



# Urinary incontinence among competitive rope-skipping athletes: a cross-sectional study

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## Abstract

**Introduction and hypothesis** The purpose of this study was to determine the prevalence, impact and management of stress urinary incontinence (SUI) among rope-skipping (RS) athletes.

**Methods** A cross-sectional observational study was employed. Survey #1 (current athletes): RS athletes aged  $\geq 13$  years attending a national RS competition (183) were invited to participate. The primary outcome was the prevalence of SUI during RS (yes/no question). Secondary outcomes included SUI interference with RS (Likert scale, 0–10), quality of life (ICIQ-SF), and the prevalence and bothersomeness of SUI for each RS event (un-validated sport-specific questionnaire inspired by the IIQ-7). Survey #2 (retired athletes): retired RS athletes were invited to complete an online questionnaire to identify whether SUI contributed to their retirement from RS.

**Results** Survey #1: 56% (103 out of 183) of athletes responded. Athletes were predominantly girls of adolescent age, normal weight, menarchal, and nulliparous. Seventy-five percent of the girls (67 out of 89) and 7% of boys (1 out of 14) reported SUI during RS, mostly when competing “double-unders” and “triple-unders.” Twenty-one percent (14 out of 67) of affected girls indicated a moderate or greater interference of SUI with RS, although the median impact of SUI on their overall quality of life was slight. Female athletes managed SUI with containment products, fluid limitation, and timed voiding. Survey #2: one of the 77 respondents (74 females, 3 males) indicated that SUI contributed to their retirement from RS.

**Conclusions** Similar to other high-impact sports, female RS athletes experience a relatively high rate of SUI while participating in RS, which may lead to decreased quality of life.

**Keywords** Stress urinary incontinence · Pelvic floor · Quality of life · Rope skipping

## Introduction

Stress urinary incontinence (SUI) is common among exercising females. Although more common in older and parous women, SUI also affects young nulliparous women in the general population (20%), and even more among those participating in higher impact activities (e.g., 80% of young, nulliparous female trampoline athletes) [1–3]. Although less

common, SUI also affects males, with increasing prevalence at older ages: 0.7% among men 19–44 years, and 2.7% over 65 years) [4]. Unfortunately, SUI is a known barrier to sport and physical activity participation, which are important lifestyle factors that contribute to maintaining health [5]. Although SUI may be relevant for both sexes, given that it is more common among females, and that females are less physically active than their male counterparts, SUI is a particularly important sports medicine issue among women [6, 7].

Rope skipping (RS) is a high-impact, female-dominated sport that is gaining popularity internationally [8, 9]. RS involves two main disciplines, single-rope and double-dutch. Single-rope is performed individually, and double-dutch involves at least three individuals; two ropes turning between two turners, and one jumper. Both single-rope and double-dutch can be performed as “speed or “freestyle.” Speed-style involves jumping as many times as possible within a defined time with an alternating foot pattern. Consecutive “double-unders” and “triple-unders” are also single-rope events, where

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the rope passes two or three times under the athlete with each jump respectively. This rhythm is performed consecutively until the rope stops. Freestyle involves athletes performing creative skills, often choreographed to music. Further information about RS events are found elsewhere [10].

Rope skipping has long been encouraged as a physical activity that maintains health [9]. Unfortunately, anecdotal evidence suggests that SUI has affected some RS athletes' participation [9]. However, there is an absence of research to suggest the extent or impact of SUI within this athletic population. It is suspected that SUI may affect female rope-skipping athletes at a similar rate to trampoline athletes, and thus it may curb their participation. It is also suspected that SUI may affect some male RS athletes, although to a lesser frequency and severity than females. Therefore, the purpose of this study is to determine the prevalence, impact, and management practices of SUI among RS athletes.

## Materials and methods

A cross-sectional observational research study was employed to answer the research questions, which included two survey questionnaires. The first survey was aimed at identifying the prevalence, impact, and management strategies of SUI among current RS athletes, and the second to determine whether SUI contributes to athletes' decisions to retire from RS participation. Approval for the study was granted by the Queen's University Health Sciences and Affiliated Teaching Hospitals Research Ethics Board (clearance # 6020689).

