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ORIGINAL ARTICLE

Prevalence of urinary incontinence in women powerlifters: a pilot study

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Abstract

Introduction and hypothesis Increased intra-abdominal pressure is associated with urinary incontinence (UI) as is increasing age, obesity, and participating in sport at an elite level. We aimed to determine the prevalence of UI in competitive women powerlifters and establish if commonly cited risk factors affect the incidence of UI.

Methods The authors developed a 17-item questionnaire to investigate the prevalence of UI and the relationship of UI with age, body mass, resistance training experience, and competition grade in competitive women powerlifters. The questionnaire was distributed through three major powerlifting federations in Australia for 16 months. The data of 134 competitive women powerlifters were collected anonymously using Qualtrics, and were analysed using multivariate analysis.

Results In combination, the age of lifters, resistance training experience, body weight categories, and competition grade accounted for a significant 28% of the variability in the Incontinence Severity Index (ISI) ($p < 0.01$). However, the ISI was not significantly different among age groups, body weight categories, or competition grade. Approximately, 41% of women powerlifters had experienced UI at some stage in life, and 37% of women powerlifters currently experienced UI during training, competition, or maximum effort lifts. However, the rate of UI experienced during daily life activities was approximately 11%.

Conclusions This study showed that competitive women powerlifters experience a higher rate of UI during lifting-related activities than in daily life and that the rate of UI correlates positively with age, body weight categories, resistance training experience, and competition grade.

Keywords BMI · Incontinence severity index · Intra-abdominal pressure · Pelvic floor · Resistance training · Stress urinary incontinence

Introduction

Urinary incontinence (UI) is a chronic and consequential problem, and has been defined by Haylen et al. as a complaint of involuntary loss of urine [1]. The incidence of UI in women is reported to range between 37 and 63% [2], and is experienced at a higher rate with increasing age. The prevalence of UI in female athletes has a wider range than that found in the general population and has been reported to be between 5.56% in women Pilates practitioners and 80% in trampolinists [3]. High-intensity exercises or high-impact activities such as skipping, jumping jacks, and running are associated with higher levels of leakage [4], whereas low-impact, low-intensity exercises appear to promote continence [5]. Athletic women also experience UI differently from non-athletic women as UI is less likely to be experienced by athletes during everyday activities such as coughing and sneezing and more likely to only be experienced during exercise [6]. Araujo et al. suggest that "athletic incontinence" should be used to describe UI that occurs during exercise in women who are otherwise continent [7].

A study by dos Santos et al. found that incontinent athletes had greater pelvic floor strength than continent athletes and concluded that perhaps UI in athletes was not due to pelvic floor muscle (PFM) weakness [8]. All the incontinent athletes in the dos Santos study could correctly activate their pelvic floor indicating that the inability to generate a strong pelvic floor contraction was not a contributing factor to their UI. Dias et al. found that although the pelvic floor deformed during a jump landing exercise, the deformations were different from those generated in a Valsalva manoeuvre [9]. Their findings

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also indicated that urethral hypermobility may be less problematic than expected as a contributing factor of UI in athletes. A similar result was noted by Kruger et al., who found that athletes had a higher rate of bladder neck mobility, but were asymptomatic for incontinence [10]. Various functional and morphological differences between athletes and non-athletes were also identified by the same authors [10]. These findings included a greater diameter of the levator ani muscle and the ability to markedly increase the area of the levator hiatus during a voluntary Valsalva manoeuvre.

Stress UI can be triggered during exercise by an increase in intra-abdominal pressure if the urethra fails to counteract the increased abdominal pressure [11]. Gerten et al. demonstrated that lifting weights increases intra-abdominal pressure and this increase correlated positively with the load lifted [12]. Powerlifting is a strength-based sport that consists of maximum effort in three lifts including squat, bench press, and deadlift. Powerlifters often wear a lifting belt and hold their breath throughout a lift to increase stability of the spine and trunk [13]; this manoeuvre causes an increase in intra-abdominal pressure, which in turn places stress on the PFMs. Lifting a small amount (i.e. 2.5 kg) of external load, has been shown to significantly increase intra-abdominal pressure [12]. Therefore, the intra-abdominal pressure and stress on PFMs of experienced lifters, who are likely to lift heavier weights, may be significantly greater than for novice lifters, resulting in a higher rate of UI in training or competition.

