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## **Residential Segregation, Neighborhood Social and Physical Context in Obesity Disparities in Hispanic Preschoolers: A Conceptual Model**

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### **ABSTRACT**

During the last decade, there has been a significant inclusion in obesity prevention studies from individual characteristics to household factors then neighborhood factors. The study of place in the context of early childhood obesity studies has been limited to the food and physical built environment. With the persistent disparities in the prevalence of childhood obesity, and Hispanic minorities being increasingly affected, there is a need to reexamine existing models and develop new model conceptual frameworks to examine the role of place and residential segregation in the context of race, ethnicity, social position, and socioeconomic disparities. In the context of place as a relational space linked to where young children live, play and learn, this paper conceptualizes the role of the neighborhood social and physical factors as well as organizational, household and/or individual factors as mediators of the correlation between residential segregation and obesity in Hispanic preschoolers. In the model, we also attempted to include the role of policies and programs in moderating the negative effects of racial residential segregation and resource inequalities and their interactions with the multiple factors that may contribute to childhood obesity. Recommendations for future research need are identified.

**Keywords:** Residential; segregation; social position; preschooler; obesity; neighborhood; Hispanic

### **INTRODUCTION**

Childhood obesity is a substantial national public health problem in the United States. Approximately 12.7 million children have been affected by the increasing obesity rates in the past decade (Ogden, Carroll, Kit, & Flegal, 2014). Compared with Whites, Hispanic and non-Hispanic Black children and adolescents reported higher obesity rates in 2011-2012 (22.4% and 20.2% respectively) (Ogden et al., 2014). Obesity in children carries several negative

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consequences, including the development of cardiovascular disease, Type 2 Diabetes Mellitus, low self-esteem, depression, and stigma (Freedman, Mei, Srinivasan, Berenson, & Dietz, 2007; Han, Lawlor, & Kimm, 2010; Messiah et al., 2012; Puhl & Latner, 2007; Pulgaron, 2013). Because differences in individual-level risk factors cannot fully explain the racial and ethnic disparities related to weight outcomes in children, social contextual influences at the neighborhood and community levels have been the focus of recent studies (Debbink & Bader, 2011; Suglia et al., 2016).

Racial residential segregation or the geographical clustering of racial and ethnic groups has been a determinant of racial inequalities in the United States (Acevedo-Garcia, Osypuk, McArdle, & Williams, 2008; Massey & Denton, 1989; Williams & Collins, 2001). Living in the midst of economically disadvantaged urban communities exposed to high levels of crime (Jones-Webb & Wall, 2008; Krivo, Peterson, & Kuhl, 2009) and higher obesity rates have been reported for Black and Hispanic minorities living in highly segregated residential areas (Corral, Landrine, & Zhao, 2014; Kershaw, Albrecht, & Carnethon, 2013). The healthy migrant or Hispanic/ Latino migrant paradox has not been reflected in Hispanic preschool overweight children (Baker, Rendall, & Weden, 2015; Kim, Collins, & Grineski, 2014). First and second generation migrant Hispanic preschoolers living in Hispanic migrant enclaves and Hispanic minority-majority metropolitan areas are experiencing increasing obesity rates (Messiah et al., 2015; Nobari et al., 2013).

While the socioecological model has been currently in use for researching factors associated with childhood obesity, there are limitations associated with the use of this model (Davison & Birch, 2001; Dev, McBride, Fiese, Jones, & Cho, 2013). The childhood obesity community studies have failed to account for neighborhood socioeconomic position and racial/ethnic factors despite reports of an attenuation in the obesity disparities for some ethnic groups at the individual and community levels (Rossen, 2014). It has been difficult to establish causality of neighborhood effects versus selective residential mobility due to the cross-sectional nature of the studies (Jokela, 2014). Current models have been limited in examining temporality in the order of factors for person-place interaction across the lifespan (Daniel, Moore, & Kestens, 2008). Therefore, our understanding of the timing of exposure to these multiple factors continues to be limited. Understanding the temporal and cumulative effects of these factors is of great importance, especially when studies report critical periods in the life course (pre-pregnancy, prenatal, infancy, early childhood) increasing the risk of obesity throughout the lifespan (Pudrovska, Logan, & Richman, 2014). A maternal-child life course framework has further been advocated in the studies (Perez-Escamilla & Kac, 2013).

In the midst of the increasingly persistent disparities in childhood obesity, there is a need to reexamine existing models and develop new model conceptual frameworks with particular attention to segregation contextual factors in the neighborhood social and physical environments. Therefore, the objective of this paper is to present a comprehensive conceptual model of determinants of obesity in preschoolers in the context of place, neighborhood physical, social environments, and residential segregation. In segregated environments with increased prevalence of obesity, we hypothesize that ethnic-related factors in the neighborhood social and physical environment are likely to mediate the association between residential segregation and obesity in Hispanic preschool children. The proposed model, Segregation, Social Position, Intermediate, Proximate, and Immediate (SSIPI) Health Risk Model, is an adaptation of the Healthy

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Environments Partnership conceptual model (HEP) (Schulz et al., 2005) and a conceptual framework of biosocial pathways in the relationship between geospatial clustering of disadvantage and cardiovascular and glycemic disease (Daniel, Moore, & Kestens, 2008).