### Survey number 1 (current athletes)

**Population and recruitment** All competitive RS athletes aged  $\geq 13$  years, attending the Rope Skipping Canada national championships, were invited to participate in the study. Female athletes were surveyed in May 2017 in Kingston, ON, Canada, and male, the following year in Windsor, ON, Canada. All eligible athletes received a questionnaire in their registration packages or by request, and the completed surveys were collected throughout the competition.

**Measures** The primary outcome was the overall prevalence of SUI during RS, which was determined by a yes/no question, "Do you leak urine during rope-skipping activities?" An 11-point Likert scale (0–10) was used to assess the overall interference of SUI with RS activities by asking the question, "Overall, how much does leaking urine interfere with your rope-skipping activities?" Overall quality-of-life (QOL) was evaluated using the International Consensus on Incontinence Questionnaire short form (ICIQ-SF), where the maximum score of 21 indicates a very severe impact on QOL [11]. An unvalidated sport-specific questionnaire inspired by the

Incontinence Impact Questionnaire short form (IIQ-7) was used to assess the prevalence and bothersomeness of SUI for each RS event type during both practice and competition ("not at all, 0"; "slightly, 1"; "moderately, 2"; "greatly, 3") [12]. Data were collected on the strategies that athletes use to manage SUI, SUI risk factors, and whether athletes stopped practicing or competing in various RS events because of SUI. The questionnaire was pilot tested with 10 female athletes eligible for participation in the study prior to full implementation, to optimize readability, clarity, and content validity pertaining to the RS-specific content.

**Statistical analysis** SPSS Version 24 for Mac was used for statistical data analysis. All measures were explored using descriptive statistics; variables are presented as frequencies, percentages, or medians with interquartile ranges (IQRs). Odds ratios were used to explore the strength of association of each SUI risk factor with SUI during RS. A *p* value of  $< 0.05$  was considered statistically significant. Female and male results were calculated and reported separately, given the established difference in SUI prevalence and risk factors between the two groups [3, 4].

### Survey number 2 (retired athletes)

Retired Canadian female and male RS athletes were invited to complete an online questionnaire asking respondents to identify their reasons for retiring from RS, to determine whether SUI contributed to this decision. The questionnaire listed the most common reasons why children and youths drop out of organized sport, with SUI added as an option [13]. The questionnaire was disseminated by Rope Skipping Canada (RSC) to their current membership via email and also more widely on social media between May and August 2017. The questionnaire was pilot tested with 10 retired athletes prior to full implementation. Respondents' reasons for RS retirement are reported as frequencies and percentages, and then further subdivided by gender. The respondent's ages and duration of RS participation are reported as median (IQR), and were calculated using SPSS Version 24 for Mac. Given that the online survey was distributed widely, often by word of mouth, a response rate was not attainable.

## Results

### Survey number 1 (current athletes): female athletes

A total of 162 athletes were invited to participate and 89 surveys were completed (55%). Results are reported as median (IQR). Table 1 summarizes respondent demographics. Table 2 summarizes SUI risk factors among respondents. Athletes were mostly menarchal (88%), nulliparous (93%), healthy, and were all non-smokers.

**Table 1** Participant demographics

Demographic variable	Female ( <i>n</i> = 89)		Male ( <i>n</i> = 14)	
	Range	Median (IQR)	Range	Median (IQR)
Age (years)	13–59	16 (15–21)	13–35	18 (13–28)
BMI (kg/m <sup>2</sup> )	15–30	21 (20–23)	18–28	21 (19.2–24.3)
Years of RS participation <sup>a</sup>	1–28	8 (6–11)	1–20	6 (2.5–10.0)
RS training volume <sup>a</sup> (min/weeks)	60–1,170	360 (240–360)	120–540	240 (240–360)

BMI body mass index, RS rope skipping, IQR interquartile range

<sup>a</sup> One missing

**Primary outcome** Stress urinary incontinence was reported in 75% (67 out of 89) of athletes during RS. Among those incontinent during RS, 21% (14 out of 67) indicated an overall interference of SUI with RS as moderate or greater (score of  $\geq 4$  on the interference question; Table 3). The median ICIQ-SF score in incontinent athletes was 4 (IQR 3–6), which indicates a slight impact of SUI on their overall quality of life.

