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Acculturation And Cardiovascular Markers And Outcomes: A Systematic Review

Dorothy Sheu
Yale University, sheudoro@gmail.com

ACCULTURATION AND CARDIOVASCULAR MARKERS AND OUTCOMES:

A SYSTEMATIC REVIEW

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Dorothy Sheu

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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 first-hand 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.[12] 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.[13,14] That is to say proxy measures of acculturation deconstruct the concept of acculturation[15] 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.[16,17] Ideally, studies should account for proxy measures of acculturation in conjunction with such contextual mediators of the acculturation process.[16–18]

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.[18]

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.[10] 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.[19]

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).[20] Findings revealed that CHD and stroke mortality rates for those in Hawaii were intermediate to that of those in California and Japan.[20] Coronary heart disease was highest in California, intermediate in Hawaii, and lowest in Japan.[20]

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.[21] Duration of residence for men and lower perceived benefits of Western medications for hypertension for women predicted medication non-adherence.[21]

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).[22] Further, as they have long been spotlighted in acculturation research and because they are a fast growing population, this review focused on Asians.[23] 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.

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

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 outcomes[26]: 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 American 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.[27,29,31–33] 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.[27,32] 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.[27,32] 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).[27] 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)).[27] 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)).[32] 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.[32]

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).[32]

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.[31] In this cross-sectional study, IMT thickness of Canadian-born appeared lower than that of those born outside of

Canada for both Asian subgroups.[31]

In another cross-sectional study, US-born had higher IMT ($p<.05$) than Japan-born, after adjustment for age and gender.[29] Plaque size appeared larger for US-born than Japan-born ($p<0.001$), after adjustment for age and gender.[29] 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).[29]

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.[27] 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)).[27] 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)).[27]

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).[31] IMT thickness of Chinese and South Asian non-migrants and migrants stratified by time since immigration differed ($p=0.048$ and 0.002, respectively).[31] Chinese immigrants who had lived in Canada for 10-20 years had a higher level ($p=0.035$) of IMT than non-immigrants.[31] 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 ($p=0.007$).[31]

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.[33] This study abstract (no full text found) says that researchers sampled 370 Chinese who had been in the US for more than 10 years.[33]

Subgroup analysis. These four studies examined Chinese, South Asian, and Japanese populations; however, only one study looked at Japanese[29] and one at South Asians.[31] In the three studies that

investigated Chinese, IMT and carotid plaque strongly associated with a longer duration of residence.[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,[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.[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;[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)[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).[37] Among women, Japan-born also had higher SMR than US-born (196 (CI=180-214) and 38 (CI=26-54), respectively).[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).[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 Angeles[29] 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.

ID	Study	Design* (N Asian Subgroup)	Time (Region)	% Female (Age of inclusion)	Outcome (Measurement)	Findings
1 Anand et al., 2000	Anand et al., 2000	CS (342 South Asian 317 Chinese)	1996-1998 (Hamilton, Toronto, Edmonton) Canada	40-45 (35-75)	CHD (history of, Rose questionnaire, ECG, self-report admission, percutaneous coronary angioplasty, coronary artery bypass graft surgery) Subclinical Atherosclerosis (ultrasound)	*Need CHD and Years in Canada for each Asian subgroup *Need atherosclerosis and Years in Canada for each Asian subgroup
2[£] Choi et al., 1990	Choi et al., 1990	CS (360 Chinese)	1981-1983 (Boston, MA) US	63 (60-96)	CHD (Clinical records) Stroke (Clinical records) PVD (Clinical Records)	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
3[¥] Dodani & Dong., 2011	Dodani & Dong., 2011	CS (159** South Asian)	? (Georgia, Kansas, Missouri) US	46 (35-65)	Atherosclerosis (Ultrasound) CAD (International Diabetes Federation Criteria; medical records)	*Need association for Length of stay in US & IMT *Length of stay in US (>=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.
4[¥] Egusa et al., 2002	Egusa et al., 2002	CS (1193 Japanese)	1992, 1993, 1995 (Hawaii & Los Angeles, CA) US	66 (45-78)	CHD (ECG) Atherosclerosis (Ultrasound)	*Abnormal Q waves* (%) Japan-born 3.8 US-born 4.7 *IMT, after adjustment for age and gender* US-born v. Japan-born: (p<0.05) *Plaque, after adjustment for age and gender* US-born v. Japan-born: (p<0.001)
5[¥] Haenszel & Kurihara, 1968	Haenszel & Kurihara, 1968	CS (9053 Japanese)	1959-62 Hawaii and Continental US US	35 (<65)	CHD (ICD-7 420-422) Stroke (ICD-7 330-334)	*CHD* US-born: Female= 196 (CI: 180-211) ; Male = 226 (CI: 218-239) Not US-born: Female = 38 (CI: 26-54) ; Male = 165 (CI: 143-191) *Stroke* US-born: Female = 40 (CI: 36-44) ; Female = 43 (CI:34-55) Not US-born: Male = 32 (CI:29-35) ; Male = 24 (CI:19-31)
6[¥] HHP	Cohen & Reed, 1984	PC (2187 Japanese)	1970-1979 (Hawaii) US	0 (57.8)	CHD (ECG, hospital discharge records, mortality records)	*Need to request CHD incidence x Nativity *Need to request CHD prevalence x Nativity, over 8 year follow-up

