

Assessment of Dietary Acculturation in East Asian Populations: A Scoping Review

Sarah D Lee, Nicole J Kellow, Tammie ST Choi, and Catherine E Huggins

Department of Nutrition, Dietetics, and Food, Faculty of Medicine Nursing and Health Sciences, Monash University, Be Active Sleep Eat (BASE) Facility, Notting Hill, Victoria, Australia

ABSTRACT

East Asian immigrants face multiple challenges upon arrival in their destination country, including an increased risk of future diabetes and cardiovascular disease development. The adoption of food and eating patterns of their host country (i.e., dietary acculturation) may contribute to this increased disease risk. To effectively examine the dietary acculturation–disease risk relationship in East Asian immigrants, sensitive tools are necessary; however, there has been no systematic review of the methods used to assess dietary acculturation in this population. A systematic scoping review of the literature was undertaken to address this gap. A systematic search was conducted in December 2019 and returned a total of 6140 papers. Manuscripts were screened independently by 2 reviewers, resulting in the final inclusion of 30 papers reporting on 27 studies. Robust measures of dietary acculturation were lacking, with only 6 studies using validated tools. Most studies used self-reported cross-sectional surveys to determine how the individual's diet had changed since immigrating, with responses provided on Likert scales. Only 3 quantitative longitudinal studies used prospective measures of diet change, through serial food-frequency questionnaires. Qualitative studies explored dietary acculturation and factors influencing change in diet through semi-structured interviews and focus groups. This review found there is no consensus in the literature on how to most effectively measure the magnitude and process of dietary acculturation in East Asian populations. There is a need for robust, longitudinal, and mixed-method study designs to address the lack of evidence and develop more comprehensive tools measuring dietary acculturation. Improving the assessment methods used to measure dietary acculturation is critical in helping to monitor the impact of interventions or policies aimed at reducing diet-related disease risk in East Asian immigrant populations. *Adv Nutr* 2021;12:865–886.

Keywords: dietary acculturation, East Asian, immigration, scoping review, measurement, dietary change, diet transition

Introduction

Dietary acculturation is a complex, multidimensional process by which a person's diet changes and adapts when they move from their home country to a new host country with a different food environment or culture (1). It is not simply a unidirectional change from diet of origin country to new host country dietary patterns, but rather depends on many factors, including country and culture of origin, age at migration, socioeconomic factors, political factors, and personal preferences (2). Dietary acculturation research has gained traction in developed countries as changing dietary and lifestyle patterns among new immigrants has emerged as a potential contributor to increased risk for chronic diseases such as type 2 diabetes (T2D), cardiovascular disease,

and obesity (3). This increase in risk for chronic diseases with increased length of residence in the host country has been especially notable for East Asian immigrants (4–7). One longitudinal study of Asian immigrant health in Australia found that increased length of residence was correlated with increased reporting of T2D among Asian immigrants compared with their native-born counterparts, even when health behaviors were controlled for (5). Another study from the United States found that, compared with whites, the prevalence of T2D among first-generation Asian immigrants increased almost twice as much over a 10-y period (4). Both studies suggest that diet and lifestyle factors may explain this difference in disease risk (4, 5). Other studies have found Chinese who immigrate to westernized countries to have a 30–50% increased risk for developing T2D compared with those who remain in China (8, 9). Westernized societies are characterized by obesogenic food environments, which is a known contributor to the high prevalence of chronic diseases, such as diabetes and heart disease (10–12). When East Asians immigrate to these

The authors reported no funding received for this study.

Author disclosures: The authors report no conflicts of interest.

Supplemental Appendix 1 and Supplemental Table 1 are available from the "Supplementary data" link in the online posting of the article and from the same link in the online table of contents at <https://academic.oup.com/advances>.

Address correspondence to Catherine Huggins (e-mail: kate.huggins@monash.edu).

Abbreviation used: T2D, type 2 diabetes.

westernized societies, it is inevitable that they undergo some change in dietary habits, due to a different food and cultural environment.

Additionally, China, the largest country in East Asia, has been undergoing a rapid nutrition transition for the last couple decades, with diets on a population level changing towards increased consumption of animal products and refined carbohydrates, which has contributed to an exponential increase in the incidence of T2D (13–15). The combination of nutrition transition with dietary acculturation after immigration may exacerbate the risk for chronic disease in this population.

This represents a significant problem, as East Asian immigrants are one of the fastest growing group of immigrants among all major immigration countries (16). Approximately 27% of immigrants to the United States originate from East and South Asia, with those from China representing the third largest group of new immigrants in 2017, and Asians are projected to make up 38% of all immigrants by the year 2065 (17). In Canada, 31% of recent immigrants are born in East Asia, while ~23% of new immigrants to Australia were born in North East Asia (18, 19). With such a significant number of new East Asian immigrants and with the current evidence showing that health deteriorates postmigration, studying the process of dietary acculturation in this population could shed some light on how and why the risk of chronic disease increases for these immigrants.

The association between acculturation and diet has been studied for over half a century, but dietary acculturation as a distinct area of research has only emerged in the last few decades (20). Satia-Abouta et al. (20) conducted a brief review of methods utilized to study dietary acculturation among US immigrants and found that early dietary acculturation studies primarily utilized methods from the social sciences, such as single-item acculturation measures (e.g., length of time in host country or language proficiency) or brief acculturation scales in an attempt to measure dietary acculturation (20). While they provide some understanding of the factors influencing acculturative stress, these traditional measures of acculturation fail to capture change in dietary patterns, so cannot provide the necessary information needed to measure dietary acculturation and how it impacts on risk for chronic disease (20). As it has been almost 2 decades since the most recent review of dietary acculturation measures, it is pertinent to re-examine the literature to determine if any progress has been made in the approaches used to measure dietary acculturation. As dietary acculturation has been recognized as specific to the culture and country of origin, it is important to define the population group when examining measures of dietary acculturation (1). Therefore, this scoping review aims to understand how dietary acculturation is currently being measured in East Asian immigrant populations and to evaluate the quality of these measurement tools. It is anticipated that this review will provide valuable insight into how dietary acculturation can best be measured, as a first step in identifying nutritional factors contributing to chronic disease risk in East Asian

immigrants. It is imperative to track dietary changes in immigrant populations and determine how these changes correlate to increased risk for cardiometabolic diseases in order to identify the best points of intervention for reducing disease risk and burden on the health care system.

Methods

To determine how dietary acculturation is assessed in East Asian immigrant populations, a systematic scoping review was undertaken. Scoping reviews are appropriate for determining the extent of existing literature on a research topic and uncovering gaps in the literature (21). Scoping reviews are useful for reviewing literature from a wide range of disciplines that is heterogenous in nature and therefore does not lend itself well to systematic review methodology (21, 22). Quality assessment of included articles is not normally a formal part of a scoping review (22). The scoping review was conducted based on the framework described by Arksey and O'Malley (22) and reported following the Preferred Reporting Items for Systematic Reviews and Meta Analyses—Extension for Scoping Reviews (PRISMA-ScR) checklist and guidelines to ensure a rigorous and systematic process (22, 23).

Search strategy

The search strategy was developed based on preliminary searching and refined in consultation with a research librarian and researchers with expertise in the field of dietary acculturation. Once the search strategy was finalized, 7 electronic databases were searched—Medline, Embase, CINAHL, Scopus, Sociological Abstracts, Cochrane, and PsychInfo—to retrieve articles indexed from database inception until December 2019. Search terms used included a combination of “diet acculturation,” “food acculturation,” “nutrition transition,” “diet transition,” and “diet shift” in order to capture the range of methods used to describe changing diets. Hand-searching of articles identified through database searching was also conducted to retrieve additional articles. An example search strategy for Medline is provided in **Supplemental Appendix 1**. No limitations were placed on publication date based on the scarcity of literature returned in initial scoping searches. Articles were limited to those conducted in humans and published in English.

Inclusion criteria

In order to be considered for inclusion, articles must have met the following criteria: 1) peer-reviewed original research studies and 2) include a question or measure related to individual dietary change in East Asian populations living outside their country of origin. Both qualitative and quantitative studies were included if they attempted to capture dietary change on an individual level. For the purpose of this review, dietary acculturation was defined as the change in dietary habits/food choices that occurs when a person moves from their home country to another host country and begins to adopt the dietary habits/food choices of the host country (2). East Asians were defined as those originating from China

(including Hong Kong and Macau), Korea, Japan, Mongolia, and Taiwan, as these countries share ethnic and cultural heritage similarities (24).

Exclusion criteria

Articles were excluded if they 1) measured dietary change at a population level (nutrition transition) rather than on an individual level (25) and 2) were not published in English.

