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Systematic review of modifiable risk factors for kidney cancer

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Abstract

To perform a systematic review of modifiable risk factors associated with the incidence of renal cell cancer (RCC). A systematic search of the literature was conducted using PubMed, Cochrane, and Web of Science databases from January 1996 until August 2017. We also extracted articles from the reference lists of identified studies and reviews. We targeted modifiable risk factors for RCC to include exercise, smoking, alcohol, diet, obesity, hypertension, and diabetes. We utilized predefined inclusion criteria and the Preferred Reporting Items for Systematic Reviews and Meta-analysis statement. We identified a total of 464 relevant articles and excluded 209 via title and 130 after abstract review. We thoroughly reviewed a total of 125 manuscripts. Seven supplementary tables describe (a) case controls and (b) prospective cohort studies. We summarize the tables in figures to visualize the overall impact of these studies association (beneficial, harmful, or null) with RCC. Total physical activity if beneficial (10/12 studies), smoking is harmful (13/14 studies), alcohol was protective (i.e., beneficial, 13/16 studies), diet was indeterminate (13 beneficial, 13 harmful, and 9 nulls), obesity and hypertension were overwhelmingly harmful (36/36 studies and 17/18, respectively), and diabetes was detrimental (23/27 studies). Modifiable risk factors play an essential role in the development of RCC, and we should develop targeted RCC prevention strategies in at-risk individuals. Published by Elsevier Inc.

Keywords: Kidney cancer; Epidemiology; Modifiable risk; Diet; Smoking; Obesity; Hypertension; Diabetes; Alcohol; Outcomes

1. Introduction

Kidney cancer (i.e., renal cell cancer [RCC]) is estimated to have a worldwide incidence of 270,000 cases yearly and nearly 116,000 deaths [1]. In the United States, estimates indicate 65,150 new cases and 13,680 deaths from kidney and renal pelvis cancers in 2017 with approximately 35% presenting as a metastatic disease [2].

While there is no recommendation for screening for renal cell carcinoma (RCC), the frequency of RCC continues to rise [3]. The rising number of RCC cases is believed to be a result of improved imaging techniques and increased accidental tumor discovery [4]. Moreover, epidemiological studies attribute a rise in RCC to the increased prevalence of associated risk factors such as obesity and hypertension [3]. Currently, we use the term modifiable risk factor to identify those negative influences on a disease that can be changed to potentially impact health outcomes.

Lifestyle modifications have been shown to reduce the incidence of a variety of cancers as well as improve cancer-specific survival [5]. Therefore, lifestyle interventions can be an inexpensive preventative and adjunctive program tailored to the individual patient and may affect outcomes. To understand the body of literature investigating modifiable associations with RCC, we provide a systematic review of the literature of the following specific modifiable lifestyle risk factors: physical activity, smoking, alcohol consumption, diet, obesity, Diabetes Mellitus (DM), and hypertension.

2. Evidence acquisition

2.1. Protocol and registration

We used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement, which is an

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evidence-based minimum set of items reporting in systematic reviews [6]. We registered the study with PROSPERO International prospective registry of systematic reviews (CRD420130005630).

2.2. Eligibility criteria

We performed a literature review search using PubMed, Cochrane, and Web of Science databases from January 1996 until August 2017. We excluded search terms "uroepithelial cell carcinoma," "transitional cell carcinoma," "genetic," "occupational risk factors," or "familial." We excluded meta-analyses and systemic reviews.

2.3. Information sources

We reviewed only published articles on Cochrane and Web of Science databases in English, and performed no further communication with other study authors. No additional datasets were used or obtained for this review.

2.4. Search

We used the following search terms as our primary variables: "kidney cancer" and "renal cell carcinoma." We partitioned modifiable behavior, or lifestyle risk factors into smoking, alcohol, physical activity, and diet. We divided modifiable metabolic risk factors into obesity, hypertension, and diabetes. We first used the secondary search variables for behavioral risk factors associated with exercise, smoking, alcohol, and diet. We included the following search terms: physical activity, exercise, smoking, alcohol consumption, and diet (to include fat, meat, and carbohydrates). Second, we searched for conditions associated with the following metabolic risk factors: obesity, body mass index (BMI), waist circumference, hypertension, high-density lipoprotein, low-density lipoprotein, cholesterol, triglycerides, dyslipidemia, diabetes, glucose, and hemoglobin A1c.

2.5. Study selection

We excluded all meta-analyses and systematic reviews from the final list, but included them while reference mining for other sources. We divided the literature into 2 broad categories: behavioral risk factors and metabolic risk factors. We classified these categories into subdivisions. We separated the searches from longitudinal studies (cohort) and case-control studies as each has different intrinsic biases. Within each group, we extracted data such as relative risks, hazard ratios (HRs), standard incidence ratios, and odd ratios; these measures were then summarily placed into tables for review.

2.6. Data collection process

We display our data collection processes in Fig. 1.

2.7. Data items

Search terms were used in PUBMED only, and we obtained no further data from outside sources. We did exclude studies not directly related to the selected lifestyle modifications as a primary outcome for simplification.

2.8. Risk of bias in individual studies

We divide tables into cohort studies and case-control studies to be transparent about the strength of associations inferred from the inherent bias of study design. Additionally, we added the sample size of each study to provide the reader with information regarding enrollment. We do not report on publication bias.

2.9. Summary measures

We give summary measures for each study in the attached tables. Case-control studies we reported odds ratios, and in cohort studies, we indicate the relative risk, HR, or standard incidence ratios provided in the original manuscript.

2.10. Synthesis of results

We perform a descriptive analysis of the literature reviewed. After initial review and selection of articles to urologists (OAB and MAL), we discuss the findings for study inclusion and consensus of the manuscript. We do not use further statistical analysis. We use funnel plot diagrams as a descriptive analysis of the current literature.

2.11. Risk of bias across studies

A qualitative assessment was performed using the guidelines for assessing quality in the research based on potential biases [7]. We included some aspects of the confounders and outcome measurements within the summary tables.

3. Evidence synthesis

3.1. Search results

We identified 441 relevant research articles searching the different databases. After conducting a reference search, our research article total increased to 464 articles based on the title. We examined the abstracts of 464 articles and selected 255 articles for full review. We rejected 130 articles as per exclusion criteria, providing a total of 125 research articles for review (Fig. 1).

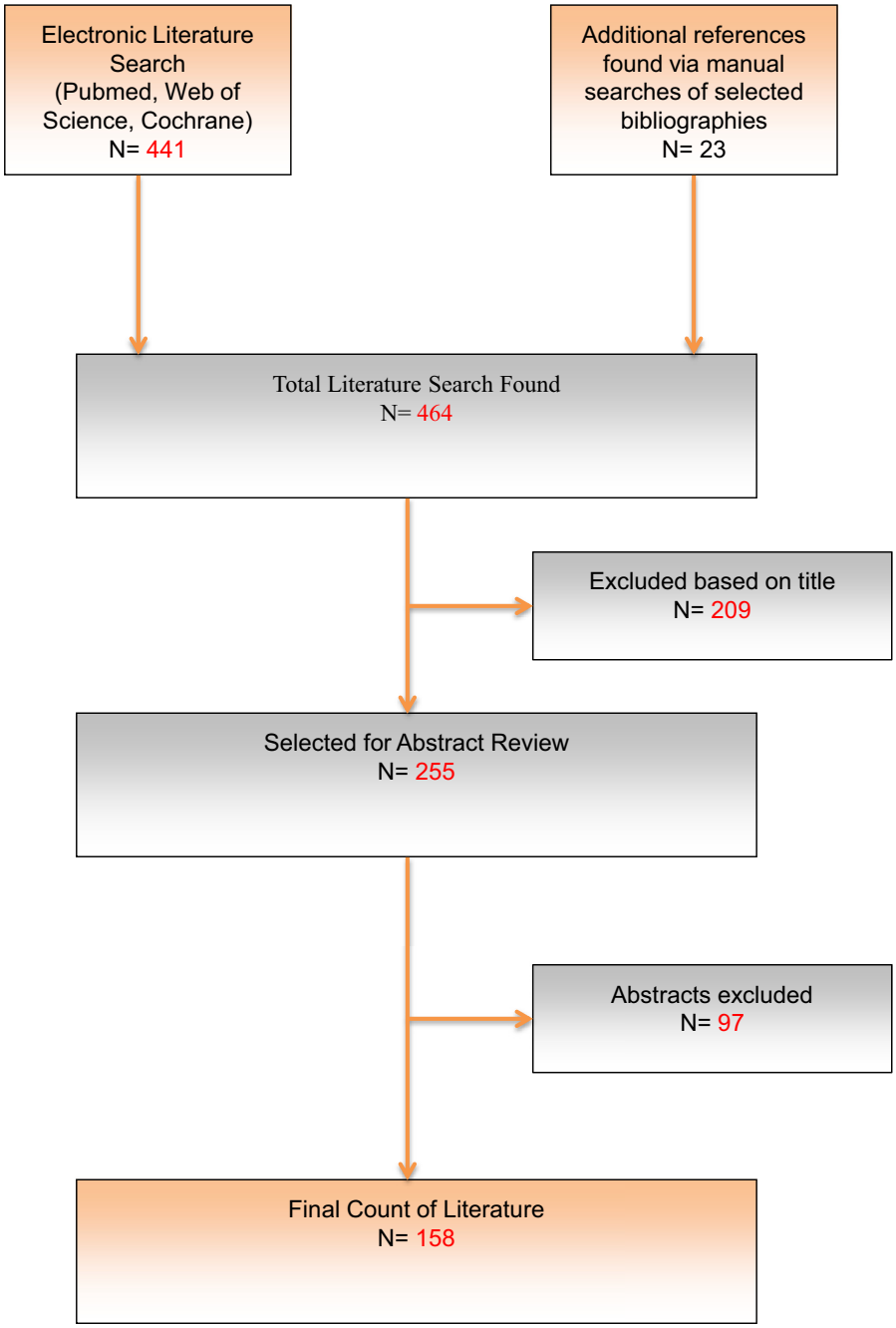

Fig. 1. Literature search flow chart.

