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A systematic review of acculturation, obesity and health behaviours among migrants to high-income countries

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Abstract

Objective: There is **extensive** evidence for weight gain among people migrating from low/**middle**-income to high-income countries, which may be due, in part, to acculturation factors. This review aimed to identify associations between acculturation and body weight among immigrants to high-income countries and identify if studies accounted for the role played by health behaviours

Methods: A **systematic** literature search using keywords was performed with three databases (Medline, PsychINFO and EMBASE). The thirty-five studies were included that utilised quantitative methodology and presented empirical findings focussed on acculturation and body weight among adult immigrants.

Findings: There was evidence presented across multiple studies for an association between acculturation (measured with standard measures or as duration of stay) and obesity. Most studies were cross sectional, which did not allow the exploration of drivers of change in health behaviours and weight gain.

Conclusion: This is the first review to examine associations between acculturation and body weight among migrants utilising both acculturation scales and proxy measures of acculturation and to examine the role of health behaviours. Evidence from this review suggests that health interventions should target first generation migrants to promote retention of their original healthy behaviours. Recent migrant groups report healthier behaviours than comparative host country populations, and therefore interventions should be promoted at the initial stages following migration to avoid uptake of unhealthy behaviours.

Introduction

According to the World Health Organisation (WHO), 65% of the World's population live in high and middle-income countries, which have high mortality rates associated with obesity-related diseases (WHO 2014). Being overweight or obese is associated with poorer health outcomes and an increased risk of some cancers, cardiovascular disease, arthritis and hypertension (Mokdad et al., 2001; Calle et al., 2003; WHO, 2014). The majority of international migration occurs from low or **middle**-income countries to a high-income country. However, there is evidence of relatively good health among most migrants, particularly among “voluntary” migrants, from low to high-income countries, and this finding is often referred to as an *immigrant health paradox*. The immigrant paradox describes how first generation ethnic minority groups, who are less acculturated, have better health-related outcomes than native born populations (Dey & Lucas, 2006; Makrides & Eschbach, 2005). Migrants to high-income countries are often in better psychological and physical health than those in their country of origin (Crimmins et al, 2007) and this is referred to as the *healthy migrant effect* (Kandula et al., 2004). However, over time, migrants are exposed to both healthy and unhealthy behaviours associated with the host country (Goel et al, 2004), influenced by the impact of environmental and contextual factors (Boyle & Norman 2009).

Acculturation refers to the psychological, behavioural, and attitudinal changes that occur when individuals and groups from different cultures come into prolonged contact with each other and whereby individuals adopt attitudes, values, customs, beliefs, and behaviours of another culture (Crespo et al 2001). Acculturation following immigration is associated with both chosen and imposed life changes that could potentially benefit, or adversely affect, physical and psychological health outcomes (Abraído-Lanza et al, 2006; Boyle & Norman, 2009). Current theories of acculturation view the process as bi-directional and one such

theory (Berry 1990, 1997) outlines four categories of acculturation that incorporate both receiving-culture acquisition and heritage-culture retention: (1) assimilation (the individual acquires the receiving culture and discards the heritage culture); (2) separation (the individual rejects the receiving culture and retains the heritage culture); (3) marginalization (the individual rejects the receiving culture and discards the heritage culture); (4) integration (biculturalism or when an individual acquires the receiving culture and retains the heritage culture) (Berry 1997; Chun et al, 2003). Berry's (1997) model takes into account both culture and stress as important factors useful in understanding migrant health behaviours. This may influence long-term health outcomes but may vary according to individual and group factors.

A greater degree of acculturation is associated with both health-reducing behaviours, such as a reduction in fruit and vegetable consumption (Neuhouser et al., 2004) and health-enhancing behaviours, including the use of preventative healthcare services (Lara et al., 2005) or increased levels of leisure-time physical activity (Crespo et al., 2000). A previous review highlighted the relationship between acculturation and obesity among migrants from low and middle-income countries to high-income countries (Delavari et al., 2013). **This paper reviewed nine studies, six of which reported a positive association between greater acculturation and higher body mass index. The authors proposed that the host culture of high income countries may promote unhealthy weight gain, partly due to rapid nutrition transition. However, the remaining three studies in the Delavari review reported that higher acculturation was associated with lower BMI, mainly among women. The authors postulated that this could be due to cultural influences on body image, female food choices and physical activity, although they did not report on health behaviours within the review. Although this was a well conducted review, it only included studies utilising acculturation scales (designed to capture different aspects of**

acculturation and enculturation in one measure). The Delavari review excluded proxy measures, which are measures that describe one component of acculturation, such as length of residence, language use or generational level. Proxy acculturation items can be useful to assess acculturation where comprehensive acculturation scales may be impractical (Cruz et al., 2008). Short proxy measures are often relatively simple and are also useful to include within larger surveys without greatly increasing participant burden. Furthermore, language spoken (during interview or at home), proportion of life lived in the host country, and generational status show high internal consistency and strong correlations with existing acculturation scales (Cruz et al., 2008). In addition, many acculturation scales have been reported to focus on specific target groups with limited cross-cultural validity of the instruments reported (Celenk and Van de Vijver, 2011). It has been suggested that proxy variables may help identify factors that mediate the acculturation process and may aid the understanding of factors that influence the individual acculturation process, whilst acculturation scales may reflect group level factors (Cabassa, 2003).

