Association between periodontal disease and coronary heart disease risk in Chinese population: evidence from a meta-analysis

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Research article

Keywords: periodontal disease, coronary heart disease, meta-analysis, Chinese population

Posted Date: June 18th, 2019

DOI: <https://doi.org/10.21203/rs.2.10364/v1>

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Abstract

Aims More and more research is focused on studying the relationship of periodontal disease with susceptibility to coronary heart disease (CHD), among which discrepancies have risen. The current study aimed to evaluate the possible relationship about periodontal disease and CHD in certain Chinese population. **Methods** The PubMed, Embase, Web of Science, the Cochrane Library, the Chinese Biomedical Database, and the Chinese National Knowledge Infrastructure were searched up to December 2018. The overall and subgroup analyses were performed using fixed or random-effect model depending on heterogeneity. **Results** A total of 2241 CHD cases and 2160 in 15 studies were used in the current study. Overall, a significantly elevated relationship about periodontal disease on CHD risk was found in all included Chinese subjects (OR=3.04, 95% CI, 2.37-3.92). Subgroup analyses by geographic location and sources of control were also performed; all the results in subgroup analyses were consistent with the overall result. Meanwhile, the significant association was found among the measures of periodontal disease with attachment loss, periodontal index, two or more clinical indications, and gum recession as well as CHD assessment method with WHO criteria and coronary arteriography. **Conclusions** Collectively, the meta-analysis indicated that periodontal disease was capable of causing CHD susceptibility among Chinese.

Introduction

At present, cardiovascular disease accounts for 30% of all deaths worldwide. Moreover, the great majority of this disease burden is currently occurred in developing countries [1]. The death of coronary heart disease (CHD) dropped significantly in United States after peaking around 1968 [2]. But, CHD had become a public health problem during the past few decades in China. The mortality rate of CHD (every 100000 people per year) in China has risen from 95.3 in 1999 to 103.4 in 2008 [3]. In 2008, the crude incidence rate of ischemic heart disease in Chinese urban inhabitants was 12.7% [4]. Although some factors which may affect the risk of CHD had been explored, a large proportion of CHD has not been explained by the traditional risk factor. In the recent publications, several evidences had involved the cause of chronic inflammation in CHD [5]. Interestingly, periodontal disease had been studied to be related with exaltation of several markers of chronic inflammation, therefore, we assumed an etiologic association about periodontal disease on CHD risk. The association about periodontal disease on CHD risk had been studied since a century ago, and many systematic reviews and meta-analyses had assessed the potential association of periodontal disease with the increased risk of CHD [6-14]. Although a large amount of evidence was showed, a scientific statement declaration by the American Heart Association in 2012 expounded that it has not enough evidence to determine the causal-related association about periodontal disease on the risk of heart disease [15]. It was still unclear whether this relationship differs among people from different race backgrounds. Therefore, the current study employed a meta-analysis to quantitatively clarify the association about periodontal disease on CHD risk based on included Chinese population.

Materials And Methods

Identification of eligible studies

Meta-analysis was conducted according to the guidelines of the PRISMA group. Search scopes included articles from PubMed, Embase, Web of Science, the Cochrane Library, the Chinese Biomedical Database [CBM], and the Chinese National Knowledge Infrastructure [CNKI] databases published until December 2018. The search keywords were ("coronary heart disease"OR "coronary disease"OR "heart disease"OR "ischemic heart disease"OR "myocardial infarction") AND ("periodontal disease"OR "periodontitis") AND ("China" OR "Chinese") . No language limitation was applied. To available identify relevant studies; we also manually search for references cited in the eligible articles. A study should be included if it met all the following criteria: (1) it was a case-control study to investigate the association about periodontal disease on CHD risk; (2) it provided odds ratios (ORs) and 95% confidence intervals (CIs); (3) it evaluated the population in Chinese; (4) the study which had the most complete data was used if two or more studies had partial overlaps. The study was excluded if it was review, letter, case report, and editorial article.

Data extraction

We filtered the titles and abstracts of all possible related papers to identify their relevancy. The full paper would be reviewed if it cannot be sure depending on the title and abstract. Information from all eligible publications was independently extracted with two investigators. The following data were extracted: first author's name; publication years; geographic location; sources of control; number of participants; and measures of periodontal disease. Sources of control were divided into hospital-based or population-based studies. The following measures for periodontal disease in dental examinations were: periodontal index, gum bleeding, attachment loss, gum recession, teeth loosening, inflammation/gingivitis, and tooth loss.

Statistical analysis

The pooled results about periodontal disease on CHD risk were calculated by ORs with 95% CIs. Z test was adopted to explore whether the pooled ORs were significant. Regarding potential heterogeneity among studies, which assessed by Cochran's Q-statistic, we defined significant heterogeneity at the levels $P < 0.10$. A random-effect model was used on the analyses when significant heterogeneity was observed, otherwise fixed-effect model was used. Sensitivity analysis was carried out by compared the results of fixed-effect model with random-effect model. Egger's test was used to detect the publication bias. Our meta-analysis was calculated by Stata 12.0 (College Station, TX, USA); $p < 0.05$ was known as significant. In addition, subgroup analyses by geographic location and source of controls to further explore the association about periodontal disease on CHD risk. Furthermore, we pooled the ORs about dental and CHD respectively if they assessed the periodontal disease differently to explore influence of the measures.

