Migrant Networks and Pathways to Child Obesity in Mexico

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Abstract:

The purpose of this research is twofold: 1) to assess the link between migrant networks and becoming overweight or obese and 2) to explore the pathways by which migrant networks may contribute to the increasing overweight and obese population of children in Mexico. Using two waves of the Mexican Family Life Survey (MxFLS), we find that children and adolescents (ages 3 to 15) living in households with migrant networks are at an increased risk of becoming overweight or obese over the period of observation relative to their peers with no migrant networks. Sedentary behavior and household-level measures of economic wellbeing explain some of the association between networks and changes in weight status, but the role of extended networks remains significant. Community-level characteristics related to migration do not account for any of the observed relationship between household-level networks and becoming overweight or obese.

In Mexico, high body mass index (BMI) emerged as a leading risk factor in adult mortality accounting for an estimated 9.9% of male deaths and 15.1% of female deaths (12.2% for both sexes) in 2004 (Stevens, Dias, Thomas, Rivera, Carvalho, Barquera et al., 2008). Of the population between ages 20 and 60, approximately 41% are overweight (25<BMI<30) and 29% obese (BMI≥30) in 2005 (Parker, Rubalcava, & Teruel, 2005). The trend is striking: with only 9.4% of the adult female population (18-49) obese in 1988, the prevalence had more than doubled (24.4%) by 1999 (Rivera, Barquera, Campirano, Campos, Safdie, & Tovar, 2002). The government has taken notice, suggesting that elevated BMI is one of the largest contributing risk factors to premature death, closely linked to diabetes and cardiovascular disease (Secretaria de Salud 2004).

Mexico is not alone. Its neighbor to the north experienced a relatively less recent and somewhat more severe increase in its obese population. For the U.S. adult population older than 20, the prevalence of obesity increased from 11% (males) and 16% (females) in 1960 to 28% and 34% by 2000 (Hedley, Ogden, Johnson, Carroll, Curtin, & Flegal, 2004). One of the fastest growing populations in terms of obesity is descendents of Mexican migrants (Guzman, 2001). Most research finds that obesity is associated with length of residency in the U.S. (Dey & Lucas, 2006; Kaplan, Huguet, Newsom, & McFarland, 2004). Similarly, the second generation is more likely to be overweight or obese than the first generation (Bates, Acevedo-Garcia, Alegría, & Krieger, 2008; Gordon-Larson, Harris, Ward, & Popkin, 2003; Popkin & Udry, 1998). These patterns have been attributed to a process of acculturation that leads to the adoption of a less healthy diet and fewer physical leisure-time activities (Himmelgreen, Pérez-Escamilla, Martinez, Bretnall, Eells, Peng et al., 2004; Kaplan et al., 2004; Khan, Sobal, & Martorell, 1997).

These observed changes in the U.S. and Mexico are of mutual concern. In the latter part of the 20th century, Mexico emerged as the largest migrant-sending country to the United States (Durand, Massey, & Zenteno, 2001; Massey, Durand, & Malone, 2002), resulting in extensive networks that link individuals and families, initiating pathways of economic exchange (Durand, Kandel, Parrado, & Massey, 1996a; Durand, Parrado, & Massey, 1996b; Massey & Parrado, 1998). Qualitative work suggests that migrant networks transmit more than just material goods, defining a concept of cultural diffusion termed "social remittances" (Levitt, 1998), where ideas and norms are passed from receiving to sending communities. Although we know U.S.-Mexico migrant networks work both ways, with information and resources flowing north and south, little attention has been paid to whether increases in the obese/overweight population in Mexico are more likely in contexts where network ties to the U.S. are stronger. In the U.S., research suggests that social networks play an important role in obesity (Christakis & Fowler, 2007). The question then becomes, if changes in BMI are related to the duration of residence and social networks within the U.S., does this also characterize the experience of individuals exposed to the U.S. via migrant networks?

This question underlies our research strategy. First, we assess the link between migrant networks and changes in BMI to determine whether children in migrant-sending households are at an increased risk of becoming overweight or obese. We focus on children because this is the stage in the life course when dietary and behavioral norms solidify. Second, we include a variety of economic, dietary, and behavior characteristics of the child and the household to identify some of the pathways by which migrant networks may contribute to the increasing overweight and obese population of children in Mexico.

To our knowledge, no published research directly addresses the link between migrant networks and obesity in Mexico. Some preliminary findings suggest that the higher prevalence of overweight among migrant children in the U.S. is not shared by children in sending communities in Mexico (Eskanazi & Neufeld, 2009). Other preliminary findings, based on cross-sectional data, indicate that Mexican children of more educated mothers who are exposed to U.S. migration may be less likely to be obese than their peers in households with no exposure to migration or with less educated mothers (Baker, Van Hook, & Altman, 2009). Despite the dearth of studies focused on the potential relationship between migrant networks and changes in BMI, two streams of research suggest a link.