In addition to an increase in intra-abdominal pressure caused by external loads, being overweight or obese is thought to increase the risk of UI [14]. This notion is supported by several studies that demonstrated a strong and positive correlation between body mass index (BMI) and the incidence of UI [15–17]. Central adiposity, as indicated by a large or increasing waist circumference, and a higher waist-to-hip ratio has also been found to increase the risk of UI [17]. The increased risk of UI in obese women is thought to be caused by a rise in intra-abdominal pressure and its effect on urethral structures [18]. In addition, obesity may also cause damage to the vascular system in the pelvic floor, leading to dysfunction of the detrusor and sphincter muscles [18].

The 84 kg+ weight division was the heaviest weight division in Powerlifting Australia at the time when data were collected [19]. Women who compete in the 84 kg+ weight division may do so because they are taller, or carry more adipose tissue or muscle than lifters in lower bodyweight categories. Without measuring lifters' height and completing a body scan to assess body composition, it is difficult to determine if a greater body mass is due to skeletal height, higher fat mass (FM) or fat-free mass (FFM). Sustersic and Kralj found that high body weight, a strong osteomuscular structure, and a lifetime of hard physical work were associated with a higher incidence of UI [20]. Consequently, we were interested to see if lifters competing in higher weight divisions were more likely to experience UI than lifters competing in lower bodyweight divisions.

Urinary incontinence is also thought to exacerbate with increasing age [20, 21], but may plateau around menopause and decrease further post-menopause [16, 17]. It is thought that UI later in life is caused by a change in position of the urethra and prolapse due to weakening of PFMs, creating pressure on the bladder [21]. Ageing may increase the need for more frequent micturition because of a reduction in bladder size, volume and early detrusor contractions [22].

A lifetime of heavy lifting has been identified as a risk factor for the development of UI in women [20]; however, the effect of age, body mass, resistance training experience, and competition grade on the incidence of UI in competitive women powerlifters has not been studied. Therefore, the aim of this study was to investigate the relationship between commonly cited risk factors and the incidence of UI in competitive women powerlifters.

Materials and methods

Participants were recruited through the help of the three major Australian powerlifting federations. The researchers contacted each federation inviting them to circulate the online questionnaire by an electronic link through email or social media. The authors aimed to include all eligible participants; however, the number of capitated members who received the link was unknown. Eligible members were women powerlifters in Australia above the age of 20 who could provide their best total. Data for this study were collected using the Qualtrics platform, an online-based survey tool. The anonymous questionnaire was available from September 2016 to December 2017, and 151 powerlifters responded to the questionnaire. The rate of urinary incontinence in this study was measured by the Incontinence Severity Index (ISI), a validated questionnaire developed and refined by Sandvik et al. [23]. Murphy et al. found that the ISI strongly correlated with the stress symptom subscales of the Urogenital Distress Inventory and is very sensitive to change seen with treatment [24]. The ISI tool is particularly useful for assessing the severity of female UI in epidemiological surveys [23].

There was no validated questionnaire to investigate the rate of UI in powerlifters. Therefore, the questionnaire for the study was self-developed to provide information on the prevalence of UI in different age groups, resistance training experience, as defined by the number of years a woman has been participating in resistance training, competition grade, and weight divisions. The questionnaire (Appendix 1) assessed the age range, bodyweight division, resistance training experience, best ever total, and UI before and after commencing powerlifting. This study was approved by the Human Ethics Committee at Charles Darwin University, and the survey was prefaced by a plain language statement explaining that participation was voluntary and that participants could choose not to participate by closing the browser at any time. Consent was deemed to be provided by participants who completed the questionnaire and submitted their responses.

Parts of the questionnaire, such as the use of the ISI and the selected age groups, were based on a large South Australian Health Omnibus Survey [25, 26]. Components of the survey such as the weight divisions were selected from the then applicable Powerlifting Australia weight divisions for competition [19]. In addition, this information was used to categorise lifters into four bodyweight categories (less than 57 kg, between 57.1 to 71.9 kg, between 72 to 83.9 kg, and more than 84 kg). Sociodemographic data such as parity, birthweight, instrumental delivery, previous pelvic surgeries and other physical activities were not collected.

