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## Trends in urinary incontinence in women between 4 and 24 months postpartum in the EDEN cohort.

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1 Title Page

2 Trends in urinary incontinence in women between 4 and 24 months postpartum in the EDEN  
3 cohort

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20 **Shortened running title**

21 Urinary incontinence between 4 and 24 months postpartum

22 **Word count:** 2646

23 Trends in urinary incontinence in women between 4 and 24 months postpartum in the EDEN  
24 cohort

25 **Abstract**

26 **Objective:** Our aim was to study risk factors associated with the prevalence, incidence and  
27 remission of urinary incontinence (UI) between 4 and 24 months postpartum.

28 **Design:** Longitudinal study (EDEN cohort).

29 **Setting:** Two French university hospitals.

30 **Population:** 1643 women completed the questionnaire at 4 months and 1409 at 24 months,  
31 including 1354 who completed it both times.

32 **Methods:** Multivariate analyses identified risk factors for UI prevalence at 24 months  
33 postpartum, persistent UI versus remission, de novo UI versus continence, de novo UI versus  
34 persistent UI, and changes in IU severity between 4 and 24 months postpartum.

35 **Main Outcome Measures:** Postnatal UI and Sandvik UI severity score.

36 **Results:** UI prevalence was 20.7% (340/1643) at 4 months and 19.9% (280/1409) at 24.  
37 Significant factors associated with UI at 24 months were older age (OR = 1.07/year [95% CI:  
38 1.04-1.11]), BMI (2.35 [1.44-3.85]  $\geq$  30 versus  $<$  25 kg/m<sup>2</sup>), higher parity (1.77 [1.14-2.76]  $\geq$   
39 3 versus 1), breast feeding (1.54 [1.08-2.19]  $\geq$  3 versus  $<$  3 months), pregnant at follow-up  
40 (3.44 [2.25-5.26]), and caesarean delivery (0.62 [0.40-0.97] versus vaginal). The likelihood of  
41 UI remission at 24 months was 51.9% (149/287). Caesarean delivery was associated with  
42 increased likelihood of UI remission (0.43 [0.19-0.97]). The risk of de novo UI at 24 months  
43 was 12.5% (135/1067) and was associated with a new pregnancy (3.63 [2.13-6.20]).

44 **Conclusions:** Between 4 and 24 months postpartum UI, remission occurred in half of the  
45 cases. These postnatal UI changes were essentially related to mode of delivery and subsequent

46 pregnancy.

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48 Abstract word count: 248.

49 **Keywords:** female urinary incontinence, postpartum, remission, incidence, pregnancy, cohort

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## INTRODUCTION

51 Urinary incontinence (UI) is defined by complaints of involuntary urinary leakage. This  
52 frequent symptom is reported by 10 to 40% of women.<sup>1</sup> It is especially disabling, has an  
53 unfavourable effect on women's social and working lives, and is costly from both individual  
54 (cost of hygiene products and treatment) and societal (health insurance costs and lost work  
55 days) perspectives.

56 The natural history of UI remains poorly understood.<sup>2</sup> Parity, ageing and obesity are the  
57 predominant risk factors for women. The prevalence of urinary leakage increases substantially  
58 during pregnancy as term approaches.<sup>2</sup> Different studies report prevalence rates of postpartum  
59 UI ranging from 3% to 73%.<sup>2</sup> The trauma associated with vaginal delivery appears to be the  
60 principal risk factor for postnatal UI. The prevalence of UI diminishes in the months after  
61 delivery.<sup>2</sup> However, we still do not know what factors are associated with this postnatal  
62 remission of symptoms. Longitudinal data after 12 months postpartum remain sparse,<sup>2-10</sup> but  
63 those few studies report that the prevalence of UI increases progressively as women age.<sup>6,8</sup>  
64 Similarly, we do not know what determinants promote the return of UI long after delivery, and  
65 few studies have focused on the remission and incidence of UI in the postpartum period. They  
66 can be examined, however, through data from the EDEN mother-child cohort, which describe  
67 UI at 4 and 24 months postpartum. The objective of this study was to describe the trends in  
68 symptoms between 4 and 24 months postpartum, to estimate remission and incidence rates,

69 and to analyse the determinants of these trends.

