Personal hygiene and asymptomatic bacteriuria in women aged 40 to 65 years

Farasita Ambarwati*, Maysarah Elfani*, Apriani Margastutie*, and Nurul Mahirah Binti Mohd. Dahuri*

ABSTRACT

*Professional Study Program, Medical Faculty, Trisakti University

Correspondence
Farasita Ambarwati, SKed.
Professional Study Program, Medical Faculty, Trisakti University
Jl. Kyai Tapa No.260
Grogol - Jakarta 11440

Asymptomatic bacteriuria (ABU) is one of the bacterial infections most frequently found in women in all age groups, particularly in postmenopausal women. Around 10-25% of women suffer from symptomatic urinary tract infection (UTI) all their life. Several risk factors are associated with the occurrence of ABU in females, such as a history of UTI, sexual activity, diabetes mellitus, personal hygiene, sexual hygiene, and menopausal status. The aim of this study was to determine the most important risk factor of influence on ABU in premenopausal and postmenopausal women at the Pasar Minggu Primary Health Center. This was an analytical cross-sectional observational study. The study sample consisted of premenopausal and postmenopausal women aged 40-65 years visiting a Primary Health Center of the Pasar Minggu Subdistrict, South Jakarta, who were selected by consecutive sampling. The data analysis used prevalence ratios and logistic regression. The results of the study showed that the prevalence of positive bacteriuria in females was 45%. Sexual activity, sexual hygiene, menopausal status of the females, and personal hygiene were risk factors of ABU. Personal hygiene was the most influential risk factor on the occurrence of ABU in both premenopausal and postmenopausal women. Since in this study ABU was present in 45% of women, thus making it a common disorder in middle-aged and older women, it is recommended that the primary care physician directly administer therapy to women with symptoms of UTI without performing laboratory analysis.

Keywords: Asymptomatic bacteriuria, personal hygiene, sexual activity, women

INTRODUCTION

Urinary tract infection (UTI) is a bacterial infection most frequently found in women and with greater frequency in older than in younger women,[1] and particularly in postmenopausal women. In young and middle-aged women the prevalence of UTI is around 5%, rising rapidly with advancing age.[2] In spite of the high prevalence of bacteriuria in postmenopausal women, the predisposing factors of UTI in this group has not been extensively studied in comparison with premenopausal women. However, reports from epidemiological and

case-control studies indicate that nonsecretory status and urological factors such as residual volume, reduced urinary flow, and incontinence, are closely associated with recurrent UTI, particularly in postmenopausal women.[3] In the US the annually recorded numbers of patients with UTI attending clinics is around 8 million, with a recurrence rate of 25% - 50%.[3,4] The underlying mechanism of recurrence has been only partially elucidated, but there is a close association between impairment or cessation of estrogen production and increased risk of UTI.[4] Postmenopausal vaginal changes lead to clinical manifestations that play a role in UTI. More than 50% of women older than 60 years of age experience a variety of urogenital symptoms.[2]

UTIs may be divided clinically into symptomatic and asymptomatic infections. The infection is called symptomatic if there is significant bacteriuria (>100.000 cfu/mL) accompanied by clinical symptoms, such as dysuria, frequent micturition, and strangury, with or without fever and lower back pain. The infection is called asymptomatic if significant bacteriuria is found in apparently healthy children or adults without symptoms pointing to UTI.[1]

The climacteric, more commonly known as menopause, is the transition period between the reproductive phase and the senile phase (senium), occurring as a result of declining ovarial functionality. The premenopausal period is the period between the age of 40 years and the onset of the climacteric phase. The postmenopausal phase is the period from 12 months after menopause up to the senium.[5] In the postmenopausal period the vaginal epithelium is atrophic, due to lack of estrogen. Epithelial atrophy is also found in the urethra, frequently leading to the urethral syndrome, which includes bacterial urethritis.[2,5,6] In the majority of UTIs the etiology is commonly found to be bacterial.