3.2. Exercise

Physical activity and obesity could exert an effect on carcinogenesis through different independent mechanisms [8,9]. The basic mechanisms that could link physical inactivity and cancer include chronic inflammation, impaired immune surveillance and responsiveness, adipokine dysregulation, impaired insulin sensitivity, and an increase in circulating levels of sex hormones [10,11]. We found a total of 12 articles relevant to physical activity and the effect on RCC (Fig. 2). Five studies were longitudinal studies investigating the association of physical activity and incident RCC (Supplementary Table 1a) [12–16] Overall, there is no obvious trend with exercise and incidence of RCC. Only 3 studies concluded a protective effect, one of which only showed the protective effect in women [12,14]. Three studies reported relative risk ranging from 0.66 to 0.87 comparing the highest level of exercise to low, leisure, or regular daily activity [14,15]. Any activity level seemed to have a small protective effect in all studies. Two studies obtained an HR, one describing a sitting time more than 9 hours compared to less than 3 hours showed an association with

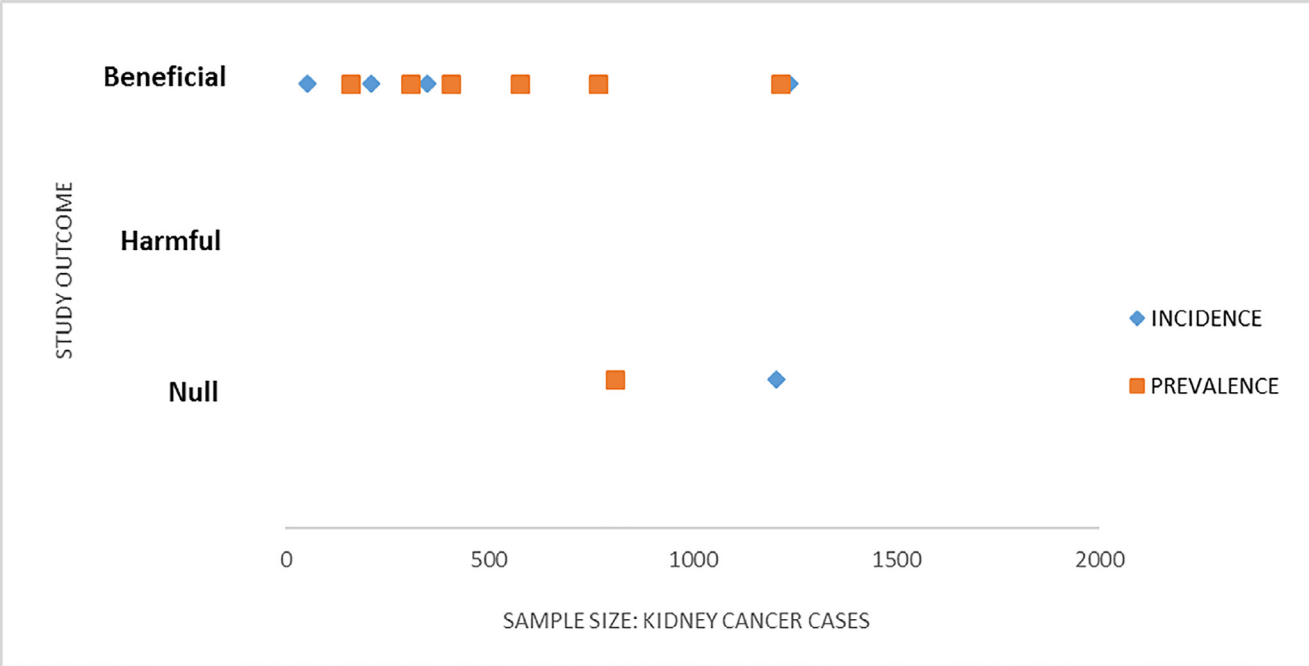

Fig. 2. Funnel plot of physical activity vs. kidney cancer incidence and prevalence.

incident RCC (HR 1.11) [13]. Williams found that running and walking may reduce incident RCC risk with HR range 0.24 to 0.39 [16]. We noted 7 cases control studies examining the association of RCC and physical activity (Supplementary Table 1b) [17–23]. Most studies used various descriptions of physical activity, such as a level of activity (low, medium, and high), activities per week, or quartiles. These studies show a protective effect of exercise reducing RCC prevalence in general. On the other hand, other authors identified an association between a lack of lifetime recreational physical activity and RCC risk [20]. One study noted a protective effect only in women [21]. Other study shows low levels of physical activity may increase the risk of RCC in whites. In contrast, higher levels of physical activity did not appear to offer a similar protective effect in blacks [23].

3.3. Smoking

Smoking is a well-established risk factor for renal cell carcinoma (RCC) [24]. Despite a steady decline in the proportion of Americans who smoke during the last 50 years, more than 20% of Americans continue to smoke regularly today [25]. Genetic alteration induced by smoking gene could be involved in increasing the risk of RCC development [26]. We identified 14 research articles discussing the effects of smoking on the risk of RCC (Fig. 3). Six longitudinal (cohort) studies investigated smoking and incidence of RCC representing 3 countries (Supplementary Table 2a) [12,27–31]. All 6 studies showed an increased risk of RCC with an approximate relative risk of 1.3 to 2.3. Two studies indicate that the risk may be higher for male smokers than female smokers [12,30]. Studies investigating former smokers compared to current smokers show less risk associated with those not currently smoking. Macleod et al. was the only study to provide an HR regarding the incidence of RCC and the length of time the person had smoked [28]. They proposed that those people who smoke for more than 20 years have a 50% greater chance of developing RCC compared to those who never smoked. Eight studies were prevalent in RCC studies with only 1 null study, while the rest showed a higher association of smoking with RCC (Supplementary Table 2b) [32–39]. The majority of studies observed positive associations of smoking with renal cell carcinoma. Two studies attempted to get at pack-years of smoking without obvious trends; however, both did not include the number of years from cessation to significantly reduced RCC prevalence [34,36].

3.4. Alcohol

Nearly 88,000 people die from alcohol-related causes annually in the United States [40]. There is a significant consensus of an association between alcohol consumption and several types of cancer [41,42]. The increased activity of total aldehyde dehydrogenase in RCC may be the factor intensifying carcinogenesis because of increasing the ability to highly carcinogenic acetaldehyde formation [43]. We found a total of 16 research articles discussing the effects of alcohol intake on the risk of developing RCC (Fig. 4). Ten of the articles were cohort studies investigating the incidence of RCC studies compared to the amount of alcohol intake representing 3 countries

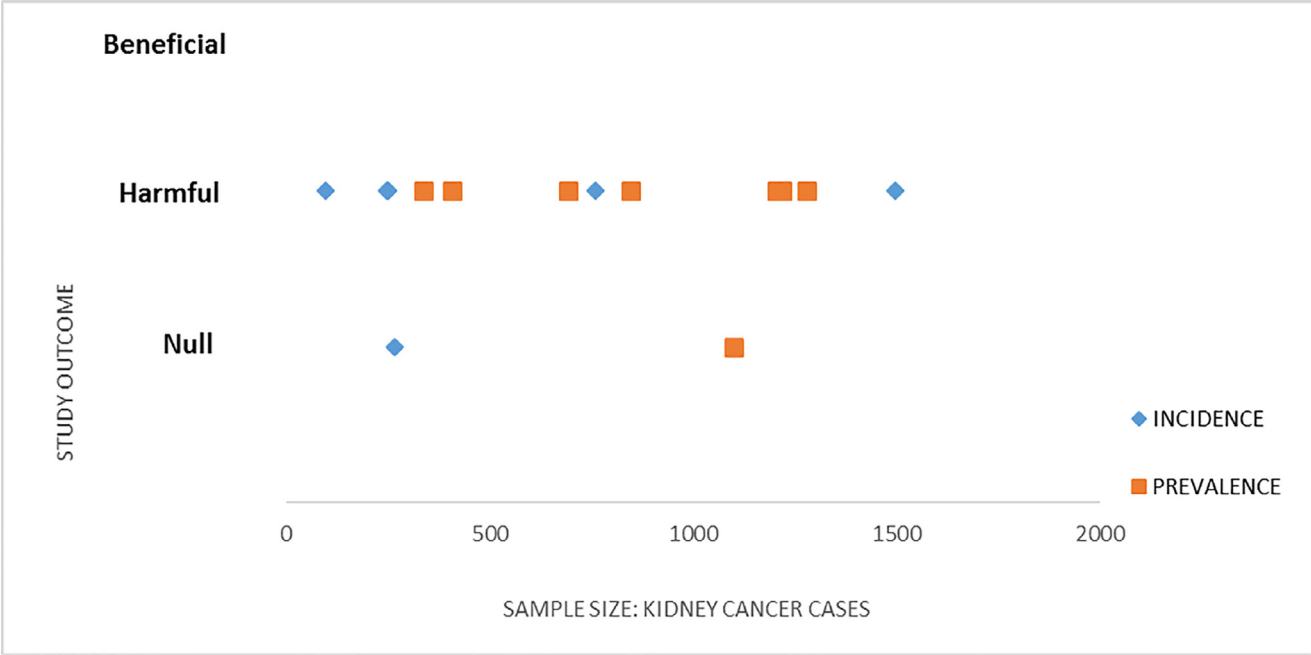

Fig. 3. Funnel plot of smoking vs. kidney cancer incidence and prevalence.

