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Original article

The association between obesity and urinary tract infection

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ABSTRACT

Background: Few studies examined the relationship between obesity and urinary tract infection (UTI), showing inconsistent results. This study aims to examine the association between obesity and UTI, and to assess whether this association is independent of diabetes mellitus and 25(OH)D level.
Methods: Using the computerized database of the largest healthcare provider in Israel, we identified a cohort of subjects ≥18 years old with available BMI and serum 25(OH)D level measurements between January 2009 and December 2009. The cohort was followed for the first UTI diagnosis from January 2010 through June 2011. Cox proportional hazard model was used to test the relationship between obesity and UTI.
Results: During follow-up, 25,145/110,736 (22.7%) females, and 4032/42,703 (9.4%) males had UTI. The crude HR for UTI in those with BMI≥50 compared to BMI<25 was 2.54 (95% CI, 1.50–4.30) in males and 1.39 (1.14–1.69) in females. After adjusting for age, 25(OH)D level, and history of diabetes mellitus, the HR for UTI in those with BMI≥50 compared to BMI<25 was 2.38 (1.40–4.03) in males and 1.25 (1.03–1.52) in females. The HR for those in the lowest quartile of serum 25(OH)D compared to the highest quartile was 1.23 (1.13–1.35) in males and 0.98 (0.95–1.02) in females. The HR for subjects with diabetes was 1.23 (1.16–1.32) in males, and 1.25 (1.20–1.28) in females.
Conclusions: Obesity is independently associated with UTI particularly in males. Low serum 25(OH)D levels are associated with increased risk of UTI in males.

1. Introduction

Obesity has become one of the most important public health problems in the United States [1]. Obesity is associated with increasing mortality and morbidity from a variety of diseases including; hypertension, dyslipidemia, metabolic syndrome, cardiovascular diseases, impaired vitamin D status, and diabetes mellitus [2–4].

Previous studies also suggest that obesity may be associated with urinary tract infection (UTI), but the results were inconsistent. Only few studies have addressed this issue, and were either small with short follow-up, or limited to diabetic or postoperative patients [5–8]. In addition, no adjustment was done for vitamin D status and diabetes mellitus, two conditions that are associated with both obesity [2,4], and increased risk of infection and UTI [9,10], which potentially could confound the association between obesity and UTI.

This study aims to examine the association between obesity and UTI in order to confirm the results of previous studies, and to assess whether this association is independent of 25(OH)D levels and diabetes mellitus.

2. Materials and methods

2.1. Study population and data source

The study population was drawn from among the insurees of Clalit Health Services (CHS), the largest not-for-profit health care provider in Israel, covering more than half of the Israeli population. Using the computerized database of CHS, we identified a cohort of subjects ≥18 years old with available BMI and serum 25(OH)D level measurements between January 2009 and December 2009. In subjects who had more than one 25(OH)D or more than one BMI measurements during this period, the result of the most recent measurement was used (n = 153,439 subjects, 110,736 females, and 42,703 males).

2.2. Follow up

The cohort was followed from the index date January 1st, 2010 until the first diagnosis of UTI, death, moving from the CHS to another health maintenance organization (HMO), or until June 31st, 2012, whichever occur first. During the follow-up period 4436 (2.9%) subjects died, and

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1405 (0.91%) subjects moved from the CHS to another healthcare provider. These subjects were censored at the date of their death or the date of their movement to another healthcare provider.

2.3. Study variables

For the purpose of this study we considered only lower urinary tract infection as defined by ICD-9 coding [6], including; acute cystitis (ICD-9, 595.0), unspecified cystitis (ICD-9, 595.9), and urinary tract infection (ICD-9, 599.0). Asymptomatic bacteriuria was not considered for the purpose of this study. We will use the terminology "UTI" to indicate lower urinary tract infection through the manuscript.

Body mass index (BMI) was calculated (weight (kilograms)/ height^2 (meters)) and was classified into five categories (<25, 25 to 29.9, 30 to 39.9, 40 to 49.9, and ≥50 kg/m^2).

Serum 25(OH)D was used to assess vitamin D status and was classified into quartiles (Q1: <37.7, Q2: 37.7 to 55.3, Q3: 55.4 to 72.6, and Q4: >72.6 nmol/L).

