PFM postpartum.

Urine stream interruption

Before pregnancy, 32 women reported that they were able to stop midstream while urinating, 4 did not know. During midterm pregnancy, 31 reported that they could stop midstream, 5 did not know. In the first 24 hours after childbirth, 19 reported that they could stop midstream, 9 said that they could not stop midstream and 7 did not know. Six weeks postpartum, 29 women reported that they could stop midstream, 4 said no and 3 did not know if they could. When answers representing the same time period as the measurements of PFM function took place, i.e. during midterm pregnancy and 6 weeks postpartum, no significant difference was found with the use of a t-test, regarding PFM strength between those who said they could stop midstream and those who said no/did not know, ($p=0.949$).

Preception of PFM contraction

Table 6 shows how the women answered the question with a closed response on 3 occasions, from mid-pregnancy to postpartum.

Many different descriptions were obtained when women used their own words in the question with the open response.

One participant did not use this possibility at all, but all the other participating women did. Some women did not express themselves on all time periods in this study.

Eighteen women described their perception of PFM contraction before pregnancy. They did so before they were taught about PFM contraction. All of them reported some kind of sensation related to the pelvic area, describing in different ways a sense of muscle contraction around the pelvic openings, in the crotch or a feeling of lifting something inside the pelvis, even like holding urine.

Table 6. Perception of PFM contraction. Numbers with percentages (%) of women answering each possibility.

	During mid-pregnancy (n=36)	24 hours after childbirth (n=36)	6-12 weeks postpartum (n=36)
Strong and clear contraction, n (%)	14 (39)	10 (28)	15 (42)
Feel the muscles contract, but cannot hold the contraction for long, n (%)	9 (25)	12 (33)	10 (28)
Feel a contraction which is difficult to hold, n (%)	1 (3)	4 (11)	7 (19)
Try, but not sure what happens in the pelvic floor, n (%)	1 (3)	8 (22)	4 (11)
Cannot feel anything happen, n (%)	0 (0)	2 (6)	0 (0)
Not answering, n (%)	11 (30)	0 (0)	0 (0)

From descriptions during mid-pregnancy, 9 of 24 women reported changes towards a weaker sensation, with weaker PFM than they had before. Fifteen women described similar or no changes compared to before the pregnancy.

When the women reported their perception in the first days after childbirth, 22 of 29 women reported weaker sensation or less strength of the muscle contraction than before childbirth. Thirteen of them were numb or sore and even afraid of trying to contract (3 women). Eight women (one of them had also reported pain during contraction), on the other hand reported little changes in the perception of PFM contraction after childbirth.

The outcome of the women's perception of the PFM approx. 6 weeks postpartum was that, 20 of 33 women reported a weaker sensation/less strength. Three of those 20, said that they had less sensation or less strength than before delivery, but for the other 17, it was not clear if they meant before the pregnancy or the delivery. The descriptions were not in as negatively worded as in the first days after delivery. When comparing answers from 6 weeks postpartum, to answers from immediately after birth, for each woman,

there was a trend towards improvements in the women's perception. Many women complained of having to use other muscles to help managing PFM contraction. One woman described, having a better connection to the pelvic floor after childbirth:

Participant 14: “ Strong contraction, I feel that I can control the muscles better, I feel I know better how they work.”

Below are examples of individual descriptions throughout the study (The women's own words have not been changed) together with information about delivery data and PFM strength changes. Two different participants were chosen, their delivery data differed on many variables, e.g. the length of the second stage of labor, what analgesia was used and birth weight. Their strength changes also differed significantly: For participant 2, PFM strength changes are representative for the sample and participant 39, atypical (appendix 12 for all descriptions):

Participant 2:

Normal vaginal birth, 2nd stage of labor: 29 minutes, 2° perineal tear, perineal analgesia, birth weight: 3702 g, infants head circumference: 36 cm,
PFM strength: 88 hPa → 41 hPa.

Q.1a (before pregnancy): I felt clearly that the muscles were contracting.

Q.2 (first days after childbirth): I feel that the muscles have weakened and now I have to use the buttocks to help contract the pelvic floor and it is very difficult.

Q.3 (approx. 6 weeks postpartum): I feel that I have to use the buttocks as well.

Participant 39:

Normal vaginal birth, 2nd stage of labor: 133 minutes, 2° perineal tear, epidural analgesia, birth weight: 3905 g, infants head circumference: 35.5 cm,

PFM strength: 26 hPa → 0 hPa (no PFM contraction during 2nd measurement).

Q.1b (during pregnancy): Tension-the buttocks contract.

Q.2 (first days after childbirth): I feel that I have less control over the muscles. I feel that I can contract but when I try to relax it's like I have already lost the contraction. If I don't go quickly to the bathroom when I need to urinate I loose the urine, cannot hold it, I can stop midstream when I urinate.

Q.3 (approx. 6 weeks postpartum): I don't feel a strong contraction when I try to contract. And when I intend to release the contraction it is already gone. I cannot quite control it.

Correlation between delivery data and changes in PFM function due to delivery

Table 7 shows the correlation for PFM function and delivery data.

No significant correlation was found between any delivery data and changes in PFM function due to childbirth. The strongest association or trend was found between perineal analgesia and PFM strength changes, $r=0.336$ but did not reach significance ($p=0.065$).

Table 7. Correlation between changes in PFM strength and endurance due to childbirth and obstetric factors.

	Difference in PFM maximal strength from mid-pregnancy to after childbirth in hPa	Difference in endurance of PFM contraction from mid- pregnancy to after childbirth in sec
Length of second stage of labour in min (n=36)	0.191; p=0.265	0.081; p=0.640
Birth weight of the infant in kg (n=31)	0.057; p=0.777	0.115; p=0.536
Circumference of infants head in cm (n=31)	0.156; p=0.401	-0.226; p=0.221
Perineal tear (n=36)	-0.192; p=0.301	0.168; p=0.365
Episiotomy (n=36)	-0.015; p=0.937	-0.025; p=0.896
Epidural analgesia (n=36)	0.168; p=0.366	0.117; p=0.531
Perineal analgesia (n=36)	0.336; p=0.065	0.207; p=0.263

Pearson's r for birth weight and circumference of the infants head for all women who delivered vaginally (n=31). Spearman's r for the length of the second stage of labor which was not normally distributed and other data, either ordinal (degree of perineal tear) or nominal variables (episiotomy, epidural and perineal analgesia (yes or no))

Symptoms from the pelvic organs

No woman reported fecal incontinence over the period studied.

Before their pregnancies, 31 women reported never leaking urine and 5 women leaked about once a week or less often. Mid-pregnancy, 24 women reported never leaking urine, 7 women leaked once a week or less often and 5 women leaked two or three times a week or more often. During their last month of pregnancy, 21 women reported never leaking urine, 8 women leaked once a week or less often and 7 women leaked two or three times a week or more often. Six to 12 weeks postpartum, 29 women reported never leaking urine, 3 women leaked about once a week or less often and 3 women leaked urine two or three times a week.

Table 8. ICIQ scores regarding individual symptoms and bother from urinary incontinence. Scores can range from zero to 21. Number of women with different scores (n=36).

	Before pregnancy	During mid-pregnancy	Last month of pregnancy	6-12 weeks postpartum
0 score	30	23	20	29
1 score	1	2		
2 scores			1	
3 scores	2		1	3
4 scores	2	5	3	
5 scores	1	1	2	
6 scores		1	1	
7 scores		2	2	3
8 scores			1	
9 scores			1	1
10 scores		2	1	
11 scores			1	
12 scores			1	
17 scores			1	

For symptoms of flatus incontinence, before pregnancy, 30 women never had flatus incontinence, 4 women about once a week or less often and 2 women two or three times a week or more often. Mid-pregnancy, 27 women never experienced flatus incontinence, 5 women experienced it about once a week or less often and 6 women experienced it two or three times a week or more often. During their last month of pregnancy, 25 women never experienced flatus incontinence, 6 women experienced it once a week or less often and 5 women experienced it two or three times a week or more often. Six-12 weeks postpartum, 27 women never experienced flatus incontinence, 7 women experienced it once a week or less often and 2 women two or three times a week.

ICIQ scores for participants are summarized in Table 8.

Table 9 shows types of the incontinence for the participants, as well as the circumstances when urine leaked.

Table 9. Type of urinary incontinence. The circumstances when urine leaked, women were able to tick as many possibilities as applied to them (n=36).

	Before pregnancy	During mid-pregnancy	Last month of pregn.	6-12 weeks post-partum
Never- Urine does not leak	31	25	20	29
Leaks before you can get to the toilet	3	3	1	2
Leaks when you cough or sneeze	3	6	12	4
Leaks when you are asleep			1	
Leaks when you are physically active/exercising		2	2	2
Leaks when you have finished urinating and are dressed		2	5	1
Leaks for no obvious reason	1	4	3	
Leaks all the time				

PFM exercises

The women were asked in all questionnaires, if and how they exercised their PFM.

Table 10 shows frequency of exercises, number of repetitions and duration of each contraction.

When asked in the last questionnaire, how many weeks postpartum women had exercised, the answers ranged from one to 12 weeks (measurement times postpartum ranged from 6-12 weeks).

When asked if they were presently doing PFM exercises, 34 answered positively, 2 negatively; one because she forgot to exercise and one because she did not have time.

Table 10. PFM exercises practised by participants throughout the study. Frequency of exercises (number of women), range of repetitions and range of duration of each PFM contraction.

	Before pregnancy	During mid- pregnancy	Last month of pregnancy	6-12 weeks postpartum
Every day (n)	1	2	1	5
At least 3 times per week (n)	2	3	8	15
1-2 times per week (n)	2	6	9	6
At least once a week (n)	2	4	5	3
Occasionally (n)	10	9	4	5
Never (n)	19	12	9	2
Number of repetition each time (range)	3-30	3-30	4-50	3-40
Duration of each contraction in seconds (range)	1-60	1-60	2-60	2-25

DISCUSSION

Short summary of results

In this study, we found that pelvic floor muscle strength and endurance, the latter measured as the length of a sustained contraction, was significantly decreased in the whole group of participants. We found also that pelvic floor muscle strength was significantly decreased after vaginal delivery, both in normal vaginal delivery and with instrumental assistance, 6-12 weeks postpartum. Endurance measured as the ability to hold a sustained contraction and to repeat contractions continuously was less influenced by the mode of delivery. Perception of the quality of the PFM contraction supported the consequential strength changes of childbirth. No correlation was found between changes in PFM function due to childbirth and the length of the second stage of labor or other delivery data. Symptoms of urinary and flatus incontinence were in general mild, but increased during the course of pregnancy, decreased postpartum but were still more prevalent then, than before pregnancy. Urinary symptoms were mostly SUI, but urgency symptoms were also reported. None of the participants in the present study complained about fecal incontinence. Few women practised PFM exercises regularly before becoming pregnant, but the number of women doing PFM exercises increased during pregnancy and postpartum.

Discussion of methodology

Participants

The mean age of the participants represented the mean age of all primiparas giving birth in LSH during the study period. The range was smaller but covered 20 years. The range of all primiparas in 2007 had a range of 39 years (78). All instrumentally assisted

deliveries were conducted with vacuum and no forceps. That could possibly be a positive factor, as certain uniformity could be seen between the women in that group, but it could also be classed as a weakness. Forceps delivery is considered by many authors to have greater consequences on PFM function than other types of vaginal delivery (47, 65, 69). We did not get the chance to observe that during our study. Although the 2 groups, instrumentally assisted vaginal and acute cesarean section were small, with only 5 women in each group, the percentage of vacuum assisted delivery and cesarean section in this study was higher than the population we compared our study to. The reason for that might be, that a small sample size is not accurately representative for the population studied or because our participants were solely primiparas, while the numbers received from the Icelandic birth registry, were for all women giving birth during the year of 2007 (77). The Icelandic birth registry showed some limitations, because information for solely primiparas and their delivery data was not easily accessible (77).

Eight women (18%) withdrew from the study after the first measurement. It is of interest to look at them and compare them to the group who participated to the end of the study. From the information which was available, mode of delivery did not differ from the women who completed their participation. Neither did the mean strength of their PFM.

One woman who ended her participation after the first measurement, was not able to contract her PFM, even after facilitation through vaginal palpation. On account of that, she did not trust herself to continue in the research. Four of the participants in Dietz's study (2004) also had the initial problems of contracting their PFM, both spontaneously and after instructions, although 3 of them managed to contract eventually (44). Peschers et al (2001) tested PFM activity in nulliparous volunteers with

EMG and ultrasound simultaneously. One participant was not able to contract her PFM voluntarily but had a normal reflex contraction when she coughed. They also observed the visa versa in 2 more women (21). In the present study, the assessor did not ask this woman about permission to test reflex activity during a cough, because the woman was deeply distressed during these findings.

Number of participants-type II errors

In the present study, pregnant women were recruited through the Primary Health Care of the Capital Area, Iceland. One limiting factor in this study was the recruitment method.

The MSc. student had to rely on the good-will of midwives working in the antenatal care, who during the period of this study, had to find participants for at least 3 other studies. One can assume that this was likely to create a strain on their working environment as well as limiting the number of possible participants. Despite that, a small number of midwives did recruit many women each. The interest of the individual midwife for this study was probably therefore, also a limiting factor. There were also time limits. A period of one year was considered to be adequate time for data collection for a master study.

In the present study there was a certain probability of making a type II error, not being able to reject a false null hypothesis; not being able to detect a significant difference when a difference really exists on account of our small sample sizes (82). Power estimation for this study, estimated 8 women to be able to detect differences between strength before and after childbirth for the correlation given (0.8). In this study we only reached 5 participants in 2 groups (instrumental vaginal birth and acute cesarean section).

Assessment tools

The strengths of the methods used for evaluating the ability to contract and to measure function of the PFM used in the present study, are that they have been widely used and checked for validity and reliability (22, 27, 89-91). The device used in this study was also tested for reliability before the main study. The results showed a very good test-retest reliability (see paper I). Another strength is probably also that the assessor was a physiotherapist with a long experience of evaluating PFM function in women. One weakness of the measurement methods is worth mentioning. Vaginal pressure probes are subject to influences from IAP. All increase in IAP is transmitted to the urethra, vagina and anus and can be interpreted as pressure increase due to PFM contraction when measured with a vaginal pressure probe (27). Therefore pressure measurements cannot be used alone. An observation of an inward movement of the perineum/the probe and confirmation of correct PFM contraction through vaginal palpation is mandatory when assessing PFM function (90, 91).

Blinding

Double-blinding in studies is usually the best way to achieve protection from many sources of bias because it rules out the possibilities of personal interpretations or expectations of outcome. In many cases this is not possible and a single-blinded methods is practised, e.g. in some rehabilitation studies (82). In the present study, neither was possible because this study was a one student's research and circumstances for blinding not available. The assessor was not blinded against the mode of delivery when the women came to second measurement. However, it was kept as a rule, not to

talk about the delivery during the measurements to try and avoid as possible, observational bias (82).

Questionnaires

The participants answered 4 repeated questionnaires. Questions and answers from them, which were chosen for this thesis included background variables, PFM exercises and symptoms from the pelvic organs. Some questions were excluded as they were not considered relevant to this thesis. The questions about incontinence have been published by the ICI and ICS and validated and checked for reliability before (87). Some of the answers from the 4 questionnaires could have been influenced by a recall bias (82). During the first visit the participants answered 2 questionnaires, the former was about health before the women became pregnant and therefore the participants had to rely on memory. The third questionnaire was answered at home or at the hospital soon after the delivery. It is not known when individual participants answered this questionnaire and how long time had elapsed for the symptoms in question, but this questionnaire addressed health during last month of pregnancy and first days postpartum.

Strengths and limitation of the study

Some strengths and limitations of the present study have been discussed here above. The greatest weakness in the study is without doubt the small sample size. This new approach of documenting women's perception of the quality of their PFM contraction can be counted as a strength of the study. As far as the author knows, this has not been done before. It gives an interesting insight into how this function is perceived, but

studies have shown that many women have difficulties, performing a right PFM contraction, even after individual instruction (23, 24).

