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# Prevalence and risk factors of stress urinary incontinence among female horseback riders in Poland

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**Stress urinary incontinence (SUI) is usually associated with aging and parity, but repetitive intra-abdominal pressure during physical activity can also trigger its onset in young women. Horseback riding, despite potential benefits for pelvic floor strengthening, may also contribute to pelvic floor strain and urinary symptoms. The study included 100 Polish women aged 21–54 engaged in horse riding, both recreational (85%) and professional (15%). Participants were divided into three age groups and screened for urinary incontinence symptoms. Quality of life was assessed with validated questionnaires (IIQ-7, UDI-6SF) and a custom 25-item survey covering equestrian practice, reproductive history, urinary symptoms, and general health. Statistical analyses were performed in R using non-parametric tests, correlation, and logistic regression. Stress urinary incontinence was reported by 36% of participants, significantly impairing quality of life. Women with higher BMI, older age, and childbirth history demonstrated increased symptom prevalence and higher IIQ-7 and UDI-6 scores ($p < 0.05$). Training type, frequency, and duration were not significantly associated with outcomes, except for shorter riding experience, which correlated with higher UDI-6 scores. Logistic regression identified age (OR = 1.07) and BMI (OR = 1.16) as risk factors, while greater height reduced SUI odds (OR = 0.92). Urinary incontinence is a relevant issue among female horse riders, negatively affecting physical, social, and emotional well-being. Age, BMI and childbirth history play crucial roles in the incidence of SUI symptoms. The longer the training experience, the lower is reported urinary incontinence distress. Preventive measures such as pelvic floor training, individualized physiotherapy, and interdisciplinary care may reduce symptom burden and support longer professional activity. Raising awareness and encouraging early intervention are essential to improving athletes' quality of life.**

**Keywords** Stress urinary incontinence, Female horseback riders, Quality of life

Regular training is the basis of good physical condition and mental health. However, every sport, trained in a methodical way, brings about some consequences: sport-related injuries and pain, pelvic floor muscles (PFM) strain and its long-term sequelae.

Even though stress urinary incontinence (SUI) is more associated with age and parity, repetitive intra-abdominal pressure, such as strenuous physical activity might be a trigger factor for its onset[1]. SUI exacerbates with the number and the intensity of training, occurring in 8% of recreational and 21% competitive athletes, while in sedentary women it was reported in 11%[2]. In many cases, incontinence is transient and limited to sport activity. Occasional SUI while performing selected sport was reported by 28% of university nulliparous athletes[3]. Nevertheless, it is still under-admitted by patients who are not seeking help[4].

Continence is provided by the proper role of the urethral support system and urethral sphincteric closure system. Urethral support system is based on stability of pelvic floor muscles and structures surrounding urethra: anterior vaginal wall, endopelvic fascia and tendinous arch of pelvic fascia[5].

Studies on the impact of physical activity on pelvic floor function do not provide a clear answer as to whether it is predominantly beneficial or may also have concomitant detrimental effects on women's health.

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On one hand, regular contractions are strengthening muscles, which provide better stabilization of the structure[6].

On the other hand, it was also found excessive intra-abdominal pressure during exercises contributes to muscle damage, especially periurethral striated muscles in overstretching mechanisms[5–7]. Another mechanism of urinary leakage is also connected to muscle fatigue after prolonged recruitment of type II fibers, which are responsible for rapid contraction and which maintain urethra close during increased intra-abdominal pressure[7].

The objective of the work was to assess the prevalence and risks factors of urinary leakage associated with horseback riding, both in amateur and professional riders. Also, we aim to assess the correlation of symptoms and quality of life. The major question of the study is if the equestrianism alone as a sport is a predisposing factor for SUI.

## Materials and methods

This research was designed as an observational cross-sectional study assessing urinary symptoms and related factors among female horseback riders. The transversal study included 100 women aged 21–54 years from across Poland, engaged in horse riding either recreationally (85%) or professionally (15%). Inclusion criteria were: female sex, age ≥ 18 years, horse riding activity, and voluntary consent to participate. Exclusion criteria were: male sex, age < 18 years, previous prolapse or urinary incontinence operations, current genitourinary infection and lack of consent. Data were collected between March and November 2023 using a self-administered electronic questionnaire in Polish. The survey link was distributed via equestrian clubs, riding schools, and social media groups dedicated to horseback riding in Poland. Participation was voluntary and anonymous, and all questionnaires were completed electronically without researcher assistance.

The research was approved by the Bioethics Committee of the Medical University in Wroclaw with a number of KB – 806/2018. Informed consent was obtained from all participants. The study was performed in accordance with the Declaration of Helsinki. The study sample size was determined based on preliminary power estimations performed prior to data collection. Power calculations indicated that approximately 85 participants would be sufficient to detect medium effect sizes (Cohen's d ≈ 0.5) in non-parametric group comparisons with 80% power at α = 0.05. To allow for subgroup analyses and potential missing data, we aimed to recruit at least 100 women, and this target was achieved.

