ASIAN JOURNAL OF PHARMACEUTICAL AND CLINICAL RESEARCH

INNOVARE ACADEMIC SCIENCES
Knowledge to Innovation

Vol 9, Suppl. 3, 2016

Online - 2455-3891
Print - 0974-2441

Research Article

ASSOCIATION BETWEEN AGE, BODY MASS INDEX, WAIST CIRCUMFERENCE, LIPID PROFILE PARAMETERS, AND SYMPTOMATIC BACTERIAL URINARY TRACT INFECTION IN IRAQI ADULT WOMEN

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Received: 06 Aug 2016, Revised and Accepted: 11 Aug 2016

ABSTRACT

Objective: This study was conducted to investigate the association between age, body mass index (BMI), waist circumference (WC), and incidence of symptomatic bacterial urinary tract infections in adult women and to study the impact of infection on lipid profile.

Methods: A total of 30 women enrolled with symptomatic bacterial urinary tract infections and 10 healthy women as control group. Mid-stream urine samples were submitted. BMI, WC, and lipid profile were measured. Both leukocyte esterase and nitrite tests were used to diagnose the urinary tract infection, and viable quantification was done as confirmatory for the diagnosis.

Results: Revealed that there was a significant relationship between the incidence of symptomatic bacterial urinary tract infections and age groups (p=0.04) as age group (21-30) years recorded the highest percentage (33.33%) followed by the age group (31-40) which recorded 30%. No significant association was found between BMI, WC and incidence of symptomatic bacterial urinary tract infections (p=0.08, p=0.14) respectively. Compared to healthy control group, there was a significant decrease in the levels of total cholesterol, triglycerides, high-density-lipoprotein, very-low-density-lipoprotein, and low-density-lipoprotein (p=0.0001, p=0.006, p=0.001, p=0.006, and p=0.0001), respectively.

Conclusion: The young women were significantly susceptible to symptomatic bacterial urinary tract infections than other age groups. Both BMI and WC were not significant indicators for the incidence of symptomatic bacterial urinary tract infections in adult women. Adult women with symptomatic bacterial urinary tract infections showed a significant decrease in lipid profile parameters when compared with the control healthy adult women.

Keywords: Age, Body mass index, Waist circumference, Lipid profile, Urinary tract infections.

 DOI: http://dx.doi.org/10.22159/ajpcr.2016.v9s3.14519

INTRODUCTION

It has been estimated that approximately 10% of humans are affected by urinary tract infection at sometimes during their lifetime, and 75% of patients treated by urologists are complaining of urinary tract infection [1]. Urinary tract infections are more likely to occur among women than men [2]. Urinary tract infection may occur in up to 50% of all women in their lifetimes and frequently require medication [3]. *Escherichia coli* and *Staphylococcus saprophyticus* account for about 80% of women [4]. However, other bacteria, viruses, and fungi can be the cause in rare cases [5]. The close proximity of the female urethral meatus to the anus, shorter urethra, sexual intercourse, incontinence, and bad toilet habits has all been reported as factors that influence the higher prevalence in females [6-8]. The urinary tract infections are more prevalent in female relatives of women with recurrent urinary tract infections, which suggest a familial genetic predisposition to the disease [3]. Many women experience relapses or re-infections of the lower urinary tract even after treatment with broad-spectrum antibiotics [2]. Not only young women but also advanced age women are also considered as risk factors for incidence of symptomatic bacterial urinary tract infections in the women. This could be attributed to the fact that after menopause there is a significant reduction in estrogen secretion by the ovary, which is often associated with vaginal atrophy [4]. Estrogens stimulate proliferation of *Lactobacillus* in the vaginal epithelium, causing reduction of vaginal pH and keeping it between 3.3 and 4.5 thereby preventing vaginal colonization by Enterobacteriaceae [4]. Increased urinary tract infections in the obese patients likely are caused by the adipose tissue that causes the inflammation that in turn weakens the immune system [9]. Some studies showed increased incidence of urinary tract infection, especially in the hospital and after surgery, was in the overweight and obese patients compared to normal-weight patients [9]. Urinary tract infections cause considerable discomfort and inconvenience to the patient and are occasionally responsible for protracted symptoms or more serious manifestations such as sepsis and death [10].

The levels of lipid and lipoproteins change during acute illness [11]. It is known that there are changes in lipids and lipoproteins in the course of many disorders. Changes in the serum lipid profile in the course of acute bacterial urinary tract infections have been described [12].

This study aims to investigate the association between age, body mass index (BMI), waist circumference (WC) and the incidence of symptomatic bacterial urinary tract infections in adult women. Furthermore, the study aims to measure the concentrations of serum lipid profile in adult women with symptomatic bacterial urinary tract infections and to investigate the impact of symptomatic bacterial urinary tract infections on the concentrations of serum lipid profile parameters.