Results

Research characteristics

One hundred and eighty-eight articles which evaluated the association about periodontal disease on CHD risk were searched. At last, fifteen articles [16-30] were included in our final analysis. All the eligible articles were published between 2001 and 2017. Figure 1 shows the flowchart of included or excluded reason. Totally, there were 2241 CHD cases and 2160 controls involved in our analysis, which were included to assess the potential association about periodontal disease on CHD risk in Chinese. The characteristics of each individual article are presented in Table 1.

Meta-analysis results

In the results of the overall analysis, periodontal disease could significantly increase the risk of CHD (ORs= 3.04, 95% CI= 2.37-3.92; Figure 2). Meanwhile, the heterogeneity was detected significantly ($I^2 = 69.8\%$, $p < 0.001$). Detailed results summarized in table 2 found that all the results in subgroup analyses were consistent with the overall analysis, suggesting no single factor had essential impact on the whole result. Furthermore, subgroup analysis was also performed to explore the sources of heterogeneity. The further subgroup study by geographic location and source of controls suggested that significant association was found in northern and southern of China, as well as population-based studies and hospital-based studies.

Some articles had explained the categories for dental examinations and CHD assessment method, as follows: attachment loss; periodontal index; two or more clinical indications; gum recession; alveolar bone loss; WHO criteria and coronary arteriography. The significant association was found among the measures of periodontal disease with attachment loss, periodontal index, two or more clinical indications, and gum recession as well as CHD assessment method with WHO

criteria and coronary arteriongraphy (Table 2). However, there was non-significant association was found in the dental assessment method with alveolar bone loss.

Sensitivity analysis and publication bias

Sensitivity analysis which described in the methods was performed. All the pooled ORs were significantly both in the total and subgroup analyses. Hence, results of the sensitivity analysis suggested that the results in the current study were relatively stable (Table 2). Publication bias was detected by Begg's funnel plot and Egger's test. As shown in Figure 3, funnel plot indicated that the shape was symmetrical. At the same time, the Egger's test ($t = 3.21$, $P = 0.007$; Figure 4) did not detect any publication bias.

Discussion

The associations about periodontal disease on both CHD and cardiovascular disease risk have been explored for many years. These diseases appear to have a number of characteristics in common such as high incidence in older persons, smokers and hypertensive patients etc [31]. Since periodontal disease and CHD are common, quantifying their association is of significant public health importance [9]. Our study assessing the association about periodontal disease, including attachment loss, periodontal index, gum recession, and alveolar bone loss, suggested that periodontal disease could be significantly increased the risk of CHD in Chinese. These analyses also provided the currently assessment of the relationship about periodontal disease on CHD risk. The present meta-analysis was carried out to clarify the effects for Chinese only and therefore to reduce the influence of different geographic location background or lifestyle.

Our meta-analysis used 15 studies involving 2241 CHD cases and 2160 controls. Pooled results from the study suggested that periodontal disease cases had an overall 3.04-fold increased risk of CHD when compared to those with no periodontal disease or the general people in China. Subgroup analyses were also conducted to further explore the effective of geographic location and sources of control. Significant association was also found about periodontal disease on CHD risk in northern and southern of China, as well as studies with hospital-based controls and population-based controls. In addition, the significant association was found among the measures of periodontal disease with attachment loss, periodontal index, two or more clinical indications, and gum recession as well as CHD assessment method with WHO criteria and coronary arteriongraphy.

There have been several published meta-analyses which reflected that periodontal disease may contribute to the risk of CHD [6-14]. It is obvious lack of standardized protocols for determining periodontal disease and CHD. Some research used self-report, which may underestimate the level of disease, while other studies including gingivitis and periodontitis may overestimate disease prevalence. Thus, this point should be addressed with a meta-analysis in order to reach a consensus. On the other hand, we only included Chinese population with relatively consistent evaluation criteria for periodontal disease and CHD, and conducting subgroup analyses by geographic location and source of controls. Two more databases (CBM and CNKI) in Chinese language were searched and more Chinese participants included in our study than the previous meta-analyses. Furthermore, the pooled OR about the association of periodontal disease on CHD risk in our study was higher than those published meat-analyses with populations except Chinese. Sensitivity analysis confirmed the reliability and stability of this study. Thus, findings from the present paper strongly supported that periodontal disease could significantly increase CHD risk in Chinese.

Some limitations existed in our study should be attention. Firstly, a publication bias has been indicated in our study, as all included studies were positive results and they may be easier to publish. Secondly, the subgroup analyses by aging, cigarette smoking, alcohol consumption, and dietary structure were not performed because there was no enough information in each individual study. Thirdly, CHD is a complex disease with multiple factors, containing environmental and genetic factors. However, some studies in our meta-analysis didn't consider the effects of environmental factors on CHD.