70

## METHODS

71 The population comes from the EDEN cohort, composed of women recruited during  
72 pregnancy between 2003 and 2006 in two French maternity units, Nancy and Poitiers  
73 university hospitals (<https://eden.vjf.inserm.fr/index.php?lang=en>). The inclusion criteria  
74 required women to be pregnant with a single fetus, have health insurance, speak and write  
75 French, and have no prepregnancy history of diabetes. Women expecting to move away from  
76 the region in the 3 years to come were excluded. Among the 3758 women invited to  
77 participate, 2002 (53%) agreed (1034 women from Nancy and 968 from Poitiers). Women  
78 were included at a mean of 15 weeks of pregnancy (range: 8-26). Their mean age was 29  
79 years (range: 18-44) and 30% of them were pregnant for the first time.

80 Postpartum UI was assessed at baseline (4 months postpartum) and at follow-up (24 months  
81 postpartum) by self-administered postal questionnaires that asked, among other things, about  
82 urinary symptoms during the preceding 4 weeks. Women were classified with UI if they  
83 answered yes to the question: "Have you had involuntary urinary leakages?" The UI type was  
84 determined with the BFLUTS (British Female Low Urinary Track Symptoms)  
85 questionnaire.<sup>11</sup> The question about frequency of leakage had four answer levels (less than  
86 once a month, once or several times a month, once or several times a week, every day and/or  
87 night), and the question about the amount of leakage three levels (drops, a little amount,  
88 more). The severity of UI at 4 and 24 months postpartum was estimated by Sandvik's score,

89 which has been validated with pad-weighing tests.<sup>12</sup>

90 The explanatory variables selected were chosen to reflect different hypotheses of

91 pathophysiologic mechanisms: traumatic factors (parity, characteristics of the index

92 pregnancy and delivery: episiotomy, long second stage of labour, child's gender, child's

93 weight, severe sphincter injury, anal incontinence 4 months postpartum, additional delivery

94 during follow-up); factors affecting tissue modification (pregnant at 24 months postpartum,

95 breast feeding, maternal age), factors affecting pelvic pressure (new pregnancy, body mass

96 index assessed before index pregnancy), constitutional factors (UI history before, during or

97 after the index delivery) and potential protective factors (postpartum pelvic floor muscle

98 training (PFMT)).<sup>2</sup> Education level and centre were considered as adjustment variables.

99 Education level may affect women's willingness to report urinary leakage and can thus modify

100 the results.<sup>13</sup> We have previously observed that a low education level is associated with both a

101 lower response rate and a lower UI incidence.<sup>14,15</sup>

102 The women who responded at 24 months and those who did not were compared with

103 Student's t test for the quantitative variables and a Chi-2 test for the qualitative variables.

104 The analyses of incidence and remission considered four groups of women, defined (Figure

105 S2) according to the presence or absence of postpartum UI at 4 months (baseline) and 24

106 months (follow-up): Group A comprised women who reported no urinary leakage at baseline

107 or at follow-up; group B, women with urinary leakage at baseline and at follow-up; group C  
108 the women who reported no leakage at baseline but reported de novo leakage at follow-up;  
109 and group D the women with leakage at baseline but not at follow-up.

110 Several multivariate logistic regressions were performed. One was an analysis of UI  
111 prevalence at 24 months postpartum, and another an analysis comparing group B (persistent  
112 UI) and group D (UI remission) to answer the question: what factors explain UI remission at  
113 some period after delivery? An analysis comparing group A (persistent continence) and group  
114 C (de novo UI) studied the question: What factors influence the onset of UI at a period after  
115 delivery? Each of these models was first studied in a bivariate analysis with each explanatory  
116 variable mentioned above; the variables with a  $P$  value  $\leq 0.20$  were included in the  
117 multivariate analyses. The variables retained for the final multivariate analyses had  $P$  values  $\leq$   
118 0.05 and were considered significant. The analyses were adjusted for centre and education  
119 level.