(Supplementary Table 3a) [12,28,44–51]. About half of the studies used grams of alcohol as a measurement, while other studies used quartiles or number of drinks. Nine out of 10 studies show a protective effect of increasing alcohol consumption and incident RCC with approximate relative risks of 0.4 to 0.8 in the majority of studies. One study in which the analyses stratified by smoking status, further support that alcohol consumption is associated with reduced RCC risk, regardless of sex or alcoholic beverage type [51]. The VITAmins and Lifestyle (VITAL) study shows no association between alcohol intake and RCC. However, because VITAL was a study of supplements and health-related behavior, it may have attracted a larger, health-conscious group with lower drinking habits [28]. We identified 6 studies as case-control studies investigating the prevalence of RCC associated with alcohol consumption representing 5 countries (Supplementary Table 3b) [52–57]. The case-control studies were more mixed regarding the protective effects of alcohol and also had a much larger range of comparisons. Only 4 studies showed a protective association of alcohol and prevalence of RCC with an approximate range of odds ratios of 0.6 to 0.8. One of these studies was significant only in women [52]. A study in Europe did not find an association between total alcohol consumption and RCC, with no sex-specific effects [54].

3.5. Diet

Research estimates that dietary modification may prevent more than 30% of cancers [58,59]. We found a total of 35 articles discussing the effects of various food items and their effect on the development of RCC (Fig. 5). Seventeen of the articles are longitudinal studies examining the associations of dietary intake and incident RCC (Supplementary Table 4a), [28,60–75]. Two studies investigated harmful triglycerides. Dietary studies have many variations in the variables examined, and the amount was analyzed. There was convincing evidence that fruit and vegetables decreased the risk of cancers of the mouth and pharynx, esophagus, stomach, and lung [76]. Two large studies ($n = 1,816$ and $n = 1,478$) from the United States examining fruits and vegetable intake noted a protective effect from RCC; however, 4 smaller studies (all <310 patients) noted no association. The increase in RCC incidence in the United States and other developing nations suggests that factors related to western lifestyles, such as a diet high in meats, processed foods, and starches, may play an important role in RCC etiology [68]. Three studies examined exposure to red meat. Two large studies, one from the United States ($n = 1,814$), found a harmful association with red meat, and other data from European study support an association between red meat consumption and risk of RCC only in women [73,77]. However, 2 U.S. studies (total $n = 1,699$) noted no association [69,72]. Approximately 85% of dietary lycopene originates from tomato fruit or tomato-based products, including juice, ketchup, soup, pizza, and pasta sauces. Other sources include watermelon, pink grapefruit, guava, and papaya [78]. One study in the United States shows an increase in lycopene intake among postmenopausal women associated with a lower risk of RCC [74]. Lycopene also found to reduce the number and size of RCC developing in the genetically susceptible TSC2 mutant Eker rats [79]. Other novel

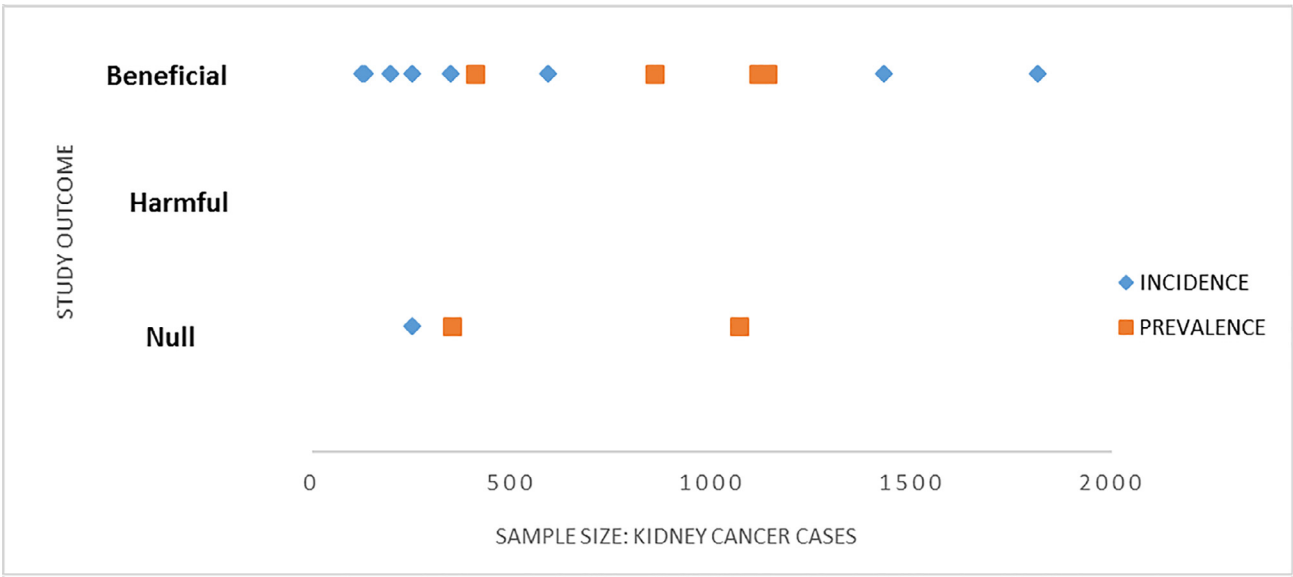

Fig. 4. Funnel plot of alcohol consumption vs. kidney cancer incidence and prevalence.

studies suggest that sodium intake is a potential independent risk factor for RCC with a significant increase in RCC risk per increment of 1 g/d [75]. Perhaps, high renal sodium load constitutes to RCC carcinogenesis through inflammation, as sodium is suggested to have inflammatory properties, which can have tumor-promoting consequences [80,81]. Regarding case-control studies, 18 studies investigated diet and RCC prevalence (Supplementary Table 4b) [54,68,82–97]. Three studies show fruit intake has a protective effect, while 4 studies noted null effect. Seven studies show protective, and 1 shows no association of vegetable with the RCC. Six studies investigated dairy products in which 4/6 noted associations with RCC. Ten studies investigated red meats noting a harmful association in 9/10 studies with 1 study indicated a particular harmful association is when the meat is barbequed. One study found significant associations between meat intake and RCC risk. The interindividual variation in RCC risk may be due to both genetic susceptibility and modifiable dietary risk factors such as mutagenic compounds

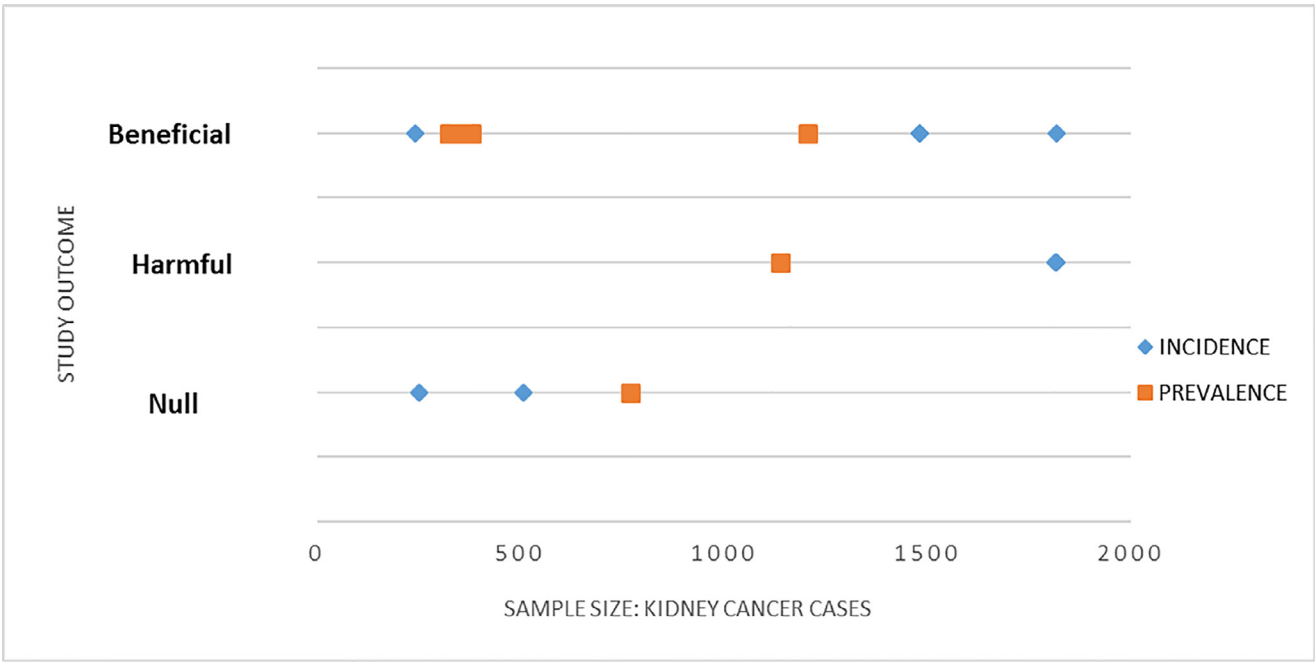

Fig. 5. Funnel plot of diet vs. kidney cancer incidence and prevalence.

caused by various methods of cooking meat [96]. Three additional studies investigated cholesterol intake, 2 had harmful, and 1 had a protective association with the RCC. An Italian case-control study explored the association between proinflammatory diet (e.g., high consumption of sugar and processed meat) and RCC as a high-risk factor especially among female [97].

