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Acculturation And Cardiovascular Markers And Outcomes: A Systematic Review

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ACCULTURATION AND CARDIOVASCULAR MARKERS AND OUTCOMES:

A SYSTEMATIC REVIEW

by

Dorothy Sheu

April 30, 2012

A thesis submitted to the faculty of the Yale University School of Public Health

in partial fulfillment of the requirements for the degree of

Master of Public Health

Division of Chronic Disease Epidemiology

Social and Behavioral Sciences Program
Acknowledgments

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I also extend my thanks to the reference librarians, Ms. Janene Batten and Ms. Janis Glover, for the incredible patience they practiced while teaching me how to conduct a systematic review. I also wish to thank Dr. Annie Gupta for her input and understanding which was crucial to getting this research off the ground.

To Arpi Karapetyan, your friendship and support provided me that extra boost needed for getting through the hardest stages of this research. Finally, thank you to my family and friends for their love and encouragement.
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Abstract

Acculturation may help illuminate the context of atherosclerosis, coronary heart disease (CHD), and stroke. This systematic review sought to examine the associations between acculturation and atherosclerosis, CHD, and stroke. A search of ten databases in addition to reference lists led to relevant articles. This research limited to quantitative studies conducted among Asian adults in North America, and further selected for those that included measurements of atherosclerosis, CHD, or stroke, to comprise this review. This review included articles of all languages, years published, and publication types. Twenty-nine articles were found that both fit the aforementioned criteria and measured acculturation. Among these studies, only two acculturation measures were reported frequently enough (<=3 studies) to be reviewed: birthplace and duration of residence. Of the 19 studies that fit this revised criteria, 9 offered available associations. A data extraction sheet collected pertinent information from each article. Through this systematic review of literature on the association between birthplace or duration of residence and atherosclerosis, CHD, or stroke, we identified a relationship between duration of residence and birthplace and atherosclerosis, as well as a possible relationship between duration of residence and birthplace and CHD. More research examining the associations between acculturation and atherosclerosis, CHD, and stroke is necessary.
Introduction

Cardiovascular disease (CVD) is the leading cause of death globally.\(^1\) In 2004, heart attack and stroke were the second and third causes of death in Canada.\(^2\) In 2006, CHD led to one in every four deaths in the United States (US).\(^3\) By 2030, the World Health Organization (WHO) predicts that close to 23.6 million people will die from CVD, mainly from heart disease and stroke.\(^1\)

Insufficiency of Current Measures Against CVD

The scientific community has devoted much research to understand the mechanisms of CVD, as well as to develop lifestyle interventions and medical treatments to prevent and treat CVD. Recent publications such as those from the National Heart Lung and Blood Institute (NHLBI) as well as the American Heart Association (AHA) elucidate some risk factors and precursors to these illnesses such as diabetes, hypertension, and atherosclerosis.\(^4,5\) One study found, for example, that increased coronary calcification correlated with heart attack by 17.2 fold.\(^6\) In addition, research also points to regular physical activity, healthy diet, and tobacco smoke avoidance as recommended actions for prevention.\(^7\) Treatment for CVD ranges from medication to installation of medical devices.\(^1\) Despite these advances, atherosclerosis increases and heart disease and stroke continue to kill.

Association between Acculturation and CVD

Acculturation may help to better understand the development of atherosclerosis, CHD, and stroke. A 2006 meta-analysis found that western lifestyle associated with higher blood pressure.\(^8\) The distress from cultural change seemed to exert greater influence on this relationship than shifts in physical activity or diet.\(^8\) Through a 2010 review, the NHLBI suggested that acculturation helps better understand CVD etiology.\(^9\) The AHA in their 2010 Call to Action, stated that acculturation generally associated with unfavorable changes in CVD risk factors among specific Asian American subgroups (Chinese and Japanese).\(^10\)

A definition of acculturation frequently referred to is that of Robert Redfield (1936): “those phenomena which result when groups of individuals having different cultures come into continuous firsthand contact, with subsequent changes in the original cultural patterns of either or both groups”.\(^11\) This
phenomenon relating to culture has been measured in a variety of ways (please refer to Zane & Mak (2003) for a content analysis of measures and Salant & Lauderdale (2003) for a critical review).

For instance, many researchers employ proxy measures of acculturation. Proxy measures of acculturation such as a person’s ‘duration of residence’ in a country and ‘place of education’ where a person spent most of their learning experience elucidate some components of acculturation, as well as have the potential to reveal institutional-level problems of unequal access to health. That is to say proxy measures of acculturation deconstruct the concept of acculturation as well as shed light on the context that shapes health. In longitudinal research, proxy measures of acculturation such as generation status may help draw attention to the broader historical and political contexts that determine health, such the discrimination encountered by first generation immigrants. Ideally, studies should account for proxy measures of acculturation in conjunction with such contextual mediators of the acculturation process.

Composites of acculturation combine proxy measures of acculturation. In Marmot and Syme’s (1976) study, researchers combined ‘years spent in Japan’ and ‘where schooling took place’ in conjunction with other proxies of acculturation to create a composite measure for “culture of upbringing”. Scales of acculturation also tap into many components of acculturation and are another measure of acculturation. Scales summarize proxy measures and have the ability to provide a more multi-dimensional measurement of the construct of acculturation.

**Moderators of the CVD-Acculturation Association**

The relationship between acculturation and CVD may be moderated by several factors. Alluded to earlier, the AHA called attention to heterogeneity in CVD risk between and within racial/ethnic subgroups. To provide an example, one study of 13,245 Asian Americans found that relative to Chinese participants, the relative risk of hospitalization for ischemic heart disease was 1.8 for Japanese, 1.9 for Filipino, and 6.6 for South Asians, controlling for age, sex, smoking, body mass index (BMI), marital status, education, and alcohol intake.

In addition to racial/ethnic subgroup, region of immigration may also affect the relationship
between acculturation and CVD. In a collaborative epidemiological study, the Ni-Hon-San compared rates of CVD for people of Japanese descent in California, Hawaii, and Japan (1842, 8006, and 2141 men, respectively). Findings revealed that CHD and stroke mortality rates for those in Hawaii were intermediate to that of those in California and Japan. Coronary heart disease was highest in California, intermediate in Hawaii, and lowest in Japan.

Sex and age have also long been observed to correlate with CVD risk. Recent research also points to a relationship between sex and acculturation. For instance, one study found that different measures of acculturation predicted hypertension medication adherence between men and women. Duration of residence for men and lower perceived benefits of Western medications for hypertension for women predicted medication non-adherence.