120 Finally we applied the same principle to the variation of the UI severity score between 4 and  
121 24 months postpartum by a linear regression of the overall population.

122 All statistical analyses were performed with SAS software (version 9.2).

123 The relevant ethics committee (for the protection of people participating in biomedical  
124 research at Kremlin-Bicêtre) approved the EDEN cohort study on December 12, 2002. Each

125 participating mother provided written consent at inclusion. The required declarations to the

126 French data protection authority have been made.

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## RESULTS

129 In all, 1643 women (87.0%) responded to the questionnaire at 4 months postpartum, 1409  
130 (74.5%) at 24 months; these included 1354 (71.7%) who responded at both 4 and 24 months  
131 (Figure S1). The population responding at 24 months differed significantly from the women  
132 lost to follow-up; the latter were younger and more often multiparous, and they had lower  
133 incomes and less education.

134 The prevalence of UI in our population was 20.7% (340/1643) at 4 months and 19.9%  
135 (280/1409) at 24 months postpartum (Figure S2). The prevalence of UI at 24 months was  
136 14.0% among women who had only caesarean deliveries, versus 20.6% for women with  
137 vaginal deliveries. UI at 24 months was significantly associated with older maternal age,  
138 parity  $\geq 3$ , vaginal compared with caesarean delivery, breast feeding for longer than 3 months,  
139 overweight or obesity, and being pregnant again at 2 years postpartum (Table 1). The other  
140 variables tested were not significantly associated with UI at 24 months postpartum.

141 Among the 287 women who reported postpartum UI at 4 months (baseline) and also  
142 completed the questionnaire at 24 months (Groups B and D, Table S1), 149 (51.9%) were  
143 continent at 24 months. UI remission between 4 and 24 months postpartum was more frequent  
144 for women whose UI first appeared during pregnancy compared with those with UI before the  
145 index pregnancy, and those whose UI was mild. Remission was less frequent for women who  
146 had had at least one vaginal delivery and for those who were pregnant when they completed

147 the 24-month questionnaire (Table 2).

148 Of the 1067 women who were continent at 4 months and completed the questionnaire at 24  
149 months (groups A and C, Table S1), 135 (12.7%) reported UI at 24 months. The factors  
150 significantly associated with the onset of de novo UI at 24 months were older maternal age,  
151 anal incontinence reported at 4 months, being pregnant at 24 months, and obesity (Table 3).

152 Among the 273 women incontinent at 24 months who also completed the 4-month  
153 questionnaire (Groups B and C, Table S1), 138 (50.5%) had persistent UI, that is, reported on  
154 both questionnaires, while 135 (49.5%) had developed de novo UI at 24 months. The group of  
155 women with persistent UI, compared with those with de novo UI at 24 months, more  
156 frequently reported moderate or severe UI (49.3% vs. 34.1%) and mixed UI (63.0% vs.  
157 48.9%) at 24 months. Moreover, their parity at inclusion was more often 3 or higher (29.7 vs.  
158 21.5%, Table S1).

159 PFMT between 4 and 24 months postpartum was not associated with UI remission (group D  
160 compared with group B,  $P=0.26$ , bivariate analysis). Only one woman, in group B (persistent  
161 UI), had surgery for this problem.

162 Trends in UI severity between 4 and 24 months were associated only with new obstetric  
163 events: an additional delivery during that interval ( $P=0.043$ ) and pregnancy at 24 months  
164 postpartum ( $P<0.0001$ ). The other variables were not significantly associated with increased

165 UI severity. Delivery in the follow-up period was associated with a mean increase of 1.3  
166 points in the Sandvik score, and a pregnancy at 24 months with an increase of 1.9. When no  
167 obstetric event occurred during this interval, the mean Sandvik score fell by 0.14 points  
168 between 4 and 24 months (Figure 1).  
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## DISCUSSION

171 Main findings

172 The prevalence of UI in our population was similar at 4 and 24 months postpartum. The  
173 prevalence at 24 months was higher among women with vaginal deliveries and those who  
174 breastfed. The remission rate between 4 and 24 months was higher in women with caesarean  
175 deliveries, and the onset of de novo UI at 24 months more frequent in women who became  
176 pregnant again after the index birth.

