SYSTEMATIC REVIEW

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Is there a link between overactive bladder and the metabolic syndrome in women? A systematic review of observational studies

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SUMMARY

Objectives: To conduct a systematic review to determine whether there is an association between metabolic syndrome (MetS) and lower urinary tract symptoms (LUTS) or overactive bladder (OAB) in women. **Methods:** We systematically reviewed English language observational studies on the effect of MetS (or component factors) on the presence of OAB or LUTS in women. We searched PubMed, Web of Science and The Cochrane Library with no date restrictions, checked reference lists and undertook citation searches in PubMed and Google Scholar. Studies were assessed for risk of bias. Because of heterogeneity, results were not pooled, but are reported narratively. **Results:** Of 27 included studies, only three looked at the link between MetS and OAB. The rest looked at links between OAB and components of MetS such as obesity or insulin resistance ($n = 10$), between MetS and urinary symptoms ($n = 3$) and between urinary symptoms and components of MetS, such as obesity ($n = 14$). Evidence is currently limited, but it does suggest that there may be important links between MetS and OAB and components of MetS such as obesity. **Conclusions:** The literature on MetS and OAB or LUTS in women is limited, and poor quality. However, the evidence available on obesity appears to support MetS as a contributor and predictor of LUTS in women. Many of the women with LUTS will be overweight and will have features of the MetS, if looked for. This provides not only an opportunity to encourage weight loss as an adjunct to therapy for the OAB symptoms but also a window of opportunity to address cardiovascular risk factors and prevent future cardiovascular morbidity and mortality.

Review criteria

Observational studies examining the link between metabolic syndrome (MetS) (or components of MetS) and the presence of OAB or LUTS were identified through database and lateral searches.

Message for the clinic

Both obesity and MetS have been shown to have complex links with LUTS. It is not known whether reducing insulin resistance and central obesity-related chronic inflammation and oxidative stress might prevent the onset of OAB or improve the outcome of current treatment. However, identifying women with MetS who harbour a portfolio of cardiovascular risk factors does provide an opportunity to address future cardiovascular risk, and prevent premature morbidity and mortality; although whether this will have an effect on the storage component of LUTS is unclear. The key variables to address are diet and lifestyle, especially exercise. The investigations should include a blood pressure recording, BMI and waist circumference measurement together with a lipid profile and HbA1c. These results should be transmitted to the GP for action.

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Background

Introduction to overactive bladder

Lower urinary tract symptoms (LUTS) is now thought of as an umbrella term, encompassing all disorders of bladder and urethral function (1), including storage, voiding and postmicturition symptoms (2). Storage symptoms are often more stressful and bothersome than voiding symptoms; especially if incontinence features as a symptom (3). The prevalence of LUTS in women has been found to be high, with 76% of women aged between 40 and 99 years reporting that they sometimes had LUTS and 53% that they often did (4).

The term overactive bladder (OAB) is used to describe storage symptoms excluding stress (exertional) urinary incontinence and has been defined as a symptom complex characterised by urinary urgency, with or without urgency incontinence, usually with urinary frequency and nocturia (5). International population-based studies have reported prevalence rates of OAB around 12% (6,7) rising to 17% in individuals aged 40 and over (8). Rates were similar in men and women and increased with age (6).

The underlying pathophysiology of OAB has not been completely explained, but includes abnormalities in the detrusor muscle, whereby spontaneous motor activity may occur, and the urothelium, which can trigger urgency by neurotransmitter release and by central mechanisms, linked to cerebral white matter changes, particularly in the prefrontal regions of the brain. The urothelium/suburothelium

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compartment of the bladder has a high metabolic rate and is now believed to play a key role in mechanosensory transduction (9).

What is metabolic syndrome?

The metabolic syndrome (MetS) is a common disorder, which describes the frequent clustering of several metabolic abnormalities, including central obesity, dyslipidaemia, hypertension, insulin resistance and glucose intolerance [Type 2 diabetes, impaired glucose tolerance (IGT) or impaired fasting glycaemia] (10). This combination of symptoms occurs in individuals more often than might be expected by chance alone (10), and when grouped together are associated with increased risk of cardiovascular disease, including coronary heart disease (CHD), stroke (11,12) and type 2 diabetes (13,14). In most cases, MetS is thought to develop as a result of poor eating habits and a sedentary lifestyle; and with the current global epidemic of obesity and diabetes the prevalence of MetS is growing rapidly (10), adversely affecting daily activities and general well-being (15). In addition to general obesity, the distribution of body fat, in particular abdominal obesity, is independently associated with the MetS in older women, particularly among those of normal body weight (16).

The World Health Organization developed the first internationally accepted definition of MetS in 1998 (17); since then, other organisations have proposed definitions, including the National Cholesterol Education Program's Adult Treatment Panel III Report (18), The International Diabetes Federation (IDF; 19) and the American Heart Association and the National Heart, Lung and Blood Institutes (20). The varying definitions (Table 1) all accept four core components of MetS – glucose intolerance, obesity, hypertension and dyslipidaemia – but differ in the specific levels set for each component and the combination of symptoms required. For example, the IDF (19) puts more emphasis on central obesity, as it is more strongly related to other MetS features than any other factor (21).

The Metabolic Syndrome and LUTS

Recently, MetS has been implicated in the aetiology of LUTS (22) and is thought to affect bladder function by its stimulating effects on the autonomic nervous system (ANS). Evidence of an association between MetS and OAB has been identified in women (23,24). MetS may cause OAB symptoms via a number of possible mechanisms. These include acting through the ANS either directly or by induction of diabetes and the production of pelvic ischaemia via atherosclerosis (25).

Accumulating evidence from clinical studies and basic research suggests that ischaemia may be an independent factor in the development of non-obstructed non-neurogenic bladder overactivity and LUTS. A close correlation between pelvic ischaemia and bladder overactivity has been documented in elderly men and women (26–29). Recent research has established a link between LUTS and the MetS in men (30), providing a rationale for the present review, which focuses on the relationship between MetS and OAB in women. The overall aim of this systematic review was to synthesise the international literature to determine whether there is an association between MetS and LUTS or OAB in women.

Methods

Inclusion criteria

We included studies pertaining to the effect of MetS on the presence of OAB or other LUTS in women. MetS was defined as: a combination, or clustering, of several metabolic abnormalities or risk factors, including (i) central obesity, (ii) dyslipidaemia, (iii) hypertension, (iv) insulin resistance with compensatory hyperinsulinaemia and (v) glucose intolerance (Type 2 diabetes, IGT, or impaired fasting glycaemia) (10). As there are relatively few studies focusing specifically on MetS, we broadened our criteria to include related components of MetS such as abdominal obesity, insulin resistance and hyperlipidaemia. Although diabetes is also a risk factor for MetS, we excluded studies focusing on diabetes on the basis that these patients may also have neuropathy and more frequent UTIs (31,32).

