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High level rhythmic gymnasts and urinary incontinence: Prevalence, risk factors, and influence on performance

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Urinary incontinence (UI) is common among exercising women, but no studies have been found in rhythmic gymnasts. The aims of the present study were to investigate the prevalence and risk factors for UI in rhythmic gymnasts and the impact of UI on performance. This was a cross-sectional study including all rhythmic gymnasts competing at the highest national and international level in Norway. One hundred and thirty-three gymnasts from 22 sports clubs were invited to participate. Background data and possible risk factors were collected via electronic questionnaires. UI was assessed by Urinary Incontinence short form (ICIQ-UI SF). The "Triad-specific self-report questionnaire" was applied to assess the female athlete triad. Joint mobility was assessed by Beighton score. Logistic regression analysis was used to assess possible risk factors. One hundred and seven nulliparous rhythmic gymnasts (80.5% response rate) from 21 sports clubs, with mean age of 14.5 (SD 1.6) years, participated in the study. Thirty-four (31.8%) reported UI with 21 (61.8%), 3 (8.8%), 6 (17.6%), and 4 (11.8%) reporting stress, urgency, mixed urinary incontinence, and leakage for no obvious reason, respectively. BMI, hypermobility, menarche, disordered eating, and hours of training were not found to be risk factors for stress urinary incontinence. Twenty-four gymnasts with UI (70.6%) reported incontinence to influence sports performance; 10 (29.4%) reported to be afraid of visible leakage and 5 (14.7%) that the leakage would happen again. Seventy-four (69.1%) had never heard about the pelvic floor. In conclusion, UI is common in rhythmic gymnasts and may influence sports performance.

KEYWORDS
female athletes, pelvic floor, performance, rhythmic gymnastics, urinary incontinence

1 | INTRODUCTION

Urinary incontinence (UI) is defined as any complaint of involuntary leakage of urine.[1] Stress urinary incontinence (SUI) is the most prevalent form of UI in the female population and is defined as complaint of involuntary loss of urine on effort or physical exertion (eg, sporting activities), or on sneezing or coughing"[1] Systematic reviews of prevalence of UI in women find the prevalences between 24% and 45% to be most commonly reported, and SUI usually accounts for more than two thirds of undergroups of UI.[2] It has been suggested that the term "activity-related incontinence" might be used in some languages in order to avoid confusion with psychological stress.[1] Since the first report on UI in exercising young women in 1989,[3] there has been an increasing interest in the topic and multiple studies have been published from

a variety of sports.[4-9] Systematic reviews have found that the prevalence rates range between 0% and 80% in different sports and with higher prevalences in sports involving high impact activities.[4-10]

Rhythmic gymnastics started as a sport in the 1940s and debuted as an Olympic sport at the 1984 Olympic Games. It is a female sport and combines the beauty and elegance of classical ballet with the strength and fitness of artistic gymnastics. The gymnasts perform routines with music, either as individuals or in groups, and execute difficult maneuvers with hand-held apparatus: hoop, ball, clubs, ribbon, and rope. All routines include stunning leaps, turns, balances, and acrobatic maneuvers. Search on PubMed and Sports Discus did not reveal any studies on UI in rhythmic gymnasts.

Known risk factors for UI in the general female population is pregnancy, vaginal birth, pelvic surgery, obesity, and age.[2] However, there is a paucity of research on risk factors for UI in young nulliparous women. Eating disorders, low body mass index (BMI), hours of exercise, and hypermobility have been suggested plausible factors for UI and other pelvic floor disorders in elite athletes.[11-13] Rhythmic gymnasts are exposed to high training volumes including high impact activities which increase intra-abdominal pressure and ground reaction forces from an early age. They have low BMI and have been found to have a high prevalence of eating disorders.[4] It has been hypothesized that eating disorders may increase the risk of UI due to increased fluid intake, low calorie intake with lack of essential vitamins, and low estrogen level.[11-13]

