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Effect of Carrot Intake in the Prevention of Gastric Cancer: A Meta-Analysis

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Purpose: Gastric cancer is the third leading cause of cancer-related mortality, with the incidence and mortality being higher in men than in women. Various studies have shown that eating carrots may play a major role in the prevention of gastric cancer. We conducted a meta-analysis to determine the relationship between carrot consumption and gastric cancer.
Materials and Methods: We searched multiple databases including PubMed, Cochrane Library, Scopus, ScienceDirect, and Persian databases like Scientific Information Database (SID) and IranMedx. The following search terms were used: stomach or gastric, neoplasm or cancer, carcinoma or tumor, and carrot. Statistical analyses were performed using Comprehensive Meta Analysis/2.0 software.
Results: We retrieved 81 articles by searching the databases. After considering the inclusion and exclusion criteria, 5 articles were included in this study. The odds ratio (OR) obtained by fixed effects model showed that a 26% reduction in the risk of gastric cancer has been associated with the consumption of carrots) OR=0.74; 95% confidence interval=0.68~0.81; P<0.0001). According to funnel graph, the results showed that the possibility of a publication bias does not exist in this study.
Conclusions: The findings of this study showed an inverse relationship between the consumption of carrots and the risk of gastric cancer.

Key Words: Stomach; Neoplasm; Carcinoma; Daucus carota

Introduction

Although the incidence of gastric (stomach) cancer is decreasing wordwide, this is one of the most common cancers. Gastric cancer is the third leading cause of death among various types of cancers. The incidence and death rates of this cancer are higher in men than in women.[1] More than 70% of gastric cancer incidences occurred in developing countries. In addition, half of them are diagnosed in East Asians.[2]

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Based on the latest report of the International Agency for Research on Cancer in 2012, the incidence and mortality rate of gastric cancer was estimated to be more than 951,000 cases (6.8% of the total cases of cancer) and 123,000 cases (8.8% of the total cases of cancer cancer) respectively, during a year.[1] In addition, the incidence of this cancer is estimated to increase to more than 1.5 million cases per year until 2030.[1] The incidence and mortality rates of gastric cancer are nearly twice in men than in women.

Different studies indicate several risk factors for gastric cancer, which includes *Helicobacter pylori* infection,[3] consumption of red meat and processed meat,[4] high consumption of salt,[5] smoking,[6] alcohol consumption,[7] and family history of cancer.[8] Of these, *H. pylori* infection is one of the most important risk factors for gastric cancer. Additionally, consumption of green tea,[9] citrus products,[10] dairy products,[11] use of soy products,[12] physical activity,[13] and consumption of fruits and vegetables[14] are the protective factors against gastric cancer. Various studies have

shown that eating vegetables like carrot may play a major role in the prevention of gastric cancer.[15]

Several studies have been conducted to examine the relationship between eating carrots and prevention of gastric cancer worldwide, but they have not been approved. Therefore, this meta-analysis aimed to investigate the relationship between carrot consumption and prevention of gastric cancer.

Materials and Methods

1. Literature and search strategy

We searched published articles in some well known databases including PubMed, Cochrane Library, Scopus, and ScienceDirect as well as Persian databases like Scientific Information Database and IranMedx. Literature searches were conducted until 1 July 2014. The following search terms were used: stomach or gastric, neoplasm or cancer, carcinoma or tumor, and carrot.

2. Inclusion and exclusion criteria

We did not consider any limitation of time and language for selecting the articles. Studies that met the following criteria were included in the present analysis: 1) case-control or cohort studies; 2) studies indicating a relationship between the consumption of vegetables (especially carrot) and gastric cancer; 3) providing odds ratios (ORs) and relative risk (RR) with 95% confidence intervals (CI); 4) providing incidence rates. The exclusion criteria included: 1) studies published more than once (researchers included more recent studies in this meta-analysis); 2) studies that reported mortality rates; 3) case reports, editorials, review articles, conference papers, and meta-analysis studies.

3. Data extraction and synthesis

Initially, we obtained a list of articles based on the inclusion and exclusion criteria and then considered them based on the researcher name, year of publication, number of samples, the country, the ORs, and CIs criteria.