Discussion of results

No significant difference in PFM strength and endurance was found between the 3 groups of women when measured for the first time during mid-pregnancy. However, the 3 groups differed significantly in age and pre-pregnancy BMI, in both cases, the acute cesarean section group was older and had a higher BMI. Meyer et al did not find significant difference in maternal age between groups in their study (40) and Sultan et al did not find any significant association between maternal age, weight or consequential nerve damage (57). Allen et al did not comment on the participants' ages (6). Advanced maternal age has been found to be associated with increased obstetric interventions such as acute cesarean section (92). In a large cohort study, increased maternal weight, was found to be strongly associated with a higher number of incidences of cesarean section (93) and a meta-analysis found that overweight and obesity had an independent risk factor for elective and acute cesarean section (94). Although having a small sample size, one can ask whether increasing maternal age during first delivery and a general increase in BMI as is noticeable in the Western World, are influencing obstetric practice.

Discussion of changes in PFM strength and endurance due to childbirth

A significant strength and endurance reduction in the PFM for the whole group of participants was found and therefore null-hypothesis nr. 1 can be rejected.

The study of Allen et al (1990) support our findings with similar results regarding PFM strength changes using a perineometer, concentric needle EMG and pudendal nerve

conduction tests. They found a reduction in strenght from late pregnancy to 2 months postpartum which was significant. Most nerve damages were seen in women with a long active second stage of labor and who had heavier babies. They concluded that vaginal delivery causes partial denervation to the pelvic floor in most women having their first baby and that “For some it was likely to be the first step along a path leading to prolapse and/or stress incontinence” (6).

Marshall et al (2002) compared endurance of the PFM in nulliparous and primiparous women (who were 9-10 months postpartum) and found that PFM performance was significantly worse in women who had delivered once compared to women who had never given birth. Their test of endurance, showed similar trend as our results for all participants, less endurance of the PFM after childbirth (3).

Discussion of changes in PFM strength due to mode of delivery

We found a significant reduction in PFM strength for all vaginal deliveries compared to acute cesarean section, therefore we can reject null-hypothesis nr. 2a.

At least two studies have been found that corresponds with the results of this study (40, 43). They include vaginal pressure measurements with a perineometer being at least one of the measurement method, with primiparas making up at least a section of all the participants, and measurements taking place before and after childbirth. The exact timing of measurements was not the same in these studies or the same as in the present study.

Peschers et al (1997) found a significant reduction in PFM strength in primiparas 6-10 weeks postpartum compared with values during last month of gestation. Their study also included a control group of women who had en elective cesarean section. Their study did not find any changes in PFM strength for the control group from late

pregnancy to 6-10 weeks postpartum. They concluded that PFM strength was impaired shortly after vaginal delivery but returned within 2 months for most women (43).

Meyer et al (1988) studied the effects of birth on urinary and anal continence and also PFM strength. They differed between spontaneous vaginal delivery and instrumental (forceps) delivery. All cesarean sections were in one group. Their results from intra-vaginal measurements were that the women who delivered by cesarean section showed no significant reductions in PFM strength, while women who had instrumentally (forceps) assisted deliveries showed the most marked and significant reduction in PFM strength and the women who delivered spontaneously also showed a significant reduction in strength. Similar results were seen in intra-anal pressure measurements (40).

In these 2 studies, results regarding PFM strength changes were very similar to the present study. However it is not possible to compare actual values of strength because variations exist, both in technical parameters as well as the fact that vaginal probes vary in size, making precise comparison impossible (95). The studies that are used here in comparison to our study, use cm H₂O to measure the pressure but the device in our study is calibrated in hPa. According to an answer to an enquiry to the Science web at the University of Iceland; 1.0 hPa is equivalent to 1.02 cm H₂O (96).

Studies using different techniques to evaluate PFM function during the course of pregnancy and childbirth have also been identified (44, 50, 53, 57, 76).

They all support our main findings, which show that after vaginal delivery, PFM functions are affected the first weeks postpartum and very possibly for longer.

Sultan et al (1994) reported among other things, on pudendal nerve damages found in primiparas who gave birth vaginally or had cesarean section for obstructed labor. Elective cesarean section was seen to be protective against consequential nerve

damages. When measured again 6 months postpartum, most of their participants showed a good recovery regarding previously detected the nerve damage (57).

Dietz (2004) evaluated PFM strength as the ability to elevate the bladder neck during contraction using ultrasound. His results showed that cesarean section was weakly protective when it was compared with vaginal delivery and instrumental delivery resulted in more of a reduction in strength compared to cesarean section (44).

Tooze-Hobson et al (2008) investigated primiparas for the effects of different modes of delivery on several variables, including bladder neck mobility and changes in levator hiatus distensibility by using 3D ultrasound (76). They found that the levator hiatal size was significantly larger in women who delivered vaginally compared to women who had a cesarean section. This was true for antenatal values during the valsalva manoeuvre. Values postpartum, showed that women who had delivered vaginally had significantly larger hiatal size at rest, valsalva and during PFM contraction compared to cesarean section. Antenatal and postnatal bladder neck mobility was also greater in women who delivered vaginally (76).

All the studies used for comparison here (40, 43, 44, 57, 76), had more participants, except for Peschers et al (43). Measurements were made during different time periods, during pregnancies which can possibly influence the initial strength used for analysis (33, 36). Likewise, measurements postpartum were not made exactly on the same time as our study and that can have influenced outcome in the same way. PFM strength after childbirth has been found to increase gradually from the first days postpartum (6, 43, 50, 76).

Discussion of changes in PFM endurance due to mode of delivery

In our study, we did not find significant differences demonstrating changes in the endurance of the PFM based on different modes of delivery. According to this, we cannot reject null-hypothesis nr. 2b.

When measuring endurance as an ability to hold a contraction for as long as possible, a great variation in the duration of the contractions was observed between the women. Although we saw a significant reduction in this function for all women as one group, we did not see differences between the three groups of different modes of delivery. The large confidence intervals for this variable in each group overlapped a great deal making interpretation difficult (82). This could of course be a type II error or mean that endurance measured as a holding time of a sustained PFM contraction is not influenced by different modes of delivery.

No studies were found that investigated the effects of modes of delivery on PFM endurance which makes comparison difficult. As stated before, one study was though identified that compared PFM endurance in nulliparous women, to women who had given vaginal birth once but did not differ between different modes of delivery (3).

Urine stream interruption

In this study we did not find a significant difference in PFM strength between women answering “yes” or “no/I don’t know”, to the question, whether they could stop the urine stream while urinating.

Kerschman-Schindl et al (2002) found that the maximal contraction force and mean force of the PFM correlated well with the ability to stop the urine stream in elderly incontinent women (91). Sartore et al (2003) studied the efficacy of different tests in identifying PFM dysfunction after vaginal delivery. They did not find correlation

between urine stream interruptions test and PFM strength. They concluded that the urine stream test was useful in testing pelvic floor performance but reflected better urethrovesical support than PFM function (86). It is not easy to interpret the results, of the present study, of the ability to stop the urine stream and its relation to PFM strength. Maybe it is possible to hypothesize that more factors than PFM strength alone contribute to the ability to stop the urine stream in healthy young women.

Discussion of perception of quality of the PFM contraction

As stated earlier on, the author is not aware of other studies on women's perception of PFM contractions. Women gave their answers with a closed response (table 6) and an open response. In order to gain answers from the first 24 hours after delivery, the women were given questionnaire 2 to take home prior to giving birth, and were asked to answer the questions as soon as possible after giving birth. What they considered possible, varied greatly. We do not have information about the exact timing each woman answered this questionnaire. Some of the answers for these days could therefore be influenced by a recall bias. The same applies for information from questionnaire 1a, which was about health before pregnancy, but was answered during mid-pregnancy.

The women's descriptions were in general, supportive of the strength changes observed by us throughout the study (all individual descriptions are given in appendix 12). Most of the women who gave their own descriptions of their perception of PFM contraction, described their sensation clearly. This is not surprising, as all participants were healthy, young and had not given birth before. The number of women who did not utilize this possibility of expressing themselves, could have done so because they were unsure of their perception of this part of their body.

One woman lost the ability to contract her PFM after childbirth. In her own descriptions of perception of the contraction, she said that in the first days after giving birth, she could feel the contraction, but when she relaxed, the contraction was already gone. Similarly at 6 weeks postpartum, she felt a weak contraction which was already gone when she intended to relax. No contraction was felt during the second measurement of this woman. No contraction was found by vaginal palpation and during measurement with the vaginal pressure probe, a downward movement (straining) of the probe was noticed although the device detected pressure. It is likely that this woman interpreted a perception of other muscles as being from the PFM, as she said: “And when I intend to release the contraction it is already gone. I cannot quite control it.”

Discussion of correlation between obstetric variables and changes in PFM function

In the present study no correlation was found between the length of the second stage of labor and other delivery data versus changes in PFM strength and endurance due to childbirth. Therefore we could not reject null-hypothesis nr. 3 and 4. Those findings are in contrast to some other studies but not all (6, 44, 47, 57).

Meyer et al (1998) did not find significant correlation between the length of the second stage of labor and changes in vaginal pressure during PFM contraction due to childbirth (40), which supports our findings.

Dietz (2004) had similar findings to the present study regarding the lack of a significant correlation between birth weight, epidural analgesia and episiotomy and a reduction in PFM strength due to childbirth. He, on the other hand, found a significant correlation between the length of second stage of labor and PFM strength reduction and he concluded that the length of the second stage of labor was probably the main obstetric factor affecting levator function (44).

Sultan et al found an association between the length of the second stage of labor, birth weight and the degree of nerve damage to the PFM (57).

Allen et al found that forceps delivery and perineal tears did not affect the degree of nerve damage (and therefor PFM function) in this study (6).

No studies were found that addressed the influences of a perineal analgesia on PFM function during childbirth. In the present study, correlation between perineal analgesia and PFM strength changes due to childbirth, was closest to significance, of all calculated correlations ($p=0.065$).

Interpretation of these results can be difficult. For the complicated event of childbirth, many extraneous variables can be present and influences from them can be impossible to detect or take into account. To name few; the sample was not randomized but chosen for convenience making a sampling error one possibility (82), the influences of different tissue type or race (75, 76, 97), different obstetric practice between hospitals/countries and obviously a small sample size.

Discussion of other results; from questionnaires

Symptoms from the pelvic organs

No woman in this study complained about fecal incontinence. Symptoms of urinary incontinence, for all frequencies (all except those who answered no) were, 14%, 33%, 42% and 19% for time periods, before pregnancy, during midterm pregnancy, last month of pregnancy and 6 weeks postpartum respectively. For most of the participants, the symptoms occurred once a week or less often. Symptoms and frequency of flatus incontinence had similar outcome. The ICIQ scores reflect also that few women had much subjective bother from these symptoms which are on the scale from zero to 21,

except for the last month of pregnancy when ICIQ scores rose (Table 8). Mørkved and Bø reported in a study from 1999, that 42% of women had urinary incontinence during pregnancy and 38%, at 8 weeks postpartum. Fecal incontinence was recorded as 4% postpartum (2). The same authors claimed in another study that SUI became more prevalent during pregnancy and then declined after childbirth (80). Chaliha and Stanton reported similar developments during this period for women, stating that incontinence increased (both stress and urge) in women during pregnancy compared to before pregnancy and then diminished again postpartum (39). Results can differ because of different definitions. The results of the present study show similar behaviour for urinary incontinence as those referred to above.

PFM exercises

Women in this study were asked if they performed PFM exercises. It was not the aim, to study the effects of PFM exercises, but it was of interest to see how women practiced them during this influential time in their lives. Their behaviour regarding the exercises changed much over the study period. There could be at least three possible reasons for this:

1. Women felt changes in the functions of their bodies, such as increased incontinence or weakness of the PFM and reacted to that.
2. The study and participation was an intervention in itself and raised awareness among the women.
3. The women received education in the antenatal care regarding the necessity to perform PFM exercises.

Regarding the third possibility, the author of this study does not know how education for pregnant women is carried out in antenatal care but it could be an interesting future subject to study.

In a Norwegian study from 2006, Bø et al reported that overall 17% of pregnant women did PFM exercises at least once a week. When comparing same periods in the present study and the study of Bø et al (98), Bø et al found lower numbers of women doing PFM exercises. This difference is possibly because our numbers come from participants actively taking part in a study about the PFM and the Norwegian statistics came from a postal survey which, based on a larger number of women (n=467), made it easier to generalize (98). Bø et al (2009) discuss in another article, that responders to questionnaires, generally tend to overestimate the frequency of their training and therefore such information should be interpreted with caution (99). That could also be the case in our study and could thus explain, why our numbers were so high.

Possible future steps

It is of great interest to compare PFM strength during pregnancy with non-pregnant controls and match participants on important variables such as age and BMI. It would be of similar interest to observe the development of the PFM function during the course of the pregnancy (if such a development exists) with repeated measurements. However that could possibly raise ethical questions regarding the privacy of pregnant women. An interest in following the participants over a longer time period postpartum was raised during the work on this study. This has already been done. Our group of participants was followed up, with 2 measurements; which were made at 6 and 12 months postpartum with permission from the National Bioethics Committee. All the measurements have been finished but have not been statistically analysed yet as they

are not a part of this masters thesis. Hopefully the results will be published at a later date.

It was by no means the purpose of this study to draw a pathological picture of the developments in functional changes in PFM as a consequence of childbirth. It was merely to quantify and qualify the changes observed. The birth of an infant is a very natural process, but it can affect the mothers health as a consequence. We can use the information collected about the development of PFM function during childbirth to establish a better education and service towards women with pelvic floor dysfunction and in prevention of pelvic floor dysfunction. A great deal of knowledge proving that PFM exercises are effective in treating and preventing PFM dysfunction is presently available (7, 100-105).

The main findings of this study, about strength reduction of the PFM due to delivery and the influences of different modes of delivery on PFM strength are similar to many previous studies. The present study did not find a correlation between the length of the second stage of labor and development of PFM strength which is in contrast to many other studies. What we add to this field of PFM studies is the insight into women's perceptions of PFM contractions.

Conclusion

Based on this cohort study, pelvic floor muscle strength decreased significantly after vaginal delivery, both normal vaginal delivery and instrumentally (vacuum) assisted vaginal delivery at 6-12 weeks postpartum. Other aspects of PFM function i.e. endurance measured as the ability to hold isometric contraction and to repeat

contractions are less influenced by the mode of delivery. The perception of the PFM contraction is well described by most young and healthy women and reduction in the strength of the PFM is demonstrated in most of the women's descriptions. We also conclude that there is no correlation between the length of the second stage of labor and changes in PFM strength and endurance as a consequence of childbirth. Further we also conclude as an outcome of our study that there is no correlation between changes in PFM strength and endurance due to giving birth and the following delivery data: The degree of perineal tear, the use of episiotomy, the use of perineal analgesia or epidural analgesia. These results could possibly be influenced by a relatively small sample size, high standard deviation and large confidence intervals, and should be interpreted with caution.