Participants were stratified into three age groups based on the potential risk of urinary incontinence (UI): 18–30 years ($n = 46$), 31–45 years ($n = 30$), and 46–55 years ($n = 24$). In total, 36 women reported UI symptoms, while 64 did not.

The impact of UI on quality of life was assessed using two validated questionnaires: the Incontinence Impact Questionnaire (IIQ-7) and the Urinary Distress Inventory (UDI-6SF). IIQ-7 consists of seven items addressing the impact of UI on daily activities, mental health, and social functioning, scored on a 0–3 Likert scale, with a maximum score of 28[8,9]. UDI-6SF contains six items evaluating urinary symptoms and their distress level, also scored on a 0–3 scale, with a maximum score of 24[10]. UDI-6SF helps in differentiation of the type of urinary incontinence: urge, stress, mixed and neurogenic incontinence. Also, a question about pain or discomfort in lower abdominal, pelvic, or genital area might indicate another condition overlapping with incontinence. Higher scores in both tools indicate greater symptom burden and quality-of-life impairment. Participants without UI did not complete these questionnaires.

In addition, a custom-designed 25-item questionnaire was administered. It covered four domains: (I) horse riding characteristics (discipline, training frequency, duration, and years of practice), (II) childbirth history and postpartum care (including consultations with gynecologists or urogynecological physiotherapists), (III) UI-related aspects (occurrence, triggers, and psychosocial consequences), and (IV) general health indicators (other physical activity, smoking, medication use, urogenital infections and procedures - such as laser or radiofrequency and comorbidities such as diabetes or hypertension). The questionnaire was developed specifically for this study to capture horse-riding characteristics, reproductive history, urinary symptoms, and general health. The initial pool of questions was generated based on literature regarding urinary incontinence in physically active women and clinical experience of a urogynecological physiotherapist.

Patients who reported not having the incidence of urinary incontinence of any kind were asked to fulfill only a 25-item questionnaire, as the UDI-6SF and IIQ-7 are designed to assess the kind and severity of incontinence symptoms.

The statistical analysis was performed entirely in R[11].

The answers given by the surveyed women were transformed according to the Likert scale - the more severe the respondent's symptoms were, the higher the point value of individual answers. Then, separately for each questionnaire (IIQ7, UDI6), the sum of points for all questions was determined. The obtained sums were unitarized to zero, according to the following formula:

$$z_i = \frac{x_i - \min(x)}{\max(x) - \min(x)},$$

where $x_i$ is the sum of the points of the $i$-th respondent in the questionnaire, $x$ is a vector of sums of points of all respondents in the questionnaire and $z_i$ is the point value of the $i$-th respondent.

The compliance of the distribution of variables with the normal distribution was verified with the Shapiro-Wilk test at the significance level α = 0.05.

The statistical significance of an impact of the considered factors on the point values of the IIQ7 (IIQ7 score) and UDI6 (UDI6 score) questionnaires, due to the lack of compliance of the variable distribution with the normal distribution, was verified with the Wilcoxon test for independent samples (in the case of two groups) or the Kruskal-Wallis test (in the case of 3 or more groups) at the significance level α = 0.05. *Post hoc* analysis after

| IIQ7 | UDI6 |
|---|---|
| 0.801<br>(0.673; 0.878) | 0.840<br>(0.755; 0.892) |

**Table 1**. Cronbach's alpha (95% confidence intervals) for IIQ7 and UDI6 subscales. Both Cronbach's alphas were statistically significant (α = 0.05). Cronbach's alphas relating to particular questionnaires did not differ statistically significantly (α = 0.05).

| Group | | IIQ7 score | *p*-value effect size |
|---|---|---|---|
| Work type | Physical<br>*n* = 37 | 0.0 (0.0–100.0)<br>14.40 (23.80) | 0.359<br>$6.55 \times 10^{-4}$ (small) |
| | Mental<br>*n* = 36 | 0.0 (0.0–35.7)<br>4.9 (9.1) | |
| | Physical and mental<br>*n* = 7 | 0.0 (0.0–28.6)<br>7.7 (11.4) | |
| Smoking | No<br>*n* = 70 | 0.0 (0.0–75.0)<br>10.1 (17.0) | 0.716<br>0.0392 (small) |
| | Yes<br>*n* = 19 | 0.0 (0.0–100.0)<br>12.2 (26.2) | |
| Additional activity | No<br>*n* = 35 | 0.0 (0.0–75.0)<br>11.2 (18.5) | 0.628<br>0.0519 (small) |
| | Yes<br>*n* = 54 | 0.0 (0.0–100.0)<br>10.1 (19.7) | |
| Physical treatments | No<br>*n* = 74 | 0.0 (0.0–100.0)<br>10.5 (19.7) | 0.531<br>0.0671 (small) |
| | Yes<br>*n* = 15 | 0.0 (0.0–57.1)<br>10.7 (16.6) | |
| Urogenital infections or procedures | No<br>*n* = 64 | 0.0 (0.0–67.9)<br>8.1 (15.5) | **0.0318***<br>0.197 (small) |
| | Yes<br>*n* = 25 | 7.1 (0.0–100.0)<br>16.7 (25.6) | |
| Urinary bladder inflammation | No<br>*n* = 32 | 0.0 (0.0–46.4)<br>6.9 (12.7) | 0.206<br>0.134 (small) |
| | Yes<br>*n* = 57 | 0.0 (0.0–100.0)<br>12.5 (21.8) | |
| Hypertension and/or diabetes | No<br>*n* = 82 | 0.0 (0.0–100.0)<br>9.4 (18.0) | **0.0403**<br>0.218 (small) |
| | Yes<br>*n* = 7 | 14.3 (0.0–75.0)<br>24.0 (27.4) | |

