ORIGINAL ARTICLE

Body Mass Index and Waist Circumference are Associated with Urinary Incontinence in Older Women

Norazlina Ya'acob[1,2], Ida Hasni Shaari[1] and Maria Justine[1]*

[1] Center for Physiotherapy Studies, Faculty of Health Sciences, Universiti Teknologi MARA Selangor, Puncak Alam Campus, 42300 Puncak Alam Selangor Malaysia
[2] Physiotherapy Unit, Hospital Putrajaya, Wilayah Persekutuan Putrajaya

ABSTRACT

Introduction and Purpose: Urinary incontinence (UI) is a prevalent problem among older persons that can be worsened by obesity and reduced muscle mass. Therefore, the purpose of this study was to identify which obesity and muscle mass indices may be associated with UI. **Materials and Methods:** This study recruited 209 participants newly referred by a doctor for UI management. The types of UI, namely stress UI (SUI), urgency UI (UUI), and Mixed UI (MUI) are diagnosed by the doctor. Obesity indices (body mass index [BMI, kg/m2], waist circumference [WC, cm], body fat %) and muscle mass indicators (skeletal muscle mass [SMI, kg/m^2], calf circumference [CC, cm]) were measured using standard tools. The association of the subtypes of UI with obesity indices and muscle mass indicators was tested using the Chi-square tests. **Results:** The analysis revealed that most of the participants in all UI subtypes presented with overweight/obese, WC of above 80 cm, higher body fat %, normal SMI, and larger CC (34 and above). BMI (X^2=16.58, p=0.015) and WC (X^2=6.69 p=0.041) were significantly associated with UI. There was no significant association between muscle mass indicators and UI (p>0.05). **Conclusion:** The current findings suggest that higher body mass index and larger waist circumference may influence the presence of UI as fat accumulation around the abdominal region may increase abdominal pressure. Future studies can explore the effectiveness of weight management in reducing the symptoms of UI in older women who are obese.
Malaysian Journal of Medicine and Health Sciences (2025) 21(SUPP5): 20–26. doi:10.47836/mjmhs.21.s5.3

Keywords: muscle mass; obesity; older persons; urinary incontinence

Corresponding Author:
Maria Justine, PhD
Email: maria205@uitm.edu.my
Tel: +603 3258 4365
Fax: +603 3258 4599

INTRODUCTION

Urinary incontinence (UI), a frequently underreported condition (1), affects approximately 15-55% of women and to involuntary urine leakage (2). UI can lead to fall incidence, urinary tract infection, skin breakdown, functional decline, and psychological constraints that increase healthcare expenses (3-6), ultimately leading to a poor quality of life (7). Moreover, UI has been reported to be an early indicator of frailty and is more prevalent in vulnerable patients (5,8). Women who are overweight or obese are at a higher risk of developing UI, partly due to excess pressure on the pelvic floor muscles (PFM) and bladder. Additionally, obesity is often associated with metabolic syndrome, which has been linked to the development of overactive bladder, further compounding UI risk in this population (9-13). Older people who suffer UI may also experience significant comorbidities, including longstanding type 2 diabetes (14), functional impairments, reduced muscle mass and strength, joint dysfunction, difficulty performing daily tasks, frailty, chronic pain, and a lower quality of life (7,15).

A previous study has shown that UI particularly the SUI among adults aged 20 and over, was associated with age, body mass index (BMI), and waist circumference (WC) (9,16). Another study reported a substantial relationship between polycystic ovary syndrome and UI and BMI among 113 nulliparous females aged 18 to 45 years (10). On the other hand, weaker pelvic floor muscles may contribute to UI, and thus, maintaining overall muscle mass and strength can be important for managing UI.