Several studies have reported a higher prevalence of bacteriuria in postmenopausal women compared with that in young or premenopausal women,[2,4] but data from developing countries are scarce. It is unclear whether women in developing countries have a higher frequency of UTI and more severe symptoms, when compared to women in developed countries.[6] There are also reports stating that the prevalence of bacteriuria in premenopausal women is higher than in postmenopausal women, as it tends to be correlated with the frequency of sexual relations, use of spermicidal agents, contraception by means of diaphragms, and history of past UTIs, but data on the prevalence rate of bacteriuria are still lacking.[7] It has also been reported that diabetic women have a higher risk of asymptomatic bacteriuria (ABU) and UTI,[8,9] although it is unclear whether postmenopausal diabetic women have a higher risk of bacteriuria in comparison with nondiabetic women. Some investigators view ABU as a complication of diabetes in women.[10,11]

Our study is based on the contradictory results of previous studies and the lack of data on the prevalence of bacteruria in pre- and postmenopausal women, especially in Indonesia. Additionally this study also aims to find a relationship between risk factors of ABU in premenopausal and postmenopausal women.

METHODS

Research design

The present study was an analytical observational study with cross-sectional approach, conducted from 3 January until 21 January 2011 at Pasar Minggu Subdistrict Primary Health Center, South Jakarta.

Research subjects and sampling

The study subjects were pre- and postmenopausal women on their first visit to the Pasar Minggu Subdistrict Primary Health Center, South Jakarta, recruited by non-probability consecutive sampling. The

inclusion criteria were: i) women in the age range of 40-65 years, with monthly periods (premenopausal women) or without monthly periods in the last year (postmenopausal women), and volunteering to participate.

Excluded from the study were menstruating or pregnant women, and those on antibiotic therapy for infections.

Sample size

The optimal sample size needed in this study was calculated according to the following formula:[12]

$$n = \left[\frac{Z_\alpha \sqrt{2\pi_1(1-\pi_1)} - Z_\beta \sqrt{\pi_1(1-\pi_1)} + \pi_2(1-\pi_2)}{(\pi_1-\pi_2)} \right]^2$$

For á = 0.05, $Z_á$ = 1.96 and for â = 0.20, $Z_â$ = 0.845. The prevalence of bacteriuria in postmenopausal women is 0.09 and in premenopausal women 0.03,[13] giving a sample size of 50 subjects in each group.

Data collection

This study used a questionnaire as research instrument for collecting personal data (name, age, marital status, education, occupation, income), sexual activity, history of UTI, incontinence, and diabetes mellitus. Personal hygiene was assessed by means of a questionnaire consisting of 4 items on hygienic measures taken by the respondents in connection with ABU. Sexual hygiene was assessed using a questionnaire of 4 items, comprising measures taken by the respondents in connection with sexual relations with their partner. Sexual activity was measured by asking the respondents about the frequency of sexual relations with their partner within the last month. Personal hygiene, sexual hygiene, and sexual activity was divided into two categories, i.e. excellent and poor.

LABORATORY METHODS

Collection of urine specimens

Before collecting the urine specimens, the external genitalia were washed with soap and water, then rinsed with clean water. The initial urinary stream was discarded and only 20 mL of the midstream urine was collected in a sterile container.[14]

Transport of urine specimens

The containers holding the urine specimens were labeled with the identity of the subject, and were subsequently placed in a thermos bottle filled with ice for transport to the Microbiology Laboratory of the Medical Faculty, Trisakti University within 4 hours after collection. The urine specimens that could not be transported in time were stored in a cooling box at the study location and were sent to the laboratory within 24 hours.