REFERENCES

1. Jolleys JV. Reported prevalence of urinary incontinence in women in a general practice. *Br Med J (Clin Res Ed)*. 1988;296:1300-2.
2. Morkved S, Bo K. Prevalence of urinary incontinence during pregnancy and postpartum. *Int Urogynecol J Pelvic Floor Dysfunct*. 1999;10:394-8.
3. Marshall K, Walsh DM, Baxter GD. The effect of a first vaginal delivery on the integrity of the pelvic floor musculature. *Clin Rehabil*. 2002;16:795-9.
4. Snooks SJ, Setchell M, Swash M, Henry MM. Injury to innervation of pelvic floor sphincter musculature in childbirth. *Lancet*. 1984;2:546-50.
5. Smith AR, Hosker GL, Warrell DW. The role of partial denervation of the pelvic floor in the aetiology of genitourinary prolapse and stress incontinence of urine. A neurophysiological study. *Br J Obstet Gynaecol*. 1989;96:24-8.
6. Allen RE, Hosker GL, Smith AR, Warrell DW. Pelvic floor damage and childbirth: a neurophysiological study. *Br J Obstet Gynaecol*. 1990;97:770-9.
7. Kegel AH. Progressive Resistance Exercise in the Functional Restoration of the Perineal Muscles. *Am J Obstet Gynecol*. 1948;56:238-49.
8. DeLancey JO. Structural support of the urethra as it relates to stress urinary incontinence: the hammock hypothesis. *Am J Obstet Gynecol*. 1994;170:1713-20; discussion 20-3.
9. Gray H, Standring S. *Gray's anatomy : the anatomical basis of clinical practice*. 39th ed. ed. Edinburgh: Elsevier Churchill Livingstone 2005.
10. DeLancey JO. Structural anatomy of the posterior pelvic compartment as it relates to rectocele. *Am J Obstet Gynecol*. 1999;180:815-23.
11. Fritsch H, Pinggera GM, Lienemann A, Mitterberger M, Bartsch G, Strasser H. What are the supportive structures of the female urethra? *Neurourol Urodyn*. 2006;25:128-34.
12. Deindl FM, Vodusek DB, Hesse U, Schussler B. Activity patterns of pubococcygeal muscles in nulliparous continent women. *Br J Urol*. 1993;72:46-51.
13. Chantraine A. Examination of the anal and urethral sphincters. In: Desmedt JE, ed. *New developments in electromyography and clinical neurophysiology*. Basel: Karger 1973:421-32.
14. Kegel AH. Stress Incontinence and Genital Relaxation. *Ciba Clin Symp*. 1952;4:35-51.
15. Bo K, Stien R. Needle EMG registration of striated urethral wall and pelvic floor muscle activity patterns during cough, valsalva, abdominal, hip adductor, and

gluteal muscle contractions in nulliparous healthy females. *Neurourol Urodyn.* 1994;13:35-41.

16. Sapsford RR, Hodges PW. Contraction of the pelvic floor muscles during abdominal maneuvers. *Arch Phys Med Rehabil.* 2001;82:1081-8.

17. Sapsford RR, Hodges PW, Richardson CA, Cooper DH, Markwell SJ, Jull GA. Co-activation of the abdominal and pelvic floor muscles during voluntary exercises. *Neurourol Urodyn.* 2001;20:31-42.

18. Neumann P, Gill V. Pelvic floor and abdominal muscle interaction: EMG activity and intra-abdominal pressure. *Int Urogynecol J Pelvic Floor Dysfunct.* 2002;13:125-32.

19. DeLancey JO. Structural aspects of urethrovesical function in the female. *Neurourol Urodyn.* 1988;7:509-19.

20. Howard D, Miller JM, Delancey JO, Ashton-Miller JA. Differential effects of cough, valsalva, and continence status on vesical neck movement. *Obstet Gynecol.* 2000;95:535-40.

21. Peschers UM, Vodusek DB, Fanger G, Schaer GN, DeLancey JO, Schuessler B. Pelvic muscle activity in nulliparous volunteers. *Neurourol Urodyn.* 2001;20:269-75.

22. Bo K, Sherburn M. Evaluation of female pelvic-floor muscle function and strength. *Phys Ther.* 2005;85:269-82.

23. Bump RC, Hurt WG, Fantl JA, Wyman JF. Assessment of Kegel pelvic muscle exercise performance after brief verbal instruction. *Am J Obstet Gynecol.* 1991;165:322-7; discussion 7-9.

24. Bo K, Larsen S, Oseid S, Kvarstein B, Hagen R, Jorgensen J. Knowledge about and ability to correct pelvic floor muscle exercises in women with urinary stress incontinence. *Neurourol Urodyn.* 1988;7:261-2.

25. Chiarelli P, Murphy B, Cockburn J. Women's knowledge, practises, and intentions regarding correct pelvic floor exercises. *Neurourol Urodyn.* 2003;22:246-9.

26. Bo K, Finckenhagen HB. Vaginal palpation of pelvic floor muscle strength: inter-test reproducibility and comparison between palpation and vaginal squeeze pressure. *Acta Obstet Gynecol Scand.* 2001;80:883-7.

27. Bo K, Kvarstein B, Hagen R, Larsen S. Pelvic floor muscle exercise for the treatment of female stress urinary incontinence: II. Validity of vaginal pressure measurements of pelvic floor muscle strength and necessity of supplementary methods for control of correct contraction. *Neurourol Urodyn.* 1990;9:479-87.

28. Benvenuti F, Caputo GM, Bandinelli S, Mayer F, Biagini C, Sommariva A. Reeducative treatment of female genuine stress incontinence. *Am J Phys Med.* 1987;66:155-68.

29. Abrams P, Cardozo L, Fall M, Griffiths D, Rosier P, Ulmsten U, et al. The standardisation of terminology of lower urinary tract function: report from the Standardisation Sub-committee of the International Continence Society. *Neurourol Urodyn*. 2002;21:167-78.
30. Messelink B, Benson T, Berghmans B, Bo K, Corcos J, Fowler C, et al. Standardization of terminology of pelvic floor muscle function and dysfunction: report from the pelvic floor clinical assessment group of the International Continence Society. *Neurourol Urodyn*. 2005;24:374-80.
31. Dietz HP, Steensma AB, Vancaillie TG. Levator function in nulliparous women. *Int Urogynecol J Pelvic Floor Dysfunct*. 2003;14:24-6; discussion 6.
32. Dschiertzig T, Stangl K. Relaxin: a pregnancy hormone as central player of body fluid and circulation homeostasis. *Cellular and Molecular Life Sciences*. 2003;60:688-700.
33. Meyer S, Bachelard O, De Grandi P. Do bladder neck mobility and urethral sphincter function differ during pregnancy compared with during the non-pregnant state? *Int Urogynecol J Pelvic Floor Dysfunct*. 1998;9:397-404.
34. Morkved S, Salvesen KA, Bo K, Eik-Nes S. Pelvic floor muscle strength and thickness in continent and incontinent nulliparous pregnant women. *Int Urogynecol J Pelvic Floor Dysfunct*. 2004;15:384-9; discussion 90.
35. Dietz HP, Eldridge A, Grace M, Clarke B. Does pregnancy affect pelvic organ mobility? *Aust N Z J Obstet Gynaecol*. 2004;44:517-20.
36. Sampsel CM, Miller JM, Mims BL, Delancey JO, Ashton-Miller JA, Antonakos CL. Effect of pelvic muscle exercise on transient incontinence during pregnancy and after birth. *Obstet Gynecol*. 1998;91:406-12.
37. Iosif CS, Ingemarsson I. Prevalence of stress incontinence among women delivered by elective cesarian section. *Int J Gynaecol Obstet*. 1982;20:87-9.
38. McKinnie V, Swift SE, Wang W, Woodman P, O'Boyle A, Kahn M, et al. The effect of pregnancy and mode of delivery on the prevalence of urinary and fecal incontinence. *Am J Obstet Gynecol*. 2005;193:512-7; discussion 7-8.
39. Chaliha C, Stanton SL. Urological problems in pregnancy. *BJU Int*. 2002;89:469-76.
40. Meyer S, Schreyer A, De Grandi P, Hohlfeld P. The effects of birth on urinary continence mechanisms and other pelvic-floor characteristics. *Obstet Gynecol*. 1998;92:613-8.
41. Stanton SL, Kerr-Wilson R, Harris VG. The incidence of urological symptoms in normal pregnancy. *Br J Obstet Gynaecol*. 1980;87:897-900.
42. Dumoulin C, Gravel D, Bourbonnais D, Lemieux MC, Morin M. Reliability of dynamometric measurements of the pelvic floor musculature. *Neurourol Urodyn*. 2004;23:134-42.

43. Peschers UM, Schaer GN, DeLancey JO, Schuessler B. Levator ani function before and after childbirth. *Br J Obstet Gynaecol.* 1997;104:1004-8.
44. Dietz HP. Levator function before and after childbirth. *Aust N Z J Obstet Gynaecol.* 2004;44:19-23.
45. Braekken IH, Majida M, Ellstrom-Eng M, Dietz HP, Umek W, Bo K. Test-retest and intra-observer repeatability of two-, three- and four-dimensional perineal ultrasound of pelvic floor muscle anatomy and function. *Int Urogynecol J Pelvic Floor Dysfunct.* 2008;19:227-35.
46. Baytur YB, Deveci A, Uyar Y, Ozcakil HT, Kizilkaya S, Caglar H. Mode of delivery and pelvic floor muscle strength and sexual function after childbirth. *Int J Gynaecol Obstet.* 2005;88:276-80.
47. Snooks SJ, Swash M, Henry MM, Setchell M. Risk factors in childbirth causing damage to the pelvic floor innervation. *Int J Colorectal Dis.* 1986;1:20-4.
48. Jozwik M, Jozwik M. Partial denervation of the pelvic floor during term vaginal delivery. *Int Urogynecol J Pelvic Floor Dysfunct.* 2001;12:81-2.
49. Peschers U, Schaer G, Anthuber C, Delancey JO, Schuessler B. Changes in vesical neck mobility following vaginal delivery. *Obstet Gynecol.* 1996;88:1001-6.
50. Tunn R, DeLancey JO, Howard D, Thorp JM, Ashton-Miller JA, Quint LE. MR imaging of levator ani muscle recovery following vaginal delivery. *Int Urogynecol J Pelvic Floor Dysfunct.* 1999;10:300-7.
51. DeLancey JO, Kearney R, Chou Q, Speights S, Binno S. The appearance of levator ani muscle abnormalities in magnetic resonance images after vaginal delivery. *Obstet Gynecol.* 2003;101:46-53.
52. Yousuf AA, Delancey JO, Brandon CJ, Miller JM. Pelvic structure and function at 1 month compared to 7 months by dynamic magnetic resonance after vaginal birth. *Am J Obstet Gynecol.* 2009.
53. Dietz HP, Lanzarone V. Levator trauma after vaginal delivery. *Obstet Gynecol.* 2005;106:707-12.
54. Smith AR, Hosker GL, Warrell DW. The role of pudendal nerve damage in the aetiology of genuine stress incontinence in women. *Br J Obstet Gynaecol.* 1989;96:29-32.
55. Snooks SJ, Badenoch DF, Tiptaft RC, Swash M. Perineal nerve damage in genuine stress urinary incontinence. An electrophysiological study. *Br J Urol.* 1985;57:422-6.
56. Astrand P-O, Rodahl K. Textbook of work physiology : physiological bases of exercise. 3rd ed. ed. New York: McGraw Hill 1986.
57. Sultan AH, Kamm MA, Hudson CN. Pudendal nerve damage during labour: prospective study before and after childbirth. *Br J Obstet Gynaecol.* 1994;101:22-8.

58. National Collaborating Centre for Women's and Children's H, National Institute for Health and Clinical E. Intrapartum care : care of healthy women and their babies during childbirth. London: RCOG Press 2007.
59. Friedman EA. Labor : clinical evaluation and management. 2nd ed. New York: London [etc.] : Appleton-Century-Crofts ; Prentice-Hall 1978.
60. Brody S. Obstetrik och gynekologi : medicinsk grundutbildning. 3., omarb. o. ut*k. uppl. ed. Stockholm: Almqvist & Wiksell 1974.
61. Pretlove SJ, Thompson PJ, Tooze-Hobson PM, Radley S, Khan KS. Does the mode of delivery predispose women to anal incontinence in the first year postpartum? A comparative systematic review. *Bjog*. 2008;115:421-34.
62. Samuelsson E, Ladfors L, Wennerholm UB, Gareberg B, Nyberg K, Hagberg H. Anal sphincter tears: prospective study of obstetric risk factors. *Bjog*. 2000;107:926-31.
63. Peschers UM, Sultan AH, Jundt K, Mayer A, Drinovic V, Dimpfl T. Urinary and anal incontinence after vacuum delivery. *Eur J Obstet Gynecol Reprod Biol*. 2003;110:39-42.
64. Groutz A, Hadi E, Wolf Y, Maslovitz S, Gold R, Lessing JB, et al. Early postpartum voiding dysfunction: incidence and correlation with obstetric parameters. *J Reprod Med*. 2004;49:960-4.
65. Handa VL, Harris TA, Ostergard DR. Protecting the pelvic floor: obstetric management to prevent incontinence and pelvic organ prolapse. *Obstet Gynecol*. 1996;88:470-8.
66. Baessler K, Schuessler B. Childbirth-induced trauma to the urethral continence mechanism: review and recommendations. *Urology*. 2003;62:39-44.
67. Dannecker C, Hillemanns P, Strauss A, Hasbargen U, Hepp H, Anthuber C. Episiotomy and perineal tears presumed to be imminent: randomized controlled trial. *Acta Obstet Gynecol Scand*. 2004;83:364-8.
68. Dannecker C, Hillemanns P, Strauss A, Hasbargen U, Hepp H, Anthuber C. Episiotomy and perineal tears presumed to be imminent: the influence on the urethral pressure profile, analmanometric and other pelvic floor findings--follow-up study of a randomized controlled trial. *Acta Obstet Gynecol Scand*. 2005;84:65-71.
69. Hudelist G, Gelle'n J, Singer C, Ruecklinger E, Czerwenka K, Kandolf O, et al. Factors predicting severe perineal trauma during childbirth: role of forceps delivery routinely combined with mediolateral episiotomy. *Am J Obstet Gynecol*. 2005;192:875-81.
70. Sartore A, Pregazzi R, Bortoli P, Grimaldi E, Ricci G, Guaschino S. Effects of epidural analgesia during labor on pelvic floor function after vaginal delivery. *Acta Obstet Gynecol Scand*. 2003;82:143-6.

71. Meyer S, Achdari C, Hohlfield P, De Grandi P, Buchser E. Effects of epidural analgesia on pelvic floor function after spontaneous delivery: a longitudinal retrospective study. *Int Urogynecol J Pelvic Floor Dysfunct.* 2002;13:359-64; discussion 64-5.
72. Schiessl B, Janni W, Jundt K, Rammel G, Peschers U, Kainer F. Obstetrical parameters influencing the duration of the second stage of labor. *Eur J Obstet Gynecol Reprod Biol.* 2005;118:17-20.
73. Groutz A, Rimón E, Peled S, Gold R, Pauzner D, Lessing JB, et al. Cesarean section: does it really prevent the development of postpartum stress urinary incontinence? A prospective study of 363 women one year after their first delivery. *Neurourol Urodyn.* 2004;23:2-6.
74. Lal M, Mann C, Callender R, Radley S. Does cesarean delivery prevent anal incontinence? *Obstet Gynecol.* 2003;101:305-12.
75. Dietz HP, Hansell NK, Grace ME, Eldridge AM, Clarke B, Martin NG. Bladder neck mobility is a heritable trait. *Bjog.* 2005;112:334-9.
76. Toozs-Hobson P, Balmforth J, Cardozo L, Khullar V, Athanasiou S. The effect of mode of delivery on pelvic floor functional anatomy. *Int Urogynecol J Pelvic Floor Dysfunct.* 2008;19:407-16.
77. Landspítali/Landlæknir. Landskrá fæðinga: Fyrirspurn um tegund fæðinga og tegundir inngripa; 2009.
78. Landspítali/Landlæknir. Landskrá fæðinga. Fyrirspurn um fjölda frumbyrja og hlutfall þeirra af fjölda fæðinga; 2008.
79. Geirsson G, Einarsson G, Guðmundsson E, Gíslason. Þvagleki meðal íslenskra kvenna-faraldsfræðileg rannsókn. *Læknablaðið.* 2002;88:313-4.
80. Morkved S, Bo K. Prevalence and treatment of post partum urinary incontinence. *Norsk Epidemiology.* 1997;7:123-7.
81. Williams JW, Pritchard JA, MacDonald PC, Gant NF. Williams obstetrics. 17th / Jack A. Pritchard, Paul C. MacDonald, Norman F. Gant. ed. Norwalk: London : Appleton-Century-Crofts ; Prentice-Hall 1985.
82. Portney LG, Watkins MP. Foundations of clinical research: Applications to practice. 2nd ed. Upper Saddle River (NJ): Prentice-Hall Health 2000.
83. Tölfræðimiðstöð Háskóla Íslands. Fyrirspurn vegna styrkútreikninga fyrir meistaraverkefni; 2007.
84. Hagstofa Íslands. 2009 [cited 2009 Jan 1]; Available from: www.hagstofa.is
85. Landspítali/Landlæknir. Landskrá fæðinga. Fyrirspurn um meðalþyngd og höfuðummál nýbura á Íslandi; 2009.