The current review updates and extends the review by Delavari and colleagues (which included literature published up to May 2011) and included studies that utilised both acculturation scales and proxy measures of acculturation. This extended review will allow identification of whether a range of acculturation factors is associated with obesity among migrants to high-income countries. Focusing on studies published since 2001 is particularly pertinent given that since 2000 the population of the UK has increased at a faster rate than any time in the previous 90 years (Migrant Watch UK, 2017) and that during the period 2000-10, the number of global migrants grew twice as fast as the previous decade (OECD-UNDESA, 2013). Due to the global recession global migration figures have since slowed

down, however, the number is still greater than seen in the 1990's. The aim of this review was to systematically review the evidence of the association between acculturation and bodyweight among migrants to high-income countries and to further explore if these studies accounted for the role played by health behaviours.

Method

This review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA; Moher et.al, 2010). A systematic search of the literature was performed utilising a keyword search of three electronic databases (Medline, PsychINFO and EMBASE). A search strategy was developed in consultation with a medical research librarian with the aim of increasing search sensitivity. The search terms were grouped into two blocks: *Block one*: acculturation*, culture*, migrant*, country of origin, ethnic*; *Block two*: obesity*, body weight, body fat, BMI, body size. The terms in each block were searched using the OR function. The results of each block of searches were then combined using the AND function. Duplicates were excluded. Titles and abstracts were read to determine the suitability of studies. Once a final list of included studies had been identified, a backward (reference) search was undertaken to ensure no relevant article had been omitted. A forward (citation) search was also then conducted. Full texts were screened for relevance according to the inclusion and exclusion criteria. Studies were included if they: (1) used a quantitative methodology; (2) were published between January 2001 to December, 2016; (3) focused on participants aged over 18 years; (4) were published in English and (5) focused on participants who had migrated from low/middle to high income countries. Studies were excluded if they were: (1) published as a conference abstract or review article; (2) were qualitative studies or (3) focused on participants aged under 18 years. For each study, the following information was obtained and recorded on a study specific datasheet: author(s),

country of study, year of publication, sample, acculturation measure, BMI measure, health behaviours and main findings.

Study Quality

All included articles underwent quality assessment using standardised quality assessment criteria for evaluating primary research papers (Kmet et al., 2011). Ten items (from the original 14 items) on the quality scale were used (e.g. are results reported in sufficient detail - including major outcomes and all mentioned secondary outcomes?). The remaining four items were excluded because they focused on intervention studies, which was not the focus of this review. Studies were assigned a score of 2 (fully met criterion), 1 (partially met criterion) or 0 (did not meet criterion). Scores were summed and divided by the number of relevant items measured. Two researchers carried out this process; some minor differences in ratings emerged and following a discussion consensus was reached. A score of greater than or equal to 1.7 was categorised as high quality, a score of 1.1 to 1.6 was categorised as moderate (medium) quality and less than 1.1 as low quality.

Results

Thirty-five studies were included in this review (Figure 1); all were rated as medium or high quality (Table 1). The sample sizes across the studies ranged from 152 to 126,796 participants. Twenty-one studies were conducted in the USA. Twenty-two studies utilised data from secondary sources. **Eight studies used acculturation scales (Ahwulia et al., 2007; Barcenas et al., 2007; Betera et al., 2003; Chen et al, 2012; Delavari et al., 2015; Isasi et al., 2015; Miller et al., 2004; Serafica et al., 2015).** **Thirty studies utilised proxy measures, of which 12 included multiple proxy measures and three included both acculturation scales and proxy measures; see Table 1).** Proxy measures included

including duration of residence (26 studies), language (seven studies), generational status (six studies), social interaction (two studies) or cultural integration (one study).

Factors Associated with Obesity

Acculturation scales

Acculturation scales were used in eight studies and included the Suinn-Lew Asian Self Identity Scale (short version: Chen et al, 2012), the American and Russian Behavioural Acculturation Scale (Miller et al., 2004), the Bidirectional Acculturation Scale for Hispanics (Barcenas et al 2007), the Vancouver Index of Acculturation (Delavari et al., 2015), the Short Acculturation Scale for Hispanics (Isasi et al., 2015); the Acculturation Scale for Filipino Americans (Serafica et al., 2015) and two researcher developed scales (Ahluwalia et al. 2007; Betera et al., 2003) . Overall there was a positive association between higher acculturation scores on the scales and greater BMI or rates of obesity reported in five of the eight studies (Barcenas et al, 2007; Betera et al., 2003; Chen et al, 2012; Miller et al, 2004; Serafica et al 2015). Only two of these five studies also examined health-related behaviours. In one study physical activity was associated with lower obesity rates among women, although this pattern was not observed among men (Barcenas et al, 2007). However, in the second study, food choice was associated with increased BMI (Chen et al 2012) although the study demonstrated that having equal preference for original country of origin foods (Asian foods) and host country foods (USA) was associated with greatest levels of obesity. Conversely, one study reported that lower acculturation scores was associated with a higher reported BMI (Ahluwalia et al., 2007), which may have been due, in part, to respondents with lower acculturation scores also reporting that they were less likely to have attempted to lose weight over the preceding 12 months) and more satisfied with their weight. Finally, one study also found

that although acculturation was not directly associated with obesity (the finding was not significant) the socioeconomic status of migrants affected whether they perceived the host environment as being conducive to health and wellness (Delavari et al., 2015). This study did not report on health behaviours.