There are distinctive benefits to the application of this model as it exclusively recognizes the role of socioeconomic position, race-based residential segregation, and income inequalities as fundamental factors likely to influence on the neighborhood social and physical environments, intermediate, proximate, and immediate sociodemographic and behavioral factors associated with childhood obesity, and ultimately cardiovascular risk (Schulz et al., 2005). We elaborate on the role of federal, state, and local policies and programs in moderating racial/ ethnic residential segregation while accounting for the effects of time during the person-place interactions throughout the life course. While the focus of this model is on preschool Hispanic children, the use of this model has relevance to other racial/ethnic groups affected by the increased prevalence of obesity and living in segregated environments. In the model we attempt to explain biological plausibility and temporarily through biosocial pathways linking place to health throughout the various stages in the life course (Daniel, et al., 2008). Lower socioeconomic position resulting from lack of social, geographical mobility and income inequalities is likely to present cumulative risks of overweight and obesity (Elhakeem, Hardy, Bann, Caleyachetty, Cosco, et al., 2016; Ravensbergen, Buliung, Wilson, and Faulkner, 2016). In this review we discuss the factors associated with overweight and obesity as well as methodological considerations for future research work in Hispanic preschoolers living in segregated environments.

**Segregation, Social position, Intermediate, Proximate, and Immediate (SSIFI) Health Risk Model**

Racial/ ethnic residential segregation and socioeconomic inequalities

Racial/ethnic residential segregation is presented in figure 1 as a fundamental factor that influences intermediate, proximate, and immediate risk factors of obesity in children in general, however, our focus here on Hispanic preschool children. Racial/ ethnic residential segregation, a form of institutional discrimination, arises from individual residential preferences and discriminatory and exclusionary practices and policies in housing markets (Massey & Denton, 1989). Foreign-born Hispanics are more segregated from non-Hispanic Whites than their U.S. born counterparts (Iceland & Scopilliti, 2008) with differential patterns based on regional concentration, population size, nativity, English language ability, and local socioeconomic conditions (Massey & Denton, 1989). Segregated residential areas represent areas of high poverty and decreased access to resources, especially for those limited by blocked social and spatial mobility (Borjas, 1998; Osypuk, Bates, & Acevedo-Garcia, 2010). Residential segregation has been correlated with inequalities in the quality of education, employment opportunities, income levels, access to retail outlets and health care providers, and poor neighborhood quality (Stromgren et al., 2014; Williams & Collins, 2001). In the model, this process is presented with the use of bi-directional arrows to indicate the reciprocal effect between residential segregation and inequalities to resources (Schulz et al., 2005).