The first set of findings stems from work on what happens to the BMI of migrants subsequent to arrival in the U.S. Many studies identify a pattern of unhealthy assimilation (Barcenas, Wilkinson, Strom, Cao, Saunders, Mahabir et al., 2007; Goel, McCarthy, Phillips, & Wee, 2004; Kaplan et al., 2004; Singh & Siahpush, 2002). Although lower at arrival, immigrant BMI appears to converge with the native born over time (Antecol & Bedard, 2006). For children, the prevalence of obesity for Mexican Americans is about twice that of their peers in Mexico (Rio-Navarro, Velazquez-Monroy, Sanchez-Castillo, Lara-Esqueda, Berber, Fanghanei et al., 2004). In addition, BMI in Mexico does not significantly predict migration to the U.S. (Luis Rubalcava, Teruel, Thomas, & Goldman, 2008), suggesting that increases in BMI occur subsequent to arrival. However, recent work challenges the notion that immigrant obesity rates converge to those of natives over time, underscoring the complex nature of acculturation (Park, Myers, Kao, & Min, 2009).

A second set of findings that links migrant networks to changes in BMI is rooted in the role of networks in a variety of outcomes. In the case of obesity, networks, observed over a period of 32 years, demonstrate a strong association with elevated BMI in the U.S. Individuals who have friends who become obese are 57% more likely to follow. Similar relationships are shown for siblings and spouses (Christakis & Fowler, 2007).

Networks are embedded in the process of international migration, tying individuals, households, and communities across borders. Having a migrant network is significantly associated with a variety of outcomes in Mexico such as lower child and infant mortality (Hildebrandt, McKenzie, Esquivel, & Schargrodsky, 2005; Kanaiaupuni & Donato, 1999), lower likelihood of low birth weight (Frank & Hummer, 2002; Hildebrandt et al., 2005), and greater community economic development (Woodruff & Zenteno, 2001). Recent work has shown that the prevalence of adult obesity is higher in high-migration relative to low-migration sending regions of Mexico (Buttenheim, Goldman, Pebley, Wong, & Chung, Forthcoming).

PATHWAYS TO OVERWEIGHT/OBESITY

The recent increase in overweight/obesity in Mexico is tied to a more general trend in Latin America and the developing world that has been termed a "nutritional transition." The nutritional transition is characterized by an increased intake of high-calorie, high-fat foods coupled with an increasingly urban and sedentary lifestyle (Popkin, 1994, 2001). Research indicates that fat consumption in Mexico, measured as a percentage of total energy, rose on average between 1988 and 1999 from an estimated 24% in 1988 to over 30% in 1999, reflecting a national-level shift away from the consumption of traditional staples like fruits, vegetables, legumes, cereals, and tortillas toward sugars and refined carbohydrates (Rivera et al., 2002).

Behavioral changes, such as increased television viewing and reduced manual labor, typically accompany or amplify dietary shifts linked to overweight/obesity in the developing world (Popkin, 1999) and the U.S. (Hill & Peters, 1998). A recent study found that 50% of Mexican television advertising targets children, touting high-calorie, processed foods that are known to contribute to increased BMI (Ramirez-Ley, Lira-Garcia, Souto-Gallardo, Tejeda-Lopez, Castaneda-Gonzalez, Bacardi-Gascon et al., 2009). In addition, television competes with more active forms of recreation. Migrant networks could theoretically facilitate these dietary and behavioral shifts. Specifically, children in networked households are potentially exposed to social norms derived from the U.S. (Levitt, 1998), which could influence changes in diet and behavior.

Mexico is the one of the largest recipients of remittances globally with an estimated 23.8 billion flowing across the border in 2008 (Ratha, Mohapatra, & Xu, 2008). Multiple studies find that the bulk of remittances to Mexico contribute to household consumption in addition to greater community and/or national economic activity, such as higher employment, investment, and income (Durand et al., 1996b), and microenterprise (Woodruff & Zenteno, 2001). At the household level, remittances from migrants who do not reside with other family or community members in the U.S. are more likely to be used for increased consumption rather than for production and savings (Mooney, 2003). Although the effect of remittance-related consumption on the quality of diet is not clearly known, children in households with remittance income may be more likely to receive relatively expensive, high calorie food. This could also facilitate the changes in dietary and leisure preferences described above.