177 Strengths and limitations

178 The strengths of our study are its longitudinal follow-up and the large number of women  
179 included, which enabled us to analyse the risk factors for UI remission and for de novo UI.  
180 The women lost to follow-up were more often socioeconomically disadvantaged. This bias  
181 could have resulted in an overestimation of UI prevalence because well-off patients report  
182 urinary leakages more easily.<sup>13,15</sup> Nonetheless, our analysis were adjusted for education level,  
183 and we do not think that this point could have modified the associations observed. Our study  
184 of UI changes without considering the UI type (stress, mixed, or urge) may limit the  
185 interpretation of the changes we observed. UI may persist but change its nature (e.g., by the  
186 disappearance of the stress component and onset of an urge component). The impact of this  
187 limitation is nonetheless likely to be low. In clinical practice, changes in the nature of UI  
188 during follow-up are rare in the absence of surgery. UI type was not linked to its remission in

189 our analysis. The lack of medical visits (neither clinical assessments nor diagnoses) in our  
190 survey prevented any objective confirmation of urinary incontinence or its type.

#### 191 Interpretation

192 At each observation point in our study, some women were no longer incontinent, while others  
193 had become so. This dynamic phenomenon has already been examined in some longitudinal  
194 studies.<sup>4,6,10,16</sup> In our study, the chance of remission at 24 months was 51.9% among women  
195 incontinent at 4 months. Although this remission might have been due to treatment, no  
196 significant association was found between postpartum UI remission and PFMT. On the  
197 contrary, the women with persistent UI underwent PFMT more often than those whose UI  
198 disappeared. We hypothesise that a process of spontaneous recovery of continence during the  
199 postnatal period explains our results. Similarly, the longitudinal study by Viktrup<sup>6</sup> did not find  
200 that remission was associated with the different treatments undertaken (physical therapy,  
201 surgery) and Hilde's<sup>17</sup> randomised trial reported that postnatal PFMT was not associated with  
202 a higher probability of urinary continence.

203 In our study, the only factor associated with UI remission was caesarean delivery of the index  
204 birth. In other words, vaginal delivery was associated with persistence of UI at 24 months  
205 postpartum. Gartland et al. found a similar result in a cohort of 1507 Australian nulliparas and  
206 observed that persistent UI between 4 and 18 months postpartum was less frequent among

207 women with caesarean deliveries.<sup>18</sup> DeLancey hypothesised that vaginal delivery affects the  
208 pelvic floor in three phases: the first, traumatic phase of delivery, a second phase of repair,  
209 and finally a maintenance phase, when other factors influence urinary continence.<sup>19-21</sup>

210 Continence appears to be restored more often in women with caesarean deliveries, while  
211 vaginal delivery appears to expose women to a relapse or a longer recovery.

212 A caesarean delivery alone does not prevent UI in all women. In our study, 14% of the women  
213 with only caesarean deliveries reported UI at 24 months postpartum. Gartland et al noted that  
214 the nulliparous women with caesareans who had postpartum UI had had their first symptoms  
215 during the pregnancy.<sup>18</sup> Postnatal UI of women with caesareans may therefore result from an  
216 effect of the pregnancy itself, rather than the delivery, on continence. This effect of pregnancy  
217 on urinary continence may persist after delivery but it is like to be spontaneously reversible  
218 more often or more rapidly after a caesarean than a vaginal delivery.

219 In our study, a new pregnancy at 24 months postpartum was associated with the onset of de  
220 novo leakage. This association is consistent with Francis's observations.<sup>22</sup> He noted that  
221 incontinent women most often reported that their UI began during a pregnancy, not  
222 necessarily the first, and that it resolved in the postpartum period, and then recurred at each  
223 subsequent pregnancy with increasing severity until it became permanent.