When investigating the association between acculturation and CVD, potential biases need to be taken into account. One way to do this is to control for how variables are measured. Research on the relationship between CVD and acculturation include both self-report and clinical data on CVD. However, self-report data is limited by concerns about validity. Thus when investigating the association between acculturation and CVD, it would be beneficial to use only clinical CVD measurements and to account for the different types of measurements of acculturation.
**Objectives**

This systematic review addressed the question of whether there exists an association between acculturation and atherosclerosis, CHD, or stroke. Because of the importance of context to acculturation—what culture one “leaves” and what one “enters” into—this review focused on Canada and the US. North America was chosen because it receives high numbers of immigrants (over 50,000,000 international migrants at 2010 midyear). Further, as they have long been spotlighted in acculturation research and because they are a fast growing population, this review focused on Asians. Acknowledging the important moderators of the association between acculturation and CVD, acculturation type, racial/ethnic subgroup, region, age, and sex oriented secondary analyses of this report. The null hypotheses were that there was no association between acculturation and atherosclerosis, CHD, or stroke, and as a result, that there were no moderators to these associations.
Methods

Protocol

The PRISMA checklist guided this protocol (Figure 1).24

Information Sources

In consultation with Yale Medical library reference librarians, the first author performed computerized literature searches in January 2012. The database search involved Medline (Ovid and Pubmed), Web of Science (Web of Knowledge), CINAHL (EbscoHost), Academic Search Premier (Ebsco), PsychInfo (Ovid and EbscoHost), SCOPUS, Cochrane, and Dissertation Abstracts. Acculturation, CVD, Asian, and North American-related subject headings (using explosion when available) and key terms were used, combined using the Boolean operator and. The first author modified the search strategy for each database, but used consistent “facets” of the clinical question each time. For this, an iterative process of testing several search terms and incorporating novel search terms with identification of new relevant citations took place. Figure 2 provides a sample search strategy. A search of reference lists led to more relevant articles. The first author made attempts to contact authors of unpublished CHD and stroke studies.

Eligibility Criteria

Criteria for inclusion or exclusion were as follows: 1) quantitative research, 2) all languages and all years available in each database 3) dissertations and conference abstracts, 4) adults, 5) South Asian, East Asian, and Southeast Asian racial/ethnic groups in North America, and 6) CHD, stroke, and atherosclerosis measured clinically.

Quantitative research and clinically measured outcomes were used to increase precision. All languages and years were included in order to prevent selection bias. Dissertations and abstracts were included in order to monitor publication bias. Studies were limited to adults, as cases in children (e.g. congenital heart disease) may not be well representative of the general population with cases (who are usually older adults). This review excluded Pacific Islanders because they are perceived as much more culturally different from south, eastern, and southeastern Asians, compared to differences among them.
Study Selection

Search results were imported to RefWorks (Figure 3). Refworks deleted exact duplicates. The first author then examined titles and abstracts for broad inclusion criteria (Asian, North America, quantitative research). Next, full texts of the remaining articles were retrieved and screened to meet full eligibility criteria. Articles demonstrated diverse indicators of acculturation, some of which were used only once or twice among studies (e.g. preference for Chinese diet, speak Chinese at home, Japanese language ability, Japanese diet); thus this review limited to the most frequent measures of acculturation used across studies: birthplace and duration of residence.

Data Collection Process

The primary author extracted information from each study using a data extraction sheet. Data extraction sheets collected information on author contact, publication year, publication type (e.g. dissertation, study abstract), study design (e.g. prospective cohort, cross-sectional), year of study, sample size, Asian subgroup, study site, sex, age, measurement of variables of interest, and associations of interest. To obtain missing data, the first author attempted to contact study authors.

Risk of Bias of Individual Studies

Risk of bias in individual studies was assessed using a quality assessment survey (Table 1). Quality assessment concerned recruitment strategy, response rate, exclusion, representativeness of sample, measure objectivity, statistical analysis, and if prospective, length of follow-up.

Risk of Bias across Studies

Risk of bias across studies that may affect cumulative evidence was assessed by examining publication bias, time periods when studies were conducted, and by contacting authors for whom associations were not provided of the main variables of interest despite having reported measuring them.

Synthesis of Results

Results were synthesized qualitatively. Subgroup analyses were conducted on acculturation type, racial/ethnic subgroup, region, age, and sex, determined priori. Quality assessment survey findings were integrated into the presentation of study findings.
### Table 1.

<table>
<thead>
<tr>
<th>ID</th>
<th>Report</th>
<th>Recruitment Strategy</th>
<th>Response Rate</th>
<th>Exclusion</th>
<th>Representativeness</th>
<th>Measure Objectivity</th>
<th>Statistical Analysis</th>
<th>If prospective, length of follow-up?</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Dodani et al., 2011</td>
<td>Via religious temples; included power calculation</td>
<td>Not addressed</td>
<td>Known CAD on medical history</td>
<td>Not addressed</td>
<td>Questionable CAD</td>
<td>Adjusted for age</td>
<td>Cross-sectional</td>
</tr>
<tr>
<td>4</td>
<td>Egusa et al. 2002</td>
<td>Not addressed</td>
<td>Not addressed</td>
<td>Not addressed</td>
<td>Not addressed</td>
<td>Yes</td>
<td>Limited to t-tests and ANOVAs; made adjustments only for age a sex, and only sometimes</td>
<td>Cross-sectional</td>
</tr>
<tr>
<td>5</td>
<td>Haenszel &amp; Kurihara, 1968</td>
<td>National vital statistics &amp; CA DPH</td>
<td>Mortality data</td>
<td>None</td>
<td>Yes, but huge age difference between birthplaces</td>
<td>Yes</td>
<td>Limited by age. Note that Japan-adjusted</td>
<td>Cross-sectional</td>
</tr>
<tr>
<td>6</td>
<td>Yano et al., 1979</td>
<td>81% of those who filled out initial questionnaire (See Worth &amp; Kagan)</td>
<td>Not addressed</td>
<td>Those with CHD at baseline (1965-1958); missing information</td>
<td>Age difference between those of different birthplaces</td>
<td>Yes</td>
<td>Limited by age for birthplace</td>
<td>6 year incidence</td>
</tr>
<tr>
<td></td>
<td>Reed et al., 1982</td>
<td>HHP participants mailed questionnaire in 1971</td>
<td>61%</td>
<td>Coronary heart disease at baseline</td>
<td>Difference in smoking and high school graduates between respondents and non-respondents</td>
<td>Yes</td>
<td>Relevant to this research, years lived in Japan was analyzed with CHD prevalence, a posteriori</td>
<td>Not applicable to association referenced</td>
</tr>
<tr>
<td>13</td>
<td>Lear et al., 2009</td>
<td>“not random”</td>
<td>Not addressed</td>
<td>Those with CVD, those living in Canada for less than 3 years*</td>
<td>Not addressed</td>
<td>Yes</td>
<td>No adjustments</td>
<td>Cross-sectional</td>
</tr>
<tr>
<td></td>
<td>MESA</td>
<td>Probability sample + referrals</td>
<td>Not addressed</td>
<td>Participants with incomplete info</td>
<td>Small population-based sample; Income, BMI, and education differences by birthplace</td>
<td>Yes</td>
<td>Multiple adjustments</td>
<td>Cross-sectional</td>
</tr>
<tr>
<td></td>
<td>Diez Roux et al. 2005</td>
<td>Probability sample + referrals</td>
<td>Not addressed</td>
<td>Participants with incomplete info</td>
<td>Small population-based sample; Income, BMI, and education differences by birthplace</td>
<td>Yes</td>
<td>Multiple adjustments</td>
<td>Cross-sectional</td>
</tr>
<tr>
<td></td>
<td>Lutsey et al. 2008</td>
<td>Probability sample + referrals</td>
<td>Not stated</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Cross-sectional</td>
</tr>
<tr>
<td>18</td>
<td>Woo et al., 2001</td>
<td>Volunteers</td>
<td>Not addressed</td>
<td>Not addressed</td>
<td>Not addressed</td>
<td>Yes</td>
<td>Matched by age, gender, smoking, bp, and lipid profiles.</td>
<td>Cross-sectional</td>
</tr>
<tr>
<td>19</td>
<td>Worth &amp; Kagan, 1970</td>
<td>WWII Registration cards</td>
<td>Mortality data</td>
<td>Incarcerated men</td>
<td>Marked mortality differences between respondent and non-respondent groups</td>
<td>Yes</td>
<td>Limited by age</td>
<td>Cross-sectional</td>
</tr>
</tbody>
</table>
Results