86. Sartore A, Pregazzi R, Bortoli P, Grimaldi E, Ricci G, Guaschino S. Assessment of pelvic floor muscle function after vaginal delivery. Clinical value of different tests. *J Reprod Med.* 2003;48:171-4.
87. Abrams P, Anderson KE, Brubaker L, Cardozo L, Cottenden A, Denis L, et al. Evaluation and treatment of urinary incontinence, pelvic organ prolaps and faecal incontinence: 3rd International Consultation on Incontinence, 2005.
88. Bo K. Pressure measurements during pelvic floor muscle contractions: The effect of different positions of the vaginal measuring device. *Neurourol Urodyn.* 1992;11:107-13.
89. Bo K, Kvarstein B, Hagen R, Larsen S. Pelvic floor muscle exercise for the treatment of female stress urinary incontinence: I. Reliability of vaginal pressure measurements of pelvic floor muscle strength. *Neurourol Urodyn.* 1990;9:471-7.
90. Frawley HC, Galea MP, Phillips BA, Sherburn M, Bo K. Reliability of pelvic floor muscle strength assessment using different test positions and tools. *Neurourol Urodyn.* 2006;25:236-42.
91. Kerschman-Schindl K, Uher E, Wiesinger G, Kaider A, Ebenbichler G, Nicolakis P, et al. Reliability of pelvic floor muscle strength measurement in elderly incontinent women. *Neurourol Urodyn.* 2002;21:42-7.
92. Usta IM, Nassar AH. Advanced maternal age. Part I: obstetric complications. *Am J Perinatol.* 2008;25:521-34.
93. Bhattacharya S, Campbell DM, Liston WA, Bhattacharya S. Effect of Body Mass Index on pregnancy outcomes in nulliparous women delivering singleton babies. *BMC Public Health.* 2007;7:168.
94. Poobalan AS, Aucott LS, Gurung T, Smith WC, Bhattacharya S. Obesity as an independent risk factor for elective and emergency caesarean delivery in nulliparous women--systematic review and meta-analysis of cohort studies. *Obes Rev.* 2009;10:28-35.
95. Bo K, Raastad R, Finckenhagen HB. Does the size of the vaginal probe affect measurement of pelvic floor muscle strength? *Acta Obstet Gynecol Scand* 2005;84:129-33.
96. Vísindavefur Háskóla Íslands. Fyrirspurn um tengsl mismunandi þrýstingsmælieininga; 2008.
97. Dietz HP. Do Asian women have less pelvic organ mobility than Caucasians? *Int Urogynecol J Pelvic Floor Dysfunct.* 2003;14:250-3; discussion 3.
98. Bo K, Haakstad LAH, Voldner N. Do pregnant women exercise their pelvic floor muscles? *Int Urogynecol J Pelvic Floor Dysfunct.* 2006.
99. Bo K, Fleten C, Nystad W. Effect of antenatal pelvic floor muscle training on labor and birth. *Obstet Gynecol.* 2009;113:1279-84.

100. Berghmans LC, Hendriks HJ, Bo K, Hay-Smith EJ, de Bie RA, van Waalwijk van Doorn ES. Conservative treatment of stress urinary incontinence in women: a systematic review of randomized clinical trials. *Br J Urol*. 1998;82:181-91.
101. Bo K, Hagen R, Kvarstein B, Jorgensen J, Larsen S. Pelvic floor muscle exercise for the treatment of female stress urinary incontinence: III. Effects of two different degrees of pelvic floor muscle exercises. *Neurourol Urodyn*. 1990;9:489-502.
102. Morkved S, Bo K. The effect of post-natal exercises to strengthen the pelvic floor muscles. *Acta Obstet Gynecol Scand*. 1996;75:382-5.
103. Hay-Smith EJ, Bo K, Berghmans LC, Hendriks HJ, de Bie RA, van Waalwijk van Doorn ES. Pelvic floor muscle training for urinary incontinence in women. *Cochrane Database Syst Rev*. 2001;CD001407.
104. Morkved S, Bo K, Schei B, Salvesen KA. Pelvic floor muscle training during pregnancy to prevent urinary incontinence: a single-blind randomized controlled trial. *Obstet Gynecol*. 2003;101:313-9.
105. Lagro-Janssen TL, Debruyne FM, Smits AJ, van Weel C. Controlled trial of pelvic floor exercises in the treatment of urinary stress incontinence in general practice. *Br J Gen Pract*. 1991;41:445-9.

APPENDIX 1

Styrkur grindarbotnsvöðva fyrir og eftir fyrstu fæðingu**Spurningalisti 1a****Svarað um miðja meðgöngu**

Taktu þér nokkrar mínútur í að svara þessum spurningalista. Svaraðu hverri spurningu eftir bestu getu. Ef ekkert af gefnum svörum hæfir því sem þér finnst, veldu það sem kemst næst því.

Almennar upplýsingar og heilsa FYRIR meðgöngu**Númer þátttakanda**

Merktu við í einn reit ef annað er ekki tekið fram.

1. Meðgöngulengd í vikum og dögum

vikur	dagar

2. Aldur

ára

3. Hæð í cm

cm

4. Þyngd í kg fyrir meðgöngu

Kg

5. Hversu langri skólagöngu hefur þú lokið?

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Grunnskóla	Framhaldsskóla	Háskóla eða sambærilegu

6. Hvað hefur þú helst haft fyrir stafni síðastliðna 12 mánuði?

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Í launuðu starfi	Heimavinnandi húsmóðir	Atvinnulaus á bótum	Í námi	Í veikinda-leyfi	Haft styrk frá Félagsþjónustu	Öryrki	Annað, hvað? _____

7. Hver er hjúskaparstétt þín?

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ég er einhleyp	Ég er í sambúð	Ég er gift

8. Reykir þú?

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Nei	Já, af og til	Já, daglega

9. Hvernig metur þú heilsu þína í dag?

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mjög góða	Góða	Hvorki góða né slæma	Frekar slæma	Slæma

10. Stundaðir þú líkamsrækt reglulega (í það minnsta vikulega í eitt ár) áður en þú varðst þunguð?

<input type="radio"/>	<input type="radio"/>
Nei	Já

Ef svarið er já, merktu við tegund líkamsræktar, hve oft í viku og hve lengi í einu að jafnaði. (Merktu við allt sem á við þig)

Tegund líkamsræktar	Hve oft í viku	Hve lengi í hvert sinn
Róleg ganga		
Hröð ganga		
Skokk/Hlaup		
Eróbíkk		
Tækjapjálfun í sal		
Lyftingar		
Dans		
Sund		
Hjólreiðar		
Boltaþróttir (fótbolti, handbolti, körfubolti, blak o.s.frv)		
Spaðaíþróttir (tennis, badminton, borðtennis)		
Annað, hvað? _____		

11. Tókst þér að stöðva miðbunu þegar þú pissaðir?

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Nei	Já	Ég veit það ekki

12. Gerðir þú grindarbotnsæfingar í það minnsta í sex mánuði áður en þú varðst þunguð? (Æfingar fyrir vöðvana umhverfis þvagrás, leggöng og endaparm)

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Nei	Já, daglega	Já, að minnsta kosti þrisvar í viku	Já, einu sinni til tvisvar í viku	Já, að minnsta kosti einu sinni í viku	Já, stundum þegar mér fannst ég þurfa þess

Ef nei í spurningu 12, svaraðu næst spurningu 16.

13. Hve margar æfingar gerðir þú að jafnaði í einu þegar þú gerðir grindarbotnsæfingar?

14. Hve lengi hélst þú hverjum vöðvasamdrætti að jafnaði?

<input type="text"/>
U.þ.b. í sek.

15. Fannstu greinilega að grindarbotnsvöðvarnir væru að dragast saman?

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Nei	Já	Ég veit það ekki

Útskýrðu með eigin orðum hvað þú fannst þegar þú reyndir að spenna grindarbotnsvöðvana:

16. Hvar lærðir þú eða heyrðir um grindarbotnsæfingar? (Merktu við allt sem á við þig)

Í kvennatímaritum	<input type="radio"/>	
Í öðrum fjölmiðlum, sjónvarpi, dagblöðum o.s.frv.	<input type="radio"/>	
Í skóla	<input type="radio"/>	Hvernig skóla?
Hjá lækni	<input type="radio"/>	
Hjá sjúkráþjálfara	<input type="radio"/>	
Hjá ljósmóður	<input type="radio"/>	
Hjá öðru heilbrigðisstarfsfólki	<input type="radio"/>	
Í líkamsrækt	<input type="radio"/>	
Hjá vinum eða ættingjum (móður, systur o.s.frv.)	<input type="radio"/>	
Með þátttöku í þessari rannsókn	<input type="radio"/>	
Á annan hátt, hvernig?		

Næstu spurningar eru um SÍÐUSTU FJÓRAR VIKURNAR áður en þú varðst þunguð. Hugleiddu hvernig þú varst að jafnaði.

17. Hve oft misstir þú þvag?

Aldrei	0	<input type="radio"/>
Um einu sinni í viku eða sjaldnar	1	<input type="radio"/>
Tvisvar eða þrisvar í viku	2	<input type="radio"/>
Um einu sinni á dag	3	<input type="radio"/>
Nokkrum sinnum á dag	4	<input type="radio"/>
Alltaf	5	<input type="radio"/>

18. Hve mikið þvag misstir þú að jafnaði? (Hvort þú notaðir innlegg eða ekki)?

Ekkert	0	<input type="radio"/>
Lítið magn	2	<input type="radio"/>
Hóflegt/meðalmagn	4	<input type="radio"/>
Mikið (magn)	6	<input type="radio"/>

19. Í heildina, hversu mikið truflaði þvagleki daglegt líf þitt?

Dragðu hring utan um númer milli 0 (alls ekkert) og 10 (mjög mikið)

Alls ekkert

Mjög mikið

0	1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	---	----

20. Hvenær misstir þú þvag? (Merktu við allt sem á við þig)

Aldrei - Ég missti ekki þvag	<input type="radio"/>
Lekur áður en ég kemst á klósett	<input type="radio"/>
Lekur þegar ég hósta eða hnerra	<input type="radio"/>
Lekur þegar ég er sofandi	<input type="radio"/>
Lekur þegar ég reyni á mig/stunda líkamsrækt	<input type="radio"/>
Lekur þegar ég er búin að pissa og hef klætt mig aftur	<input type="radio"/>
Lekur af engri sérstakri ástæðu	<input type="radio"/>
Lekur alltaf	<input type="radio"/>

21. Þjáðist þú af einhverju eftirfarandi? (Merktu við allt sem á við þig)

Að finnast þú þurfa oft að pissa	<input type="radio"/>	
Tíðum þvaglátum	<input type="radio"/>	
Erfiðleikum við að tæma blöðru	<input type="radio"/>	
Þörf fyrir að pissa á nóttunni	<input type="radio"/>	Hve oft hverja nótt?
Einhverju öðru, hverju?		
Engu af ofantöldu	<input type="radio"/>	

22. Áttir þú við loftleka að stríða? (Að þurfa að leysa vind og geta ekki haldið í sér)

Aldrei	<input type="radio"/>
Um einu sinni í viku eða sjaldnar	<input type="radio"/>
Tvisvar eða þrisvar í viku	<input type="radio"/>
Um einu sinni á dag	<input type="radio"/>
Nokkrum sinnum á dag	<input type="radio"/>
Alltaf	<input type="radio"/>

23. Áttir þú við hægðaleka að stríða?

Aldrei	<input type="radio"/>
Um einu sinni í viku eða sjaldnar	<input type="radio"/>
Tvisvar eða þrisvar í viku	<input type="radio"/>
Um einu sinni á dag	<input type="radio"/>
Nokkrum sinnum á dag	<input type="radio"/>
Alltaf	<input type="radio"/>

APPENDIX 2

Styrkur grindarbotnsvöðva fyrir og eftir fyrstu fæðingu**Spurningalisti 1b****Svarað um miðja meðgöngu**

Taktu þér nokkrar mínútur í að svara þessum spurningalista. Svaraðu hverri spurningu eftir bestu getu. Ef ekkert af gefnum svörum hæfir því sem þér finnst, veldu það sem kemst næst því.

Ástand og heilsa Í DAG**Númer þátttakanda**

Hugleiddu hvernig þú varst að jafnaði SÍÐUSTU FJÓRAR VIKUR

Merktu við í einn reit ef annað er ekki tekið fram.

1. Meðgöngulengd í vikum og dögum

vikur	dagar

2. Þyngd í kg í dag

kg

3. Stundar þú líkamsrækt reglulega (í það minnsta vikulega)?

<input type="radio"/>	<input type="radio"/>
Nei	Já

Ef svarið er já, merktu við tegund líkamsræktar, hve oft í viku og hve lengi í einu að jafnaði. (Merktu við allt sem á við þig)

Tegund líkamsræktar	Hve oft í viku	Hve lengi í hvert sinn
Róleg ganga		
Hröð ganga		
Skokk/Hlaup		
Eróbíkk		
Tækjapjálfun í sal		
Lyftingar		
Dans		
Sund		
Hjólreiðar		
Boltaíþróttir (fótbolti, handbolti, körfubolti, blak o.s.frv)		
Spaðaíþróttir (tennis, badminton, borðtennis)		
Annað, hvað? _____		

4. Tekst þér að stöðva miðbunu þegar þú pissar? (Reyndu áður en þú svarar spurningunni)

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Nei	Já	Ég veit það ekki

5. Hve oft missir þú þvag núna?

Aldrei	0	<input type="radio"/>
Um einu sinni í viku eða sjaldnar	1	<input type="radio"/>
Tvisvar eða þrisvar í viku	2	<input type="radio"/>
Um einu sinni á dag	3	<input type="radio"/>
Nokkrum sinnum á dag	4	<input type="radio"/>
Alltaf	5	<input type="radio"/>

6. Hve mikið þvag missir þú að jafnaði núna? (Hvort þú notar innlegg eða ekki?)

Ekkert	0	<input type="radio"/>
Lítið magn	2	<input type="radio"/>
Hóflegt/meðalmagn	4	<input type="radio"/>
Mikið (magn)	6	<input type="radio"/>

**7. Í heildina, hversu mikið truflar þvagleki daglegt líf þitt núna?
Dragðu hring utan um númer milli 0 (alls ekkert) og 10 (mjög mikið)**

Alls ekkert

Mjög mikið

0	1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	---	----

8. Hvenær missir þú þvag núna? (Merktu við allt sem á við þig)

Aldrei - Ég missi ekki þvag	<input type="radio"/>
Lekur áður en ég kemst á klósett	<input type="radio"/>
Lekur þegar ég hósta eða hnerra	<input type="radio"/>
Lekur þegar ég er sofandi	<input type="radio"/>
Lekur þegar ég reyni á mig/stunda líkamsrækt	<input type="radio"/>
Lekur þegar ég er búin að pissa og hef klætt mig aftur	<input type="radio"/>
Lekur af engri sérstakri ástæðu	<input type="radio"/>
Lekur alltaf	<input type="radio"/>

9. Þjáist þú af einhverju eftirfarandi núna? (Merktu við allt sem á við þig)

Að finnast þú þurfa oft að pissa	<input type="radio"/>	
Tíðum þvaglátum	<input type="radio"/>	
Erfiðleikum við að tæma blöðru	<input type="radio"/>	
Þörf fyrir að pissa á nóttunni	<input type="radio"/>	Hve oft hverja nótt?
Einhverju öðru, hverju?		
Engu af ofantöldu	<input type="radio"/>	

10. Átt þú við loftleka að stríða núna? (Að þurfa að leysa vind og geta ekki haldið í sér)

Aldrei	<input type="radio"/>
Um einu sinni í viku eða sjaldnar	<input type="radio"/>
Tvisvar eða þrisvar í viku	<input type="radio"/>
Um einu sinni á dag	<input type="radio"/>
Nokkrum sinnum á dag	<input type="radio"/>
Alltaf	<input type="radio"/>

11. Átt þú við hægðaleka að stríða núna?