Strength training of the pelvic floor muscles (PFM) has level 1A evidence to be effective in treatment of UI, and especially of SUI, in the general female population.[14] PFM training has no adverse effects and is recommended to be first-line treatment for UI.[14] However, to date there is scant knowledge on the effect of PFM training among elite athletes, and we do not know whether it is effective among rhythmical gymnasts.[6]

Although some athletes report that UI may negatively affect sports performance,[12] and some quit sports participation,[15] studies have shown that athletes seldom report the condition to coaches and health personnel.[12,16,17] One study also indicates that athletes have scant knowledge about the pelvic floor and pelvic floor dysfunctions.[18]

The aim of the present study was to investigate the prevalence and risk factors for UI in rhythmic gymnasts and, furthermore, to investigate the impact of UI on performance and their knowledge of the pelvic floor and PFM training.

2 | MATERIAL AND METHODS

This was a cross-sectional study including all rhythmic gymnasts competing at the highest national and international levels in Norway. One hundred and thirty-three gymnasts from 22 sports clubs were invited to participate. All participants, or parents of gymnasts younger than 16 years of age, gave written consent to participate. The study was approved by the Regional Ethics Committee (2018/1047/REK Sør-øst B, 09.08.2018) and the Norwegian Centre for Research Data (NSD: 148616, 10.10.2018).

Background data on demographics and possible risk factors were collected via electronic anonymous questionnaires sent by e-mail. Inclusion of possible risk factors was based on former epidemiological studies and included age, parity, body mass index (BMI), number of hours exercising per week, menstrual status, and disordered eating.[2,5,6,11] Benign joint hypermobility was also considered a risk factor and was assessed clinically. UI was assessed by Urinary Incontinence short form (ICIQ-UI SF).[19]

The ICIQ-UI SF has been translated into Norwegian language and has shown to have good construct validity, acceptable convergent validity, and good reliability,[19,20] The rhythmic gymnasts were categorized as continent if they answered "never" to the question: "How often do you leak urine"? They were classified with SUI if they answered: "leaks when you cough or sneeze" and/ or "leaks when you are physically active/exercising" to the question "When does urine leak"? In addition to frequency of leakage and diagnosis of type of UI, the ICIQ-UI SF also include questions on amount of leakage (none, small amount, moderate amount, or large amount) and how UI affects daily life (scale from 0 to 10). Summing up frequency, amount, and how UI affects daily life gives the ICIQ-UI-SF Sumscore (0-21).

Following up on the ICIQ-UI-SF questionnaire, we also included a question on how UI might influence performance of rhythmic gymnastics with the response alternatives: no influence, loss of concentration, afraid of visible leakage, afraid that urine loss will smell, make mistakes in the routine, feel frustrated/annoyed/worried, feel embarrassed, afraid it may happen again, and other factors. In addition, we asked whether they had heard about the PFM (yes/no/do not know), whether they knew why they should train the PFM (yes/no/do not know), and how they should train the PFM (yes/no/do not know).

The "Triad-specific self-report questionnaire" was applied to assess the female athlete triad.[21] The triad involves three components: (a) low energy availability with or without disordered eating, (b) menstrual dysfunction, and (c) low bone density. In addition, two questions from the Low Energy Availability in Females Questionnaire (LEAF-Q) were used to cover menarche.[22] Reliability and validity of the LEAF-Q questionnaire have been tested in 37 female dancers and endurance athletes. LEAF-Q produced an acceptable sensitivity (78%) and specificity (90%) in order to correctly classify current disordered eating and/or reproductive function and/or

bone health. Test-retest reliability was 0.79 after a two-week interval of retesting.[23]

The prevalence of benign hypermobility joint syndrome was assessed clinically using Beighton score. The nine tests are recommended by the British Society of Rheumatology and have been tested for reliability.[24] Both intra- and inter-ester reliabilities have been found to be >0.7.[25] The tests include passive extension of each fifth finger past 90 degrees, passive apposition of each thumb to the forearm, hyperextension of each elbow past 190 degrees, hyperextension of each knee past 10 degrees, and trunk flexion to allow the palms to lie flat on the floor. The rhythmic gymnasts were categorized as being hypermobile if they scored on 5 or more of 9 variables.[26]

Beighton score was assessed clinically and data on UI, menarche, and the female athlete triad were collected by an electronic questionnaire. The data on these variables were collected at a national competition and in a regular club training setting by one examiner only and who was a trained sports physical therapist (MCDG). The physical therapist was present when the gymnasts answered the questionnaire to help out interpreting the questions.