Micobiological culture

Upon arrival at the laboratory the urine specimens were directly processed according to standard conventional methods.[1] Volumes of 0.01 and 0.001 mL noncentrifuged urine were plated on blood agar and McConkey agar. The agar plates were then incubated under aerobic conditions at 35^0 C for 20-24 hours, after which a count was made of the growing colonies, and the mean number of colonies per mL urine was calculated. Identification of the isolates were done according to standard methods. Colony counts of <10.000 cfu/mL were considered not indicative of bacteriuria; colony counts in the range of 10.000 – 100.000 cfu/mL were probably due to contamination; while colony counts of >100.000 cfu/mL definitely indicated bacteriuria.[14] ABU is a microbiologic diagnosis on urine specimens collected with minimal contamination and rapidly transported to the laboratory to limit bacterial growth.

Data analysis

Univariate analysis was used for explaining the frequency distribution curve against the variables under study, while for determining the presence of an association of several key variables with asymtomatic bacteriuria the prevalence ratio (PR) was used. Logistic regression is a statistical method which can be used to estimate the probability of disease for a given covariate pattern. The results of logistic regression lead naturally to an estimate of the odds ratio but may also be used to estimate the PR.[15] The statistical tests were considered significant for p <0.05. The Statiscal Package for the Social Sciences version 15.0 (SPSS Inc., Chicago, IL) was used for the statistical analysis.

Ethical clearance

After we received permission and administrative clearance from the head of the Pasar Minggu Subdistrict Primary Health Center, the subjects meeting the inclusion criteria were entered into the study after giving written informed consent. Initially the subjects were informed of the purpose and the general outlines of the study. After the subjects understood and agreed they were given an informed consent form for signing. The present study received ethical clearance from the Ethics Commission of the Medical Faculty, Trisakti University.

RESULTS

This study recruited 100 women who were willing to participate in the study. Fifty women in the age range of 40-50 years and 50 women aged 51-65 years were assigned to the premenopausal and postmenopausal groups, respectively. Mean age of the subjects was 50.5 ± 6.55 years, 54% of subjects had higher education (SMA + University) and 80% still had a partner. The prevalence of diabetes was 26% (Table 1).

Table 1. Description of demographic characteristics, history of diabetes mellitus and UTI, and sexual activity of the respondents

Variable	n = 100
Age (years)	50.5 ± 6.55
Marital status	
Single (unmarried + widowed)	20 (20)
Married	80 (80)
Educational level	
Low (uneducated + primary school)	8 (8)
Intermediate (junior high)	38 (38)
High (senior high + university)	54 (54)
Employment history	
Employed	48 (48)
Unemployed	52 (52)
Menopausal status	
Premenopause	50 (50)
Postmenopause	50 (50)
History of diabetes mellitus	
Present	26 (26)
Absent	74 (74)
Sexual hygiene	
Excellent	64 (64)
Poor	36 (36
Personal hygiene	
Excellent	88 (88)
Poor	12 (12)
Sexual activity	
Frequent	46 (46)
Rare/none	54 (54)
History of UTI	
Present	46 (46)
Absent	54 (54)
History of incontinence	
Present	51 (51)
Absent	49 (49)
Asymptomatic bacteriuria	
Present	45 (45)
Absent	55 (55)

Subjects with UTI were 46 in number (46%) and those with excellent sexual hygiene totaled 64%. In this study the overall number of subjects with ABU, among both premenopausal and postmenopausal women, was 45 (45%).

The results of bacteriological culture showed that *Escherichia coli* was the principal causative organism of bacteriuria in women, being present in 26 subjects (57.8%). The

Table 2. Distribution of causative bacteria of ABU in the respondents (n=45)

Causative bacteria	n (%)
Escherichia coli	26 (57.8)
Klebsiella pneumoniae	7 (15.6)
Staphylococcus epidermidis	9 (20.0)
Enterococcus spp.	1 (2.2)
Bacillus spp.	2 (4.4)

remaining infections were caused by *Klebsiella* spp. (15.6%), *Staphylococcus epidermidis* (20.0%), *Enterococcus* spp. (2.2%), and *Bacillus* spp. (4.4%) (Table 2).