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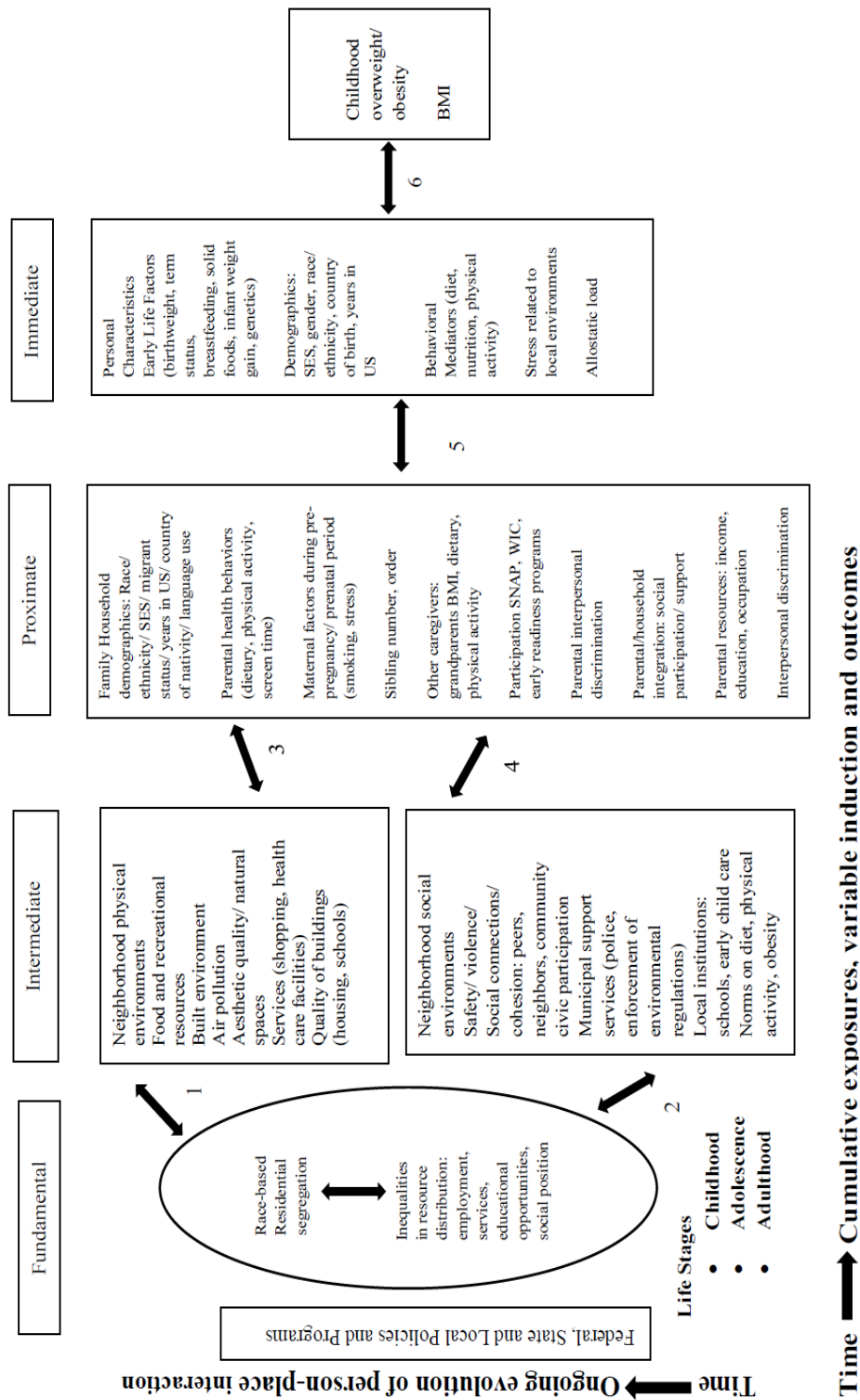


Figure 1. Schematic representation of Residential Segregation, Neighborhood Social and Physical Context in Obesity Disparities in Hispanic Preschoolers (Adapted from Schulz et al. (2005) and Daniel, Moore, & Kestens, (2008)).

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Hispanic immigrants working in ethnic enclaves report negative economic outcomes as a result of undesirable jobs and lower wages when compared to those working in mainstream economies (Xie & Gough, 2011). Despite these findings, some studies report living in Hispanic enclaves being associated with increased access to social networks, social support, and healthy practices and norms for Hispanic migrants (Kim et al., 2014; Osypuk et al., 2010). Hispanic and foreign-born neighborhoods have been reported as having a protective effect against obesity in children (Kimbrow & Denney, 2013). However, these findings have not been consistent, especially when Hispanic preschoolers experience higher obesity rates compared to other ethnic groups in some geographical areas (Weedn, Hale, Thompson, & Darden, 2014). The interaction effects of neighborhood deprivation and individual-level socioeconomic status appear to be more marked in Hispanic preschoolers when compared to non-Hispanic Whites and Blacks (Rossen, 2014). The studies further suggest increasing obesity risks for Hispanic preschoolers living in Spanish-speaking segregated areas, with individual factors, such as Spanish speaking as the household language mediating the association (Nobari et al., 2013). These conflicting findings warrant the need to explore further the role of family household and individual factors in the context of segregated residential environments among Hispanics. We discuss these as intermediate, proximate, and immediate factors in the association with childhood obesity.

As proposed by Daniel et al. (2008), variation in the timing and intensity of the exposures resulting in variable induction times between exposure and disease outcome as individuals move from place to place and neighborhoods evolve over time (Daniel et al., 2008; Houghton, Kelleher, & Duncan, 2003). Daniel et al (2008) describe the changes in structure and context as dynamic, evolving through time, reflected on the y axis. Communities may experience the effects of changes in policies and programs to prevent childhood obesity at the neighborhood level (Ritchie et al., 2015; Yoong et al., 2016). Reports from longitudinal studies indicate changes in child body mass index (BMI) may take place in response to changes in the neighborhood food store environment across time (Chen & Wang, 2016). With changes in environmental characteristics, mobility may serve a protective role in weight gain during the lifespan (Jones, 2015). The time factor on the x axis signifies the cumulative exposures, whether immediate, proximate, intermediate, or fundamental, prone to variable induction and outcome times (Daniel et al., 2008; Schulz et al., 2005).