2.1 | Statistical analyses

Background variables are presented as numbers with percentages or means with standard deviation (SD). The prevalence is reported as frequency and percentage. Kolmogorov-Smirnov and Shapiro-Wilk tests were used to assess the normality of distribution of scores. Student's *t* test and chi-square/Fisher's exact tests were used to compare background and possible risk factors between gymnasts with and without UI. *P*-value was set to .05.

BMI < 18.5, hypermobility, amenorrhea, exercise volume per week, and reported former or present disordered eating were considered possible risk factors for SUI. These factors were entered into a logistic regression analysis, and results are reported as odds ratios with 95% CI.

3 | RESULTS

One hundred and seven nulliparous rhythmic gymnasts (80.5% response rate) from 21 sports clubs participated in the study, and all answered the questionnaires and fulfilled the clinical examination. Mean age was 14.5 (SD 1.6), range of 12-21 years, and mean BMI was 18.9 (SD 2.2), range of 13.2-23.8 with 47 gymnasts (43.9%) having a BMI ≤ 18.5. Thirty-three gymnasts (31.4%) had a BMI ≤ 17. Mean age of the gymnasts when starting with rhythmic gymnastics was 7.5 years (SD 1.9), range of 4-13 years, and mean number of years as a competing gymnast was 4.3 (SD 1.5) years, range of 2-12 years. Mean hours of exercise per week was 15.7 (SD 7.8), range of 6-43 hours. Fifty (46.7%) gymnasts were classified as hypermobile according to Beighton score, 37 (34.6%) had not reached menarche age, and 10 (9.3%) reported former or present disordered eating.

Thirty-four (31.8%) reported UI with 21 (61.8%), 3 (8.8%), 6 (17.6%), and 4 (11.8%) reporting SUI, urgency urinary incontinence, mixed incontinence, and leakage for no obvious reason, respectively. Of those reporting SUI, 12 of 21 (57.1%) reported leakage only during physical activity while 2 of 21 (9.5%) were incontinent only during sneezing and coughing. Seven (33.3%) had SUI both during coughing/sneezing and physical activity. Most gymnasts (n = 30, 88.2%) reported a small amount of leakage while two gymnasts reported either moderate or large amount of leakage, respectively. Mean score on UI interfering with daily life was 1.2 (SD 1.1). The total sum score on ICIQ was 4.7 (SD 2.1) out of 21, with 14 (41.2%) scoring ≥ 5. Two participants scored 10/21.

Table 1 shows no statistical significant difference in any background variables or possible risk factors between rhythmic gymnasts with and without UI. The omnibus tests of model coefficients were not significant (0.252), and the model only explained between 5.0% and 7.9% of the variation in SUI and classified 80% of those with SUI and no SUI in the correct category. None of the rhythmic gymnasts with SUI reported former or present disordered eating, and this variable could therefore not be included in the logistic regression analysis. As shown in Table 2, none of the expected risk factors for SUI made a unique statistically significant contribution to the model.