In this paper we accomplish two goals. First, we assess whether children embedded in migrant networks are at a greater risk of becoming overweight/obese relative to children with no network ties to the U.S. Second, we evaluate the degree to which we can explain the association between migrant networks and changes in BMI by accounting for sociodemographic and behavioral characteristics of the child and the social and economic characteristics of the household and community.

DATA AND SAMPLE

To model changes in weight status of children in Mexico, we employ the Mexican Family Life Survey (MxFLS). MxFLS, collected in 2002 (MxFLS-1) and 2005 (MxFLS-2), is an ongoing longitudinal survey containing 8,440 households and 147 communities (Louise Rubalcava & Teruel, 2006). It is both nationally and regionally representative, containing extensive economic and demographic information at the household and individual levels. Of those sampled in MxFLS-1, including individuals that had left their household of origin, 94% were located and interviewed again in MxFLS-2 (Luis Rubalcava et al., 2008).

MxFLS-1 and MxFLS-2 record detailed anthropometric information for all household members, including direct measures of height and weight. For non-anthropometric measures, MxFLS divides respondents into two groups by age – children (≤15) and adults (>15). The wording of questions about some behaviors, such as television watching and domestic labor, varies between the two age categories. We limit the analysis to children between ages 3 and 15 in MxFLS-1 so as to maintain consistency in the measurement of individual behaviors. Questions pertaining to these children were usually asked of a parent, typically the mother. We do not consider children who are already overweight (n=701) or obese (n=247) at MxFLS-1. The resulting sample, shown in Table 1, consists of 3,593 children living in 2,233 households across

147 communities who have complete information on height, weight, and various individual, household, and community characteristics.

Although direct measurements of height and weight in MxFLS-1 provide more accurate assessments of obesity status than would be possible from parental reports, the restriction of data collection to a single household visit meant that only children who were present at the time of the survey had their measurements taken. Of the 5,244 children between ages 3 and 15 with complete information on all other measures, 31.5% have no height and/or weight recorded in MxFLS-1 and/or MxFLS-2. Although this is a high non-response rate, the absence of BMI measures for a given child appears to be attributable to his or her presence at the time of the interview rather than to variables of primary interest in this analysis (obesity status and the existence of migration networks in the United States). For example, in regression models, the presence of a migrant network does not significantly predict non-response on the anthropometric measures (data not shown). Thus, missing data on height and weight are unlikely to seriously bias the results in this analysis.

[Insert Table 1 here.]

MEASURES

Individual-Level Measure of Transitioning to Overweight/Obese

The outcome variable is the change in overweight status between survey waves. The BMI thresholds for adults, calculated as weight/height^2, are typically 25 kg/m^2 for overweight and 30 kg/m^2 for obese (WHO, 1995). Because these thresholds do not take into account the growth trajectory of children, we elected to follow the approach of the International Obesity Task Force by using BMI cut-offs by age and sex, derived from BMI values for six countries in four continents (Cole, Bellizzi, Flegal, & Dietz, 2000). For our sample of not overweight or obese children at the first wave, we define the outcome to equal 1 for children who transition into overweight or obese status between MxFLS-1 and MxFLS-2, and 0 otherwise. As shown in Table 1, approximately one-fifth of the children in our sample are overweight/obese by MxFLS-2.

[Insert Table 2 here.]

Household-Level Measure of Migrant Networks

The key explanatory variable, the presence and strength of household migrant networks, is measured at the household level. MxFLS records up to four relationships with current migrants in the U.S. for each adult (age 15 or above) in a given household. Based on the relationship of these network ties, we distinguish close from extended relations: close relations include spouse, parent, sibling and child; extended relations include in-laws, grandparents, grandchildren, cousins, uncles, aunts, nieces, nephews, and other unspecified relatives. In the presence of both types of ties, we categorize the individual's household as having a close network. Using this information, we define a three-category measure (see Table 2): close networks, for children living in households where an adult member reports at least one close network tie (35% of households); extended networks, for children in a household where an adult member reports only extended network ties (15%); and no networks (the omitted category, 50%).

Individual-Level Measures of Behavior and Core Sociodemographic Characteristics

To explore the extent to which behaviors of the child explain a link between household migrant networks and changes in overweight status, we consider several measures that describe the recreational and domestic routines of the child (Table 1). The first variable defines the number of hours per week the child spends watching television. The measure captures both the level of inactivity of the child and the potential exposure to information about foods associated with increased BMI. As a result of remittance income or goods, embedded households may be more likely to both afford a television and have the free time to watch it. The measure has three categories: no television for the week (omitted), up to 5 hours per week (up to 1 hour per day of the work week), and more than 5 hours per week. About three quarters of sampled children report watching more than 5 hours per week compared to 12% who report watching no television.