ID	Study	Design* (N Asian Subgroup)	Time (Region)	% Female (Age of inclusion)	Outcome (Measurement)	Findings
HHP (continued)	Reed et al, 1982	PC (4653 Japanese)	1971-79 (Hawaii) US	0 (50-65+)	CHD (hospital records (including ECG), mortality records, autopsy)	Years lived in Japan has a strong association with CHD prevalence.
	Yano et al., 1979	PC (7705 Japanese)	1965 to 1968 – 1971 to 1974 (Hawaii) US	0 (60-68)	CHD (hospital records (including ECG), death certificates, autopsy)	*Six-year incidence rate/1000 of CH*, ($p<0.05$) 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."
7 Kanaya et al., 2010	Kanaya et al., 2010	CS (150 South Asian Indian)	2006-2007 (SF Bay area, CA) US	50 (45-84)	Atherosclerosis (Ultrasound)	*Diabetes is primary variable—Need <u>years lived in US</u> and subclinical atherosclerosis, controlling for diabetes.
8 Klatsky et al., 1994	Klatsky et al., 1994	CS (6064 Chinese; 1718 Japanese; 4283 Filipino; 1180 Other Asian)	1978-1985 to 1989 (Northern California) US	9.5-13.9 (23-55)	CHD (ICD-9: 410-414)	*Contacted author for birthplace-CHD. No data available.
9 Langenberg et al., 2007	Langenberg et al., 2007	CS (389 Filipinas)	1995-1999 (San Diego, CA) US	100 (40-86)	CHD (ECG, positive Rose questionnaire, hospitalization, reported MI)	*Requested OR from models including all risk factors simultaneously for CHD & <u>Duration of residence</u>. Not provided.
10 Le et al., 2008	Le et al., 2008	CS (159 Vietnamese)	2004-2006 (Boston, MA) US	64 (35+)	Atherosclerosis (Chart review)	*Need relationship between CAD and <u>length of residence in US</u>.

ID	Study	Design* (N Asian Subgroup)	Time (Region)	% Female (Age of inclusion)	Outcome (Measurement)	Findings
11 Li & Froelicher, 2010	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	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	? (?)	Sub-clinical Atherosclerosis (Ultrasound)	*IMT* 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	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¥ MESA	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)