Data were analysed using SPSS 25.0 (SPSS, Chicago, IL, USA). To estimate the proportion of variance in ISI that can be accounted for by age, resistance training experience, bodyweight categories, and competition grade, a multiple regression analysis was performed. A Kruskal–Wallis one-way ANOVA was used to compare the ISI among different age groups, bodyweight categories, and competition grade. Competition grade was calculated based on the woman's highest recorded total using the Powerlifting Australia grading classification [19]. The probability level of statistical significance was set at $p \leq 0.05$, and descriptive statistics were expressed as means ± SD. Effect sizes were calculated using $\eta^2 = \frac{x^2}{N-1}$ where Chi-squared is the same as Kruskal–Wallis H, and N is the total sample size [27]. Cohen's f was calculated using $f = \sqrt{\frac{\eta^2}{1-\eta^2}}$ formula [28], and values of 0.01, 0.059 and 0.138 were considered to be small, medium, and large effects [28].

The relationships among age groups, resistance training experience, powerlifting experience, bodyweight categories, and competition grade with ISI were assessed using a Kendall's Tau-B.

The last question of the questionnaire gave the women an opportunity to provide a general comment.

Results

Analysis of data showed that 151 participants attempted the questionnaire. However, the responses of 17 participants, who did not complete the questionnaire, were excluded from this study. The responses of the remaining 134 participants are summarised in Fig. 1. In combination, the age of participants, resistance training experience, bodyweight categories, and competition grade accounted for a significant 28% of the variability in the ISI, $R^2 = 0.277$, adjusted $R^2 = 0.215$, $f(4, 47) = 4.494$, $p = 0.004$. Non-standardised (B) and standardised (β) regression coefficients, and squared semi-partial correlations (sr^2) for each predictor in the regression model are reported in Table 1.

The results of Kruskal–Wallis ANOVA analyses are presented in Table 2. There was no statistically significant difference in ISI among different age groups ($p > 0.05$). The incidence of lifting-related UI and daily-life UI in different age groups is illustrated in Fig. 2. The lifting-related UI was higher than daily-life UI for all age groups.

In addition, there was no statistically significant difference among body weight categories ($p > 0.05$). Figure 3 demonstrates the lifting-related UI and daily-life UI in different bodyweight categories. Similar to the incidence of UI in different age groups, the rate of lifting-related UI was higher than that of daily-life UI in all bodyweight categories.

Similarly, as demonstrated in Fig. 4, the lifting-related UI was higher than daily-life UI at all competition grades, and the rate of UI among different competition grades was not statistically significant ($p > 0.05$). The D grade lifters had significantly less experience in resistance training (1.5 ± 1 years) compared with other grades. However, the difference in resistance training experience among C (6 ± 5.2 years), B (5 ± 4.5 years), A (5 ± 4.5 years), EII (4.9 ± 4.5 years), and EI (4.9 ± 14.4 years) grades was not significant. Of the 36 women in this study who experienced UI in training, 14 women did not experience UI during competitions. This number represents a 39% lower rate of UI in competition than in training.

Kendall's tau-b indicated that the correlation between resistance training experience and ISI was positive and significant $\tau = 0.26$ $p = 0.02$, $N = 54$. However, the relationship between age groups ($\tau = 0.16$ $p = 0.14$, $N = 54$), powerlifting experience ($\tau = 0.16$ $p = 0.16$, $N = 54$), bodyweight categories ($\tau = 0.14$ $p = 0.20$, $N = 54$), and competition grade ($\tau = -0.14$ $p = 0.23$, $N = 54$) with ISI were not significant.

The voluntary comments made by 27 of the women at the end of the survey were classified into five themes:

1. UI in training: the lifts identified as causing UI were deadlifts ($n = 11$), with two women stating that sumo deadlifts were more likely to cause UI than conventional deadlifts, squats ($n = 5$) and front squats ($n = 2$). Wearing a belt while lifting was reported by 5 women as contributing to UI.
2. Intensity vs volume: 4 women commented that they experienced UI at the end of sets using moderate to heavy weights and 14 women stated that they experienced UI with very heavy or maximal weights. One woman indicated the weight that triggered UI became progressively heavier as her strength increased.
3. Triggers for UI outside training: comments about triggers for UI outside training included jumping movements ($n = 4$) and sneezing ($n = 2$).