The second measure of child behavior is derived from a more general question asking the number of hours involved in sports, cultural activities, or entertainment outside the house. Although this measure does not distinguish physical from non-physical activities, it provides an approximation for the number of hours per week the child was engaged in sports and recreation. This variable has the following three categories: no sport or recreation (omitted), up to 2 hours per week, and more than 2 hours weekly. Over 80% of the sample reports engaging in no sports or recreation over the course of a week.

We include two additional measures intended to capture the number of hours that children spent on domestic labor. Indoor domestic labor is defined as helping out with household tasks, asked in a single question. The measure has the following three categories: no indoor labor for the week (omitted), up to 5 hours per week, and more than 5 hours per week. About 40% of the children in the sample report doing some indoor domestic labor over the course of a week. Outdoor domestic labor is constructed from a combination of questions about whether a child performs the following tasks: carrying water, carrying wood, or contributing to non-commercial agriculture. This variable is dichotomous, distinguishing children who do any one of these three tasks (1) from those who do not (0). Relative to indoor domestic labor, outdoor domestic work is far less common with nearly 90% of children in the sample reporting none. Households with migrant networks may have a reduced need for domestic labor as hired help could be procured and infrastructure installed (e.g., plumbing and heating) with remittance income. We also control for several core sociodemographic characteristics of the child: baseline (MxFLS-1) age, age squared, sex, and BMI.

Household-Level Measures of Diet

We include two measures of the household diet, shown in Table 2, to capture the approximate amount of sugary and processed foods available to the child. Changes in a child's diet could be attributable to exposure to new dietary norms via links to a U.S. migrant population and a greater income to purchase more expensive, processed foods. The first measure is the per capita monthly household consumption of soda, measured in liters. The measure has 3 categories: no consumption of soda (omitted), up to 5 liters per month, and more than 5 liters per month. Nearly one fifth of households reports per capita monthly consumption of soda greater than 5 liters. The second measure is the log per capita monthly expenditure on processed foods, which is included as a continuous measure.

Household-Level Measures of Economic Wellbeing

Some of the primary impacts of migration for those that remain in the country of origin are likely to be economic because migrant networks are the pathways by which remittances, goods, and information about employment travel. We include several measures to account for the assets, expenditures, transfer income, and general economic wellbeing of the household. The first, the logarithm of per capita household assets, is derived from a series of questions that ask individuals about the ownership and value in pesos of the following items: a house, an additional house, a bicycle, a motorcycle/truck/car, an electric appliance not elsewhere listed, a washer/dryer, a domestic appliance, a horse/mule/donkey, a pig/goat, chickens, or saved assets and/or heavy farm machinery. The second measure, constructed from detailed questions describing the overall household economy, is the logarithm of per capita expenditure, which accounts for all monthly household expenses. This measure reflects the household economic status in a context where measures like income often fail to accurately describe individuals who are not receiving wages (Xu, Ravndal, Evans, & Carrin, 2009).

Remittances provide a direct measure of the economic impact of migration. Although we cannot distinguish remittances related to a household's U.S. migration network from other types of external transfers (e.g., non-coresident or domestic exchanges), we construct a measure that captures all transfers from non-resident relations to each adult household member. We sum these transfers over the year prior to MxFLS-1, creating a per capita measure, and take the logarithm of the result. We also include a dichotomous variable to account for the receipt of cash transfers from the program *Oportunidades*, which provides financial incentives to families to improve school attendance. This program, which provides increasingly large monthly education grants ranging from 105 pesos in primary school to over 660 in upper-secondary school (Behrman, Parker, & Todd, 2005), can offer a substantial boost to household income and affects over one quarter of households in our sample. Two additional measures – the total number of rooms and the presence of electricity – capture a dimension of household economic wellbeing related to the child's physical environment.

Household-Level Measures of Social Background and Support

Household composition may mediate the role of migration. Mexican households that contain multiple generations are less likely to receive remittances relative to households with a single, nuclear family (Sana & Massey, 2005). Additionally, high school age Mexican children who live in single-mother households because of the absence of a migrant father are more likely than children in two-parent households to also live with a grandparent (Creighton, Park, & Teruel, 2009). Obesity or weight gain is associated with being cared for by a grandparent for children age 3 and younger in the U.K. (Pearce, Li, Abbas, Ferguson, Graham, & Law, 2010) or by an informal caregiver for infants in the U.S. (Kim & Peterson, 2008). Although this research does not address the mechanisms underlying these associations, indulgence of children with high calorie or large quantities of food and low levels of physical activity are plausible candidates.