ID	Study	Design* (N Asian Subgroup)	Time (Region)	% Female (Age of inclusion)	Outcome (Measurement)	Findings
MESA (Continued)	Lutsey et al., 2008	CS (803 Chinese)	2000-2002 (Los Angeles, CA; Chicago, IL) US	51 (45-84)	Atherosclerosis (Ultrasound)	*Prevalence of carotid plaque (%)* *Adjusted for age, gender, education, income. (p=0.02)* Not born in the US: 23 US-born: 45 *Adjusted for age, gender, education, income, foreign born, cholesterol, statin use, BMI, systolic bp, hypertension med use, smoking, and diabetes. (p=0.002)* Not born in the US: 22 US-born: 44 % *Maximum IMT (mm)* *Adjusted for age, gender, education, income. (p=0.007)* Not born in the US: 0.82 US-born: 1.02 *Maximum IMT (mm)* *Adjusted for age, gender, education, income, foreign born, cholesterol, statin use, BMI, systolic bp, hypertension med use, smoking, and diabetes. (p=0.004)* Not born in the US: 0.82 US-born: 1.04
16 Sheth et al., 1997	Sheth et al., 1997	CS (10989 South Asian & 21548 Chinese)	1981-1991 Canada	? (35-74)	CHD (Canadian Mortality Data Base) Stroke (Canadian Mortality Data Base)	**Contacted author for IHD & Nativity data.* *No data available.* **Contacted author for CBVD & Nativity data.* *No data available.*
17 Singh & Miller, 2004	Singh & Miller, 2004	? (? Chinese, Japanese, Filipino)	1986-1994 1986-2000 1992-1995 US	? (?)	CVD (ICD 390-448)	**Contacted author for ICD 410-414 x Nativity.* *Data no longer available.* **Contacted author for ICD 430-438 x Nativity.* *Data no longer available.*
18¥ Woo et al., 2001	Woo et al., 2001	CS (370 Chinese)	*?* (San Francisco, CA) US	? (15-70***)	Atherosclerosis (Ultrasound)	*IMT (mm)* <25 years duration: 0.67(± 0.13) >25 years duration: 0.71 ± 0.18
19¥ Worth & Kagan, 1970	Worth & Kagan, 1970	CS (1791 Japanese)	1965-1968 US	0 (60-64)	CHD (Hawaii State health department) Stroke (Hawaii State health department)	*ASHD mortality rate* Japan-born: 2 Hawaii-born: 5.47 *Stroke mortality rate* Japan-born: 1.7 Hawaii-born: 1.9

* 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.[19,26–35,37–48] Nine of these provided associations between the variables of interest.[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.[27,29,31,32] However, duration of residence associated with coronary calcification.[27] Additionally, duration of residence in North America correlated with increased IMT in both studies that provided this association.[31,33] Among Chinese, higher IMT and carotid plaque were associated with longer duration of residence.[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.[31]

All studies of CHD but one[37] uncovered a relationship between acculturation proxies and CHD. All these studies investigated Japanese samples except for one study[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.[37] In contrast, two Japanese cohorts in Hawaii discovered protective associations between being born outside of the US and CHD.[46,47] Subsequent analyses on the HHP, one of the two studies, suggested that duration of residence may account for birthplace effects.[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.[29] The CHD study of South Asians found that duration of time in the US for South Asians significantly associated with CAD after age adjustment.[28] 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.[46–48] Studies with participants from Hawaii and other places have more mixed findings.[29,37]

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.[37,46] Age was a confound for both studies: those born in the US were younger than those who were born outside of the US.[37,49] 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.[28] After adjustment, each ten years spent in the US correlated with increases in CAD cases ($p=0.006$).[28]

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.[13] 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.[12,13] As explained in this review, this diversity makes the comparison of acculturation across health outcomes very difficult.[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.[28] This study did not find a significant association between acculturation and CAD.[28] However, the researchers did discover a positive association between time in the US and CAD.[28]

This juxtaposition of evidence calls attention to multifaceted underpinnings of acculturation as a construct.[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.[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.[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.[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.[51] In a separate study, first generation status correlated with reported discrimination;[16] 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.[19] 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

1. WHO. Cardiovascular diseases (CVDs). 2011. Available at: http://www.who.int/mediacentre/factsheets/fs317/en/index.html#. Accessed March 2, 2012.

2. Human Resources and Skills Development Canada. Health-mortality from leading diseases. 2012. Available at: http://www4.hrsdc.gc.ca/.3ndic.1t.4r@-eng.jsp?iid=5#M_1. Accessed April 25, 2012.

3. Heron M, Ph D, Hoyert DL, et al. National Vital Statistics Reports Deaths: Final Data for 2006. *Statistics*. 2009;57(14).