**Table 2**. IIQ7 score depending on lifestyle and health. Data are presented as median (range) and mean (standard deviation). n denotes size of each group. *One-sided test.

the Kruskal–Wallis test, whose p-value < 0.05, was performed using Dunn's test at a significance level α = 0.05. The analysis described above was performed using the *rstatix* library[12].

The correlation analysis of age, height, body weight, BMI, IIQ7 score and UDI6 score was performed using the *psych* library[13]. The statistical significance of correlation coefficients was verified at the significance level α = 0.05. The statistical significance of differences in the corresponding correlation coefficients (in healthy women and in women with diagnosed NTM) was verified on the basis of confidence intervals. Correlation coefficients whose confidence intervals had no common part were considered statistically significantly different[14].

The statistical significance of the impact of age, height, body weight and BMI on the occurrence of NTM was verified on the basis of logistic regression analysis at the significance level α = 0.05.

The statistical significance of the influence of factors (e.g. number of deliveries) on the occurrence of NTM was verified by the $\chi^2$ test or Fisher's exact test at the significance level α = 0.05 with a *post hoc* analysis in the case of 3 or more levels of the factor.

## Results

Internal consistency was high for both instruments, with Cronbach's alpha of 0.801 for IIQ-7 and 0.840 for UDI-6 (Table 1). Both coefficients were statistically significant and did not differ significantly between questionnaires.

### IIQ-7 outcomes

Lifestyle and health factors were generally not associated with IIQ-7 scores, except for women reporting recurrent urogenital infections/urogynecological procedures and those with hypertension or diabetes, who presented significantly higher scores ($p = 0.0318$ and $p = 0.0403$, respectively; Table 2).

Women with stress urinary incontinence (SUI) reported markedly higher IIQ-7 scores compared with those without symptoms ($p = 1.13 \times 10^{-7}$, large effect size; Table 3). Longer symptom duration and difficulties in everyday life or travel were strongly associated with higher scores. UI-related behaviors, such as urination "in reserve," problems with sexual activity, and feelings of embarrassment, were also linked to significantly higher IIQ-7 values.

Reproductive history was not significantly associated with IIQ-7 scores, including birth status, number or type of deliveries, and participation in uro-physiotherapy (Table 4). Similarly, equestrian training characteristics (type, frequency, duration, and intensity) showed no significant relationships with IIQ-7 results (Table 5).

## UDI-6 outcomes

Lifestyle and health analyses indicated higher UDI-6 scores among women with a history of urogenital infections/procedures ($p = 0.0437$) and urinary bladder inflammation ($p = 0.0098$), while other factors were not significant (Table 6).

The presence of SUI was strongly associated with elevated UDI-6 scores ($p = 1.28 \times 10^{-11}$, large effect size; Table 7). Higher scores were also observed in women with longer symptom duration, difficulties in daily life or traveling, urination "in reserve," and feelings of embarrassment. Problems with sexual activity were linked to particularly high UDI-6 values.

Reproductive history was related to UDI-6 outcomes. Women who had given birth demonstrated significantly higher scores than nulliparas ($p = 0.0039$; Table 8). Increasing number of births was associated with a progressive increase in UDI-6 scores, although type of delivery and uro-physiotherapy were not significant factors.

Equestrian training characteristics were generally not associated with UDI-6, with the exception of training duration. There was no significant difference in severity of symptoms between amateur, recreational and professional groups. Also, no correlation with the training duration or training frequency was found. Women training less than one year demonstrated higher scores compared to those with longer experience ($p = 0.0105$; Table 9).

