

# *Salud America!*

The Robert Wood Johnson Foundation Research  
Network to Prevent Obesity Among Latino Children



## **Physical Activity, Overweight and Obesity Among Latino Youth**

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The Robert Wood Johnson Foundation Research Network to Prevent Obesity Among Latino Children

## RESEARCH BRIEF

December 2011

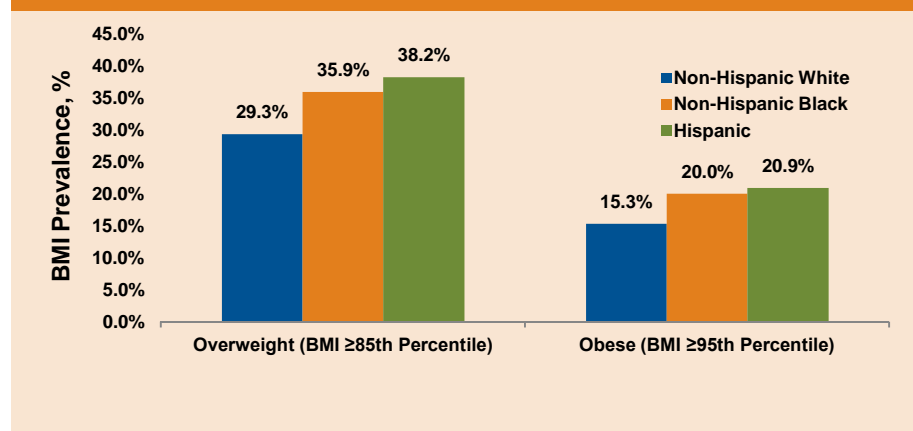
# Physical Activity, Overweight and Obesity Among Latino Youth

## Introduction

Latino youth are more likely to be overweight or obese than their white peers (Figure 1).<sup>1</sup> According to current estimates, more than 38 percent of Latino youth ages 2-19 in the United States are overweight and almost 21 percent are obese.<sup>1</sup> The higher prevalence of overweight and obesity among Latino youth increases their likelihood for developing health and psychological problems, including cardiovascular disease, asthma, type 2 diabetes, liver disease, sleep apnea, depression, anxiety and psychological stress.<sup>2,3</sup> These negative effects on Latino youth—and the nation as a whole—cannot be understated, as Latinos currently represent the most populous and fastest growing ethnic minority in the United States. In 2010, the 50.5 million Latinos in the United States comprised 16 percent of the total population—a figure that grew by 43 percent between 2000 and 2010.<sup>4</sup> In the coming years, the negative effects felt in this large minority population will likely ripple through the health of the nation as a whole, resulting in greater health care expenditures, higher disability rates, lost work productivity, stunted economic growth, and perhaps even threats to national security.<sup>5-9</sup>

FIGURE 1

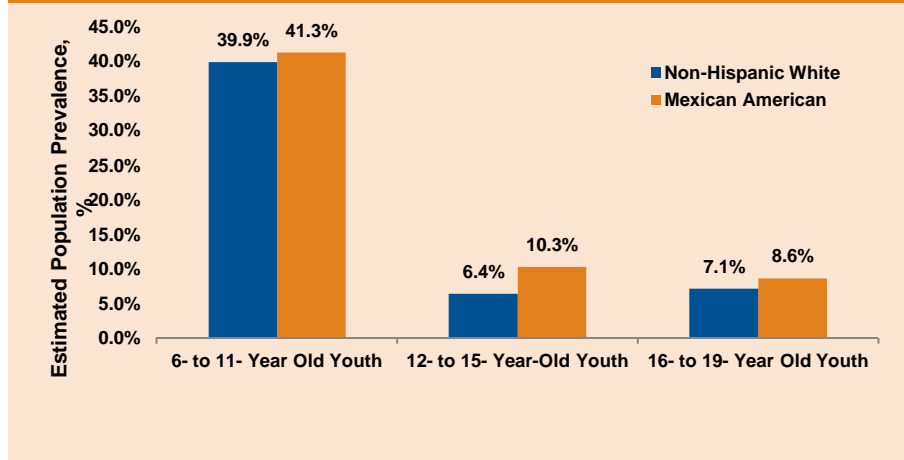
High body mass index (BMI) among U.S. youth ages 2-19 is most prevalent in Latinos, 2007-2008<sup>1</sup>



Data source: National Health and Nutrition Examination Survey 2007-2008.