Screening

All retrieved records were imported into Endnote software (version X9.3.1; Clarivate Analytics) for removal of duplicates before being uploaded to an online systematic review screening software program (Covidence systematic review software; Veritas Health Innovation, Melbourne, Australia). Using prespecified inclusion criteria, titles and abstracts were screened independently by 2 authors (SDL and NJK). The screening protocol was piloted on 300 records to ensure consistency in applying eligibility criteria. Studies selected during first-pass screening were then retrieved and full-text articles were screened independently by 2 authors (SDL and NJK). Conflicts were resolved through discussion between the 2 reviewers until consensus was achieved. Interrater agreement was high at 94% overall.

Data extraction

Data extraction was completed by 1 author (SDL) using a data-extraction template developed in conjunction with the authorship team. A subsample of extractions was verified by a second author (NJK). Key characteristics of included papers were extracted, including study country, study design, participant type and number, analysis methods, and key findings relating to measurement of dietary acculturation.

Synthesis approach

Extracted data were collated into separate data sheets for quantitative and qualitative methods used to examine dietary acculturation. Studies using quantitative methods were evaluated for the specific dietary acculturation assessment tool(s) utilized, including the number and type of questions, scoring system, validity and reliability, as well as strengths and weaknesses of the measurement method. Interview/focus group questions used in qualitative studies to explore dietary acculturation were extracted and collated to create an overall picture of the qualitative approaches used to explore dietary acculturation.

Results

After removal of duplicates, a total of 3617 records were included in stage 1 screening (title and abstract), resulting in 228 articles eligible for full-text screening. During stage 2 screening (full-text), 198 articles were excluded, leaving 30 articles reporting on 27 studies ($n = 16$ quantitative, $n = 9$ qualitative, $n = 2$ mixed methods) meeting criteria for inclusion in this review (1, 26–54) (Figure 1). Studies were conducted with East Asian populations in the United States ($n = 16$), Canada ($n = 4$),

United Kingdom ($n = 2$), Australia ($n = 2$), Belgium ($n = 1$), Korea ($n = 1$), and in both the United States and Canada ($n = 1$). Participants in the included studies originated from all East Asian countries except for Mongolia, with $n = 20/27$ studies including participants of Chinese ethnicity. Data from a total of 49,502 participants were included in the 27 studies. The 16 quantitative studies were primarily cross-sectional ($n = 13$) (Table 1), while qualitative studies used multiple data-collection methods including semi-structured interviews ($n = 5$), focus groups ($n = 4$), semi-structured food consumption diary ($n = 1$), participant observation ($n = 1$), and photovoice records ($n = 1$) (Table 2). Two mixed-methods studies used qualitative focus groups/interviews as well as quantitative 24-h dietary recalls (Table 3) (40, 52).

A summary of key study characteristics, separated by methodological approach, quantitative studies, qualitative studies, and mixed methods can be found in Tables 1–3, respectively, with expanded study information in Supplemental Table 1.

Quantitative measures of dietary acculturation

Studies used a wide variety of tools to quantitatively assess dietary acculturation, including food-based assessment to capture dietary intake, dietary acculturation scales, and general eating habits questionnaires (Table 4). Most studies utilized multiple tools to capture dietary acculturation, and only 2 studies used the same tool. To capture dietary acculturation, these assessment tools were either administered at multiple time points to assess change in diet over time or administered once only by asking participants to fill out questionnaires retrospectively and recall their diets before immigrating.

Six studies measured dietary acculturation using food-based assessments, such as 24- or 48-h dietary recalls ($n = 3$), food-frequency questionnaires ($n = 4$), and the Food Similarity Index (a tool developed to measure how similar an individual's diet is to that of a US-born person of the same age) (50) ($n = 1$). Four studies used scales developed specifically to measure changes in dietary patterns of immigrants. Nine studies utilized questionnaires developed to assess general change in food consumption patterns pre- and postmigration. All food-habits questionnaires were only used in individual studies, but they contained similar types of questions, including meal/snack frequency, frequency of fruit/vegetable consumption, and general change in diet.

Qualitative assessment of dietary acculturation

Qualitative methods used to explore dietary acculturation captured 3 primary themes of questions: diet prior to migration, diet postmigration, and factors influencing eating habits. All qualitative approaches involved asking participants to describe changes in their diets postmigration and the factors influencing their current dietary habits, including food-preparation methods, food procurement, and perceptions regarding the relation between diet and disease. Some

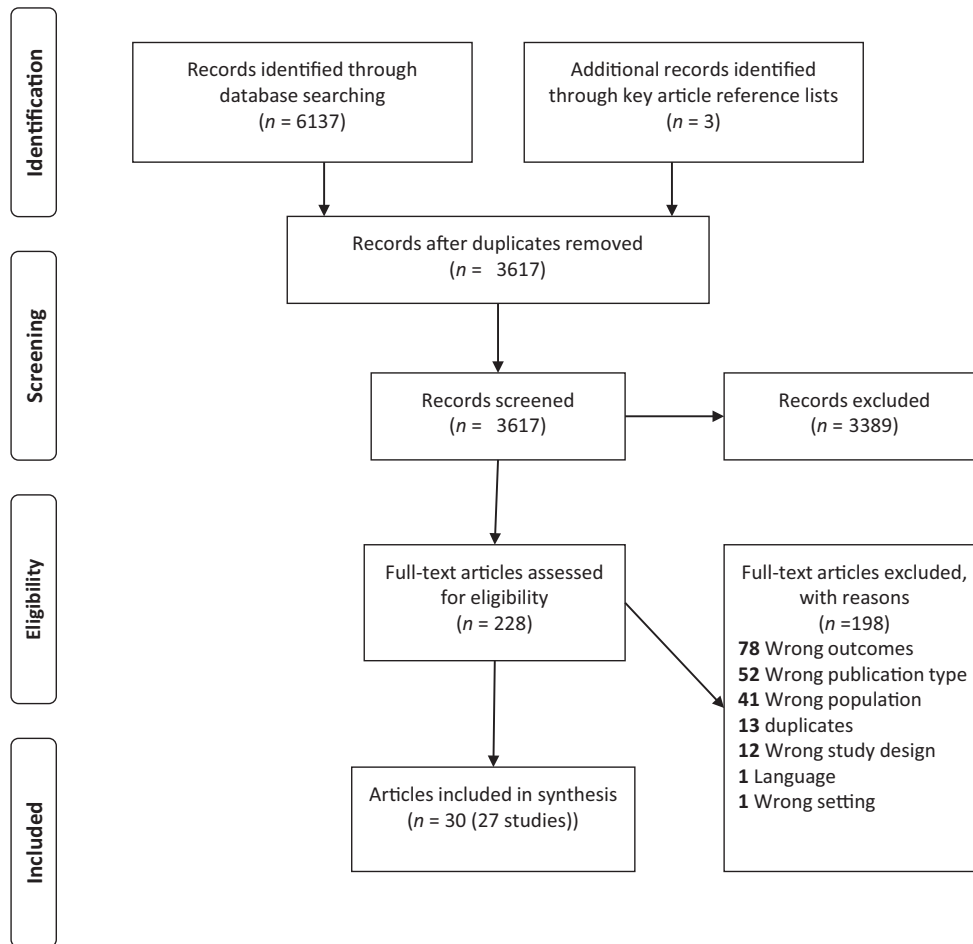


FIGURE 1 PRISMA flow diagram. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta Analyses.

example questions used to explore dietary acculturation included “If you think that your diet and physical activity have changed since coming to Canada, what are the most important reasons?” (51) and “What types of changes have been made to your diet?” (30). These studies used both closed and open-ended questions to elucidate responses from participants with regard to dietary acculturation as well as to collect demographic information for analysis purposes.

How do diets change?

Findings regarding dietary acculturation varied widely. For example, some studies found immigrants increased fruit and vegetable consumption after moving, while some decreased consumption (1, 26, 28, 46). Both qualitative and quantitative studies found that dietary acculturation depended on a range of factors, including ethnic and nonethnic cultural ties, such as having friends from the host country, and food environment factors, such as cost and quality of foods. Multiple studies found that breakfast was the first meal to change postmigration, either to become more Western or to be skipped entirely (28, 47, 52). Some of the reasons for this change were that participants found traditional breakfasts

time-consuming to prepare while Western-style breakfast foods were more convenient to access.

Limitations of measurement methods

The included studies provided some discussion of the limitations of the methods used to measure dietary acculturation. While these varied widely across the studies, some key shortcomings of the tools used included reliance on food-frequency questionnaires with inadequate food types, measure of perception of change rather than actual dietary change, and missing questions on region of origin for participants.

