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Does Acculturation Affect the Dietary Intakes and Body Weight Status of Children of Immigrants in the U.S. and Other Developed Countries? A Systematic Review

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Abstract

Objective: This paper reviews available studies on the relationship between acculturation and obesity among children of immigrants who have at least one foreign-born parent.

Methods: A systematic review of relevant studies was undertaken using PubMed, Web of Science, and PsychInfo.

Results: The initial search identified 1,317 potentially relevant publications, of which 21 were retained after three rounds of screening. Most studies were conducted in the U.S. The majority of studies used BMI or overweight/obesity prevalence as the outcome variable, while two studies used dietary intake. Three studies used standardized acculturation scales, while most of the studies used generation, duration of residency in host country, and language as proxy measures of acculturation. The relationship between acculturation and outcomes varied between the host countries and origin countries for children of immigrants.

Conclusion: This study suggests children of immigrants with different cultural backgrounds may interact with host countries to varying degrees, ultimately influencing their diet behaviours and body weight status. Researchers are encouraged to adopt standardized acculturation scales to compare the results across countries and populations.

Keywords

acculturation; acculturation scale; immigration; children; BMI; diet

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Introduction

Childhood obesity has reached an epidemic level globally, although the prevalence of childhood obesity varies significantly across continents (de Onis et al. 2010). The highest childhood obesity rates are observed in the Americas and Europe. For example, more than one third of children aged 2 to 9 in the U.S. were overweight or obese (Ogden et al. 2014). Comparatively, developing countries have a lower prevalence of childhood obesity, but some of these countries, such as China and Brazil, have observed a dramatic increase in childhood obesity rates in recent years (Wang et al. 2002, 2012). For example, the prevalence of overweight and obesity among Chinese boys and girls has increased from 1.8% to 23.6% and 1.8% to 13.6%, respectively, from 1985–2000 (Ji 2008). Preventing and controlling the childhood obesity epidemic has become a public health priority for many countries.

While obesity is a growing health problem worldwide, it is particularly a concern for some vulnerable groups, such as immigrants. For example, newly immigrated adults from low- and middle-income countries usually demonstrate a healthier body weight status than their local counterparts. However, as they live in the host country for 10 years or longer, the risk for them to develop overweight or obesity overtakes or surpasses that for the host population (Singh et al. 2011; Volken and Ruesch 2012; Toselli 2014). Moreover, extensive literature has found that adult immigrants were more likely to develop overweight or obesity as they became more proficient in the host language and more assimilated into the host culture (Barcenas et al. 2007; Chen et al. 2012), i.e., acculturation is positively related to obesity risk among adult immigrants.

Acculturation among immigrants and the health outcomes associated with the cultural adaptation process have been studied extensively (Pérez-Escamilla and Putnik 2007; Delavari 2013). After migration, adult immigrants are exposed to the culture and social environment of the host country. As they become acculturated, their values, attitudes, and health behaviours, such as food preferences and physical activity style, may change and ultimately affect their body weight status (Pérez-Escamilla and Putnik 2007; Gerber 2012). There is growing interest in the relationship between acculturation and health status among children of immigrants. A finding of a negative acculturation effect has been prevalent, i.e., children's health deteriorates as they are more assimilated to the host culture. For example, second generation children experienced higher odds of low birth weight (Ramraj et al. 2015). Although some children of immigrants may have the initial advantage in health behaviours, the gap closes when children acculturate into the host country (Sanou et al. 2014).

Existing systematic reviews have focused on the relationship between adult immigrants' acculturation and body weight status. While the majority of the reviews found a positive relationship between acculturation to the host culture and unhealthy weight gain (Pérez-Escamilla and Putnik 2007; Delavari et al. 2013), there were inconsistent findings across studies. Many factors, including race/ethnicity, gender, socioeconomic status, and origin country, are powerful effect modifiers on the relationship between acculturation and obesity risk. For example, the positive effect that duration of residence had on Body Mass Index (BMI) among Asian, white, and black immigrants was not as dramatic as that among

Hispanic immigrants (Oza-Frank and Cunningham 2010). In a systematic review of acculturation and obesity among immigrant populations in high-income countries, Delavari et al. (2013) suggested the relationship between acculturation and obesity was more complex among women than men. A uniform positive relationship was found between higher acculturation and body mass index among men, but both positive and negative relationships were found among women.

Systematic reviews on acculturation and childhood obesity are sparse. Two recent reviews examined obesity among minority children in the US, which includes a few studies on children of immigrants (Lu et al. 2015; Dixon et al. 2012). However, these two studies did not target children of immigrants exclusively, and the scope was limited to the US. Moreover, these two reviews briefly discussed the possible impact of acculturation on childhood obesity but did not focus on this process. Since acculturation requires a time lag to have an effect on body weight status, it would have been challenging to assess the relationship between acculturation and childhood obesity given the limited time periods used in some of the studies. Therefore, a systematic review is needed to summarize the evidence from different studies across countries. A complicating factor is that acculturation may not be directly measurable in children, such as language preference, life attitude, and values. Young children (e.g., infants or toddlers) are exposed to the host culture indirectly through their parents and other caregivers. Due to these challenges, it is necessary to compare studies systematically to gain insight into acculturation and its relationship to obesity in children of immigrants.