While the focus of this model is towards the framing of racial residential segregation, neighborhood social and physical contextual effects on preschoolers, the effects are likely to carry throughout the lifespan. Childhood, adolescence, and adulthood are presented as part of the life stages on the x axis as they represent distinctive, vulnerable periods in the tracking of overweight and obesity throughout the life course (Davidson et al., 2014; Johnson et al., 2014). During childhood, school-related factors, including peers, the school environment, and the neighborhood surrounding the school environment are likely to impact on children's risk of obesity (Elder, et al., 2010). Adolescents and youth are subject to different types of influences, including peers, the media over the type of foods and activities in the school or social network. Ultimately, the increased in BMI is likely to track in the adult years, impacting on cardiovascular disease risk as well as other obesity-related chronic diseases.

Intermediate Factors: Neighborhood Physical and Social Environments

Racial/ethnic residential segregation and its associated inequalities are likely to affect the quality of the neighborhood physical and social environments where Hispanic children reside



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(arrows 1 and 2). Hispanic and Black children face increasing inequalities in accessibility to higher-opportunity neighborhoods when compared to non-Hispanic Whites (Acevedo-Garcia et al., 2008; Rossen, 2014). For Mexican-Americans living below poverty level, the risk of obesity does not attenuate even in the midst of lower neighborhood deprivation as observed in non-Hispanic Whites (Rossen, 2014). Hispanics living in neighborhoods with higher immigrant composition have reported worse neighborhood factors (walkability, social cohesion or trust, and lower neighborhood civic participation) when compared to neighborhoods with lower proportion of foreign-born Hispanics (Osypuk, Diez Roux, Hadley, & Kandula, 2009). Factors such as parental perception of physical and social neighborhood disorder, traffic safety, availability of places for child's physical activity, and neighborhood social informal controls have been associated with lower levels of physical activity and higher Body Mass Index (BMI) in Hispanic preschoolers (Mendoza, McLeod, Chen, Nicklas, & Baranowski, 2014; O'Connor et al., 2014). Mothers of foreign-born Hispanics living in neighborhoods with higher concentration of immigrants report lower levels of physical activity and higher levels of physical and social neighborhood disorder (Brewer & Kimbro, 2014). Therefore, parents are more likely to have their children engage in sedentary behaviors, especially the increased use of screen time (Mendoza et al., 2014; O'Connor et al., 2014). This is represented by the bidirectional arrows between the interpersonal parental factors and the intermediate factors in the conceptual model (arrows 3 and 4). Municipal support systems, including adequacy and competence of police, fire-fighting, and other municipal services can help moderate the negative physical and social neighborhood factors as they relate to safety in residentially segregated environments (Schulz et al., 2005).

Lower socioeconomic status communities are also more likely to experience higher concentration of air pollutants (Hajat, Hsia, & O'Neill, 2015). Higher prenatal exposure to air pollutants has been associated with higher body size in young children, after adjustment for gender, age, ethnicity, birth weight, maternal receipt of public assistance, and pre-pregnancy obesity (Rundle et al., 2012). Exposure to pollutants is also likely to increase the risk of low birth weight and small-for-gestational-age births (Vinikoor-Imler, Davis, Meyer, Messer, & Luben, 2014). These findings have been reported in infants born to women with lower socioeconomic status, chronic hypertension, diabetes and high BMI (Laurent et al., 2014). Next, the food environment represents another important factor to examine in segregated residential areas for its implications in the prevention of childhood obesity. Non-chain supermarkets, grocery stores, fast-food restaurants, and energy-dense foods are more prevalent in low-income, minority neighborhoods (Zenk et al., 2005). Hispanic census tracts with up to 20% of households living below the federal poverty level report having the most grocery stores (Bower, Thorpe, Rohde, & Gaskin, 2014; Zenk et al., 2005). These factors are likely to contribute to the accessibility of fresh fruit, vegetables, low-fat milk, and high-fiber foods (Jaskiewicz et al., 2013; Larson, Story, & Nelson, 2009).

Some studies report children's increasing weight status despite proximity to local supermarkets with accessibility to healthier food options (Chaparro et al., 2014; Ohri-Vachaspati, Lloyd, Delia, Tulloch, & Yedidia, 2013). While there are no studies on residential segregation and food options for preschoolers, limited studies report Black adults' selection of food markets being associated with lower BMI status while supermarkets, wholesale clubs, and food pantries have resulted in opposite findings (Hosler, Michaels, & Buckenmeyer, 2016). Small corner

groceries are more prevalent in Black neighborhoods as compared to racially mixed and white neighborhoods in predominantly Black-White communities (Morland, Wing, Diez Roux, & Poole, 2002; Zenk, Mentz, Schulz, Johnson-Lawrence, & Gaines, 2016). Hispanics living in neighborhoods with higher immigrant composition are more likely to be exposed to healthier food environments (Osypuk et al., 2009). Findings from limited studies suggest that there are differentials in quality of the diets in Hispanics by ethnic subgroups. One study reported differentials in the children's consumption of ethnic foods, with Mexicans having the healthier diets and lower obesity rates when compared to Dominicans and Puerto Rican subgroups (Vangeepuram, Mervish, Galvez, Brenner, & Wolff, 2012).