Table 4 summarizes the frequency of athletes who experience SUI by RS event types. For athletes who experience SUI while RS, consecutive “double unders” and “triple unders” were associated with the greatest prevalence of SUI during competition, 67% and 86% respectively. Further, 19% and 48% of athletes who experience SUI while RS reported being affected “moderately” or “greatly” for “double unders” and “triple unders” respectively. A similar pattern was present regarding the prevalence and severity of SUI during practice. Attrition from participation in either of these two events due to SUI was 6% in competition and 16% in practice.

**Table 2** Athlete characteristics with respect to stress urinary incontinence (SUI) risk factors

Athlete characteristics	Female ( <i>n</i> = 89) <i>n</i> (%)	Male ( <i>n</i> = 14) <i>n</i> (%)
Nulliparous	83 (93)	n/a
Menarchal	78 (90) <sup>a, c</sup>	n/a
Caffeinated carbonated drink consumption	49 (55)	9 (64.3)
Coffee consumption	41 (47) <sup>a, c</sup>	4 (28.6)
Alcohol consumption	29 (33) <sup>a</sup>	5 (35.7)
Hormonal contraceptive	25 (28)	n/a
Constipation	10 (12) <sup>b</sup>	2 (14.3)
Pelvic surgery	1 (1)	0 (0)
History of eating disorder	1 (1)	0 (0)
Presence of medical condition	1 (1)	3 (21.4)
Current smoker	0 (0)	0 (0)

<sup>a</sup> One missing

<sup>b</sup> Two missing

<sup>c</sup> One “prefer not to answer”

Athletes’ SUI management practices are shown in Table 5. Most athletes managed their SUI by voiding before or between RS events. Despite the significant impact of SUI on some athletes, none was receiving treatment for it.

Table 6 summarizes the prevalence of SUI risk factors among those athletes who are incontinent while RS, and the association of these risk factors with SUI while RS. Although diverse risk factors were reported, only menarche was found to be associated with SUI while RS, with an OR of 8 compared with premenarchal athletes (95% CI 1.5–56).

### Survey number 1 (current athletes): male athletes

Twenty-one athletes were invited to participate and 14 surveys were completed (67%). Table 1 summarizes participant demographics, whereas SUI risk factors among male respondents are found in Table 2. Athletes were mostly healthy and were all non-smokers.

Regarding the primary outcome, 7% of male athletes reported SUI during RS. The one incontinent RS athlete indicated that the overall interference of SUI on RS was only “a small amount” (score of 2–3 on the interference question; Table 3). However, this athlete’s ICIQ-SF score was 8, indicating a moderate impact of urinary incontinence on their overall quality of life. This athlete’s SUI occurs only during “double unders” and “triple unders,” and affects him only slightly during competition and moderately during practice. SUI did not lead to discontinuation of RS participation, using SUI management strategies, or seeking treatment.

**Table 3** Overall interference of SUI on RS

Overall interference of SUI on RS	Female ( <i>n</i> = 67) <sup>a</sup> <i>n</i> (%)	Male ( <i>n</i> = 1) <i>n</i> (%)
1: not at all	17 (25.8)	0 (0)
2–3: a small amount	35 (52.2)	1 (7.1)
4–5: a moderate amount	8 (11.9)	0 (0)
6–7: a large amount	4 (6.0)	0 (0)
8–10: extremely	2 (3.0)	0 (0)