Aldrei	<input type="radio"/>
Um einu sinni í viku eða sjaldnar	<input type="radio"/>
Tvisvar eða þrisvar í viku	<input type="radio"/>
Um einu sinni á dag	<input type="radio"/>
Nokkrum sinnum á dag	<input type="radio"/>
Alltaf	<input type="radio"/>

12. Gerir þú grindarbotnsæfingar núna? (Æfingar fyrir vöðvana umhverfis þvagrás, leggöng og endaparm)

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Nei	Já, daglega	Já, að minnsta kosti þrisvar í viku	Já, einu sinni til tvisvar í viku	Já, að minnsta kosti einu sinni í viku	Já, stundum þegar mér fannst ég þurfa þess

Ef svarið er nei í spurningu 12, svaraðu næst spurningu 16.

13. Hve margar æfingar gerir þú að jafnaði í einu þegar þú gerir grindarbotnsæfingar núna?

14. Hve lengi heldur þú hverjum vöðvasamdrætti að jafnaði núna?

<input type="text"/>
U.þ.b. í sek.

15. Hvernig upplifir þú samdrátt grindarbotnsvöðvanna núna?

Ég finn sterkan og greinilegan samdrátt	<input type="radio"/>
Ég finn vöðvana dragast saman, en get ekki haldið vöðvasamdrættinum lengi	<input type="radio"/>
Ég finn samdrátt sem erfitt er að halda	<input type="radio"/>
Ég reyni að draga vöðvana saman en er ekki viss hvað gerist í grindarbotninum	<input type="radio"/>
Mér finnst ekkert gerast	<input type="radio"/>

Útskýrðu með eigin orðum hvað þú finnur þegar þú reynir að spenna grindarbotnsvöðvana núna:

16. Þegar þú dregur grindarbotnsvöðvana saman núna, heldur þú að aðrir vöðvar dragist saman um leið?

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Nei	Já	Ég veit það ekki

17. Ef svarið er já í spurningu 16, hvaða vöðvahópar telur þú að spennist/þvingist um leið? (Merktu við allt sem á við þig)

Kviðvöðvar (naflinn dregst inn)	<input type="radio"/>
Kviðvöðvar (mjaðmagrindin hreyfist)	<input type="radio"/>
Innanlærisvöðvar (lærin og hnén dragast saman)	<input type="radio"/>
Rassvöðvar (setvöðvar/þjóhnappar)	<input type="radio"/>
Öndunarvöðvar (eins og að halda niðri í sér andanum)	<input type="radio"/>
Aðrir vöðvahópar, hverjir?	

Þakka þér kærlega fyrir að taka þátt í þessari rannsókn og svara spurningalistunum. Ef þú hefur einhverju við þetta að bæta, metum við skoðun þína mikils.

APPENDIX 3

Styrkur grindarbotnsvöðva fyrir og eftir fyrstu fæðingu**Spurningalisti 2****Svarað fyrsta sólarhring eftir fæðingu**

Taktu þér nokkrar mínútur í að svara þessum spurningalista. Svaraðu hverri spurningu eftir bestu getu. Ef ekkert af gefnum svörum hæfir því sem þér finnst, veldu það sem kemst næst því.

Heilsa Á seinni hluta meðgöngu og ástand Í DAG**Númer þátttakanda**

Hugleiddu hvernig þú varst að jafnaði SÍÐUSTU FJÓRAR VIKUR fyrir fæðinguna

Merktu við í einn reit ef annað er ekki tekið fram.

1. Hve oft misstir þú þvag?

Aldrei	0	<input type="radio"/>
Um einu sinni í viku eða sjaldnar	1	<input type="radio"/>
Tvisvar eða þrisvar í viku	2	<input type="radio"/>
Um einu sinni á dag	3	<input type="radio"/>
Nokkrum sinnum á dag	4	<input type="radio"/>
Alltaf	5	<input type="radio"/>

2. Hve mikið þvag misstir þú að jafnaði? (Hvort þú notaðir innlegg eða ekki?)

Ekkert	0	<input type="radio"/>
Lítið magn	2	<input type="radio"/>
Hóflegt/meðalmagn	4	<input type="radio"/>
Mikið (magn)	6	<input type="radio"/>

3. Í heildina, hversu mikið truflaði þvagleki daglegt líf þitt?

Dragðu hring utan um númer milli 0 (alls ekkert) og 10 (mjög mikið)

Alls ekkert									Mjög mikið	
0	1	2	3	4	5	6	7	8	9	10

4. Hvenær misstir þú þvag? (Merktu við allt sem á við þig)

Aldrei - Ég missti ekki þvag	<input type="radio"/>
Lekur áður en ég kemst á klósett	<input type="radio"/>
Lekur þegar ég hósta eða hnerra	<input type="radio"/>
Lekur þegar ég er sofandi	<input type="radio"/>
Lekur þegar ég reyni á mig/stunda líkamsrækt	<input type="radio"/>
Lekur þegar ég er búin að pissa og hef klætt mig aftur	<input type="radio"/>
Lekur af engri sérstakri ástæðu	<input type="radio"/>
Lekur alltaf	<input type="radio"/>

5. Þjáðist þú af einhverju eftirfarandi? (Merktu við allt sem á við þig)

Að finnast þú þurfa oft að pissa	<input type="radio"/>		
Tíðum þvaglátum	<input type="radio"/>		
Erfiðleikum við að tæma blöðru	<input type="radio"/>		
Þörf fyrir að pissa á nóttunni	<input type="radio"/>	Hve oft hverja nótt?	
Einhverju öðru, hverju?			
Engu af ofantöldu	<input type="radio"/>		

6. Áttir þú við loftleka að stríða? (Að þurfa að leysa vind og geta ekki haldið í sér)

Aldrei	<input type="radio"/>
Um einu sinni í viku eða sjaldnar	<input type="radio"/>
Tvisvar eða þrisvar í viku	<input type="radio"/>
Um einu sinni á dag	<input type="radio"/>
Nokkrum sinnum á dag	<input type="radio"/>
Alltaf	<input type="radio"/>

7. Áttir þú við hægðaleka að stríða?

Aldrei	<input type="radio"/>
Um einu sinni í viku eða sjaldnar	<input type="radio"/>
Tvisvar eða þrisvar í viku	<input type="radio"/>
Um einu sinni á dag	<input type="radio"/>
Nokkrum sinnum á dag	<input type="radio"/>
Alltaf	<input type="radio"/>

8. Gerðir þú grindarbotnsæfingar? (Æfingar fyrir vöðvana umhverfis þvagrás, leggöng og endaparm)

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Nei	Já, daglega	Já, að minnsta kosti þrisvar í viku	Já, einu sinni til tvisvar í viku	Já, að minnsta kosti einu sinni í viku	Já, stundum þegar mér fannst ég þurfa þess

Ef svarið er nei í spurningu 8, svaraðu næst spurningu 11.

9. Hve margar æfingar gerðir þú að jafnaði í einu þegar þú gerðir grindarbotnsæfingar?

10. Hve lengi hélt þú hverjum vöðvasamdrætti að jafnaði?

<input type="text"/>
U.þ.b. í sek.

11. Hvar lærðir þú eða heyrðir um grindarbotnsæfingar? (Merktu við allt sem á við þig)

Í kvennatímaritum	<input type="radio"/>		
Í öðrum fjölmiðlum, sjónvarpi, dagblöðum o.s.frv.	<input type="radio"/>		
Í skóla	<input type="radio"/>	Hvernig skóla?	
Hjá lækni	<input type="radio"/>		
Hjá sjúkráþjálfara	<input type="radio"/>		
Hjá ljósmóður	<input type="radio"/>		
Hjá öðru heilbrigðisstarfsfólki	<input type="radio"/>		
Í líkamsrækt	<input type="radio"/>		
Hjá vinum eða ættingjum (móður, systur o.s.frv.)	<input type="radio"/>		
Með þátttöku í þessari rannsókn	<input type="radio"/>		
Á annan hátt, hvernig?			

Mig langar að biðja þig að spenna grindarbotnsvöðvana núna og segja mér hvað þú upplifir þegar þú gerir það.

12. Hvernig upplifir þú samdrátt grindarbotnsvöðvanna núna?

Ég finn sterkan og greinilegan samdrátt	<input type="radio"/>
Ég finn vöðvana dragast saman, en get ekki haldið vöðvasamdrættinum lengi	<input type="radio"/>
Ég finn samdrátt sem erfitt er að halda	<input type="radio"/>
Ég reyni að draga vöðvana saman en er ekki viss hvað gerist í grindarbotninum	<input type="radio"/>
Mér finnst ekkert gerast	<input type="radio"/>

Útskýrðu með eigin orðum hvað þú finnur þegar þú reynir að spenna grindarbotnsvöðvana núna, svona stuttu eftir fæðingu:

13. Þegar þú dregur grindarbotnsvöðvana saman núna, heldur þú að aðrir vöðvar dragist saman um leið?

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Nei	Já	Ég veit það ekki

14. Ef svarið er já í spurningu 13, hvaða vöðvahópar telur þú að spennist/þvingist um leið? (Merktu við allt sem á við þig)

Kviðvöðvar (naflinn dregst inn)	<input type="radio"/>
Kviðvöðvar (mjaðmagrindin hreyfist)	<input type="radio"/>
Innanlærisvöðvar (lærin og hnén dragast saman)	<input type="radio"/>
Rassvöðvar (setvöðvar/þjóhnappar)	<input type="radio"/>
Öndunarvöðvar (eins og að halda niðri í sér andanum)	<input type="radio"/>
Aðrir vöðvahópar, hverjir?	

15. Tekst þér að stöðva miðbunu þegar þú pissar? (Reyndu áður en þú svarar spurningunni)

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Nei	Já	Ég veit það ekki

Þakka þér kærlega fyrir að taka þátt í þessari rannsókn og svara spurningalistunum. Ef þú hefur einhverju við þetta að bæta, metum við skoðun þína mikils.

APPENDIX 4

Styrkur grindarbotnsvöðva fyrir og eftir fyrstu fæðingu**Spurningalisti 3****Svarað um 6 vikum eftir fæðingu**

Taktu þér nokkrar mínútur í að svara þessum spurningalista. Svaraðu hverri spurningu eftir bestu getu. Ef ekkert af gefnum svörum hæfir því sem þér finnst, veldu það sem kemst næst því.

Heilsa EFTIR fæðingu og ástand Í DAG**Númer þátttakanda**

Svör eiga aðeins að endurspegla ástand eftir fæðingu

Merktu við í einn reit ef annað er ekki tekið fram.

1. Tími frá fæðingu í vikum og dögum

vikur	dagar

2. Þyngd í kg

kg

3. Stundar þú líkamsrækt reglulega (í það minnsta vikulega)?

<input type="radio"/>	<input type="radio"/>
Nei	Já

Ef svarið er já, merktu við tegund líkamsræktar, hve oft í viku og hve lengi í einu að jafnaði. (Merktu við allt sem á við þig)

Tegund líkamsræktar	Hve oft í viku	Hve lengi í hvert sinn
Róleg ganga		
Hröð ganga		
Skokk/Hlaup		
Eróbíkk		
Tækjapjálfun í sal		
Lyftingar		
Dans		
Sund		
Hjólreiðar		
Boltaíþróttir (fótbolti, handbolti, körfubolti, blak o.s.frv)		
Spaðaíþróttir (tennis, badminton, borðtennis)		
Annað, hvað? _____		

4. Hve oft missir þú þvag núna?

Aldrei	0	<input type="radio"/>
Um einu sinni í viku eða sjaldnar	1	<input type="radio"/>
Tvisvar eða þrisvar í viku	2	<input type="radio"/>
Um einu sinni á dag	3	<input type="radio"/>
Nokkrum sinnum á dag	4	<input type="radio"/>
Alltaf	5	<input type="radio"/>

5. Hve mikið þvag missir þú að jafnaði núna? (Hvort þú notar innlegg eða ekki)?

Ekkert	0	<input type="radio"/>
Lítið magn	2	<input type="radio"/>
Hóflegt/meðalmagn	4	<input type="radio"/>
Mikið (magn)	6	<input type="radio"/>

**6. Í heildina, hversu mikið truflar þvagleki daglegt líf þitt núna?
Dragðu hring utan um númer milli 0 (alls ekkert) og 10 (mjög mikið)**

Alls ekkert

Mjög mikið

0	1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	---	----

7. Hvenær missir þú þvag núna? (Merktu við allt sem á við þig)

Aldrei - Ég missi ekki þvag	<input type="radio"/>
Lekur áður en ég kemst á klósett	<input type="radio"/>
Lekur þegar ég hósta eða hnerra	<input type="radio"/>
Lekur þegar ég er sofandi	<input type="radio"/>
Lekur þegar ég reyni á mig/stunda líkamsrækt	<input type="radio"/>
Lekur þegar ég er búin að pissa og hef klætt mig aftur	<input type="radio"/>
Lekur af engri sérstakri ástæðu	<input type="radio"/>
Lekur alltaf	<input type="radio"/>

8. Hefur þú þjáðst af einhverju eftirfarandi eftir fæðinguna? (Merktu við allt sem á við þig)

Að finnast þú þurfa oft að pissa	<input type="radio"/>	
Tíðum þvaglátum	<input type="radio"/>	
Erfiðleikum við að tæma blöðru	<input type="radio"/>	
Þörf fyrir að pissa á nóttunni	<input type="radio"/>	Hve oft hverja nótt?
Einhverju öðru, hverju?		
Engu af ofantöldu	<input type="radio"/>	

9. Átt þú við loftleka að stríða núna? (Að þurfa að leysa vind og geta ekki haldið í sér)

Aldrei	<input type="radio"/>
Um einu sinni í viku eða sjaldnar	<input type="radio"/>
Tvisvar eða þrisvar í viku	<input type="radio"/>
Um einu sinni á dag	<input type="radio"/>
Nokkrum sinnum á dag	<input type="radio"/>
Alltaf	<input type="radio"/>

10. Átt þú við hægðaleka að stríða núna?

Aldrei	<input type="radio"/>
Um einu sinni í viku eða sjaldnar	<input type="radio"/>
Tvisvar eða þrisvar í viku	<input type="radio"/>
Um einu sinni á dag	<input type="radio"/>
Nokkrum sinnum á dag	<input type="radio"/>
Alltaf	<input type="radio"/>

11. Tekst þér að stöðva miðbunu þegar þú pissar? (Reyndu áður en þú svarar spurningunni)

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Nei	Já	Ég veit það ekki

12. Hefur þú gert grindarbotnsæfingar eftir fæðinguna? (Æfingar fyrir vöðvana umhverfis þvagrás, leggöng og endaparm)

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Nei	Já, daglega	Já, að minnsta kosti þrisvar í viku	Já, einu sinni til tvisvar í viku	Já, að minnsta kosti einu sinni í viku	Já, stundum þegar mér fannst ég þurfa þess

Ef svarið er nei í spurningu 12, svaraðu næst spurningu 17.

13. Ef svarið er já í spurningu 12, í hve margar vikur hefur þú gert grindarbotnsæfingar eftir fæðinguna?

vikur

14. Ert þú enn að gera grindarbotnsæfingar í dag?

<input type="radio"/>	<input type="radio"/>
Nei	Já

15. Hve margar æfingar gerir þú að jafnaði í einu þegar þú gerir grindarbotnsæfingar?

16. Hve lengi heldur þú hverjum vöðvasamdrætti að jafnaði?

<input type="text"/>
U.þ.b. í sek.