This study aimed to review the relationship between acculturation, dietary intake, and obesity among children of immigrants who have at least one foreign-born parent. Since most studies only examine children of immigrants' body weight status in one host country, there is little knowledge about whether the relationship between acculturation and childhood obesity varies by parents' origin countries as well. Our systematic review provides comparable evidence across host and origin countries, and we develop a conceptual framework to lay out the pathway. Our results will help researchers identify new patterns of acculturation and obesity between children of different immigrant groups.

Methods

Conceptual framework

Our review is guided by the integrated acculturation theory, which recognizes the influence of two cultures in immigrants' acculturation processes, i.e., the host culture and the traditional culture from the origin countries (Berry et al. 2006; Riedel et al. 2011). We have laid out a hypothesized pathway for how these two cultures influence the body weight status of children of immigrants. The health behaviors and outcomes, such as dietary intake, in immigrant families are the result of the interaction between the cultures of both the origin and the host countries. Our contribution to the field is the hypothesis that the cultural influence from the origin countries is not static. Through media, social networking, and physical visits, immigrants and their children receive updates from the culture in their origin countries, all of which could affect their dietary intake and health behaviors in their host countries (King & Wood, 2013). To reflect this integrated acculturation perspective, we used

the prevalence of childhood obesity in the host and origin countries among children of immigrants as proxies for the “obesogenic” cultures in both countries. These prevalence rates were estimated from the literature given the country, region, and study years.

Search strategy

We conducted a comprehensive search of the PubMed, Web of Science, and PsychInfo databases. The search strategy focused on three elements: (1) Immigration status. Terms used to locate papers with this element included migrant, immigrant, culturally and linguistically diverse, and foreign-born. (2) Population. Terms used for searching included child, adolescents, youths, and childhood. (3) Nutritional status. Terms used for searching included dietary intake, nutrition, feeding, overweight, obesity, and under-nutrition.

In the initial search, these terms were simultaneously inserted in databases as a “keyword” or “topic” (in Web of Science) for articles that were published in English from January 2005 to February 2015. The process of selection included three rounds of screening. In the first round, articles were included or excluded based on their title. Articles were included if their titles had reference to children of immigrants and body weight status or diet intake or behaviours. In the second round, articles were retained or excluded after reviewing their abstracts based on the inclusion and exclusion criteria. In the third round, the full-text version of each of the remaining articles was reviewed. In each round of screening, articles were rejected if the first reviewer decided the study did not meet the inclusion criteria. If the first reviewer was not certain, the full text of the study was obtained and read by the second reviewer, who made the final decision on inclusion or exclusion of the study. All included studies were read by two reviewers.

Literature search and inclusion criteria

The literature search focused on published studies that examined the relationship between acculturation and risk of obesity. Because the acculturation process for children might be different from that for adults, as stated in the introduction, we considered four types of studies: (1) studies that address the relationship between acculturation and body weight status, including BMI, obesity/overweight prevalence, and weight change; (2) studies that examine the impact of acculturation on energy intake, dietary pattern, and feeding practices (these being the intermediate outcomes of acculturation and the most critical factors that contribute to body weight); (3) studies that use proxy measures of acculturation, such as generation of immigrants, residence duration, and language proficiency;¹ and (4) studies that measure the impact of parental acculturation on the body weight and dietary intake of children.

Studies that only examined the relationship between immigration status and body weight but did not address any dimension of acculturation were excluded. Studies with a focus on refugees or asylum seekers were excluded because the trauma of such experiences can severely affect children’s nutritional status. A complete list of the inclusion and exclusion criteria is provided in Table 1.

Comparison of study findings

Because the included studies are markedly heterogeneous in study variables and methods, a formal meta-analysis is inappropriate. We analysed the included studies according to the host and origin countries of the immigrants, different categories of outcome and exposure variables, and study designs. We grouped the relationships between body weight status and acculturation into four types: positive, negative, no significant relationship, and non-linear relationship. When there were more than two studies in one host country, we arranged them in chronological order, compared the studies, and analysed the change in the relationship between the outcome and acculturation.

Results

Studies meeting our inclusion criteria

A total of 1,317 papers were identified in the initial search; 160 of them were retained after the title review. After reading the abstracts of these 160 papers, 32 were kept. The vast majority of the rejected papers either did not address acculturation or focused only on children, immigration, overweight, or obesity rather than on the relationship between the variables. Some of the articles were rejected because they were not original, empirical research (i.e., they were reviews, meeting abstracts, book chapters, dissertations, etc.) or not written in English. Some qualitative research papers were rejected because their sample size was less than 40. The full texts of these 32 papers were acquired and read. Overall, 21 papers met the inclusion criteria. The process of selection is illustrated in Figure 2.