We initially identified 1682 unique citations (Table 1). After the first round of screening based on titles and abstracts with broad inclusion criteria (Asian, North America, quantitative), 285 records remained for further evaluation. Using full exclusion criteria for screening the full texts of articles, 29 records remained. After further limiting to studies that measured birthplace or duration of residence (24), final screening yielded 24 articles and 19 studies. Among these articles, two were retrieved from the reference list search.

Nine studies (10 articles) reported measuring atherosclerosis with duration of residence or birthplace.26–35 Fourteen studies (18 articles) reported measuring both CHD and birthplace or duration of residence.19,26,28,29,34,36–48 There were seven studies (9 articles) that reported measuring stroke and birthplace and three that reported measuring stroke and duration of residence.26,37,39–42,44–46

A total of nine of these studies (11 articles) provided the association of the exposures and outcomes of interest.26–29,31–33,37,46–48 One study provided associations of aggregated outcomes26: their cross-sectional study of Chinese in Boston found that 30 subjects reported history of stroke, angina, myocardial infarction, and/or aortic aneurysm and that all subjects were born in China (personal communication with E. Choi, March 16, 2012). Evidence across acculturation proxies and atherosclerosis, CHD, and stroke suggested that those who spent less time in and/or were born outside of North America were less associated with atherosclerosis and CHD than those who spent more time or were born in North America. After disaggregating these outcomes, this collection of studies still revealed an association between duration of residence and birthplace and atherosclerosis, as well as a possible relationship between duration of residence and birthplace and CHD.

Atherosclerosis

Carotid plaque and intima media thickness (IMT), but not coronary calcification, associated with birthplace. Duration of residence, however, correlated with coronary calcification and IMT. There were a total of 4 studies that examined the association between sub-clinical or clinical atherosclerosis and
birthplace or duration of residence. Of studies with available associations, 3 looked at birthplace and 3 at duration of residence. Sample sizes ranged from 205 to 1193 and years the studies were conducted from 1992 to 2002 (with two studies unknown). All studies employed a cross-sectional design.

**Birthplace.** The Multi-Ethnic Study of Atherosclerosis (MESA) is a population-based prospective study that examines measures of atherosclerosis in ethnic groups, within whom participants have been selected via probability sampling and referrals. The reports from MESA used in this review were of cross-sectional data with samples of approximately 800 Chinese. Income, BMI, and education were very different between Chinese born in the US and those born outside of the US; the researchers made adjustments for these variables. The relative prevalence of coronary calcification in 2000-2002 for Chinese born outside of the US (vs. US-born) was not significant when adjusting for sex, age, education, and income 0.92 (CL=0.68-1.25) nor after making additional adjustments for current and former smoking, low density lipoprotein (LDL) and high density lipoprotein (HDL) cholesterol, BMI, hypertension, and diabetes 0.96 (CL=0.70-1.32). The relative difference in the amount of coronary calcification among this cohort with detectable calcification was also not significant when adjusted for sex, age, education, and income (0.87 (CL=0.38-2.02)). Findings from MESA showed that carotid plaque prevalence among US-born Chinese was higher than in Chinese born outside of the US when adjusted for age, gender, education, and income (45% vs. 23%, respectively, p=0.02; PR=1.91 (99% CI=0.94-2.94)). Carotid plaque among Chinese born outside of the US was 22% and 44% among those US-born (p=0.02) after additional adjustments for LDL, HDL, cholesterol, statin use, BMI, systolic blood pressure (SBP), hypertension medication use, smoking status, and diabetes status.

Birthplace differences were observed in maximum internal carotid IMT as well (p=0.007 and 0.004 for the two adjusted models above, respectively). Chinese born in the US showed higher maximum internal carotid IMT than foreign born Chinese (1.02mm vs. 0.82mm, respectively, for second model).

Also looking at birthplace and IMT, the Multi-Cultural Community Health Assessment Trial (M-CHAT) recruited 216 Chinese and 205 South Asians who lived in Canada for over three years. In this cross-sectional study, IMT thickness of Canadian-born appeared lower than that of those born outside of
Canada for both Asian subgroups. In another cross-sectional study, US-born had higher IMT (p<.05) than Japan-born, after adjustment for age and gender. Plaque size appeared larger for US-born than Japan-born (p<0.001), after adjustment for age and gender. The participants in this study had significant differences by birthplace for age (both sexes), BMI between men, triglycerides between women, systolic BP (men and women), fasting insulin resistance index (men and women), and diet (men and women).

**Duration of residence.** While birthplace had no significant effect on coronary calcification in MESA, the relative prevalence of coronary calcification for each 10 years in the US for Chinese was 1.06 (CL1.01-1.11), adjusting for sex, age, education, and income. After making additional adjustments for current and former smoking, LDL and HDL cholesterol, BMI, hypertension, and diabetes, this association persisted (1.05 (CL1.00-1.11)). The relative difference for each 10 years in the US in the amount of coronary calcification among persons with detectable calcification was not significant (1.05 (CL0.92-1.21)).