We used the International Continence Society definition of OAB, which defines it as a symptom syndrome; characterised by urinary urgency, with or without urgency incontinence, usually with increased daytime frequency and nocturia (33). We also included studies reporting urgency urinary incontinence (UUI) or mixed urinary incontinence (MUI), but excluded those only reporting stress urinary incontinence (SUI) as this is not associated with OAB. We also excluded studies where the type of incontinence was not specified.

We included all studies that examined an association between OAB and MetS in women. This included cross-sectional studies, cohort studies and case–control studies. Our main outcome of interest was the association between OAB and MetS, but we also looked at the association of other components of MetS (such as abdominal obesity measured by waist circumference) with OAB or urinary symptoms associated with OAB such as urgency incontinence.

Table 1 Definitions of MetS

Organisation	Definition of MetS
The American Heart Association and the National Heart Lung and Blood Institute criteria for the MetS (relevant to men)	Diagnosis of the MetS requires any three of the following: • Waist circumference > 38 inches (88 cm) • Blood pressure of 130 mmHg systolic OR 85 mmHg diastolic, or greater OR on antihypertensive Medication • HDL-C < 0.9 mmol/l OR drug treatment for reduced HDL-C • Fasting triglycerides of 1.7 mmol/l or greater OR drug treatment for elevated triglycerides • Fasting glucose of 5.6 mmol/l or greater OR drug treatment for elevated glucose
The WHO definition of the MetS	Glucose intolerance, IGT or type 2 diabetes and/or insulin resistance together with two or more of the other components listed below • Impaired glucose regulation or diabetes • Insulin resistance (under hyperinsulinaemic euglycaemic conditions, glucose uptake below lowest quartile for background population under investigation) • Raised arterial pressure ≥ 140/90 mmHg • Raised plasma triglycerides (≥ 1.7 mmol/l; 150 mg/dl) and/or low HDL cholesterol (< 0.9 mmol/l, 35 mg/dl men; < 1.0 mmol/l, 39 mg/dl women) • Central obesity (men: waist to hip ratio > 0.90; women: waist to hip ratio > 0.85) and/or BMI > 30 kg/m^2 • Microalbuminuria (urinary albumin excretion rate ≥ 20 μg/min or albumin:creatinine ratio (≥ 20 mg/g)
The new International Diabetes Federation (IDF)	Must have central obesity plus any two of the following four factors • Raised triglycerides ≥ 150 mg/dl (1.7 mmol/l) or specific treatment for this lipid abnormality • Reduced HDL cholesterol < 40 mg/dl (1.03 mmol/l) in men, < 50 mg/dl (1.29 mmol/l) in women • Raised blood pressure. Systolic BP ≥ 130 or diastolic BP ≥ 85 mmHg • Raised fasting plasma glucose FPG ≥ 100 mg/dl (5.6 mmol/l) or previously diagnosed type 2 diabetes

Identification of studies

To identify studies for the review, we searched the following electronic databases: PubMed, Web of Science (including SCI, SSCI, HCI), Google Scholar and the Cochrane Library. In addition, we used 'lateral searching' techniques such as checking reference lists of relevant papers, and using the 'Cited by' option on Google Scholar and Scopus, and the 'Related articles' option on PubMed. Methodological search filters were not used. Searches were limited to published English language studies. There were no date restrictions. Database searches were run in August 2012 and lateral searching was updated in October 2013; search terms can be seen in Box 1.

Box 1 Search terms

PubMed (terms were adapted for other databases)

((overactive bladder [MH] OR 'bladder problems' OR incontinence OR 'pelvic floor disorder' OR urologic diseases [MH]) AND 'metabolic syndrome' OR insulin resistance [MH] OR diabetes [MH] OR hypertension [MH] OR 'cardiovascular disease' OR hyperlipidemia OR 'polycystic ovary syndrome') AND Women* OR woman* OR female*[Title/Abstract] Filters: Humans Filters: Humans

Study screening

Electronic search results were downloaded into EndNote bibliographic software and, where possible, duplicates deleted. Title and abstracts were screened by one author with a random 10% of records independently screened by a second author to check for agreement. Full manuscripts of all potentially relevant citations were screened independently by two reviewers using a screening form with clearly defined criteria. Uncertainties were resolved by consensus or by discussion with a third reviewer.

Data extraction, critical appraisal and analysis

For studies that met the inclusion criteria, data were extracted onto a predesigned, and piloted, form. Data included the following: type of study design (e.g. cross-sectional, case–control), characteristics of participants (including age, sex, ethnicity), number of participants, country of origin, outcomes relating to MetS or OAB (including how they were measured) and estimation of association between MetS, or components of MetS, and OAB.

The methodological quality of studies was assessed using criteria based on those of the Centre for Evidence Based Management. The core quality assessment principles are summarised in Table 2. Owing to sub-

Table 2 Core principles of study quality assessment

Study type and tool used	Scoring criteria
Surveys/cross-sectional Scored as Yes, no, or Can't answer	1. Did the study address a clearly focused question/ issue? 2. Is the research method (study design) appropriate for answering the research question? 3. Is the method of selection of the subjects (employees, teams, division, organisations) clearly described? 4. Is the sample free from selection bias? 5. Was the sample representative with regard to the population to which the findings will be referred? 6. Was the sample size based on prestudy considerations of statistical power? 7. Was a satisfactory response rate achieved? 8. Are the measurements (questionnaires) likely to be valid and reliable? 9. Was the statistical significance assessed? 10. Are confidence intervals given for the main results?
Case–control study Scored as Yes, no, or Can't answer	1. Did the study address a clearly focused question/ issue? 2. Is the research method (study design) appropriate for answering the research question? 3. Were there enough subjects in the study to establish that the findings did not occur by chance? 4. Was the selection of cases and controls based on external, objective and validated criteria? 5. Were both groups comparable at the start of the study? 6. Were objective and unbiased outcome criteria used? 7. Is there data dredging? 8. Are objective and validated measurement methods used to measure the outcome? If not, was the outcome assessed by someone who was unaware of the group assignment? 9. Is the size effect practically relevant 10. How precise is the estimate of the effect? Were confidence intervals given?

stantial heterogeneity, studies were not pooled in a meta-analysis, but are presented in a narrative and tabular summary. Results are reported in the following categories: (i) OAB and MetS; (ii) OAB and associated components of MetS (e.g. obesity); (iii) UUI or MUI and MetS; and (iv) UUI or MUI and associated components of MetS. Where possible, data are reported as relative risks with 95% confidence intervals.

Results

Description of studies

Twenty-nine papers reporting 27 studies met the inclusion criteria (Table 3) (4,7,23,24,34–57). An overview of the selection process can be seen in Figure 1. Two studies were classified as case–control studies (24,46) and the rest as surveys/cross-sectional studies. The number of participants in studies ranged from 60 to 27,936.

Fifteen studies made a specific reference to OAB (4,23,24,35,36,38,40,43–46,50–52,55,56). The others categorised urinary symptoms in a variety of ways including LUTS, UUI, SUI and MUI. Details of the type of incontinence and how it was measured and classified can be seen in Table 4.