Study characteristics and samples

The 21 studies were published in 2005–2015; fourteen were conducted in the US, three in Australia, one in Israel, one in Canada, one in Spain, and one in Germany. Seventeen were cross-sectional studies, while three were longitudinal. A study conducted in Canada by Quon et al. (2012) used both cross-sectional and longitudinal designs.

Of the studies conducted in the US, most of the study subjects emigrated originally from Haiti, Mexico, other countries of Latin America, and Asia (e.g., Allen et al. 2007). Of the studies conducted in Australia, the study sample was from sub-Saharan Africa and Asia, New Zealand and the Pacific, the UK and Ireland, and the rest of Europe (e.g., Renzaho et al. 2009). The subjects of the Israel-based study mainly emigrated from Russia, former Soviet Union countries, Ethiopia, and East Africa (Kaufman et al. 2013). The study conducted in Germany covered immigrants mainly from Turkey, Russia, and Poland (Will et al. 2005). Immigrants in the Spanish study were mainly from Latin America and Eastern Europe (Esteban-Gonzalo et al. 2013). Therefore, these studies included a diverse immigrant population originally from a variety of countries. Four studies measured dietary intake as the outcome variables (Allen et al. 2007; Liu et al. 2012; Cheah & Van Hook 2012; Esteban-Gonzalo et al. 2013). The other studies measured BMI, weight gain, or overweight/obesity prevalence.

Measures of acculturation

Two models have been developed to understand the complex process of acculturation: unidimensional and bi-dimensional. The unidimensional model treats traditional and host cultures as two mutually exclusive cultures and describes acculturation as a process of moving from one culture to the other (Kang 2006). The bi-dimensional model assumes that the adoption of the host culture and maintaining of the traditional culture can co-exist (Berry 2006).

Both unidimensional and bi-dimensional models of acculturation were used in the selected studies. Of the studies that used the unidimensional model, seven used generation, three used parental duration of residency in host country, two used language, and five used a combination of generation, duration of residency, or language as a proxy measure of acculturation. Of the three studies that used a standardized acculturation scale, Cheah and Van Hook (2012) used a modified parent version of the Chinese Children Acculturation Scale to measure the acculturation level of Chinese and Korean parents toward American culture. Griffith et al. (2014) used the Acculturation, Habits, and Interests Multicultural Scale for Adolescents to measure the acculturation pattern of both adolescents and their parents. While the Chinese Children Acculturation Scale used by Cheah and Van Hock et al. (2012) was unidimensional and focused more on acculturation toward the host country, the Acculturation, Habits, and Interests Multicultural Scale for Adolescents measured both the assimilation to the host country and the maintenance of traditional culture and was therefore considered a bi-dimensional scale.

Measures of body weight status and dietary intakes

Body Mass Index (BMI) is the predominant measure and was adopted in nine studies. Overweight or obesity was used in 16 studies. Different standards for identifying obesity and overweight were used. The CDC standard was predominantly used in US- and Canada-based studies, where overweight was defined as a BMI at or above the 85th percentile and lower than the 95th percentile and obesity as a BMI at or above the 95th percentile based on the CDC age- and gender-specific growth chart (Kuczmarski et al. 2000). The study conducted in Germany and one study conducted in Australia used the International Obesity Task Force (IOTF) standard (Cole et al. 2000). The IOTF standard includes a set of age- and gender-specific BMI cut-off points for determining overweight and obesity among children aged 2–18. There were two studies that used the WHO standard, which determines overweight and obesity based on BMI-for-age Z-scores (WHO 2006). Six studies used dietary intake, fast food consumption, or feeding behaviours as the outcomes of acculturation. Two studies used weight gain, which only measures the positive energy balance in the absolute term, but not in the relative term (Hall et al. 2012; Fenton et al. 2013).

Empirical evidence on the relationship between acculturation and body weight status

Table 2 summarizes the included studies on the association between acculturation and obesity-related health outcomes, which significantly varies by children of immigrant populations. Due to the limited number of studies and cross-sectional design in non-US countries, we can only observe the general patterns of acculturation and body weight status among children of immigrants. Will et al. (2005) examined a population of 6-to-7-year-old

children whose parents were originally from Russia, Poland, and Turkey, which were the main immigrant ethnic groups in Germany. A positive association was observed between duration of residence and childhood overweight. A similar study conducted in Israel found a positive relationship as well among immigrants who were originally from East Europe, former Soviet Union countries, and East Africa (Kaufman et al. 2013). However, the only study in Canada found a negative association between generations of immigrants and BMI among immigrant adolescents, although the origin countries were not specified.