METHODS

This study was conducted in Baghdad during the period from November 2015 to January 2016.

Inclusion criteria

Randomly selected 30 adult females with symptomatic bacterial urinary tract infections and 10 adult healthy females without urinary tract infections attending private laboratory in Baghdad were enrolled in this study.

Exclusion criteria

The following criteria were excluded from this study: Pregnant women, postpartum women, women with a malignancy, those with human immune virus infection, those with sexually transmitted diseases,

those with fungal infections, diabetic women, presence of permanent urinary catheter, those with urinary incontinence, neurogenic bladder, connective tissue diseases, kidney malformations, the chronic use of corticosteroid therapy, hyperlipidemia, hypertension, and who received treatment with lipid-lowering drugs within a previous month. The control group was subjected to the same criteria with the exception that they are without urinary tract infections.

Women who presented with recurrent urinary tract infections over a 2-year period were excluded from the study.

Methodology

Weight was determined using a digital electronic weighing scale with an accuracy of a 0.1 Kg and wearing light clothing. Height was measured to the nearest 0.1 cm using a tape measure and women standing upright without shoes. BMI was calculated by the weight in kilograms divided by the height in meters squared (Kg/m^2) [9]. BMI was classified as underweight (<18.5 Kg/m^2), normal weight (18.5-24.9) Kg/m^2, overweight (25-29.9) Kg/m^2, and obesity as having a BMI ≥30.0 Kg/m^2 [9]. WC was measured to the nearest 0.1 cm at the level of the iliac crest while the subject was at minimal respiration [13]. Women with WC ≤88 cm were considered to have a normal WC while women with WC >88 cm were considered to have a high WC [13].

The control group was selected from healthy adult normal women who underwent medical check-ups at a private clinic and without any history of urinary tract infections.

Mid-stream urine collection was done to minimize sample contamination. Macroscopic and direct microscopic examinations were done to all urine samples. Pus cells ≥5/HPF (high power field) significantly considered infection [14].

The pairing of both leukocyte esterase and nitrite tests was used for the diagnosis of urinary tract infection [15]. Leukocyte esterase test was positive for the presence of urinary tract infection if there were more than 5 leucocytes/HPF [15]. The urine nitrite test was a qualitative test and for screening for bacteria in urine and if positive, indicated the presence of more than 10 organisms/ml [15]. Leukocyte esterase test and nitrite test were performed by using dipstick (Cybow, Korea).

To confirm the diagnosis of urinary tract infection, a loop full (0.002 ml) of well mixed uncentrifuged urine was streaked on the surface of blood agar medium [blood agar base (CONDA, Spain)]. The plates were incubated aerobically at 37°C for 24 hrs [14]. The presence more than 10^5 colony forming unit/ml in mid-stream urine was considered as a significant number of bacteria for urinary tract infection [16]. Women enrolled in this study included who presented a significant bacterial growth and complaining from urinary tract infection symptoms then they diagnosed as having symptomatic bacterial urinary tract infections. Those who showed a significant bacterial growth but with no symptoms of urinary tract infections were diagnosed as complaining of asymptomatic bacterial urinary tract infections and were excluded from this study.

An overnight fasting venous blood sample was taken from every woman, and serum levels of total cholesterol (TC), triglycerides (TG), and high-density-lipoprotein cholesterol (HDL-C) concentrations were measured using enzymatic colorimetric methods. For TC, TG and HDL-C measurements, SPINREACT (Spain) kits were used. TC, TG, and HDL-C concentrations were expressed in mg/dl.

Very-low-density lipoprotein (VLDL) concentration expressed in mg/dl was calculated using the following formula:

VLDL = TG/5 [17].

Low-density-lipoprotein (LDL) concentration expressed in mg/dl was calculated according to the following formula:

LDL = TC- (VLDL+HDL-C) [18].

Reference values for TC, TG, and HDL-cholesterol were considered according to that mentioned in the leaflets. For TC, if levels were up to 200 mg/dl were considered normal and if (200-239) mg/dl were considered as borderline and if 240 mg/dl and above were considered high. For TG concentrations, normal levels for women were (35-135) mg/dl. For HDL-cholesterol measurements, up to 35 mg/dl were considered high risk and levels >60 mg/dl were considered as low risk. HDL cholesterol levels >40-60 mg/dl were desired [19]. Normal concentrations for VLDL were considered from 2 to 30 mg/dl [24]. LDL was considered to be too high if it was 190mg/dl or higher [19].

Ethical consideration

Signed and confirmed agreements were obtained from all women included in this study.