3.6. Obesity

Overweight (BMI ≥25 kg/m^2) affects more than 1 billion people, and more than 300 million of them are considered obese (BMI ≥30 kg/m^2) [98]. Overweight or obesity is an established cause of several cancers including breast, endometrium, esophagus (adenocarcinoma), renal, and colon and rectum [99]. Adiposity, which is a strong correlate of higher BMI, is known to contribute to inflammation. Adipocytes also secrete multiple products including adipokines (leptin and adiponectin) and inflammatory cytokines implicated in modulating cancer risk [100,101]. We identified 36 research articles discussing the effects of obesity on RCC (Fig. 6). Cohort studies investigated the incidence of RCC among a selected population (Supplementary Table 5a). Of the 21 studies investigating RCC incidence and obesity, we show a positive correlation in all studies totaling over 18,000 patients [12,28–30,70,77,102–116]. A Twenty-year prospective study on a Korean population showed a significant association between obesity and RCC among men and women (RR 1.46 for obese men; RR 1.40 for obese women) [113]. In 2 large studies, one is Canadian and the other in Australia, cancer cases were found to be attributable to excess body weight slightly higher in male (25.4%, 20% respectively) than female (23.0%, 17% respectively) [115,116]. A study on postmenopausal women found that measurement of abdominal adiposity is stronger than BMI, and when BMI and WC mutually adjusted, WC showed a stronger association compared to BMI [114].The majority of the 15 case-control studies observed positive associations of obesity and the prevalence of RCC with increasing BMI (Supplementary Table 5b) [17,19,20,33,35,117–126]. BMI was almost uniformly used in case-control studies to examine the association of obesity among 5 different countries. Three studies with over 1,000 patients a trend to increased risk with increasing BMI was noted, especially those with a BMI >30 having nearly a 3-fold increased the risk of RCC [35,117,121]. Four studies focus on adiponectin as a marker for obesity. One study among male smokers shows the highest quartile of adiponectin having a 50% less risk of RCC [122]. Liao et al.'s study suggests that there may be racial differences in the associations between adipocytes and RCC risk; however, they did not find an association between obesity and RCC [124].

3.7. Hypertension

The prevalence of hypertension is increasing in the United States, particularly among blacks and among women, which may explain in part the recent demographic trends of increasing RCC incidence in these groups [127]. One hypothesis is that chronic renal hypoxia, as occurs in established hypertensive nephrosclerosis, causes local up-

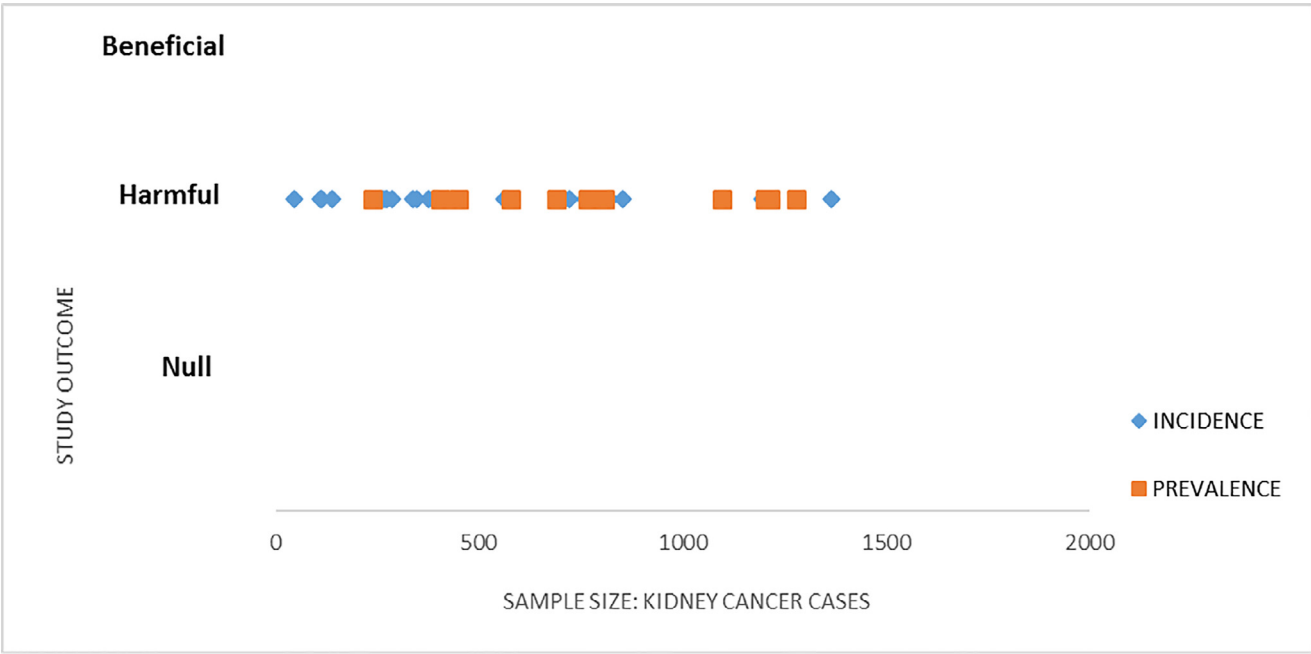

Fig. 6. Funnel plot of obesity vs. kidney cancer incidence and prevalence.

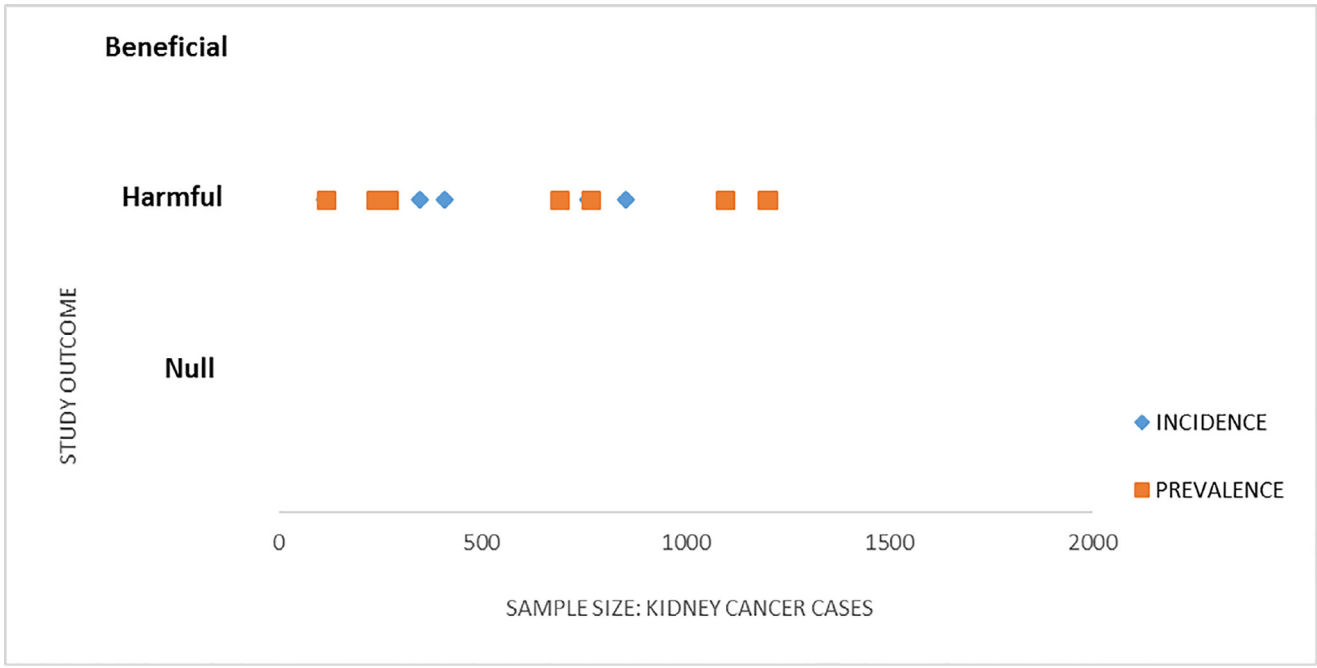

Fig. 7. Funnel plot of hypertension vs. kidney cancer incidence and prevalence.

regulation of hypoxia-inducible factors, lipid peroxidation, and formation of reactive oxygen species [128,129] Genetic modification by hypertension or sodium intake found to be associated with RCC risk, indicating that the renin–angiotensin–aldosterone system may be a candidate pathway in RCC etiology [130]. We identified 18 research articles were found relevant to hypertension and the risk of RCC (Fig. 7). Ten longitudinal articles focused on various aspects of hypertension and incident RCC (Supplementary Table 6a) [12,28–30,70,111,131–134]. Seven out of the 10 studies showed a higher rate of incident of kidney cancer in patients with hypertension, while 1 study did not find this association in men. One cohort study on adolescents with hypertension shows no evidence of increased risk for those with an established diagnosis of hypertension after 17 years follow-up [133]. The largest studies were from Sweden ($n = 855$) and the United States ($n = 759$) both showing increase the risk of RCC with the severity of hypertension [28,70]. Both studies stress the importance of diastolic blood pressure as well as systolic blood pressure. Five studies used relative risk to describe the association noting the range to be 1.2 to 2.2 compared to nonhypertensive controls. Four studies use HRs as a descriptive measure for the risk of RCC with a range from 0.32 to 3.33 depending on the severity of hypertension. Other study found an independent association between obesity and hypertension with the development of RCC and shows a robust association in long-term follow-up in U.S. men and women [134]. Eight articles had a case-control study design examining prevalence of RCC in hypertensive patients (Supplementary Table 6b) [33,35,117,123,135–138]. An examination of the data showed that all articles described an association between hypertension and an increased risk of RCC. The odds ratios ranged from 1.12 to 2.6. Most studies investigated hypertension as an all-or-none event; however, 1 study noted that those with more poorly controlled are 2 times more likely also to have RCC [137].