| Group | | IIQ7 score | *p*-value<br>effect size |
|---|---|---|---|
| Stress urinary incontinence | No<br>*n* = 53 | 0.0 (0.0–100.0)<br>4.7 (16.4) | **$1.13 \times 10^{-7}$**<br>0.563 (large) |
| | Yes<br>*n* = 36 | 14.3 (0.0–75.0)<br>19.0 (19.9) | |
| Stress urinary incontinence symptoms | No symptoms<br>*n* = 48 | 0.0[a] (0.0–50.0)<br>3.0 (10.0) | **$1.63 \times 10^{-6}$**<br>0.314 (large) |
| | Up to 5 Years<br>*n* = 23 | 21.4[b] (0.0–100.0)<br>24.4 (25.5) | |
| | 5–10 years<br>*n* = 11 | 7.1[b] (0.0–42.9)<br>9.7 (12.6) | |
| | Over 10 years<br>*n* = 7 | 7.1[b] (0.0–75.0)<br>17.9 (26.3) | |
| Difficulties in everyday life | No<br>*n* = 68 | 0.0 (0.0–100.0)<br>6.1 (15.4) | **$2.53 \times 10^{-5}$**<br>0.447 (moderate) |
| | yes<br>*n* = 21 | 21.4 (0.0–75.0)<br>24.7 (23.3) | |
| Difficulties while traveling | No<br>*n* = 64 | 0.0 (0.0–35.7)<br>3.5 (7.9) | **$6.76 \times 10^{-8}$**<br>0.573 (large) |
| | Yes<br>*n* = 25 | 28.6 (0.0–100.0)<br>28.4 (26.7) | |
| Urination in reserve | No<br>*n* = 53 | 0.0 (0.0–57.1)<br>6.5 (13.6) | **0.0121**<br>0.267 (small) |
| | Yes<br>*n* = 36 | 7.1 (0.0–100.0)<br>16.4 (24.2) | |
| Urine holding | No<br>*n* = 20 | 0.0 (0.0–35.7)<br>5.7 (12.0) | 0.119<br>0.166 (small) |
| | Yes<br>*n* = 69 | 0.0 (0.0–100.0)<br>11.9 (20.6) | |
| Problems with sexual activity | No<br>*n* = 83 | 0.0 (0.0–75.0)<br>8.7 (16.2) | **0.00816**<br>0.281 (small) |
| | Yes<br>*n* = 6 | 21.4 (0.0–100.0)<br>35.1 (37.1) | |
| Ashamed/embarrassed/angry feeling | No<br>*n* = 68 | 0.0 (0.0–35.7)<br>5.1 (9.9) | **$6.04 \times 10^{-6}$**<br>0.480 (moderate) |
| | Yes<br>*n* = 21 | 21.4 (0.0–100.0)<br>28.1 (29.3) | |

**Table 3.** IIQ7 scores depending on the symptoms of stress urinary incontinence. Data are presented as median (range) and mean (standard deviation). n denotes size of each group. Groups with statistically significant differences are marked with different letters (α = 0.05).

| Group | | IIQ7 score | *p*-value<br>effect size |
|---|---|---|---|
| Birth | No<br>*n* = 42 | 0.0 (0.0–100.0)<br>10.1 (21.1) | 0.162<br>0.149 (small) |
| | yes<br>*n* = 47 | 0.0 (0.0–75.0)<br>10.9 (17.4) | |
| Number of births | 0<br>*n* = 42 | 0.0 (0.0–100.0)<br>10.1 (21.1) | 0.460<br>-0.0049 (small) |
| | 1<br>*n* = 17 | 0.0 (0.0–42.9)<br>9.9 (14.1) | |
| | 2<br>*n* = 25 | 0.0 (0.0–67.9)<br>9.6 (16.0) | |
| | 3 or more<br>*n* = 5 | 7.1 (0.0–75.0)<br>20.7 (31.6) | |
| Birth type | c-section<br>*n* = 12 | 10.7 (0.0–42.9)<br>14.0 (15.4) | 0.357<br>0.00139 (small) |
| | Natural birth<br>*n* = 31 | 0.0 (0.0–67.9)<br>8.2 (14.8) | |
| | c-section and natural birth<br>*n* = 5 | 7.1 (0.0–75.0)<br>19.3 (31.7) | |
| Urophysiotherapy | No<br>*n* = 24 | 3.6 (0.0–75.0)<br>10.9 (17.8) | 0.929<br>0.0145 (small) |
| | Yes<br>*n* = 24 | 0.0 (0.0–67.9)<br>10.7 (16.9) | |

**Table 4**. IIQ7 score depending on number and type of births. Data are presented as median (range) and mean (standard deviation). n denotes size of each group.