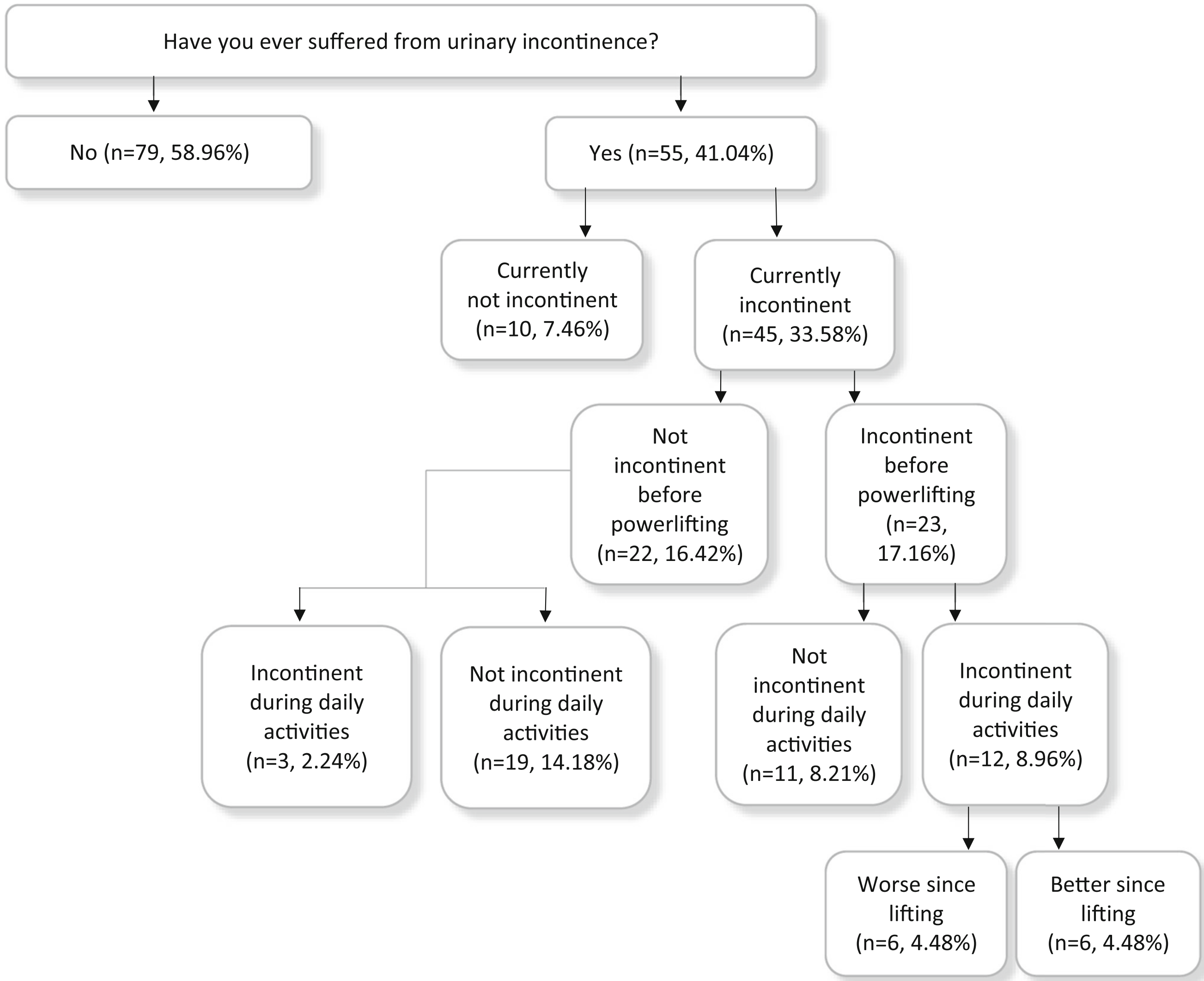

Fig. 1 Flowchart of the number of participants and percentages at 95% confidence interval (CI)

4. Perceived causes of UI: surgical procedures ($n = 1$), urinary tract infections ($n = 1$), childbirth ($n = 2$), caffeine ($n = 1$), lack of sleep ($n = 1$), ageing ($n = 2$) and weight gain ($n = 1$).
5. Practices the women engaged in to control or minimise UI: pelvic floor exercises ($n = 2$), not wearing a belt ($n = 2$), prophylactic voiding ($n = 3$), lifting ($n = 2$) and improving their diet ($n = 1$).