In the M-CHAT study, the IMT of Chinese and South Asian immigrants increased with each ten years spent in Canada (p=0.048 and p=0.002, respectively). IMT thickness of Chinese and South Asian non-migrants and migrants stratified by time since immigration differed (p=0.048 and 0.002, respectively). Chinese immigrants who had lived in Canada for 10-20 years had a higher level (p=0.035) of IMT than non-immigrants. Indian immigrants who had lived in Canada for less than 10 years had less IMT than immigrants who were there for 10-20 years (p=0.023) and greater than or equal to 30 years (p=0.007).

In yet another cross-sectional study, Chinese who spent greater than 25 years in San Francisco showed greater IMT than those who had been there for less than 25 years, after matching for age, gender, smoking status, bp, and lipid profiles. This study abstract (no full text found) says that researchers sampled 370 Chinese who had been in the US for more than 10 years. 

**Subgroup analysis.** These four studies examined Chinese, South Asian, and Japanese populations; however, only one study looked at Japanese and one at South Asians. In the three studies that
investigated Chinese, IMT and carotid plaque strongly associated with a longer duration of residence.\textsuperscript{31–33}

These results reflect participants from California (San Francisco & LA), Illinois (Chicago), and Hawaii within the US, as well as Canada. There do not appear to be any clear trends based on region of study. Where age was reported, 45 was the youngest age studied while 84 was the oldest. It is unclear if two of the studies made age adjustments,\textsuperscript{31,33} while the two others made appropriate adjustments. Where sex was reported, percent female ranged from 51\% to 66\%. Unfortunately sex was not reported in 2 of the 4 articles.

**CHD**

Five studies examined CHD and birthplace or duration of residence as a primary association of interest.\textsuperscript{28,29,37,46–48} All studies but one found a relationship between acculturation proxies and CHD. Of those with available associations, sample size ranged from 159 to 9053 and year of study from 1959 to 1995 (one study unknown). All studies reported cross-sectional data. Birthplace was the proxy measure of acculturation in each study except for one;\textsuperscript{28} further, the HHP was the only study to offer associations for both birthplace and duration of residence. All studies except for one (which studied South Asians)\textsuperscript{28} examined participants of Japanese descent.

Summary ratios from National Vital Statistics and data from the California Department of Health suggested that Japan-born males had a higher standardized mortality ratio (SMR) than US-born males (limited to those under 65 and standardized to mortality in Japan at a rate of 100, 226 (CI=218-239) and 165 (CI=143-191), respectively).\textsuperscript{37} Among women, Japan-born also had higher SMR than US-born (196 (CI=180-214) and 38 (CI=26-54), respectively).\textsuperscript{37} Subsequent analyses of the mortality data revealed that large birthplace-related age differences modify these male and female summary ratios. The slope of the curve for age-specific death rates for both men and women suggest that the US-born (younger population) projected to be similar to that of Japan-born mortality rates at older age.

A separate study observed that Japan-born men aged 60 to 64 had a lower mean annual mortality from ASHD than their Hawaii-born counterparts (2.0 vs. 5.47, respectively).\textsuperscript{46} The 1791 Japanese men in
Worth and Kagan’s (1970) report were recruited for the HHP, took a preliminary questionnaire, but died before baseline examination. Their mortality rate was markedly different (lower) than questionnaire non-respondents.46 Those generally referred to as HHP participants exclude the sample in Worth & Kagan’s (1970) study.

The HHP was a prospective cohort study of coronary heart disease among 8006 men. In a report on 7705 men of the HHP, those born outside of the US had a lower six-year incidence rate for total CHD than Hawaii-born Japanese (p<0.05).47 Additional analyses illustrate that the effect of birthplace on CHD can be mostly explained by the total time spent in Japan,47 those with a six-year incidence of CHD spent less time in Japan than those without CHD (significant at the 0.01 level).47 In another HHP report, one sampling 4653 men, the researchers looked at individual questions on their acculturation measure (a composite measure) and found that years lived in Japan was among the five that showed the strongest patterns of association with CHD prevalence.48

In a separate study, Japan-born had lower incidence of abnormal Q waves on resting electrocardiography (ECG) in comparison to US-born Japanese (p<0.05).29 It does not appear that this study made any adjustments to this association.29 Another cross-sectional study looked at coronary artery disease (CAD) in 159 South Asian Indian participants.28 The researchers found that duration in the US was significantly associated (p=0.006) with CAD after age adjustment for South Asians in the US.28 The point estimate for CAD for years of stay in the US is significant with age-adjustment (0.067 (95% CI=0.009, 0.475).28

**Subgroup analysis.** All studies included participants from Hawaii except for one study.28 In addition to Hawaii, one study included participants from Los Angeles29 and another participants from the continental US.37 Studies with participants only from Hawaii suggested a relationship between acculturation and CHD.46–48 Studies with participants from Hawaii and other places have more mixed findings.29,37

There were marked differences in age distributions between US- and Japan-born Japanese across
studies that most authors controlled for. In one study, the majority of participants were over 55 for Japan-born and under 55 for US-born; mortality projections suggest no acculturation (birthplace) differences.\(^37\)

Likewise, in the reports surrounding the HHP, the number of Japan-born was so small that age-specific comparisons could only be made in the oldest age groups.\(^{46,47}\) While one report\(^{46}\) limited findings to age at death for those 60-64, the other\(^{47}\) limited their results to ages 60-68 and directly age-adjusted their rates. Another adjusted by age.\(^{48}\) In one study where age was a confound (Japan-born were older than US-born Japanese in the US (p<0.005 and p<0.05, males and females, respectively)), it was unclear if the authors adjusted for age when analyzing ECG results.\(^{29}\) Two studies included female participants.\(^{28,37}\)

**Stroke**

There were a total of two studies that looked directly at the association between stroke and a proxy of acculturation (birthplace).\(^{37,46}\)

In the 1965-1968 pre-HHP cohort, Japan-born Japanese in Hawaii had a lower stroke mortality rate per 1000 than those born in the US (1.7 versus 1.90, respectively).\(^{46}\) An age restriction of 60-64 was set for this analysis. In the National Vital Statistics study, Japan-born males in the US had a slightly higher stroke SMR than their US-born counterparts (32 (CI=29-35) versus 24(CI=19-31), when standardized to the mortality rate of the Japanese population 100).\(^{37}\) Female Japan-born in the US also had a slightly higher stroke SMR than their US-born counterparts (40(CI=36-44) vs. 43(CI=34-55), when standardized to the mortality rate of the Japanese population 100).\(^{37}\) Japan-born Japanese male and females were younger than their US-born Japanese counterparts.\(^{37}\) Age-adjusted mortality rates supported a lack of an acculturation (birthplace) and stroke differential.\(^{37}\) The researchers stated that extrapolation of the US born (younger) data does not indicate a birthplace differential in the future.\(^{37}\)