4. NHLBI. What is atherosclerosis? 2011. Available at: http://www.nhlbi.nih.gov/health/health-topics/topics/atherosclerosis/. Accessed April 2, 2012.

5. Roger VL, Go AS, Lloyd-Jones DM, et al. Heart disease and stroke statistics--2011 update: a report from the American Heart Association. *Circulation*. 2011;123(4):e18-e209.

6. Raggi P, Callister TQ, Shaw LJ. Progression of coronary artery calcium and risk of first myocardial infarction in patients receiving cholesterol-lowering therapy. *Arteriosclerosis, thrombosis, and vascular biology*. 2004;24(7):1272-7.

7. NHLBI. How can atherosclerosis be prevented or delayed? 2011. Available at: http://www.nhlbi.nih.gov/health/health-topics/topics/atherosclerosis/prevention.html. Accessed April 2, 2012.

8. Steffen PR, Smith TB, Larson M, Butler L. Acculturation to Western society as a risk factor for high blood pressure: A meta-analytic review. *Psychosomatic medicine*. 2006;68(3):386-97.

9. Narayan KMV, Aviles-Santa L, Oza-Frank R, et al. Report of a NHLBI Workshop: Heterogeneity in cardiometabolic risk in Asian Americans In the U.S. Opportunities for research. *Journal of the American College of Cardiology*. 2010;55(10):966-73. Available at: http://www.ncbi.nlm.nih.gov/pubmed/20202512. Accessed April 3, 2012.

10. Palaniappan LP, Araneta MRG, Assimes TL, et al. Call to action: Cardiovascular disease in Asian Americans: A science advisory from the American Heart Association. *Circulation*. 2010;122(12):1242-52.

11. Redfield R, Linton R, Herskovits MJ. Memorandum for the study of acculturation. *American Anthropological Association*. 1936;38(1):149.

12. Sue S. Foreward. In: Chun KM, Organista PB, Gerardo M, eds. *Acculturation: Advances in theory, measurement, and applied research*. 1st ed. Washington, D.C.: American Psychological Association; 2002:xvii-xxi.

13. Salant T, Lauderdale DS. Measuring culture: A critical review of acculturation and health in Asian immigrant populations. *Social Science & Medicine*. 2003;57(2003):71-90.

14. Zambrana RE, Carter-Pokras O. Role of acculturation research in advancing science and practice in reducing health care disparities among Latinos. *American journal of public health*. 2010;100(1):18-23.

15. Zane N, Mak W. Major approaches to the measurement of acculturation among ethnic minority populations: A content analysis and an alternative empirical strategy. In: Chun K, Organista PB, Marin G, eds. *Acculturation: Advances in theory, measurement, and applied research*. 1st ed. Washington, D.C.: American Psychological Association; 2002:39-60.

16. Viruell-Fuentes EA, Morenoff JD, Williams DR, House JS. Language of interview, self-rated health, and the other Latino health puzzle. *American Journal of Public Health*. 2011;101(7):1306-13. Available at: http://www.ncbi.nlm.nih.gov/pubmed/21164101. Accessed April 11, 2012.

17. Cabassa LJ. Measuring acculturation: Where we are and where we need to go. *Hispanic Journal of Behavioral Sciences*. 2003;25(2):127-146.

18. Lara M, Gamboa C, Kahramanian MI, Morales LS, Bautista DEH. Acculturation and Latino health in the United States: A review of the literature and its sociopolitical context. *Annual Review of Public Health*. 2005;26:367-97. Available at: http://www.ncbi.nlm.nih.gov/pubmed/15760294. Accessed February 29, 2012.

19. Klatsky A, Tekawa I, Ma M, Sidney S. The Risk of Hospitalization for Ischemic Heart Disease among Asian Americans in Northern California. *American Journal of Public Health*. 1994;84(10).

20. Benfante R. Studies of Cardiovascular Disease and Cause-Specific Mortality Trends in Japanese-American Men Living in Hawaii and Risk Factor Comparisons with Other Japanese Populations in the Pacific Region: A Review. *Human Biology*. 1992;64(6):791-805.