Three studies conducted in Australia demonstrated that the relationship between acculturation and body weight status might depend on the children's ages and the parental origin countries. Two small sample studies which examined African children of immigrants in Australia found the opposite answers. Renzaho et al. (2008) suggested that integrated or marginalized children had a higher BMI, while keeping the traditions of the origin countries among children of immigrants was associated with a lower risk of obesity. However, Griffith et al. (2014) suggested that parental integration was negatively associated with BMI, while adolescents' acculturation patterns were not significantly associated with their BMI. Notably, the target population was different in these two studies: children were 3–12 years of age in Renzaho et al. (2008), while adolescents were studied in Griffith et al. (2014). Moreover, the acculturation scale was also not the same between two studies. Renzaho et al. (2008) developed their own scale, which included language use (mother tongue vs. English), cultural identity, traditional dietary preference, integration with social groups, and participation in culture-specific events. Griffith et al. (2014) used a validated scale, the Acculturation, Habits, and Interests Multicultural Scale for Adolescents Scale, which measures friendship, music and media use, cultural celebration, food preference, and cultural identity. These differences may explain the different results between these two studies. In a separate study, Renzaho et al. (2009) used a nationally representative sample from children of immigrants and found English language use at home was negatively associated with overweight and obesity risk among children of immigrants aged 4–5 years old from Asia, New Zealand and the Pacific, and Europe. Therefore, acculturation may help reduce the obesity risk among children of certain immigrants groups in Australia.

The US studies had a stronger design than the non-US studies, having a larger number of observations (in the thousands or tens of thousands) and a longitudinal design in three studies. Therefore, these US studies provided the most credible evidence not only for understanding the association but also for understanding how acculturation may cause changes in body weight status. With these advantages, the pattern of the relationship of acculturation and body weight status in these studies is much more consistent than what is found in non-US studies, with limited variations.

Latino or Spanish-speaking populations account for the largest immigrant group in the US, which is also the focus of most US studies. The prevailing evidence suggests a positive relationship between generations of residence and dietary intake, BMI, and obesity risk (Allen et al. 2007; Singh et al. 2009; Liu et al. 2012; McCullough and Marks 2014). For example, McCullough and Marks (2014) documented the immigrant paradox by observing that second- and third-generation immigrant Latino youth had significantly higher BMI and overweight levels than first-generation youth. However, in a California study with a large

population (N = 26,630), Butternheim et al. (2013) challenged the traditional thinking of the healthy immigrant paradox and found that the health advantage of immigration did not hold for children. Rather, first generation young adult males (ages 18–24 years) and adolescent females (ages 12–17 years) had higher obesity rates than their second- or third-generation peers. Another study conducted in California found that low-income children aged 2–5 years were more likely to be obese if Hispanic mothers preferred to speak Spanish instead of English (Nobari et al. 2013). More interestingly, if the English-preferred Hispanic mothers lived in a neighbourhood with other mothers speaking the same language, children were less likely to develop obesity. The specific location of these two studies and the particular socioeconomic groups studied may limit the general interpretation of these results. Another national study did not find a significant relationship between generation level and childhood obesity (Singh et al. 2013).

Asian children of immigrants are also the focus of a few US studies. The healthy dietary intake of Asian children of immigrants and BMI had no significant relationship to generation levels (Allen et al. 2007; Cheah et al. 2012; Singh et al. 2009, 2013). In a California study, children's BMIs were lower with Chinese-speaking mothers who lived with other mothers also speaking Chinese (Nobari et al. 2013). Therefore, maintenance of Asian culture may be protective against childhood obesity. Acculturation among non-Hispanic blacks was positively associated with BMI (Strickman-Stein et al. 2010; Singh et al. 2013). The BMI percentile of Haitian-born children increased by 3.7% for each year of US residency (Strickman-Stein et al. 2010). Singh et al. (2013) used data from the 2003 and 2007 National Survey of Children's Health to test the association between acculturation and obesity among children of immigrants. The only significant relationship was found among non-Hispanic black children.

The three longitudinal studies provide evidence about the relationship between weight gain and acculturation. Van Hook and Baker (2010) found that children with immigrant parents gained more weight than any other children's group. However, within the same group, children with English-proficient parents gained more weight than those with low-English-proficiency parents. Li et al. (2011) found that speaking Spanish at home was linked with a higher risk of overweight among children at nine months of age and younger. Van Hook and Balistren (2007) argued that the relationship between acculturation and weight gain may differ due to the economic development in emigrating countries. If children's parents were originally from lower-income countries, acculturation was positively related to weight gain. However, if they were from higher-income countries, acculturation was negatively associated with weight gain. This provides a new dimension for interpreting how the traditional culture and socioeconomic status may be interactively associated with body weight status.