Only four studies looked specifically at MetS (23,40,42,43). Definitions of MetS were based on criteria relating to waist circumference and levels of triglycerides, high-density lipoprotein cholesterol, blood pressure and fasting glucose. The remaining studies included information about components of MetS such as obesity, insulin resistance and dyslipidaemia. Obesity was most commonly measured using the body mass index (BMI; reported in 27 studies) but a number of studies also looked at waist circumference (reported in nine studies) or waist-hip ratio.

Study quality

Of the observational studies, 13 were judged to be free from selection bias because they involved a population-based sample or large samples from general practice or a HMO database. In seven studies, the response rate was not clear, but of the others, 11 were judged to have a satisfactory response rate ($\geq$ 50%). Quality assessment scores can be seen in Table 5 and a summary of quality assessment domains for the 25 cross-sectional studies in Figure 2.

Findings

Three studies looked at the link between OAB and MetS, 12 the link between OAB and associated risk factors (such as obesity and hyperlipidaemia), three the association between MetS and urinary symptoms and 14 the link between UUI or MUI and components of MetS. Details of the results (including effect sizes) can be seen in Table 5.

Table 3 Table of included studies

Reference	Aims and country	Study type	Inclusion criteria	Participant info	Outcomes measured
Brown et al. (1999)	Aim: Determine prevalence of stress, urge and mixed urinary incontinence and associated risk factors in postmenopausal women Country: USA	Survey/cross-sectional	Postmenopausal women less than 80 years of age, proven coronary heart disease and had a uterus	*n* = 2747 Age: 66.7 (mean) Ethnic origin; White: 89%. Black 8%. Hispanic 2%. Asian 0.5%. Other 0.5%	SUI UUI BMI
Cheung et al. (2009)	Aim: To measure the prevalence of OAB and management in primary care settings Country: USA	Survey/cross-sectional	Men and women over the age of 16	*n* = 311 (230 women) Age: 18–97 Ethnic origin: Black: 75.7% Hispanic: 11.7% White: 1.3% Other: 11.3%	OAB SUI UUI MUI Obesity
de Boer et al. (2011)	Aim: To study the prevalence and risk factors of OAB and its relationship with symptoms of pelvic organ prolapse Country: the Netherlands	Survey/cross-sectional	Women between the ages of 45 and 85 registered on the patient list of 8/9 GPs	*n* = 1397 Age: 45–85 Ethnic origin: Caucasian: 98.5% Non-Caucasian: 1.5%	OAB PoP Obesity
Elia et al. (2001)	Aim: To assess possible correlation between obesity and LUTS in women Country: USA	Survey/cross-sectional	All patients evaluated in Urogynaecology outpatient dept	*n* = 553 Age: High BMI/Obese (mean): 54.7 Low BMI/Normal: 55.5	UUI Frequency Obesity
Garnica et al. (2011)	Aim: To determine the relationship between OAB with or without UI and hyperlipidaemia Country: USA	Case–control	Women over the age of 40 Used data from the *GLOBE* study. The Bladder Health Survey was used, the data from the urgency and UI questions were utilised	*n* = 3599 (45% of baseline survey) Age: 59 (mean) (SD = 0.13) Gender: 100% female Socio-economic: 90% had high school education or higher	OAB Hyperlipidaemia Hyperlipidaemia was based on the diagnosis according to the International Classification of Diseases (9th ed)
Hall et al. (2008)	Aim: Conduct cluster analysis of urological symptoms to determine whether comorbidities, demographics and lifestyle factors are associated with cluster membership Country: USA	Cohort study	Women from the BACH survey Split into four clusters with varying degrees of urinary problems. UUI in all groups. Increasing severity of symptoms clusters 1–4	*n* = 3167 total patients. 2403 reported at least one symptom and were included in the analysis, C1: 1296. C2: 577. C3: 330. C4: 200 Age: Asymptomatic: 47.4. Cluster 1: 49. Cluster 2: 48. Cluster 3: 52.4. Cluster 4: 54.9 Ethnic origin: (%) C1: W (52.9), B(33.5), H (13.6); C2: W (66.8), B(22.8), H (10.4); C3: W (66.2), B (24.9), H (8.9); C4: W (53.9), B (35.8), H (14.2)	SUI UUI BMI Waist circumference
Hannestad et al. (2003)	Aim: To examine whether lifestyle factors such as smoking, obesity and physical activity were associated with urinary incontinence in women Country: Norway	Survey/cross-sectional (population-based)	Aged 20 and over living in one county in Norway	*n* = 27,936	UUI, SUI, MUI, BMI

Table 3 Continued

Reference	Aims and country	Study type	Inclusion criteria	Participant info	Outcomes measured
Hong et al. (2010)	Aim: To examine the correlation between metabolic syndrome and lower urinary tract symptoms in the aspects of gender-specific medicine Country: Korea	Survey/cross-sectional	Subjects who had participated in general health examinations at a specific hospital between March 2008 and July 2009 Exclusion: diagnosed with/ been treated with a drug for urological disease	*n* = 922 Age: Overall mean: 48.8 (SD = 6.8) Men: 48.8 (SD = 6.2) Women: 48.9 (SD = 7.6) Gender: 42% female Other: 143 (15.5%) satisfied diagnostic criteria for MS. 33 were females	LUTs MS MS Had to satisfy 3 of the NCEP-ATP III criteria. (1) Hypertension (2) hyperglycaemia (3) obesity (4) hypo-HDL cholesterol of less than 50 mg/dl (5) hypertriglyceridaemia of 150 mg/dl or higher
Jackson et al. (2004)	Aim: estimate the prevalence of and risk factors for SUI and UUI in a biracial sample of well-functioning women Country: USA	Survey/cross-sectional	No difficulty walking one-quarter mile, climbing 10 steps or performing activities daily	*n* = 1124 Age 70–79 Ethnicity: 50% White, 50% Black	UUI SUI
Kim et al. (2011)	Aim: To evaluate the association of metabolic syndrome with female pelvic floor dysfunction in middle-aged to older Korean women Country: Korea	Survey/cross-sectional	Women who had visited a comprehensive medical screening clinic between May 2009 and Jan 2010 for routine health examinations, over 40 years old	*n* = 984 Age: 49.5 (mean) (range 40–77)	PFD MS Obesity Waist Circumference MS: Measured by the presence of five risk factors: (1) waist circumference of over 80 cm for W (2) elevated triglycerides (3) reduced high-density lipoprotein cholesterol (4) elevated blood pressure (5) elevated fasting glucose
Khullar et al. (2013)	Aim: evaluate the relationship between body mass index and urinary incontinence Country: USA, UK, Sweden	Survey/cross-sectional (secondary analysis of EpiLUTS study)	> 40 years of age, able to read English, provide consent and have access to the internet Exclusion: pregnancy or UTI	*n* = 23,248 Age: Men: 54–64. Women: 56–60 Gender: 56.7% female Ethnicity: over 80% White in all groups	UUI MUI BMI
Kinjo et al. (2009)	Aim: Analyse the relationship between female OAB and MS Country: Japan	Survey/cross-sectional	Women who presented to female urology clinic	*n* = 205 Age: 53.4 (mean) Gender: 100% female Ethnic origin: 100% Japanese	OAB MS MS: According to Ministry of Health, Labour and Welfare in Japan (1) waist circumference over 90 cm{∴σοφτΕντερ}(2) triglycerides over 150 mg/dl and/or HDL cholesterol less than 40 mg/dl{∴σοφτΕντερ}(3) blood pressure greater than 130/85 mmHg{∴σοφτΕντερ}(4) fasting glucose equal to or greater than 110 mg/dl
Lawrence et al. (2007)	Aim: Associations between obesity and diabetes and female PFDs, SUI, OAB and AI in community-dwelling adults Country: USA	Survey/cross-sectional	Women who were selected from the Kaiser Permanente Southern California membership who had an	*n* = 4458 (37% response rate) Age: 56.6 Ethnic origin: 62% White, 19% Hispanic,	OAB Obesity