224 Women with de novo UI in the late postnatal period differed from the women whose UI began

225 in the early postpartum and persisted in two ways: parity of the former was lower at inclusion  
226 and they were more likely to have had another baby in the interval. The risk of UI persistence  
227 at 24 months postpartum is increased among women with UI before the index pregnancy. It is  
228 as if on the occasion of this new delivery the women whose UI is recent caught up to the risk  
229 level of women with UI that began a longer time ago. McArthur et al. reported that the rate of  
230 persistent UI increased with the number of deliveries.<sup>4</sup> We hypothesise that women newly  
231 incontinent at 24 months postpartum developed the disease later, corresponding to the time  
232 required to accumulate the same risk factors (especially obstetric) as the women already  
233 incontinent at 4 months.

234 In our study, the Sandvik score deteriorated from 4 to 24 months among the women who had  
235 given birth during that interval and those newly pregnant at 24 months, while it fell slightly  
236 through 24 months for those with no new obstetric event in the interval. This finding further  
237 illustrates the favourable course of continence during the late postnatal period except in cases  
238 of new obstetric events and suggests that the repair of obstetric injuries continues during this  
239 period unless blocked by a new obstetric event.

240 New obstetrics events, pregnancy and delivery, appear to be central to the development of  
241 postpartum UI in mothers. In this population, the natural history of UI is a dynamic and  
242 individual phenomenon, combining progressive repair with an accumulation of supplementary  
243 risk factors, principally pregnancy and delivery.

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## CONCLUSION

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Our longitudinal study shows that the prevalence and course of UI in the postpartum period is

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essentially associated with pregnancies and deliveries. Although the prevalence of UI at 4 and

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24 months indicates that symptoms are stable over this period, our longitudinal follow-up

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shows a dynamic process that is a function of intercurrent obstetric events.

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The remission rate observed in the postpartum period is higher among women with caesarean

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deliveries. This remission is not complete at 4 months and can continue, absent an intercurrent

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obstetric event, up to at least 24 months postpartum. Other studies may be necessary over a

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longer term to know just how long this remission continues and if caesarean delivery remains

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associated with postnatal remission of UI over a longer period. Among young mothers, the

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onset of new urinary symptoms at some point after a delivery is principally linked to yet

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another pregnancy or delivery.

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### **Disclosure of interest**

None to declare.

### **Contributions to authorship**

EQ and XF performed literature searches, and wrote and edited the article. MJSC and XF initiated the project, EQ and MJSC performed data collection and analysis.

### **Details of ethical approval**

The study was approved by the CCPPRB (Comité Consultatif de Protection des Personnes dans la Recherche Biomédicale) of Kremlin-Bicêtre, December 12, 2002.

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Table 1. Factors associated with prevalence of urinary incontinence 24 months postpartum in the EDEN cohort. Multivariate analysis, logistic regression adjusted for centre and education level (N = 1409).

Risk factors	24 months postpartum urinary continence status:	Continent N= 1129	Incontinent N= 280	OR	95 % CI
		n (%), or mean (std)			
Maternal age	(mean, years)	31.4 (4.7)	33.3 (4.6)	1.07	1.04-1.11
Parity	1	557 (49.3)	110 (39.3)	1	-
	2	404 (35.8)	97 (34.6)	1.07	0.75-1.52
	≥ 3	167 (14.8)	72 (25.7)	1.77	1.14-2.76
Mode of index delivery	natural	815 (72.2)	218 (77.9)	1	-
	instrumental	125 (11.1)	27 (9.6)	0.96	0.58-1.57
	caesarean	185 (16.4)	35 (12.5)	0.62	0.40-0.97
Duration of breast feeding	none	319 (28.3)	61 (21.8)	1.04	0.69-1.57
	< 3 months	352 (31.2)	68 (24.3)	1	-
	+ 3 months	454 (40.2)	146 (52.1)	1.54	1.08-2.19
Body mass index	< 25 kg/m <sup>2</sup>	855 (75.7)	187 (66.8)	1	-
	25-29 kg/m <sup>2</sup>	192 (17.0)	55 (19.6)	1.59	1.09-2.33
	≥ 30 kg/m <sup>2</sup>	78 (6.9)	33 (11.8)	2.35	1.44-3.85
Pregnant at 24 months postpartum	no	1036 (91.8)	231 (82.5)	1	-
	yes	89 (7.9)	49 (17.5)	3.44	2.25-5.26

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Factor not found to be significant and excluded from the multivariate analysis: Monthly household income, additional information about index delivery (episiotomy, long second stage of labour, child's gender, child's weight, severe sphincter injury), postpartum pelvic floor muscle training, anal incontinence 4 months postpartum, additional delivery during the follow-up, UI history.