We account for four household-level measures of family structure – the presence of a grandmother and/or a grandfather, the relationship of the caregiver (both parents, only mother, only father or guardian), and the total household size. Slightly more than 10% of households have a grandparent in the household and more than three-quarters (78.6%) of households include both parents as caregivers.

We include two indirect measures pertaining to the child's social background: the ethnicity and the education of the child's caregiver. The ethnicity variable, admittedly crude given the diversity in Mexican society, is a dichotomous indicator of whether at least one caregiver speaks an indigenous (i.e., non-Spanish) language (18.4% of households). The measure of education reflects the years of schooling of the most educated caregiver (7.9 years on average). A final measure, whether at least one caregiver receives insurance from a public or private source (42.7% of households), captures the access of the child to health care and is included as a dichotomous measure.

[Insert Table 3 here.]

Community-Level Measures of Remittances, Migration, Urbanicity, and Access to Television

We consider four local and municipal measures derived from the 2000 Census and released by the National Population Council in Mexico (CONAPO). Two of these variables measure remittance behavior and recent migration history and are recorded for municipalities (*municipios*). The two remaining measures, urbanicity and the availability of television, are recorded for localities (*localidades*), which are smaller geographic units of analysis. Municipal-level measures are assigned to all localities within a given municipality; on average, there are only 1.1 localities per municipality in our data set.

To account for the percentage of households receiving remittances in 2000, we group the values from the sampled municipalities into quartiles and assign a given household the quartile corresponding to its location; the lowest quartile serves as the reference category. The top quartile reports an average of 15.8% of households receiving some form of remittance in 2000. The migration measure is based on the number of migrants that emigrated from a given municipality between 1995 and 2000. As with the measure of remittances, this is constructed as a categorical variable based on quartiles of the distribution of municipalities in the sample. We capture the urbanicity of the community in which the household resides by considering localities with fewer than 2,500 residents (the smallest category identified in the data) to be rural. The final measure records the proportion of the households in a given locality that own a television. Given that these variables reflect the local and municipal context, we refer to them as community-level measures.

[Insert Table 4 here.]

METHODS

To model the link between migrant networks and changes in overweight status, we explicitly account for the possibility that children within a shared household and community environment may be correlated in terms of BMI, migrant networks, diet, parental background, and other socioeconomic attributes. In other words, they are more likely to be similar to each other than to children in other households or communities. As shown in Table 4, the sample includes an average of 1.6 children per household and 24.4 children per community. We estimate a multilevel random-intercept logistic model described by equation 1 (Rabe-Hesketh & Skrondal, 2008):

$$(1)\ \ \text{logit}\left(\Pr\left\{y_{ijk}=1 \middle| x_{ijk}, x_{jk}, x_k, z_{jk}, z_k\right\}\right) = \beta_0 + \beta_1 x_{ijk} + \beta_2 x_{jk} + \beta_3 x_k + \sigma_{jk} + \sigma_k,$$

where the outcome y_{ijk} (becoming overweight/obese between waves) is a function of individual (*i*), household (*j*), and community (*k*) factors. This approach includes random intercepts that vary over households ($z_{jk} \sim \text{N}(0,\sigma_{jk})$) and communities ($z_k \sim \text{N}(0,\sigma_k)$). The random components z_{jk} and z_k are assumed to be independent from each other and across clusters within a given level of analysis. To assess the need for a multilevel approach, we compared the random-intercept model to the standard logit model using a likelihood-ratio χ^2 test. For all five of the models described below, we reject the null hypothesis ($p<0.001$) that both the household and community random-effect parameters are equal to zero, suggesting that a random-intercept model is preferable. We fit equation (1) using the *xtmelogit* command in Stata 11 (StataCorp, 2009).

[Insert Table 5 here.]

RESULTS

Table 5 reports the estimated coefficients and test statistics from multilevel logistic regression models of becoming overweight/obese between the two survey waves. Although the use of longitudinal data ensures that the migrant networks are established prior to the observed change in overweight status, the results cannot be interpreted as the causal impact of being embedded in migrant networks on changes in overweight status. In particular, we cannot exclude the possibility that unmeasured characteristics determine both the presence of migrant networks and changes in weight status.

Model 1 includes controls for the age, sex and baseline BMI of the child in addition to household migrant network strength. The estimates suggest that children in households with extended networks are significantly more likely to become overweight/obese relative to children in households with no networks. The estimated coefficient for close networks is positive, but only marginally significant ($p<0.10$). Predicted probabilities of becoming overweight or obese between waves, based on assigning all variables in Model 1 except network strength their observed values, indicate a substantial effect of migration networks: the probabilities equal 0.17 for children with no networks as compared with 0.24 and 0.20 for children with extended and close networks respectively (data not shown).