Table 1 Non-standardised (*B*) and standardised (β) regression coefficients, and squared semi-partial correlations (sr^2) for each predictor in the regression model predicting the Incontinence Severity Index

Variable	*B* (95% CI)	β	sr^2
Age groups	0.21 (−0.13, 0.54)	0.19	0.02
Resistance training experience	0.14 (0.10, 0.26)	0.32	0.07
Weight categories	0.03 (−0.01, 0.07)	0.22	0.04
Competition grade	−0.30 (−0.64, 0.05)	−0.23	0.05

Discussion

This study investigated the relationship between commonly cited risk factors and UI in competitive women powerlifters. The results showed that age, resistance training experience, weight categories and competition grade accounted for 28% of the variability in UI, as measured by the ISI. The results indicated that UI is a prevalent problem in women powerlifters, with 41 % of women powerlifters experiencing UI at some point in their life. The prevalence of UI in this study was similar to that of the South Australian Omnibus survey, as determined by the ISI [25], and athletes involved in other sports [3]. Approximately 16.5% of UI sufferers in

Table 2 Incontinence Severity Index in different age groups, competition grade, and bodyweight categories using Kruskal–Wallis one-way ANOVA

		N	Mean rank	*H* (corrected for ties)	*df*	*p*	η^2	Cohen's *f*
Age groups (years)	20–24	8	26.19	8.85	7	0.26	0.17	0.45
	25–29	15	24.73					
	30–34	9	26.17					
	35–39	8	24.75					
	40–44	4	28.13					
	45–49	6	27.25					
	50–54	2	47.25					
	55–59	2	50.25					
Competition grade (Powerlifting Australia)	EI	19	30.29	3.46	5	0.63	0.07	0.27
	EII	7	27.93					
	A	11	20.36					
	B	7	25.00					
	C	5	25.00					
	D	5	27.67					
Bodyweight categories (kg)	≤57	10	26.35	2.47	3	0.48	0.05	0.22
	57.1–71.9	13	22.81					
	72–83.9	19	28.45					
	≥83.9	12	32.04					

this study had developed UI since commencing powerlifting. These women, however, stated that UI was mostly experienced during training and competition, and only 2.2% developed sustained UI outside training and competition. A possible mechanism could be that heavy lifting, not their daily activities, surpasses their personal threshold for leakage, as described by Eliasson et al. [5]. Similarly, a study by Thyssen et al. found that 4% of women had frequent urine leakage while participating in sport and only 0.3% experienced urine leakage during everyday activities [29]. Athletes were also more likely to experience urine loss during training, than during competition and this was attributed to higher

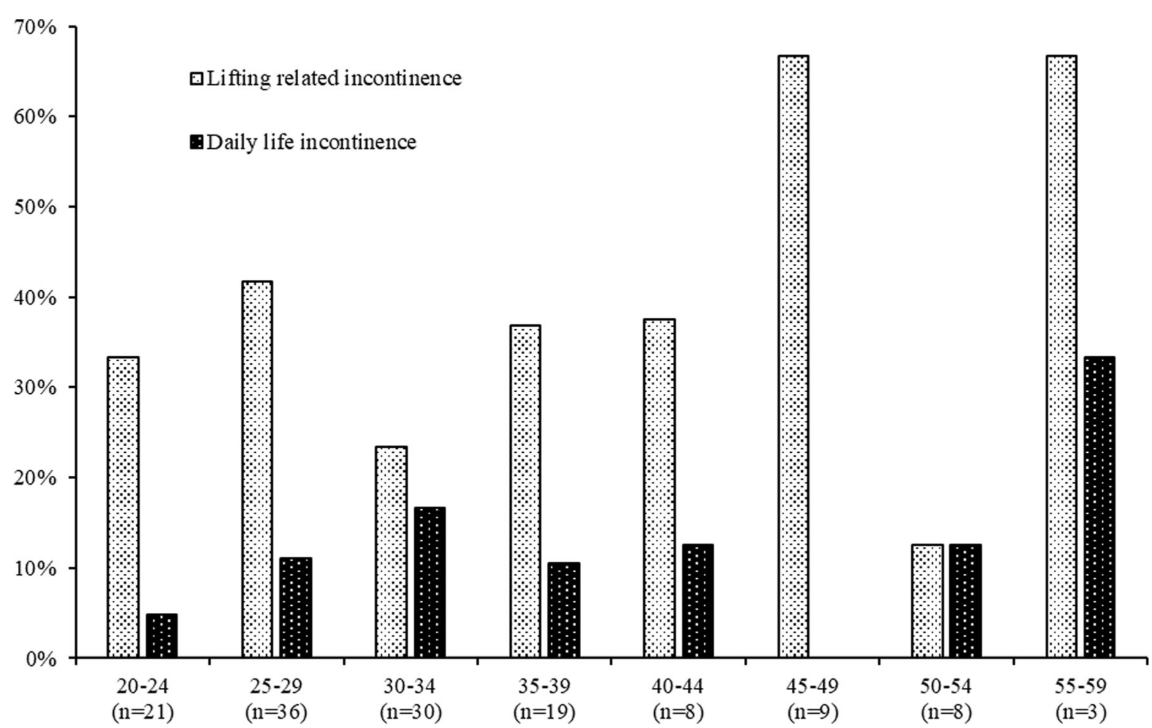

Fig. 2 Lifting-related and daily-life prevalence of urinary incontinence in different age groups