Upon questions on how UI affected sports performance 24 (70.6%) out of 34 gymnasts with UI reported that the condition had some influence; 10 (29.4%) reported to be afraid

TABLE 1 Comparison of possible risk factors between rhythmic gymnasts with and without urinary incontinence (UI). Mean with standard deviation (SD) or numbers with percentages

	UI N = 34	No UI N = 73	*P*-value
Age	14.4 (1.4)	14.6 (1.7)	.534
BMI	18.7 (2.0)	18.9 (2.3)	.688
BMI ≤ 18.5	17 (53.1)	30 (41.1)	.254
Number of years as competitive gymnast	4.2 (1.5)	4.3 (1.6)	.770
Hours exercises per week	19.6 (7.8)	17.8 (6.9)	.242
Hypermobility	18 (52.9)	32 (43.8)	.379
Menarche	23 (67.6)	47 (64.4)	.741
Recommended to change weight	4 (11.8)	19 (26.0)	.094
Numbers with self-reported former or present disordered eating	2 (5.9)	8 (11.0)	.498

	B	Odds ratio	95% CI Lower	95% CI Upper	*P*-value
Hypermobility	.799	2.223	0.811	6.092	.120
BMI ≤ 18.5	.648	1.911	0.617	5.918	.262
Menarche	.974	2.650	0.699	10.046	.152
Hours of exercise per week	−.001	0.999	0.931	1.072	.975
Constant	−2.748	0.064			.011

TABLE 2 Odds ratios with 95% confidence intervals of risk factors for stress urinary incontinence in rhythmic gymnasts (n = 107)

of visible leakage and 5 (14.7%) that the leakage would happen again. Seventy-four (69.1%) had never heard about the pelvic floor. Seventy-nine (73.9%) did not know why, and eighty-three (77.6%), how, they should train the pelvic floor muscles.

4 | DISCUSSION

More than 30% of elite, nulliparous, teenage rhythmic gymnasts reported UI. The most common form of UI was SUI. In general, the amount of leakage was small, but the ICIQ-UI SF total score was 4.7 and some were severely bothered by the condition. In the present study, expected risk factors such as low BMI, hypermobility, amenorrhea, report of former and present disordered eating, and training load were not found to be statistically significant. Very few gymnasts had any knowledge of the pelvic floor and the possible effect of PFM training.

The prevalence of UI among rhythmic gymnasts is within the range of prevalences found in other sports.[5,6] As far as we have ascertained, this is the first study on rhythmic gymnasts, but in some studies a few rhythmic gymnasts have been included among other athletes.[11,27] However, in these studies the results have not been reported separately for each sport and therefore no direct comparison can be drawn. In the study by Bø & Sundgot Borgen,[11] the participants were grouped in different sports and aesthetic sports included gymnastics, sports dance, rhythmic gymnastics, aerobics, figure skating, and diving. The overall prevalence of UI in this study across sports groups was 52%, but the total number of athletes in the aesthetic group was only 52, and the number of rhythmic gymnasts was not reported. Carvalhais et al[27] included only 6 rhythmic gymnasts, and they were grouped with figure roller skating, synchronized swimming and acrobatic gymnastics, showing a prevalence of 21.4%. The high number of synchronized swimmers in this group may explain the lower prevalence compared with the study of Bø & Sundgot Borgen.[11] The two above-cited studies also used different questionnaires on UI.

The prevalence of UI in the present study was lower than reported in other high impact esthetic sports such as trampoline jumping (>70%).[28,29] The trampoline jumpers had a comparable age to the rhythmic gymnasts, but a higher prevalence in the rhythmic gymnasts may have been expected due to more ground reaction forces occurring during their repetitive jumping on a floor covered by a thin carpet only. However, the trampoline jumpers reported more frequent leakage when practicing new, strenuous, and difficult acrobatic elements and in double summersaults. This indicates that leakage occurs not only during the landing phase. The prevalence of UI in other comparable sports such as artistic gymnastics is between 56% and 67%[17,22] and 43% among ballet dancers.[17] Few research groups have compared the prevalence of UI in elite athletes with that of a control group.[11,16,27,30,31] All studies, except one,[11] found statistically significant higher prevalence of UI in elite athletes compared to non-athletes, with athletes being 2-3 times more likely to report UI than non-athletes.[7,27,31] However, the studies did not control for important factors such as bladder volume, and the population included in the above-mentioned studies differ in age, parity, BMI, and level of sports performance. The control groups also vary in their activity level and participation in sport. The studies including parous women[3,16,27,30] did not control for this, and difference in BMI was not controlled for in other studies.[3,11,16] Hence, caution should be taken when comparing results from different studies.