Presently, limited studies have been done solely among older persons to identify whether obesity indices and muscle mass indicators may influence subtypes of UI. Understanding the association between obesity indices and UI can enhance knowledge of the distribution of weight and fat in older people that contribute to UI. On the other hand, muscle mass is an important parameter in diagnosing the presence of sarcopenia which is a generalized muscle weakness associated with advanced age (17-19). A measure of calf circumference (CC) is also worth studying as it has been shown to mimic muscle mass in older people and is used as a screening method for probable sarcopenia (20,21). Due to the various negative consequences of obesity that may interact with ageing physiological changes particularly changes in muscle mass, understanding their relationship with UI may provide evidence to guide healthcare providers in tackling these issues. Therefore, the purpose of this study was to examine the association of different types of UI with obesity indices (BMI, WC, body fat), and muscle mass (skeletal muscle index [SMI] and CC) in older women diagnosed with UI. This study holds valuable implications for stakeholders in geriatric and women's health, offering insights that can aid in tailoring interventions for older women with UI. By identifying specific obesity and muscle mass indices associated with UI, healthcare providers can target preventive measures, potentially reducing UI prevalence, improving quality of life, and lowering healthcare costs related to ageing populations

MATERIALS AND METHODS

A cross-sectional study was conducted to compare several demographic groups at a single moment in time. The UiTM Research Ethics Committee (REC/05/2021(MR/306) and the Medical Research Ethics Committee (MREC) (NMMR/ID-22-01113-WSE (IIR) granted the research ethical clearance for this study. Data collection was conducted from July 29, 2022, to July 2023 at the Kuala Lumpur Hospital's Geriatric Day Care Clinic and Specialist Ambulatory Care Centre. This setting was chosen for data collection because it served as the Ministry of Health's first established geriatric clinic in Malaysia and has grown to become the hub for referrals.

The study's participants were chosen through the use of the purposeful sampling approach. The G-Power software, version 3.1.9.2 (22), was used to calculate the sample size with the given α (0.05) and effect size (0.25) based on the association between the primary variables and UI subtypes, suggesting the recruitment of about 210 participants.

Women 60 years of age and older who were referred by a physician, diagnosed with UI (type of UI), spoke English or Malay fluently, and showed no signs of cognitive impairment as measured by a Mini-cog score greater than 2 were eligible for inclusion. Exclusion criteria included severe illnesses, neurological conditions such as Parkinson's disease or stroke, severe post-stroke sequelae (e.g., hemiparesis, aphasia), and sensory deficits (as diagnosed during a comprehensive geriatric assessment (CGA) or self-reported geriatric syndromes).
A stadiometer was used to measure height without shoes, to the closest 0.1 centimetre. Participants wore light clothing and without shoes during the weight measurement. The BMI was calculated based on the following formula = (Weight (kg) / Height (m) x Height (m). A body mass index of 18.5–24.9 kg/m^2 was considered normal weight, but BMIs of less than 18.5 kg/m^2, 25–29.9 kg/m^2 and more than 30 kg/m^2 were categorized as underweight, overweight, and obese, respectively. The muscle mass was measured using the bioelectrical impedance analysis (INBODY, Japan). The SMI (kg/m^2) was then calculated using the following formula = muscle mass (kg)/Height (m) x Height (m). Participants had to face front and stand erect on the BIA platform to take measurements. Participants' shoulders were slightly adducted without slackening the BIA wires were slack, the participants grasped the hand-held electrodes with both elbows completely extended. In less than 30 seconds, the required parameters' findings were displayed in the BIA, and the researcher recorded them on the data collection form.

A non-elastic measuring cloth tape was used to measure WC and CC. To measure the WC, the participants stood straight with thin clothing, arms at the sides, feet closed together, and body weight evenly spread over both feet. Measurements were taken after a normal breath with the tape placed at 1 cm above the naval and parallel to the floor and averaged two measurements (cm). If the discrepancy between the two measures is more than 1 cm, the two measurements will be taken again (23). The cut-off points for WC for Asians (80 cm for women) were used to categorize the participants (24).