Organizational factors in the social environment, such as the child care center or early learning environment present opportunities in the prevention of childhood obesity (Benjamin Neelon, Taveras, Ostbye, & Gillman, 2014). Lower-income Hispanic children attend preschool classrooms segregated by family income, race, and ethnicity (Reid & Kagan, 2015). In some metropolitan areas there is preference by Hispanic families to have their children attend family child care centers operated by Hispanic staff (Lindsay, Salkeld, Greaney, & Sands, 2015). In these settings, educators play a significant role in the promotion and modeling of healthy behaviors in young children (Ward, Belanger, Donovan, & Carrier, 2015). Their perceptions and beliefs are important as they may shape the physical activity, screen-time, and dietary behaviors in children under their care (Tovar, Mena, Risica, Gorham, & Gans, 2015). Policy-related factors displayed to the left of the conceptual model have significant implications as federal, state, local policies and programs may help moderate the effects of residential segregation and inequalities for Hispanic minorities. Changes in child care regulations in nutrition, physical activity, and screen-time have been associated with lowering prevalence of obesity in low-income preschool groups (Sekhobo et al., 2014). Other factors such as the centers' participation in the Child and Adult Care Food program (CACFP) moderately increases the consumption of milk, fruits, vegetables, and meat/meat alternatives, and may reduce the prevalence of overweight and underweight in young children (Korenman, Abner, Kaestner, & Gordon, 2013; Ritchie et al., 2012).

#### Proximate Factors: Parental Household Factors

Parental household factors in the context of residential segregation in the preschool Hispanic population need to be explored. Based on studies in older children, foreign-born Hispanic immigrants are more likely to have lower family income and maternal education, and to live in areas of higher immigrant density and greater linguistic isolation (Gordon-Larsen, Harris, Ward, & Popkin, 2003). Rapid acculturation of overweight-related behaviors is likely to take place in U.S. born relative to foreign-born immigrants. However, children and adolescents tend to participate in global culture more quickly than their parents (Gordon-Larsen et al., 2003; Sobal, 2001). Longer U.S. residence has been associated with increased overweight later in the life course, as observed in Puerto Rican and Cuban youth (Gordon-Larsen et al., 2003). Acculturation factors such as language use in the household also need to be explored, especially when children of Spanish-speaking-only households are twice as likely to have an obese preschool child when compared to English-only speaking households (Messiah et al., 2015).

It has been well established that parents play an important role in the prevention of obesity in children during the preschool age. Children's dietary and physical activity behaviors have been associated with parental dietary and physical activity behaviors (Pearson, Biddle, &

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Gorely, 2009; Ruiz, Gesell, Buchowski, Lambert, & Barkin, 2011). The parental influences are likely to moderate the child's individual factors, thus increasing his/her risk of obesity (arrow 5). Other factors such as parents' food practices and their perception of a healthy weight may also play a role in their child's weight status (Chaparro, Langellier, Kim, & Whaley, 2011; Sherry et al., 2004). Parental underestimation of their child's weight status is more prevalent in Hispanic parents of an overweight/obese child when compared to other racial/ethnic groups (Boutelle, Fulkerson, Neumark-Sztainer, & Story, 2004; Gauthier & Gance-Cleveland, 2015, 2016). The family and cultural context are also important, as Hispanic mothers report pressures of familial and cultural influences endorsing a "chubby child" despite health-related and social consequences of childhood overweight (Lindsay, Sussner, Greaney, & Peterson, 2011). These factors need to be studied, especially when lower-income Spanish speaking families with young children are likely to have traditional foods more readily available than American foods (Evans et al., 2011).

Factors such as food availability and cost, health concepts, the eating habits of children, and long work hours also play a role in the parents' selection of foods brought into the home environment (Gray, Cossman, Dodson, & Byrd, 2005). Lower-income Hispanic children are likely to experience food insecurity and this in turn increases their risk of obesity (Mangini, Hayward, Dong, & Forman, 2015; Papas, Trabulsi, Dahl, & Dominick, 2015). Higher food security has been associated with higher consumption of fruit and vegetables and lower consumption of unhealthy foods, moderated by ethnicity in Hispanic and Haitian households (Asfour et al., 2015). Low-income Hispanic households face higher rates of food insecurity than national average (26.2%) when compared to Black and White, non-Hispanic households (Coleman-Jensen, Nord, Andrews, & Carlson, 2011). The presence of federally funded nutrition assistance programs such as the Supplemental Nutrition Assistance Program (SNAP) may help moderate the food insecurity in the household for parents and preschool Hispanic children living in segregated residential areas (Mabli & Worthington, 2014). Participation in these programs may also serve as a vehicle for nutrition education and promotion of physical activity in Hispanic vulnerable populations (Mabli & Worthington, 2014; Stang & Bayerl, 2010).