4. Statistics and analysis

Considering that OR criteria is measurable in both case-control studies and cohort studies, at first RR criteria is transformed to OR. Thereafter, all selected studies were analyzed by using the software. In addition, the studies were sub-grouped based on the type of study, sex of the subjects, anatomical view of the gastric (cardia, non-cardia), and a family history of gastric cancer.

I^2 index and Q test were used to assess quantitative heterogeneity of the results ($P<0.1$). I^2 index describes the percentage of observed differences between indicators of studies based on the heterogeneity between them. The range of I^2 index is 0%~100%, in which 0% indicates any heterogeneity between the studies and the largest values report the highest heterogeneity.[16]

We used two models to calculate the OR with 95% CI: random effects (DerSimonian and Laird)[17] method and fixed effects model. We used linear regression Egger's and Begg's rank correlation and funnel plot to assess publication bias ($P<0.5$). Statistical analyses were performed using Comprehensive Meta Analysis/2.0 software (Biostat, Englewood, NJ, USA).

Results

1. Literature search

We found 81 articles by searching the databases and then we conducted a preliminary assessment of the articles based on the inclusion and exclusion criteria. Finally, a total of 5 published articles were chosen regarding the relationship between eating carrots and preventing gastric cancer (Fig. 1).

2. Study characteristics

In Table 1, the main characteristics of the eligible studies have been summarized. One of the articles was written in Lithuanian language[15] and four in English. Of these 5 articles, two are published in Japan,[18,19] whereas the other articles were from the Netherlands,[20] Sweden,[21] and Lithuania.[15] Four studies have been conducted during 2000~2010 and one of them during 2010~2014.

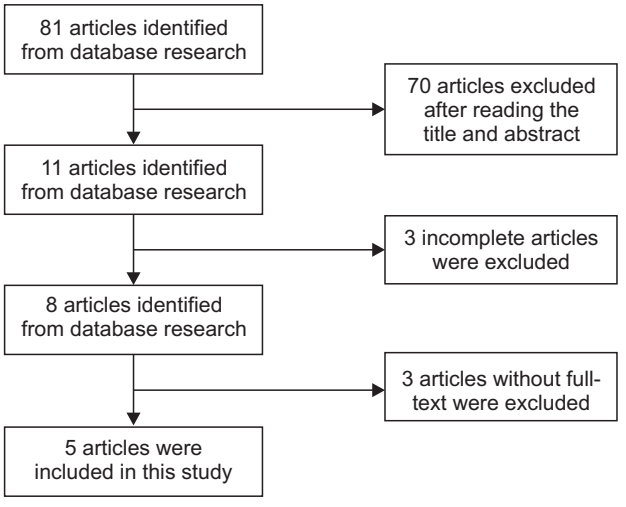

Fig. 1. Flow chart of study selection.

Table 1. Characteristics of the studies correlating the effects of carrot consumption on gastric cancer risks

Study (yr)	Area	Type of study	No. of control	No. of case	Sub-groups	Odds ratio	Confidence Interval	Amount of carrot consumed
Zickute et al. (2005)[15]	Lithuania	Hospital-based case-control	1,137	379	-	0.53	0.33~0.85**	1~6/wk
Steevens et al. (2011)[20]	Netherlands	Cohort	120,852	156	C	0.72	0.4~1.31	25 g/d
				460	NC	0.79	0.55~1.30	25 g/d
Kobayashi et al. (2002)[18]	Japan	Cohort	39,993	404		0.64	0.45~0.92*	2~4/wk
Ekström et al. (2000)[21]	Sweden	Case-control	1,067	74	C	0.58	0.39~0.86**	≥2~4/wk
				406	NC	0.75	0.63~0.89**	≥2~4/wk
Huang et al. (2004)[19]	Japan	Case-control	60,257	1,988	FHGC+	0.71	0.54~0.92*	≥3/wk
					FHGC−	0.81	0.7~0.94**	≥3/wk

C = cardia; NC = non-cardia; FHGC+ = family history of gastric cancer; FHGC− = No family history of gastric cancer. *P<0.05, **P <0.01.