Discussion

The purpose of this scoping review was to determine how dietary acculturation is assessed in East Asian immigrant populations. The 27 studies included in this scoping review highlight the lack of standardized and validated instruments available to measure and understand dietary acculturation in East Asian immigrants, as only 2 studies used the same measure of dietary acculturation. The diversity of study designs and instruments creates a confusing picture of

TABLE 1 Quantitative studies assessing dietary acculturation among East Asian immigrant populations¹

Author(s), year (reference)	Country	Study design	Population	Sample size	Dietary acculturation measure(s)	Primary findings relating to dietary acculturation
Adekunle et al., 2013 (27)	Canada	Cross-sectional study	Chinese-Canadians	250	Ethnic Canadian Dietary Acculturation Scale (ECDAS)	High acculturation score correlated with purchase of fewer specifically Chinese vegetables Significant increase in frequency of burger consumption
Almohanna et al., 2015 (29)	United States	Longitudinal study Data collection at 3 time points: baseline, 6-wk follow-up, and 12-wk follow-up	Postsecondary international students from a range of countries including China and South Korea	35	Food-habits questionnaire 24-h diet recall FFQ	
An, 2018 (31)	United States	Cross-sectional study	Self-identified as ethnic Chinese and who lived in the USA	505	Western dietary acculturation scale Chinese dietary acculturation scale	Immigrants who retained their cultural identity received more diet-specific social support than did immigrants who lost their identity
Chadee et al., 1996 (33)	United States	Cross-sectional study	Japanese immigrants living in Los Angeles	1181	Change in food consumption survey developed and piloted by the authors; 5-point scale 24-h dietary recalls	Beef consumption increased significantly in immigrants compared with when they were living in Japan Among immigrants, there was increased consumption of American foods, increased eating away from home, and increased fast-food consumption
Kim et al., 2007 (35)	United States	Cross-sectional study	Hypertensive and normotensive Korean Americans and native Koreans	398		Changes in dietary habit were correlated positively with language, media use, friendship, food, and ethnic self-identity The high-acculturation group demonstrated a statistically significant tendency to consume more bread, cereal, spaghetti (lasagna, other pasta with tomato sauce), pizza, ham, and lunch meats, green salad, sweetcorn, chocolate, candies, and diet soft drinks
Kim and Chan, 2004 (34)	United States	Cross-sectional study	Korean Americans	486	Questionnaire evaluating extent dietary habits changed after immigration and the types of meals consumed recently	

(Continued)

TABLE 1 (Continued)

Author(s), year (reference)	Country	Study design	Population	Sample size	Dietary acculturation measure(s)	Primary findings relating to dietary acculturation
Lee et al., 2015 (36)	Korea	Cross-sectional study	Chinese international students	142	Author-developed questionnaire on dietary behaviors and food consumption patterns	Decreased dietary behaviors postmigration: frequency of eating breakfast, number of meals per day, meal regularity, frequency of eating vegetables daily, frequency of eating fruits daily Increased behaviors: fast-food consumption, tendency to skip meals, late-night snacks Increased consumption frequency of items from all 7 food groups Decreased consumption frequency of traditional foods Education was correlated with increased consumption of all 7 food groups
Ly and Cason, 2003, 2004 (37, 38)	United States	Cross-sectional study	Adult Chinese Americans	399	General food-habits questionnaire FFQ	Education was correlated with increased consumption of all 7 food groups Reduced number of meals per day Increased fat and sweets intake and decreased vegetable intake
Pan et al., 1999 (41)	United States	Cross-sectional study	International postsecondary students born in China, Taiwan, Hong Kong, Korea, or Japan, aged 18 y and older	63	Author-developed food-habits questionnaire FFQ	Education was correlated with increased consumption of all 7 food groups Reduced number of meals per day Increased fat and sweets intake and decreased vegetable intake
Perez-Cueto et al., 2009 (42)	Belgium	Cross-sectional study	International university students including some from Asia	235	Author-developed questionnaire on diet change and knowledge of healthy eating	Increases in the consumption of fruits and vegetables, more low-fat milk or dairy products, and more fiber-rich foods were reported No significant association was found between reporting dietary changes and continent of origin
Pierce et al., 2007 (43)	United States	Cross-sectional study	Japanese Americans (second- and third-generation)	496	FFQ; 40 items 10 items used in confirmatory factor analysis of food-frequency data to create Japanese and Western food factor scores	On average, the second-generation participants had higher Japanese food factor scores and lower Western food factor scores than did the third generation

(Continued)

TABLE 1 (Continued)

Author(s), year (reference)	Country	Study design	Population	Sample size	Dietary acculturation measure(s)	Primary findings relating to dietary acculturation
Rosenmöller et al., 2011 (44)	Canada	Cross-sectional study	Chinese immigrants	120	Author-developed questionnaire addressing: perceived changes in dietary patterns, food preparation, and nutrition knowledge and awareness	Increasing consumption of fruits and vegetables, decreasing the use of deep-frying after immigration Increased awareness and knowledge about healthy foods with increased length of residence in Canada Increased portion sizes, dining out frequency, and consumption of convenience foods with increased length of residence in Canada Women who were younger, more educated, employed outside the home had a higher Western score (more acculturated) Higher Western acculturation score was associated with higher dietary fat intake and increase in fruit and vegetable intake after immigration Women who believed that the Chinese diet is healthier than a typical Western diet and who reported that some healthful foods are expensive in North America were more likely to have maintained Chinese eating patterns
Satia et al., 2001a, 2001b, Satia-Abouta et al., 2002 (1, 26, 46)	United States and Canada	Cross-sectional study	Chinese descent women aged 20 and older living in Seattle and Vancouver	244	Chinese Dietary Acculturation Scale (CDAS) Western Dietary Acculturation Scale (WDAS) Dietary change questionnaire	The developed inventory of household foods was strongly associated with current dietary behavior, changes in food consumption, and westernization of dietary patterns

(Continued)

TABLE 1 (Continued)

Author(s), year (reference)	Country	Study design	Population	Sample size	Dietary acculturation measure(s)	Primary findings relating to dietary acculturation
Tseng et al., 2015 (49)	United States	Longitudinal study Data collection at minimum of 2 time points; baseline and follow-up (between 2 and 4 data-collection points) 2.7 y mean follow-up time	Chinese immigrant women	312	48-h dietary recall interviews (baseline and at least 1 follow-up) Diet Quality Index–International	Increasing length of US residence was associated with a small but significant increase in acculturation score Greater acculturation was associated with an increase in energy intake and percent of energy from fat only in less educated women Length of US residence was a poorer predictor of change in dietary behavior than was acculturation score The Food Similarity Index was found to be valid measure across a range of ages and ethnicities and could be used as a tool to measure the similarity of immigrants' diets to someone born in the USA
Van Hook et al., 2015 (50)	United States	Secondary analysis	All children and adults who participate in the NHANES dietary survey	18,349 children; 27,365 adults	Food Similarity Index	Food Similarity Index score was positively associated with consuming American foods, negatively associated with ethnic foods, and positively associated with time and generations in the USA At 8 y follow-up it was found that percentage of energy from protein and fats increased while contribution from carbohydrate decreased In women, consumption of all micronutrients was increased significantly except for sodium, retinol, B-carotene, and vitamin C; in men, intakes of iron, riboflavin, and B-carotene increased significantly
Zhang et al., 2002 (54)	Australia	Longitudinal study Data collection at 2 time points: baseline and 8 y mean follow-up time	Adults of Chinese ethnicity, aged 25 y and over with Australian citizenship or permanent resident status	262	Multiple FFQs (baseline and average of 8 y follow-up)	Food Similarity Index score was positively associated with consuming American foods, negatively associated with ethnic foods, and positively associated with time and generations in the USA At 8 y follow-up it was found that percentage of energy from protein and fats increased while contribution from carbohydrate decreased In women, consumption of all micronutrients was increased significantly except for sodium, retinol, B-carotene, and vitamin C; in men, intakes of iron, riboflavin, and B-carotene increased significantly

¹FFQ, food-frequency questionnaire.

TABLE 2 Qualitative studies exploring dietary acculturation among East Asian immigrant populations

Author(s), year (reference)	Country	Study design/data collection method	Population	Sample size	Dietary acculturation measure(s)	Primary findings relating to dietary acculturation
Alakaam et al., 2015 (28)	United States	Grounded theory: focus groups using an interview guide	Post-secondary international students from a range of countries including East Asia	32	Focus group topics: (1) Previous dietary habits prior to coming to the United States (2) Current dietary habits and food choice changes (3) The influence of different factors on these changes (4) The overall health effects after living in United States	Higher consumption of fried food, meats, sugar, salt, convenience food, cereals, bread, dairy products, soda beverages, snacks, desserts, and less fruits and vegetables; switch from tea to coffee and skipping breakfast or eating a light breakfast
Amos and Lordly, 2014 (30)	Canada	Photovoice methodology and 2 focus group discussions	International students attending a 13-wk university nutrition bridging program	15	Focus group topics: (1) What is your food experience like in Canada? (2) What meaning does food hold for you? (3) What barriers and facilitators to food preparation do you encounter? (4) What types of changes have been made to your diet? (5) How are you adjusting to Canadian food culture?	All participants felt their home country food was healthier than Canadian food Participants maintained a strong connection to traditional foods and their cultural identity was connected to these foods
Cappellini and Yen, 2013 (32)	UK	Longitudinal qualitative inquiry with interpretivist paradigm 4 sets of focus group discussions	Chinese international students attending a 1-y business program	12	Focus group topics: (1) Daily consumption routine (2) Shopping (3) Traveling (4) Relations with family and friends in China as well as relations in the UK	The study found food consumption depended on ethnic and nonethnic ties and acculturation stage (Resistance, Maintenance, or Assimilation)
Hartwell et al., 2011 (39)	UK	Qualitative inquiry	Postgraduate international students (European and Asian) attending a Master's course	10	Interview question topics: (1) Demographics (2) Length in country (3) Living arrangements (4) Food-procurement behaviors (5) Influences on food-purchasing behaviors (6) Food prep and cooking (7) Typical eating patterns	Analysis revealed a distinctive "external push" and "internal pull" influence on food habits Religion, culture, price, and familiarity had an influence on their food purchase decisions, but participants used a variety of means to ensure that their food culture was maintained