**Publication bias**

Of the 10 studies that reported measuring the variables of interest but did not provide associations in their article, only one author was able to provide the association requested for via telephone or email contact.\(^{26}\) Multiple authors responded stating that they no longer had access to their datasets. Thus publication bias could not be evaluated.
It is important to note that many of the studies in this collection are over two decades old. Thus, findings from this review need to take this into account.
<table>
<thead>
<tr>
<th>ID</th>
<th>Study</th>
<th>Design* (N Asian Subgroup)</th>
<th>Time (Region)</th>
<th>% Female (Age of inclusion)</th>
<th>Outcome (Measurement)</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Anand et al., 2000</td>
<td>CS (342 South Asian 317 Chinese)</td>
<td>1996-1998 (Hamilton, Toronto, Edmonton, Canada)</td>
<td>40-45 (35-75)</td>
<td>CHD (history of, Rose questionnaire, ECG, self-report admission, percutaneous coronary angioplasty, coronary artery bypass graft surgery) Subclinical Atherosclerosis (ultrasound)</td>
<td>*Need CHD and Years in Canada for each Asian subgroup *Need atherosclerosis and Years in Canada for each Asian subgroup</td>
</tr>
<tr>
<td>2</td>
<td>Choi et al., 1990</td>
<td>CS (360 Chinese)</td>
<td>1981-1983 (Boston, MA)</td>
<td>63 (60-96)</td>
<td>CHD (Clinical records) Stroke (Clinical records) PVD (Clinical Records)</td>
<td>Author contacted and responded: “30 subjects reported history of stroke, angina, MI and/or aortic aneurysm. All of these 30 subjects were born in China.” *Need PVD and nativity</td>
</tr>
<tr>
<td>3</td>
<td>Dodani &amp; Dong., 2011</td>
<td>CS (159** South Asian)</td>
<td>? (Georgia, Kansas, Missouri) US</td>
<td>46 (35-65)</td>
<td>Atherosclerosis (Ultrasound) CAD (International Diabetes Federation Criteria; medical records)</td>
<td>*Need association for Length of stay in US &amp; IMT Length of stay in US (&gt;=10 years) and CAD Without and with age adjustment: p=0.060, 0.006, respectively OR estimates for CAD by years of stay in the US Without and with age adjustment: 0.076 (0.005-1.123) and 0.067 (0.009-0.475), respectively.</td>
</tr>
<tr>
<td>6</td>
<td>Cohen &amp; Reed, 1984</td>
<td>PC (2187 Japanese)</td>
<td>1970-1979 (Hawaii) US</td>
<td>0 (57.8)</td>
<td>CHD (ECG, hospital discharge records, mortality records)</td>
<td>*Need to request CHD incidence x Nativity *Need to request CHD prevalence x Nativity, over 8 year follow-up</td>
</tr>
<tr>
<td>ID</td>
<td>Study</td>
<td>Design* (N Asian Subgroup)</td>
<td>Time (Region)</td>
<td>% Female (Age of inclusion)</td>
<td>Outcome (Measurement)</td>
<td>Findings</td>
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<tr>
<td>5</td>
<td>Reed et al, 1982</td>
<td>PC (4653 Japanese)</td>
<td>1971-79 (Hawaii) US</td>
<td>0 (50-65+)</td>
<td>CHD (hospital records including ECG, mortality records, autopsy)</td>
<td>Years lived in Japan has a strong association with CHD prevalence.</td>
</tr>
<tr>
<td>7</td>
<td>Yano et al., 1979</td>
<td>PC (7705 Japanese)</td>
<td>1965 to 1968 – 1971 to 1974 (Hawaii) US</td>
<td>0 (60-68)</td>
<td>CHD (hospital records including ECG, death certificates, autopsy)</td>
<td>Six-year incidence rate/1000 of CH, (p&lt;0.05) Japan-born: 45.9 Other-born: 74.7 Average duration of time spent in Japan, (significant at α 0.01) Six-year incident case of CHD: 2.06 Six-year disease free: 3.32 “While both variables are (birthplace and years in Japan) are related to CHD, the contribution of birthplace can be mostly explained by the total time spent in Japan.”</td>
</tr>
<tr>
<td>7</td>
<td>Kanaya et al., 2010</td>
<td>CS (150 South Asian Indian)</td>
<td>2006-2007 (SF Bay area, CA) US</td>
<td>50 (45-84)</td>
<td>Atherosclerosis (Ultrasound)</td>
<td>*Diabetes is primary variable—Need years lived in US and subclinical atherosclerosis, controlling for diabetes.</td>
</tr>
<tr>
<td>9</td>
<td>Langenberg et al., 2007</td>
<td>CS (389 Filipinas)</td>
<td>1995-1999 (San Diego, CA) US</td>
<td>100 (40-86)</td>
<td>CHD (ECG, positive Rose questionnaire, hospitalization, reported MI)</td>
<td>*Requested OR from models including all risk factors simultaneously for CHD &amp; Duration of residence. Not provided.</td>
</tr>
<tr>
<td>10</td>
<td>Le et al., 2008</td>
<td>CS (159 Vietnamese)</td>
<td>2004-2006 (Boston, MA) US</td>
<td>64 (35+)</td>
<td>Atherosclerosis (Chart review)</td>
<td>*Need relationship between CAD and length of residence in US.</td>
</tr>
<tr>
<td>ID</td>
<td>Study</td>
<td>Design* (N Asian Subgroup)</td>
<td>Time (Region)</td>
<td>% Female (Age of inclusion)</td>
<td>Outcome (Measurement)</td>
<td>Findings</td>
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</table>
| 11 | Li & Froelicher, 2010 | PC (90 Chinese) | 2006-2007 (SF Bay area Chinatown, CA) US | 50 (66-92) | CHD (?) Stroke (?) | *Requested info on CHD x length of stay in US
*Requested into on Stroke x Length of stay in US |
| 12 | Li | CS (200 Chinese) | 2002-2003 (SF Bay Area Chinatown, CA) US | 50 (18+) | CHD (Modified JNC VI guidelines) Stroke (Modified JNC VI guidelines) | *Requested info on CHD x length of stay in US
*Requested into on Stroke x Length of stay in US |
| 13 | M-CHAT Lear et al., 2009 | CS (216 Chinese, 205 South Asian) | ? (Canada) | ? (7) | Sub-clinical Atherosclerosis (Ultrasound) | IMF
Chinese with each ten years (p=0.048)
South Asian with each ten years (p=0.002)
Chinese immigrants who had lived in Canada for 10-20 years had a higher level (p=0.035) of intima media thickness than non-immigrants.
Indian immigrants who had lived in Canada for less than 10 years had a less intima media thickness than immigrants who were there for 10-20 years (p=0.023) and greater than or equal to 30 years (p=0.007).
Canada-born IMT thickness appears lower than that of those born outside of Canada for both Asian subgroups. |
| 14 | Marmot & Syme, 1976 | CS (3809 Japanese) | 1969 US | 0 (<=65) | Definite CHD (MN Codes 1:1, 1:2, 7:1, or angina by questionnaire) | *Requested Info on CHD x Nativity (“Generation”)
Received reply to look at dissertation. Association not in dissertation. |
| 15 | Diez Roux et al., 2005 | CS (797 Chinese) | 2000-2002 (Los Angeles, CA; Chicago, IL) US | 53 (45-84) | Atherosclerosis (Chest CT) | Relative prevalence among those with coronary calcification
Adjusting for education, income, sex, & age
Not born in the US (ref=US-born): 0.92 (0.68-1.25)
Each 10 years in the US: 1.06(1.01-1.11)
Adjusting for education, income, sex, age, smoking, cholesterol, BMI, hypertension, & diabetes
Not born in the US (ref=US-born): 0.96 (0.70-1.32)
Each 10 years in the US: 1.05(1.00-1.11)
Relative difference among those with detectable calcification, adjusting for education, income, sex, & age
Not born in the US (ref=US-born): 0.87(0.38-2.02)
Each 10 years in the US: 1.05(0.92-1.21) |
<table>
<thead>
<tr>
<th>ID</th>
<th>Study</th>
<th>Design* (N Asian Subgroup)</th>
<th>Time (Region)</th>
<th>% Female (Age of Inclusion)</th>
<th>Outcome (Measurement)</th>
<th>Findings</th>
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<td><strong>Prevalence of carotid plaque (%)</strong>&lt;br&gt;Adjusted for age, gender, education, income. (p=0.02)&lt;br&gt;Not born in the US: 23&lt;br&gt;US-born: 45&lt;br&gt;Adjusted for age, gender, education, income, foreign born, cholesterol, statin use, BMI, systolic bp, hypertension med use, smoking, and diabetes. (p=0.002)&lt;br&gt;Not born in the US: 22&lt;br&gt;US-born: 44 %&lt;br&gt;<strong>Maximum IMT (mm)</strong>&lt;br&gt;Adjusted for age, gender, education, income. (p=0.007)&lt;br&gt;Not born in the US: 0.82&lt;br&gt;US-born: 1.02&lt;br&gt;<strong>Maximum IMT (mm)</strong>&lt;br&gt;Adjusted for age, gender, education, income, foreign born, cholesterol, statin use, BMI, systolic bp, hypertension med use, smoking, and diabetes. (p=0.004)&lt;br&gt;Not born in the US: 0.82&lt;br&gt;US-born: 1.04</td>
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</tr>
<tr>
<td>MESA (Continued)</td>
<td>Lutsey et al., 2008</td>
<td>CS (803 Chinese)</td>
<td>2000-2002 (Los Angeles, CA; Chicago, IL) US</td>
<td>51 (45-84)</td>
<td>Atherosclerosis (Ultrasound)</td>
<td></td>
</tr>
<tr>
<td>18*</td>
<td>Woo et al., 2001</td>
<td>CS (370 Chinese)</td>
<td>? (San Francisco, CA) US</td>
<td>? (15-70***</td>
<td>Atherosclerosis (Ultrasound)</td>
<td>IMT (mm)&lt;br&gt;&lt;25 years duration: 0.67±0.13&lt;br&gt;&gt;25 years duration: 0.71±0.18</td>
</tr>
</tbody>
</table>