21. Li W-W, Froelicher ES. Gender differences in Chinese immigrants: Predictors for antihypertensive medication adherence. *Journal of Transcultural Nursing: Official Journal of the Transcultural Nursing Society / Transcultural Nursing Society*. 2007;18(4):331-8. Available at: http://www.ncbi.nlm.nih.gov/pubmed/17911573. Accessed March 15, 2012.

22. United Nations Department of Economic and Social Affairs Population Division. Northern America. *Trends in International Migrant Stock*. 2009. Available at: http://esa.un.org/migration/p2k0data.asp. Accessed April 29, 2012.

23. Hoeffel EM, Rastogi S, Kim MO, Shahid H. *The Asian population: 2010 Census Briefs*. 2012:1-24.

24. PRISMA. Checklist PRISMA 2009. *PLoS Medicine*. 2009:1-2.

26. Choi ES, McGandy RB, Dallal GE, et al. The prevalence of cardiovascular risk factors among elderly Chinese Americans. *Archives of internal medicine*. 1990;150(2):413-8. Available at: http://www.ncbi.nlm.nih.gov/pubmed/2302017.

27. Diez Roux AV, Detrano R, Jackson S, et al. Acculturation and socioeconomic position as predictors of coronary calcification in a multiethnic sample. *Circulation*. 2005;112(11):1557-65. Available at: http://www.ncbi.nlm.nih.gov/pubmed/16144996. Accessed April 3, 2012.

28. Dodani S, Dong L. Acculturation, coronary artery disease, and carotid intima media thickness in South Asian immigrants- Unique population with increased risk. *Ethnicity & Disease*. 2011;21(3):314-321.

29. Egusa G, Watanabe H, Ohshita K, et al. Influence of extent of westernization of lifestyle on the progression of preclinical atherosclerosis in Japanese subjects. *Journal of Atherosclerosis and Thrombosis*. 2002;9:299-304.

30. Kanaya a M, Wassel CL, Mathur D, et al. Prevalence and correlates of diabetes in South Asian Indians in the United States: findings from the metabolic syndrome and atherosclerosis in South Asians living in America study and the multi-ethnic study of atherosclerosis. *Metabolic syndrome and related disorders*. 2010;8(2):157-64. Available at: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3139526&tool=pmcentrez&rendertype=abstract. Accessed April 3, 2012.

31. Lear SA, Humphries KH, Hage-Moussa S, Chockalingam A, Mancini GBJ. Immigration presents a potential increased risk for atherosclerosis. *Atherosclerosis*. 2009;205(2):584-9. Available at: http://www.ncbi.nlm.nih.gov/pubmed/19181317. Accessed April 3, 2012.

32. Lutsey PL, Diez Roux AV, Jacobs DR, et al. Associations of acculturation and socioeconomic status with subclinical cardiovascular disease in the multi-ethnic study of atherosclerosis. *American Journal of Public Health*. 2008;98(11):1963-70. Available at: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2575668&tool=pmcentrez&rendertype=abstract. Accessed April 3, 2012.

33. Woo KS, Chook P, Chan S-W, et al. Changing dietary patterns and subclinical atherosclerosis in Chinese Americans: The impact of prolonged early acculturization. *European Heart Journal*. 2001;22:374.

34. Anand SS, Yusuf S, Vuksan V, et al. Differences in risk factors, atherosclerosis and cardiovascular disease between ethnic groups in Canada: The study of health assessment and risk in ethnic groups (SHARE). *Indian heart journal*. 2000;52(7 Suppl):S35-43. Available at: http://www.ncbi.nlm.nih.gov/pubmed/11339439.

35. Le LH, Nguyen H, Ozonoff A, et al. Prevalence of cardiovascular risk factors and acculturation in Vietnamese Americans. 2008:378.

36. Cohen JB, Reed D. The type A behavior pattern and coronary heart disease among Japanese men in Hawaii. *Journal of Behavioral Medicine*. 1985;8(4):343-52. Available at: http://www.ncbi.nlm.nih.gov/pubmed/4093972.

37. Haenszel W, Kurihara M. Studies of Japanese migrants: Mortality from cancer and other diseases among Japanese in the United States. *Journal of the National Cancer Institute*. 1968;40(1):43-68.