Maternal factors have received increased attention in the programming of childhood obesity early in the life course. Findings from longitudinal and cross-sectional studies report maternal adversity and chronic exposure to stress in the life course increase the risk of pre-pregnancy obesity, maternal gestational weight gain, and obesity risk in the offspring (Ranchod et al., 2016; Boney, Verma, Tucker, & Vohr, 2005). An increase in maternal stressors has been reported to amplify a food secure child's probability of being overweight or obese (Gundersen, Lohman, Garasky, Stewart, & Eisenmann, 2008). For Hispanic mothers, stress-related factors including interpersonal discrimination have also been associated with increased obesity risks in Hispanic preschoolers (Acevedo-Garcia, Rosenfeld, Hardy, McArdle, & Osypuk, 2013; Kelly, Becares, & Nazroo, 2013). Low-birthweight (weight < 2500 grams) presents increased obesity risks when combined with accelerated weight gain during the first six months of life (Bjerregaard et al., 2014; Sacco, de Castro, Euclides, Souza, & Rondo, 2013). Simultaneously, living in disadvantaged neighborhoods, comprised of poverty, deprivation, racial residential segregation or racial composition, and crime increases the risk for preterm birth and low birth weight in infants (Ncube, Enquobahrie, Albert, Herrick, & Burke, 2016). Differences have been observed between foreign and U.S. born Hispanic enclaves, with U.S. born Mexican American mothers



living in U.S. born Hispanic enclaves reporting higher prevalence of low-birthweight rates when compared to those living in Mexican-born enclaves (Osypuk et al., 2010).

Other maternal factors such as pregnancy-induced hypertension, preeclampsia, undernutrition, smoking during pregnancy, hypercholesterolemia, increased glucocorticoid secretion, and chronic exposure to stress have been reported in high-prevalence low-birthweight segregated areas (Szostak-Wegierek & Szamotulska, 2011). However, maternal smoking during pregnancy, an established risk factor for childhood obesity, is prevalent in Hispanic women living in less racially segregated area with higher exposure to non-Hispanic White groups (Yang, Shoff, Noah, Black, & Sparks, 2014). Access to prenatal care may help moderate the segregation effects in Hispanic mothers, as they report inadequate prenatal care utilization associated with increased risk of prematurity and other negative birth outcomes (Partridge, Balayla, Holcroft, & Abenhaim, 2012). The limited studies indicate Hispanic and Black lower-income women are less likely to seek prenatal care when compared to non-Hispanic Whites (Chang, Tabet, Elder, Kiel, & Flick, 2016; Chung, Gregorich, Armitage, Gonzalez-Vargas, & Adams, 2014). Factors such as the concentration of community hospitals and hospital obstetric beds and supply of health care professionals are likely to help mitigate the negative effects of residential segregation in highly prevalent low-birthweight areas (Nyarko & Wehby, 2012). The mode of delivery of prenatal education and medical care for ethnic minorities such as Hispanics may contribute to their increase in prenatal care utilization (Lindberg, DeBoth, & Anderson, 2016; Tandon, Cluxton-Keller, Colon, Vega, & Alonso, 2013).

#### Immediate Individual Factors

Immediate factors such as the child's dietary and physical activity behaviors present a more direct effect in the development of childhood obesity (arrow 6). Living in immigrant enclaves may be differentially protective for Hispanic children based on individual and household factors (Glick & Yabiku, 2015). While higher immigrant density may be significantly more protective for lower income children, it may be less protective for those in worse general health, including those with higher BMI measures (Kim et al., 2014). As displayed in the model, parental and household factors will influence on the immediate individual factors (arrow 6). Despite Hispanic households' access to a yard or open space and usable play equipment, Hispanic children, especially foreign-born Hispanic children report lower levels of physical activity (Brewer & Kimbro, 2014) (Chuang, Sharma, Skala, & Evans, 2013; Innella, Breitenstein, Hamilton, Reed, & McNaughton, 2015). Studies report television watching during meals and using TV as babysitter and tool to learn English being prevalent in Hispanic children (Lindsay, Sussner, Greaney, & Peterson, 2009). Recent studies report racial and ethnic differences in the proportion of children meeting the 5-2-1-0 targets ( $\geq 5$  servings of fruit and vegetables,  $\leq 2$  hours of screen-time,  $\geq 1$  hour of physical activity, and 0 sugar-sweetened beverages daily), and Hispanic children reporting the lowest levels of physical activity. Overall, they are second to Blacks in not meeting these overall targets (Haughton, Wang, & Lemon, 2016).