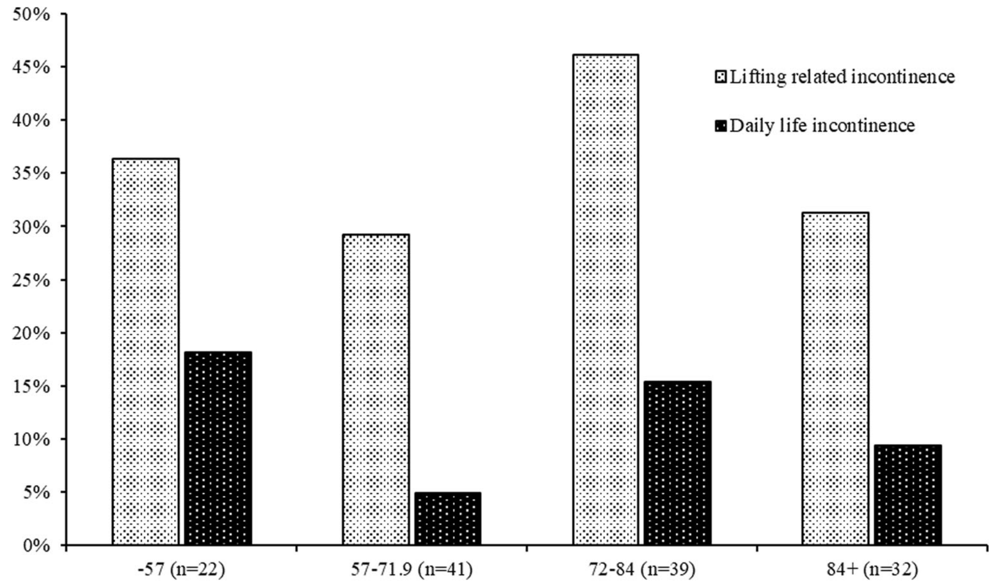

Fig. 3 Lifting-related and daily-life prevalence of urinary incontinence in different bodyweight categories

catecholamine levels during competition, which act on receptors in the urethra, keeping it closed [29]. This could explain why the rate of UI in women powerlifters in our study was 39% lower in competition than in training—even though in competition, they would most likely lift heavier weights.

The information regarding individual lifts that caused the most amount of leakage in our study was provided by some of the women in response to an open question at the end of the survey. The lifts identified as causing leakage were heavy lifts, lifts where there were many repetitions in a set and lifts such as squats and deadlifts. Sumo (wide-stance) deadlifts caused a greater problem than conventional deadlifts and wearing a belt exacerbated symptoms further. One participant observed that as she became stronger, lifts that had previously caused leakage, no longer caused leakage. The rate of UI in active women is well documented. Activities with a high impact on the pelvic floor are likely to increase leakage, whereas low-impact activities are related to lower rates of leakage [5]. Movements that produce repetitive contact with a hard surface such as jumping, skipping and running are cited as causing more