* CS= Cross-sectional; PC=Prospective Cohort  
** Only 35 had CCA-IMT measured. Demographic information for full sample size.  
*** Analyses are on 33+  
? Data not presented or cannot be disaggregated from other data that fail to meet inclusion criteria
Discussion

This systematic review identified 19 studies that measured atherosclerosis, CHD, or stroke, and birthplace or duration of residence.\textsuperscript{19,26--35,37--48} Nine of these provided associations between the variables of interest.\textsuperscript{26--29,31--33,37,46--48} Among these, this review examined associations between these proxies of acculturation and four studies measuring atherosclerosis, four CHD, and two stroke. This collection of studies revealed a relationship between duration of residence and birthplace and atherosclerosis, as well as a possible relationship between duration of residence and birthplace and CHD. Too few studies investigated the relationship between stroke and proxies of acculturation to draw any conclusions about their association. Despite the varying measures of atherosclerosis (e.g. IMT, coronary plaque) and CHD (e.g. prevalence, incidence, mortality) examined, cumulative study findings suggested that Asians born outside of and who spend less time in North America experienced less atherosclerosis and CHD than their counterparts who were born and have spent more time in North America.

This review found atherosclerosis to correlate with acculturation proxies in different ways. Those born in North America exhibited higher carotid plaque and IMT, but not coronary calcification.\textsuperscript{27,29,31,32} However, duration of residence associated with coronary calcification.\textsuperscript{27} Additionally, duration of residence in North America correlated with increased IMT in both studies that provided this association.\textsuperscript{31,33} Among Chinese, higher IMT and carotid plaque were associated with longer duration of residence.\textsuperscript{31--33} Interestingly, in one study, duration of residence in Canada not associated with higher IMT for Chinese and South Asian immigrants, but for European immigrants as well.\textsuperscript{31}

All studies of CHD but one\textsuperscript{37} uncovered a relationship between acculturation proxies and CHD. All these studies investigated Japanese samples except for one study\textsuperscript{28} which looked at South Asians. In the first study of Japanese, age served as a huge confounder and after adjustment, no significant relationship was found.\textsuperscript{37} In contrast, two Japanese cohorts in Hawaii discovered protective associations between being born outside of the US and CHD.\textsuperscript{46,47} Subsequent analyses on the HHP, one of the two studies, suggested that duration of residence may account for birthplace effects.\textsuperscript{47,48} Alternatively, the most recent study of Japanese found a significant relationship between CHD and birthplace, but it does
not appear the authors made any necessary adjustments to their analysis. The CHD study of South Asians found that duration of time in the US for South Asians significantly associated with CAD after age adjustment. Age confounded almost all studies and yet not all studies made adjustments for age; further, not all studies made additional adjustments beyond age. Future studies necessitate more rigorous statistical analyses to explore the relationship between birthplace or duration of residence and CHD.