Model 2 indicates that, as expected, watching television significantly increases the risk of becoming overweight/obese for both moderate (0-5 hours) and frequent (5+ hours) watchers. The directions of the coefficients for most of the other dietary and behavioral measures are in the expected direction, but are not significant. For children engaged in sports and recreation, the estimate is positive, which may be due to our inability to distinguish physical from non-physical forms of recreation. Although the inclusion of these measures slightly reduces the magnitude of the estimated coefficients for migration networks, children in households with extended networks remain significantly more likely to become overweight/obese between MxFLS-1 and MxFLS-2 than those without networks.

After the introduction of the household-level measures of economic wellbeing in Model 3, the estimated coefficient for children in households with extended migrant networks is further attenuated, but remains significant. This suggests that the included measures of diet, behavior, and economic context only partially explain the association between having a network in the U.S. and becoming overweight/obese. Children in households with greater resources, as reflected by more rooms, are more likely to become overweight/obese relative to their peers living in households with fewer rooms. When compared to Model 3, the magnitude and significance of the estimated coefficients for household-level migration networks change little in Model 4, which accounts for social background and support. The presence of a grandmother in the household significantly increases a child's risk of becoming overweight/obese, which has been shown in another context (Pearce et al., 2010), and may be attributable to indulgence of children in terms of food or a lack of shared physical activity.

Model 5, which includes community-level measures, indicates that children living in communities where relatively more households received remittances are significantly more likely to become overweight/obese. In contrast, children living in communities where a greater proportion of the population migrated between 1995 and 2000 are significantly less likely to become overweight/obese. Some work has suggested that communities with longer migration relationships with the U.S. can reach a point of network saturation and declining rates of subsequent migration (Massey, 1990) or that the relationship between networks and migration is related to urbanicity and history (Fussell & Massey, 2004), not just remittances. This may explain why greater recent community-level migration is negatively associated with becoming overweight or obese while community-level measures of remittances, which reflect relationships established over a longer period of time, show a positive association. The inclusion of community-level measures of remittances and migration barely changes the magnitude of the estimated coefficients for household migrant networks, indicating that these measures do not explain the greater risk of becoming overweight/obese for children linked to migration networks within their households.

The estimated coefficients for migration network strength are attenuated by about 11% and 21% between Model 1 and Model 5, for children in extended and close networks respectively. The relatively large values of the intrahousehold correlations (e.g., $\rho_{jk} = 0.346$ in Model 1) underscore the importance of the household environment for changes in weight status: children living in the same household are much more similar to one another than to children in distinct households in terms of the likelihood that they maintain or change their weight status.

On the other hand, the very small reductions in these estimates with the inclusion of additional variables (e.g., $\rho_{jk} = 0.324$ in Model 5), suggest that the measures of economic wellbeing, social background, and social support do not explain the within-household correlation in becoming overweight or obese. Additional household measures not available in the MxFLS, such as the level and use of remittances and more detailed accounting of diet and exercise, would be likely to improve the model.

CONCLUSIONS

This paper demonstrates that children embedded in migrant networks are at a greater risk of becoming overweight or obese relative to children with no network ties to the United States. The results also show that the behavior and diet of the child and the economic and social context of the household explain some, but not all, of the relationship. Children in households with an extended family member in the U.S. remain significantly more likely to become overweight or obese even after an extensive set of individual, household, and community characteristics are taken into account.

We conclude that migrant networks, which have been shown to be avenues of remittance income and key information about destinations (Palloni, Massey, Ceballos, Espinosa, & Spittel, 2001), are pathways by which health behaviors are transmitted. This conclusion speaks directly to previous theoretical work on the importance of network linkages for the diffusion of information (Granovetter, 1983) and empirical work on the diffusion of obesity across social networks (Christakis & Fowler, 2007). Our work underscores the role of networks between Mexico and the U.S. as a potential facilitator of the recent rapid increase in the population of overweight and obese children in Mexico.

Although our models include available measures of behavior, diet, and a number of contextual factors, much of the household-level variation remains unexplained and the magnitude of the coefficients for household migrant networks is only modestly reduced across models. One goal of this work has been to distinguish among various theoretical pathways by which migrant networks may contribute to changes in the weight status of the child. Our results indicate that sedentary behavior and household-level measures of economic wellbeing explain some – but not most – of the association between networks and changes in weight status, suggesting that some pathways remain unmeasured. Community-level characteristics directly related to migration do not account for any of the observed relationship between household-level networks and becoming overweight or obese.