Statistical analysis

The statistical analysis was performed using (Statistical Analysis System version 9.1). Unpaired t-test was used to compare the difference between means. Proportions were compared by chi-square. $p<0.05$ was considered statistically significant [20].

RESULTS

Only adult women with symptomatic bacterial urinary tract infections were enrolled in this study.

Table 1 showed a significant incidence of symptomatic bacterial urinary tract infections according to women ages where the highest incidence was detected in women ages ranged from 21 to 30 years (33.33%) and the lowest for women aged ≤20 and ≥51 years (6.67%, 6.67%, respectively).

Table 2 demonstrated the non-significant increase in the incidence of symptomatic bacterial urinary tract infections in obese women group ($p=0.08$). However, there was a marked increase in elevated BMI women (both excessive weight and obese groups) (83.33%) in comparison to normal weight women (16.67%) in their susceptibility to symptomatic bacterial urinary tract infections.

Table 3 revealed that high WC (>88 cm) was not a risk factor for the occurrence of symptomatic bacterial urinary tract infections and demonstrated that 63.33% of the women patients were among WC ≤88 cm group, and 36.67% of them were among WC >88 cm group ($p=0.14$).

Table 1: The association between the age and the symptomatic bacterial urinary tract infection in the adult women

Age group/year	n (%)
≤20	2 (6.67)
(21-30)	10 (33.33)
(31-40)	9 (30.00)
(41-50)	7 (23.33)
≥51	2 (6.67)
Chi-square	9.66
p	0.04

P: Probability. ($p<0.05$) considered significant

Table 2: The association between the BMI and the symptomatic bacterial urinary tract infection in the adult women

BMI	Normal values in (Kg/m^2)	Number of women and (%)
Normal weight	18.5-24.9	5 (16.67)
Excessive weight	25-29.9	15 (50)
Obesity	≥30	10 (33.33)
Chi-square value		5
p		0.08

P: Probability. ($p<0.05$) considered significant. BMI: Body mass index

Table 4 showed a significant (p<0.05) decrease in serum lipid profile in 30 women with symptomatic bacterial urinary tract infections compared to the control 10 healthy adult women group. The women with symptomatic bacterial urinary tract infections showed significantly (p<0.05) low levels of serum TC, TG, high-density lipoproteins, low-density lipoproteins, and VLDL.

DISCUSSION

This study showed a significant incidence of symptomatic bacterial urinary tract infections among young women (Table 1). These results agreed with Zakaria *et al*. [21] who reported that the high incidence of urinary tract infections was in the reproductive ages. Akter *et al*. [22] found that women at the reproductive age of 16-30 years (45.9%) followed by 31-45 years (24.3%) were more susceptible to urinary tract infections. In addition, Najar *et al*. [23] reported that symptomatic urinary tract infections occur most commonly in the women of child-bearing age, and a vast majority of acute symptomatic urinary tract infections involve young women. On the contrast, there were results demonstrated that urinary tract infections increase with advancing age. Gavazzi and Krause [24] mentioned that urinary tract infections in the elderly were the more frequent and severe than in the general population. Hammar *et al*. [25] showed that higher age associated with increased incidence of urinary tract infections in females with type2 diabetes. To explain our results, the significant high occurrence of urinary tract infections at reproductive ages might be due to their initial exposure to sex [21]. Sexual activity and the use of diaphragms and spermicides promote colonization of the periurethral area with coliform bacteria [26]. Hence, increased sexual activity in young women makes them more prone to urinary tract infections than other ages [10].

This study revealed a notable increase in the susceptibility to complain from symptomatic bacterial urinary tract infections among excessive weight followed by obese women groups, but these findings were not significantly different (Table 2). Nassaji *et al*. [9] did not support obesity as a risk factor for the urinary tract infections in adult patients. Geerlings *et al*. [27] confirmed that there was no relationship between obesity and symptomatic urinary tract infections. It was demonstrated that there was no increased incidence of urinary tract infections associated with the increased BMI in women with type 2 diabetes [25]. On the other hand, there were contradicting results showed that the obesity as a significant indicator for the incidence of urinary tract infections. Semins *et al*. [28] reported that elevated BMI appeared to be associated with an increased risk for urinary tract infections and pyelonephritis. It was shown that increased incidence of urinary tract infections was associated with the increasing BMI in obese subjects in institutionalized geriatric patients [29]. BMI is an important measure of excess body fat [30]. Adipose tissue participates actively in inflammation and immunity, producing and releasing a variety of pro-inflammatory and anti-inflammatory factors [9]. Increased susceptibility to urinary tract infections in elevated BMI women may be related to decreased tumor necrosis factor α production and increased nitric oxide release [31]. To illustrate our results, the marked increased susceptibility to suffer from symptomatic bacterial urinary tract infections among elevated BMI groups could be attributed to the increase in liberated free radicals compared to low levels of anti-oxidants since fat tissue participates actively in inflammation.