The social and physical neighborhood context may contribute to the development of childhood obesity by an accumulation of disadvantage over time through exposures during critical periods in the developmental trajectories (Daniel et al., 2008; Galobardes, Smith, & Lynch, 2006). Exposures to negative, stressful conditions as well as those that may place a physiological demand, may result in overexposure to neural, endocrine, and immune stress

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mediators (allostatic load), leading to increasing weight, elevated glucose levels, lower high density lipoproteins, and cardiovascular risk (Schulz et al., 2012). Factors such as nativity, migration history, including time since immigration, number of residential moves, duration of residency, and intensity of exposures between and within places need to be considered with differential individual experiences though the life course (Daniel et al., 2008). Some of these factors have been associated with increasing weight status in Hispanic ethnic minorities (Glick & Yabiku, 2015; Goulao, Santos, & Carmo, 2015). The life-course perspective is necessary to frame the mechanisms by which risk factors in the early childhood period may contribute to the development of chronic diseases such as obesity during the life trajectory (Acevedo-Garcia et al., 2013; Daniel et al., 2008). Early childhood overweight and obesity track into the adulthood stage (Nader et al., 2006), and disparities in maternal/caregiver factors contribute to the programming of obesity early in the life course (Dixon, Pena, & Taveras, 2012).

Other factors such as early initiation and longer duration of breastfeeding present protective effects in the development of childhood obesity (Spatz, 2014). Hispanics report lower breastfeeding rates in eastern states (Lind, Perrine, Li, Scanlon, & Grummer-Strawn, 2014; Scanlon, Grummer-Strawn, Li, & Chen, 2010). Breastfeeding rates in Hispanics are likely to decrease with greater U.S. acculturation (Perez-Escamilla & Putnik, 2007; Rassin et al., 1994; Singh, Kogan, & Dee, 2007) and second and third-generation status (Barcelona de Mendoza, Harville, Theall, Buekens, & Chasan-Taber, 2016). Spanish-speaking mothers are more likely to initiate, intend, and maintain breastfeeding when compared to English-speaking Hispanic mothers, non-Hispanic Whites, and Black mothers (McKinney et al., 2016). In the promotion of lactation, employment requirements to have a site and/or break time for mothers to lactate and the presence of a state coalition funded for a longer period of time have been associated with higher breastfeeding state rates (Dozier & McKee, 2011). Supportive programs such as the Supplemental Nutrition Program for Women, Infants, and Children (WIC) present opportunities to increase breastfeeding practices in Hispanic mothers (Zhou, Emerson, Husaini, & Hull, 2014). Lastly, limited studies indicate genetics contributing to obesity susceptibility through biological pathways related to glutamate signaling, insulin secretion, energy metabolism, and adipogenesis (Farooqi & O'Rahilly, 2006; Locke et al., 2015; Shungin et al., 2015; Willer et al., 2009). It has been suggested that epigenetic mechanisms may mediate early environmental exposures during pregnancy with programmed changes in gene expression that may affect fetal/newborn development resulting in offspring obesity and obesity-associated metabolic abnormalities such as metabolic syndrome (Desai, Jellyman, & Ross, 2015). Their role in the context of neighborhood social and physical factors in segregated environments in Hispanic preschoolers needs to be explored.

## DISCUSSION

Despite reports of racial residential segregation within Hispanic communities, Hispanics continue to be underrepresented in studies of neighborhood context, residential segregation, and early childhood and maternal health (Mendez, Hogan, & Culhane, 2014; Messer, Vinikoor-Imler, & Laraia, 2012; Kramer & Hogue, 2009; Oka & Wong, 2014). The adult population has been the target of recent residential segregation obesity studies (Kershaw & Albrecht, 2014; Kershaw et al., 2013). Early childhood studies in Hispanic subgroups have centered on maternal prenatal and infant birth weight related outcomes (Acevedo-Garcia, Soobader, & Berkman, 2007; Osypuk et

al., 2010). Based on the limited studies, there is a need for more comprehensive methodological approaches to measure the various dimensions of residential segregation, particularly for Hispanics (Massey, 2012; Massey & Denton, 1989; Reardon & O'Sullivan, 2004). There are methodological inconsistencies in the measures used to account for the population group distribution and isolation or interaction within areal units or neighborhoods (Oka & Wong, 2014). Other factors such as school segregation, neighborhood social, economic, and contextual factors need to be addressed in the studies (Britton & Shin, 2013; Evenson et al., 2009; Vinikoor-Imler, Messer, Evenson, & Laraia, 2011) (Acevedo-Garcia et al., 2013).