Table 3 presents a summary of the relationship between several key variables and the prevalence of ABU in female subjects. In subjects with past UTI the risk of bacteriuria was 3.05 times that of subjects without past UTI (PR=3.05;95% C.I. 1.84-5.05). Similarly, subjects with frequent sexual activity with their partners had a risk of ABU of 1.6 times that of subjects who rarely or never had seksual relations with their partners (PR=1.60;95% C.I. 1.03-2.49). Differring results were found in subjects with excellent sexual and personal hygiene, where the risk of ABU was lower than that of subjects with poor sexual and personal hygiene.

Table 3. Relationship between several key variables and ABU in female subjects

Variable	ABU Yes (n=45/%)	ABU No (n=55/%)	PR (95% CI)
Marital status			
Married	33 (41.3)	47 (58.8)	0.66 (0.44-1.07)
Single	12 (60)	8 (40)	
Educational level			
Low	29 (63.0)	17 (37.0)	2.21 (1.33-3.39)
High	16 (29.6)	38 (70.4)	
Employment status			
Employed	21 (43.8)	27 (56.2)	0.95 (0.61-1.46)
Unemployed	24 (46.2)	28 (53.8)	
Menopausal status			
Premenopause	19 (38.0)	31 (62.0)	0.73 (0.46-1.13)
Postmenopause	26 (52.0)	24 (48.0)	
History of diabetes mellitus			
Present	15 (57.5)	11 (42.5)	1.40 (0.86-2.28)
Absent	30 (40.5)	44 (59.5)	
History of incontinence			
Present	26 (50.9)	25 (49.1)	1.31 (0.84-2.05)
Absent	19 (38.8)	30 (61.2)	
History of UTI			
Present	34 (73.9)	12 (26.1)	3.05 (1.84-5.057)
Absent	11 (20.4)	43 (79.6)	
Sexual hygiene			
Excellent	19 (28.8)	47 (71,2)	0.37 (0.24-0.57)
Poor	26 (76.5)	8 (23.5)	
Personal hygiene			
Excellent	34 (38.6)	54 (61.4)	0.42 (0.30-0.57)
Poor	11 (91.7)	1 (0.3)	
Sexual activity			
Frequent	26 (56.5)	20 (43.5)	1.60 (1.03-2.49)
Rare/none	19 (35.2)	35 (64.8)	

Abbreviations: PR: prevalence ratio; CI: confidence interval; UTI: urinary tract infection

Table 4. Multivariable logistic regression
model with selected variables for ABU

Variable	OR (95% C.I.)
Sexual activity	0.19 ((0.04-0.87)
Sexual hygiene	0.12 (0.03-0.42)
Personal hygiene	0.06 (0.006-0.601)
History of UTI	0.13 (0.04-0.42)
Menopausal status	0.12 (0.02-0.60)

Abbreviations: CI: confidence interval; OR: odds ratio; UTI:
urinary tract infection

We constructed a series of multivariable
logistic regression models based on *a priori*
hypotheses about potential risk factors. In the
final model, 5 variables continued to be
associated with ABU: sexual activity, sexual
hygiene, personal hygiene, history of UTI, and
menopausal status (Table 4). A history of UTI
(OR, 0.131; 95% CI, 3.25-5.42) was strongly
associated with ABU. Premenopausal women
had a lower risk of ABU than did
postmenopausal women.