2.4. The 25(OH)D assay

25(OH)D was tested using the LIAISON® 25-OH Vitamin D TOTAL assay (DiaSorin), a competitive two-step chemiluminescence assay. The measuring range is 4.0–150 ng/mL (10–375 nmol/L), the analytical sensitivity<1.0 ng/mL (2.5 nmol/L), and the functional sensitivity <4.0 ng/mL (10 nmol/L). The intra-assay precision is up to 5%, and the inter-assay precision is up to 15%. The specificity for 25-OH Vitamin D2 is 104%, and for 25-OH Vitamin D3 is 100%. Performance characteristics of the Vitamin D assay were checked in the method evaluation process done by Clalit Health Services and were compatible to the manufacturer-generated data. The accuracy of the measurements in the individual laboratory is confirmed by in-house daily quality control (QC) monitoring and by periodic external QC program (DEQAS).

2.5. Statistical analysis

Continuous data are presented as means with standard deviations (SD). Categorical variables are presented as proportions. The unpaired

Table 1
Characteristics of the study participants stratified by gender; CHS cohort, Israel.

All

Variable	Body mass index (BMI) (kg/m^2)						P value
	All (n=153,439)	<25 (n=54,845)	25–29.9 (n=54,710)	30–39.9 (n=39,350)	40–49.9 (n=4,108)	≥50 (n=426)	
Gender							<0.001
Males	27.8%	25.4%	33.1%	25.3%	14.9%	16.4%	
Females	72.2%	74.6%	66.9%	74.7%	85.1%	83.6%	
Ethnicity							<0.001
Jews	88.0%	91.0%	89.1%	83.6%	76.2%	76.1%	
Arabs	12.0%	9.0%	10.9%	16.4%	23.8%	23.9%	
History of DM	23.1%	12.1%	23.6%	35.1%	46.0%	42.3%	<0.001
25(OH)D							<0.001
Mean ± SD	56.4 ± 25.6	60.5 ± 26.9	67.0 ± 24.5	51.3 ± 24.2	43.5 ± 22.5	41.9 ± 23.8	
Age							<0.001
Mean ± SD	59.3 ± 17.3	54.6 ± 19.7	62.0 ± 15.8	62.2 ± 14.5	59.1 ± 14.1	58.6 ± 14.9	
UTI	19%	18.1%	18.6%	20.5%	22.1%	27.0%	<0.001

Males

Variable	Body mass index (BMI) (kg/m^2)						P value
	All males (n=42,703)	<25 (n=13,947)	25–29.9 (n=18,105)	30–39.9 (n=9,969)	40–49.9 (n=612)	≥50 (n=70)	
Ethnicity							<0.001
Jews	86.1%	88.2%	86.8%	82.4%	79.4%	85.7%	
Arabs	13.9%	11.8%	13.2%	17.6%	26.6%	14.3%	
History of DM	29.2%	18.9%	29.4%	42.0%	50.5%	38.6%	<0.001
25(OH)D							<0.001
Mean ± SD	58.0 ± 24.6	60.8 ± 26.2	58.5 ± 23.8	53.8 ± 23.4	46.0 ± 20.6	46.7 ± 23.7	
Age							<0.001
Mean ± SD	59.7 ± 18.0	56.1 ± 21.1	61.9 ± 16.6	61.2 ± 14.9	55.8 ± 14.9	57.6 ± 19.2	
UTI	9.4%	8.6%	9.3%	10.6%	13.4%	20.0%	<0.001

Females

Variable	Body mass index (BMI) (kg/m^2)						P value
	All females (n=110,73)	<25 (n=40,898)	25–29.9 (n=36,605)	30–39.9 (n=29,381)	40–49.9 (n=3,496)	≥50 (n=356)	
Ethnicity							<0.001
Jews	88.7%	92.0%	90.2%	84.0%	75.7%	74.2%	
Arabs	11.3%	8.0%	9.8%	16.0%	24.3%	25.8%	
History of DM	20.8%	9.8%	20.7%	32.8%	45.2%	43.0%	<0.001
25(OH)D							<0.001
Mean ± SD	55.8 ± 25.9	60.4 ± 27.1	56.3 ± 24.8	50.4 ± 24.4	43.0 ± 22.8	41.0 ± 23.8	
Age							<0.001
Mean ± SD	59.2 ± 17.1	54.1 ± 19.2	62.1 ± 15.4	62.5 ± 14.4	59.6 ± 13.8	58.8 ± 14.0	
UTI	22.7%	21.3%	23.3%	23.8%	23.6%	28.4%	<0.001

DM; diabetes mellitus.