We suggest that a reasonable next step would be to use a direct measure of remittance income, in lieu of the broader measure of transfers available in the MxFLS, to ascertain the importance of an expanded household budget attributable to migrant ties in the U.S. In addition, more detailed measurement of dietary and behavioral changes that occur subsequent to the receipt of remittances and/or the establishment of migrant networks would be likely to provide insights into the proximate mechanisms by which migrant networks lead to changes in weight status. There is evidence that the prevalence rates of obesity in Mexico and the U.S. are converging, particularly for females (WHO, 2009), and that sugars and refined carbohydrates are replacing dietary staples (Rivera 2002), suggesting that information, behaviors, and diet in the U.S. may differ less and less from what is found within Mexico. For this reason, we may observe a weakening of the link between migrant networks and child obesity in the future. Situating migrant networks firmly within the broader literature on the transmission of health behaviors via social networks provides a clearer understanding of the role of international migration and globalization in the diffusion of more than just information and economic resources.

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Table 1: Individual-Level Descriptive Statistics for Sample of Non-Overweight Children Age 3-15

	Mean (SD) or %
Transitioned into Overweight/Obese between MxFLS-1 and MxFLS-2	
No	79.4%
Yes	20.6%
Weekly TV Watching (hours)	
0	12.0%
(0-5]	14.0%
>5	74.0%
Weekly Sports and Recreation (hours)	
0	83.6%
(0-2]	2.6%
>2	13.8%
Weekly Indoor Domestic Labor (hours)	
0	60.5%
(0-5]	26.4%
>5	13.1%
Weekly Outdoor Domestic Labor (hours)	
0	88.8%
>0	11.2%
Sex	
Female	41.2%
Male	58.8%
Age in MxFLS-1	7.55 (3.04)
BMI in MxFLS-1	16.22 (1.68)
n	3,593

Source: MxFLS-1 and MxFLS-2

Table 2: Household-Level Descriptive Statistics

	Mean (SD) or %
Migration Network Strength	
None	50.3%
Extended	14.7%
Close	35.0%
Monthly Household Soda Consumption (liters)	
0	28.1%
(0-5]	53.4%
>5	18.5%
Log per Capita Expenditure on Processed Foods	0.56 (0.86)
Log per Capita Household Assets	0.32 (0.13)
Log per Capita Household Expenditure	1.70 (0.57)
Log per Capita Transfers from Non-Household Members	2.07 (2.77)
Household Receives Oportunidades	
No	73.4%
Yes	26.6%
Number of Rooms in Household	2.01 (0.97)
Household had Electricity	
No	1.8%
Yes	98.2%
Caregiver Speaks Indigenous Language	
No	81.6%
Yes	18.4%
Education of Caregiver (years)	7.86 (3.80)
Grandmother in Household	
No	86.8%
Yes	13.2%
Grandfather in Household	
No	89.5%
Yes	10.5%
Caregiver	
Both Parents	78.6%
Mother	17.4%
Father and/or Guardian	4.0%
Total Household Size	5.48 (1.90)
Caregiver Receives Insurance	
No	57.3%
Yes	42.7%
n	2,233

Source: MxFLS-1

Table 3: Municipal-Level Descriptive Statistics

	%	mean (SD)
Percentage of Households Receiving Remittances in 2000		
1st quartile	25.2%	1.12 (0.46)
2nd quartile	28.6%	2.47 (0.44)
3rd quartile	23.8%	5.00 (1.15)
4th quartile	22.5%	15.81 (5.99)
Percentage of Population that Migrated to U.S. 1995-2000		
1st quartile	26.5%	0.88 (0.44)
2nd quartile	25.2%	2.25 (0.58)
3rd quartile	25.9%	4.66 (1.35)
4th quartile	22.5%	14.45 (4.98)
Urbanicity		
non-rural	50.3%	
rural	49.7%	
Proportion of Households with Television		0.19 (0.05)
n	147	

Source: CONAPO and MxFLS-1

Table 4: Distribution of Children by Level of Analysis

	Min.	Mean	Max.
Household (n=2233)	1	1.6	6
Community (n=147)	1	24.4	124

Source: MxFLS-1

Table 5: Three-Level Random-Intercept Logistic Regression Models of Transitioning into Overweight/Obese – Children Ages 3 to 15 in MxFLS-1