| group | | IIQ7 score | *p*-value<br>effect size |
|---|---|---|---|
| Training type | Amateur<br>*n* = 22 | 0.0 (0.0–67.9)<br>11.7 (18.8) | 0.713<br>-0.0154 (small) |
| | Recreational<br>*n* = 54 | 0.0 (0.0–100.0)<br>9.4 (19.3) | |
| | Professional<br>*n* = 13 | 0.0 (0.0–57.1)<br>13.2 (20.2) | |
| Training duration | Less than a year<br>*n* = 11 | 7.1 (0.0–75.0)<br>18.5 (27.7) | 0.492<br>-0.00695 (small) |
| | 1–2 years<br>*n* = 12 | 0.0 (0.0–21.4)<br>4.5 (7.6) | |
| | 3–5 years<br>*n* = 12 | 0.0 (0.0–46.4)<br>7.4 (15.1) | |
| | over 5 years<br>*n* = 54 | 0.0 (0.0–100.0)<br>10.9 (19.5) | |
| Training frequency | 1–2 times per week<br>*n* = 48 | 0.0 (0.0–75.0)<br>8.4 (16.8) | 0.724<br>-0.0158 (small) |
| | 3–4 times per week<br>*n* = 25 | 0.0 (0.0–57.1)<br>12.1 (17.6) | |
| | over 4 times per week<br>*n* = 16 | 0.0 (0.0–100.0)<br>14.3 (27.1) | |
| Single training duration | less than 1 h<br>*n* = 45 | 0.0 (0.0–100.0)<br>12.9 (22.2) | 0.303<br>0.00452 (small) |
| | 1–1.5 h<br>*n* = 39 | 0.0 (0.0–57.1)<br>7.1 (14.2) | |
| | over 1.5 h<br>*n* = 5 | 0.0 (0.0–46.4)<br>16.4 (22.8) | |

**Table 5**. IIQ7 score depending on training type. Data are presented as median (range) and mean (standard deviation). n denotes size of each group.

## Correlation analyses

Correlation analysis showed significant negative associations of height with both IIQ-7 and UDI-6 scores, while BMI was positively correlated with UDI-6 (Table 10). IIQ-7 and UDI-6 scores were strongly intercorrelated ($r = 0.70$, $p < 0.05$).

| Group | | UDI6 score | *p*-value<br>effect size |
|---|---|---|---|
| Work type | Physical<br>*n* = 39 | 0.0 (0.0–100.0)<br>20.4 (30.0) | 0.350<br>0.00126 (small) |
| | mental<br>*n* = 38 | 9.5 (0.0–95.2)<br>17.7 (22.8) | |
| | Physical and mental<br>*n* = 7 | 19.0 (0.0–90.5)<br>32.0 (35.9) | |
| Smoking | No<br>*n* = 74 | 9.5 (0.0–95.2)<br>20.8 (24.9) | 0.118<br>0.164 (small) |
| | Yes<br>*n* = 18 | 0.0 (0.0–100.0)<br>18.3 (35.8) | |
| Additional activity | No<br>*n* = 33 | 9.5 (0.0–100.0)<br>22.7 (28.3) | 0.454<br>0.0784 (small) |
| | Yes<br>*n* = 59 | 4.76 (0.0–95.2)<br>19.0 (26.6) | |
| Physical treatments | No<br>*n* = 79 | 9.5 (0.0–100.0)<br>20.1 (27.2) | 0.714<br>0.0388 (small) |
| | Yes<br>*n* = 13 | 14.3 (0.0–95.2)<br>22.0 (28.1) | |
| Urogenital infections or procedures | No<br>*n* = 68 | 4.76 (0.0–95.2)<br>16.4 (23.3) | **0.0437**<br>0.21 (small) |
| | Yes<br>*n* = 24 | 16.7 (0.0–100.0)<br>31.5 (34.2) | |
| Urinary bladder inflammation | No<br>*n* = 36 | 0.0 (0.0–76.2)<br>12.7 (21.1) | **0.00979**<br>0.270 (small) |
| | Yes<br>*n* = 56 | 14.3 (0.0–100.0)<br>25.3 (29.6) | |
| Hypertension and/or diabetes | No<br>*n* = 86 | 9.5 (0.0–100.0)<br>20.0 (27.1) | 0.837<br>0.0223 (small) |
| | Yes<br>*n* = 6 | 14.3 (0.0–61.9)<br>25.4 (30.4) | |

**Table 6**. UDI6 score depending on lifestyle and health. Data are presented as median (range) and mean (standard deviation). n denotes size of each group.

Subgroup analyses indicated that in women diagnosed with SUI, BMI was strongly correlated with body weight ($r$ = 0.94) and with both IIQ-7 and UDI-6 scores. In healthy women, significant associations were observed between body height and weight ($r$ = 0.50) (Table 11).

## Logistic regression analysis
Logistic regression identified age (OR = 1.07, $p$ = 0.0011) and BMI (OR = 1.16, $p$ = 0.0284) as significant predictors of SUI (Table 12). Greater height was associated with reduced odds of SUI (OR = 0.92, $p$ = 0.0316).

## Reproductive history and SUI
The occurrence of SUI was significantly higher among women who had given birth compared to nulliparas ($p$ = 0.0007). An increasing number of births was associated with a higher prevalence of SUI ($p$ = 0.0013; Table 13).

## Discussion
Our research indicates that stress urinary incontinence (SUI) is present among female horseback riders and is associated with established risk factors such as age, BMI, and parity. These results are consistent with previous studies indicating that increasing age and body weight contribute to weakening of pelvic floor structures, thereby increasing SUI risk[15]. In this context, cooperation with physiotherapists during equestrian training may be valuable, which is supported by Carboni's observations showing improved pelvic floor function following guided training[16]. These associations highlight that demographic factors remain more influential than sport-specific factors in determining SUI risk among horseback riders in our study.