3.8. Diabetes

Diabetes was associated with a 17% and 21% increased risk of developing any cancer and death from any cancer, respectively [139]. Insulin resistance, hyperinsulinemia, proinflammatory status, and increased oxidative stress may be the underlying mechanisms that increase the cancer risk among diabetic patients [140,141]. We identified 27 research articles discussing the effect of diabetes on the risk of incident RCC (Fig. 8). We identified 20 longitudinal studies investigating the incidence of RCC associated with those diagnosed with diabetes mellitus only 2 of which were null studies (Supplementary Table 7a) [12,28,50,70,71,135,136,142–160]. Nearly all (18/20) noted an association between diabetes and eventual development of RCC. The largest study performed on the topic was from the United States with over 8,000 patients with a relative risk of 1.09 in those with diabetes compared to those without diabetes [144]. A Swedish study of over 800 people noted HRs over 2.5 in quintiles compared to the lowest quintile; however, this was not reproduced in any other studies [70]. For example, a study from South Korea and the UK noted increased RCC with increasing glucose levels, none of the HRs were above 2 [71,143]. T1DM was associated with a more than 2-fold increase in risks of

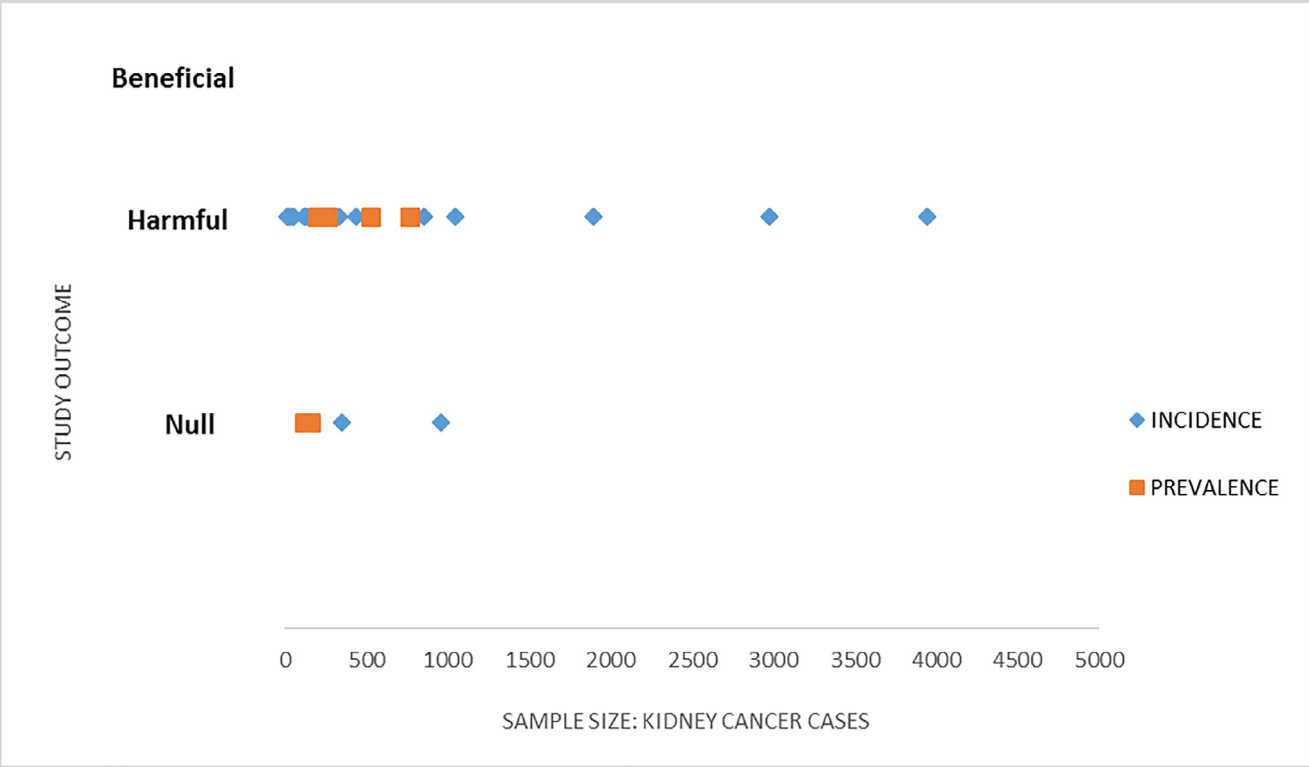

Fig. 8. Funnel plot of diabetes mellitus vs. kidney cancer incidence and prevalence.

RCCs in men (2.12; 95% confidence interval 1.06–3.79) [152]. A study in Taiwan ($n = 1,898$) found that the risk of RCC significantly increased diabetic men and women with age >45 and >65 years, respectively [149]. Seven studies utilized a case-control data analysis investigating diabetes association with RCC studies (Supplementary Table 7b) [135,136,157–161]. These studies show a split between null (2 studies) and those with an association (5 studies). The majority of studies investigated diabetes compared to nondiabetes and obtained odds ratios ranging from 1.06 to 6.3. Only 1 study investigated the difference between glycemic index and glycemic load via quintiles noting trends in higher quintiles associated with higher prevalence of RCC [159]. In that particular study, those with a glycemic load in the highest quintile had a 2.5-fold higher risk of RCC compared to the lowest quintile.

4. Conclusions

Increased use of diagnostic imaging will likely increase the number of incidental renal tumors. Unfortunately, many RCCs are found at advanced stages and become difficult to treat. One strategy focuses on modifiable risk factors such as regular exercise, alcohol with low-to-moderate consumption, and fruit and vegetables have a protective association with the RCC. Smoking cessation programs and weight loss programs may be beneficial for those at risk. Regular primary care visits are essential to maintain healthy blood pressure and prevent diabetes. Further studies are needed to understand the molecular basis behind these associations for the prevention of renal cell carcinogenesis and to improve outcomes.

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Conflicts of interest

The authors declare that they have nothing to disclose.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at https://doi.org/10.1016/j.urolonc.2018.12.008.

References

[1] Ljungberg B, Campbell SC, Choi HY, et al. The epidemiology of renal cell carcinoma. Eur Urol 2011;60:615–21.
[2] Siegel R, Miller KD, Jemal A. Cancer statistics, 2018. CA Cancer J Clin 2018;68:7–30.