Duration of Residence

Longer duration of residence (examined in 26 of the studies) was associated with higher rates of being overweight and obese in 17 studies (Afable et al. 2016; Albrecht et al. 2015; Ball and Kenardy 2002; Betera et al 2003; Creighton et al. 2012; Dijkshoom et al. 2008; Gele and Mbalilaki 2013; Isasi et al 2015; Kaplan et al 2004; Lindstrom and Sundquist 2005; Mcdonald and Kennedy 2005; Quesnel-Vallee et al. 2009; Park et al. 2009; Ro and Bostean 2015; Roshania et al 2008; Shah et al 2015; Ullmann et al 2013). In one of these studies the effect was only significant for women (Ro and Bostean 2015) and in one the effect was only observable for men (Quesnel-Vallee). Conversely in two studies shorter duration of residence was associated with increased risk of obesity, although neither of these studies reported health behaviours (Oakkar et al. 2015; Shi et al. 2015). One study did not report any data related to duration of residence and weight (Jonnalagadda et al. 2002) and one study reported a mixed pattern of evidence with people in the mid quartiles (14 to 32 years duration of residence) reporting the largest BMIs (Lesser et al. 2014). Five studies reported no significant association between duration of residence and weight (Iversen et al 2013; Miller et al 2004; Nguyen et al 2015; Raberg et al 2010; Tran et al. 2013). Nguyen and colleagues reported no association between obesity and length of residency in foreign born Asian participants residing in California when analysed as a homogenous group but further exploratory subgroup analysis revealed that participants who were Filipino born were more likely

to be obese with longer residency. Greater acculturation and longer duration of residence was associated with more self-reported dietary change (Chen et al, 2012; Lin et al., 2003; Lesser et al., 2014; Roshania et al., 2008). In addition, it was reported that although South Asian migrants in Canada increased their consumption of fruit and vegetables they also increased their consumption of convenience foods, sugary drinks and red meat (Lesser et al., 2014).

Six studies looked at the relationship between generational status and obesity. Although first generation migrants were observed to have increased obesity rates with longer duration of residence (Park et al, 2009; Bennet et al., 2007) and compared to the host population (Hauck et al. 2011) it was apparent that second generation migrants were observed to have higher obesity rates or a higher recorded body mass index (BMI) than first generation migrants (Creighton et al. 2012; Hauck et al., 2011; Smith et al, 2011; Ullmann et al 2013). However, there appeared to be a plateau effect as second generation migrants were also observed to have greater BMI than third generation migrants (Bennet et al 2007). Within these studies three examined the role of health behaviours and reported that low levels of physical activity was associated with greater body weight (Smith et al. 2011; Hauck et al. 2011) as was a greater number of unhealthy dietary behaviours, which were observed among second, rather than first generation migrants (Creighton et al. 2012). Second generational migrants were more likely to adopt unhealthy behaviours such as smoking tobacco, consuming alcohol, snack foods and sweet foods, as well as reporting lower levels of physical activity (Creighton et al. 2012; Smith et al 2011).

Culture and language

Seven studies examined the association between not speaking the host country's language fluently and rates of obesity, however three of these studies did not report any findings relating to this relationship (Creighton et al. 2012; Lin et al. 2003; Ro and Bostean 2015). The remaining studies all reported that better host (English) language skills were associated with lower obesity rates (Bennet et al 2007; Nguyen et al., 2015; Miller et al. 2004; Shi et al 2015). One study examined cultural orientation and found no association between scores on this measure and obesity (Dijkshoorn et al. 2008). Finally, one study reported greater social acculturation (tendency to mix with people outside of your ethnic group) was associated with greater risk of obesity (Creighton et al 2012), whereas a second study examining social interaction found no association with obesity (Tran et al. 2013).

Discussion

This review aimed to identify acculturation factors associated with migrant obesity as measured with both acculturation scales and proxy measures of acculturation. **Thirty-five studies met the criteria for this review; these studies were predominantly undertaken in the USA, Canada, Australia and the UK. This review has shown that acculturation (whether determined using acculturation scales or proxy measures) is associated with weight gain amongst migrants in most studies.**

Most of the studies that utilised acculturation scales reported similar findings. They reported a positive association between acculturation and weight gain (Barcenas et al, 2007; Betera et al., 2003; Chen et al, 2012; Miller et al, 2004; Serafica et al 2015, concluding that the more acculturated people were the higher the BMI. Longer duration

of residence was associated with greater likelihood of being overweight or obese. **However, there was inconsistencies in findings according to gender suggesting a more complex relationship than is often accounted for in the literature.** It has been suggested previously that acculturation measures, whether acculturation scales or proxy measures, may not adequately capture individual differences and experiences of the acculturation process (Creighton et al, 2012). However, current literature and measures are not exhaustive and lack a detailed focus on the role of extraneous and social sources (including the media, family units, wider social networks) and the role of neighbourhood or work-related influences. For example, preliminary research examining the role of social (friend) networks in the adoption of obesity related behaviours among adolescents in Australia highlighted that same-sex peers are important determinants of many health behaviours, including physical activity, sun-safe behaviours and consumption of high-calorie foods (De la Haye 2010), highlighting the need to account for factors, such a social norms, when examining changes in obesity related behaviours among migrant populations.