(Continued)

TABLE 2 (Continued)

Author(s), year (reference)	Country	Study design/data collection method	Population	Sample size	Dietary acculturation measure(s)	Primary findings relating to dietary acculturation
Saccone and Obeng, 2015 (45)	United States	Phenomenological design: semi-structured interviews	International students from 5 continents	25	(8) Change in eating behaviors since living in country and why (9) Feelings about eating behaviors (10) Influence on change in eating behaviors Question topics: (1) Changes in diet in the USA (2) Factors affecting food decisions and eating patterns (3) Perceived health consequences Interview topics:	Many participants noted a trial period of more energy-dense food, with most explicitly stating a return to traditional eating practices with negotiated inclusion of foods prevalent in the US diet Dietary acculturation appears to be a passive, noncognitive process with convenience, cost, and food quality being the most important factors predicting dietary change after immigration Breakfast was the first meal to be "westernized"
Satia et al., 2000 (47)	United States	Semi-structured interviews Participant observations Focus groups	Chinese-American women	42	(1) Knowledge, attitudes, and beliefs about diet and disease (2) Factors that influence dietary change (3) Changes in diet since immigrating to the United States	
Sutton-Brady et al., 2010 (48)	Australia	Exploratory phenomenological approach: Open-ended interviews Semi-structured food and media consumption diaries	First-generation and second-generation Korean migrant families with children between the ages of 8 and 15	24	Participant observations—occurred during interviews to observe household food consumption and have participants classify foods as either "Chinese" or "American" Focus group topics: same as interviews—used to validate interview findings 2-wk food and media diary—to examine consumption of traditional Korean and non-Korean foods Interviews—to discuss food diaries	Previous food-consumption habits comprised purely traditional foods; after migration, these habits represent a compromise between participants' cultural background and life as immigrants with a mixed diet; more convenient;

(Continued)

TABLE 2 (Continued)

Author(s), year (reference)	Country	Study design/data collection method	Population	Sample size	Dietary acculturation measure(s)	Primary findings relating to dietary acculturation
Vitale and Doherty, 2018 (51)	Canada	Semi-structured interviews	East/South East Asian and Hispanic immigrants	100	Interviews included open-ended and closed questions and Likert-type scales, for a total of 41 items Open-ended questions included: "If you gained weight since coming to Canada, why is that?" and "If you think that your diet and physical activity have changed since coming to Canada, what are the most important reasons?" "Study participants were also asked to indicate how similar their current diets were when compared with those in their home countries, measured on a 3-point Likert-scale as "Exactly the Same," "Very Similar," "Similar," "Different," and "Very Different"	simpler, easier to prepare Western meals rather than the rice, side dishes and soups of traditional meals The most common theme was the exposure to an unfamiliar environment that encouraged the acquisition of unhealthy behaviors East/South East Asian participants were more likely to perceive that their eating habits had not changed since the time of arrival, given the pervasive diffusion of ethnic grocery stores and the easiness to purchase traditional ingredients
Yan and FitzPatrick, 2016 (53)	United States	Qualitative inquiry within a constructivist paradigm: semi-structured interviews	Undergraduate international students in first year from 5 different countries	18	Interview questions: (1) How does being immersed in American culture influence their attitude toward and practice of physical activity, diet, and alcohol consumption? (2) What are the facilitators and barriers for them to adopt physical activity, diet, and drinking behaviors? (3) What strategies have they adopted to overcome those barriers?	The majority of international students did not like the food provided in the cafeteria, mainly because the food was very different from their "home food" and the food was very rich (i.e., high in fat and calories) The acculturation of health behavior is influenced by individual, environmental, and cultural factors, and international students' different attitudes toward the new culture and new types of behavior

TABLE 3 Mixed-methods studies measuring dietary acculturation among East Asian immigrant populations

Author(s), year (reference)	Country	Study design	Population	Sample size	Dietary acculturation measure(s)	Primary findings relating to dietary acculturation
Lane et al., 2019 (40)	Canada	Mixed-methods, cross-sectional	Immigrants and refugees and their children, with 49.3% originating from Asia and living in Canada for <5 y	322	Open-ended questions to better understand newcomer family dietary practices and dietary changes experienced in Canada	Difficulty maintaining a traditional diet for their family in the midst of a busy schedule and their children's demands to eat more fast foods and sugar-sweetened beverages
Wu and Smith, 2016 (52)	United States	Mixed-methods, cross-sectional	Chinese international students	43	Open-ended questions examples: (1) "Please describe your typical meal pattern in China before coming to the USA." (2) "Please describe your typical meal patterns since coming to the USA."	Most participants believed that their diets had changed since moving, but many had tried "American" food before Breakfast was the first meal to change to Western for males, while females consumed a Western lunch more often Snack foods consumed were also mostly Western American friends also played an important role in exposing Chinese students to American cuisine, thus accelerating their dietary acculturation

the process and consequences of dietary acculturation for East Asian immigrants. This mixed result has also been found in other literature examining dietary acculturation among Hispanic adults in the United States (55). There have been some improvements in the measurement of dietary acculturation in the last 20 y, including the development of targeted dietary acculturation scales and the recognition of the need for assessment of dietary intake at multiple time points. However, the most appropriate methods to adequately capture dietary acculturation in this population are still unclear. Standardized methods are critical in order to better explore the relation between dietary acculturation and risk for cardiometabolic disease as well as for enhanced comparison of disease risk between immigrant populations in different countries.

One population that has been studied more extensively with regard to dietary acculturation is Latino/Hispanic immigrants in the United States. A review of the literature looking at dietary acculturation of Hispanics in the United States found that, despite the existence of a number of validated tools for measuring dietary acculturation in this population, they are rarely consistently utilized, making comparison of findings between studies rather difficult (55). The authors of this study hypothesized that one of the reasons for the confusing picture of dietary acculturation is due to a heavy reliance on cross-sectional designs as well as the incapability of current assessment methods to capture the social, economic, and political environments that influence the dietary acculturation process (55). The findings from this scoping review largely echo those found by Arandia et al. (55), which are that the use of primarily cross-sectional study designs along with inconsistent assessment tools and inadequate consideration for contextual factors make it difficult to draw conclusions about the impact of dietary acculturation on the health outcomes of immigrants. This is not surprising as dietary acculturation literature from 2 decades ago also suggested that cross-sectional designs, which only collect data at 1 point in time, are inadequate to capture dietary acculturation, and prospective longitudinal research is needed in order to better understand how diets of immigrants change over time (26). Despite these recommendations, we identified only 4 (1 qualitative and 3 quantitative) studies that utilized a prospective longitudinal research designs and all of the cross-sectional studies included in this review relied on participants to recall how their diet had changed, which introduces recall bias (56).