DISCUSSION

This study investigated potential risk
factors for ABU among women aged between
40 and 65 years. Although ABU is common,
its prevalence in populations varies widely
with age, gender, and the presence of
genitourinary abnormalities. In healthy
women, the prevalence of bacteriuria increases
with advancing age, from 1% among
schoolgirls to >20% among healthy
community-dwelling women older than 80
years.[13] The findings in our study were similar;
there was a prevalence of ABU of 45% in
women in the 45-65 year age group, while
postmenopausal women had a higher risk of
ABU than premenopausal women. After
menopause, the vagina undergoes various
changes that lead to vaginal colonization by
uropathogenic *E. coli* and to the development
of bacteriuria.[16] Vaginal symptoms of frequent
occurrence in the early postmenopausal period

reportedly affect around 30% of women,
increasing up to around 47% in the late
postmenopausal period.[17] Before menopause
the vaginal fluid is acid in reaction, but
subsequently the pH becomes neutral, thus
enabling the proliferation of enteric bacteria
associated with UTI.[5] Furthermore,
postmenopausal women reportedly also suffer
from symptoms of incontinence without prior
urinary bladder dysfunction or neurological
abnormalities.[18] The declining estrogen level
that is part of the menopausal process and is
considered to be a risk factor for bacteriuria,
results in the loss of the normal vaginal flora,
which consists predominantly of lactobacilli.
This triggers a rise in vaginal pH and increases
the colonization of the introitus by *E. coli*.[19]
The vaginal and urethral epithelia are estrogen
responsive, as they have a common
embryological origin, and function to protect
these organs against infection. However, with
advancing age these epithelia undergo
degenerative changes,[4,6] causing a decline in
their regulatory capacity in postmenopause and
facilitating infection. However, it has been
suggested by Hooton[20] that in healthy
postmenopausal women the incidence of UTI
is probably lower than in premenopausal
women.

In agreement with the generally accepted
view that risk factors for UTI in women include
sexual activity, our study also found that
women with frequent sexual activity had a
higher risk of ABU. Sexual activity of the
women with their partners constituted a general
risk factor for the occurrence of ABU. In
addition, the results of our study indicate that
history of past UTI is one of the important risk
factors for ABU in female subjects aged 40 to
65 years. Several studies also found that a
history of previous UTI is an important risk
factor for asymptomatic UTI in young and
postmenopausal women.[7,21]

The most frequently encountered
microorganism causing UTI in this study was
Escherichia coli with a prevalence of 57.8%

in female subjects, followed by *Klebsiella pneumoniae*. Studies on the etiology of bacteriuria have found that *Escherichia coli* is the causative agent in more than 80% of all UTIs and causes both ABU and symptomatic UTI.[22-24] Uropathogenic *E. coli* possess various virulence traits, enabling these bacteria to attack and infect the normal urinary tract.[25] The reported virulence traits include the presence of fimbriae or pili, which function as ligands for glycolipid and glycoprotein receptors in uroepithelial cells.[26-28] Another risk factor for ABU in the present study was a past history of urinary incontinence in the female subjects.

Studies on behavior in connection with UTI or bacteriuria are very few in number.[22] The behavior in question include personal hygiene, sexual hygiene and sexual activity, all of which are risk factors for ABU, both in premenopausal and postmenopausal women.[22,29] Our study indicates that female subjects with excellent sexual hygiene had a far lower risk than those with poor sexual hygiene. Perineal hygiene is important in women, who should be encouraged to shower after sexual intercourse to reduce colonization by fecal and perineal organisms.[30]

Although there are many similarities among the various UTI risk factors in pre- and postmenopausal women, the single basic factor distinguishing both groups is their sexual activity. As stated in several reports, one of the dominant UTI risk factors in premenopausal women is their sexual activity and use of spermicides.[19,22,29] Diabetes melitus results in disturbances of the immune system and other organ functions, thus facilitating the occurrence of infection, among which the most frequent is UTI.[10,31] It has previously been reported by several studies that advancing age with added burden of diabetes may increase the risk of UTI in an individual.[29] However, our study results differed in this respect, as a history of diabetes mellitus in women was not a risk factor for ABU, although we did not

enquire in more detail about the treatment given to the study subjects. Indeed, in subjects who were not treated regularly for their diabetes mellitus, the risk of ABU was higher than in subjects under regular treatment, although there was no increase in the odds of UTI in women with diabetes who did not receive treatment.[32] The fact that the rate of ABU increases with advancing age may be explained by the low estrogen levels, atrophy of the vaginal epithelium, impaired voiding, and changes in personal as well as sexual hygiene.[33,34]