Few studies directly examined the relationship between acculturation (in it various definitions) and specific health behaviours or controlled for specific behavioural variables in determining the relationship between acculturation and weight gain (Creighton et al. 2012; Lesser et al., 2014; Roshania et al., 2008). The health-related behaviours that were identified through this review (eating high calorie foods, low levels of physical activity) are well established as being associated with weight gain. Furthermore, studies in this review highlighted that migrants developed food consumption patterns that were reported to be similar to those observed amongst the host population. In line with this, the operant model of acculturation posits that health behaviours that are highly prevalent among traditional minorities would decrease with acculturation and thereby have a lower prevalence among

acculturated cohorts. The model predicts that a high consumption of fruits and vegetables recorded amongst culturally traditional minority groups would likely decrease with greater duration of residence (Kaplan et al, 2002; Landrine & Klonoff, 2004), as was observed in this review.

Differences in country of origin could be attributed to epidemiological transition (mortality and morbidity trend from infectious to degenerative and manmade diseases) (Frenk et al, 1991), for example Mexico is undergoing an epidemiological transition similar to developed countries, with more inhabitants being urbanised and living a less active lifestyle and relying on cheaper high calorie foods (Rivera et al, 2001). Migrant obesity rates may also be attributable to nutritional transition (Delavari et al, 2013) which happens in the host countries whereby migrants from low income countries locate from agrarian societies (who consume fresh foods and undertake regular physical activity) to an environment where they have easier access to processed goods and fewer opportunities to undertake daily physical activity. For example, within the USA, Latino migrant populations reported a higher consumption of fast foods and consumed inexpensive convenient foods that had high calories (Perez-Escamilla, 2010). It is proposed that the rate of transition is quicker in a migrant population than an already settled population, which accounts for the greater changes in body weight. However, an alternative explanation is that economic rather than cultural drivers influence food choices and associated obesity rates, with migrant populations purchasing low cost, readily available high calorie foods. Income inequalities have been proposed to influence obesity rates (Pickett et al, 2005), although it may be that lower socioeconomic status acts as a stressor encouraging the uptake of unhealthy behaviours as a maladaptive coping strategy. The adoption of unhealthy behaviours could also be attributed to acculturative stress (Caplan, 2007), which is the psychological impact of adaptation to a new culture whereby an

individual may be exposed to a range of short and long-term significant stressors.

Acculturative stress emphasises the process of acculturation as stressful, whereby migrants are likely to exhibit maladaptive behaviours due to stressors such as low socioeconomic status and perceived or actual discrimination (Anderson 1991).

Further research is needed to examine the role of the socioeconomic status of migrants and the role of cost, convenience or pragmatic concerns (e.g. how to prepare novel foods) in decisions around food choices. Furthermore, macro-level forces, such as low cost, high calorie foods (and the aggressive marketing of these), transport and neighbourhood factors may be significant drivers in the global increase in obesity that operates over and above those changes observed by acculturation factors.

There were a number of limitations across the included studies. Some studies relied on self-reported height and weight data to calculate body mass index, which is known to be associated with misreporting and an underestimation of obesity (Gosse 2014). Furthermore, ethnicities that are more appreciative of a heavier body weight might misreport their weight, resulting in unreported obesity. Identifying this potential for under-estimation may highlight a lack of obesity risk awareness amongst individuals. Most studies did not examine the BMI of migrants in their home countries before they migrated, to ascertain if these participants were classified as obese on arrival in the host country or if the weight gain was as a result of changes in behaviour following arrival in the host country. Most studies were cross-sectional, thereby precluding the exploration of changes in migrant weight and health behaviours over time. Furthermore, the studies did not allow exploration across populations or examine the various drivers that affect changes in health behaviours and ultimately changes in weight over time.

The findings of this review have important implications for the development of culturally appropriate health-psychology led interventions to support the health of increasingly diverse populations. It is important to highlight the role played by acculturation on the health of people migrating from middle or low-income countries to high income countries. Evidence shows that acculturation could either enhance healthy behaviours or act as a barrier to the engagement of healthy behaviours. Evidence from this review suggests that health interventions should target early migrants (first generation) to promote retention of their original healthy behaviours. Recent migrant groups report healthier behaviours than comparative host country populations, and therefore interventions should be promoted at the initial stages following migration to avoid uptake of unhealthy behaviours. Tovar et. al, (2014) found that health interventions rarely account for specific acculturation factors (language, country of origin, length of stay) that are associated with obesity. Furthermore, interventions with a community based approach (Cullen et. al, 2009; Schwartz et. al, 2013; Ziebarth et. al, 2012) have been shown to be effective because such interventions target factors of direct relevance to specific populations (are culturally sensitive) and utilise community resources with the potential to lead to increased uptake and lower attrition rates (Israel et. al, 1998).