38. Langenberg C, Araneta MRG, Bergstrom J, Marmot M, Barrett-Connor E. Diabetes and CHD in Filipino-American women: Role of growth and life-course socioeconomic factors. *Diabetes care*. 2007;30(3):535-41. Available at: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2542981&tool=pmcentrez&rendertype=abstract. Accessed April 3, 2012.

39. Li W-W, Froelicher ES. Gender differences in Chinese immigrants: predictors for antihypertensive medication adherence. *Journal of Transcultural Nursing: Official Journal of the Transcultural Nursing Society / Transcultural Nursing Society*. 2007;18(4):331-8. Available at: http://www.ncbi.nlm.nih.gov/pubmed/17911573. Accessed March 15, 2012.

40. Li W-W, Stewart AL, Stotts N, Froelicher ES. Cultural factors associated with antihypertensive medication adherence in Chinese immigrants. *Journal of Cardiovascular Nursing*. 2006;21(5):354-362.

41. Li W-W, Wallhagen MI, Froelicher ES. Factors predicting blood pressure control in older Chinese immigrants to the United States of America. *Journal of Advanced Nursing*. 2010;66(10):2202-12. Available at: http://www.ncbi.nlm.nih.gov/pubmed/20722800. Accessed April 3, 2012.

42. Li W-W, Wallhagen MI, Froelicher ES. Hypertension control, predictors for medication adherence and gender differences in older Chinese immigrants. *Journal of Advanced Nursing*. 2008;61(3):326-35. Available at: http://www.ncbi.nlm.nih.gov/pubmed/18197867. Accessed April 3, 2012.

43. Marmot MG, Leonard SS. Acculturation and coronary heart disease in Japanese-Americans. *Journal of Epidemiology*. 1976;104(3):225-247.

44. Sheth T, Nargundkar M, Chagani K, et al. Classifying ethnicity utilizing the Canadian Mortality Data Base. *Ethnicity & Health*. 1997;2(4):287-95. Available at: http://www.ncbi.nlm.nih.gov/pubmed/9526691.

45. Singh GK, Miller BA. Health, life expectancy, and mortality patterns among immigrant populations in the United States. *Revue Canadienne de Santé Publique*. 2004;95(3):I-14-I-21.

46. Worth RM, Kagan A. Ascertainment of men of Japanese ancestry in Hawaii through World War II Selective Service registration. *Journal of Chronic Diseases*. 1970;23(5):389-97. Available at: http://www.ncbi.nlm.nih.gov/pubmed/5492969.

47. Yano K, Blackwelder WC, Kagan A, et al. Childhood cultural experience and the incidence of coronary heart disease in Hawaii Japanese men. *American Journal of Epidemiology*. 1979;109(4):440-50. Available at: http://www.ncbi.nlm.nih.gov/pubmed/443242.

48. Reed D, Mcgee D, Cohen J, et al. Acculturation and CHD among Japanese. *American Journal of Epidemiology*. 1982;115(6):894-905.

49. Robertson TL, Kato H, Rhoads GG, et al. Epidemiologic studies of coronary heart disease and stroke in Japanese men living in Japan, Hawaii and California. Incidence of myocardial infarction and death from coronary heart disease. *The American Journal of Cardiology*. 1977;39(2):239-43. Available at: http://www.ncbi.nlm.nih.gov/pubmed/835482.

50. Srinivasan S, Guillermo T. Toward improved health: Disaggregating Asian American and Native Hawaiian/Pacific Islander data. *American Journal of Public Health*. 2000;90(11):1731-4.

51. Sam DL, Vedder P, Liebkind K, Neto F, Virta E. Immigration, acculturation, and the paradox of adaptation in Europe. *European Journal of Developmental Psychology*. 2008;5(2):37-41.

Figure 1.

Section/Topic	#	Checklist Item	Reported on Page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	
ABSTRACT			
Structured summary	2	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.	
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	
METHODS			
Protocol and registration	5	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.	
Eligibility criteria	6	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.	
Information sources	7	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.	
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	
Risk of bias in individual studies	12	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.	
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	
Synthesis of results	14	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.	
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	
RESULTS			
Study selection	17	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.	
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome-level assessment (see Item 12).	
Results of individual studies	20	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.	
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	
DISCUSSION			
Summary of evidence	24	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).	
Limitations	25	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).	
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	

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Figure 2.