Acculturation and obesity prevalence in origin and host countries

Table 3 summarizes the findings based on the origin and host countries with their corresponding obesity rates across time. Since the US has a very high prevalence of childhood obesity, children of immigrants were all from countries with lower obesity rates. There was no significant relationship between acculturation and body weight status if the

children or the children's parents were originally from Asia (Allen et al. 2007; Singh et al. 2009, 2013; Cheah and Van Hook, 2012). However, Haiti had an extremely low prevalence of childhood obesity (2.8%); thus, the body weight status of children emigrating from Haiti to the US was positively associated with the acculturation process (Strickman-Stein et al. 2010). Mixed results were found among children coming from Latin America to the US (Allen et al. 2007; Sussner et al. 2009; Li et al. 2011; Liu et al. 2012; Van Hook et al. 2012; Buttenheim et al. 2013; McCullough et al. 2014). In the German and Israeli studies, when home countries had lower rates of childhood obesity than the host countries, body weight status was positively associated with acculturation (Will et al. 2005; Kaufman et al. 2013). Studies conducted in Australia and Canada presented a more negative association between acculturation and children of immigrants' body weight status. Part of the immigrant group was originally from the UK or other European countries, where childhood obesity prevalence rates were similar to those of the host countries (Renzaho et al. 2009; Quon et al. 2012). In summary, based on the existing evidence, the gap between obesity rates in origin and host countries may interact with the acculturation process to influence body weight status among children of immigrants, with the only exception being children of immigrants from Asia.

Discussion

This is the first systematic review of the scientific evidence that has emerged in the last decade on the relationship between acculturation and body weight status among children of immigrants in the US and other developed countries. Compared with the positive findings among immigrant adults (Delavari et al. 2013), the results among children of immigrants were mixed, which echoes the literature on general health outcomes and acculturation (Ro, 2014). Positive, negative, and insignificant relationships have been found across host countries and origin countries. Several factors may have contributed to these diverse patterns.

First, measuring children's acculturation process is more challenging and heterogeneous than measuring adults' acculturation. Children's exposure to the new culture in the host country will be from direct contact through their own life experience or indirect impact from their parents (Dancel et al. 2015). As distinct from immigrant adults, generation level is still an important indicator of acculturation for children of immigrants, who are commonly classified as first, first and half, and second generations (Quon et al. 2012). In our systematic review, ten out of 21 studies had used generations as one measure of acculturation in their analyses. Years of residence for immigrant parents in the host countries is an alternative measure of acculturation and was adopted by 8 studies in our review. Language proficiency was also used in 7 studies. However, the definition of language proficiency can vary by parents vs. children (Sussner et al. 2009; Renzaho et al. 2009; Van Hook and Baker 2010), language of the home country vs. language in the host country (Nobari et al. 2013; Van Hook and Baker 2010; Sussner et al. 2009), and language used at home or language used in social media (Li et al. 2011; Renzaho et al. 2008; Renzaho et al. 2009). Therefore, language proficiency has many more dimensions to be considered if it is to be used as a proxy of cultural integration in the host country among children of immigrants. In other studies, several standardized acculturation scales were used, such as the Chinese Children

Acculturation Scale (Cheah et al. 2012), African Acculturation Scale (Renzaho et al. 2008), and Acculturation, Habits, and Interests Multicultural Scale for Adolescents (Griffith et al. 2014). This suggests that there is a significant need to establish a universal standard for acculturation measurement that can be applied to children of immigrants across regions. Moreover, researchers are encouraged to adopt a standardized acculturation scale instead of using generation level or language proficiency in this line of research. The inconsistent results of the studies reviewed here may at least in part reflect the inconsistent use of acculturation measurements across those studies.

Children of immigrants can be vulnerable to the food culture in more-developed host countries, where unhealthy foods are more accessible and favoured (Swinburn et al. 2011). Among immigrant adults, nutritional transition, or transit from healthy and nutritious food to unhealthy and fatty food, is more rapidly developed with their acculturation to the more-developed host country (Popkin et al. 2012). Immigrant parents' food choices will directly influence their children's dietary intake, which means the synchronization of nutritional transition across two generations. If children of immigrant parents were born in the host countries and had limited exposure to their parents' home culture, they more readily adopt the unhealthy food culture of their country of birth (Renzaho et al. 2012). Therefore, the relative cultural exposure of children of immigrants may explain the direction of the association between acculturation, dietary intake, and their ultimately body weight status.

The host countries in this review are all in the Organization for Economic Co-operation and Development (OECD), in which the average prevalence of obesity is 18.4% (OECD 2014). The US, Mexico, New Zealand, Hungary, Australia, and Canada are the top six OECD countries with the highest obesity rates. However, our systematic review suggests the direction of the relationship between acculturation and body weight status among children may not be positively related to the obesity rates in the host countries. Although more positive relationships were found in the US, the studies in Australia and Canada indicated negative effects (Renzaho et al. 2009; Quon et al. 2012). Although Germany's and Israel's obesity rates are below the average rates in the OECD, the existing evidence in the literature suggests a positive relationship in those countries (Will et al. 2005; Kaufman et al. 2013). However, the origin country is a more consistent linkage between acculturation and children's body weight status, as discussed above. Thus, to summarize our findings: The culture of the origin country may weigh more than that of the host country in the acculturation process. It is important for policy makers in the host country to recognize this in order to adopt culturally sensitive obesity prevention programs for children of immigrants.