[3] Decastro GJ, McKiernan JM. Epidemiology, clinical staging, and presentation of renal cell carcinoma. Urol Clin North Am 2008;35:581–92:vi.
[4] Nguyen MM, Gill IS, Ellison LM. The evolving presentation of renal carcinoma in the United States: trends from the surveillance, epidemiology, and end results program. J Urol 2006;176:2397–400: discussion 400.
[5] Stein CJ, Colditz GA. Modifiable risk factors for cancer. Br J Cancer 2004;90:299–303.
[6] Liberati A, Altman DG, Tetzlaff J, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions: explanation and elaboration. BMJ 2009;339:b2700.
[7] Hayden JA, Cote P, Bombardier C. Evaluation of the quality of prognosis studies in systematic reviews. Ann Intern Med 2006;144:427–37.
[8] Sanchis-Gomar F, Lucia A, Yvert T, et al. Physical inactivity and low fitness deserve more attention to alter cancer risk and prognosis. Cancer Prev Res (Phila) 2015;8:105–10.
[9] Byers T. Physical activity and gastric cancer: so what? An epidemiologist's confession. Cancer Prev Res (Phila) 2014;7:9–11.
[10] McTiernan A. Mechanisms linking physical activity with cancer. Nat Rev Cancer 2008;8:205–11.
[11] Walsh NP, Gleeson M, Shephard RJ, et al. Position statement: part one: immune function and exercise. Exerc Immunol Rev 2011;17:6–63.
[12] Setiawan VW, Stram DO, Nomura AM, Kolonel LN, Henderson BE. Risk factors for renal cell cancer: the multiethnic cohort. Am J Epidemiol 2007;166:932–40.
[13] George SM, Moore SC, Chow WH, Schatzkin A, Hollenbeck AR, Matthews CE. A prospective analysis of prolonged sitting time and risk of renal cell carcinoma among 300,000 older adults. Ann Epidemiol 2011;21:787–90.
[14] Moore SC, Chow WH, Schatzkin A, et al. Physical activity during adulthood and adolescence in relation to renal cell cancer. Am J Epidemiol 2008;168:149–57.
[15] Mahabir S, Leitzmann MF, Pietinen P, Albanes D, Virtamo J, Taylor PR. Physical activity and renal cell cancer risk in a cohort of male smokers. Int J Cancer 2004;108:600–5.
[16] Williams PT. Reduced risk of incident kidney cancer from walking and running. Med Sci Sports Exerc 2014;46:312–7.
[17] Shu X, Lin J, Wood CG, Tannir NM, Wu X. Energy balance, polymorphisms in the mTOR pathway, and renal cell carcinoma risk. J Natl Cancer Inst 2013;105:424–32.
[18] Tavani A, Zucchetto A, Dal Maso L, et al. Lifetime physical activity and the risk of renal cell cancer. Int J Cancer 2007;120:1977–80.
[19] Pan SY, DesMeules M, Morrison H, Wen SW. Canadian Cancer Registries Epidemiology Research Group. Obesity, high energy intake, lack of physical activity, and the risk of kidney cancer. Cancer Epidemiol Biomarkers Prev 2006;15:2453–60.
[20] Chiu BC, Gapstur SM, Chow WH, Kirby KA, Lynch CF, Cantor KP. Body mass index, physical activity, and risk of renal cell carcinoma. Int J Obes 2006;30:940–7.
[21] Canniotoa R, Ettera JL, Gutermanb LB, Josepha JM, Gulatic NR, Schmittd KL, et al. The association of lifetime physical inactivity with bladder and renal cancer risk: a hospital-based case-control analysis.. Cancer Epidemiol 2017;49:24–9.
[22] Menezes RJ, Tomlinson G, Kreiger N. Physical activity and risk of renal cell carcinoma. Int J Cancer 2003;107:642–6.
[23] Xiao Q, Liao L, Matthews CE, Chow W-H, Davis F, Schwartz K, et al. Physical activity and renal cell carcinoma among black and white Americans: a case-control study. BMC Cancer 2014;14:707.
[24] Hunt JD, van der Hel OL, McMillan GP, Boffetta P, Brennan P. Renal cell carcinoma in relation to cigarette smoking: meta-analysis of 24 studies. Int J Cancer 2005;114:101–8.
[25] Centers for Disease Control and Prevention. 2007.
[26] Eckel-Passow JE, Serie DJ, Bot BM, Joseph RW, Cheville JC, Parker AS. ANKS1B is a smoking-related molecular alteration in clear cell renal cell carcinoma. Br J Cancer Urol 2014;14:14. https://doi.org/10.1186/1471-2490-14-14.
[27] Blakely T, Barendregt JJ, Foster RH, et al. The association of active smoking with multiple cancers: national census-cancer registry cohorts with quantitative bias analysis. Cancer Causes Control 2013;24:1243–55.
[28] Macleod LC, Hotaling JM, Wright JL, et al. Risk factors for renal cell carcinoma in the vitamin and lifestyle (VITAL) study. J Urol 2013;190:1657–61.
[29] Flaherty KT, Fuchs CS, Colditz GA, et al. A prospective study of body mass index, hypertension, and smoking and the risk of renal cell carcinoma (United States). Cancer Causes Control 2005;16:1099–106.
[30] Chow WH, Gridley G, Fraumeni JF Jr, Jarvholm B. Obesity, hypertension, and the risk of kidney cancer in men. New Engl J Med 2000;343:1305–11.
[31] Nordlund LA, Carstensen JM, Pershagen G. Cancer incidence in female smokers: a 26-year follow-up. Int J Cancer 1997;73:625–8.
[32] Cote ML, Colt JS, Schwartz KL, et al. Cigarette smoking and renal cell carcinoma risk among black and white Americans: effect modification by hypertension and obesity. Cancer Epidemiol Biomarkers Prev 2012;21:770–9.
[33] Benichou J, Chow WH, McLaughlin JK, Mandel JS, Fraumeni JF Jr. Population attributable risk of renal cell cancer in Minnesota. Am J Epidemiol 1998;148:424–30.
[34] Theis RP, Dolwick Grieb SM, Burr D, Siddiqui T, Asal NR. Smoking, environmental tobacco smoke, and risk of renal cell cancer: a population-based case-control study. BMC Cancer 2008;8:387.
[35] Brennan P, van der Hel O, Moore LE, et al. Tobacco smoking, body mass index, hypertension, and kidney cancer risk in central and eastern Europe. Br J Cancer 2008;99:1912–5.
[36] Hu J, Ugnat AM. Canadian Cancer Registries Epidemiology Research Group. Active and passive smoking and risk of renal cell carcinoma in Canada. Eur J Cancer 2005;41:770–8.
[37] Chiu BC, Lynch CF, Cerhan JR, Cantor KP. Cigarette smoking and risk of bladder, pancreas, kidney, and colorectal cancers in Iowa. Ann Epidemiol 2001;11:28–37.
[38] Yuan JM, Castelao JE, Gago-Dominguez M, Yu MC, Ross RK. Tobacco use in relation to renal cell carcinoma. Cancer Epidemiol Biomarkers Prev 1998;7:429–33.
[39] Tsivian M, Moreira DM, Caso JR, Mouraviev V, Polascik TJ. Cigarette smoking is associated with advanced renal cell carcinoma. J Clin Oncol 2011;29:2027–31.
[40] Centers for Disease Control and Prevention. Alcohol-related disease impact (ARDI) application, 2013. Available online: www.cdc.gov/ARDI.
[41] IARC Working Group on the Evaluation of Carcinogenic Risks to Humans. Personal habits and indoor combustions. In: IARC monographs on the evaluation of carcinogenic risks in humans. International Agency for Research on Cancer: Lyon, France, 2012; Volume 100E, p. 373−472.
[42] Testino G. The burden of cancer attributable to alcohol consumption. Maedica 2011;6:313–20.
[43] Orywal K, Jelski W, Werel T, Szmitkowski M. The activity of class I, II, III and IV alcohol dehydrogenase isoenzymes and aldehyde dehydrogenase in renal cell carcinoma. Exp Mol Pathol 2015;98:403–6.
[44] Lee JE, Hunter DJ, Spiegelman D, et al. Alcohol intake and renal cell cancer in a pooled analysis of 12 prospective studies. J Natl Cancer Inst 2007;99:801–10.
[45] Allen NE, Balkwill A, Beral V, Green J, Reeves G. Million Women Study Collaborators. Fluid intake and incidence of renal cell carcinoma in UK women. Br J Cancer 2011;104:1487–92.

[46] Lew JQ, Chow WH, Hollenbeck AR, Schatzkin A, Park Y. Alcohol consumption and risk of renal cell cancer: the NIH-AARP diet and health study. Br J Cancer 2011;104:537–41.
[47] Lee JE, Giovannucci E, Smith-Warner SA, Spiegelman D, Willett WC, Curhan GC. Total fluid intake and use of individual beverages and risk of renal cell cancer in two large cohorts. Cancer Epidemiol Biomarkers Prev 2006;15:1204–11.
[48] Rashidkhani B, Akesson A, Lindblad P, Wolk A. Alcohol consumption and risk of renal cell carcinoma: a prospective study of Swedish women. Int J Cancer 2005;117:848–53.
[49] Mahabir S, Leitzmann MF, Virtanen MJ, et al. Prospective study of alcohol drinking and renal cell cancer risk in a cohort of Finnish male smokers. Cancer Epidemiol Biomarkers Prev 2005;14:170–5.
[50] Nicodemus KK, Sweeney C, Folsom AR. Evaluation of dietary, medical and lifestyle risk factors for incident kidney cancer in postmenopausal women. Int J Cancer 2004;108:115–21.
[51] Karami S, Daugherty SE, Purdue MP. A prospective study of alcohol consumption and renal cell carcinoma risk. Int J Cancer 2015;137:238–42.
[52] Parker AS, Cerhan JR, Lynch CF, Ershow AG, Cantor KP. Gender, alcohol consumption, and renal cell carcinoma. Am J Epidemiol 2002;155:455–62.
[53] Greving JP, Lee JE, Wolk A, Lukkien C, Lindblad P, Bergstrom A. Alcoholic beverages and risk of renal cell cancer. Br J Cancer 2007;97:429–33.
[54] Hsu CC, Chow WH, Boffetta P, et al. Dietary risk factors for kidney cancer in Eastern and Central Europe. Am J Epidemiol 2007;166:62–70.
[55] Hu J, Chen Y, Mao Y, Desmeules M, Mery L. Canadian Cancer Registries Epidemiology Research Group. Alcohol drinking and renal cell carcinoma in Canadian men and women. Cancer Detect Prev 2008;32:7–14.
[56] Pelucchi C, Galeone C, Montella M, et al. Alcohol consumption and renal cell cancer risk in two Italian case-control studies. Ann Oncol 2008;19:1003–8.
[57] Pelucchi C, La Vecchia C, Negri E, Talamini R, Franceschi S. Alcohol drinking and renal cell carcinoma in women and men. Eur J Cancer Prev 2002;11:543–5.
[58] World Cancer Research Fund/American Institute for Cancer Research. Washington, DC: American Institute for Cancer Research; 1997.
[59] Beliveau R, Gingras D. Role of nutrition in preventing cancer. Can Fam Physician 2007;53:1905–11.
[60] Daniel CR, Park Y, Chow WH, Graubard BI, Hollenbeck AR, Sinha R. Intake of fiber and fiber-rich plant foods is associated with a lower risk of renal cell carcinoma in a large US cohort. Am J Clin Nutr 2013;97:1036–43.
[61] Lee JE, Mannisto S, Spiegelman D, et al. Intakes of fruit, vegetables, and carotenoids and renal cell cancer risk: a pooled analysis of 13 prospective studies. Cancer Epidemiol Biomarkers Prev 2009;18:1730–9.
[62] Allen NE, Roddam AW, Sieri S, et al. A prospective analysis of the association between macronutrient intake and renal cell carcinoma in the European Prospective Investigation into Cancer and Nutrition. Int J Cancer 2009;125:982–7.
[63] Lee JE, Hunter DJ, Spiegelman D, et al. Intakes of coffee, tea, milk, soda and juice and renal cell cancer in a pooled analysis of 13 prospective studies. Int J Cancer 2007;121:2246–53.
[64] Weikert S, Boeing H, Pischon T, et al. Fruits and vegetables and renal cell carcinoma: findings from the European prospective investigation into cancer and nutrition (EPIC). Int J Cancer 2006;118:3133–9.
[65] Rashidkhani B, Akesson A, Lindblad P, Wolk A. Major dietary patterns and risk of renal cell carcinoma in a prospective cohort of Swedish women. J Nutr 2005;135:1757–62.
[66] van Dijk BA, Schouten LJ, Kiemeney LA, Goldbohm RA, van den Brandt PA. Vegetable and fruit consumption and risk of renal cell carcinoma: results from the Netherlands cohort study. Int J Cancer 2005;117:648–54.
[67] Dellavalle CT, Daniel CR, Aschebrook-Kilfoy B, et al. Dietary intake of nitrate and nitrite and risk of renal cell carcinoma in the NIH-AARP Diet and Health study. Br J Cancer 2013;108:205–12.
[68] Daniel CR, Cross AJ, Graubard BI, et al. Large prospective investigation of meat intake, related mutagens, and risk of renal cell carcinoma. Am J Clin Nutr 2012;95:155–62.
[69] Cross AJ, Leitzmann MF, Gail MH, Hollenbeck AR, Schatzkin A, Sinha R. A prospective study of red and processed meat intake in relation to cancer risk. PLoS Med 2007;4:e325.
[70] Haggstrom C, Rapp K, Stocks T, et al. Metabolic factors associated with risk of renal cell carcinoma. PloS One 2013;8:e57475.
[71] Van Hemelrijck M, Garmo H, Hammar N, et al. The interplay between lipid profiles, glucose, BMI and risk of kidney cancer in the Swedish AMORIS study. Int J Cancer 2012;130:2118–28.
[72] Lee JE, Spiegelman D, Hunter DJ, et al. Fat, protein, and meat consumption and renal cell cancer risk: a pooled analysis of 13 prospective studies. J Natl Cancer Inst 2008;100:1695–706.
[73] Rohrmann S, Linseisen J, Overvad K, Lund Würtz AM, Roswall N, Tjonneland A, et al. Meat and fish consumption and the risk of renal cell carcinoma in the European prospective investigation into cancer and nutrition. Int J Cancer 2015;136:E423–31.
[74] Ho WJ, Simon MS, Yildiz VO, Shikany JM, Kato I, Beebe-Dimmer JL, et al. Antioxidant micronutrients and the risk of renal cell carcinoma in the women's health initiative cohort. Cancer 2015;121:580–8.
[75] Deckers IA, van den Brandt PA, van Engeland M, Soetekouw PM, Baldewijns MM, Goldbohm RA, et al. Long-term dietary sodium, potassium and fluid intake; exploring potential novel risk factors for renal cell cancer in the Netherlands Cohort Study on diet and cancer. Br J Cancer 2014;110:797–801.
[76] Key TJ, Schatzkin A, Willett WC, Allen NE, Spencer EA, Travis RC. Diet, nutrition and the prevention of cancer. Public Health Nutr 2004;7:187–200.
[77] Pischon T, Lahmann PH, Boeing H, et al. Body size and risk of renal cell carcinoma in the European Prospective Investigation into Cancer and Nutrition (EPIC). Int J Cancer 2006;118:728–38.
[78] Bramley PM. Is lycopene beneficial to human health? Phytochemistry 2000;54:233–6.
[79] Sahin K, Cross B, Sahin N, Ciccone K, Suleiman S, Osunkoya AO, et al. Lycopene in the prevention of renal cell cancer in the TSC2 mutant Eker rat model. Arch Biochem Biophys 2015;572:36–9.
[80] Fiore MC, Jimenez PM, Cremonezzi D, Juncos LI, Garcia NH. Statins reverse renal inflammation and endothelial dysfunction induced by chronic high salt intake. Am J Physiol Renal Physiol 2011;301:F263–70.
[81] Hanahan D, Weinberg RA. Hallmarks of cancer: the next generation. Cell 2011;144:646–74.
[82] Lindblad P, Wolk A, Bergstrom R, Adami HO. Diet and risk of renal cell cancer: a population-based case-control study. Cancer Epidemiol Biomarkers Prev 1997;6:215–23.
[83] Yuan JM, Gago-Dominguez M, Castelao JE, Hankin JH, Ross RK, Yu MC. Cruciferous vegetables in relation to renal cell carcinoma. Int J Cancer 1998;77:211–6.
[84] Brock KE, Gridley G, Chiu BC, Ershow AG, Lynch CF, Cantor KP. Dietary fat and risk of renal cell carcinoma in the USA: a case-control study. Br J Nutr 2009;101:1228–38.
[85] Brock KE, Ke L, Gridley G, et al. Fruit, vegetables, fiber and micronutrients and risk of US renal cell carcinoma. Br J Nutr 2012;108:1077–85.
[86] Grieb SM, Theis RP, Burr D, Benardot D, Siddiqui T, Asal NR. Food groups and renal cell carcinoma: results from a case-control study. J Am Dietetic Assoc 2009;109:656–67.
[87] Montella M, Tramacere I, Tavani A, et al. Coffee, decaffeinated coffee, tea intake, and risk of renal cell cancer. Nutr Cancer 2009;61:76–80.