Table 3 Continued

Reference	Aims and country	Study type	Inclusion criteria	Participant info	Outcomes measured
			address on file with a health plan	10% Black, 8% Pacific Islander, 1% other Other: 10% diabetic/Prevalence: 15% SUI, 13% OAB, 25% AI, 35% had any PFD	
Link et al. (2011)	Aim: The association of different measures of adiposity with OAB (including frequency and urgency), whether the association varies by gender or age and whether it persists when models are adjusted by other confounders Country: USA	Survey/cross-sectional	BACH study. Resident of Boston, Massachusetts between 30 and 79, men and women	*n* = 5503 Gender: 58% women Ethnic origin: 1767 Black 1877 Hispanic 1859 White	OAB Frequency Obesity Waist circumference
McGrother et al. (2006)	Aim: To identify predictive morbidities for urinary storage syndromes Country: UK	Cohort study	Aged 40 or more registered with GP and living at home in Leicestershire	*n* = 12,570 Age: 59.5 (mean)	SUI OAB Obesity
Melin et al. (2007)	Aim: To estimate the prevalence and severity of nocturia and LUTS in obese women and to identify risk factors associated with nocturia in obese population Country: Sweden	Case–control	Women referred to clinic for a consultation between Feb 2003 and Jan 2006. Over 18, BMI over 35	*n* = 246 obese patients 379 control patients Age: Obese: 45 (SD: 12) Control: 45 (SD: 12) Gender: 100% female	OAB Obesity Waist circumference LUTs – Nocturia, frequency, bothersome(ness)
Mommsen (1994)	Aim: Study possible role of obesity in the aetiology of adult female urinary incontinence Country: Denmark	Survey/cross-sectional	Women referred to obesity clinic	*n* = 2631 Age: 30–59 years old	UUI, SUI, MUI BMI
Peyrat (2002)	Aim: To assess prevalence of and risk factors for urinary incontinence in young and middle-aged women Country: France	Survey/cross-sectional	Women working in French academic hospital	*n* = 1700 Age: 20–62	UUI, SUI, MUI BMI
Schwartz et al. (2009)	Aim: To examine the prevalence, severity and impact of incontinence in obese compared with non-obese girls Country: USA	Survey/cross-sectional	Women participants between the ages of 12 and 17. From two clinics BMI > 95th percentile for age and gender were obese, < 95th percentile were non-obese	*n* = Obese: 40 Non-obese: 20 Age: Obese: 15. Non-obese: 14.9 Gender: 100% female Ethnic origin: Obese: 42.5% White, 20% African American, 37.5% Other Non-obese: 30% White, 40% African American, 30% Other	Urinary Incontinence (including SUI and UUI) Obesity Distinguished adolescent girls with urinary incontinence. Occurring once or more per week; however, subjects with significant volume of leaked urine, even if infrequently, were included. Categorised as either stress or urge incontinence

Table 3 Continued

Reference	Aims and country	Study type	Inclusion criteria	Participant info	Outcomes measured
Stewart & Minassian (2010) Same study as Garnica et al. (2011)	Aim: Using the data from the General Longitudinal Overactive Bladder Evaluation (GLOBE) to understand predictors of variation in urgency and urinary incontinence (UI) symptoms over time Country: USA	Survey/cross-sectional	Geisinger Clinic primary care patients of at least 40 years old if they'd had a 'clinical encounter' within the last 4 years	*n* = Baseline survey: 6937 (44% response rate) Follow-up interview: 71% No other participant information given	OAB
Teleman et al. (2004)	Aim: To investigate the prevalence of the factors associated with overactive bladder in middle-aged women Country: Sweden	Survey/cross-sectional	Recruited from observational study involving women aged 50–59 living in Lund area of Sweden	*n* = 2682 (50% reporting incontinence)	OAB, MUI
Townsend et al. (2007, 2008)	Aim: To describe the relations between BMI, weight gain and incident urinary incontinence in middle-aged women Country: USA	Cohort study	Female nurses who had previously filled in questionnaire for Nurse's Health Study in 1989	*n* = 30,982 Age: 46.1 (mean) Gender: 100% female Ethnic Origin: % 4 BMI cats: < 21, 21–24, 25–29, > 30 White predominant in each BMI category	SUI, UUI, MUI Obesity, weight gain
Uzun & Zorba (2012a)	Aim: Investigate the relevance of MS in the aetiopathogenesis of OAB in women Country: Turkey	Survey/cross-sectional	Female patients who applied to the polyclinics with OAB symptoms or other urological complaints aged between 30 and 70	*n* = 313 OAB 208 age-matched controls Age: OAB – 51.43. Controls – 46.60 Gender: 100% female	OAB MS Obesity Waist circumference MS – 2006 International Diabetes Federation: Waist circumference over 80 cm, and two of the following: fasting plasma glucose > 100 mg/dl, serum triglyceride level > 150 mg/dl, specific treatment of lipid abnormalities % systolic bp of > 130 mmHg and/or diastolic bp of > 85 mmHg
Uzdan et al. (2012b)	Aim: Investigate the association of IR with OAB in female patients Country: Turkey	Case–control	Female patients at urology department	122 with OAB and 62 age-matched controls Age: Range 30–76. mean age OAB group 52.1, no OAB 51.1	Insulin Resistance Waist circumference BMI Cholesterol and triglycerides
Waetjen et al. (2007)	Aim: compare characteristics of and baseline factors associated with prevalent and incident urinary incontinence in a diverse cohort of midlife women Country: USA	Survey/cross-sectional	Aged 42–52 and belonging to one of the 5 racial/ethnic groups to be studied	*n* = 3301 Age 45.8 (mean) Ethnicity: White 1550; Black 934; Chinese 250; Japanese 281: Hispanic 286	UUI, SUI BMI Waist circumference