This review has several strengths. First, it fills an important knowledge gap in examining the relationship between acculturation and body weight status among children of immigrants across regions and time. We have emphasized that the process between acculturation and childhood obesity varied significantly depending on children's origin countries. This finding reflects a natural extension of the bi-dimensional and integrated acculturation theory (Berry et al. 2006; Riedel et al. 2011). The traditional culture in origin countries plays a role in the acculturation process and is worth more research to fully understand the relationship between acculturation and childhood obesity. This study summarizes the acculturation scales used, the direction of the relationship, and the heterogeneity of the relationship as it varies

by origin country and host country. However, we observed a limited use of multi-attribute measurement of acculturation in the field. Since the idea of acculturation stems from the perspectives of anthropology, sociology, and psychology (Rudmin 2003), more multidisciplinary research is needed to fully understand the direction of the relationship and its determinants. Another strength of this review lies in the geographic variation of the studies reviewed. Our review includes six host countries, including countries with higher than or below-average OECD obesity rates. Therefore, this study paints a more colourful picture of the interactions of cultures and the association of these with body weight status among children of immigrants. With other host countries and origin countries, we understand that the association of acculturation and body weight status is not dominantly positive, as indicated in Delavari et al. (2013).

One of the major limitations of previous studies is the lack of a consistent and multi-attribute measure of children's and parents' acculturation. Using generation levels or language proficiencies may not fully capture the complex interactions between different cultures and how these interactions may influence children's health behaviours. The varying acculturation scales lack a standard that can be useful to researchers from different disciplines. These variations limit the generalizability and the comparison of results across studies. Therefore, more research is needed to develop a standardized acculturation measure for children of immigrants so that public health researchers can apply a valid tool to examine the relationship between acculturation and childhood obesity. Finally, most of the studies in this review were cross-sectional in design, which cannot indicate causation between acculturation and body weight status among children of immigrants. The three studies with a panel design were only conducted in the US. Therefore, if a cohort of children of immigrants can be established, more longitudinal studies can shed more insight into this complex relationship.

In conclusion, research findings regarding the relationship between acculturation and children of immigrants' body weight status in developed countries are mixed. The directions of the relationship vary across the origin country and the host country. The use of a standardized measure of acculturation and the adoption of a longitudinal study design are needed in future research in order to understand the acculturation process and take advantage of this knowledge to prevent obesity among children of immigrants.

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Figure 1.
Conceptual Framework of the Association between Acculturation and Body Weight Status among Children of Immigrants.

Figure 2.
Article Selection Process

Table 1.**Study Inclusion and Exclusion Criteria.**

Study inclusion criteria:

- a) The publication is published between 2005 and 2015.
- b) The study is with children aged up to 17 years old.
- c) The publication is peer-reviewed.
- d) The publication is published in English.
- e) The immigration process is defined as moving from birth places to a foreign country or culturally different regions, such as moving from less-developed rural areas to more-developed urban areas. Children of immigrant parents are also considered as children of immigrants.
- f) Outcome variables: BMI, obesity/overweight prevalence, and weight change, energy intake, dietary intake, and feeding practice.
- g) Exposure variables: proxy and standardized measure of acculturation, parental acculturation

Study exclusion criteria:

- a) Studies on adopted children or fostered children from foreign countries.
- b) The sample size is less than 40.
- c) Studies on refugees or asylum seekers.
- d) Studies that do not address at least one domain of acculturation, such as language, cultural diversity, or social norms.
- e) Studies that do not distinguish racial/ethnic minorities and immigrants.

Table 2.

Studies on Acculturation, Dietary Intakes, and Body Weight Status among Children of Immigrants 2005–2015.