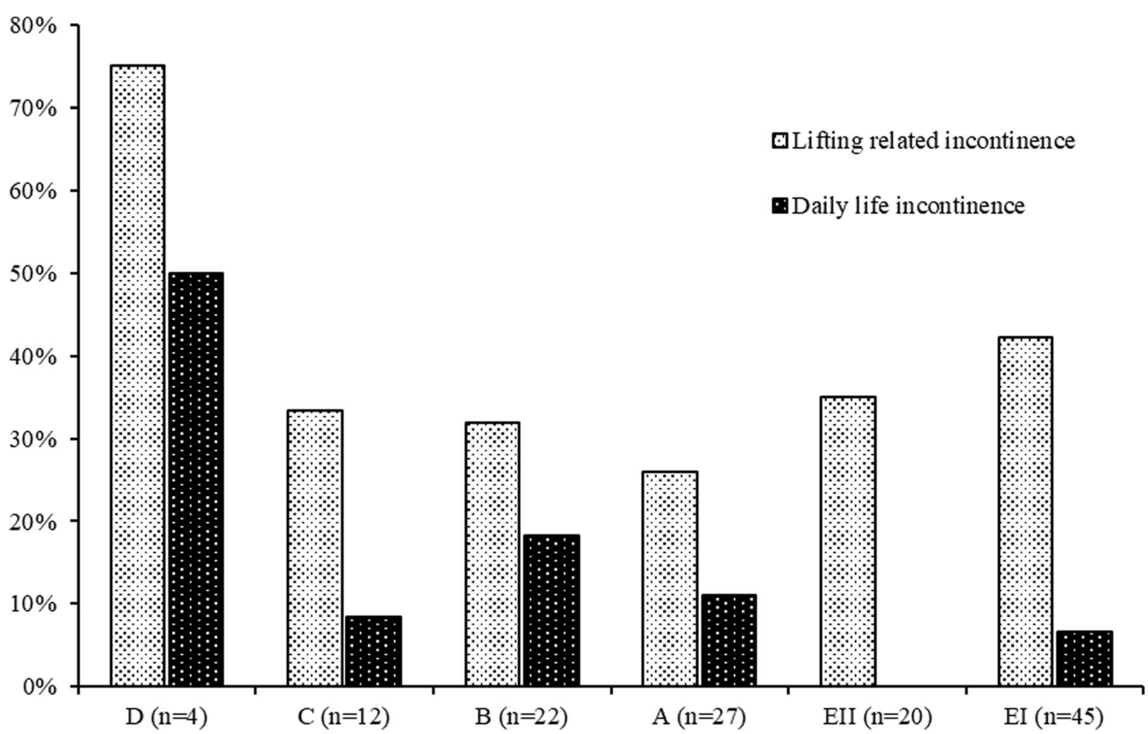

Fig. 4 Lifting-related and daily-life prevalence of urinary incontinence at different competition grades

leakage than activities such as yoga and Pilates [4]. More moderate forms of exercise such as walking are associated with a decrease in leakage [30]. Studies examining the rate of UI during resistance training rank the incidence of UI produced by these activities within the lower range [31]. Studies that include resistance training often do not break down the results into individual lifts; however, a study by Brennand et al. identified squats as problematic while maintaining that classic weightlifting-style activities, such as deadlifts, push/shoulder press, clean and jerk, snatch and bench press, were minimally problematic [4].

An important finding in this study was that 10 women who had previously experienced UI were no longer incontinent. A further 4.5% of women indicated an improvement in UI during daily life activities since commencing powerlifting training. Another 4.5% experienced an exacerbation of their symptoms of UI during daily life activities. It is not clear why some women experienced improvement in symptoms whereas others reported an increase in their symptoms. Individual outcomes could be related to the women's ability to sufficiently activate their PFMs before lifting. PFM strength and the ability to effectively activate the PFMs was not assessed in this study. Therefore, it is difficult to comment on the relationship between the strength of PFMs and UI in women powerlifters.

A common risk factor for the development of UI in women is obesity and a high BMI [14]. Research shows that women who are not overweight have a lower incidence of UI [32], and a reduction in BMI has been shown to be significantly associated with reduced symptoms of UI [33]. A strong association between intra-abdominal pressure and BMI suggests that PFMs might be exposed to a chronic state of increased stress in women with a high BMI [34].

Although it is acknowledged that this study did not find a statistically higher rate of UI in women in the 84 kg+ category compared with other bodyweight categories, the overall relationship between bodyweight and UI was positive. One possible reason why the UI in lifters in the 84 kg+ weight category was not significantly higher than lightweight categories is that competitive lifters are more likely to be fitter than the general population and carry their weight as muscle rather than body fat; therefore, their BMI is not a good indicator of obesity. BMI results have been found to be insufficient when estimating obesity and the measure of body composition is a more useful measure when determining health status [35]. Studies citing BMI as a risk factor for UI such as the one conducted by Khullar et al. are population-representative rather than athlete-representative [15]. It would be prudent to include a question regarding the stature of lifters in future studies so that BMI can be calculated, allowing the relationship between BMI and UI in powerlifters to be further investigated.

The results of multiple regression suggested that the prevalence of UI increased with age in this cohort of lifters. Several factors may affect UI with increasing age, including parity, obesity and diabetes [17]. A longitudinal study may provide an insight into the prevalence of UI with increasing age in women powerlifters.