Table 3 Continued

Reference	Aims and country	Study type	Inclusion criteria	Participant info	Outcomes measured
Whitcomb et al. (2009)	Aim: determine the prevalence and bother from pelvic floor disorders (PFD) by obesity severity Country: USA		People who had undertaken the KP CARES questionnaire who were over a BMI of 30	*n* = 1155. 690 = obese, 284 = severely obese, 181 = morbidly obese 3238 non-obese women Age: Mean 46.4 (SD = 14.8) Ethnic origin: 58% Caucasian, 23% Hispanic, 14% African American, 3% Asian-Pacific Islander, 2% other or unknown	Pelvic Organ prolapse, SUI, OAB, Anal incontinence Obesity
Yu et al. (2006)	Aim: To investigate the prevalence, correlates, perception of OAB and doctor-consultation behaviour among community adults Country: Taiwan	Survey/cross-sectional	Registered residents in Matsu aged 30 or over Exclusion: Complaints of micturition pain or hernia, those aged over 80, incomplete data sets	*n* = 1827. M = 902, F = 925 Age: Women: 22.6% between 30 and 39 34.5% between 40 and 49 19.4% between 50 and 59 12.8% between 60 and 69, 10.8% 70–79% Mean: 49.9 Gender: 50.6% females	OAB Obesity Lipidaemia

AI, anal incontinence; BMI, body mass index; LUTS, lower urinary tract symptoms; MUI, mixed urinary incontinence; OAB, overactive bladder; PFD, pelvic floor disorders; SUI, stress urinary incontinence; UUI, urgency urinary incontinence.

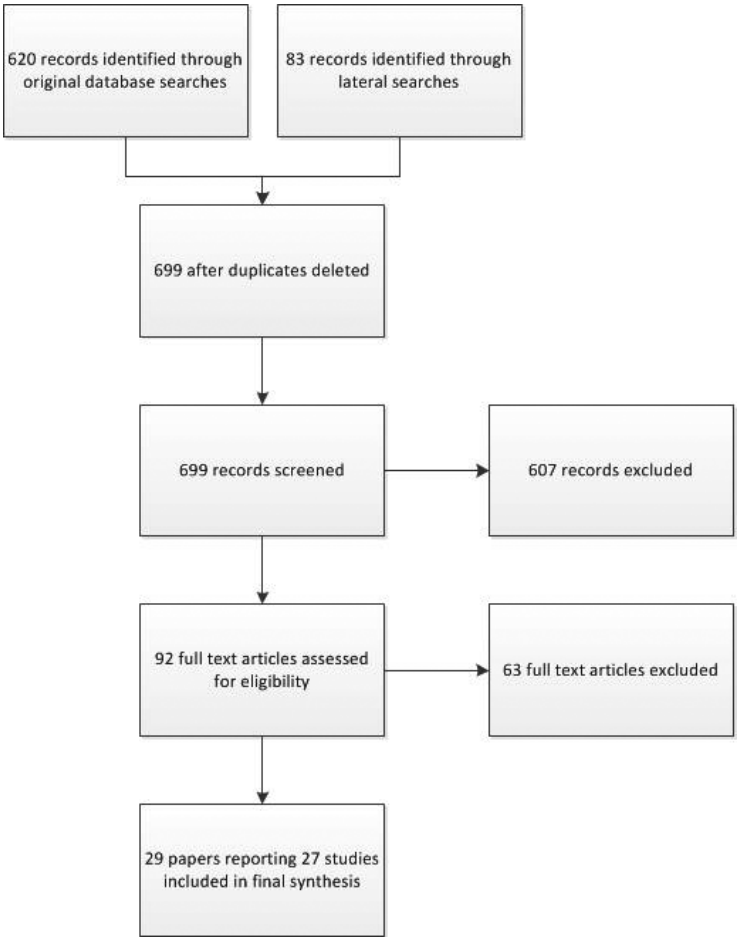

Figure 1 Flow chart of study selection process

MetS and overactive bladder

Of the three studies that looked at whether there appeared to be a link between OAB and MetS (23,40,43), all found a significant association. However, these studies had relatively small sample sizes and none scored more than six on the quality assessment tool.

OAB and associated risk factors

Ten studies considered whether there was a link between OAB and obesity. There was a statistically significant link between obesity (as measured by BMI) and OAB in eight (4,23,35,36,44–46,51), although in one small study (35), this was only significant in premenopausal women. Four of the studies that found a positive correlation had a quality assessment score of 8 or above. Of the others, one found a non-significant trend towards increasing prevalence of OAB with higher degree of obesity (55) and one (24) no significant association between OAB and BMI. Two studies found increasing odds of OAB in those with an increased waist circumference (23,45) and another reported no significant association between OAB and waist circumference (24). Four studies looked at the link between hyperlipidaemia and OAB; three found no significant association (23,24,38) and one found increased odds of OAB in those with hyperlipidaemia (56).

MetS and urinary symptoms (LUTS, urgency, frequency)

Of the three studies that examined the link between MetS and urinary symptoms (40,42,52), one (52) found a possible association, one (40) a significant difference in LUTS scores in those with MetS and one an association between MetS and MUI but not UUI (42).

Urinary symptoms (e.g. LUTS, UUI) and associated risk factors

Ten studies found an increased likelihood of urinary symptoms in those who were obese, but four did not (7,38,40,48). Of those that did find an association