In conclusion, the meta-analysis indicated that periodontal disease was capable of causing CHD susceptibility among Chinese. While some limitations existed in the current paper, more studies with large participants of different background are warranted to validate this association reported in our analysis. It is recommended to prevent the heart disease with the maintenance of periodontal health due to the high mortality rate of cardiovascular diseases and the relatively minor morbidity of periodontal therapy.

Abbreviations

CHD: coronary heart disease; OR: odds ratio; CI: confidence interval; CBM: Chinese Biomedical Database; CNKI: Chinese National Knowledge Infrastructure; HC: hospital control; PC: healthy population control.

Declarations

Acknowledgment

None

Funding

National Natural Science Foundation of China (Grant No. 81570955)

Availability of data and materials

All data are included in the study.

Authors' contributions

Qiang Fu and Yuan-yuan Ma designed the paper. Lin Ren, Rui-xin Chen and Yang Zou collected and analyzed the data. Qing-wei Cai drafted the manuscript and all the authors approved submission.

Competing interests

The author reports no conflicts of interest.

Consent for publication

Not applicable

Ethics approval and consent to participate

Not applicable

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Tables

Table 1. Characteristics of studies included in the meta-analysis

References	Geographic areas	Sources of control	CHD Case number	Control number	CHD Cases		Controls		Dental assessment method	CHD assessment method
					Periodontal disease	No periodontal disease	Periodontal disease	No periodontal disease		
Chen 2001	Guangdong	PC	40	40	33	7	10	30	attachment loss	WHO criteria
Lin 2001	Beijing	HC	88	128	47	41	49	79	periodontal index	WHO criteria
Liu 2003	Tianjin	PC	216	216	92	124	26	190	periodontal index	coronary arterionography
Huang 2003	Shaanxi	HC	146	136	76	70	44	92	two or more clinical indications	coronary arterionography
Tang 2004	Guangxi	HC	250	250	156	94	115	135	periodontal index	—
Liu 2006	Shandong	HC	45	40	36	9	19	21	periodontal index	WHO criteria
Zhang 2006	Xinjiang	HC	277	238	152	125	71	167	attachment loss	coronary arterionography
Zhang 2006a	Shandong	HC	76	74	40	36	25	49	attachment loss	coronary arterionography
Li 2006	Shaanxi	HC	357	305	307	50	220	85	periodontal index	coronary arterionography
Meng 2008	Heilongjiang	PC	150	150	87	63	49	101	gum recession	WHO criteria
Wu 2008	Hunan	HC	77	75	65	12	26	49	gum recession	coronary arterionography
Dong 2009	Guangdong	PC	161	162	122	39	97	65	alveolar bone loss	coronary arterionography
Chen 2011	Guangdong	HC	46	34	37	9	10	24	alveolar bone loss	coronary arterionography
Zhang 2012	Hebei	HC	162	162	110	52	89	73	gum recession	coronary arterionography
Lu 2017	Jiangsu	HC	150	150	126	24	96	54	two or more clinical indications	coronary arterionography

HC, hospital controls; PC, healthy population controls.

Table 2. The association between periodontal disease and CHD risk among Chinese.

Analysis model	n	ORr(95%CI)	ORf(95%CI)	P _h
Total analysis	15	3.04 (2.37-3.92)	2.74 (2.40-3.12)	0.000
Geographic areas				
South China	7	3.89 (2.38-6.35)	2.81 (2.31-3.41)	0.000
North China	8	2.66 (2.03-3.49)	2.68 (2.25-3.19)	0.032
Control sources				
Healthy population controls	4	4.08 (2.18-7.64)	3.52 (2.70-4.58)	0.002
Hospital controls	11	2.75 (2.10-3.58)	2.52 (2.17-2.93)	0.002
Dental assessment method				
attachment loss	3	3.86 (1.74-8.56)	3.10 (2.29-4.19)	0.012
periodontal index	5	2.75 (1.82-4.17)	2.60 (2.11-3.19)	0.007
two or more clinical indications	2	2.55 (1.77-3.66)	2.55 (1.78-3.67)	0.481
gum recession	3	3.49 (1.47-8.27)	2.82 (2.10-3.78)	0.001
alveolar bone loss	2	4.24 (0.93-19.21)	2.78 (1.81-4.25)	0.008
CHD assessment method				
WHO criteria	4	3.74 (1.87-7.46)	3.01 (2.20-4.12)	0.009
coronary arteriography	10	3.08 (2.27-4.19)	2.85 (2.44-3.33)	0.000

ORr: Odd ratio for random-effects model; ORf: Odd ratio for fixed-effects model; P_h: *P* value for heterogeneity test.

Figures

Figure 1

Flow diagram of the literature search.

Figure 2

The forest plot on the association between periodontal disease and CHD risk in total analysis.

Figure 3

Publication bias assessment using Begg's funnel plot.

Figure 4

Egger's linear regression.