



## Low serum cholesterol as a risk factor for kidney and bladder cancer among Korean men: using a national cohort sample

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The relationship between serum cholesterol level and cancer risk is controversial. Recent studies showed that low pre-operative serum cholesterol levels may be associated with worse pathologic outcomes and poor cancer-specific survival in patients with renal cell carcinoma [1, 2]. However, it is unclear whether low serum cholesterol can increase the risk of urologic cancer incidence. We investigated the association between serum total cholesterol and the incidence of kidney and bladder cancer among Korean men using a national cohort sample.

This study was based on the National Health Insurance Service-National Sample Cohort (NHIS-NSC), a population-based cohort established by the Korean NHIS. The NHIS-NSC has been described in a previous study [3]. This cohort was created in January 2002 and was followed for 11 years until December 2013. We included 82,832 men aged  $\geq 40$  years after excluding subjects who reported having any malignant disease, chronic liver disease, or renal disease at or before baseline examination, those who had missing information on serum cholesterol, those who died within 2 years from the initial examination, and those who were diagnosed of kidney or bladder cancer within 3 years from the cholesterol assessment to reduce the possibility of the reverse causation.

We categorized total cholesterol levels as follows:  $< 170$  mg/dL, 170–189 mg/dL, 190–209 mg/dL, 210–229 mg/dL, and  $\geq 230$  mg/dL. The development of kidney or bladder cancer was detected using ICD-10 codes, which included malignant neoplasm of kidney (C64) and malignant neoplasm of bladder (C67). Cox regression analysis was used to examine the association between the total cholesterol level and the incidence of kidney or bladder

cancer after adjusting for age and any confounding variables. The results from Cox regression analysis are presented with the hazard ratio (HR) and 95% confidence interval (CI). All data were analyzed using STATA version 14 (StataCorp LP, College Station, TX).

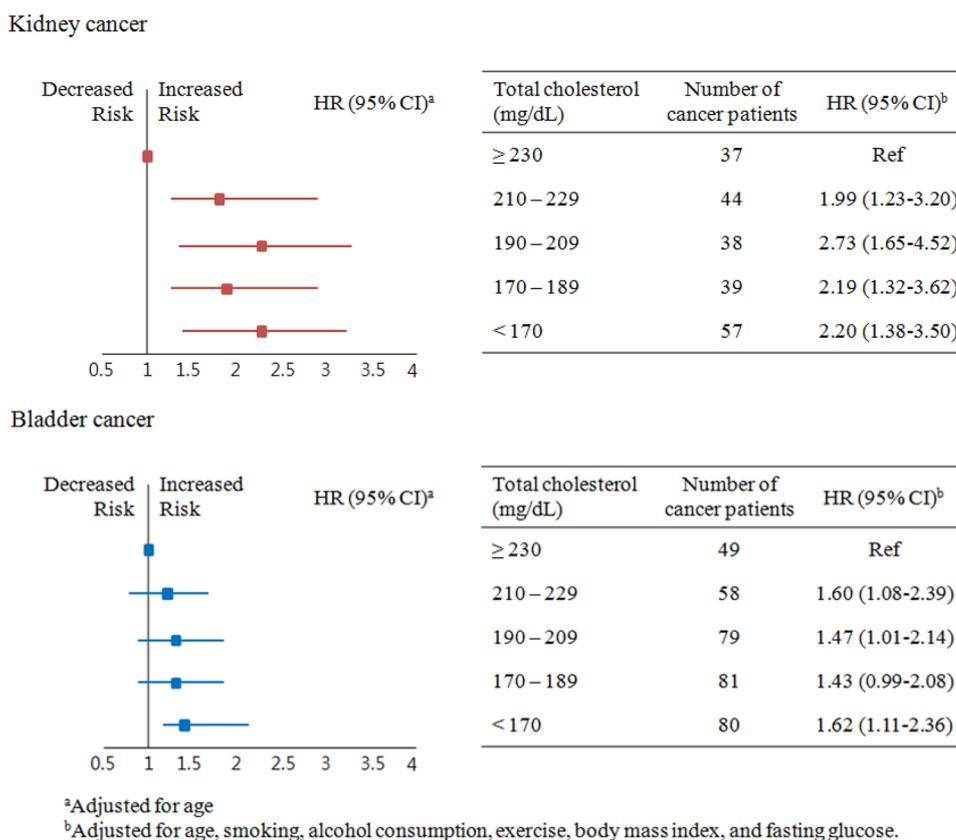
During the 11-year follow-up period, 215 men were newly diagnosed with kidney cancer, and 347 men were diagnosed with bladder cancer. In comparison with the HR at a total cholesterol level of  $\geq 230$  mg/dL, the HR (95% CI) for kidney cancer was increased to 1.99 (1.23–3.20), 2.73 (1.65–4.52), 2.19 (1.32–3.62), and 2.20 (1.38–3.50) ( $p$  for trend  $< 0.001$ ) and the HR (95% CI) for bladder cancer was increased to 1.60 (1.08–2.39), 1.47 (1.01–2.14), 1.43 (0.99–2.08), and 1.62 (1.11–2.36) ( $p$  for trend  $< 0.05$ ) at a total cholesterol level of 210–229 mg/dL, 190–209 mg/dL, 170–189 mg/dL, and  $< 170$  mg/dL, respectively (Fig. 1).

This study demonstrated that a high cholesterol level ( $\geq 230$  mg/dL) may be a protective factor against kidney and bladder cancer among Korean men. We did not analyze data of women due to the small number of urologic cancer in women. The statistical power was too weak to perform the analysis. Our findings are consistent with the results of a previous study showing that the long-term use of statins could increase the risk of cancers of the urinary tract, especially bladder cancer [4]. In addition, a recent study reported that low serum cholesterol could be a risk factor for renal cell cancer [5]. Our results suggest that low serum cholesterol may be a risk factor for kidney and bladder cancer.

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**Fig. 1** Hazard ratios for incidence of kidney and bladder cancer followed up 11 years according to baseline serum cholesterol levels of Korean men



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**Compliance with ethical standards**

**Conflict of interest** The authors have declared no conflicts of interest.

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