Table 4 Type of incontinence and method of measurement

Study ID	Type of incontinence OAB/LUTS/UUI/SUI/mixed	Method of classification/measurement
Brown et al. (1999)	UUI, SUI, MUI	Variety of questions relating to voiding and incontinence UUI – have you unintentionally leaked some urine before you could get to the bathroom?
Cheung et al. (2009)	OAB, LUTS (including SUI, UI and MUI)	Overactive Bladder-Validated 8-question Screener (OAV-V8). OAB defined as an OAB-V8 score equal to or greater than 8
de Boer et al. (2011)	OAB	Urinary Distress Inventory (UDI). Symptoms were dichotomised. If symptoms denied/ not bothered = no (absent). If present and little to severely bothered = yes (present)
Elia et al. (2001)	UUI, SUI	Urgency – strong desire to void accompanied by fear of leakage or pain Frequency – voiding more often than every 2 h or more than six times during daytime
Garnica et al. (2011) Stewart & Minassian (2010)	OAB	Bladder health survey – used questions relating to urgency and UI. OAB is defined as a composite score of 5 + (range, 0–12)
Gokkaya et al. (2013)	LUTS	Turkish validated versions of the International Prostate Symptom Score (IPSS) and Bristol Female Lower Urinary Tract Symptoms (BFLUTS)
Hannestad et al. (2003)	UUI, SUI, Mixed	Sandvik severity index
Hall et al. (2008)	SUI, UUI	14 non-pain-related urological questions (similar to those in EPIC study)
Hong et al. (2010)	LUTS, OAB	IPSS (International prostate symptom score) and OABq-SF (Overactive Bladder Questionnaire Short Form)
Jackson et al. (2004)	UUI, SUI	Questions adapted from previous studies. Question – in the past 12 months have you leaked even a small amount of urine? And In the past 12 months, how often have you leaked urine? Classified as UIU –the urge to urinate and can't get to a toilet fast enough
Kim et al. (2011)	MUI	Pelvic Floor Distress Inventory-20 (PFDI-20) including the Urinary Distress Inventory-6 (UDI-6). Analysis focused on Q. 16 and 17 for urgency and stress UI
Kinjo et al. (2009)	OAB	Overactive bladder symptom score (OABSS) and International consultation of incontinence questionnaire (ICIQ-SF)
Khullar et al. (2013)	UUI, SUI, MUI	LUTS tool
Lawrence et al. (2007)	OAB	Epidemiology of prolapse and incontinence questionnaire (EPIQ) Based on responses to stem questions and degree of bother
Link et al. (2011)	OAB	OAB defined as urinary frequency, and urgency or urge leakage Frequency: < every 2 h, rated 'fairly often, usually, almost always' or > 8 times daily. Urgency: difficulty postponing, strong urge in the last month or week (four times). Urgency leakage: 1 or more occasions of accidental in the last week
McGrother et al. (2006)	OAB, SUI	OAB defined as urgency leakage or urgency – occurring monthly or more
Melin et al. (2007)	OAB, LUTS	Short-form Incontinence Impact Questionnaire (IIQ-7) and Urogenital Distress Inventory (UDI)
Mommsen (1994)	UUI, SUI, MUI	Question – have you experienced episodes of UI?, Urge – defined as feeling of urge to void
Peyrat (2002)	UUI, SUI, MUI	Question – do you currently have some involuntary leakage of urine? Urge – defined as involuntary loss of urine preceded by a sensation of urgency or by rapid and uncontrollable voiding with little or no warning
Schwartz et al. (2009)	SUI, UUI	Questions adapted from several validated questionnaires including BFLUTS
Teleman et al. (2004)	OAB, MUI	BFLUTS
Townsend et al. (2007)	SUI, UUI, MUI	Sandvik Severity Index
Uzum & Zorba (2012a)	OAB, LUTS	OAB validated 8 question screener. Score of 8 or less needed for OAB diagnosis
Uzum & Zorba (2012b)	OAB	International Continence Society 2010 definition of OAB OAB-OAB validated 8 question screener. Score of 8 or less needed for OAB diagnosis
Waetjen et al. (2007)	UUI, SUI	Question – in past year have you ever leaked even a small amount of urine involuntarily? Urge – urge to void and can't reach toilet fast enough
Whitcomb et al. (2009)	OAB, SUI	EQIP Prolapse and Incontinence Questionnaire (includes questions relating to POP, SUI, OAB, AI)
Yu et al. (2006)	OAB	International Continence Society 2010 definition of OAB Structured questionnaire to collect info on LUTS (symptom frequency assessed on scale similar to that used in American Urological Association Symptom Index

LUTS, lower urinary tract symptoms; MUI, mixed urinary incontinence; OAB, overactive bladder; SUI, stress urinary incontinence; UUI, urgency urinary incontinence.

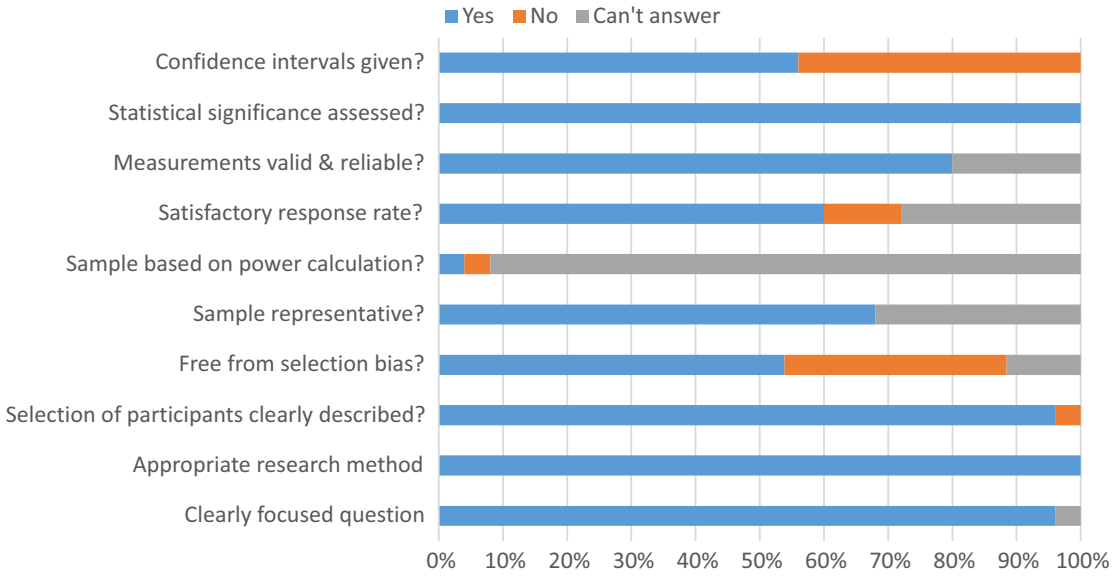

Figure 2 Summary of quality assessment domains for cross-sectional studies

between urinary symptoms and increased BMI, eight reported an increase in MUI (34,39,41,47,49,53,54,57). One study (40) reported no significant correlation between levels of high-density lipoproteins (HDL) and International Prostate Symptom Score.

Discussion

We included 27 studies, but, of those, only three looked specifically at the link between MetS and OAB in women. The remaining literature evaluated the links between OAB and components of MetS such as obesity or insulin resistance ($n = 10$), between MetS and urinary symptoms ($n = 3$) and between urinary symptoms and components of MetS ($n = 14$). Although the evidence is currently limited, it does suggest that there may be important links between MetS and OAB and between MetS and OAB symptom complex.

Several studies have demonstrated strong links between MetS and OAB in men (30,58,59). OAB has also been reported to be significantly associated with an increased prevalence of erectile dysfunction (ED) in men (60,61) and ED has been reported to be strongly related to MetS (62). Possible common explanatory aetiological mechanisms include atherosclerotic vascular disease, decreased nitric oxide levels or nitric oxide synthase expression and alterations of calcium regulatory proteins in smooth muscle, all of which influence both bladder and penile physiology. Although the anatomy and pathophysiology in relation to obstruction and OAB symptoms are clearly different in men and women, the underlying bladder pathophysiology may share some common features. An association between OAB and decreased sexual enjoyment in women mediated via decreased clitoral swelling, similar to ED in men, has also been reported (60). In both sexes, changes in bladder function may relate to changes in the bladder vasculature, epithelium, neuronal supply, smooth muscle and connective tissue, leading to LUTS. In older women, LUTS questionnaire scores show similar results to those of age-matched men (63,64).