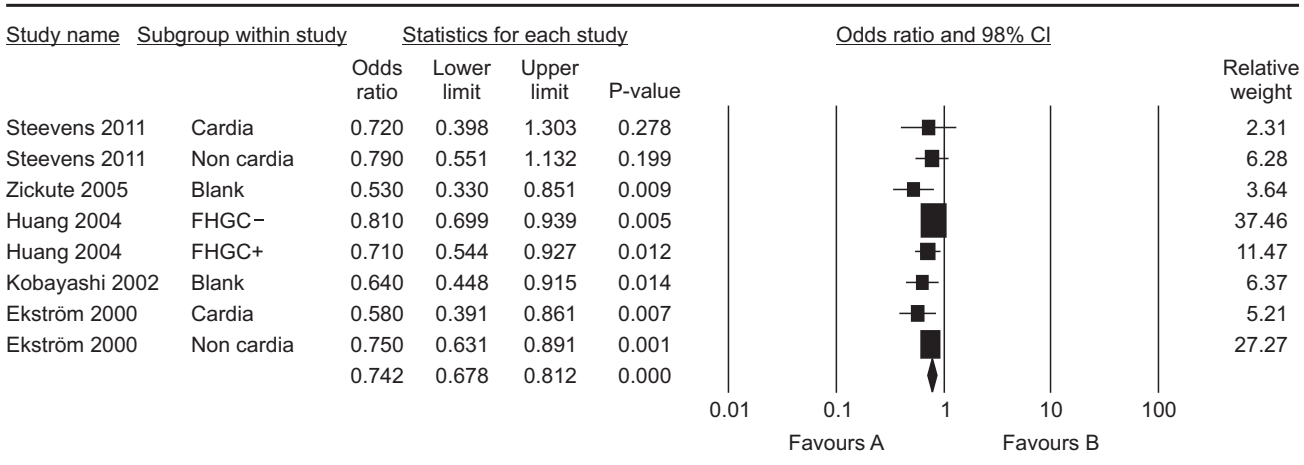

Fig. 2. Forest plot of relationship between the consumption of carrots and gastric cancer. Blank = the absence of subgroups in the study; FHGC− = No family history of gastric cancer; FHGC+ = family history of gastric cancer; CI = confidence interval.

All articles were adjusted based on age, sex, and smoking criteria. Three articles were adjusted for body mass index,[18,19,21] three articles for alcohol consumption,[15,18,20] two articles for salt intake,[18,21] two for eating fruits and raw vegetables[19,20] and two for consuming vitamins.[18,21] The other factors considered for adjusting include affected area, urban environment, drinking habits, physical activity, educational level, family history of gastric cancer, and red meat and fish consumption.

3. Heterogeneity test results

The results of the heterogeneity test showed no significant heterogeneity among the five articles that were analyzed in this study (I^2=0; P=0.576).[22] The OR is calculated by fixed effects model, which showed that eating carrots decreased the risk of

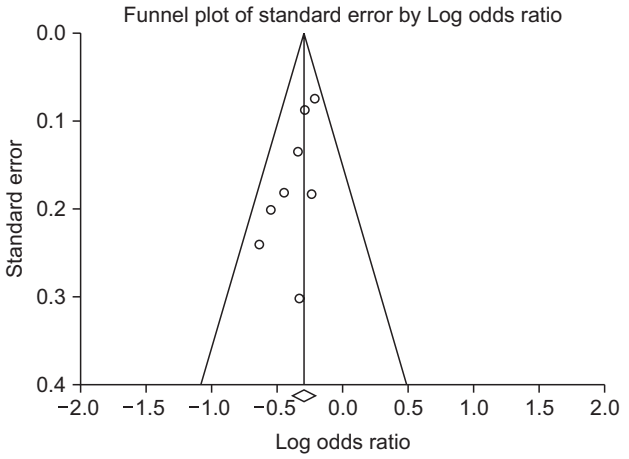

Fig. 3. Funnel plot of relationship between the consumption of carrots and gastric cancer.

gastric cancer by 26% (OR=0.74; 95% CI=0.68~0.81; P<0.0001, Fig. 2).