Several studies have proposed that horseback riding may strengthen pelvic musculature. Some research suggests that regular equestrian practice may even be associated with a lower risk of SUI and is not linked to sexual dysfunctions or lower urinary tract symptoms[17]. Although Battaglia et al. reported clitoral microcalcifications in riders, potentially indicating microtrauma, examined women remained asymptomatic[18], which aligns with our observation that not all mechanical loads translate directly into symptoms in riders reporting SUI.

Schäfer indicated that as the muscle tension increases with the horse's ride velocity, that sport may have different impacts depending on the kind of activity[19]. Elmeua González showed that different parts of muscles were involved in novice and advanced riders. Discrepancies in muscle involvement are due to different forms of horseback riding - it is performed in a different way during diverse horse gaits: walk, trot, canter. Differences were also shown between recreational riders and professionals[20]. These findings are consistent with our results showing that professional riders reported SUI less frequently, possibly due to refined technique and improved

| Group | | UDI6 score | *p*-value<br>effect size |
|---|---|---|---|
| Stress urinary incontinence | No<br>*n* = 60 | 0.0 (0.0–90.5)<br>7.4 (15.5) | **$1.28 \times 10^{-11}$**<br>0.706 (large) |
| | Yes<br>*n* = 32 | 40.5 (0.0–100.0)<br>44.6 (27.8) | |
| Stress urinary incontinence symptoms | No symptoms<br>*n* = 56 | $0.0^a$ (0.0–57.1)<br>5.6 (11.0) | **$1.86 \times 10^{-10}$**<br>0.514 (large) |
| | Up to 5 years<br>*n* = 20 | $35.7^b$ (0.0–100.0)<br>43.6 (31.3) | |
| | 5–10 years<br>*n* = 10 | $47.6^b$ (14.3–95.2)<br>46.2 (27.5) | |
| | Over 10 years<br>*n* = 6 | $31.0^b$ (0.0–76.2)<br>37.3 (27.5) | |
| Difficulties in everyday life | No<br>*n* = 74 | 2.38 (0.0–90.5)<br>13.3 (21.9) | **$5.67 \times 10^{-7}$**<br>0.522 (large) |
| | Yes<br>*n* = 18 | 45.2 (0.0–100.0)<br>49.5 (27.9) | |
| Difficulties while traveling | No<br>*n* = 71 | 0.0 (0.0–95.2)<br>12.5 (20.2) | **$2.16 \times 10^{-6}$**<br>0.494 (moderate) |
| | Yes<br>*n* = 21 | 42.9 (0.0–100.0)<br>46.7 (31.4) | |
| Urination in reserve | No<br>*n* = 57 | 0.0 (0.0–100.0)<br>15.0 (24.4) | **0.00397**<br>0.301 (moderate) |
| | yes<br>*n* = 35 | 19.0 (0.0–95.2)<br>29.0 (29.5) | |
| Urine holding | No<br>*n* = 25 | 0.0 (0.0–90.5)<br>13.3 (23.3) | **0.0496**<br>0.205 (small) |
| | Yes<br>*n* = 67 | 9.5 (0.0–100.0)<br>23.0 (28.2) | |
| Problems with sexual activity | No<br>*n* = 87 | 9.5 (0.0–100.0)<br>17.8 (24.7) | **0.00274**<br>0.313 (moderate) |
| | Yes<br>*n* = 5 | 66.7 (14.3–95.2)<br>64.8 (32.4) | |
| Ashamed/embarrassed/angry feeling | No<br>*n* = 74 | 2.4 (0.0–95.2)<br>13.3 (21.7) | **$6.82 \times 10^{-7}$**<br>0.518 (large) |
| | Yes<br>*n* = 18 | 50.0 (0.0–100.0)<br>49.5 (28.4) | |

**Table 7**. UDI6 scores depending on the symptoms of stress urinary incontinence. Data are presented as median (range) and mean (standard deviation). n denotes size of each group. Groups with statistically significant differences are marked with different letters ($\alpha = 0.05$).

neuromuscular control acquired over years of training. Notably, despite these biomechanical differences, our study did not identify significant associations between specific training characteristics and SUI occurrence.

Our study also confirms the significance of widely recognized SUI risk factors BMI, parity and age, known to contribute to pelvic floor weakening. Interestingly, while earlier studies associated taller height with increased risk of incontinence[21], we observed the opposite trend. As no anatomical or functional explanation has been identified, this finding requires further investigation.

The incidence of urogenital infections in our sample was relatively high, but aligns with a Polish study showing that infections such as candidiasis affect up to 24% of women aged 15–44[22]. Although no specific data exist regarding urinary tract infections in equestrians, prolonged riding time, delayed voiding, and exposure to cold conditions may contribute to irritation or infection, which could partially explain some urinary symptoms reported in our cohort.