Model	(1)		(2)		(3)		(4)		(5)	
	β	(z)	β	(z)	β	(z)	β	(z)	β	(z)
Household-Level Migration Network Strength (ref.=none)										
Extended	0.430*	(2.57)	0.391*	(2.34)	0.350*	(2.10)	0.366*	(2.20)	0.381*	(2.25)
Close	0.248+	(1.87)	0.231+	(1.76)	0.178	(1.34)	0.164	(1.24)	0.196	(1.39)
Individual-Level Measures of Behavior										
Weekly TV Watching (hours; ref.=0)										
(0-5]			0.469*	(2.00)	0.365	(1.55)	0.335	(1.42)	0.330	(1.39)
>5			0.551**	(2.77)	0.430*	(2.15)	0.412*	(2.04)	0.400+	(1.95)
Weekly Sports and Recreation (hours; ref.=0)										
(0-2]			0.069	(0.20)	0.004	(0.01)	-0.025	(-0.08)	-0.047	(-0.14)
>2			0.124	(0.77)	0.069	(0.43)	0.076	(0.47)	0.050	(0.31)
Weekly Indoor Domestic Labor (hours; ref.=0)										
(0-5]			-0.160	(-1.18)	-0.175	(-1.29)	-0.163	(-1.21)	-0.174	(-1.28)
>5			-0.021	(-0.12)	-0.012	(-0.07)	-0.000	(-0.00)	-0.013	(-0.08)
Weekly Outdoor Domestic Labor (hours; ref.=0)										
>0			-0.232	(-1.15)	-0.191	(-0.94)	-0.171	(-0.84)	-0.107	(-0.51)
Household-Level Measures of Diet										
Monthly Household Soda Consumption (liters; ref.=0)										
(0-5]			0.047	(0.35)	0.044	(0.33)	0.063	(0.47)	0.038	(0.28)
>5			0.231	(1.30)	0.193	(1.09)	0.226	(1.27)	0.176	(0.98)
Log per Capita Household Expenditure on Processed Foods			-0.010	(-0.14)	-0.037	(-0.52)	-0.017	(-0.24)	-0.013	(-0.18)
Household-Level Measures of Economic Wellbeing										
Log per Capita Household Assets					1.112	(1.36)	1.025	(1.25)	1.131	(1.36)
Log per Capita Household Expenditure					-0.076	(-0.40)	-0.190	(-0.76)	-0.218	(-0.86)
Log per Capita Household Transfers from Non-Household Members					0.008	(0.37)	0.012	(0.60)	0.010	(0.48)
Household Receives Opportunidades (1=yes)					-0.172	(-1.16)	-0.157	(-1.02)	-0.093	(-0.57)
Number of Rooms in Household					0.121*	(2.03)	0.131*	(2.07)	0.127*	(2.02)
Household Has Electricity (1=yes)					0.862+	(1.66)	0.788	(1.53)	0.778	(1.51)

Table 5, Continued: Three-Level Random-Intercept Logistic Regression Models of Transitioning into Overweight/Obese – Children Ages 3 to 15 in MxFLS-1

Model	(1)	(2)	(3)	(4)		(5)	
				β	(z)	β	(z)
Household-Level Measures of Social Background and Support							
Caregiver Speaks Indigenous Language (1=yes)				-0.295+	(-1.69)	-0.221	(-1.19)
Education of Caregiver (years)				-0.008	(-0.43)	-0.013	(-0.71)
Grandmother in Household (1=yes)				0.446*	(2.30)	0.462*	(2.36)
Grandfather in Household (1=yes)				-0.019	(-0.09)	-0.028	(-0.13)
Caregiver (ref.=Both Parents)							
Mother				-0.033	(-0.20)	-0.052	(-0.31)
Father and/or Guardian				-0.623+	(-1.72)	-0.629+	(-1.73)
Total Household Size				-0.073	(-1.16)	-0.075	(-1.18)
Caregiver Receives Insurance (1=yes)				-0.232+	(-1.81)	-0.259*	(-1.98)
Community-Level Measures of Remittances, Migration, and Access to Television							
Proportion of Households Receiving Remittances in 2000 (quartiles; ref.=1st)							
2nd						0.628*	(2.42)
3rd						0.698*	(2.25)
4th						0.817+	(1.94)
Proportion of Population that Migrated to U.S. 1995-2000 (quartiles; ref.=1st)							
2nd						-0.280	(-1.10)
3rd						-0.684*	(-2.29)
4th						-0.759+	(-1.85)
Urbanicity (1=rural)						-0.169	(-0.96)
Proportion of Households with Television						0.461	(0.21)
n	3593	3593	3593	3593		3593	
$\hat{\sigma}_{jk}$	1.153***	1.139***	1.119***	1.094***		1.115***	
$\hat{\sigma}_{k}$	0.587***	0.550***	0.525***	0.533***		0.462***	
ρ_{jk}	0.346	0.339	0.330	0.331		0.324	
ρ_{k}	0.117	0.110	0.107	0.108		0.095	

+p<0.10, *p<0.05 , **p<0.01 ,***p<0.001

Source: MxFLS-1 and MxFLS-2

Note: All models include individual-level controls for the sex, age, age^2, and baseline BMI of the child