17. Hvers vegna hefur þú ekki þjálfað grindarbotnsvöðvana eftir fæðinguna?

Ég hef reynt en það er sársaukafullt	<input type="radio"/>
Ég held það verði sársaukafullt ef ég reyni	<input type="radio"/>
Ég tel mig ekki þurfa að gera æfingarnar	<input type="radio"/>
Ég hef ekki tíma	<input type="radio"/>
Mig langar ekki að gera æfingarnar	<input type="radio"/>
Ég get ekki dregið vöðvana saman	<input type="radio"/>
Aðrar ástæður, hverjar?	<input type="text"/>

18. Hvar lærðir þú eða heyrðir um grindarbotnsæfingar? (Merktu við allt sem á við þig)

Í kvennatímaritum	<input type="radio"/>	
Í öðrum fjölmiðlum, sjónvarpi, dagblöðum o.s.frv.	<input type="radio"/>	
Í skóla	<input type="radio"/>	Hvernig skóla? <input type="text"/>
Hjá lækni	<input type="radio"/>	
Hjá sjúkrapjálfa	<input type="radio"/>	
Hjá ljósmóður	<input type="radio"/>	
Hjá öðru heilbrigðisstarfsfólki	<input type="radio"/>	
Í líkamsrækt	<input type="radio"/>	
Hjá vinum eða ættingjum (móður, systur o.s.frv.)	<input type="radio"/>	
Með þátttöku í þessari rannsókn	<input type="radio"/>	
Á annan hátt, hvernig?		<input type="text"/>

19. Hvernig upplifir þú samdrátt grindarbotnsvöðvanna núna?

Ég finn sterkan og greinilegan samdrátt	<input type="radio"/>
Ég finn vöðvana dragast saman, en get ekki haldið vöðvasamdrættinum lengi	<input type="radio"/>
Ég finn samdrátt sem erfitt er að halda	<input type="radio"/>
Ég reyni að draga vöðvana saman en er ekki viss hvað gerist í grindarbotninum	<input type="radio"/>
Mér finnst ekkert gerast	<input type="radio"/>

Útskýrðu með eigin orðum hvað þú finnur þegar þú reynir að spenna grindarbotnsvöðvana núna:

20. Þegar þú dregur grindarbotnsvöðvana saman núna, heldur þú að aðrir vöðvar dragist saman um leið?

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Nei	Já	Ég veit það ekki

21. Ef svarið er já í spurningu 20, hvaða vöðvahópar telur þú að spennist/þvingist um leið? (Merktu við allt sem á við þig)

Kviðvöðvar (naflinn dregst inn)	<input type="radio"/>
Kviðvöðvar (mjaðmagrindin hreyfist)	<input type="radio"/>
Innanlærisvöðvar (lærin og hnén dragast saman)	<input type="radio"/>
Rassvöðvar (setvöðvar/þjóhnappar)	<input type="radio"/>
Öndunarvöðvar (eins og að halda niðri í sér andanum)	<input type="radio"/>
Aðrir vöðvahópar, hverjir?	

22. Ertu með barnið á brjósti?

Já	<input type="radio"/>
Nei, ég hef aldrei haft það á brjósti	<input type="radio"/>
Nei, ég hætti með það á brjósti á _____ viku	<input type="radio"/>

Þakka þér kærlega fyrir að taka þátt í þessari rannsókn og svara spurningalistunum. Ef þú hefur einhverju við þetta að bæta, metum við skoðun þína mikils.

APPENDIX 5

Pelvic floor muscle strength before and after first childbirth**Questionnaire 1a****Answered approx. at mid-pregnancy**

Please take a few minutes to fill out this questionnaire. We welcome your feedback and your answers will be kept confidential. Thank you for your participation.

General information and health BEFORE pregnancy**Participant's number**

Please tick one box if not otherwise stated.

1. Pregnancy length (gestational length) in weeks and days

Weeks	Days

2. Age

Years

3. Height in cm

Cm

4. Weight in kg before pregnancy

Kg

5. How long education have you finished?

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Elementary school	Upper secondary school	University or another further education

6. What have you been mainly occupied with for the last 12 months?

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
In a paid job	Home working	Unemployed	In school	On sick leave	Living on a social system welfare	Disabled	Something else, what

7. Marital status

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
single	Co-habiting	Married

8. Do you smoke?

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Yes, daily	Yes, occasionally	No

9. How would you grade your health today?

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Very good	Good	Neither good nor bad	Rather bad	Bad

10. Did you perform exercises regularly, at least 1 year before the pregnancy, at least once a week?

<input type="radio"/>	<input type="radio"/>
No	Yes

If yes, write the type of exercises you did, how many times per week and for how long time each time. (Please tick all that apply to you)

Type of exercise	Times/week	Duration each time
Slow walking		
Fast walking		
Jogging/running		
Aerobics		
Weight training in a gym		
Weight lifting		
Dance		
Swimming		
Bicycling		
Ball games (soccer, handball, basketball, volleyball etc)		
Racket sports (tennis, badminton, table tennis)		
Other, what? _____		

11. Were you able to stop the midstream while voiding (please try before answering the question):

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
No	Yes	I do not know

12. Did you exercise your pelvic floor muscles at least 6 months before the pregnancy? (Muscles surrounding the urethra, vagina and anus)

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
No	Yes, every day	Yes, at least 3 times per week	Yes, 1-2 times per week	Yes, at least 1 time per week	Yes, occasionally, when I felt the need

If no in question 12, go to question 16

13. How many repetitions in average each time you exercised your pelvic floor?

14. How long did you hold each contraction?

Ca. in seconds

15. Did you feel clearly then that the pelvic floor muscles were contracting?

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
No	Yes	I do not know

Explain by your own words what you felt when you tried to contract your pelvic floor muscles

16. Where did you learn or hear about pelvic floor muscle exercises? (Please tick all that apply to you)

In women's magazines	<input type="radio"/>	
In other types of media, TV, newspapers etc	<input type="radio"/>	
In school	<input type="radio"/>	What type of school?
By a medical doctor	<input type="radio"/>	
By a physical therapist	<input type="radio"/>	
By a midwife	<input type="radio"/>	
By other health care employees	<input type="radio"/>	
In fitness class	<input type="radio"/>	
By friends, relatives (mother, sister etc.)	<input type="radio"/>	
By participating in this study	<input type="radio"/>	
Other way, how?		

These questions are about THE FOUR WEEKS before you got pregnant. Please think about how you were, on average

17. How often did you leak urine?

Never	0	<input type="radio"/>
About once a week or less often	1	<input type="radio"/>
Two or three times a week	2	<input type="radio"/>
About once a day	3	<input type="radio"/>
Several times a day	4	<input type="radio"/>
All the time	5	<input type="radio"/>

18. How much urine did you usually leak (whether you wear protection or not)?

None	0	<input type="radio"/>
A small amount	2	<input type="radio"/>
A moderate amount	4	<input type="radio"/>
A large amount	6	<input type="radio"/>

**19. Overall, how much did leaking urine interfere with your everyday life?
Please ring a number between 0 (not at all) and 10 (a great deal)**

Not at all

A great deal

0	1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	---	----

20. When did urine leak? (Please tick all that apply to you)

Never- Urine does not leak	<input type="radio"/>
Leaks before you can get to the toilet	<input type="radio"/>
Leaks when you cough or sneeze	<input type="radio"/>
Leaks when you are asleep	<input type="radio"/>
Leaks when you are physically active/exercising	<input type="radio"/>
Leaks when you have finished urinating and are dressed	<input type="radio"/>
Leaks for no obvious reason	<input type="radio"/>
Leaks all the time	<input type="radio"/>

21. Did you suffer from any of the following conditions? (Please tick all that apply to you)

Frequent need to urinate	<input type="radio"/>		
Frequent urination	<input type="radio"/>		
Problems with emptying the bladder	<input type="radio"/>		
Need to urinate during the night	<input type="radio"/>	How often each night?	
Something else, what			
None of the items above	<input type="radio"/>		

22. Did you suffer from flatus (gas) incontinence?

Never	<input type="radio"/>
About once a week or less often	<input type="radio"/>
Two or three times a week	<input type="radio"/>
About once a day	<input type="radio"/>
Several times a day	<input type="radio"/>
All the time	<input type="radio"/>

23. Did you suffer from fecal incontinence?

Never	<input type="radio"/>
About once a week or less often	<input type="radio"/>
Two or three times a week	<input type="radio"/>
About once a day	<input type="radio"/>
Several times a day	<input type="radio"/>
All the time	<input type="radio"/>

APPENDIX 6

Pelvic floor muscle strength before and after first childbirth**Questionnaire 1b****Answered approx. at mid-pregnancy**

Please take a few minutes to fill out this questionnaire. We welcome your feedback and your answers will be kept confidential. Thank you for your participation.

Condition TODAY

Participant's number

Please think about how you have been, on average, over the PAST FOUR WEEKS

Please tick one box if not otherwise stated.

1. Pregnancy length (gestational length) in weeks and days

Weeks	Days

2. Weight in kg now

Kg

3. Do you perform exercises regularly now, at least once a week?

<input type="radio"/>	<input type="radio"/>
No	Yes

If yes, write the type of exercises you do, how many times per week and for how long time each time. (Please tick all that apply to you)

Type of exercise	Times/week	Duration each time
Slow walking		
Fast walking		
Jogging/running		
Aerobics		
Weight training in a gym		
Weight lifting		
Dance		
Swimming		
Bicycling		
Ball games (soccer, handball, basketball, volleyball etc)		
Racket sports (tennis, badminton, table tennis)		
Other, what? _____		

4. Are you able to stop the midstream while voiding (please try before answering the question):

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
No	Yes	I do not know

5. How often do you leak urine now?

Never	0	<input type="radio"/>
About once a week or less often	1	<input type="radio"/>
Two or three times a week	2	<input type="radio"/>
About once a day	3	<input type="radio"/>
Several times a day	4	<input type="radio"/>
All the time	5	<input type="radio"/>

6. How much urine do you usually leak now (whether you wear protection or not)?

None	0	<input type="radio"/>
A small amount	2	<input type="radio"/>
A moderate amount	4	<input type="radio"/>
A large amount	6	<input type="radio"/>

**7. Overall, how much does leaking urine interfere with your everyday life now?
Please ring a number between 0 (not at all) and 10 (a great deal)**

Not at all					A great deal					
0	1	2	3	4	5	6	7	8	9	10

8. When does urine leak now? (Please tick all that apply to you)

Never- Urine does not leak	<input type="radio"/>
Leaks before you can get to the toilet	<input type="radio"/>
Leaks when you cough or sneeze	<input type="radio"/>
Leaks when you are asleep	<input type="radio"/>
Leaks when you are physically active/exercising	<input type="radio"/>
Leaks when you have finished urinating and are dressed	<input type="radio"/>
Leaks for no obvious reason	<input type="radio"/>
Leaks all the time	<input type="radio"/>

9. Do you now suffer from any of the following conditions? (Please tick all that apply to you)

Frequent need to urinate	<input type="radio"/>		
Frequent urination	<input type="radio"/>		
Problems with emptying the bladder	<input type="radio"/>		
Need to urinate during the night	<input type="radio"/>	How often each night?	
Something else, what			
None of the items above	<input type="radio"/>		

10. Do you now suffer from flatus (gas) incontinence?

Never	<input type="radio"/>
About once a week or less often	<input type="radio"/>
Two or three times a week	<input type="radio"/>
About once a day	<input type="radio"/>
Several times a day	<input type="radio"/>
All the time	<input type="radio"/>

11. Do you now suffer from fecal incontinence?

Never	<input type="radio"/>
About once a week or less often	<input type="radio"/>
Two or three times a week	<input type="radio"/>
About once a day	<input type="radio"/>
Several times a day	<input type="radio"/>
All the time	<input type="radio"/>

12. Do you exercise your pelvic floor muscles now? (Muscles surrounding the urethra, vagina and anus)

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
No	Yes, every day	Yes, at least 3 times per week	Yes, 1-2 times per week	Yes, at least 1 time per week	Yes, occasionally, when I feel the need

If no in question 12, go to question 16**13. How many repetitions in average each time you exercise your pelvic floor now?**

14. How long do you hold each contraction now?

<input type="text"/>
Ca. in seconds

15. How would you grade the experience now when you contract your pelvic floor muscles?

Strong and clear contraction	<input type="radio"/>
I can feel the muscles contract, but I cannot hold the contraction for long	<input type="radio"/>
I feel a contraction which is difficult to hold	<input type="radio"/>
I try, but I'm not sure what happens in my pelvic floor	<input type="radio"/>
I cannot feel anything happen	<input type="radio"/>

Explain by your own words what you feel when you try to contract your pelvic floor muscles now.

16. When you contract your pelvic floor muscles now, do you think you contract other muscles at the same time?

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
No	Yes	I do not know

17. If yes in question 16, which muscle group(s) do you feel contracted/stressed at the same time? (Please tick all that apply to you)

The abdominal muscles (tucking in the navel)	<input type="radio"/>
The abdominal muscles (moving the pelvis)	<input type="radio"/>
The adductor muscles of the thigh (moving the legs closer to each other)	<input type="radio"/>
The gluteal muscles (seating muscles/buttocks)	<input type="radio"/>
The respiratory muscles (e.g. holding your breath)	<input type="radio"/>
Some other muscle groups, which?	

Thank you very much for giving this research and this questionnaire a part of your valuable time. If you have something to add, please do so. Your input is greatly appreciated.

APPENDIX 7

Pelvic floor muscle strength before and after first childbirth**Questionnaire 2****Answered first day after delivery**

Please take a few minutes to fill out this questionnaire. We welcome your feedback and your answers will be kept confidential. Thank you for your participation.

Health DURING second half of pregnancy and condition TODAY

Participant's number

Please think about how you have been, on average, FOUR WEEKS before you gave birth

Please tick one box if not otherwise stated.

1. How often did you leak urine?

Never	0	<input type="radio"/>
About once a week or less often	1	<input type="radio"/>
Two or three times a week	2	<input type="radio"/>
About once a day	3	<input type="radio"/>
Several times a day	4	<input type="radio"/>
All the time	5	<input type="radio"/>

2. How much urine did you usually leak (whether you wear protection or not)?

None	0	<input type="radio"/>
A small amount	2	<input type="radio"/>
A moderate amount	4	<input type="radio"/>
A large amount	6	<input type="radio"/>

**3. Overall, how much did leaking urine interfere with your everyday life?
Please ring a number between 0 (not at all) and 10 (a great deal)**

Not at all

A great deal

0	1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	---	----

4. When did urine leak? (Please tick all that apply to you)

Never- Urine does not leak	<input type="radio"/>
Leaks before you can get to the toilet	<input type="radio"/>
Leaks when you cough or sneeze	<input type="radio"/>
Leaks when you are asleep	<input type="radio"/>
Leaks when you are physically active/exercising	<input type="radio"/>
Leaks when you have finished urinating and are dressed	<input type="radio"/>
Leaks for no obvious reason	<input type="radio"/>
Leaks all the time	<input type="radio"/>

5. Did you suffer from any of the following conditions? (Please tick all that apply to you)

Frequent need to urinate	<input type="radio"/>	
Frequent urination	<input type="radio"/>	
Problems with emptying the bladder	<input type="radio"/>	
Need to urinate during the night	<input type="radio"/>	How often each night?
Something else, what		
None of the items above	<input type="radio"/>	

6. Did you suffer from flatus (gas) incontinence?

Never	<input type="radio"/>
About once a week or less often	<input type="radio"/>
Two or three times a week	<input type="radio"/>
About once a day	<input type="radio"/>
Several times a day	<input type="radio"/>
All the time	<input type="radio"/>

7. Did you suffer from fecal incontinence?

Never	<input type="radio"/>
About once a week or less often	<input type="radio"/>
Two or three times a week	<input type="radio"/>
About once a day	<input type="radio"/>
Several times a day	<input type="radio"/>
All the time	<input type="radio"/>

8. Have you exercised your pelvic floor muscles? (Muscles surrounding the urethra, vagina and anus)

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
No	Yes, every day	Yes, at least 3 times per week	Yes, 1-2 times per week	Yes, at least 1 time per week	Yes, occasionally, when I felt the need

If no in question 8, go to question 11.