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Table 2. Factors associated with persistent urinary incontinence between 4 and 24 months postpartum in the EDEN cohort. Multivariate analysis, logistic regression for remission (Group D) versus persistence (Group B) of urinary incontinence between 4 and 24 months after delivery index, adjusted for centre and education level (N = 287).

Women incontinent at 4 months, continence status at 24 months		Remission	Persistent incontinence	OR (95% CI)	
		Group D N=149	Group B N=138		
Risk factors		n (%)	n (%)		
UI history (4 months postpartum)	before index pregnancy	40 (26.9)	80 (58.0)	3.94	1.91-8.11
	during index pregnancy	64 (42.0)	32 (23.2)	1	-
	after index delivery	34 (22.8)	20 (14.5)	1.03	0.49-2.18
UI severity (4 months postpartum)	mild	91 (61.1)	68 (49.3)	1	-
	moderate to very severe	52 (34.9)	69 (50.0)	2.13	1.20-3.79
Mode of index delivery	vaginal birth	107 (71.8)	108 (78.2)	1	-
	instrumental delivery	17 (11.4)	15 (10.9)	1.04	0.41-2.60
	caesarean section	25 (16.8)	15 (10.9)	0.43	0.19-0.97
Pregnant at 24 months postpartum	no	127 (85.2)	111 (80.4)	1	-
	yes	7 (4.7)	23 (16.7)	3.87	1.39-10.78

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Factor not found to be significant and excluded from the multivariate analysis: Monthly household income, additional information about index delivery (episiotomy, long second stage of labour, child's gender, child's weight, severe sphincter injury), postpartum pelvic floor muscle training, duration of breast feeding, anal incontinence 4 months postpartum, additional delivery during the follow-up, maternal age, parity, body mass index, UI Type.

306 Table 3. Factors associated with de novo urinary incontinence at 24 months postpartum in the  
 307 EDEN cohort. Multivariate analysis, logistic regression for persistent continence at 4 and 24  
 308 months postpartum (Group A) versus de novo urinary incontinence at 24 months postpartum  
 309 (Group C) adjusted for centre and education level (N = 1067).  
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Women continent at 4 months, continence status at 24 months		Persistent continence Group A N= 932	De novo incontinence Group C N= 135	OR	95% CI
Risk factors		n (%), or mean (std)	n (%), or mean (std)		
Maternal age	(mean, years)	31.9 (4.6)	33.5 (4.6)	1.09	1.04-1.13
Anal incontinence (4 months postpartum)	no	808 (86.7)	100 (74.1)	1	-
	yes	120 (13.1)	32 (24.2)	1.94	1.20-3.14
Pregnant at 24 months postpartum	no	830 (89.1)	103 (76.3)	1	-
	yes	73 (8.3)	26 (19.3)	3.63	2.13-6.20
Body mass index	<25 kg/m <sup>2</sup>	571 (61.2)	69 (51.1)	1	-
	25-29 kg/m <sup>2</sup>	180 (19.3)	35 (25.9)	1.49	0.89-2.49
	≥30 kg/m <sup>2</sup>	91 (9.8)	20 (14.8)	2.56	1.37-4.77

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 312 Factor not found to be significant and excluded from the multivariate analysis: Monthly household income,  
 313 additional information about index delivery (mode of delivery, episiotomy, long second stage of labour, child's  
 314 gender, child's weight, severe sphincter injury), postpartum pelvic floor muscle training, duration of breast  
 feeding, additional delivery during the follow-up, parity, UI history.

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Figures

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Figure 1. Trends of the mean Sandvik score between 4 and 24 months postpartum according  
321 to intercurrent obstetric events (pregnant at 24 months, delivery between 4 and <24 months;  
322 N= 1354).

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Figure S1. Flow chart

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Figure S2. Continence status 4-24 months postpartum (N= 1354)

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