Another limitation of the current evidence base on dietary acculturation is that most quantitative studies focused on capturing nutrient intake while failing to capture the environmental, cultural, and personal factors that may affect an immigrant's experience of dietary acculturation. Only 1 study compared diets of immigrants with those of native-born individuals to develop a Food Similarity Index comparing immigrant diets with the typical American diet (50). The advantage of this is that it helps control for diet changes that occur as part of shifting food systems within the destination country rather than because of dietary

TABLE 4 Summary of dietary acculturation measurement methods from quantitative studies of East Asian immigrants¹

Author(s), year (reference)	Tool(s)	Scoring/number of items	Validity/reliability	Strengths	Limitations
Adekunle et al., 2013 (27)	Ethnic Canadian Dietary Acculturation Scale (ECDAS)	7 items, 5-point Likert scale	$\alpha = 0.637$	This tool is not specific to Chinese diets so can be adapted for use to assess dietary acculturation of any ethnic background	This scale only included 1 item related to diet, which was "I prefer foods that are not my ethnic foods" This scale could not be used alone to comprehensively assess dietary acculturation
Almohanna et al., 2015 (29)	General questionnaire to assess eating habits, meal frequency, degree of commitment to their native diet, knowledge of nutrition, and level of physical activity FFQ 24-h diet recall Western Dietary Acculturation Scale (WDAS) (Satie et al. 2001)	65 items	General questionnaire was previously pilot tested on 35 international students; other tools not tested for reliability and validity	Serial FFQs can measure change in diet over a period of time and FFQs and 24-h dietary recalls have been shown to be reliable measures of nutrient intake	This study does not use a validated tool to measure dietary acculturation specifically
An, 2018 (31)	Chinese Dietary Acculturation Scale (CDAS) (Satie et al. 2001)	73 items 15-item binary scale (yes/no) Provides a summary score of level of Chinese and Western dietary practices	$\alpha = 0.76$ $\alpha = 0.66$	This tool has been tested for reliability and validity in multiple studies and shown good agreement with traditional measures of acculturation	This tool only captures limited aspects of dietary intake, so should ideally be used in tandem with other measures of diet, such as 24-h dietary recalls or FFQs
Chadee et al., 1996 (33)	Change in food-consumption survey developed and piloted by the authors; participants asked to rate how their consumption of rice, noodles, fish, and meats had changed since living in the USA	5-point Likert scale (1 = increased substantially, 5 = decreased substantially)	Developed and pilot-tested by Satia et al., 2001 (see below) Adapted from previously pilot-tested survey and pretested in a subsample of Japanese expatriates and corrections to the final surveys made	This tool examines some key aspects of dietary consumption and is not specific to the Japanese diet, so could be applied for use in other East Asian populations	This tool relies on respondents recalling dietary change rather than measuring change directly, which may introduce recall bias; it cannot be used to measure change in nutrient intake, only change in overall dietary patterns

(Continued)

TABLE 4 (Continued)

Author(s), year (reference)	Tool(s)	Scoring/number of items	Validity/reliability	Strengths	Limitations
Kim et al., 2007 (35)	Dietary acculturation—assessed using 24-h dietary recalls and comparing dietary pattern and diet quality of immigrants with their native counterparts	Foods were grouped into 3 categories: Korean ($n = 21$), American ($n = 23$), and common foods ($n = 26$). The frequency of Korean, American and common food consumption was calculated by summing the numbers of consumed Korean, American, and common foods during the last 24 h	Not validated	24-h dietary recalls are a reliable measure of diet and can be used for comparing group mean intake This method used 2 independent assessors to classify foods into categories	The tool only captures dietary intake changes for a limited number of foods Dietary intake was only measured over a period of 24 h, which may not reflect accurately participants' usual diet Dietary acculturation within the individual was not measured; this method assumes that individuals who have immigrated have different levels of dietary acculturation based on place of residence
Kim and Chan, 2004 (34)	Questionnaire evaluating: if dietary habits changed after immigration The types of meals consumed recently (Korean or American)	1 item, 5-point Likert scale (1 = strongly disagree, 5 = strongly agree) 1 item, 5-point Likert scale (1 = very Korean, 5 = American)	Not tested for reliability or validity	Easy tool to adapt for other countries and cultural background	Not a comprehensive measure of change in diet; this tool relies on respondents recalling dietary change rather than measuring change directly; it cannot be used to measure change in nutrient intake, only change in overall dietary patterns
Lee et al., 2015 (36)	Author-developed questionnaire on dietary behaviors and food consumption patterns: 1. Frequency of eating breakfast 2. Eating speed 3. Number of meals/day	10 items, 3- or 4-point scale; to assess dietary change, participants were asked to answer each question twice, once for while they were living in China and once for after moving to Korea	Pilot tested with 5 Chinese students and changes made	This tool captures change in dietary behaviors pre- and postmigration, which is useful for assessing dietary acculturation	This tool relies on participants' memory for determining how diet has changed postmigration; it would be more beneficial to administer this tool twice, once in their home country and again after moving

(Continued)

TABLE 4 (Continued)

Author(s), year (reference)	Tool(s)	Scoring/number of items	Validity/reliability	Strengths	Limitations
	<p>4. Frequency of meal regularity</p> <p>5. Uniformity of meal size</p> <p>6. Frequency of eating vegetables per day</p> <p>7. Frequency of eating fruits per day</p> <p>8. Frequency of eating bread or instant noodles (instead of rice) per week</p> <p>9. Frequency of fast-food consumption</p> <p>10. Frequency of late-night snack consumption</p> <p>FFQ</p> <p>General food-habits questionnaire</p>	<p>97 items; frequency of consumption (per day/week/month)</p> <p>Participants asked to report food consumption twice (for 1 y before immigration and within the past 12 mo in the United States)</p> <p>10 items</p>	<p>FFQ adapted from questionnaire that was tested for content validity and reliability</p> <p>Food-habits questionnaire pilot tested with 30 Chinese Americans</p>	<p>Serial FFQs can measure change in diet over a period of time and the tool was pilot-tested</p> <p>Participants asked consumption frequency for grain products, vegetables, fruits, animal products, dairy products, fats/sweets, and beverages before and after immigration; participants were required to use their memory to retrieve and report consumption information</p>	<p>Participants required to recall and report consumption information before immigration—potential for recall bias</p>
<p>Ly and Cason, 2003, 2004 (37, 38)</p>	<p>FFQ</p> <p>General food-habits questionnaire including:</p> <p>Number of meals per day</p> <p>Number of snacks per week</p> <p>Number of times eating out/week</p> <p>Gender of food preparer</p> <p>Monthly food expenditure, religious dietary practices, dietary supplements</p> <p>Factors influencing change in food habits</p>	<p>72 items; consumption (per day/week/year)</p> <p>Participants asked to rate consumption of each food item/answer food habits questions twice (for country of origin and since moving to the USA)</p>	<p>Author-developed and pilot tested for content validity with 5 participants</p>	<p>Assessed general food habits as well as consumption of specific foods (FFQ) to provide a better picture of overall dietary pattern changes</p>	<p>This method could not assess nutrient intake as only frequency of consumption was assessed, not portion sizes</p> <p>Self-administered, so potential for reporting bias</p> <p>Change in diet assessed by asking participants to recall consumption prior to moving, which may introduce recall bias</p>
<p>Pan et al., 1999 (41)</p>	<p>FFQ</p> <p>General food-habits questionnaire including:</p> <p>Number of meals per day</p> <p>Number of snacks per week</p> <p>Number of times eating out/week</p> <p>Gender of food preparer</p> <p>Monthly food expenditure, religious dietary practices, dietary supplements</p> <p>Factors influencing change in food habits</p>	<p>72 items; consumption (per day/week/year)</p> <p>Participants asked to rate consumption of each food item/answer food habits questions twice (for country of origin and since moving to the USA)</p>	<p>Author-developed and pilot tested for content validity with 5 participants</p>	<p>Assessed general food habits as well as consumption of specific foods (FFQ) to provide a better picture of overall dietary pattern changes</p>	<p>This method could not assess nutrient intake as only frequency of consumption was assessed, not portion sizes</p> <p>Self-administered, so potential for reporting bias</p> <p>Change in diet assessed by asking participants to recall consumption prior to moving, which may introduce recall bias</p>

(Continued)

TABLE 4 (Continued)

Author(s), year (reference)	Tool(s)	Scoring/number of items	Validity/reliability	Strengths	Limitations
Perez-Cueto et al., 2009 (42)	Author-developed questionnaire: 1. Have you made any changes to your diet since your arrival in Belgium? 2. I eat more fruits and vegetables 3. I drink less soft drinks 4. I eat less fried foods 5. I eat less sugar and confectionary 6. I consume more low-fat milk products 7. I eat less processed foods 8. I eat more fiber-rich foods Japanese and Western Food Factor Scale: an FFQ that results in a Japanese and Western factor score	8 items Binary scale (yes/no) Remaining items (2–8), 5-point Likert scale (1 = not at all, 5 = very much)	Not validated	This questionnaire can be used in participants from any cultural background and could be adapted for other countries	Dietary changes are only assessed on a very broad level; change in nutrient intake cannot be assessed This tool does not include cultural foods or eating considerations that should be considered when measuring dietary acculturation
Pierce et al., 2007 (43)	Japanese food items: fish, rice, tsukemono, tofu, soy sauce Western food items: cheese, meat, snacks, soda	9 items; consumption (servings/day) converted into a Japanese food score and a Western food score (between –2 and 2) Scores reflect the extent to which a traditional Japanese and a typical Western diet are being consumed	Convergent validity tested for food items correlating to either Western or Japanese food factors Entire tool not validated or tested for reliability	Developed using confirmatory factor analysis to ensure that the selected food items represent a traditional Japanese or Western diet Tested on 2 generations of Japanese-American immigrants and showed good convergence with traditional measures of acculturation (i.e., length of residence) Questionnaire developed based on the findings of earlier qualitative interviews in combination with previously reported questionnaires	This tool is only applicable to Japanese immigrant populations; it cannot be used in other East Asian populations The 9 food items do not account for dietary behaviors such as skipping meals or certain cooking methods and it cannot be used to determine nutrient intake This questionnaire relies on recall of previous dietary patterns to address how diet has changed after immigration, which may introduce recall bias
Rosenmöller et al., 2011 (44)	Author-developed questionnaire: 1. Has your general portion size (how much you eat in 1 meal) changed since coming to Canada?	5 items; 5-point Likert scale, (1 = much less, 5 = much more)	Not validated or tested for reliability	Questionnaire developed based on the findings of earlier qualitative interviews in combination with previously reported questionnaires	