[88] Hu J, La Vecchia C, DesMeules M, Negri E, Mery L. Canadian Cancer Registries Epidemiology Research Group. Nutrient and fiber intake and risk of renal cell carcinoma. Nutr Cancer 2008;60:720–8.
[89] Bravi F, Bosetti C, Scotti L, et al. Food groups and renal cell carcinoma: a case-control study from Italy. Int J Cancer 2007;120:681–5.
[90] Handa K, Kreiger N. Diet patterns and the risk of renal cell carcinoma. Public Health Nutr 2002;5:757–67.
[91] Mellemgaard A, McLaughlin JK, Overvad K, Olsen JH. Dietary risk factors for renal cell carcinoma in Denmark. Eur J Cancer 1996;32A:673–82.
[92] Hu J, Mao Y, White K. Canadian Cancer Registries Epidemiology Research Group. Diet and vitamin or mineral supplements and risk of renal cell carcinoma in Canada. Cancer Causes Control 2003;14:705–14.
[93] De Stefani E, Fierro L, Mendilaharsu M, et al. Meat intake, 'mate' drinking and renal cell cancer in Uruguay: a case-control study. Br J Cancer 1998;78:1239–43.
[94] Zhang C, Yu L, Xu T, et al. Association of dyslipidemia with renal cell carcinoma: a 1:2 matched case-control study. PloS One 2013;8:e59796.
[95] Boeing H, Schlehofer B, Wahrendorf J. Diet, obesity and risk for renal cell carcinoma: results from a case control-study in Germany. Z Ernahrungswiss 1997;36:3–11.
[96] Melkonian SC, Daniel CR, Ye Y, Tannir NM, Karam JA, Matin SF, et al. Gene-environment interaction of genome-wide association study-identified susceptibility loci and meat-cooking mutagens in renal cell carcinoma etiology. Cancer 2016;122:108–15.
[97] Shivappa N, Hébert JR, Rosato V, Rossi M, Montella M, Serraino D, et al. Dietary inflammatory index and renal cell carcinoma risk in an Italian case-control study. Nutr Cancer 2017: 1–7.
[98] World Health Organization. Geneva: World Health Organization; 2009.
[99] International Agency for Research on Cancer. Lyon, France: International Agency for Research on Cancer; 2002.
[100] Tsatsoulis A, Mantzaris MD, Bellou S, Andrikoula M. Insulin resistance: an adaptive mechanism becomes maladaptive in the current environment—an evolutionary perspective. Metabolism 2013;62:622–33.
[101] Yehuda-Shnaidman E, Schwartz B. Mechanisms linking obesity, inflammation and altered metabolism to colon. J Obes Rev 2012;13:1083–95.
[102] Leiba A, Kark JD, Afek A, et al. Adolescent obesity and paternal country of origin predict renal cell carcinoma: a cohort study of 1.1 million 16 to 19-year-old males. J Urol 2013;189:25–9.
[103] Adams KF, Leitzmann MF, Albanes D, et al. Body size and renal cell cancer incidence in a large US cohort study. Am J Epidemiol 2008;168:268–77.
[104] Lukanova A, Bjor O, Kaaks R, et al. Body mass index and cancer: results from the Northern Sweden Health and Disease Cohort. Int J Cancer 2006;118:458–66.
[105] Oh SW, Yoon YS, Shin SA. Effects of excess weight on cancer incidences depending on cancer sites and histologic findings among men: Korea National Health Insurance Corporation study. J Clin Oncol 2005;23:4742–54.
[106] Reeves GK, Pirie K, Beral V, et al. Cancer incidence and mortality in relation to body mass index in the million women study: cohort study. BMJ 2007;335:1134.
[107] Samanic C, Chow WH, Gridley G, Jarvholm B, Fraumeni JF Jr. Relation of body mass index to cancer risk in 362,552 Swedish men. Cancer Causes Control 2006;17:901–9.
[108] Sawada N, Inoue M, Sasazuki S, et al. Body mass index and subsequent risk of kidney cancer: a prospective cohort study in Japan. Ann Epidemiol 2010;20:466–72:(prognosis).
[109] Song YM, Sung J, Ha M. Obesity and risk of cancer in postmenopausal Korean women. J Clin Oncol 2008;26:3395–402.
[110] Bjorge T, Tretli S, Engeland A. Relation of height and body mass index to renal cell carcinoma in two million Norwegian men and women. Am J Epidemiol 2004;160:1168–76.
[111] Lindgren AM, Nissinen AM, Tuomilehto JO, Pukkala E. Cancer pattern among hypertensive patients in North Karelia, Finland. J Hum Hypertens 2005;19:373–9.
[112] Luo J, Margolis KL, Adami HO, et al. Body size, weight cycling, and risk of renal cell carcinoma among postmenopausal women: the Women's Health Initiative (United States). Am J Epidemiol 2007;166:752–9.
[113] Park S, Kim Y, Shin HR, Lee B, Shin A, Jung KW, et al. Population-attributable causes of cancer in Korea: obesity and physical inactivity. PLoS One 2014;9:e90871.
[114] Kabat GC, Xue X, Kamensky V, Lane D, Bea JW, Chen C, et al. Risk of breast, endometrial, colorectal, and renal cancers in postmenopausal women in association with a body shape index and other anthropometric measures. Cancer Causes Control 2015;26:219–29.
[115] Zakaria D, Shaw A. Cancers attributable to excess body weight in Canada in 2010. Health Promot Chronic Dis Prev Can 2017;37:205–14.
[116] Kendall BJ, Wilson LF, Olsen CM, Webb PM, Neale RE, Bain CJ, et al. Cancers in Australia in 2010 attributable to overweight and obesity. Aust N Z J Public Health 2015;39:452–7.
[117] Yuan JM, Castelao JE, Gago-Dominguez M, Ross RK, Yu MC. Hypertension, obesity and their medications in relation to renal cell carcinoma. Br J Cancer 1998;77:1508–13.
[118] Beebe-Dimmer JL, Colt JS, Ruterbusch JJ, et al. Body mass index and renal cell cancer: the influence of race and sex. Epidemiology 2012;23:821–8.
[119] Chow WH, McLaughlin JK, Mandel JS, Wacholder S, Niwa S, Fraumeni JF Jr. Obesity and risk of renal cell cancer. Cancer Epidemiol Biomarkers Prev 1996;5:17–21.
[120] Dal Maso L, Zucchetto A, Tavani A, et al. Renal cell cancer and body size at different ages: an Italian multicenter case-control study. Am J Epidemiol 2007;166:582–91.
[121] Hu J, Mao Y, White K. Canadian Cancer Registries Epidemiology Research Group. Overweight and obesity in adults and risk of renal cell carcinoma in Canada. Soz Praventivmed 2003;48:178–85.
[122] Liao LM, Weinstein SJ, Pollak M, et al. Prediagnostic circulating adipokine concentrations and risk of renal cell carcinoma in male smokers. Carcinogenesis 2013;34:109–12.
[123] Shapiro JA, Williams MA, Weiss NS. Body mass index and risk of renal cell carcinoma. Epidemiology 1999;10:188–91.
[124] Liao LM, Hofmann JN, Cho E, Pollak MN, Chow WH, Purdue MP. Circulating levels of obesity-related markers and risk of renal cell carcinoma in the PLCO cancer screening trial. Cancer Causes Control 2017;28:801–7.
[125] Wang H, Wu J, Gu W, Wang B, Wan F, Dai B, et al. Serum adiponectin level may be an independent predictor of clear cell renal cell carcinoma. J Cancer 2016;7:1340–6.
[126] Liao LM, Schwartz K, Pollak M, Graubard BI, Li Z, Ruterbusch J, et al. Serum leptin and adiponectin levels and risk of renal cell carcinoma. Obesity (Silver Spring) 2013;21:1478–85.
[127] Hajjar I, Kotchen TA. Trends in prevalence, awareness, treatment, and control of hypertension in the United States, 1988-2000. JAMA 2003;290:199–206.
[128] Kaelin WG Jr. The von-Hippel-Lindau gene, kidney cancer and oxygen sensing. J Am Soc Nephrol 2003;14:2703–11.
[129] Gago-Dominguez M, Castelao JE, Yuan JM, Pike MC, Sevanian A, Haile RW. Lipid peroxidation: a novel and unifying concept of the etiology of renal cell carcinoma. Cancer Causes Control 2002;13:287–93.
[130] Deckers IA, van den Brandt PA, van Engeland M, van Schooten FJ, Godschalk RW, Keszei AP, et al. Potential role of gene-environment interactions in ion transport mechanisms in the etiology of renal cell cancer. J Sci Rep 2016;6:34262.