This study found a positive and significant correlation between resistance training experience and the incidence of UI. This finding is in agreement with previous studies that suggest that a lifetime of physical activity might slightly increase the odds of stress UI [36]. The correlation in the literature appears to be stronger for women who engage in heavy labour [20] rather than women who lift as a recreational activity or sport [37]. Studies have identified an increased rate of UI in women engaging in high-volume physical training or activities with a high impact on the pelvic floor in comparison with women who train at lower levels or inactive women [5, 37]. Alternatively, mild to moderate physical activity has been reported to reduce the odds of developing UI [5, 36]. It is important to determine why some women experienced fewer symptoms of UI since commencing powerlifting whereas others experienced an exacerbation of symptoms. It is not enough to compare the relationship among morphology, function and biomechanics in continent and incontinent athletes [37]. The difference between women who improve with resistance training and those who do not needs further investigation.

Despite the positive correlation between the rate of UI and the competition grade of women powerlifters, the difference between competition grades was not statistically significant. This is an important finding, as elite lifters are more likely to be training with heavier loads than novice powerlifters. Subsequently, the volume of training will be higher in elite lifters than in novice lifters. Da Roza et al. reported that trampolinists with the highest performance scores and training volume also had the highest incidence of UI [37], and that women who participate in organised exercise involving high-volume training are more likely to suffer from UI [37]. Several differences could explain the discrepancies between the current study and those found by Da Roza et al.. First, the participants of this study were competitive powerlifters with significant experience in performing deadlifts and squats, whereas the participants of Da Rosa's study took part in a variety of organised sports. Second, powerlifting, unlike high-impact sports such as trampolining, is a low-impact sport. Finally, the progressive overloading in powerlifting is very gradual and allows the pelvic floor to adjust to increases in intra-abdominal pressure. This supports the theory that female athletes may have a strong pelvic floor and the regular increase in intra-abdominal pressure that results in a contraction of the PFMs will train and strengthen the pelvic floor [38].

Although the rate of UI, as measured by the ISI, was not significantly higher for elite lifters, it was elevated in the D-grade lifters. This finding may be attributed to the short average period that participants in this group had been powerlifting (1.5 years); however, this result needs to be interpreted with caution owing to the small number of D-grade women. It is possible that the pelvic floor and body composition of this group of lifters has not undergone the adaptive changes that come with long-term lifting.

A limitation of the study was that the development of UI by some lifters in this study could have been associated with factors not investigated in this study. Information regarding parity, other risk factors and sociodemographic data were not collected. This was unfortunate, as this information may have clarified why some women experienced an exacerbation of their symptoms of UI whereas others remained unchanged or improved over time. In addition, calculating BMI may have revealed interesting information about the correlation between BMI and UI in powerlifters. A further limitation is that women relied on recall rather than on an objective measure of UI.

Conclusion

The results of this study indicated that the prevalence of UI in women powerlifters was 37% during lifting activities and 11% during everyday activities. Elite powerlifters with a long history of performing resistance training were more likely to experience UI. In addition, women were more likely to experience leakage in training than in competition, and during certain lifts such as deadlifts and squats or when wearing a belt.

Compliance with ethical standards

Conflicts of interest LW is the Secretary of a not-for-profit organisation, Darwin Powersports Incorporated. Darwin Powersports Incorporated promotes strength sports and conducts local powerlifting and strongman competitions. DC and DG declare that they have no conflicts of interest.

Appendix 1

Female powerlifters and continence questionnaire.

1. Please nominate your age range.
2. Which of the following powerlifting federations do you currently belong to? CAPO, GPC, PA or others.
3. How long have you participated in any type of strength-/weight-based training?
4. How long have you been powerlifting?
5. What body weight do you usually compete at?
6. What is your best ever total in kilogrammes?
7. Approximately what is your current total in kilogrammes?
8. Do you or have you ever suffered from urinary incontinence?
9. Did you suffer from any form of urinary incontinence before powerlifting?
10. Have your symptoms improved or gotten worse as your lifting age has increased?
11. Do you currently suffer from urinary incontinence outside of training?
12. Do you currently suffer from urinary incontinence during training?
13. Do you currently suffer from urinary incontinence when competing?
14. Do you currently suffer from urinary incontinence during a maximum-effort lift?
15. How often do you experience urine leakage? Never = 0; less than once a month = 1; a few times a month = 2; a few times a week = 3; every day and/or night = 4.
16. How much urine do you lose each time? None = 0; drops = 1; small splashes = 2; more = 3.
17. Are there any other comments you would like to make?

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