There are a number of reported reasons why women with MetS may be at greater risk of developing OAB. These include inflammatory sympathetic overactivity, pro-inflammatory status, oxidative stress and endothelial dysfunction in addition to ischaemic damage during bladder storage, decreased perfusion of the bladder and bladder neck, an increase in non-esterified fatty acids and a nitric oxide deficiency. OAB may result from pathological change in all layers of bladder wall, rather than just the smooth muscle (myogenic theory) or nerves (neurogenic theory) (23). OAB is associated with impaired bladder contractility, in contrast to normal ageing, in addition to an overactivity (65).

Insulin resistance caused by obesity is a significant component of MetS and it is argued that pro-inflammatory state, increased free fatty acids, hypercoagulability, and cellular oxidative stress lead to premature vascular disease (66). In one study investigating this, there was a positive correlation with serum insulin levels in women with OAB. In addition, HOMA-IR, a measure of insulin resistance, was significantly higher in the OAB group in comparison to controls. HDL cholesterol levels were significantly lower in women with OAB (24).

Table 5 Summary of results

Study ID	Number of participants	Age (mean)	Association of OAB and MetS	Association of OAB and associated risk factors	Association of UUI or MUI and MetS	Association of UUI or MUI and associated risk factors	Quality score
Brown et al. (1999)(34)	2763 (393 UUI, 339 MUI)	66.7	Not measured (NM)	NM	NM	Yes obesity but not statistically significant for UUI BMI: UUI OR 1.09 (95% CI 0.99, 1.22) MUI 1.26 (1.15, 1.38) Waist/hip ratio UUI OR 1.06 (0.91, 1.23) MUI OR 1.09 (0.96, 1.23)	6
Cheung et al. (2009) (35)	311	Range 18–97	NM	*Yes obesity* – Significantly associated with obesity (BMI > 30) (p = 0.018). whencontrolled for menopause status only significant in premenopausal women	NM	NM	6
de Boer et al. (2011) (36)	1397	Range 45–85	NM	*Yes obesity* – BMI 25–30 OR 1.4 (1.1, 1.7), BMI ≥ 30 OR 2.3 (1.7, 3.2)	NM	*Yes obesity* and urgency and urge incontinence BMI 25–30 Urgency OR 1.3 (1.0, 1.7), urge incontinence OR 1.5 (1.1, 1.9) BMI ≥ 30 Urgency OR 2.2 (1.6, 3.1), urge incontinence OR 2.2 (1.6, 3.1)	8
Elia et al. (2001) (37)	553	54.4	NM	NM	NM	*Yes obesity* – prevalence of urinary urgency (p < 0.05) and incontinence (p < 0.001) increased as BMI increased Mixed incontinence OR 2.41 (1.5, 3.87)	7
Garnica et al. (2011) (38) Stewart & Minassian (2010) (50)	3599	59 (SD 0.13)	NM	*No hyperlipidaemia*. No significant association when adjusted for other confounders OR 0.97 (95% CI 0.81–1.16)	NM	No obesity – at 12-month follow-up no significant association UUI and BMI BMI 25–29.99 OR 1.29 (0.84, 1.99) BMI 30 + OR 0.97 (0.64, 1.47)	8
Gokkaya et al. (2013) (52)	155	Non-MS grp 42 (SD 12.1), MS grp 50.6 (SD 11.5)	NM	NM	Possible association MS and LUTS – 3/6 subscales of BFLUTS significantly higher in patients with MS	NM	5
Hall et al. (2008) (39)	3205	Asymptomatic;47.4, cluster 1: 49, C2: 57.7, C3: 52.4; C4: 54.9	NM	NM	NM	Yes – Obesity. Symptomatic women had higher BMIs and waist circumference on average than asymptomatic women	8

Table 5 Continued

Study ID	Number of participants	Age (mean)	Association of OAB and MetS	Association of OAB and associated risk factors	Association of UUI or MUI and MetS	Association of UUI or MUI and associated risk factors	Quality score
Hannestad et al. (2003) (57)	27,936	≥ 20 (mean age not given)	NM	NM	NM	*Yes – obesity.* Increasing BMI associated with all types incontinence but higher for MUI than UUI BMI 25–29: UUI OR 1.6 (1.1, 2.4), MUI OR 1.7 (1.5, 1.9) BMI 30–34: UUI OR 1.5 (1.2, 1.9), MUI 2.3 (2.0, 2.7) BMI 35–39: UUI OR 1.4 (0.9, 2.1), MUI 3.5 (2.9, 4.3) BMI 40+: UUI OR 1.8 (0.9, 3.5), MUI OR 3.7 (2.7, 5.2)	9
Hong et al. (2010) (40)	384 (8.6% had MS)	48.9 (SD 7.6)	*Yes MS and OAB* – significant difference in 5/6 categories on OABq-SF	NM	Yes MS – significant differences in LUTS	No significant correlation between BMI, HDL and IPSS score. BMI (0.573), HDL (0.338)	6
Jackson et al. (2004) (7)	1584	73.5 (SD 2.9)				*No – obesity*: no significant correlation between BMI and urge incontinence (but was associated with SUI)	6
Kim et al. (2011) (42)	984	49.5. Without MS 48.9 (SD 5.5), with MS 52.9 (SD 7.1)	NM	NM	Yes MS and MUI: MS significantly associated with PFDI-20 (especially urinary distress inventory subscale) $p = 0.002$ No MS and UUI. 18.1% vs. 14.2% $p > 0.05$	NM	8
Kinjo et al. (2009) (43)	205 (19% had MS)	53.4	*Yes MS and OAB* – significant difference in OABSS score ($p < 0.05$)	NM	NM	NM	5
Khullar et al. (2013) (41)	13,178	Mean age in 6 groups ranges from 54 to 64	NM	NM	NM	*Yes – obesity*: being obese (BMI) increased odds of UUI (OR 1.67, $p < 0.0001$), and MUI 9OR 2.58, $p < 0.0001$)	8
Lawrence et al. (2007) (44)	3962	56.6	NM	*Yes obesity*; association with BMI & OAB, Crude OR 2.67 (2.20–3.22)	NM	NM	8
Link et al. (2011) (45)	3202 (19.7% had OAB)	Range 30–79	NM	*Yes obesity*: prevalence of OAB increased as waist (OR 1.10/10 cm increase) or hip circumference (OR 1.12/10 cm increase), or BMI (OR 1.03 kg/m^2) increased	NM	NM	7