The process of acculturation has the capacity to be either protective, or detrimental, to health outcomes through the promotion of either positive or negative health behaviours. Future research is needed to explore what it is about the acculturation process that leads to adoption of unhealthy behaviours. Findings could help target interventions to promote positive health behaviours amongst migrant populations and to improve health outcomes through culturally

sensitive interventions to encourage the retention of existing, or the adoption of novel, healthy behaviours.

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Table 1: Acculturation factors associated with obesity or overweight among migrants

Study	Study Design	Measure of Acculturation	Sample size/ Country of origin	Measure of BMI / body size	Associations with weight				Quality
					Acculturation scale	Duration of residence/ generational status	Culture and language	Health related behaviours / weight	
Afable et al. (USA)	Cross sectional	Duration of residence	1,213 Philippines	Clinician measured	-	Longer duration of residence (15 years) associated with higher BMI (OR = 1.7; 95% CI 1.1 to 2.5)	-	Not examined	Med
Ahluwalia et al. (USA)	Secondary Analysis [National Health and Nutrition Examination Survey]	Acculturation scale (researcher developed – focused on language)	1,301 Mexico	Researcher Measured	Lower acculturation score less likely to have a high (≥ 30) BMI (24% vs 32%)	-	-	Lower acculturation score less likely to have attempted to lose weight in last year (OR 0.49; 95% CI 0.31 to 0.79)	High
Albrecht et al. (USA)	Secondary analysis [Multi-Ethnic Study of Atherosclerosis]	Duration of residence	877 Hispanic countries (not detailed) 689 China	Researcher Measured (waist circumference)	-	<15 years duration had greater annual increases in waist circumference than immigrants with duration >30 years (mean difference 0.19; SE 0.09; $p < 0.05$)	-	More walkable neighbourhoods associated with slower increases in waist circumference over time among Chinese sample only (change in cm 0.5; SD 6.4; $p < 0.05$)	High
Ball & Kenardy (Australia)	Secondary Analysis [Women's Health Australia Project]	Duration of residence	14,779 various countries of origin	Self –reported	-	Longer duration of residence associated with higher BMI ($F = 56.8$, $p < 0.05$)	-	Women migrating after 1991 were 36% less likely to have dieted in the past year than host population ($p < 0.01$)	Med
Barcenas et al. (USA)	Cross-sectional	Acculturation scale (Bi-dimensional Acculturation scale BAS)	7,503 Mexico	Self –reported	Greater acculturation scores more likely to be obese than those who were less acculturated 46% vs 43% ($p < 0.001$) OR 1.43 (95% CI 1.11 to 1.84)	-	-	High degree of physical activity associated with less likelihood of obesity among women only (men n.s.) (prevalence OR 0.67; 95% CI, 0.59 to 0.77).	High
Bennet et al. (USA)	Secondary analysis [Healthy Directions-Health Centres Study]	Language; generational status	551 Africa; America– non-Hispanic countries	Self –reported	-	2 nd generation more likely to be obese than 3 rd generation (OR = 0.54; 95% CI, 0.37 to 0.80)	Low to moderate language acculturation more likely to be obese (OR = 0.45; 95% CI 0.23 to 0.88)	Not examined	High

Study	Study Design	Measure of Acculturation	Sample size/ Country of origin	Measure of BMI / body size	Associations with weight				Quality
					Acculturation scale	Duration of residence/ generational status	Culture and language	Health related behaviours / weight	
Betera et al. (USA)	Cross-sectional	Acculturation scale (researcher developed); duration of residence	1,205 El Salvador	Self-reported	High acculturation associated with obesity in regression model R ² =45%	Number of years in the US predictor of overweight among 20-29 year olds (t=2.2*, p<0.01); 30-39 year olds (t=4.4; p<0.001) and ≥ 40 years (t=6.9; p<0.001).	Preference for Spanish media associated with overweight among 20-29 year olds (t=3.2; p<0.001)	Not examined	Med
Chen et al. (USA)	Cross-sectional	Short version of Suinn-Lew Asian Self-Identity Acculturation Scale (SL-ASIA)	847 China, Korea and Vietnam	Researcher Measured	Higher score associated with increased BMI (b = 0.71, SE = 0.28)	-	Self-identified as Americans (b = 1.51, SE = 0.77) associated with increased BMI.	Equal preference of Asian/American food in restaurants associated with increased BMI (b = 0.92, SE = 0.28)	High
Creighton et al. (USA)	Secondary analysis (Los Angeles Family and Neighbourhood Survey)	Language; duration of residence; social acculturation	1,610 Mexico	Researcher measured or self-reported	-	Longer duration of residence associated with obesity. Highest prevalence of obesity among 2 nd generation Mexican (OR 2.1; p<0.001) and Black immigrants (OR 2.3; p<0.001)	Great social acculturation associated with greater risk of obesity (OR 1.36).	Unhealthy dietary behaviours more common among with native born Mexicans -0.464(p<0.01) and black Americans - 0.611(p<0.001) than the 1 st generation migrants	High
Delavari et al. (Australia)	Cross sectional	Vancouver Index of Acculturation	152 Iran	Researcher measured	No association between pattern of acculturation and weight	-	-	n.s.	Med
Dijkshoorn et al. (Netherlands)	Cross sectional	Duration of residence; cultural orientation	1,384 Turkey; Morocco	Self-reported	-	Longer duration of residence associated with obesity among men (OR 2.46; 95%CI 1.20 to 5.04) and women (OR 9.32; 95%CI 1.18 to 73.4)	n.s.	Not examined	Med
Gele & Mbalilaki (Norway)	Cross sectional	Duration of residence	208 Somalia	Researcher Measured	-	Longer duration of residence (≥ 14 years) associated with general and abdominal obesity OR 7.16; 95% CI: 2.14 to 23.8	-	Physical inactivity associated with general and abdominal obesity OR 2.19; 95% CI: 1.06 to 4.49)	Med