<sup>a</sup> One missing

**Table 4** Stress urinary incontinence among female RS athletes while participating in different RS event types

RS event	Number of athletes who participate in the event	Any SUI during event <i>n</i> (%)	SUI bothersomeness during RS event		
			Slightly <i>n</i> (%)	Moderately <i>n</i> (%)	Greatly <i>n</i> (%)
<b>Competition</b>					
30-s speed	61	13 (21)	12 (20)	0 (0)	1 (2)
3-min speed	58	15 (26)	15 (26)	0 (0)	0 (0)
Double-dutch speed	60	11 (18)	10 (17)	0 (0)	1 (2)
Consecutive double-unders	54	36 (67)	26 (48)	7 (13)	3 (6)
Consecutive triple-unders	56	48 (86)	21 (38)	19 (34)	8 (14)
Single-rope freestyle	57	11 (19)	8 (14)	2 (4)	1 (2)
Double-dutch freestyle	59	11 (19)	9 (15)	1 (2)	1 (2)
<b>Practice</b>					
30-s speed	59	10 (17)	8 (14)	1 (2)	1 (2)
3-min speed	56	13 (23)	10 (18)	3 (5)	0 (0)
Double-dutch speed	58	10 (17)	8 (14)	1 (2)	1 (2)
Consecutive double-unders	55	32 (58)	21 (38)	7 (13)	4 (7)
Consecutive triple-unders	55	47 (86)	26 (47)	11(20)	10 (18)
Single-rope freestyle	56	13 (23)	9 (16)	3 (5)	1 (2)
Double-dutch freestyle	55	9 (16)	6 (11)	2 (4)	1 (2)

**Survey number 2 (retired athletes)**

Seventy-four females and 3 males completed the online questionnaire. Respondents had participated in competitive RS for a median of 9 years (IQR 6–12). Table 7 summarizes the reasons why athletes chose to retire from RS. Only one female athlete identified that SUI was one of eight reasons for retiring from RS.

**Table 5** Management strategy for SUI in RS athletes who leak while RS

SUI management strategy	Female ( <i>n</i> = 67)		Male ( <i>n</i> = 1)	
	<i>n</i> (%)	Missing, <i>n</i>	<i>n</i> (%)	Missing, <i>n</i>
Voiding before events	46 (72)	3	0 (0)	0
Voiding between events	45 (71)	4	0 (0)	0
Using containment (e.g., pad or tampon)	24 (38)	4	0 (0)	0
Limiting fluid intake before rope skipping	12 (20)	6	0 (0)	0
Seeking treatment for UI	0 (0)	0	0 (0)	0

Some athletes used multiple management methods; hence, total percentage exceeds 100%

**Table 6** Risk factors for SUI and their association with SUI among female RS athletes (*n* = 67)

SUI risk factor	SUI during RS <i>n</i> = 67 (%)	Odds ratio <sup>c</sup> (CI)	<i>p</i>
Menarchal <sup>a</sup>	63 (96)	<b>8.1</b> (1.5–56.0)*	<b>&lt;0.05*</b>
Caffeinated drink consumption	36 (54)	<b>0.8</b> (0.3–2.2)	NS
Coffee consumption <sup>a</sup>	29 (45)	<b>0.7</b> (0.2–1.8)	NS
Alcohol consumption <sup>b</sup>	23 (34)	<b>1.3</b> (0.4–4.1)	NS
Hormonal contraceptive	17 (26)	<b>0.6</b> (0.2–1.7)	NS
Constipation <sup>a</sup>	8 (12)	<b>1.3</b> (0.2–13.7)*	NS*
Parous	5 (8)	<b>1.7</b> (0.2–83.9) <sup>d</sup>	NS*
Pelvic surgery	1 (1)	N/A	N/A
History of eating disorder	1 (1)	N/A	N/A
Presence of medical condition	1 (1)	N/A	N/A
Current smoker	0 (0)	N/A	N/A

\*Fisher’s exact method used to calculate *p* and CI

<sup>a</sup> Two missing

<sup>b</sup> One missing

<sup>c</sup> Conditional maximum likelihood estimate of odds ratio

**Discussion**

Young, nulliparous, and healthy female RS athletes experience a very high rate of SUI (75%) while participating in RS. These results are consistent with our initial hypothesis. Among those who are incontinent while RS, approximately 1 in 5 are affected moderately or greatly overall in their specific RS activities. SUI occurs most often among these athletes when performing “double unders” and “triple unders.” The majority of athletes who experience SUI during RS are affected while performing “triple unders,” and half are affected at least moderately or greatly. The frequency and severity of SUI during “double unders” is slightly less. Fortunately, however, the majority of incontinent RS athletes indicate that overall, their quality of life is not significantly impacted by SUI, as shown on the ICIQ score. Yet, sadly, some athletes have stopped participating in these two events because of SUI. Although frequent, no incontinent athlete was receiving treatment, despite some athletes being greatly affected.