ABU may also result in long-term cardiovascular-renal damage, the possibility of which should always be kept in mind, and a complete search for all possible causes of ABU and treatment modalities should be done to reduce this important cause of chronic disease. To minimize potential bias in this study, particularly to prevent misclassification of ABU, we used a case definition of bacteriuria, namely a bacterial count of >100.000 cfu/mL, that is more than 95% specific for this diagnosis.[14] Since the population consisted of female patients attending the health center, the results may not be generalized to other populations.

CONCLUSIONS

In the population of the present study, the risk factors for women in the age range of 40 - 65 years reflect the health status of their transitional period towards old age. History of UTI and incontinence, personal and sexual hygiene, sexual activity, and menopausal status were all associated with a higher risk of ABU. Prospective studies in different patient populations are needed to better understand the risk factors of UTI.

ACKNOWLEDGEMENTS

REFERENCES

1. Boekitwetan P, Suryawidjaja JE, Aidilfit M, Lesmana M. Multimicronutrient supplementation and asymptomatic urineary tract infections in the elderly. Univ Med 2009;28:25–33.

2. Raz R. Hormone replacement therapy or prophylaxis in postmenopausal women with recurrent urinary tract infection. J Infect Dis 2001;183 Suppl 1:S74-6

3. Dwyer PL, O'Reilly M. Recurrent urinary tract infection in the female. Curr Opin Obstet Gynecol 2001;14:537-43.

4. Curran EM, Hart-Van Tassel A, Judy BM, Nowicki B, Montgomery-Rice V, Estes M, et al. Estrogen increases menopausal host susceptibility to experimental ascending urinary-tract infection. J Infect Dis 2007;195:680-3.

5. Grady D. Management of menopausal symptoms. N Engl J Med 2006;355:2338-47.

6. Stamm WE. Estrogens and urinary tract-infection. J Infect Dis 2007;95:623-4.

7. Hu KK, Boyko EJ, Scholes D, Normand E, Chen CL, Grafton J, Fihn SD. Risk Factors for Urinary Tract Infections in Postmenopausal Women. 2004. Arch Intern Med 2004;64:989-93.

8. Stapleton A. Urinary tract infections in patients with diabetes. Am J Med 2002;113 Suppl 1A:S80-4.

9. Boyko EJ, Fihn SD, Scholes D, Chen CL, Normand EH, Yarbro P. Diabetes and the risk of acute urinary tract infection among postmenopausal women. Diabetes Care 2002;25:1778-83.

10. Bonadio M, Boldrini E, Forotti G, Matteucci E, Vigna A, Mori S, et al. Asymptomatic bacteriuria in women with diabetes: influence of metabolic control. Clin Infect Dis 2004;38:41-5.

11. Dalal S, Nicolle L, Marrs CF, Zhang L, Harding G, Foxman B. Long-term *Escherichia coli* asymptomatic bacteriuria among women with diabetes mellitus. Clin Infect Dis 2009;49:491-7.

12. Dawson B, Trapp RG, editors. Research questions about two separate or independent groups. In: Basic & clinical biostatistics. 4th ed. New York; Lange Medical Books/MCGRaw-Hill;2004.p. 134-61.

13. Nicolle LE. Asymptomatic bacteriuria: when to screen and when to treat. Infect Dis Clin North Am 2003;17:367-94.

14. Thomson RE Jr, Miller JM. Specimen collection, transport, and processing: bacteriology. In: Murray PR, Baron EJ, Jorgensen JH, Pfaller MA, Yolken RH, editors. Manual of Clinical Microbiology, 8th ed. Washington DC: American Society for Microbiology;2003.p.320-2.