#	Outcomes	Study authors (Publication year)	Data collection year	Study design (Sample size)	Study country	Origin of immigrant	Age of participants	Acculturation dimension	Result
1	Dietary intake	Allen et al. (2007)	2000–2001	Cross-sectional (N = 5,801)	USA	Asian, Latino	12–17 years	Generation	The dietary intakes of Asian children of immigrants stayed stable across generations. The dietary intakes got poorer as Latino children of immigrants acculturated to the US ($p < .01$ for milk consumption, consumed fruit and vegetable, and amount of soda consumed).
2	Diet, BMI, Obesity/overweight (CDC)	Liu et al. (2012)	1999–2004	Cross-sectional	USA	Mexico	12–19 years	Generation, language preference	First generation adolescents consumed more fruits, vegetables, grains and meats but less sweetened beverages, whole grains, saturated fat, sodium and oil ($p < .05$). English preference was associated with higher risks of obesity ($p < .05$).
3	BMI, fast food consumption	McCullough et al. (2014)	2001	Cross-sectional (N=2,292)	USA	Latino	16–27 years	Generation	First generations had healthier BMI than second and third generations ($p < .01$) No significant association between fast-food consumption and generations.
4	Feeding practice, dietary intakes, BMI	Cheah & Van Hook et al. (2012)	2010	Cross-sectional (N = 130)	USA	Korea, China	3–9 years	Social activities engagement, language proficiency, and lifestyle	No significant association between outcome variables and parents' acculturation.
5	Dietary intake	Esteban-Gonzalo et al. (2013)	2007–2008	Cross-sectional	Spain	Latin American, Eastern Europe	13–17 years old	Length of residence in Spain(cutoff= 6 years)	Adolescent immigrants living in Spain for more than 6 years showed a similar dietary pattern to the Spanish individuals, were more likely to fulfill dietary recommendations for eggs ($p < .05$), legumes, milk/dairy products and consumed an excessive amount of sweet foods ($p < .001$), did not meet recommendations for bread and cereals ($p < .05$).Negative association was found for vegetable consumption among adolescent immigrants living in Spain less than 6 years.
6	Dietary intake, BMI, Obesity	Renzaho et al. (2008)	2001–2002	Cross-sectional (N = 337)	Australia	Sub-Saharan African	3–12 years	Language use, cultural identity, diet habit, participation in cultural events and social groups, language-based media use	Integrated and marginalized children were associated with higher BMI ($p = .019$, $p = .008$ respectively). Traditional orientation was associated with lower obesity ($p < .001$).
7	BMI	Nobari et al. (2013)*	2003–2009	Cross-sectional (N = 250,029)	USA	Hispanic, Chinese	2–5 years	Language use	Children's BMIs were lower with English-speaking mothers. Negative relationship existed between children's BMIs and the proportion of English-speaking mothers in the Hispanic neighborhood and Chinese-speaking mothers in Chinese neighborhood ($p < .001$).
8	BMI	Van Hook et al. (2012)	2002–2006	Cross-sectional (N = 9,982)	USA	Mexico	6–19 years	Generation, residency duration (cut off = 5 years)	Second generation children have higher BMI percentile and overweight prevalence than first and third generations ($p < .001$ for both).
9	BMI	Strickman-Stein et al. (2010)	2004–2006	Cross-sectional (N = 250)	USA	Haiti	2–18 years	Residency duration	Length of residence in US was positively associated with BMI percentile among Haitian-born children ($p = .001$).
10	BMI	Sussner et al. (2009)	2005–2006	Cross-sectional (N = 571)	USA	Latin-America	24 months, 36 months	Duration of stay (cut off = 8 years), language use	BMI was positively associated with mothers' exclusive use of native language at children's age of 24 months ($p = .02$).
11	Obesity	Buttenheim et al. (2013)	2006–2008	Cross-sectional (N = 26,630)	USA	Mexican-origin	4–24 years	Generation, residency duration (cut-off= 5 years)	Overall second-generation children of immigrants reported higher obesity prevalence than third-generation (OR = 1.18, $p < .05$). Among young adult males (ages 18–24), both first-generation, and second generation has higher obesity prevalence than third-generation (OR = 1.58, $p < .05$; OR = 1.72, $p < .05$).
12	BMI	Singh et al. (2009)	2003	Cross-sectional (N=46,707)	USA	Non-specific	10–17 years	Generation	Overall, first- and second-generation children of immigrants were more likely to have healthy weight compared to native children (OR = 0.74; 95% CI = 0.56, 0.98; OR = 0.84; 95% CI = 0.71, 0.99).
13	BMI	Singh et al. (2013)	2007	Cross-sectional (N = 91,642 in total; 12,539 children of immigrants)	USA	Not Specific	< 18 years	Generation	No significant association between BMI and general level for the total population. BMI was positively associated with generation level for non-Hispanic black children.
14	Weight gain	Van Hook et al. (2007)	1998–2007	Longitudinal (N = 16,664)	USA	Not specific	K-5th grade	Generation	The association between weight gain and generation varies by children's SES and the income status of the origin country. For children from lower-income countries, the association between weight gain and generation was positive among lower SES children and negative for higher SES children ($p < .05$).
15	BMI, Weight gain	Van Hook et al. (2010)	1998–2007	Longitudinal (N = 21,000)	USA	Not-specific	K-5th grade	Generation, parental English proficiency	For boys generation was negatively associated with body weight status and weight gain (first generation $b = 4.96$, $p < .001$; 1.5 generation $b = 3.14$, $p < .10$). However, for boys whose parents are raised outside of the US, parents' English proficiency was positively related to gained weight.
16	Obesity/overweight	Li et al. (2011)	2001–2005	Longitudinal (N = 9,700 at 9 months; N = 8,200 at 4 years)	USA	Not-specific	9 months, 4 years	Language spoken, duration of stay in US (cut-off = 10 years)	Speaking Spanish at home was significantly associated with higher overweight (OR = 1.35, 95% CI = 1.07, 1.70).