The protocol for measuring CC was based on the recommendations from the National Health and Nutrition Examination Survey (NHANES) (25). The participants were asked to sit on a chair while having their CC measured using the cloth tape (26). The tape was placed snugly on the largest circumference of the calf region of the non-dominant leg. The measurement was taken, with accuracy to within 0.1 cm. Measurements were taken three times and agreed within 0.5 cm. In this study, cut-off marks of <33 cm were used to indicate low muscle mass (27).

Data analysis was done using IBM SPSS Statistics (IBM SPSS Statistics: IBM Corporation, Armonk, NY) version 25 of the Statistical Package for the Social Sciences (SPSS). The data's normal distribution was assessed using the Kolmogorov-Smirnov test which indicated a normal distribution among the UI types. The research participants' differences in the normally distributed continuous data were examined using a one-way analysis of variance test (ANOVA). The independent variables (obesity indices and muscle mass) were categorized into two categories based on the 50th percentile for each category (see Table II). The Chi-square test of association was performed to determine the association of the independent variables with the dependent variables (UI subtypes). A p-value of < 0.05 was used to indicate the level of statistical significance.

RESULTS

The sociodemographic details of the research participants are shown in Table I. A total of 209 participants were recruited and categorized into 70 SUI (33.49%), 69 UUI (33.01%) and 70 MUI (33.49%). There is no significant difference in the mean age among all the three groups (p > 0.05). Most participants were Malay, multiparous, and married. While in terms of education, the majority in the SUI had no formal education, while the UUI and MUI mostly had primary school education.

Table I: Characteristic of participants (N = 209)

Characteristics	Types of Urinary Incontinence			P Value
	SUI (N = 70)	UUI (N = 69)	MUI (N = 70)	
Age (Years)	67.27 ± 5.06 (60 – 79)	68.23 ± 5.90 (60 – 84)	67.26 ± 5.44 (60 – 80)	0.332[a]
Ethnicity				
Malay	36 (51.43%)	41 (59.42%)	45 (64.29%)	0.437[b]
Chinese	22 (31.43%)	21 (30.43%)	15 (21.43%)	
Indian	12 (17.14%)	7 (10.14%)	10 (14.28%)	
Educational Level				
No formal education	31 (44.29%)	22 (31.88%) 26 (37.68%)	22 (31.43%) 30 (42.86%)	0.206[b]
Primary school	17 (24.29%)	17 (24.64%)	12 (17.14%)	
High school	19 (27.14%)	4 (5.80%)	6 (8.57%)	
Certificate/ Diploma / Degree	3 (4.28%)			
Parity				
Primipara 1	5 (7.14%)	5 (7.25%)	9 (12.85%)	0.286[b]
Multipara (2 – 5)	33 (47.14%)	43 (62.32%)	37 (52.86%)	
Grandmultipara (6 and above)	28 (40.0%)	20 (28.99%)	23 (32.86%)	
Nullipara	4 (5.71%)	1 (1.45%)	1 (1.43%)	
Marital Status				
Married	67 (95.71%)	64 (92.75%)	63 (90.0%)	0.424[b]
Divorced / widowed	3 (4.29%)	5 (7.5%)	7 (10.0%)	

Pearson Chi-square, significant at p < 0.05. [a] = One-Way ANOVA; [b] = Pearson Chi-square test; [c] = Fisher's exact test
Note: SUI: stress urinary incontinence ; UUI: urge urinary incontinence; MUI:

Table II displays the mean values of obesity indices and muscle mass data for all the UI groups. The results showed no significant differences between UI types in BMI, WC, SMI and CC (All p > 0.05).

Table III displays the obesity indices (BMI and WC) and muscle mass (SMI and CC) data for all UI groups. There were significant association of BMI and WC with UI types (p = 0.015, p = 0.041). While, CC, MM, SMI and Body fat mass showed no significant association (p > 0.05). In terms of BMI, the majority in the SUI were overweight, with higher WC values, the largest CC value, the lowest MM value and higher SMI value.