Table 3: The association between the waist circumference/cm and the symptomatic bacterial urinary tract infection in the adult women

Waist circumference/cm	Number of women and (%)
≤88	19 (63.33)
>88	11 (36.67)
Chi-square value	2.14
p	0.14

P: Probability. (p<0.05) considered significant

Table 4: Comparison of the lipid profile parameters between the adult females with symptomatic bacterial urinary tract infections and the healthy adult women

Parameters	Women with urinary tract infections (mg/dl)	Healthy women (mg/dl)	p	Normal values (mg/dl)
Cholesterol	107.9±1.61	143.6±2.47	0.0001	≤200
Triglycerides	72.53±2.32	89.9±4.79	0.006	35-135
HDL	39.46±0.65	47.1±1.51	0.001	>40-60
VLDL	14.5±0.46	17.98±0.96	0.006	2-30
LDL	53.62±1.71	78.52±3.25	0.0001	<190

Value: Mean±standard error. P: Probability. (p<0.05) was considered significant. HDL: High-density-lipoprotein, VLDL: Very-low-density lipoprotein, LDL: Low-density lipoprotein

Our study was the first to show if there was any association between the incidence of symptomatic bacterial urinary tract infections and high WC (Table 3). WC was strongly correlated with the percentage of body fat [32]. The women with high WC >88 cm indicated; they were with visceral obesity [33]. An enlarged WC is due to the increasing of abdominal subcutaneous or visceral adipose depots or both [33]. It has been postulated that women with high WC may be less susceptible to trauma to the genital area during sex because the adipose tissue offers them protection [31]. Furthermore, as the adipose tissue favors estrogen synthesis, increased estrogenization in these women, resulting from the peripheral conversion of androstenedione to estrone, may exert some beneficial effect on the urinary tract reducing the susceptibility to infection [31].

This study indicated a considerable significant decrease in serum lipid profile levels among adult women with symptomatic bacterial urinary tract infections compared to control healthy adult women (Table 4). Al-Hadraawy *et al*. [10] reported similar results since they found a significant decrease in serum levels of TC, TG, low-density lipoproteins, and VLDL. However, they found a significant increase in serum high-density lipoprotein which was inconsistent with our finding. The results obtained by Johnkennedy *et al*. [5] agreed with our results concerning that patients with urinary tract infections had significantly decreased levels of TC, TG, high-density lipoprotein, and low-density lipoprotein. VanLeeuwen *et al*. [34] exhibited results went with our findings as they showed a significant decrease in the serum levels of TC, TG, high-density lipoprotein, and low-density lipoprotein for patients with acute illness when compared with control group. Alvarez and Romas [35] mentioned that serum levels of high-density lipoprotein were significantly (p<0.05) decreased during sepsis. Nassaji *et al*. [36] conducted a study among patients with acute bacterial infections and found the lower serum levels of TC and high-density lipoprotein and non-significant differences in TG and low-density lipoprotein as compared with the control. A study found that critically ill infected patients had lower TC and high-density lipoprotein when compared with non-infected patients [37]. Another study included patients with bacterial pneumonia found lower serum TG levels among this group of patients [38]. The inconsistent finding was reported by Gordon *et al*. [39] who mentioned that in the critically ill patients, the mean serum TG concentration was higher in patients with an infection compared to patients without infection, but these differences were not statistically significant. It is known that the changes in lipids and lipoproteins in the course of many disorders characterized by infection and inflammation [11]. Urinary tract infections cause oxidative stress. Increased formation of reactive oxygen species (which include hydroxyl radicals, superoxide anions, and hydrogen peroxide) and/or decreased antioxidant defense can be defined as oxidative stress [40]. Lipid peroxidation is one of the most important expressions of oxidative stress induced by reactive oxygen species [40]. Infections produce alterations in the composition and function of lipoproteins, including changes in sphingolipid concentrations, decreased reverse cholesterol

transport, and increased oxidation of lipids [36]. Infections facilitate cytokine-induced alterations in lipid and lipoprotein metabolism leading to decreased serum levels of TC, high-density lipoprotein, and low-density lipoprotein [41].

CONCLUSIONS

Young women were significantly more susceptible to symptomatic bacterial urinary tract infections than other age groups. Both BMI and WC were not significant indicators for the incidence of symptomatic bacterial urinary tract infections in adult women. Adult women with symptomatic bacterial urinary tract infections showed a significant decrease in lipid profile parameters as compared with the control healthy adult women. Although the study tried to involve the largest number of patients, unfortunately, the available number was limited. Hence, we recommend conducting further studies with larger samples to investigate the other risk factors and the effects of urinary tract infections on other biochemical markers.

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