9. How many repetitions in average each time you exercised your pelvic floor?

10. How long did you hold each contraction?

Ca. in seconds

11. Where did you learn or hear about pelvic floor muscle exercises? (Please tick all that apply to you)

In women's magazines	<input type="radio"/>	What type of school?	
In other types of media, TV, newspapers etc	<input type="radio"/>		
In school	<input type="radio"/>		
By a medical doctor	<input type="radio"/>		
By a physical therapist	<input type="radio"/>		
By a midwife	<input type="radio"/>		
By other health care employees	<input type="radio"/>		
In fitness class	<input type="radio"/>		
By friends, relatives (mother, sister etc.)	<input type="radio"/>		
By participating in this study	<input type="radio"/>		
Other way, how?			

I would like to ask you to contract your pelvic floor muscles now and tell me what you feel when you do it.

12. How would you grade the experience now when you contract your pelvic floor muscles?

Strong and clear contraction	<input type="radio"/>
I can feel the muscles contract, but I cannot hold the contraction for long	<input type="radio"/>
I feel a contraction which is difficult to hold	<input type="radio"/>
I try, but I'm not sure what happens in my pelvic floor	<input type="radio"/>
I cannot feel anything happen	<input type="radio"/>

Explain by your own words what you feel when you try to contract your pelvic floor muscles now directly after birth.

13. When you contract your pelvic floor muscles now, do you think you contract other muscles at the same time?

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
No	Yes	I do not know

14. If yes in question 13, which muscle group(s) do you feel contracted/stressed at the same time? (Please tick all that apply to you)

The abdominal muscles (tucking in the navel)	<input type="radio"/>
The abdominal muscles (moving the pelvis)	<input type="radio"/>
The adductor muscles of the thigh (moving the legs closer to each other)	<input type="radio"/>
The gluteal muscles (seating muscles/buttocks)	<input type="radio"/>
The respiratory muscles (e.g. holding your breath)	<input type="radio"/>
Some other muscle groups, which?	

15. Are you able to stop the midstream while voiding (please try before answering the question):

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
No	Yes	I do not know

Thank you very much for giving this research and this questionnaire a part of your valuable time. If you have something to add, please do so. Your input is greatly appreciated.

APPENDIX 8

Pelvic floor muscle strength before and after first childbirth**Questionnaire 3****Answered approx. 6 weeks after delivery**

Please take a few minutes to fill out this questionnaire. We welcome your feedback and your answers will be kept confidential. Thank you for your participation.

Health AFTER delivery and condition TODAY**Participant's number**

Please let answers apply only to condition after birth

Please tick one box if not otherwise stated.

1. Time from birth in weeks and days

Weeks	Days

2. Weight in kg

Kg

3. Do you perform exercises regularly now after birth, at least once a week?

<input type="radio"/>	<input type="radio"/>
No	Yes

If yes, write the type of exercises you do, how many times per week and for how long time each time. (Please tick all that apply to you)

Type of exercise	Times/week	Duration each time
Slow walking		
Fast walking		
Jogging/running		
Aerobics		
Weight training in a gym		
Weight lifting		
Dance		
Swimming		
Bicycling		
Ball games (soccer, handball, basketball, volleyball etc)		
Racket sports (tennis, badminton, table tennis)		
Other, what? _____		

4. How often do you leak urine now?

Never	0	<input type="radio"/>
About once a week or less often	1	<input type="radio"/>
Two or three times a week	2	<input type="radio"/>
About once a day	3	<input type="radio"/>
Several times a day	4	<input type="radio"/>
All the time	5	<input type="radio"/>

5. How much urine do you usually leak now (whether you wear protection or not)?

None	0	<input type="radio"/>
A small amount	2	<input type="radio"/>
A moderate amount	4	<input type="radio"/>
A large amount	6	<input type="radio"/>

**6. Overall, how much does leaking urine interfere with your everyday life now?
Please ring a number between 0 (not at all) and 10 (a great deal)**

Not at all

A great deal

0	1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	---	----

7. When does urine leak now? (Please tick all that apply to you)

Never- Urine does not leak	<input type="radio"/>
Leaks before you can get to the toilet	<input type="radio"/>
Leaks when you cough or sneeze	<input type="radio"/>
Leaks when you are asleep	<input type="radio"/>
Leaks when you are physically active/exercising	<input type="radio"/>
Leaks when you have finished urinating and are dressed	<input type="radio"/>
Leaks for no obvious reason	<input type="radio"/>
Leaks all the time	<input type="radio"/>

**8. Have you suffered from any of the following conditions after you gave birth?
(Please tick all that apply to you)**

Frequent need to urinate	<input type="radio"/>	
Frequent urination	<input type="radio"/>	
Problems with emptying the bladder	<input type="radio"/>	
Need to urinate during the night	<input type="radio"/>	How often each night?
Something else, what		
None of the items above	<input type="radio"/>	

9. Do you suffer from flatus (gas) incontinence now?

Never	<input type="radio"/>
About once a week or less often	<input type="radio"/>
Two or three times a week	<input type="radio"/>
About once a day	<input type="radio"/>
Several times a day	<input type="radio"/>
All the time	<input type="radio"/>

10. Do you suffer from fecal incontinence now?

Never	<input type="radio"/>
About once a week or less often	<input type="radio"/>
Two or three times a week	<input type="radio"/>
About once a day	<input type="radio"/>
Several times a day	<input type="radio"/>
All the time	<input type="radio"/>

11. Are you able to stop the midstream while voiding (please try before answering the question):

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
No	Yes	I do not know

12. Have you exercised your pelvic floor muscles after you gave birth? (Muscles surrounding the urethra, vagina and anus)

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
No	Yes, every day	Yes, at least 3 times per week	Yes, 1-2 times per week	Yes, at least 1 time per week	Yes, occasionally, when I feel the need

If no in question 12, go to question 17.

13. If yes in question 12, how many weeks have you exercised your pelvic floor after birth?

Weeks

14. Are you still exercising your pelvic floor muscles today?

<input type="radio"/>	<input type="radio"/>
No	Yes

15. How many repetitions in average each time you exercise your pelvic floor?

--

16. How long do you hold each contraction?

Ca. in seconds

17. Why have you not exercised your pelvic floor muscles after the birth?

I have tried, but it is painful	<input type="radio"/>
I think it will be painful if I try	<input type="radio"/>
I don't think I need the exercises	<input type="radio"/>
I don't have time	<input type="radio"/>
I don't want to	<input type="radio"/>
I'm not able to contract them	<input type="radio"/>
Other reasons, which?	

18. Where did you learn or hear about pelvic floor muscle exercises? (Please tick all that apply to you)

In women's magazines	<input type="radio"/>	
In other types of media, TV, newspapers etc	<input type="radio"/>	
In school	<input type="radio"/>	What type of school?
By a medical doctor	<input type="radio"/>	
By a physical therapist	<input type="radio"/>	
By a midwife	<input type="radio"/>	
By other health care employees	<input type="radio"/>	
In fitness class	<input type="radio"/>	
By friends, relatives (mother, sister etc.)	<input type="radio"/>	
By participating in this study	<input type="radio"/>	
Other way, how?		

19. How would you grade the experience now when you contract your pelvic floor muscles?

Strong and clear contraction	<input type="radio"/>
I can feel the muscles contract, but I cannot hold the contraction for long	<input type="radio"/>
I feel a contraction which is difficult to hold	<input type="radio"/>
I try, but I'm not sure what happens in my pelvic floor	<input type="radio"/>
I cannot feel anything happen	<input type="radio"/>

Explain by your own words what you feel when you try to contract your pelvic floor muscles.

20. When you contract your pelvic floor muscles now, do you think you contract other muscles at the same time?

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
No	Yes	I do not know

21. If yes in question 20, which muscle group(s) do you feel contracted/stressed at the same time? (Please tick all that apply to you)

The abdominal muscles (tucking in the navel)	<input type="radio"/>
The abdominal muscles (moving the pelvis)	<input type="radio"/>
The adductor muscles of the thigh (moving the legs closer to each other)	<input type="radio"/>
The gluteal muscles (seating muscles/buttocks)	<input type="radio"/>
The respiratory muscles (e.g. holding your breath)	<input type="radio"/>
Some other muscle groups, which?	

22. Are you breastfeeding today?

Yes	<input type="radio"/>
No, I have never breastfed the baby	<input type="radio"/>
No, I stopped breastfeeding in week _____	<input type="radio"/>

Thank you very much for giving this research and this questionnaire a part of your valuable time. If you have something to add, please do so. Your input is greatly appreciated.

APPENDIX 9

**Annex 2 : International Consultation on Incontinence Questionnaire (ICIQ) -
ICIQ UI SF (Short-form)**

Initial number

DAY MONTH YEAR
Today's date

Many people leak urine some of the time. We are trying to find out how many people leak urine, and how much this bothers them. We would be grateful if you could answer the following questions, thinking about how you have been, on average, over the PAST FOUR WEEKS.

1 Please write in your date of birth:

DAY MONTH YEAR

2 Are you (tick one):

Female ☐ Male ☐

3 How often do you leak urine? (Tick one box)

never	<input type="checkbox"/>	0
about once a week or less often	<input type="checkbox"/>	1
two or three times a week	<input type="checkbox"/>	2
about once a day	<input type="checkbox"/>	3
several times a day	<input type="checkbox"/>	4
all the time	<input type="checkbox"/>	5

4 We would like to know how much urine you think leaks.

How much urine do you usually leak (whether you wear protection or not)? (Tick one box)

none	<input type="checkbox"/>	0
a small amount	<input type="checkbox"/>	2
a moderate amount	<input type="checkbox"/>	4
a large amount	<input type="checkbox"/>	6

5 Overall, how much does leaking urine interfere with your everyday life?

Please ring a number between 0 (not at all) and 10 (a great deal)

0	1	2	3	4	5	6	7	8	9	10	
not at all											a great deal

ICIQ score: sum scores 3+4+5

6 When does urine leak? (Please tick all that apply to you)

never – urine does not leak	<input type="checkbox"/>
leaks before you can get to the toilet	<input type="checkbox"/>
leaks when you cough or sneeze	<input type="checkbox"/>
leaks when you are asleep	<input type="checkbox"/>
leaks when you are physically active/exercising	<input type="checkbox"/>
leaks when you have finished urinating and are dressed	<input type="checkbox"/>
leaks for no obvious reason	<input type="checkbox"/>
leaks all the time	<input type="checkbox"/>

Thank you very much for answering these questions.

APPENDIX 10

Styrkur grindarbotnsvöðva fyrir og eftir fyrstu fæðingu. Og hvernig konur upplifa samdrátt vöðvanna.

Upplýsingar fyrir væntanlega þátttakendur.

September 2006

Ágæta verðandi móðir.

Vísindarannsókn, sem ber ofangreindan titil fer nú fram hér í mæðravernd Heilsugæslunnar á höfuðborgarsvæðinu og á Kvennadeild LSH og þér hefur verið boðin þátttaka vegna þess að þú átt von á þínu fyrsta barni og meðgangi virðist alveg eðlileg. Rannsóknin er samstarfsverkefni Landspítala-háskólasjúkrahúss, læknadeildar Háskóla Íslands og Miðstöðvar mæðraverndar.

Þóra Steingrímsdóttir, fæðingalæknir ber ábyrgð á framkvæmd hennar. Hægt er að ná til hennar í síma 585 1400 (Miðstöð mæðraverndar) eða 543 1000 (Kvennadeild Landspítala-háskólasjúkrahúsi) eða gsm 863 3781 og með tölvupósti á netfangið thoraste@landspitali.is. Aðrir rannsakendur eru: Kari Bø prófessor, Norges Idrettshøgskole í Osló, Árni Árnason PhD, lektor við Sjúkrapjálfunarskor Læknadeildar H.Í. og Þorgerður Sigurðardóttir sjúkrapjálfari, meistaranemi við læknadeild Háskóla Íslands. Rannsókn þessi er rannsóknarverkefni Þorgerðar og mun hún framkvæma mælingar og taka viðtöl.

Rannsóknin fjallar um styrkmælingar á grindarbotnsvöðvum og svörun spurningalista um upplifun þína á vöðvasamdrætti grindarbotnsvöðvanna. Meðganga og fæðing eru meðal sterkustu áhrifavalda á starfsemi grindarbotnsvöðva og þekkt að þessir þættir geti veikt styrk þeirra og í kjölfarið finni sumar konur fyrir þvagleka eða öðrum einkennum s.s. þreytu, hægða- eða loftleka eða seinna meir sigi á líffærum eins og blöðru, legi eða endaparmi. Mikilvægt er að auka þekkingu okkar á þeirri þróun sem verður frá meðgöngu og fram yfir fæðingu og kanna áhrif fæðingarmáta, lengdar fæðingar og þyngdar barns þar á.

Viljir þú taka þátt í þessari rannsókn felur það í sér eina mælingu og svörun spurningalista á miðri meðgöngu, svörun spurningalista á fæðingardeild áður en farið er heim og síðari mælingin er 6 vikum eftir fæðingu ásamt svörun spurningalista. Rannsóknin nær þannig yfir u.þ.b. 26 vikur ef meðgöngulengd þín er eðlileg.

Mælingarnar eru framkvæmdar með mælitæki sem nemur þrýsting af samdrætti grindarbotnsvöðvanna í leggöngum. Þú verður beðin um að spennna vöðvana nokkrum sinnum og skráður verður styrkur, lengd vöðvasamdrátta og fjöldi samdrátta sem þú átt gott með að framkvæma. Mælingarnar sjálfar taka nokkrar mínútur.

Einnig verða lagðir fyrir þig 4 spurningalistar um heilsufar og upplifun þína á samdrætti grindarbotnsvöðva, listarnir eru 5-6 bls. að lengd hver og tekur u.þ.b. 10-15 mínútur að svara hverjum þeirra. Í fyrsta viðtali verða 2 listar lagðir fyrir þig. Í öðru viðtali 1 listi og í þriðja og síðasta viðtali verður 1 listi lagður fyrir þig. Spurningalistunum er ætlað að draga upp mynd af heilsufari þínu og líðan sem tengist grindarbotni frá því fyrir meðgöngu og þar til eftir fæðingu. Viðtöl 1 og 3 munu fara fram í Tápi ehf. Sjúkrapjálfun, Hlíðasmára 14 í Kópavogi. Þar munt þú fá þægilegt og rúmgott herbergi til að svara spurningalistunum í næði en rannsakandinn

(Þorgerður) verður þér innan handar ef þú þarft á því að halda. Mælingarnar verða framkvæmdar að því loknu. Treyst verður á velvilja þátttakenda að koma sér sjálfir á staðinn í Hlíðasmára 14 í Kópavogi. Ef ferðakostnaður er hindrun verður hægt að fá hann endurgreiddan. Viðtal 2 verður á fæðingardeild Landspítala-Háskólasjúkrahúss, þar sem þú munt svara spurningalista 2 áður en þú ferð heim að fæðingu lokinni.

Mælingarnar hafa enga þekkta áhættu í för með sér.

Þér er frjálst á öllum stigum að hætta þátttöku í rannsókninni eða svara ekki tilteknum spurningum á spurningalistunum en þótt þú gerir það eða afþakkir boð um þátttöku, hefur það engin áhrif á þá meðferð eða þjónustu sem þú hlýtur hjá heilbrigðisþjónustunni og mismunandi aðilum hennar.

Þátttaka þín er mjög mikilvæg og viljum við að sjálfsögðu hvetja þig til að taka þátt í öllum þáttum rannsóknarinnar svo niðurstöður hennar verði sem marktækastar. Þú gætir auk þess haft hag af þátttökunni þar sem þú munt fá góðar leiðbeiningar um samdrátt og styrkingu grindarbotnsvöðvanna.