15. Santos CAST, Fiaccone RL, Oliveira1 NF, Cunha S, Barreto ML, do Carmo BB, et al. Estimating adjusted prevalence ratio in clustered cross-sectional epidemiological data. BMC Med Res Method 2008;8:80 doi:10.1186/1471-2288-8-80.

16. Brown JS, Vittinghoff E, Kanaya AM, Agarwal SK, Hulley S, Foxman B. Urinary tract infections in postmenopausal women: effect of hormone therapy and risk factors. Obstet Gynecol 2001;98: 1045-52.

17. Dennerstein L, Dudley EC, Hopper Jl, Guthrie JR, Burger HG. A prospestive population-based study of menopausal symptoms. Obstet Gynecol 2000;96:351-8.

18. Jackson SL, Scholes D, Boyko EL, Abraham L, Fihn SSD. Predictors of urinary incontinence in prospective cohort of postmenopausal women. Obstet Gynecol 2006;108:855-62.

19. Stamm WE, Norrby SR. Urinary tract infections: disease panorama and challenges. J Infect Dis 2001;183 Suppl 1:S1-4.

20. Hooton TM. Pathogenesis of urinary tract infections: an update. J Antimicrob Chemother 2000;46 Suppl 1:S1-7.

21. Shortliffe LM, McCue JD. Urinary tract infection at the age extremes: pediatrics and geriatrics. Am J Med 2002;113 Suppl 1A:S55-66.

22. Moore EE, Hawes SE, Scholes D, Boyko EJ, Hughes JP, Fihn SD. Sexual intercourse and risk of symptomatic urinary tract infection in post-menopausal women. J Gen Intern Med 2008;23: 595-9.

23. Zhang L, Foxman B. Molecular epidemiology of *Escherichia coli* mediated urinary tract infections. Front Biosci 2003;8:e235-44.

24. Hedlund M, Duan RD, Nilsson A, Svensson M, Karpman D, Svanborg C. Fimbriae, transmembrane signaling, and cell activation. J Infect Dis 2001;183 Suppl 1:S47–50.

25. Ribera MC, Pascual R, Orozco D, Perez Barba C, Pedrera V, Gil V. Incidence and risk factors associated with urinary tract infection in diabetic

patients with and without asymptomatic bacteriuria. Eur J Clin Microbiol Infect Dis 2006; 25:389-93.

26. Johnson JR. Microbial virulence determinants and the pathogenesis of urinary tract infections. Infect Dis Clin North Am 2003;17:261-78.

27. Grodstein F, Lifford K, Resnick NM, Curhan GC. Postmenopausal hormone therapy and risk of developing urinary incontinence. Obstet Gynecol 2004;103:254-60.

28. Moore EE, Jackson SL, Boyko EJ, Scholes D, Fihn SD. Urinary incontinence and urinary tract infection. Temporal relationships in postmenopausal women. Obstet Gynecol 2008; 111:317-23.

29. Amiri FN, Rooshan MH, Ahmady MH, Soliamani MJ. Hygiene practices and sexual activity associated with urinary tract infection in pregnant women. J Social Med 2006;15:104-10.

30. Harris N, Teo R, Mayne C, Tincello D. Recurrent urinary tract infection in gynaecological practice. Obstet Gynaecol 2008;10:17–21.

31. Geerlings SE. Urinary tract infections in patients with diabetes mellitus: epidemiology, pathogenesis and treatment. Int J Antimicrob Agents 2008;31 Suppl:S54-7.

32. Boyko EJ, Fihn SD, Scholes D, Chen CL, Normand EH, Yarbro P. Diabetes and the risk of acute urinary tract infection among postmenopausal women. Diabetes Care 2002;25: 1778-83.

33. Scholes D, Hooton TM, Roberst PL, Gupta K, Stapleton AE, Stamm WE. Risk factors associated with acute pyelonephritis in healthy women. Ann Intern Med 2005;142:20-7.

34. Sheffield JS, Cunningham FG. Urinary tract infection in women. Obstet Gynecol 2005;106: 1085-92.