(Continued)

TABLE 4 (Continued)

Author(s), year (reference)	Tool(s)	Scoring/number of items	Validity/reliability	Strengths	Limitations
Satia et al., 2001a, 2001b, Satia-Abouta et al., 2002 (1, 26, 46)	<p>2. How has your method of food preparation changed since coming to Canada?</p> <p>3. How have the foods you generally eat changed since coming to Canada?</p> <p>4. Has your interest in information about the food you eat, such as ingredients, nutrition information and taking note of food labels, changed since coming to Canada?</p> <p>5. How do you feel about these issues in Canada compared to your home country?</p> <p>Chinese Dietary Acculturation Scale (CDAS): In the past month, did you...?</p> <p>Eat tofu</p> <p>Eat a Chinese-style breakfast</p> <p>Balance yin/yang foods</p> <p>Eat traditionally preserved foods</p> <p>Avoid cold foods and drinks</p> <p>Western Dietary Acculturation Scale (WDAS): In the past month, did you...?</p> <p>Eat bread, rolls, or bagels</p> <p>Eat sweets, cakes, or pies for dessert</p> <p>Drink milk products</p> <p>Eat between meals</p> <p>Eat at Western fast-food restaurants</p> <p>Eat pizza or spaghetti with tomato sauce</p> <p>Eat ground beef and hamburgers</p>	<p>5 items, binary scale (yes/no)</p> <p>10 items, binary scale (yes/no)</p> <p>14 items, 3-point scale; (consumption increased, decreased, or remained the same) during the last 5 y or since immigration to North America</p> <p>A higher score reflected more healthful changes</p>	<p>Kuder-Richardson reliability coefficient = 0.55 (CDAS) and 0.72 (WDAS)</p> <p>Pilot-tested and validated</p> <p>Was the dietary change questionnaire validated?</p>	<p>This questionnaire covers a range of questions to capture change in dietary patterns and behaviors; it can also be adapted for use by different ethnic background participants</p> <p>Developed through qualitative studies (interviews and focus groups) of dietary habits of Chinese immigrant women living in North America</p> <p>Includes cultural considerations as well as food and beverage intake to develop a more comprehensive picture of dietary acculturation</p>	<p>Cannot be used to assess change in nutrient intake</p> <p>These tools were developed using data from a study with Chinese immigrant women, but no men were included in the study, so the tools may not be valid in males</p> <p>The tools are specifically for participants of Chinese descent as they include cultural dietary patterns unique to the Chinese</p>

(Continued)

TABLE 4 (Continued)

Author(s), year (reference)	Tool(s)	Scoring/number of items	Validity/reliability	Strengths	Limitations
Tseng et al., 2015 (49)	<p>Eat packaged or prepared foods (e.g., TV dinners)</p> <p>Drink carbonated beverages</p> <p>Eat any kind of cheese</p> <p>Dietary change questionnaire; subscales</p> <p>Fat-related change</p> <p>Fruit- and vegetable-related change</p> <p>Two 48-h dietary recall interviews, conducted ~2 wk apart, (baseline and at least 1 follow-up)</p> <p>Diet Quality Index—International—Moderation subscale (evaluates intake of food and nutrients that are related to chronic diseases and that may need restriction)</p> <p>Food Similarity Index; indicates how similar each individual's diet is to the diets of age-matched US-born persons</p>	<p>Multiple-pass approach to dietary recalls; mean intake over the 4 d used in analysis</p> <p>Score from 0 to 30 (higher score indicates better moderation in diet)</p>	<p>Diet Quality Index is a validated tool, but not a validated measure of dietary acculturation</p>	<p>Measuring dietary change by using multiple dietary recalls can provide a reliable measure of change in dietary intake</p>	<p>This method does not incorporate any cultural aspects of diet, which may be important to capture in order to measure dietary acculturation</p>
Van Hook et al., 2015 (50)	<p>Adapted Food Adoption Questionnaire—to assess the inclusion of and transition to Western foods</p>	<p>A score calculated based on individual dietary intake data, which is converted into ranks and used in a formula to derive a score for food similarity; higher values indicating greater food similarity</p> <p>6 items, with a score from 1 (only Chinese foods) to 5 (only Western foods)</p> <p>Score from 0 to 30 (higher score indicates more Western food adoption)</p>	<p>Face validity</p> <p>Not validated</p>	<p>This tool can be used in any ethnic group in relation to how their diet compares with the average US diet</p> <p>This tool could be adapted for use in other ethnic groups by changing the types of foods included</p>	<p>As this tool relies on US dietary recall data, it is only valid for use in the United States</p> <p>Reliability of tool not assessed</p> <p>This method does not incorporate any cultural aspects of diet which may be important to capture in order to measure dietary acculturation</p>
Wu and Smith, 2016 (52)	<p>Multiple FFQs, developed for the Chinese population in Melbourne</p>	<p>266 items; consumption measured (per day/week/month/year)</p>	<p>FFQ was validated in sample population, but has not been validated as measure of dietary acculturation</p>	<p>Measuring dietary change by using multiple FFQs can provide a reliable measure of change in dietary intake</p>	<p>FFQ was developed in 2002, and would require updating to reflect current Australian food supply if used in future research</p>

¹FFQ, food-frequency questionnaire.

acculturation of the individual immigrant (50). However, the Food Similarity Index does not account for any regional differences in home-country diet of immigrants, so cannot measure the magnitude or nature of any dietary change that has occurred. In fact, none of the studies took into consideration that participants from different regions may have varied dietary patterns to begin with. Even within the same country there can be tremendous diversity in cuisines, which might lead to different experiences and outcomes of dietary acculturation between participants from the same country of origin (57). This is a limitation of the evidence and makes it difficult to compare dietary acculturation results across participants. On this note, since the publication of some of the earlier studies in this review, China has undergone rapid nutrition transition and many traditional East Asian foods and ingredients have become more widely available in major Western cities, which may influence trends in dietary acculturation and should be considered in future assessment (15, 25). Another important contextual factor, which was absent from assessment tools in included studies, is that the reason for migration might have impacted on dietary acculturation. An immigrant who leaves his or her home voluntarily for economic or educational reasons may experience dietary acculturation very differently from those migrating as refugees. All these environmental, socioeconomic, cultural, and personal factors would likely impact on the dietary acculturation process of immigrants and would be beneficial to consider in future research.

Qualitative studies included in this review attempted to fill some of the gaps left by quantitative studies in trying to explore why diets change when immigrants move and the complex interplay between environment and personal choices in dietary acculturation. However, the majority of qualitative studies also relied on participants to recall their previous dietary habits in order to compare with current diets and describe how they have changed. Qualitative methods to explore dietary acculturation could be enhanced by collecting data at multiple time points to provide a richer picture of the dynamic nature of dietary acculturation. Longitudinal qualitative research is increasingly used in health care research to better understand how and why change happens in addition to what types of change occurs (58).

One study found that immigrants' diets changed to become more westernized for a period of time before eventually returning to a more traditional diet (32). This highlights again the need for further longitudinal and mixed-methods research to determine how immigrants' diets change postmigration and why as cross-sectional studies are inadequate for capturing the complexity and fluidity of the dietary acculturation process. Mixed-methods approaches are valuable for increasing understanding of complex, multifaceted research questions as they allow for the inclusion of both quantitative and qualitative research methods (59). Another review of dietary acculturation among Hispanics in the United States also concluded that there is a necessity to conduct qualitative research alongside cross-sectional and longitudinal research

in order to more comprehensively explore the acculturation process (55). Of the 2 mixed-methods studies included in this review, only the study by Wu and Smith (52) assessed dietary acculturation both quantitatively (Food Adoption Questionnaire) and qualitatively through focus groups. This allowed for assessment of current dietary practices (either Western or Chinese) along with understanding how and why dietary acculturation occurs (52). A better understanding of both how and why the diets of East Asian immigrants change will allow for the development of targeted interventions aimed at improving dietary intake and reducing the risk of disease for East Asian immigrants.

Current practices for the identification and management of chronic disease in countries such as Australia, Canada, and the United States may not be appropriate for East Asian immigrants who have different genetic and cultural risk factors for disease (60). East Asians are at greater risk for diabetes at a younger age and at a lower BMI than whites, so the condition may go undetected longer, leading to missed opportunities for early intervention in the disease trajectory (60, 61). Additionally, there is a need for more ethnicity-tailored approaches to diabetes management as cultural beliefs and family influences may affect the way that East Asians immigrants respond to a diagnosis of T2D and subsequent adherence to disease-management strategies (62, 63). Data on dietary acculturation are essential in tailoring advice to East Asian immigrants as they will allow for a better understanding of overall dietary patterns for this population and how to best mitigate the impact on risk for chronic diseases. Improved understanding of dietary acculturation will also allow for the development of targeted public health policies to improve the dietary habits of immigrants, lower health care costs, and save lives.