Sample search strategy:

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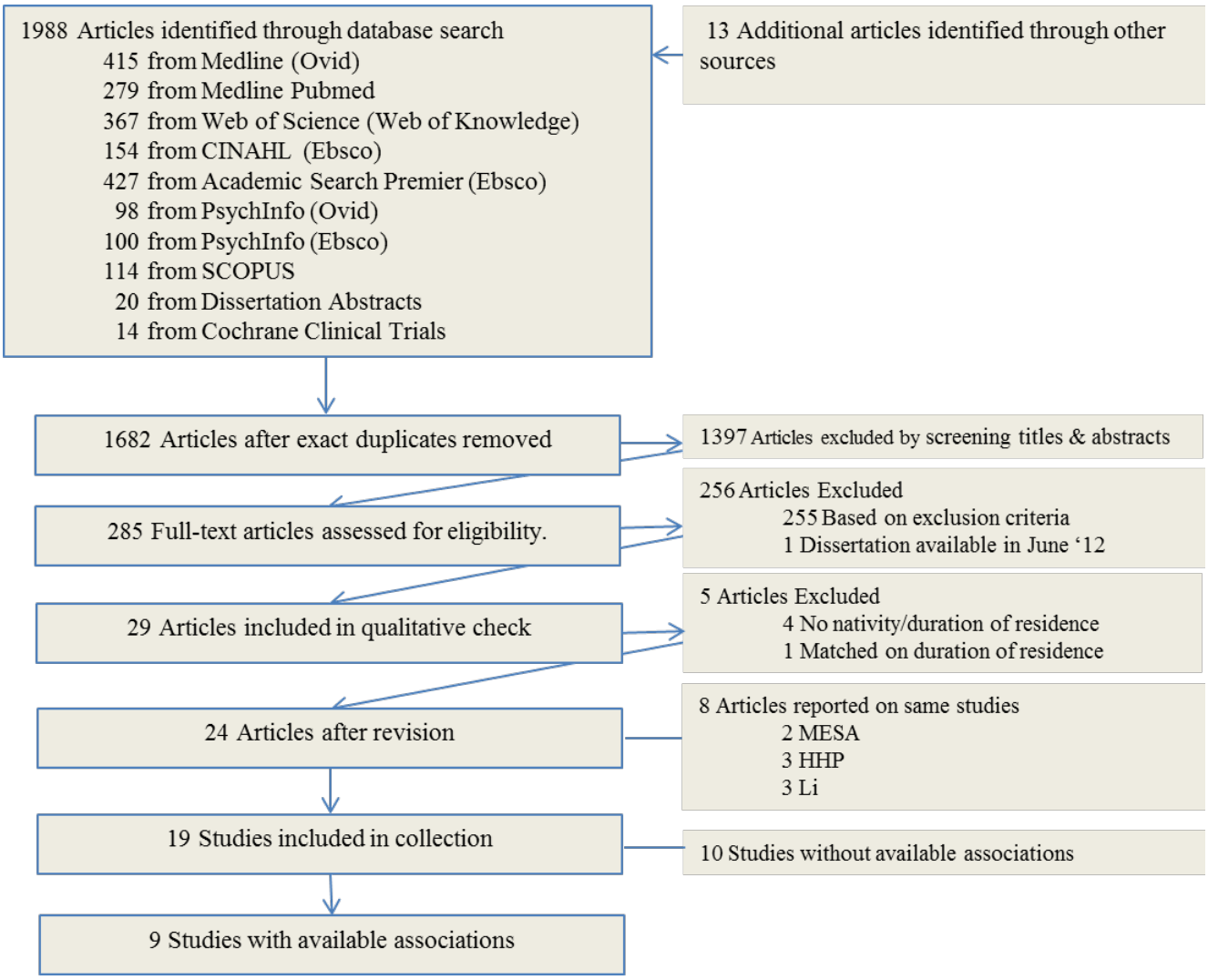
Figure 3.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