Table II: Comparison of obesity indices and muscle mass parameters among different types of urinary incontinence in older women

Variables	Types of Urinary Incontinence			P Value
	SUI (N = 70)	UUI (N = 69)	MUI (N = 70)	
BMI (kg/m²)	25.88 ± 2.27	25.55 ± 3.76	25.48 ± 4.16	0.771
Waist circumference (cm)	86.35 ± 8.18	86.52 ± 11.77	86.23 ± 13.86	0.989
Calf circumference (cm)	35.49 ± 2.77	34.84 ± 4.36	35.05 ± 4.65	0.620
Muscle mass (kg)	22.05 ± 4.33	20.91 ± 5.21	20.83 ± 5.09	0.261
Skeletal muscle index (kg/m²)	9.26 ± 2.02	8.81 ± 2.35	9.04 ± 2.50	0.518
Body Fat mass (%)	32.50 ± 11.13	33.36 ± 11.24	34.41 ± 10.64	0.591

One-Way ANOVA test is significant at p<0.05; Note: SUI: stress urinary incontinence; UUI: urge urinary incontinence; MUI: mixed

Table III: Association between obesity indices, muscle mass, calf circumference by category and types of urinary incontinence

Variables	Types of Urinary Incontinence			X²	P Value
	SUI (N = 70)	UUI (N = 69)	MUI (N = 70)		
BMI (kg/m²)					
Underweight (< 18.5)	0 (0.0%)	0 (0.0%)	3 (4.29%)	16.585	0.015
Normal (18.5 – 24.9)	24 (34.29%)	32 (46.38%)	29 (41.43%)		
Overweight (25 – 29.9)	42 (60.0%)	28 (40.58%)	26 (37.14%)		
Obese (> 30)	4 (5.71%)	9 (13.04%)	12 (17.14%)		
Waist circumference (cm)					
< 80	8 (11.43%)	15 (21.74%)	20 (28.57%)	6.686	0.041
80 and above	62 (88.57%)	54 (78.26%)	50 (71.43%)		
Calf circumference (cm)					
35 and above	47 (67.14%)	36 (52.17%)	34 (48.57%)	5.588	0.064
Below 35	23 (32.86%)	33 (47.83%)	36 (51.43%)		
Muscle mass (kg)					
>33	0 (0.0%)	1 (1.45%)	1 (1.43%)	1.641	0.601
33 and below	70 (100%)	68 (98.55%)	69 (98.57%)		
Skeletal muscle index (kg/m²)					
8.75 and above	44 (62.86%)	32 (46.38%)	37 (52.86%)	3.888	0.145
8.75 below	26 (37.14%)	37 (53.62%)	33 (47.14%)		
Body Fat mass (%)					
Normal	28 (40.0%)	30 (43.48%)	24 (34.29%)	1.264	0.533
Obese	42 (60.0%)	39 (56.52%)	46 (65.71%)		

[b]Pearson Chi-square test, significant at p < 0.05. Notes; BMI: body mass index; SMI: skeletal muscle index; SUI: Stress urinary incontinence; UUI: Urge urinary incontinence; MUI: Mixed urinary incontinence.

DISCUSSIONS

The current study aimed to examine the association of obesity indices and muscle mass with UI, particularly the subtypes of UI. The findings showed only the BMI and WC were significantly associated with UI. In this study, it is important to note that the majority of the study participants presented with excessive body weight (overweight and obese), large WC and higher body fat percentage. The findings are consistent with several earlier reported studies (20,28-31). A study suggested that women who presented with excessive BMI are at a risk of UI and risk tends to rise over time (11). However, two studies (32,33), argued that obesity might not necessarily increase the risk of incontinence. This could be because of different characteristics of the study participants, such, as age, level of frailty, or other demographic factors that could have influenced the outcomes (33). Obesity causes an increase in abdominal pressure that in turn strain on the bladder, causing urine to leak when coughing or sneezing (11). In addition, prolonged abdominal pressure may disrupt the role of PFM in supporting the bladder (34) causing the bladder to descend which in turn leads to urine leakage.