In the present study, no statistically significant risk factors were found to explain the odds of having UI. Factors found in former published studies were chosen to explore the odds. Bø & Sundgot Borgen[11] found that Norwegian elite athletes representing several sports reporting UI had more eating disorders than their continent counterparts did. This was supported by a study of Portuguese elite athletes where athletes with disordered eating presented increased odds of UI (OR = 3.09; 95% CI: 1.74-5.50).[32] On the other hand, Yi et al[13] found that 24% of tri-athletes had at least one arm of the female athlete triad, but the athletic triad was not associated with symptoms of any pelvic floor disorders, for example, UI. Our results did not confirm other findings from other sports where low BMI[12,29] and length of participation in sport/hours of training[15,18,33-43] were significant risk factors. This may be explained by the high training load and low BMI in all the rhythmic gymnasts. However, it has been debated that children and adolescents'

BMI values should be classified differently from adults'[36] BMI was not adjusted for age or physical evolution in the present study or in former published studies on UI in athletes. Other risk factors such as family history and constipation[27] were not investigated in the present study.

Although the rhythmic gymnasts in the present study had a total score of 4.7 on the ICIQ-UI SF, not all gymnasts reported that UI affected their sports performance or daily life. Visible leakage was what bothered them the most. Given the minimal clothing of the rhythmic gymnasts and the performance of movements with legs apart in many different positions, leakage of urine may be exposed to fellow gymnasts, coaches, judges, and the audience. Eliasson et al[15] found that 61% of former trampoline jumpers leaked while trampolining; 53% said it affected them psychologically and 12% had stopped trampolining due to UI. Caylet et al[16] reported that even small drops of urine were found to be embarrassing in female athletes participating in athletics, volleyball, swimming, rugby, handball, basketball, football, tennis, and fight sports. Jacome et al[12] studying 106 track and field, basket and indoor football athletes in Portugal reported that the athletes felt concerned, annoyed, and frustrated and were afraid for new episodes. UI affected performance, but not activities of daily living. In a group of 57 cross-country skiers and 55 runners, Poswiata & Opera[37] reported that 70% were bothered by the condition whereof 9% were significantly or heavily bothered.

The prevalence of UI is generally high across studies in female athletes, but it may also be underreported.[16] There are few studies on UI in the general female adolescent population. Milsom et al[2] reported the prevalence to be 2.9% among females aged 15-17 years. A higher prevalence has been found in the control groups of studies on elite athletes, but these studies also included women of higher age[11,16,27] and some of the included participants were parous. Caylet et al[16] found that 84% of the athletes had never spoken to anyone about the problem. In the present study, we asked about the rhythmic gymnasts' knowledge of the pelvic floor and PFM training. As expected, only few of these young rhythmic gymnasts had heard about the pelvic floor or knew how to train the PFM. Low level of knowledge and adequate practice to treat UI has been found in another study of athletes,[18] but is also common in the non-athlete, young, nulliparous population. Neels et al[38] found that nulliparous women aged 18-27 years rated their general knowledge about the pelvic floor as a mean of 2.4 (SD 2.01) on a VAS scale from 0 to 10.

Although two studies did not find increased risk of UI many years after cessation of sports participation,[39,40] early debut of UI is reported to be a risk factor for UI later in life.[2,40] Hence, treatment of the condition and prevention of further development of UI in athletes should be a priority for health personnel and coaches. Hopefully, this study will increase the knowledge of UI in rhythmic gymnasts among coaches. In addition, we suggest that information about the condition should be part of the professional curricula for coaches and health personnel working with high level athletes. In the general population, women with SUI who do PFM training are 8 times more likely to be cured.[14] They have fewer UI episodes, less UI, and improved quality of life.[14] The effect is increased with supervised training. However, we have only been able to find one small randomized controlled trial on the effect of strength training of the PFM on UI in female athletes. Ferreira et al[41] found a significant improvement in UI in a group of volleyball players after 3 months of PFM training compared with a control group only receiving information via a pamphlet. This is promising, but there is a need for further high-quality randomized trials in other sports, including rhythmic gymnastics.