Study	Study Design	Measure of Acculturation	Sample size/ Country of origin	Measure of BMI / body size	Associations with weight				Quality
					Acculturation scale	Duration of residence/ generational status	Culture and language	Health related behaviours / weight	
Hauck et al. (Australia)	Secondary analysis [Victoria Population Health Survey]	Generational status	15,783 Various countries of origin	Self-reported	-	1 st generation South European have higher BMI (coef 1.06, SE 0.22) than native Australians and South (coef -1.40, SE 0.36) and East Asian (coef -2.51, SE 0.24) migrants have lower BMI. Differences not apparent with 2 nd generation migrants	-	Walking < 10 minutes per week associated with greater body weight (coef across groups between 0.49 and 0.55)	High
Isasi et al.(USA)	Secondary analysis [Hispanic Community Health Study]	Short Acculturation Scale for Hispanics; duration of residence	16,415 Various countries of origin	Researcher measured	n.s.	Longer duration associated with moderate (OR 1.5, 95% CI 1.1 -1.9) or extreme obesity (OR 2.2, 95% CI 1.4 to 3.5)	-	Eating Hispanic and American foods in equal amounts more likely to have extreme obesity than eating more Hispanic food (OR 1.45, 95% CI 1.04 to 2.02).	High
Iversen et al. (Norway)	Secondary analysis [Oslo Health Study; Oslo Migrant Health Study]	Duration of residence, language skills	14,208 Turkey, Sri Lanka, Iran, Pakistan, Vietnam	Researcher measured	-	n.s.	Smaller increase in BMI with better language skills among Turkish women (r=-0.70, p<005)	Not examined	High
Jonnalagadda & Diwan (USA)	Cross sectional	Duration of residence	236 India	Self-reported	-	n.r.	-	BMI associated with physical activity (r=-0.24, p<0.05) and total fat intake ((r=0.27, p<0.05)	High
Kaplan et al. (USA)	Secondary analysis [National Health Interview Survey]	Duration of residence	2,420 Various countries of origins	Self-reported	-	Longer duration of residence (> 15 years) associated with greater risk of obesity (OR 4.3; 95% CI 2.39 to 7.78)	-	Controlled for smoking and physical activity	High
Lesser et al. (Canada)	Secondary analysis [Multi-Cultural Community Health Assessment Trial]	Duration of residence	207 Bangladesh, India, Nepal, Pakistan, Sri Lanka	Researcher measured	-	Mixed pattern of evidence with BMI – 2 nd quartile (14 to 21 years) higher BMI than 3 rd quartile (21 to 32 years)	-	Duration of residence was associated with increased stir fry/BBQ (r= 0.201, p <0.05), baking/grilling (r = 0.302, p < 0.001), microwaving (r=	Med

Study	Study Design	Measure of Acculturation	Sample size/ Country of origin	Measure of BMI / body size	Associations with weight				Quality
					Acculturation scale	Duration of residence/ generational status	Culture and language	Health related behaviours / weight	
Lin et al. (USA)	Secondary analysis [Massachusetts Hispanic Elderly Study]	Language	582 Puerto Rica; Dominican Republic	Researcher measured	-	-	n.r.	0.181, p<0.05) and consumption of red meat (r = 0.201, p<0.05)	Med
Lindstrom & Sundquist (Sweden)	Cross sectional	Duration of residence	3,788 Various countries of origin	Self –reported	-	Longer duration of residence associated with greater risk of obesity in men (OR 2.5; 95% CI 1.04 to 6.1) and women (OR 5.5; 95% CI 1.4 to 22.1)	-	Not examined	High
Mcdonald & Kennedy (Canada)	Secondary analysis [National Population Health Survey; Canadian Community Health Survey; Canadian Census]	Duration of residence	126,796 Various countries of origin	Self –reported	-	Migrant women 7% less likely to obese on arrival and obesity rates converge to same as host population after 20 to 30 years.	-	Not examined	Med
Miller et al. (USA)	Longitudinal	American and Russian Behavioural Acculturation Scale; duration of residence	218 Russia	Researcher measured	Higher Russian behavioural acculturation score (maintaining home culture and language) associated with higher BMI (r= 0.252, p< 0.001)	n.s.	Need to maintain original culture associated with greater BMI and waist circumference (beta=-.15,p<.05) (r ² =.25,p<.01)	Maintaining original dietary culture was a risk factor for obesity (statistics n.r.)	High
Nguyen et al. (USA)	Secondary analysis [California Health Survey]	Duration of residence; language	2,871 (defined as Asian – various country of origin)	Self –reported	-	n.s.	English proficiency associated with lower obesity rates (r= -0.089, df= 2585, p< 0.001)	Not examined	High
Oakkar et.al.	Secondary	Duration of	7,073	Clinician	-	Shorter duration of	-	Not examined	High