It is important to note that of these studies all but one took place in Hawaii. Studies with participants only from Hawaii suggested a relationship between acculturation and CHD. Studies with participants from Hawaii and other places have more mixed findings. While many other reports measured both stroke and birthplace and duration of residence, only two reported the association between them. Further, the studies on stroke and birthplace were dated. Age was a confound for both studies: those born in the US were younger than those who were born outside of the US. In both cases, researchers employed limits on age.

Accordingly, age should be adjusted for in future studies. The effect of age can be seen in studies that conduct unadjusted and adjusted analyses; for example, in one study, no adjustment for age yielded an insignificant relationship between length of stay in the US and CAD. After adjustment, each ten years spent in the US correlated with increases in CAD cases (p=0.006). In this collection of studies with available associations, participant demographics shifted from exclusively looking at Japanese to Chinese and South Asian as well. No studies examined other Asian subgroups (e.g. Filipinos, Vietnamese). Future studies should sample a greater diversity of Asian subgroups.

It is also of note that this collection of studies involved a greater percentage of men than women. This observation reflects a review of acculturation measurement that found that most physical health studies focused on men. A greater proportion of women should be included in future research.

In addition to the moderators identified by the subgroup analyses in this review (e.g. age, sex) there may exist many other factors that interact with the CVD-acculturation association. While some studies adjust for risk factors of CVD, this is not the case uniformly. Findings of studies that do not
adjust, or adjust only for age and/or sex, need to be interpreted carefully.

In the final set of studies included in this review, acculturation was measured diversely. This finding is also consistent with previous reviews which suggested that acculturation measures are as diverse as the Asian immigrant groups they seek to measure.\textsuperscript{12,13} As explained in this review, this diversity makes the comparison of acculturation across health outcomes very difficult.\textsuperscript{13} The spread of acculturation measures examined in this current research were limited to birthplace and duration of residence. Other measures of acculturation were not reported frequently enough to warrant review.

As birthplace and duration of residence serve as proxies of acculturation, the conclusions of this research do not claim to represent the broader construct of acculturation. In this review’s collection of articles, only one study utilized a scaled measure of acculturation.\textsuperscript{28} This study did not find a significant association between acculturation and CAD.\textsuperscript{28} However, the researchers did discover a positive association between time in the US and CAD.\textsuperscript{28}

This juxtaposition of evidence calls attention to multifaceted underpinnings of acculturation as a construct.\textsuperscript{28} Although duration of residence may capture one facet of acculturation, it cannot be used in place of the construct of acculturation as a whole. The context of where they were born and why they moved may expose immigrants to diverse processes that differentially influence their levels of acculturation.\textsuperscript{17} These in return may influence their susceptibility to atherosclerosis, CHD, and stroke.

To provide an example, birthplace and duration of residence may predict acculturation quite differently depending on whether a person immigrates as a child or an adult.\textsuperscript{13} An unpublished study computed the percentage of life years (1- age at immigration/ age) in the US in order to capture both age at immigration as well as years since migration (M.R. Araneta, personal communication, March 21, 2012 regarding Narayan et al., 2010). Interestingly, their study did not find associations between percentage of life years in the US and PVD, stroke, MI, angina, CHD, or any CVD (M.R. Araneta, personal communication, March 21, 2012 regarding Narayan et al., 2010).

Generation status also impacts the relationship between acculturation level and health.\textsuperscript{50} Lutsey and colleagues (2008) measured atherosclerosis prevalence differences between those who were born
outside of the US, those who were born in the US with one or both parents not born in the US, those with both parents born in the US but two or more grandparents not born in the US, and those with both parents and three or more grandparents born in the US. While this study found no significance due to too few Chinese participants in the higher generation categories, second generation immigrants in other studies report worse health than first generation immigrants. In a separate study, first generation status correlated with reported discrimination; discrimination may in turn serve as a negative stressor impacting health.

Future studies need to clarify the relationship between these outcomes and different acculturation proxies, as well as expand to look at other measures (composites, scales) of acculturation. In this review, it is apparent that duration of residence had a stronger association with atherosclerosis prevalence than birthplace. In addition to individually testing the effect of each facet of acculturation, interaction effects of acculturation components (e.g. composite scores of duration of residence, age at immigration) need to be investigated as well.

**Limitations**

In spite of the greatest efforts to conduct a systematic review, there were some limitations. The search strategy of this review included some CVD related terms (e.g. hypertension, heart failure) that were not the outcomes of focus in this analysis. While this affected the number of articles collected during the database search portion of the protocol (number of articles identified), the data analysis and study conclusions should remain unaffected.

Further, eligibility criteria excluded Pacific Islanders from the definition of Asian (because of cultural difference) and self-report measures of the outcome in order to increase the precision across studies. Unfortunately, the screening process for articles revealed that several studies combined Asians with Pacific Islanders and atherosclerosis, CHD, and stroke with the larger CVD category. Unable to disaggregate much of this data, the number of studies included in this review was reduced.

It is also important to note that the database search, screening, data extraction, and analysis were conducted by one researcher. Thus, no inter-rater reliability was able to be provided for any of these steps.
In order to discuss publication bias, this review sought to include all types of publications, as well as publications that measured but did not report the association between birthplace and duration of residence, and CHD, atherosclerosis and stroke. Unfortunately, of those that did not report the association, few authors of the studies were able to provide requested data. Reasons ranged from no longer having access to datasets to no response to author contact.

**Future studies**

In addition to sampling a greater diversity of Asian subgroups, adjusting for covariates, and exploring other forms of acculturation, there are several opportunities and directions for future research. To begin, the findings of this review necessitate more research to clarify the relationship between duration of residence and CHD—does duration of residence really better predict CHD than birthplace? Further, will replication still produce findings that suggest that certain measures of atherosclerosis (e.g. coronary calcification) are unaffected by birthplace? Another important topic to further explore is stroke; as indicated by the few studies found in this review, more researchers need to dedicate studies on the association between acculturation and stroke. In addition, greater research needs to be invested in examining whether this increased atherosclerosis leads to more CVD outcomes like CHD or stroke overtime.

Such future studies need to be prospective in design. Only one study was prospective in design. While cross-sectional studies help identify research areas that need to be investigated, prospective studies are capable of identifying possible pathways through which acculturation may affect CVD outcomes. Prospective studies can help explain why being born in or spending more time in North America positively correlates with these outcomes. An ideal study design would follow participants before they leave their home country and then overtime as they spend time in North America.