Öll gögn, sem safnað verður, tengjast nafni þínu einungis með númeri, en einn handskrifaður listi verður til sem tengir nafn og númer saman. Listinn verður í vörslu rannsækenda. Að rannsókn lokinni verður listanum eytt.

Tryggingaraðili rannsóknarinnar er Vátryggingafélag Íslands.

Rannsóknin hefur hlotið samþykki Vísindasiðanefndar (tilvís. 06-070) og verið tilkynnt til Persónuverndar samkvæmt reglum þar að lútandi.

Með von um gott og ánægjulegt samstarf,

Þóra Steingrímsdóttir, ábyrgðarmaður rannsóknarinnar

“Ef þú hefur spurningar varðandi rétt þinn sem þátttakandi í rannsókninni eða vilt hætta þátttöku í henni getur þú snúið þér til Vísindasiðanefndar, Vegmúla 3, 108 Reykjavík. Sími: 551-7100, fax: 551-1444.”

APPENDIX 11

Pelvic floor muscle function before and after first childbirth

and women's perception of quality of the contraction

Information for potential participants

September 2006

Dear mother-to-be

A scientific research project will be taking place over the next few months in The Primary Healthcare Centre in the capital area of Iceland and in the maternity ward of Landspítali. You have been invited to participate in the study due to the fact that you are expecting your first child and appear to be experiencing a pregnancy without any apparent implications. The study is a joint project between Landspítali University Hospital, the faculty of medicine at The University of Iceland and the centre for antenatal care in the primary health care.

Póra Steingrimsdóttir, obstetrician is responsible for the study. She can be reached by phone at 5851400 (center for antenatal care) and 5341000 (maternity ward Landspítali) or by mobile at 8633781 and by email at thoraste@landspitali.is. Other researchers are: Professor Kari Bø from Norwegian School of Sport Sciences in Oslo, Arni Arnason PhD, lecturer at the department of Physiotherapy of the medical faculty of the University of Iceland and Þorgerdur Sigurðardóttir, physiotherapist and masters student at the medical faculty of the University of Iceland. This study is Þorgerdur's research project, for which she will be interviewing and conducting measurements.

The central focus of the study is measurements of the strength of the pelvic floor muscles and the answering of a list of questions regarding your experience of the contraction of the pelvic floor muscles. Pregnancy and childbirth are among the most influential factors regarding the function of the pelvic floor muscles and it is known that these factors could weaken the muscles. As a consequence women can experience urinary incontinence along with other side effects such as tiredness, anal incontinence or pelvic organ prolaps. It is important to increase our knowledge of developments of the pelvic floor during pregnancy and on to childbirth and after. In relation to these developments, the effects of obstetric factors in childbirth, the length of the delivery as well as the weight of the infant, are also factors that must be studied.

If you would like to take part in this study you will be required to attend one measurement session and answer a questionnaire mid pregnancy. You will also be required to answer a questionnaire prior to returning home after giving birth and finally you must attend a second measurement session 6 weeks after giving birth as well as answer a questionnaire for the third and final time. This demonstrates that the study covers a period of 26 weeks, provided the length of your pregnancy is normal. The measurements are conducted with a measuring device which senses the pressure from the pelvic floor muscles in the vagina. You will be asked to contract the muscles a few times and the strength, duration and number of contractions you can comfortably do will be noted down. The measurements will take a few minutes each.

You will also be required to answer 4 questionnaires on your health and how you experience the contraction of the pelvic floor muscles, the questionnaires are 5-6 pages long and each one takes about 10-15 minutes to answer. In the first interview you will be given two questionnaires to complete, in the second interview you will have to answer one questionnaire and in the third and final interview you will also be set one questionnaire to complete. The purpose of the questionnaires is to get an idea of your state of health in relation to the pelvic floor, from pregnancy until after childbirth. Interviews 1 and 3 will take place in Táp ehf. Physiotherapy clinic, at Hlíðasmári 14, Kópavogur. There you will be allocated a comfortable and spacious room where you can answer the questionnaires in peace, however, the researcher (Þorgerdur) will be within reach if you need any help. The measurements will be conducted once the questionnaires have been completed. We will be relying on participants' ability to get themselves to and from Hlíðasmári 14 in Kópavogur, however we can reimburse you if the cost of travel back and forth is a hindrance.

Interview number 2 will take place at the maternity ward at LSH, where you will answer questionnaire number 2 prior to returning home after giving birth.

The measurements involve no known risks

You are free at any stage to withdraw your participation in the project and to not answer certain questions in the questionnaires. Doing this or deciding not to take part in the project will not affect the way you are treated or the service you get from the primary healthcare and its staff.

Your participation is very important and we would of course like to encourage you to take part in all sections of the research project so that its findings can be as significant as possible. You might also gain from participating as you will get good instructions for contracting and strengthening the pelvic floor muscles.

All the data collected will only be related to you by a number, however there will be one handwritten list connecting participants' names to numbers. That list will be held by researchers. The list will be destroyed once the research project is completed.

The project is insured by Vátryggingarfélag Íslands.

The research project has been accepted by National Bioethics Committee (ref. 06 – 070) and the Protection of Privacy have been informed of the project in accordance with the relevant rules.

Hoping that you will be able to help us with this research,
Yours sincerely,

Þóra Steingrímsdóttir, project manager.

<p>“If you have any questions regarding your rights as a participant in the study or would like to withdraw your participation in the study you can turn to National Bioethics Committee, Vegmúla 3, 108 Reykjavík. Phone: 551-7100, fax: 551-1444.”</p>
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APPENDIX 12

PERCEPTION OF THE PFM CONTRACTION FOR ALL PARTICIPANTS

Participant 2:

Q1a. (before pregnancy): I felt clearly that the muscles were contracting.

Q2. (first days after childbirth): I feel that the muscles have weakened and now I have to use the buttocks to help contract the pelvic floor and it is very difficult.

Q3. (approx. 6 weeks postpartum): I feel that I have to use the buttocks as well.

Participant 3:

Q1a. (before pregnancy): Good muscle contraction, heat and pressure in muscles.

Q1b. (during pregnancy): I feel a clear contraction, pressure. I cannot hold the contraction as long as before the pregnancy and I am not able to do as many repetitions.

Q3. (approx. 6 weeks postpartum): I feel a tension but cannot hold it strongly for more than a few seconds

Participant 4:

Q1a. (before pregnancy): Everything closed down there, contracted together.

Q1b. (during pregnancy): Same as before, but perhaps a little bit more difficult to hold the contraction.

Q2. (first days after childbirth): I am still numb down there, but I can feel a little bit that the muscles can contract.

Q3. (approx. 6 weeks postpartum): I find it harder to contract now and it feels like I have to use both buttocks and thigh muscles at the same time.

Participant 5:

Q1b. (during pregnancy): I feel the muscles contract and like I'm lifting up a little bit.

Q2. (first days after childbirth): I feel a strong contraction which is easy to hold for some time.

Q3. (approx. 6 weeks postpartum): I feel a clear contraction which I can hold for quite some time.

Participant 6:

Q1a. (before pregnancy): The muscles contracted and lifted up.

Q1b. (during pregnancy): Same as before.

Q3. (approx. 6 weeks postpartum): A tension and moves upward.

Participant 7:

Q1a. (before pregnancy): I feel a contraction like holding urine.

Q1b. (during pregnancy): I feel a tension in the muscles, like when I need to urinate.

Q2. (first days after childbirth): I feel that it is difficult to contract, but can contract a little bit, feel a little pain.

Q3. (approx. 6 weeks postpartum): I feel strongly that the muscles contract and the abdominal and buttock muscles tense at the same time, like I do when I have to hold the urine.

Participant 8:

Q2. (first days after childbirth): I'm terribly numb after suturing and don't feel the muscles at all. I don't have the courage to contract.

Q3. (approx. 6 weeks postpartum): I find it harder to know exactly where to contract than before the delivery.

Participant 10:

Q2. (first days after childbirth): I feel the muscles contract.

Participant 11:

Q2. (first days after childbirth): Less feeling than before, I think I cannot contract as hard as before.

Q3. (approx. 6 weeks postpartum): Less feeling, less strength.

Participant 13:

Q1b. (during pregnancy): I feel the muscles contract, it feels rather uncomfortable.

Q2. (first days after childbirth): Uncomfortable, I cannot hold for long.

Q3. (approx. 6 weeks postpartum): I feel that the muscles contract. Though it is a little bit harder to hold for long than before the delivery.

Participant 14:

Q2. (first days after childbirth): I am sore, I think I cannot hold a contraction.

Q3. (approx. 6 weeks postpartum): Strong contraction, I feel that I can control the muscles better, I feel I know better how they work.

Participant 15:

Q3. (approx. 6 weeks postpartum): I feel a contraction which relaxes slowly.

Participant 16:

Q1a. (before pregnancy): I felt the muscles lift, then they got tired.

Q1b. (during pregnancy): It feels like before, contracts together but becomes difficult after few seconds.

Q2. (first days after childbirth): I lack power but can hold a contraction for a short while. Still, I can feel the tension.

Q3. (approx. 6 weeks postpartum): Similar than before but can hold for a shorter period of time than before.

Participant 18:

Q1a. (before pregnancy): It went very well, it felt a kind of exciting.

Q1b. (during pregnancy): I feel that the muscles contract up, everything becomes tighter og vacuums, like sucking. Like I can catch something with these muscles. Strong me.

Q3. (approx. 6 weeks postpartum): Everything is really cool, good and strong feeling compared to the fact that I had a really difficult delivery 6 weeks ago.

Participant 19:

Q1b. (during pregnancy): I feel a tension which I cannot hold for long, I become irritated in my legs.

Q2. (first days after childbirth): I feel that the muscles are weak.

Q3. (approx. 6 weeks postpartum): I feel that they are weak.

Participant 20:

Q1a. (before pregnancy): I felt the muscles contract towards the vagina.

Q3. (approx. 6 weeks postpartum): I feel a good contraction which goes upward but not as strong as before.

Participant 21:

Q1a. (before pregnancy): I felt how the muscles contracted and I could easily stop the flow of urine. I feel a great connection between the muscles and sex. If I do exercises it helps me control my orgasm.

Q1b. (during pregnancy): I feel that I do not have the same control for how long I contract the muscles, otherwise it is the same feeling.

Q2. (first days after childbirth): I feel a lot of pain, think everything is swollen.

Q3. (approx. 6 weeks postpartum): I feel a contraction but it is not as strong as before.

Participant 22:

Q1a. (before pregnancy): I feel a tension, movement like tensing a thread.

Q2. (first days after childbirth): I don't feel anything, still numb, no feeling.

Q3. (approx. 6 weeks postpartum): I feel a contraction in the muscles, like I'm closing an opening.

Participant 23:

Q1b. (during pregnancy): I feel that the muscles contract, similar to other muscles in the body.

Q2. (first days after childbirth): I feel tension in the muscles.

Q3. (approx. 6 weeks postpartum): I feel the muscles contract but nothing like it was before the pregnancy.

Participant 24:

Q1a. (before pregnancy): The area around the anus, vagina and urethra contracts together. It is like contracting other muscles in the body, only weaker.

Q1b. (during pregnancy): The muscles in the pelvic floor contract like before.

Q2. (first days after childbirth): I am very swollen and sore, but can feel contraction.

Q3. (approx. 6 weeks postpartum): I feel muscle contraction around anus and vagina.

Participant 25:

Q1a. (before pregnancy): Much contraction down there.

Q1b. (during pregnancy): I feel tension down there, the anus contracts together.

Q2. (first days after childbirth): I don't feel any difference, but I don't dare to contract strongly because of pain.

Q3. (approx. 6 weeks postpartum): The muscles are weaker and it is not as easy to locate them as before. Also, I cannot hold the tension for as long as before.

Participant 26:

Q1b. (during pregnancy): I feel like the cervix is contracting together and up.

Participant 27:

Q1b. (during pregnancy): I feel that they contract quite well in the anal area.

Q2. (first days after childbirth): The muscles contract and I feel pain after being sutured.

Q3. (approx. 6 weeks postpartum): I feel a contraction around the anus and sometimes in the abdomen. It is often difficult to breath when I do exercises.

Participant 28:

Q1a. (before pregnancy): It was like I was lifting the whole area inside the pelvis.

Q1b. (during pregnancy): Like I'm contracting everything inside the pelvis.

Q2. (first days after childbirth): It is like contracting muscles with muscle fever.

Q3. (approx. 6 weeks postpartum): It is like I'm contracting and lifting the whole area.

Participant 29:

Q1a. (before pregnancy): I felt a tension inside the pelvis when I contracted the muscles.

Q1b. (during pregnancy): When I contract the pelvic floor I feel tension.

Q2. (first days after childbirth): I feel that the abdominal, buttocks and thigh muscles are also contracting.

Q3. (approx. 6 weeks postpartum): I feel a tension in the pelvis. When I contract the pelvic floor muscles I feel a contraction in abdominal and buttock muscles.

Participant 33:

Q2. (first days after childbirth): Same feeling as before, same length for each contraction.

Q3. (approx. 6 weeks postpartum): I feel the muscles contract around the vagina.

Participant 34:

Q2. (first days after childbirth): They contract.

Q3. (approx. 6 weeks postpartum): They contract.

Participant 35:

Q1a. (before pregnancy): The feeling of lifting up and holding the muscles, it is like taking them inside the body.

Q1b. (during pregnancy): The muscles are lifting up, coming into me somehow, it's like holding and keeping.

Q2. (first days after childbirth): I feel that the muscles are a bit stiff.

Q3. (approx. 6 weeks postpartum): Connection between muscles.

Participant 36:

Q2. (first days after childbirth): I have a lot of pain and I am afraid to contract the pelvic muscles because of pain. I have a catheter.

Q3. (approx. 6 weeks postpartum): I feel the pelvic floor contract and lift but it is not as strong as before, it's difficult to hold the contraction, it's rather weak.

Participant 37:

Q1a. (before pregnancy): I felt the muscles in my crotch contract.

Q1b. (during pregnancy): It seems like it is more difficult to contract the muscles now. Like being weak when trying to contract.

Q3. (approx. 6 weeks postpartum): I feel a tension in the muscles.

Participant 38:

Q1b. (during pregnancy): When I contract the pelvic floor muscles, I feel the muscles contract together and up, like I'm closing something.

Q2. (first days after childbirth): I am so sore because of suturing that I cannot hold the contraction for long.

Q3. (approx. 6 weeks postpartum): I feel a clear contraction but not at all as strong as before the delivery.

Participant 39:

Q1b. (during pregnancy): Tension-the buttocks contract.

Q2. (first days after childbirth): I feel that I have less control over the muscles. I feel that I can contract but when I try to relax it's like I have already lost the contraction. If I don't go quickly to the bathroom when I need to urinate I loose the urine, cannot hold it, I can stop midstream when I urinate.

Q3. (approx. 6 weeks postpartum): I don't feel a strong contraction when I try to contract. And when I intend to release the contraction it is already gone. I cannot quite control it.

Participant 40:

Q1b. (during pregnancy): I feel all the openings close (urethra, vagina and anus) in the contraction and a good rest when I relax.

Q2. (first days after childbirth): The muscles clearly contract but they are very tired.

Q3. (approx. 6 weeks postpartum): I feel the muscles clearly contract. I have a feeling that they have been in better shape before.

Participant 42:

Q1a. (before pregnancy): I imagined that I was rolling a ball up the vagina.

Q1b. (during pregnancy): I feel that I cannot contract the muscles completely, only 90% but I can hold the contraction for quite a long time. (Or nothing has changed from before)

Q2. (first days after childbirth): I am numb, feel that the sutures in the vagina move, I feel that I can hold a tension around the anus.

Q3. (approx. 6 weeks postpartum): The muscles contract, I feel that I have to contract the abdominal muscles as well.

Participant 43:

Q1a. (before pregnancy): I felt quite clearly what I was contracting.

Q1b. (during pregnancy): I feel that it is more difficult to contract now.

Q2. (first days after childbirth): I feel that I'm contraction but I cannot hold for long.

Q3. (approx. 6 weeks postpartum): I contract the muscles but I'm not sure how powerful it is.

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