[131] Weikert S, Boeing H, Pischon T, et al. Blood pressure and risk of renal cell carcinoma in the European prospective investigation into cancer and nutrition. Am J Epidemiol 2008;167:438–46.
[132] Vatten LJ, Trichopoulos D, Holmen J, Nilsen TI. Blood pressure and renal cancer risk: the HUNT study in Norway. Br J Cancer 2007;97:112–4.
[133] Leiba A, Kark JD, Afek A, Derazne E, Keinan-Boker L, Shamiss A, et al. Hypertension in adolescence is not an independent risk factor for renal cancer: a cohort study of 918,965 males. J Am Soc Hypertens 2013;7:283–8.
[134] Sanfilippo KM, McTigue KM, Fidler CJ, Neaton JD, Chang Y, Fried LF, et al. Hypertension and obesity and the risk of kidney cancer in 2 large cohorts of US men and women. J Hypertens 2014;63:934–41.
[135] Lai SW, Liao KF, Lai HC, Tsai PY, Sung FC, Chen PC. Kidney cancer and diabetes mellitus: a population-based case-control study in Taiwan. Ann Acad Med Singapore 2013;42:120–4.
[136] Zucchetto A, Dal Maso L, Tavani A, et al. History of treated hypertension and diabetes mellitus and risk of renal cell cancer. Ann Oncol 2007;18:596–600.
[137] Colt JS, Schwartz K, Graubard BI, et al. Hypertension and risk of renal cell carcinoma among white and black Americans. Epidemiology 2011;22:797–804.
[138] Shen T, Shu XO, Xiang YB, Li HL, Cai H, Gao Y-T, et al. Association of hypertension and obesity with renal cell carcinoma risk: a report from the Shanghai Men's and Women's Health Studies. Cancer Causes Control 2015;26:1173–80.
[139] Noto H, Tsujimoto T, Noda M. Significantly increased risk of cancer in diabetes mellitus patients: a meta-analysis of epidemiological evidence in Asians and non-Asians. J Diabetes Investig 2012;3:24–33.
[140] Arcidiacono B, Iiritano S, Nocera A, Possidente K, Nevolo MT, Ventura V, et al. Insulin resistance and cancer risk: an overview of the pathogenetic mechanisms. Exp Diabetes Res 2012;2012:789174.
[141] Zucchetto A, Dal Maso L, Tavani A, Montella M, Ramazzotti V, Talamini R, et al. History of treated hypertension and diabetes mellitus and risk of renal cell cancer. Ann Oncol 2007;18:596–600.
[142] Inoue M, Iwasaki M, Otani T, Sasazuki S, Noda M, Tsugane S. Diabetes mellitus and the risk of cancer: results from a large-scale population-based cohort study in Japan. Arch Intern Med 2006;166:1871–7.
[143] Jee SH, Ohrr H, Sull JW, Yun JE, Ji M, Samet JM. Fasting serum glucose level and cancer risk in Korean men and women. JAMA 2005;293:194–202.
[144] Atchison EA, Gridley G, Carreon JD, Leitzmann MF, McGlynn KA. Risk of cancer in a large cohort of U.S. veterans with diabetes. Int J Cancer 2011;128:635–43.
[145] Khan M, Mori M, Fujino Y, et al. Site-specific cancer risk due to diabetes mellitus history: evidence from the Japan Collaborative Cohort (JACC) study. Asian Pac J Cancer Prev 2006;7:253–9.
[146] Joh HK, Willett WC, Cho E. Type 2 diabetes and the risk of renal cell cancer in women. Diabetes Care 2011;34:1552–6.
[147] Swerdlow AJ, Laing SP, Qiao Z, et al. Cancer incidence and mortality in patients with insulin-treated diabetes: a UK cohort study. Br J Cancer 2005;92:2070–5.
[148] Hemminki K, Li X, Sundquist J, Sundquist K. Risk of cancer following hospitalization for type 2 diabetes. Oncologist 2010;15:548–55.
[149] Chen HF, Chen SW, Chang YH, Li CY. Risk of malignant neoplasms of kidney and bladder in a cohort study of the diabetic population in Taiwan with age, sex, and geographic area stratifications. J Med (Baltimore) 2015;94:e1494.
[150] Dankner R, Boffetta P, Balicer RD, Boker LK, Sadeh M, Berlin A, et al. Time-dependent risk of cancer after a diabetes diagnosis in a cohort of 2.3 million adults. Am J Epidemiol 2016;183:1098–106.
[151] Lindblad P, Chow WH, Chan J, Bergström A, Wolk A, Gridley G, et al. The role of diabetes mellitus in the aetiology of renal cell cancer. J Diabetol 1999;42:107–12.
[152] Hsu PC, Lin WH, Kuo TH, Lee HM, Kuo C, Li CY. A population-based cohort study of all-cause and site-specific cancer incidence among patients with type 1 diabetes mellitus in Taiwan. J Epidemiol 2015;25:567–73.
[153] Carstensen B, Read SH, Friis S, Sund R, Keskimäki I, Svensson AM, et al. Cancer incidence in persons with type 1 diabetes: a five-country study of 9,000 cancers in type 1 diabetic individuals. J Diabetol 2016;59:980–8.
[154] Wang M, Hu RY, Wu HB, Pan J, Gong WW, Guo LH, et al. Cancer risk among patients with type 2 diabetes mellitus: a population-based prospective study in China. Sci Rep J 2015;5:11503.
[155] Liu X, Hemminki K, Försti A, Sundquist K, Sundquist J, Ji J. Cancer risk in patients with type 2 diabetes mellitus and their relatives. Int J Cancer 2015;137:903–10.
[156] Lin CC, Chiang JH, Li CI, Liu CS, Lin WY, Hsieh TF, et al. Cancer risks among patients with type 2 diabetes: a 10-year follow-up study of a nationwide population-based cohort in Taiwan. BMC Cancer 2014;14:381.
[157] Li C, Balluz LS, Ford ES, Okoro CA, Tsai J, Zhao G. Association between diagnosed diabetes and self-reported cancer among U.S. adults: findings from the 2009 behavioral risk factor surveillance system. Diabetes Care 2011;34:1365–8.
[158] Rousseau MC, Parent ME, Pollak MN, Siemiatycki J. Diabetes mellitus and cancer risk in a population-based case-control study among men from Montreal, Canada. Int J Cancer 2006;118:2105–9.
[159] Galeone C, Pelucchi C, Maso LD, et al. Glycemic index, glycemic load and renal cell carcinoma risk. Ann Oncol 2009;20:1881–5.
[160] Tseng C-H. Type 2 diabetes mellitus and kidney cancer risk: a retrospective cohort analysis of the national health insurance. PLoS One 2015;10:e0142480.
[161] Song XS, Fan B, Ma C, Yu ZL, Bai SS, Zhang Z, et al. Clinical research on the correlations between type 2 diabetes mellitus and renal clear cell carcinoma. Chin J Surg 2013;51:627–30.