Previous studies have shown that strenuous sports can temporarily increase SUI symptoms, although long-term effects may not persist beyond the period of intense activity[1]. This is relevant to our group, whose age distribution may not yet fully reflect the later-life consequences of repeated high-impact exposure. A possible mechanism of urinary incontinence across sports is the imbalance between forces exerted on perineal structures and the stabilizing capacity of pelvic tissues[4].

A confounding factor, found also among our patients, might be a presence of comorbidities, such as hypertension and diabetes, leading to more frequent urination, nycturia or nocturia.

Limitation of the study is lack of objective gynecological test performed in the studied group: Bonney test and ultrasound confirmation, as anatomical changes in the urethral support system can be confirmed with urethral funneling. Major limitations of our study is a non-homogenous group of patients, especially concerning age, parity and professional level of equestrianism. Future studies incorporating objective pelvic floor assessment and gait-specific biomechanical analysis are needed to clarify the mechanisms underlying SUI in equestrians.

| Group | | UDI6 score | *p*-value effect size |
|---|---|---|---|
| Birth | No<br>*n* = 43 | 4.8 (0.0–90.5)<br>10.5 (18.2) | **0.00387**<br>0.302 (moderate) |
| | Yes<br>*n* = 49 | 19.0 (0.0–100.0)<br>29.0 (30.8) | |
| Number of births | 0<br>*n* = 43 | 4.8 (0.0–90.5)<br>10.5 (18.2) | **0.0198**[1]<br>0.078 (moderate) |
| | 1<br>*n* = 18 | 21.4 (0.0–90.5)<br>29.4 (29.9) | |
| | 2<br>*n* = 26 | 14.3 (0.0–100.0)<br>26.7 (33.0) | |
| | 3 or more<br>*n* = 5 | 42.9 (0.0–61.9)<br>39.0 (24.6) | |
| Birth type | c-section<br>*n* = 11 | 28.6 (0.0–100.0)<br>38.5 (40.9) | 0.519<br>-0.0146 (small) |
| | Natural birth<br>*n* = 34 | 19.0 (0.0–95.2)<br>24.9 (27.8) | |
| | c-section and natural birth<br>*n* = 5 | 33.3 (14.3–61.9)<br>33.3 (20.2) | |
| Urophysiotherapy | No<br>*n* = 26 | 14.3 (0.0–90.5)<br>25.5 (32.8) | 0.457<br>0.107 (small) |
| | Yes<br>*n* = 24 | 23.8 (0.0–100.0)<br>32.3 (32.8) | |

**Table 8**. UDI6 score depending on number and type of births. Data are presented as median (range) and mean (standard deviation). n denotes size of each group. [1]Post hoc analysis did not allow to identify groups with statistically significant differences (α = 0.05).

| Group | | UDI6 score | *p*-value effect size |
|---|---|---|---|
| Training type | Amateur<br>*n* = 22 | 7.1 (0.0–95.2)<br>20.8 (30.2) | 0.99<br>-0.0222 (small) |
| | Recreational<br>*n* = 57 | 9.5 (0.0–100.0)<br>21.0 (27.8) | |
| | Professional<br>*n* = 13 | 9.5 (0.0–57.1)<br>16.8 (19.6) | |
| Training duration | Less than a year<br>*n* = 11 | 47.6[a] (0.0–95.2)<br>43.3 (27.7) | **0.0105**<br>0.0935 (moderate) |
| | 1–2 years<br>*n* = 13 | 14.3[ab] (0.0–76.2)<br>22.0 (27.3) | |
| | 3–5 years<br>*n* = 10 | 2.38[b] (0.0–14.3)<br>5.2 (6.1) | |
| | Over 5 years<br>*n* = 58 | 4.8[b] (0.0–100.0)<br>18.2 (27.1) | |
| Training frequency | 1–2 times per week<br>*n* = 52 | 9.5 (0.0–95.2)<br>21.3 (27.3) | 0.706<br>-0.0146 (small) |
| | 3–4 times per week<br>*n* = 24 | 7.1 (0.0–100.0)<br>16.5 (26.9) | |
| | Over 4 times per week<br>*n* = 16 | 9.5 (0.0–90.5)<br>22.9 (28.3) | |
| Single training duration | Less than 1 h<br>*n* = 48 | 9.5 (0.0–95.20<br>21.8 (27.7) | 0.786<br>-0.017 (small) |
| | 1–1.5 h<br>*n* = 39 | 9.5 (0.0–95.2)<br>17.0 (24.5) | |
| | Over 1.5 h<br>*n* = 5 | 19.0 (0.0–100.0)<br>32.4 (41.7) | |

**Table 9**. UDI6 score depending on training type. Data are presented as median (range) and mean (standard deviation). n denotes size of each group. Groups with statistically significant differences are marked with different letters (α = 0.05).