Strengths and limitations

This scoping review is the first to examine dietary acculturation measurement tools for East Asian immigrants. The use of a systematic searching strategy ensured a rigorous and replicable review process. By searching 7 electronic databases in addition to the reference lists of key articles, this review was able to capture the breadth of literature available on the topic. Including quantitative, qualitative, and mixed-methods studies in this review enabled us to identify the range of methods currently used in the literature to measure dietary acculturation in East Asian immigrant populations. Scoping reviews lend themselves well to dietary acculturation research as they are able to capture a disparate body of literature; however, the diversity of results also limited the extent of analysis possible in this review (22).

Considerations for future studies

Future studies should aim to explore the dynamic and intertwined relation between acculturation and dietary habits while also taking into consideration the many confounding factors of dietary change. One recommendation would be to utilize a systems-thinking approach in dietary acculturation studies to construct a better picture of how each of the

environmental, social, and personal variables interact and connect to impact on the whole overarching picture of how and why an immigrant undergoes dietary changes (64, 65). It is important to also capture the many environmental, personal, and sociocultural factors that influence dietary acculturation as well as the heterogeneity of immigrants themselves in order to understand this complex and dynamic phenomenon (55). For East Asian immigrants, this might include an examination of whether cultural health beliefs, such as the consumption of food for medicinal purposes, influence eating habits after migration (66, 67). This could be practically accomplished by including assessment of both knowledge and practice of specific cultural health beliefs in eating-habits questionnaires using Likert scales. Another important consideration is the assessment of ties to the East Asian community in the host country as this may influence the degree and nature of dietary acculturation (26, 66).

In terms of the measurement tools used to assess dietary acculturation, most were not tested for content validity or reliability, so it is hard to know how well they capture the concept of dietary acculturation or how they would perform if administered multiple times in the same population. Future studies would benefit from pilot testing of tools to evaluate their psychometric properties in order to enhance the rigor and validity of results or from the use of existing tools that have been validated in the relevant populations. In order to rigorously measure dietary acculturation, it is insufficient to simply conduct dietary assessments, such as food-frequency questionnaires or 24-h dietary recalls, as these methods fail to capture the cultural factors that may influence food intake. It may be necessary to develop food-frequency questionnaires specifically designed to capture dietary acculturation or to consider linking food and nutrient databases internationally for better comparison of dietary change when people move between countries. Future studies on dietary acculturation should consider incorporating both longitudinal collection of food intake as well as a measure of cultural influences on dietary intake. An important cultural consideration is that dietary acculturation often occurs at different rates for each eating occasion of the day, such that breakfast is often the first meal to change while cultural eating patterns are most strongly retained for dinner among East Asian immigrants (28, 47, 52, 66). Therefore, future studies would benefit from including meal-specific eating-habits questions to determine more nuanced changes in eating habits for East Asian immigrants.

Ideally, measurement of dietary acculturation would attempt to determine dietary intake prior to immigration or as soon as possible after immigration and to follow up new immigrants for an extended time period in order to capture long-term change. One possibility for tracking dietary acculturation in this population would be to include dietary surveys along with medical assessments during the immigration process and then following up with immigrants annually, for a period of 10 y postmigration, to determine how dietary patterns change. Alternatively, population-level

nutrition surveys could be utilized to capture changes in immigrants' diets through the addition of tailored dietary acculturation scales to national nutrition surveys as well as incorporating a wider range of cultural foods in these surveys.

In order to understand the health and social consequences of dietary acculturation for East Asian immigrants, we first need to develop more comprehensive assessment methods that consider both dietary intake (assessed at multiple time points postmigration) and sociocultural factors, such as the importance of food as medicine (67), that contribute to dietary acculturation.

Conclusions

There is still no consensus on how to best measure dietary acculturation of East Asian immigrants, leading to widely varied results in the study of dietary acculturation outcomes. Development of more comprehensive methods for measuring dietary acculturation is needed to monitor the impact of interventions or policies aimed at reducing diet-related disease risk in immigrant populations. As dietary acculturation is such a complex phenomenon, with a myriad of individual and societal influences, a mixed-methods longitudinal approach is likely the most appropriate way to measure it in East Asian immigrants.

Acknowledgments

The authors' responsibilities were as follows—SDL and NJK: conducted all abstract and full-text screening as well as data extraction; SDL, NJK, CEH, and TSTC: contributed to the design of the review and writing and revising of the manuscript; and all authors: read and approved the final manuscript.

References

1. Satia JA, Patterson RE, Kristal AR, Hislop TG, Yasui Y, Taylor VM. Development of scales to measure dietary acculturation among Chinese-Americans and Chinese-Canadians. *J Am Diet Assoc* 2001;101(5):548–53.
2. Satia JA. Dietary acculturation and the nutrition transition: an overview. *Appl Physiol Nutr Metab* 2010;35(2):219–23.
3. Delavari M, Sonderlund AL, Swinburn B, Mellor D, Renzaho A. Acculturation and obesity among migrant populations in high income countries—a systematic review. *BMC Public Health* 2013;13:458.
4. Fan W, Lee DH, Billimek J, Choi S, Wang PH. The changing landscape of diabetes prevalence among first-generation Asian immigrants in California from 2003 to 2013. *BMJ Open Diabetes Res Care* 2017; 5(1).
5. Pasupuleti SSR, Jatrana S, Richardson K. Effect of nativity and duration of residence on chronic health conditions among Asian immigrants in Australia: a longitudinal investigation 2016;48(3):322–41.
6. Wong S, Dixon L, Gilbride J, Kwan T, Stein R. Measures of acculturation are associated with cardiovascular disease risk factors, dietary intakes, and physical activity in older Chinese Americans in New York City. *J Immigrant Minority Health* 2013;15(3):560–8.
7. Yang EJ, Chung HK, Kim WY, Bianchi L, Song WO. Chronic diseases and dietary changes in relation to Korean Americans' length of residence in the United States. *J Am Diet Assoc* 2007;107(6): 942–50.