Results also suggest that SUI occurs among male RS athletes, although it is much less common than in females, consistent with our initial hypothesis. Similar to female RS athletes, the male RS athlete was affected by SUI most often during “double unders” and “triple unders.” Although SUI had a small impact on his RS activities, the impact on his overall QOL was moderate. He did not employ any strategies to contain urine while RS, nor was he receiving treatment for it.

Retired RS athletes who responded to the online survey did not cease RS participation because of SUI: only one female athlete identified that SUI contributed to her decision to retire.

**Table 7** Rationale for RS retirement

Reasons for RS retirement	Total ( <i>n</i> = 77) <i>n</i> (%)	Female ( <i>n</i> = 74) <i>n</i> (%)	Male ( <i>n</i> = 3) <i>n</i> (%)
School became a priority	29 (38)	27 (36)	2 (67)
Obtained employment	27 (35)	25 (34)	2 (67)
Lack of time	25 (32)	24 (32)	2 (67)
Moved away from RS team	24 (31)	24 (32)	1 (33)
Participation in other sports	21 (27)	20 (27)	0 (0)
Negative team dynamics	15 (19)	15 (20)	1 (33)
Injury	15 (19)	15 (20)	0 (0)
Peers were no longer participating	13 (17)	12 (16)	0 (0)
Not enjoyable any longer	12 (16)	10 (14)	1 (33)
Participation in other activities	7 (9)	6 (8)	2 (67)
Not interested in competing any longer	6 (8)	7 (9)	0 (0)
Lack of transportation	4 (5)	4 (5)	0 (0)
Others were putting too much pressure on me	4 (5)	1 (1)	0 (0)
I put too much pressure on myself	3 (4)	0 (0)	3 (100)
My body type or size was no longer adequate	3 (4)	3 (4)	3 (100)
Lack of parental support	3 (4)	3 (4)	0 (0)
High cost of participation	3 (4)	3 (4)	0 (0)
Medical illness	2 (3)	2 (3)	0 (0)
Was no longer challenging	1 (1)	1 (1)	0 (0)
Became too challenging	1 (1)	1 (1)	0 (0)
Urinary incontinence	1 (1)	1 (1)	0 (0)

Most athletes cited multiple reasons for discontinuing RS

The high rate of SUI among young, nulliparous females while RS is comparable with that observed among trampoline athletes with similar demographics (mean age 15 years, range 12–22), which is the highest rate of SUI among athletes recorded in the literature (80%) [1, 2]. This prevalence is significantly greater than the overall prevalence of SUI experienced during physical exercise among women (25%) and also young nulliparous women (20%) in the general population, where the type of exercise may involve less impact [3, 5]. Given that SUI increases with higher impact activities, the higher prevalence of SUI among RS athletes is likely due to its high-impact nature [2, 14]. The data obtained from this study correlate well with this observation, given that higher-impact RS events (i.e., “double unders” and “triple unders”) demonstrated a higher prevalence of SUI.

The above findings now establish RS as one of the sports in which females are at greatest risk of experiencing SUI while participating. Given that SUI is known to be a barrier to sport and physical activity, the concern is that SUI may deter RS participation. Given that some athletes have stopped taking part in “double unders” and “triple unders” due to SUI, this suggests that sport attrition has already occurred to some extent. The finding that some RS athletes are greatly affected by

SUI, yet none are receiving treatment for it may indicate a need for athletes, parents, and coaches to be educated in this regard [14–16]. Therefore, RS organizations should develop an awareness program about SUI prevalence and its management during RS aimed at these stakeholders to reduce any associated stigma, discuss SUI prevention, and to encourage SUI treatment with conservative management such as pelvic floor muscle training, where appropriate. Further, RS organizations may wish to consider modifying certain competitive events (e.g., “triple unders”), as many athletes are affected, and some have already discontinued participation in these events because of SUI. The results of this study are relevant to both competitive RS athletes and individuals who participate in other activities that involve RS, notably CrossFit, owing to its popularity in the fitness community [17].