Preventive measures such as pelvic floor training, individualized physiotherapy, and interdisciplinary care may reduce symptom burden and support longer professional activity. Raising awareness and encouraging early intervention are essential to improving athletes' quality of life[4,16,23].

Speaking with athletes about the mechanism of SUI, using preventive measures and advising them to simultaneously exercise Kegel's muscle may broaden the knowledge and help limit the distress associated with involuntary leakage.

| | IIQ7 score | UDI6 score |
|---|---|---|
| Age | -0.06 | 0.17 |
| Height | -0.26* | -0.30* |
| Weight | -0.01 | 0.14 |
| BMI | 0.11 | 0.29* |
| IIQ7 score | 1.00 | 0.70* |
| UDI6 score | 0.70* | 1.00 |

**Table 10**. Correlation analysis of IIQ7 and UDI6 scores with age, height, weight and BMI. Correlation coefficients marked with * were statistically significantly different from zero (α = 0.05).

| | Age | Height | Weight | BMI | IIQ7 score | UDI6 score |
|---|---|---|---|---|---|---|
| Age | 1.00 | 0.05 | 0.23 | 0.24 | -0.18 | -0.24 |
| Height | -0.09 | 1.00 | 0.50* | -0.02 | -0.18 | -0.29 |
| Weight | 0.02 | 0.12 | 1.00 | 0.85* | -0.19 | -0.16 |
| BMI | 0.04 | -0.21 | 0.94 | 1.00 | -0.12 | 0.00 |
| IIQ7 score | -0.31 | -0.25 | 0.05 | 0.14 | 1.00 | 0.90* |
| UDI6 score | -0.18 | -0.20 | 0.18 | 0.23 | 0.49 | 1.00 |

**Table 11**. Correlation analysis of IIQ7 and UDI6 scores with age, height, weight and BMI for healthy women (upper triangle) and with diagnosed SUI (lower triangle). Correlation coefficients marked with * were statistically significantly different from zero (α = 0.05). The corresponding correlation coefficients were not statistically significantly different (α = 0.05).

| | *p*-value | OR | CI |
|---|---|---|---|
| Age | 0.0011 | 1.0694[a] | (1.0180; 1.1294) |
| Height | 0.0316 | 0.9236[b] | (0.8366; 1.0087) |
| Weight | 0.2163 | 1.0250[ab] | (0.9757; 1.0810) |
| BMI | 0.0284 | 1.1572[ab] | (0.9957; 1.3895) |

**Table 12**. SUI diagnosis association with age, height, weight and BMI. p-value is for single logistic regression model. OR = odds ratio, CI = 98.75% confidence interval. Odds ratios differing statistically significantly were marked with different letters (α = 0.05).

| Factor | | SUI | | p-value |
|---|---|---|---|---|
| | | No | Yes | |
| Giving birth | No | 40 | 9 | 0.000693 |
| | Yes | 24 | 27 | |
| Number of births | 0[a] | 40 | 9 | 0.001264 |
| | 1[b] | 9 | 10 | |
| | 2[b] | 14 | 13 | |
| | 3 or more[b] | 1 | 4 | |

**Table 13**. SUI diagnosis depending on giving birth and number of births. Groups with statistically significant differences are marked with different letters (α = 0.05).

## Conclusions

The study confirmed that stress urinary incontinence and related symptoms may significantly impair quality of life among female horse riders, particularly in older women, those with higher BMI, and those with a history of childbirth. Our results suggest that longer riding experience is associated with lower incontinence-related distress, although the exact influence of horseback riding on SUI remains difficult to determine. There is an impact of the time of training and incidence of urinary leakage symptoms, suggesting that longer training predisposes to develop either preventing behaviors or is associated with better pelvic floor functioning. However, it is hard to verify the exact influence of horseback activity on urinary incontinence. Preventing or treating urinary incontinence may not only enhance athletes quality of life, but also prolong their professional activity lifespan.

Interdisciplinary team of professionals including sport doctors, orthopedics, physiotherapists, and, if recommended, gynecologist, should provide care and counselling on sport professionals.

## Data availability

The datasets used and/or analyzed during the current study areavailable from the corresponding author on reasonable request.

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## Author contributions

Conceptualization, Gabriela Kołodyńska, Wiktoria Misztela; Data curation, Maciej Zalewski and Anna Mucha; Formal analysis, Maciej Zalewski, Anna Mucha, Aleksandra Piątek and Waldemar Andrzejewski; Funding acquisition, Maciej Zalewski; Investigation, Anna Mucha; Methodology, Waldemar Andrzejewski; Project administration and Supervision, Gabriela Kołodyńska; Writing – original draft, Gabriela Kołodyńska; Writing – review & editing, Waldemar Andrzejewski, Aleksandra Piątek.

## Declarations

## Competing interests

The authors declare no competing interests.

## Informed consent

Informed consent was obtained from all subjects involved in the study.

## Institutional review board statement

The study was approved by the Bioethics Committee of the Medical University of Wrocław number KB – 806/2018.

## Additional information

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