Study	Study Design	Measure of Acculturation	Sample size/ Country of origin	Measure of BMI / body size	Associations with weight				Quality
					Acculturation scale	Duration of residence/ generational status	Culture and language	Health related behaviours / weight	
(USA)	analysis [California Men's Health Study]	residence /generational status	China; Japan; Philippines; Korea; Vietnam	measured		residence (OR 0.64, 95% CI 0.51 to 0.80) 1 st generation less likely to be overweight than 3 rd generation (OR 0.50; 95% CI 0.44 to 0.57)			
Park et al. (USA)	Secondary Analysis [National Health Interview Surveys]	Duration of residence (in 5 year blocks)	26,521 Various countries of origin	Self –reported	-	Longer duration of residence the greater the obesity prevalence rates (11.2% among those resident for 0-4 years to 22.3% among those resident for 10 -14 years; p<0.05)	-	Not examined	High
Quesnel-Vallee et al. (Canada)	Secondary analysis [National Population Health Survey]	Duration of residence	5,464 Various countries of origin	Self –reported	-	Longer duration of residence associated with greater BMI in men (mean change in BMI each year 0.03, 95% CI 0.00 to 0.07)	-	Regular physical activity was associated with lower BMI than infrequent physical activity among females (adjusted estimate - 0.22; 95% CI -0.32 to -0.12)	High
Raberg et al. (Norway)	Cross sectional	Duration of residence	629 Pakistan; Sri Lanka	Researcher measured	-	n.s.	-	Lower BMI associated with eating more hot meals (adjusted β - 0.54; 95% CI -0.99 to -0.10, p< 0.05)	High
Ro & Bostean (USA)	Secondary analysis [National Latino and Asian American Survey]	Duration of residence; language	2,782 Various countries of origin	Self –reported	-	n.s. for men Longer duration of residence associated with greater BMI among women (B=0.65, p<0.05)	n.r.	-	High

Study	Study Design	Measure of Acculturation	Sample size/ Country of origin	Measure of BMI / body size	Associations with weight				Quality
					Acculturation scale	Duration of residence/ generational status	Culture and language	Health related behaviours / weight	
Roshania et.al. (USA)	Secondary Analysis [New Migrant Survey]	Duration of residence	6,421 Various countries of origin	Self-reported	-	Longer duration of residence (<1 year vs ≥ 15 years) associated with greater likelihood of being overweight/obese (OR = 10.96, 95% CI 5.33 to 22.56, p<0.001).	-	Higher dietary change associated with overweight/obesity (OR 1.32, 95% CI 1.13 to 1.53, p<0.01) Length of stay associated with greater dietary change (less 1 year (22.2%) vs 37.6% at >15 years)	High
Serafica et al. (USA)	Cross sectional	Acculturation Scale for Filipino Americans	108 Philippines	Researcher measured	Greater acculturation associated with higher BMI (t=2.87, p<0.01)	-	-	-	Med
Shah et al. (United Arab Emirates)	Cross sectional	Duration of residence	1,375 India, Pakistan, Bangladesh	Researcher measured	-	Longer duration of residence associated with central obesity (6 to 10 years duration: AOR 1.63 95% CI 1.13 to 2.35, p<0.008; >10 years duration AOR 1.95 95% CI 1.26 to 3.01, p<0.002; respectively) Shorter duration of residence (<5 years) associated with greater likelihood of obesity (OR 1.843; 95% CI 1.45 to 2.34)	-	n.s.	Med
Shi et al (USA)	Secondary Analysis [Los Angeles County Health Survey]	Language; duration of residence	15,471 Various countries of origin	Self-reported	-	Shorter duration of residence (<5 years) associated with greater likelihood of obesity (OR 1.843; 95% CI 1.45 to 2.34)	Speaking English at home associated with lower likelihood of obesity (OR =0.674; 95% CI 0.514 to 0.882)	n.r.	Med
Smith et al. (England)	Secondary analysis [Health Survey for England]	Generational status	9,494 Various countries of origin	Researcher measured	-	Second generation Indian (OR 1.76; 95% CI 1.14 to 2.71) or Chinese (OR 3.65; 95% CI 1.37 to 9.78) more likely to be obese	-	Adjusting for poor dietary factors and low physical activity associated with a small increase in odds of obesity (n.s.). Alcohol intake associated with a reduced risk of obesity across all most groups (n.s.).	High