There are a number of limitations of this study. First, given that only Canadian RS athletes at the national level were included, and that no data on ethnicity were collected, results are not necessarily generalizable to individuals from other countries or ethnicities, or those from the general population who engage in recreational or other forms of RS. Further, the overall number of participants in the study was low, which could be improved by increasing the eligibility criteria to include athletes from other countries. Second, it remains unclear whether RS athletes do not seek treatment for SUI because they feel uncomfortable, whether they consider the symptom to be normal or harmless, and/or whether they are unaware of treatment options. Therefore, future research should include an exploration of participant experience to elucidate athletes’ reasons for not seeking treatment. Moreover, given that the retired athletes who responded to the online questionnaire were involved for a prolonged period, the low percentage of retired athletes who indicated that SUI contributed to RS retirement should be interpreted with caution, given that it remains unknown whether SUI is a barrier to participation in earlier stages of RS involvement, identifying a knowledge gap. Furthermore, not only were we unable to reach all retired RSC athletes affiliated with RSC, we had no means of reaching those retired athletes who did not maintain ties with RSC, which may affect the rate of SUI as a factor implicated in RS discontinuation. This low rate (1%) of SUI contributing to RS retirement may be an under-estimate, given that 12% of retired trampoline athletes reported retiring from trampoline secondary to SUI, despite comparable demographics between the two study populations [14]. To address this knowledge gap, future studies could prospectively monitor the reasons that athletes give for discontinuing sport participation.

Other limitations are methodological in nature: being a cross-sectional survey, some athletes may have chosen not to participate by lack of interest, possibly because they might not have been affected directly or indirectly by SUI, which would affect our rates and over-estimate the real prevalence. Another limitation involves the use of unvalidated sport-specific IIQ-

styled questionnaires. It would have been interesting to obtain scores for the validated versions of these questionnaires, but we chose not to for two reasons. On the one hand, because the incontinence was expected to be limited to the RS activity, we felt that including the IIQ and/or UDI questionnaires themselves would have had a limited discriminatory ability with the relative expected rarity of the SUI overall, and on the other hand, adding these two additional questionnaires would have increased the burden to athletes and might have had an impact on participant recruitment.

This study advances the literature pertaining to SUI among athletes in several ways. First, research assessing SUI prevalence among athletes has almost exclusively focused on females, whereas this study assessed its prevalence among both genders. Given that a male athlete in this study indicated experiencing SUI during sport participation, future research groups may wish to extend their study population to include male athletes, particularly those participating in high-impact sports. Further, little research has been conducted on the contribution of SUI to athletes' decisions to retire from their sport, and this study aimed to provide further such insight [14].

Lastly, this study determined both the prevalence and bothersomeness of SUI for each RS event type, rather than only determining the overall SUI prevalence for the sport. This refined approach appears to be unique within the SUI prevalence literature, given that none of the articles included in a recent systematic review on this topic addressed sport-specific components contributing to both SUI prevalence and bothersomeness [18]. Such specificity may enable evidence-based rule changes that aim to mitigate negative effects of SUI on athletes, and thus encourage continued participation. Future SUI prevalence research may benefit from uncovering specific aspects of each sport that contribute to SUI, in an effort to adjust rules for the benefit of athlete health, where possible.

In summary, similar to other high-impact sports and despite their young age, female RS athletes experience an overall high rate of SUI while participating in RS, which can lead to a decrease in quality of life, albeit possibly modest, and attrition from participation for some athletes. This research will help to guide SUI awareness, prevention, and management strategies for RS athletes, coaches, parents, and organizations.

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## Compliance with ethical standards

**Conflicts of interest** The project was funded by Rope Skipping Canada (Sarah L Dobrowolski is a board member of Rope Skipping Canada). The remaining authors claim that they have no conflicts of interest.

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