Table 5 Continued

Study ID	Number of participants	Age (mean)	Association of OAB and MetS	Association of OAB and associated risk factors	Association of UUI or MUI and MetS	Association of UUI or MUI and associated risk factors	Quality score
McGrother et al. (2006) (4)	12,570	59–5 (SD 13) Range 40–98	NM	*Yes obesity:* association BMI BMI > 25–30 (overweight) cross-sectional OR 1.2 (0.97, 1.14), longitudinal OR 1.3 (1.0, 1.8) BMI > 30 (obese); cross-sectional data OR 1.5 (1.2, 1.8), longitudinal OR 1.6 (1.1, 2.2)	NM	NM	9
Melin et al. (2007) (46)	625 (246 obese, 379 control)	Cases 45 (SD 12) Controls 45 (SD 12)	NM	Yes obesity: Obese women (BMI ≥ 30) had significant risk association with frequent urination (OR 4.7 95% CI 1.5–17.2), strong urge to empty bladder (OR 5.5, 95% CI 1.7–17.2), Urine leakage related to feeling of urgency (OR 7.2, 95% CI 2.2–23.3)	NM	NM	6
Mommsen & Foldspang (1994) (47)	2589	Range 30–59	NM	NM	NM	Yes obesity: prevalence of UUI and MUI significantly associated with BMI ($p < 0.0001$)	6
Peyrat et al. (2002) (48)	1700 (1.6% UUI, 13.5% MUI)	39.72	NM	NM	NM	No obesity – no significant association between BMI and UI. But prevalence of UI increased with age and obesity	5
Schwartz et al. (2009) (49)	60 (40 obese, 20 non-obese)	Obese 15, non-obese 14.9	NM	NM	NM	*Yes obesity* – MUI; Incontinence severity scores higher in obese group ($p = 0.009$)	5
Teleman et al. (2004) (51)	6917	Range 50–59	NM	*Yes – OAB associated with obesity* BMI ≥ 30 OAB1 OR 1.5 (95% CI 1.1–2.1) $p = 0.013$ OAB2 OR 1.6 (1.2–2.3) $p = 0.004$	NM	NM	9
Townsend et al. (2007, 2008)(53,77)	30,982	46.1	NM	NM	NM	*Yes obesity – associated with increasing odds of UUI and MUI* BMI 27.5–29.9: UUI OR 2.75 (1.33, 5.66), MUI OR 2.95 (1.65, 5.26); BMI 30–34.9: UUI OR 2.85 (1.43, 5.70), MUI OR 2.82 (1.60, 4.98); BMI ≥ 35: UUI OR 6.10 (3.11, 11.98), MUI OR 5.60 (3.17, 9.88)	9

Table 5 Continued

Study ID	Number of participants	Age (mean)	Association of OAB and MetS	Association of OAB and associated risk factors	Association of UUI or MUI and MetS	Association of UUI or MUI and associated risk factors	Quality score
Uzum & Zorba (2012) (23)	313 with OAB, 208 age-matched controls	OAB 51.43 (SD 11.395), no OAB 46.6 (SD 10.414)	Yes association of OAB and MS. 65% vs. 35% p = 0.002	*Yes obesity* – BMI and WC significantly greater in OAB group than controls (BMI p = 0.001, WC p = 0.002) No significant difference in total cholesterol, LDL, HDL or Triglycerides	NM	NM	6
Uzum & Zorba (2012) (24)	122 OAB, 62 age-matched controls	OAB 52.1 (SD 8.6), no OAB 51.1 (SD 6.4)	NM	*No obesity* – no significant association between OAB and BMI (p = 0.21) or WC (p = 0.12) Yes serum insulin levels – p = 0.036 Yes – HDL, No – total cholesterol, triglyceride, LDL	NM		6
Waetjen et al. (2007) (54)	3302	45.8	NM	NM	NM	Yes obesity – association of UUI and MUI with BMI UUI: prevalent OR 1.03 95% CI 1.00–1.06), incident OR 1.03 (1.01, 1.06) MUI; prevalent 1.04 (0.97, 1.11), incident 1.09 (1.04, 1.13)	8
Whitcomb et al. (2009) (55)	1155	56.4 (SD 14.8)	NM	*Possibly obesity and OAB* – Trend towards increasing prevalence of OAB with higher degree of obesity but not statistically significant	NM	NM	8
Yu et al. (2006) (56)	925	49.9	NM	Yes hyperlipidaemia. OR 1.77 (95% CI 1.09, 2.89) p = 0.03	NM	NM	8

AI, anal incontinence; BMI, body mass index; LUTS, lower urinary tract symptoms; MUI, mixed urinary incontinence; OAB, overactive bladder; PFD, pelvic floor disorders; SUI, stress urinary incontinence; UUI, urgency urinary incontinence.

Additionally, an epidemiological survey (67) demonstrated an association between increasing C-reactive protein, a marker of inflammation, and OAB for both men and women. An association with reduced blood flow to the bladder and LUTS in older women has also been demonstrated (26). Many women with polycystic ovary syndrome have bladder storage symptoms and additional features of the MetS, especially insulin resistance, obesity, and a raised serum testosterone concentration. These women have a higher prevalence and a greater degree of hyperinsulinaemia (68,69); as many as 30% have IGT and 7.5% have diabetes, (70) leading to increased cardiovascular risk (71). Because the ovarian hyperandrogenism contributes to insulin resistance (72), it may be contributing to the bladder storage symptoms in these women (73).

Limitations

We used systematic and rigorous methods to synthesise the current evidence on the link between OAB and MetS in women. However, there are a number of methodological limitations that could have a bearing on the validity of the results. We found only three studies that looked specifically at the association of OAB and MetS; other studies looked at components of MetS (such as obesity) or urinary symptoms more generally (e.g. LUTS). In addition, the quality of the studies was mixed with none of the studies fulfilling all of the criteria on the quality assessment checklists.

Implications for practice

The evidence supporting links between the MetS and LUTS in women is weaker than in men. However, current evidence does suggest that in women presenting with OAB, consideration should be given to whether the MetS is present. Although it is not known whether reducing insulin resistance and obesity related chronic inflammation and oxidative stress might prevent the onset of OAB and reduce LUTS, identifying women with MetS provides an opportunity to address the portfolio of cardiovascular risk factors and prevent premature morbidity and mortality. Although it remains prudent to recommend weight loss in overweight and obese women, control of all modifiable cardio-metabolic risk factors in both normal and overweight persons to prevent transition to the MetS and diabetes should be considered the ultimate goal (74).

Obesity and type 2 diabetes are particularly detrimental to women's health. Women with a higher degree of abdominal obesity are especially susceptible to type 2 diabetes, and women with diabetes have a disproportionally higher relative risk of CHD than men with diabetes (75,76). As the MetS may be a better predictor of future cardiovascular risk in women than the BMI, waist circumference may be a more important clinical measure than the BMI. Key variables to explore are diet and lifestyle, especially exercise routines, lipids, blood pressure and dysglycaemia. Investigations should include a blood pressure recording, BMI and waist circumference measurement together with a lipid profile and HbA1c. These results should be transmitted to the Primary Healthcare Team for action.

Conclusions

There is increasing evidence to suggest there may be a link between MetS and OAB or LUTS. There is good evidence to suggest that obesity is an important predictor of LUTS in women. Many obese women will have features of the MetS, if looked for, and this provides a window of opportunity to address cardiovascular risk factors and prevent future cardiovascular morbidity and mortality; the effect of intervention on LUTS in women is unclear.

Author contributions

MK and FB wrote the protocol; FB, KC and EP extracted and analysed the data; FB and MK wrote the first draft of the manuscript; all authors reviewed, critically commented and edited the document at each stage of its development.

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