As for other young elite athletes, a majority of the rhythmic gymnasts in the present study had no knowledge about PFM training. There is a need for further studies on how to increase their knowledge and whether PFM training could be implemented as part of their general strength training programs. One study found that most young athletes are not able to contract the PFM correctly at their first attempt, but that this could be learned by proper teaching.[34] Hence, a thorough instruction and feedback of how to train the PFM is important. Given the young age of these athletes, it is mandatory that assessment and treatment are done in an ethical and correct way.[42] Suprapubic ultrasound is a reliable, valid, and non-invasive method to assess and teach PFM contraction,[43] and can therefore be recommended as the gold standard method in this young age group. We also recommend that the athletes are referred to experienced health personnel, preferably female gynecologists and/or women's health physical therapists specializing in this area, for thorough assessment and follow-up training.

The present study did not investigate mechanisms for UI during physical activity. To date, there are two opposing hypotheses on the effect of physical activity and the pelvic floor[4]: 1 physical activity strengthens the pelvic floor and thereby reduces the risk of UI and 2 physical activity weakens the pelvic floor, thereby increases the risk of UI. PFM strength was not assessed in the present study, but the high prevalence of UI found in rhythmic gymnasts and in other sports[4,10] indicates that strenuous exercise does not protect against UI. Gymnasts are exposed to a high weekly training load of high impact activities, and repetitive takeoffs and landings may unmask an underlying condition that would not be experienced during sedentary activities. For now, one can only speculate whether high exposure of high impact activities can cause UI or whether the condition is due to underlying genetic factors such as a low position of the pelvic floor inside the pelvis, weak PFM and/or connective tissue, and/or a delayed neurophysiological response to increases in

intra-abdominal pressure. There is a need for further studies to explore possible mechanisms for UI in young, nulliparous female athletes.

Strengths of the present study were the high response rate and use of reliable and valid instruments to measure UI[19,20] and risk factors.[23,26] A physical therapist was present when the gymnasts answered the questionnaire and could clarify questions upon request. A possible limitation can be that the sample size may have been too small to detect statistically significant differences between those with and without UI and SUI. Since we included all rhythmic gymnasts in Norway, the only way to expand the sample size is to include rhythmic gymnasts from different nationalities in future follow-up studies. The results of the present study may serve as a base for power calculations in future studies. Another limitation is that precautionary strategies such as limitation of fluid intake were not asked for. In addition, the results from Norwegian elite rhythmic gymnasts cannot be generalized to rhythmic gymnasts with higher training dosage.

5 | CONCLUSIONS

The prevalence of UI in young, nulliparous rhythmic gymnasts is above 30% and 70% reported that the condition had some influence on sports performance. Most gymnasts had no knowledge of the pelvic floor or PFM training. There is a need for RCTs with high methodological and interventional qualities to evaluate the effect of PFM training in this group of young girls exposed to high load and impact on the pelvic floor.

6 | PERSPECTIVE

A high prevalence of UI was reported in young, nulliparous rhythmic gymnasts, and the condition negatively influenced sports performance. The prevalence rate was within the range of prevalence among other high impact sports.[4-10] This calls for interventions toward prevention and treatment. Gymnasts and dancers may be especially exposed to stigma and embarrassment due to minimal clothing and close-up exposure of the pelvic area during their performance. Strength training of the pelvic floor muscles has 1A level of evidence to treat UI in the general female population and is recommended to be first-line treatment.[14] Pelvic floor muscle training has no known adverse effects and should be offered to the gymnasts. Few of the rhythmic gymnasts had any knowledge about the pelvic floor. Therefore, increased awareness of pelvic floor dysfunctions and the potential for effective treatment of UI in elite athletes should be included in future educational courses for coaches and health personnel engaged in female elite sport.

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