4. Publication bias

Funnel plot is shown in Fig 3. Based on Begg's test and Egger's test, the absence of a publication bias has been proven (P=0.04) (P=0.016).

Discussion

Results obtained from observational studies (case-control, cohort) showed that consumption of carrots is associated with a decrease in the risk of gastric cancer. In addition, the results of this study showed that carrot intake could reduce the risk of gastric cancer by up to 26% (OR=0.74; CI=0.68~0.81; P<0.0001). The present study suggests an inverse relationship between eating carrots and the risk of gastric cancer. Studies suggested that carrot is a vegetable rich in bioactive compounds such as carotenoids (alpha, beta), vitamins (thiamine, riboflavin, niacin), and phenolic compounds.[23] Probably, anticancer properties of carrots are due to the presence of carotenoids and phenolic compounds. Carotenoids have antioxidant activity; thus, they are effective for maintaining health and preventing coronary heart disease and cancer by disabling free radicals.[24,25] In addition, phenolic compounds have antioxidant, antimutagenic, and antitumor activities.[26]

Several studies have shown that the risk factors are different for various types of gastric cancer.[27,28] Gastric cancer can be classified into two types, which includes classification based on the anatomical location of the stomach (cardia and non-cardia type) and Lauren classification for gastric cancer (diffuse and intestinal type).[27] Some studies have reported that *H. pylori* infection is a risk factor for non-cardia gastric cancer, but it may be a protective factor for gastric cardia cancer. A meta-analysis showed that any single factor might increase or decrease the risk of different types of gastric cancer.[29] Comparing the results of two studies suggested that carrot intake has a different effect in the prevention of gastric cancer.[20,21] In addition, the present study indicates that the consumption of carrots has a strong impact on the prevention of gastric cardia cancer (OR=0.62; CI=0.44~0.86; P<0.004) more than the non-cardia type (OR=0.75; CI=0.64~0.88; P<0.0001). In addition, an increase in carrot consumption may be related to healthy lifestyle and behaviors such as physical activity,[19] consumption of fruit and vegetables,[19-21] decreasing salt intake as well as stopping alcohol and cigarette use.[19] This shows that individuals who consume carrots pay more attention to their health.

The OR obtained from cohort studies (OR=0.71; 95% CI=0.56~0.89; P<0.04) and case-control studies showed that the relationship between the consumption of carrots and the risk of gastric cancer are stronger in cohort studies than case-control studies. This may be due to characteristics of the cohort studies such as greater matching in confounding factors, larger sample size, and long time follow-up. However, one meta-analysis that examined the relationship between vegetable consumption and gastric cancer showed that this relationship was stronger in case-control studies than cohort studies.[30] Moreover, the cohort and case control studies had 223,306 control and 3,867 cases, respectively, which were included in the present meta-analysis. This sample size increased the power of the test for detecting an association between carrot consumption and gastric cancer. It is essential to consider that the number of studies entered in a meta-analysis is effective in the statistical analysis.

One of the mentioned studies indicated that consumption of carrots is more effective for the prevention of gastric cancer in individuals who have a family history of gastric cancer than those who do not have a family history of gastric cancer. This shows that individuals who are at risk of gastric cancer can prevent it by selecting a suitable lifestyle.[19]

Like other observational studies, our study has limitations. First, we cannot completely prove the absence of a publication bias. It should be noted that a meta-analysis cannot address problems occurring due to confounding factors. It is noteworthy that the majority of studies included in this meta-analysis were adjusted for the main confounding factors. This issue reduced the publication bias in this study. Most of the articles had been published in English language, and some articles were likely to be in non-English languages. Another limitation of this study was the failure of reporting *H. pylori* infection. However, studies that classified the status of *H. pylori* infection in patients did not show any evidence of the effect of vegetable consumption on improving this infection.[31-33] However, the consumption of vegetables has been suggested to have a more protective effect on individuals infected with *H. pylori* than on those not infected.[34]

In conclusion, the findings of this study showed an inverse relationship between the consumption of carrots and the risk of gastric cancer. This property of carrots has a greater effect in gastric cardia cancer than in other types of cancer.

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Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

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