8. Misra A, Ganda OP. Migration and its impact on adiposity and type 2 diabetes. *Nutrition* 2007;23(9):696–708.
9. Jin K, Gullick J, Neubeck L, Koo F, Ding D. Acculturation is associated with higher prevalence of cardiovascular disease risk-factors among Chinese immigrants in Australia: evidence from a large population-based cohort. *Eur J Prev Cardiol* 2017;24(18):2000–8.
10. Dendup T, Feng X, Clingan S, Astell-Burt T. Environmental risk factors for developing type 2 diabetes mellitus: a systematic review. *Int J Environ Res Public Health* 2018;15(1).
11. Morland K, Wing S. The contextual effect of the local food environment on residents' diets: the Atherosclerosis Risk in Communities Study. *Am J Public Health* 2002;92(11):1761–7.
12. Sarkar C, Webster C, Gallacher J. Are exposures to ready-to-eat food environments associated with type 2 diabetes? A cross-sectional study of 347 551 UK Biobank adult participants. *Lancet Planet Health* 2018;2(10):e438–50.
13. Chan JCN, Zhang Y, Ning G. Diabetes in China: a societal solution for a personal challenge. *Lancet Diabetes Endocrinol* 2014;2(12):969–79.
14. Ma RCW, Lin X, Jia W. Causes of type 2 diabetes in China. *Lancet Diabetes Endocrinol* 2014;2(12):980–91.
15. Popkin BM. Synthesis and implications: China's nutrition transition in the context of changes across other low- and middle-income countries. *Obes Rev* 2014;15(S1):60–7.
16. Migration Policy Institute. The top sending countries of immigrants in Australia, Canada, and the United States 2011 [Internet]. Available from: <https://www.migrationpolicy.org/programs/data-hub/top-sending-countries-immigrants-australia-canada-and-united-states> (accessed 2020).
17. Radford J. Key findings about U.S. immigrants: Pew Research Center; 2019 [Internet]. Available from: <https://www.pewresearch.org/fact-tank/2019/06/17/key-findings-about-u-s-immigrants/> (accessed 2020).
18. Edmonston B. Canada's immigration trends and patterns. *Canadian Studies in Population* 2016;43(1-2):78–116.
19. Australian Bureau of Statistics. *Migration, Australia, 2017–18*. Australian Bureau of Statistics, Australian Government; 2019 [Internet]. Available from: <https://www.abs.gov.au/statistics/people/population/migration-australia/2017-18>.
20. Satia-Abouta, J, Patterson, RE, Neuhouser, ML Elder, J. Dietary acculturation: applications to nutrition research and dietetics. *J Am Diet Assoc* 2002;102:1105–18. 12171455
21. Colquhoun HL, Levac D, O'Brien KK, Straus S, Tricco AC, Perrier L, Kastner M, Moher D. Scoping reviews: time for clarity in definition, methods, and reporting. *J Clin Epidemiol* 2014;67(12):1291–4.
22. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. *Int J Soc Res Methodol* 2005;8(1):19–32.
23. Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, Moher D, Peters MDJ, Horsley T, Weeks L, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): checklist and explanation. *Ann Intern Med* 2018;169(7):467.
24. Kort M. *The handbook of East Asia*, Minneapolis (MN): Lerner Publishing Group; 2005.
25. Popkin BM, Lu B, Zhai F. Understanding the nutrition transition: measuring rapid dietary changes in transitional countries. *Public Health Nutr* 2002;5(6a):947–53.
26. Satia-Abouta J, Patterson RE, Kristal AR, Teh C, Tu S-P. Psychosocial predictors of diet and acculturation in Chinese American and Chinese Canadian women. *Ethnicity Health* 2002;7(1):21–39.
27. Adekunle B, Filson G, Sethuratnam S. Immigration and Chinese food preferences in the greater Toronto area. *Int J Consumer Stud* 2013;37(6):658–65.
28. Alakaam AA, Castellanos DC, Bodzio J, Harrison L. The factors that influence dietary habits among international students in the United States. *J Int Students* 2015;5(2):104–20.
29. Almohanna A, Conforti F, Eigel W, Barbeau W. Impact of dietary acculturation on the food habits, weight, blood pressure, and fasting blood glucose levels of international college students. *J Am Coll Health* 2015;63(5):307–14.
30. Amos S, Lordly D. Picture this: a photovoice study of international students' food experience in Canada. *Can J Diet Pract Res* 2014;75(2):59–63.
31. An Z. Diet-specific social support, dietary acculturation, and self-efficacy among Chinese living in the United States. *J Int Intercult Commun* 2018;11(2):136–53.
32. Cappellini B, Yen DAW. Little emperors in the UK: acculturation and food over time. *J Bus Res* 2013;66(8):968–74.
33. Chadee DD, Mori H, Kurihara K. An analysis of household beef consumption of Japanese expatriates in U.S.: implications for future beef consumption in Japan. *J Int Food Agribus Market* 1996;8(1):75–91.
34. Kim J, Chan MM. Acculturation and dietary habits of Korean Americans. *Br J Nutr* 2004;91(3):469–78.
35. Kim MJ, Lee SJ, Ahn Y-H, Bowen P, Lee H. Dietary acculturation and diet quality of hypertensive Korean Americans. *J Adv Nurs* 2007;58(5):436–45.
36. Lee J, Gao RR, Kim JH. Acculturation and changes in dietary behavior and anthropometric measures among Chinese international students in South Korea. *Nutr Res Pract* 2015;9(3):304–12.
37. Lv N, Cason KL. Current dietary pattern and acculturation of Chinese Americans in Pennsylvania. *Topics Clin Nutr* 2003;18(4):291–300.
38. Lv N, Cason KL. Dietary pattern change and acculturation of Chinese Americans in Pennsylvania. *J Am Diet Assoc* 2004;104(5):771–8.
39. Hartwell HJ, Edwards JSA, Brown L. Acculturation and food habits: lessons to be learned. *Br Food J* 2011;113(11):1393–405.
40. Lane G, Nisbet C, Vatanparast H. Dietary habits of newcomer children in Canada. *Public Health Nutr* 2019;22(17):3151–62.
41. Pan Y-L, Dixon Z, Himburg S, Huffman F. Asian students change their eating patterns after living in the United States. *J Am Diet Assoc* 1999;99(1):54–7.
42. Perez-Cueto F, Verbeke W, Lachat C, Remaut-De Winter AM. Changes in dietary habits following temporal migration. *Appetite* 2009;52(1):83–8.
43. Pierce BL, Austin MA, Crane PK, Retzlaff BM, Fish B, Hutter CM, Leonetti DL, Fujimoto WY. Measuring dietary acculturation in Japanese Americans with the use of confirmatory factor analysis of food-frequency data. *Am J Clin Nutr* 2007;86(2):496–503.
44. Rosenmöller DL, Gasevic D, Seidell J, Lear SA. Determinants of changes in dietary patterns among Chinese immigrants: a cross-sectional analysis. *Int J Behav Nutr Phys Act* 2011;8:42.
45. Saccone BH, Obeng CS. Food choices and eating patterns of international students in the United States: a phenomenological study. *Int Public Health J* 2015;7(4):357–61.
46. Satia JA, Patterson RE, Kristal AR, Hislop TG, Pineda M. A household food inventory for North American Chinese. *Public Health Nutr* 2001;4(2):241–7.
47. Satia JA, Patterson RE, Taylor VM, Cheney CL, Shiu-Thornton S, Chitnarong K, Kristal AR. Use of qualitative methods to study diet, acculturation, and health in Chinese-American women. *J Am Diet Assoc* 2000;100(8):934–40.
48. Sutton-Brady C, Davis T, Jung M. Perceived cultural spaces and cultural in-betweens: consumption among Korean Australians. *J Consum Behav* 2010;9(5):349–63.
49. Tseng M, Wright DJ, Fang CY. Acculturation and dietary change among Chinese immigrant women in the United States. *J Immigrant Minority Health* 2015;17(2):400–7.
50. Van Hook J, Quiros S, Frisco ML. The Food Similarity Index: a new measure of dietary acculturation based on dietary recall data. *J Immigrant Minority Health* 2015;17(2):441–9.
51. Vitale M, Doherty ST. Lifestyle and weight changes among immigrants in Canada. *Int J Migration Health Soc Care* 2018;14(4):439–54. doi: 10.1108/IJMHSC-04-2018-0023.
52. Wu B, Smith C. Acculturation and environmental factors influencing dietary behaviors and body mass index of Chinese students in the United States. *Appetite* 2016;103:324–35.

53. Yan Z, FitzPatrick K. Acculturation and health behaviors among international students: a qualitative approach. *Nurs Health Sci* 2016;18(1):58–63.
54. Zhang H, Hsu-Hage BHH, Wahlqvist ML. Longitudinal changes in nutrient intakes in the Melbourne Chinese Cohort Study. *Public Health Nutr* 2002;5(3):433–9.
55. Arandia G, Nalty C, Sharkey JR, Dean WR. Diet and acculturation among Hispanic/Latino older adults in the United States: a review of literature and recommendations. *J Nutr Gerontol Geriatr* 2012;31(1):16–37.
56. Kipnis V, Midthune D, Freedman L, Bingham S, Day NE, Riboli E, Ferrari P, Carroll RJ. Bias in dietary-report instruments and its implications for nutritional epidemiology. *Public Health Nutr* 2002;5(6a):915–23.
57. Song F, Cho MS. Geography of food consumption patterns between South and North China. *Foods* 2017;6(5):34.
58. Carduff E, Murray SA, Kendall M. Methodological developments in qualitative longitudinal research: the advantages and challenges of regular telephone contact with participants in a qualitative longitudinal interview study. *BMC Res Notes* 2015;8(1):142.
59. Tariq S, Woodman J. Using mixed methods in health research. *JRSM Short Reports* 2013;4(6).
60. Chan JCN, Malik V, Jia W, Kadowaki T, Yajnik CS, Yoon K-H, Hu FB. Diabetes in Asia: epidemiology, risk factors, and pathophysiology. *JAMA* 2009;301(20):2129–40.
61. Ma H, Wu X, Guo X, Yang J, Ma X, Lv M, Li Y. Optimal body mass index cut-off points for prediction of incident diabetes in a Chinese population. *J Diabetes* 2018;10(12):926–33.
62. Chesla CA, Chun KM, Kwan CML. Cultural and family challenges to managing type 2 diabetes in immigrant Chinese Americans. *Diabetes Care* 2009;32(10):1812.
63. Choi TST, Walker KZ, Palermo C. Culturally tailored diabetes education for Chinese patients: a qualitative case study. *J Transcult Nurs* 2017;28(3):315–23.
64. Arnold RD, Wade JP. A definition of systems thinking: a systems approach. *Procedia Computer Science* 2015;44:669–78.
65. Friel S, Pescud M, Malbon E, Lee A, Carter R, Greenfield J, Cobcroft M, Potter J, Rychetnik L, Meertens B. Using systems science to understand the determinants of inequities in healthy eating. *PLoS One* 2017;12(11):e0188872.
66. Kwok S, Mann L, Wong KP, Blum IP. Dietary habits and health beliefs of Chinese Canadians. *Can J Diet Pract Res* 2009;70(2):73–80.
67. Oktay S, Ekinci EK. Medicinal food understanding in Korean gastronomic culture. *J Ethn Food* 2019;6(1):4.