Study	Study Design	Measure of Acculturation	Sample size/ Country of origin	Measure of BMI / body size	Associations with weight				Quality
					Acculturation scale	Duration of residence/ generational status	Culture and language	Health related behaviours / weight	
Tran et al. (Australia)	Secondary analysis [45 and Up]	Duration of residence, social interaction	797 Vietnam	Self-reported	-	n.s.	n.s.	n.r.	Med
Ullmann et. al. (USA)	Secondary analysis [Los Angeles Family and Neighbourhood Survey]	Duration of residence; generational status	975 Various countries of origin	Self-reported	-	Longer duration of residence associated with weight gain (mean at baseline 74.6 kg to 76.4kg at follow-up; p<0.05) Being 2 nd generation Hispanic was a predictor of weight gain (est coef 0.30; 95% CI 0.08 to 0.51; p < 0.01)	-	Not examined	High

AOR - adjusted odds ratio; CI – confidence interval; OR- odds ratio; n.s. – not significant; n.r. – not reported

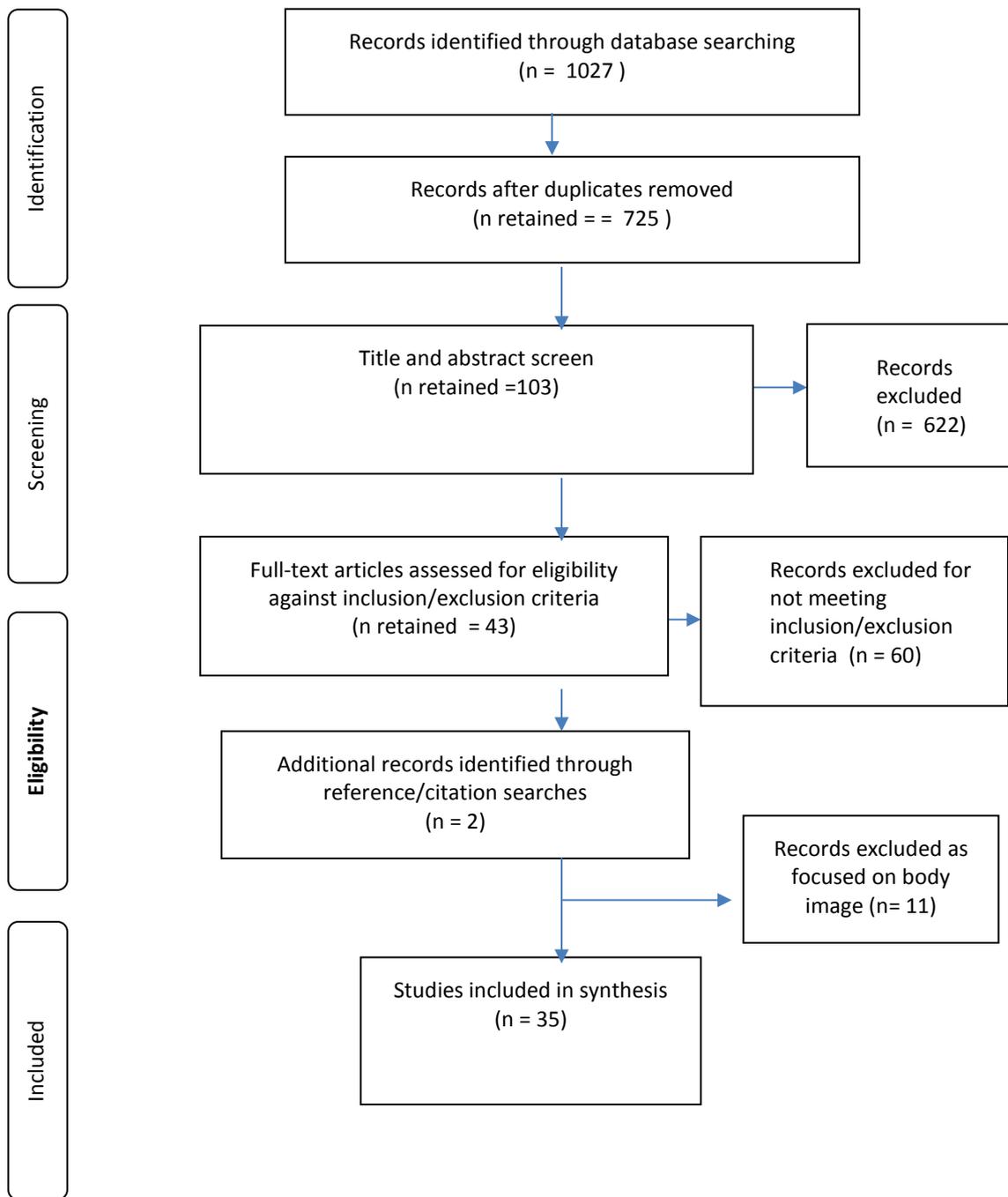


Figure 1: Process of study selection