In this study, we found that WC is significantly associated with UI as the majority of the participants in each category of UI presented WC of > 80 cm. This finding is consistent with two other studies (20,31) indicating that WC is more reliable as a clinical predictor of UI than BMI (35-37). This is because WC is a direct measure of central obesity or accumulation of visceral fat around the abdomen that can raise abdominal pressure putting strain on the bladder and PFM. On the other hand, believing that high BMI can independently cause an increase in abdominal pressure may not be sufficient as BMI is a measure of the overall body weight relative to height that does not differentiate between muscle mass, bone density and fat distribution. Hence, it is wise to conclude that WC as a measure for central obesity is more impactful on intra-abdominal pressure and PFM than peripheral obesity as measured by the BMI.

The present study also investigated whether muscle mass as presented by SMI and CC as these measures are commonly used to indicate the presence of sarcopenia or age-associated generalized muscle weakness (17-19). Although this study did not find a significant association of these parameters with subtypes UI, it is noteworthy to discuss that the majority of the participants presented with normal SMI but large CC. A previous study had shown that participants with SUI had noticeably less trunk muscular mass but also did not find a significant relationship between UI types and muscle mass (29). Several studies supported that muscle mass, particularly in the PFM, is associated with elevated risk of UI in older women (38,39). Another study reported that a strong correlation was found between UI and sarcopenia among older people (40-42). The lack of a relationship in the current study could be due to several reasons. SMI is a measure of the overall muscle mass of the body that may not directly indicate the muscle mass of the PFM that is related to UI. Furthermore, the current study employed a cross-sectional study design that may not capture the relationship between changes in muscle mass and the development of UI. However, measuring the muscle mass of the PFM may be challenging due to the complexity of isolating its assessment.

Utilizing CC as a surrogate biomarker for muscle weakness may be more practical and acceptable in clinical settings, however, we did not find a significant association between UI and CC. A larger CC is often associated with more muscle mass and lower limb strength; therefore, CC can represent muscle mass to some extent (21). However, extra adipose tissue in individuals with obesity may skew the connection between muscle mass and CC (11) as CC tends to increase with obesity. The validity of CC as a direct measure of MM may be impaired, although it may still give some indication of lower limb muscle mass and strength in obese persons (43). Moreover, CC is less reliable as a gauge of muscle mass in obese people because the amount of adipose tissue in this group might obscure the real amount of muscle mass (11) (44). CC is nevertheless useful, especially in obese people, for evaluating the health and function of the lower limbs despite these limitations (45). Furthermore, the use of CC as one of the indicators for reduced muscle mass may not be accurate considering the current study included different ethnicities, as CC is influenced by ethnicity and genetics (27,46).

On the other hand, the current study still has a potential gap, as it did not include measures such as pelvic floor muscular strength that may mediate the relationship between obesity indices and UI. Additionally, age-related height loss in older adults may cause an overestimation of BMI, skewing results related to UI. Hence, using armspan as a proxy for original height could offer a more accurate basis for BMI calculations in future studies, particularly in older populations (47). Moreover, while increased waist circumference influenced UI, other factors associated with metabolic syndrome (MetS), including insulin resistance, chronic inflammation, and altered hormonal profiles, may be worth a future study to determine its potential contribution to UI.

CONCLUSION

In conclusion, the current study found that only BMI and WC were significantly associated with different types of UI, and not CC, SMI, and body fat. This study focuses exclusively on older adults with diagnosed UI who may be increasingly affected by obesity and muscle changes, the current findings offer how central and peripheral body fat distribution may influence UI differently, thus, emphasizing the relevance of WC as a practical screening tool over BMI, reinforcing the role of central obesity in UI risk. Hence, it is suggested that healthcare providers incorporate anthropometry and body composition assessment while tailoring intervention to individualized needs to improve outcomes and enhance the quality of life of older people with UI. Future studies should focus on exploring the impact of PFM strength and bladder function on UI to gain an understanding of the relationship in older women.

ACKNOWLEDGMENTS

The publication of this article was funded by the Faculty of Health Sciences, Universiti Teknologi MARA, Puncak Alam Campus.

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