Other limitations of the studies include the use of self-reported maternal data and limited maternal child information from birth certificates (Britton & Shin, 2013; Debbink & Bader, 2011). Other interpersonal factors such as maternal prenatal and pre-pregnancy health measures, including pre-pregnancy maternal weight (Messer et al., 2012), and country of natality (Britton & Shin, 2013) need to be included as these may play a differential role in the birth and weight-related outcomes for children living in segregated environments. Further studies are needed to clarify some of the contradictory findings as they relate to childhood obesity with attention to ethnic subgroups. The limited residential segregation studies have been characterized by the use of multilevel, population-based, cross-sectional, and hierarchical modeling methods using prevalent health outcomes (Osypuk, 2013). Further research including longitudinal studies, modeling the mediation of immediate, proximal, and distal exposures in segregated environments across time based on the age and developmental period of exposure are also needed (Acevedo-Garcia & Osypuk, 2008; Osypuk, 2013). Merging of individual and neighborhood factors with geographical information system (GIS) techniques to examine spatial segregation in the context of health are also needed (Wen & Maloney, 2011), especially in the preschool population.

Studies and health promotion efforts addressing obesity trends in Hispanic children must account for organizational and environmental influences on the day-to-day social context of young immigrant families (Lindsay et al., 2009). We need to continue the study of nutrition, physical activity, and sedentary behaviors related to overweight and obesity in young children in the context of the ecological model (Institute of Medicine, 2004). The ecological framework may inform our understanding of the effects of racial residential segregation in the various levels that children may be exposed during critical periods such as the early childhood years (Acevedo-Garcia et al., 2013). While no single study can provide the necessary data to understand the complex nature of obesity in children (Cockrell Skinner & Foster, 2013), rigor in measures to address the neighborhood influences in the food environment on individual dietary and physical activity behavior instruments at the community level are also advocated (Saelens & Glanz, 2009). Racial residential segregation studies need to be inclusive of cultural values, frameworks, resources, and institutional policies and practices (Griffith, Johnson, Ellis, & Schulz, 2010). Residential segregation studies in neighborhood local and metropolitan areas are advocated as these may represent a different range of exposures, structural barriers or risks (Osypuk, 2013). Measures such as the neighborhood index of opportunity present an alternative measure of neighborhood-based protective (risk) factors of children's health development (Acevedo-Garcia et al., 2013). Their use in the context of childhood obesity as a health outcome will need to be explored.

## CONCLUSION

With the persistent disparities in the prevalence of obesity in Hispanic young children and the complex nature of childhood obesity, there is a need for improved conceptual frameworks to examine the contextual factors in the environments in which preschool children live and play. The ecological and life course frameworks should be considered in the study of individual, household, organizational, and community factors associated with childhood obesity in race-based segregated environments. This paper conceptualizes the role of the neighborhood social and physical factors as well as organizational, household and/or individual factors as mediators of the correlation between residential segregation and obesity in Hispanic preschoolers. We presented this model as a strategy to guide in the specification of factors in testable analytical models of racial residential segregation and obesity in Hispanic preschool children early in the life course. The model also has implications for other ethnic and migrant minorities living in ethnic enclaves in the United States.

As presented in the model in figure 1, racial and ethnic residential segregation interacts with inequalities in allocation of resources in Hispanic communities/ neighborhoods. Factors in the neighborhood social and physical environments, as well as household, organizational, and individual factors are likely to mediate the association between residential segregation and child's development of obesity during the preschool period. Policies and programs targeting the nutrition, physical activity, and early life risk factors associated with obesity present significant opportunities to help mitigate the negative effects of residential segregation and inequalities for Hispanic young children. Based on the last two decades of childhood obesity research, we have an increased understanding of the fundamental, intermediate, proximate, and immediate factors associated with obesity during the early childhood period. Research in the context of racial residential segregation shows that while segregated residential areas may be affected by adverse environments limited to physical activity or access to healthy foods, they may represent supportive environments particularly for new immigrants through the social networks, common languages, practices, and norms.

This review provides practitioners, researchers, and policy makers with important information on factors associated with childhood obesity in the preschool Hispanic population living in segregated, disadvantage areas. In terms of policy, this review highlights the importance of national, state, and local programs in moderating the effects of food insecurity and negative food and physical activity environments for Hispanic preschool minorities. Future studies should examine whether the experience and effects of institutional discrimination in the form of residential segregation vary by developmental age, country of natality, length of residential stay, as well as number of residential moves for young children. It will be important to determine the cumulative effects of these exposures across time, and whether interpersonal and institutional discrimination may interact effecting increased risk of obesity in Hispanics children. This review highlights methodological considerations for future studies of racial residential segregation and intervention work in lower-income, Hispanic children during the early childhood period. Considerations for future studies should extend to the use of longitudinal studies to observe the causal effect of racial/ethnic neighborhood factors on obesity risk. Other factors to account for should include the study of changes within the community with migration/mobility of other ethnic groups across time. State, federal, and community programs and policies should also be studied in their role to offset disparities.

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