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#	Outcomes	Study authors (Publication year)	Data collection year	Study design (Sample size)	Study country	Origin of immigrant	Age of participants	Accultura-tion dimension	Result
17	Overweight	Will et al. (2005)	2002	Cross-sectional (N = 525)	Germany	36% Turkish; 25% Russia; and 15% Poland	6–7 years	Family duration of stay (cut-off = 10 years)	Duration of stay of the family in Germany for 30 and more years was associated with higher prevalence of overweight (OR = 1.92; 95% CI = 0.97, 3.79).
18	BMI	Quon et al. (2012)	1994–1995, 2000–2001	Cross-sectional longitudinal (N = 26,442)	Canada	Unknown	6–17 years	Generation	Second- and mixed- generations reported lower BMI than higher generations ($p < .05$). Compared to other generations, first generation was associated with more weight gain during adolescence ($p < .05$).
19	BMI, overweight/obesity (WHO)	Kaufman et al. (2013)	2008	Cross-sectional (N = 238)	Israel	Russia, former Soviet Union countries, Ethiopia and East Africa	4–7 years	Parental duration of stay in Israel (cut-off = 10 years)	Native Israeli children and children of acculturated immigrants were heavier and had higher prevalence overweight and obesity than children of new immigrants ($p = .03$, $p = .02$ respectively).
20	Overweight/Obesity	Renzaho et al. (2009)	2004	Cross-sectional (N = 4,983)	Australia	Asia, New Zealand and the Pacific, UK and Ireland, rest of Europe	4–5 years	Language use at home	English language use at home was associated with lower overweight or obesity among boys OR = 0.49; 95% CI = 0.27, 0.88; $p = .017$).
21	BMI	Griffith et al. (2014)	Not mentioned	Cross-sectional (N = 100)	Australia	Sub-Saharan African	Mean age = 15.0	Friendship, music and media, celebration, food, cultural identity (Acculturation, Habits, and Interests Multicultural Scale)	Parental integrated acculturation pattern was associated lower BMI among adolescents (b = −.17, 95% CI = −.57, −.01).

Table 3.
Prevalence of Overweight and Obesity in Host and Emigrating Countries or Areas Mentioned in Reviewed Papers.

Host society	Data collection year	Prevalence of obesity and overweight in host society	Emigrating society	Prevalence of obesity and overweight in emigrating society	Result	Studies
USA	2000–2006	28.1–30% (Fryar et al. 2014)	Latin America	6.8–6.9% (de Onis et al. 2010)	Positive association between body weight status and acculturation	Allen et al. (2007), McCullough et al. (2014)
	2003	33.6% (Fryar et al. 2014)		6.9% (de Onis et al. 2010)	No significant association	Singh et al. (2009)
	2001–2005	28.1–30% (Fryar et al. 2014)		6.8–6.9% (de Onis et al. 2010)	Negative	Li et al. (2011), Sussner et al. (2009)
	1999–2006	30–33.6% (Fryar et al. 2014)	Mexico	28% boys, 29% girls (OECD 2014)	Second generation had higher prevalence than first generation and native children	VanHook et al. (2012), Liu et al. (2012).
	2006–2008	30–31.6% (Fryar et al. 2014)			Negative, among female adolescents	Buttenheim et al. (2013)
	2004–2006	30–33.6% (Fryar et al. 2014)		2.8% (de Onis and Blossner 1997)	Positive	Strickman-Stein et al. (2010)
USA	2000–2007	28.1–33.6% (Fryar et al. 2014)	Asia	3.7%–4.2% (de Onis et al. 2010)	No significant association	Allen et al. (2007), Singh et al. (2009), Singh et al. (2013)
	2003–2009	30–33.6% (Fryar et al. 2014)	China	19.2% (Sun 2014)	No significant association	Cheah & Van Hook et al. (2011)
	2007	31.5% (Fryar et al. 2014)	Korea	21% (Lee and Park 2013)	No significant relationship	Singh et al. (2013)
Germany	1998–2007	28.1%–33.6% (Fryar et al. 2014)	Unidentified		Relationship was moderated by the income status of children and emigrating country, language proficiency of mothers	Van Hook et al. (2007, 2010)
	2002	19.8% (Apfelbacher et al. 2008)	Turkey	12.7% for girls, 12.9% for boys (Oner et al. 2004)	Positive	Will et al. (2005)
	2008	20% for girls, 24% for boys (OECD 2014)	Russia	11.1% (Popkin et al. 2006)	Positive	Kaufman et al. (2013)
Australia	2001–2004	26.7% (Australian Institute of Health and Welfare 2004)	Eastern Africa	6.7% (de Onis et al. 2010)	Integrated acculturation was negatively associated with body weight variables	Renzaho et al. (2008), Griffith et al. (2014)
			Sub-Saharan Africa	8.5% (Harvard School of Public Health 2015)	Negative, among boys	Renzaho et al. (2009)
			Asia	4.9% (de Onis et al. 2010)		
Spain	2007–2008	29.1% for children 2–15 years old (Pizarro & Royo-Bordonada 2012)	UK	25.8% (Popkin et al. 2006)	Negative, among adolescents	Esteban-Gonzalo et al. (2013)
	2000–2001	29% for boys, 27% for girls (Starky 2005)	China	11.4% (Popkin et al. 2006)		Quon et al. (2012)
			India	19.3% (Misra 2011) (data collected in 2010 in urban area)		