Finally, this review reveals a need for greater sampling of Asian populations. Atherosclerosis, CHD, and stroke are major health issues among the Asian population, yet this is an area of research that has barely been broached. Asian Americans are a fast growing population in North America and their health needs will only increase accordingly. This is particularly the case for the South Asian population,
who have evidenced a high risk for CVD. Few studies in this collection of articles looked at the South Asian population.

The increase in immigrant groups such as Asians, in addition to the generalizability of the acculturation experience to those outside of immigrant groups, calls for more research investments to understand the intersection of acculturation and CVD.
References


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<tr>
<th>Section/Topic</th>
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<th>Checklist Item</th>
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<tbody>
<tr>
<td><strong>TITLE</strong></td>
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<tr>
<td>Title</td>
<td>1</td>
<td>Identify the report as a systematic review, meta-analysis, or both.</td>
</tr>
<tr>
<td><strong>ABSTRACT</strong></td>
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<tr>
<td>Structured summary</td>
<td>2</td>
<td>Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.</td>
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<tr>
<td><strong>INTRODUCTION</strong></td>
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<tr>
<td>Rationale</td>
<td>3</td>
<td>Describe the rationale for the review in the context of what is already known.</td>
</tr>
<tr>
<td>Objectives</td>
<td>4</td>
<td>Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PIKOS).</td>
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<tr>
<td><strong>METHODS</strong></td>
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<tr>
<td>Protocol and registration</td>
<td>5</td>
<td>Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.</td>
</tr>
<tr>
<td>Eligibility criteria</td>
<td>6</td>
<td>Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.</td>
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<tr>
<td>Information sources</td>
<td>7</td>
<td>Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.</td>
</tr>
<tr>
<td>Search</td>
<td>8</td>
<td>Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.</td>
</tr>
<tr>
<td>Study selection</td>
<td>9</td>
<td>State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).</td>
</tr>
<tr>
<td>Data collection process</td>
<td>10</td>
<td>Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.</td>
</tr>
<tr>
<td>Data items</td>
<td>11</td>
<td>List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.</td>
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<tr>
<td>Risk of bias in individual studies</td>
<td>12</td>
<td>Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.</td>
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<tr>
<td>Summary measures</td>
<td>13</td>
<td>State the principal summary measures (e.g., risk ratio, difference in means).</td>
</tr>
<tr>
<td>Synthesis of results</td>
<td>14</td>
<td>Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.</td>
</tr>
<tr>
<td>Risk of bias across studies</td>
<td>15</td>
<td>Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).</td>
</tr>
<tr>
<td>Additional analyses</td>
<td>16</td>
<td>Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.</td>
</tr>
<tr>
<td><strong>RESULTS</strong></td>
<td></td>
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<tr>
<td>Study selection</td>
<td>17</td>
<td>Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.</td>
</tr>
<tr>
<td>Study characteristics</td>
<td>18</td>
<td>For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.</td>
</tr>
<tr>
<td>Risk of bias within studies</td>
<td>19</td>
<td>Present data on risk of bias of each study and, if available, any outcome-level assessment (see Item 12).</td>
</tr>
<tr>
<td>Results of individual studies</td>
<td>20</td>
<td>For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group and (b) effect estimates and confidence intervals, ideally with a forest plot.</td>
</tr>
<tr>
<td>Synthesis of results</td>
<td>21</td>
<td>Present results of each meta-analysis done, including confidence intervals and measures of consistency.</td>
</tr>
<tr>
<td>Risk of bias across studies</td>
<td>22</td>
<td>Present results of any assessment of risk of bias across studies (see Item 15).</td>
</tr>
<tr>
<td>Additional analysis</td>
<td>23</td>
<td>Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression)</td>
</tr>
<tr>
<td><strong>DISCUSSION</strong></td>
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<tr>
<td>Summary of evidence</td>
<td>24</td>
<td>Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., health care providers, users, and policy makers).</td>
</tr>
<tr>
<td>Limitations</td>
<td>25</td>
<td>Discuss limitations at study and outcome level (e.g., risk of bias), and at review level (e.g., incomplete retrieval of identified research, reporting bias).</td>
</tr>
<tr>
<td>Conclusions</td>
<td>26</td>
<td>Provide a general interpretation of the results in the context of other evidence, and implications for future research.</td>
</tr>
<tr>
<td><strong>FUNDING</strong></td>
<td></td>
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<tr>
<td>Funding</td>
<td>27</td>
<td>Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.</td>
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</tbody>
</table>

doi:10.1371/journal.pmed.1000971.001
Figure 2.

Sample search strategy:

PubMed Medline


(coronary heart disease[MeSH Terms]) OR ((calcification) OR (atherosclerosis) OR (angina) OR ("high blood pressure")) OR (stroke) OR (atherosclerosis[MeSH Terms]) OR (angina pectoris[MeSH Terms]) OR (high blood pressure[MeSH Terms]) OR (hypertension[MeSH Terms]) OR (stroke[MeSH Terms]) OR (myocardial ischaemia[MeSH Terms]) OR (myocardial ischemia[MeSH Terms]) OR (cerebrovascular disorder[MeSH Terms]) OR (cerebral arterial disease[MeSH Terms]) OR (vascular disease[MeSH Terms]) OR (myocardial infarction[MeSH Terms]) OR (cardiac arrest[MeSH Terms]) OR (heart failure[MeSH Terms]) OR (heart attack[MeSH Terms]) OR (cardiac arrhythmia[MeSH Terms]) OR (cardiovascular disorder[MeSH Terms]) OR (cardiovascular disease[MeSH Terms]) OR (coronary) OR (coronary disease[MeSH Terms]) OR (coronary artery disease[MeSH Terms]) OR (heart) OR (heart[MeSH Terms]) OR (heart disease[MeSH Terms]) OR (heart disorder[MeSH Terms])

Figure 3.

1988 Articles identified through database search
- 415 from Medline (Ovid)
- 279 from Medline Pubmed
- 367 from Web of Science (Web of Knowledge)
- 154 from CINAHL (Ebsco)
- 427 from Academic Search Premier (Ebsco)
- 98 from PsychInfo (Ovid)
- 100 from PsychInfo (Ebsco)
- 114 from SCOPUS
- 20 from Dissertation Abstracts
- 14 from Cochrane Clinical Trials

13 Additional articles identified through other sources

1682 Articles after exact duplicates removed

285 Full-text articles assessed for eligibility.

29 Articles included in qualitative check

24 Articles after revision

19 Studies included in collection

9 Studies with available associations

1397 Articles excluded by screening titles & abstracts

255 Based on exclusion criteria
- 254 Due to duplication
- 1 Dissertation available in June '12

5 Articles Excluded
- 4 No nativity/duration of residence
- 1 Matched on duration of residence

8 Articles reported on same studies
- 2 MESA
- 3 HHP
- 3 Li

10 Studies without available associations