Insufficient physical activity and excessive sedentary behavior contribute significantly to the obesity epidemic among Latino youth. National studies show that Mexican-American children and teens have higher physical activity levels—but also higher rates of obesity—than white youth (Figure 2).<sup>10-12</sup> National data also show that the vast majority of U.S. teenagers fail to meet the recommended one hour per day of moderate-to-vigorous physical activity.<sup>13</sup> Studies of Latino youth support this finding, indicating that physical activity levels decrease markedly with increasing age and showing that physical activity is consistently lower among Latino girls than boys.<sup>10,14,15</sup>

**FIGURE 2**  
**Mexican American youth are more likely to achieve physical activity recommendations (≥ 60 min/day for 5 of 7 days) than white youth, 2003-2004<sup>12</sup>**



Data source: Accelerometer data from the National Health and Nutrition Examination Survey, 2003-2004.

Preventing obesity among Latino youth will require a sizeable decrease in energy intake and/or a reciprocal increase in physical activity.<sup>16</sup> This brief summarizes research that examines environmental, socioeconomic and cultural factors related to physical activity and/or obesity among Latino youth. These findings will help inform solutions for reversing the obesity epidemic among Latino youth.

## Key Research Results

- Latino parents report more barriers to their children's physical activity than do white parents, including transportation problems, concerns about neighborhood safety, and the expense and availability of local recreation opportunities (Figure 3).** These data come from a nationally representative survey of children ages 9-13 and their parents. The survey was conducted by the Centers for Disease Control and Prevention to assess physical activity levels among American youth.<sup>17</sup>

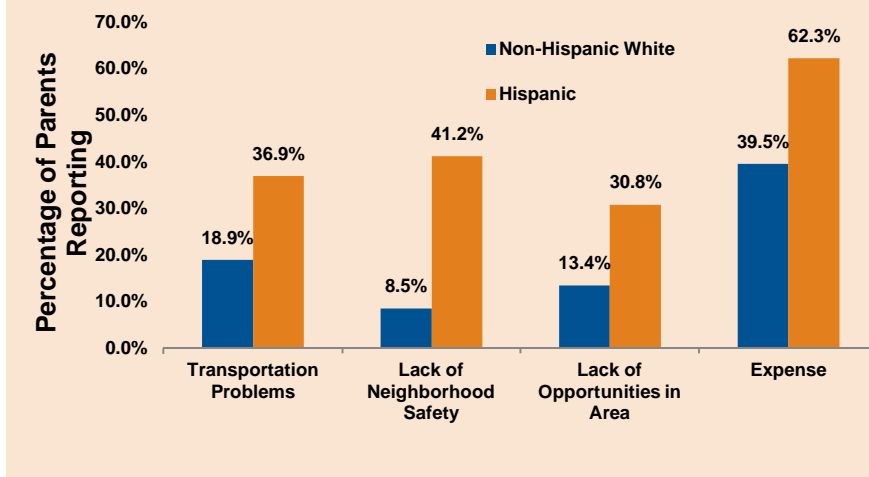
*Environmental and socioeconomic factors pose barriers to physical activity and facilitate sedentary behavior among Latino youth.*

- **Latino children living in lower-income communities and unsafe neighborhoods are more likely to be physically inactive, overweight and/or obese.**<sup>18-21</sup> Analysis of cross-sectional, nationally representative data from the National Survey of Children's Health determined that the correlation between living in a poorer household (household income  $\leq$ 150% of the federal poverty level) and being overweight or obese is strongest for Latino children compared with white or black children (odds ratio: 2.00 vs. 1.54 and 1.22, respectively).<sup>18</sup> Living in neighborhoods that have high rates of crime or lack safe parks, playgrounds or streets is a major contributor to this outcome. Research shows that neighborhoods with higher proportions of immigrant Latinos are more likely to be considered unsafe than those with lower proportions.<sup>19</sup> Latino children in these neighborhoods may then be likelier to stay indoors and watch television or other media which may, in turn, contribute to childhood obesity.<sup>20,21</sup> A recent nationally representative study suggests that maternal perceptions of inadequate police protection correlate with increased television watching among children and are a significant determinant of children's BMI.<sup>20</sup> Moreover, views of inadequate police protection typically had larger and more significant effects on BMI among Latino and black children compared with white children.<sup>20</sup>
- **Latino children are more likely to live in unsafe areas with poor street environments, which may negatively affect opportunities to walk to school.**<sup>19,22</sup> For example, a cross-sectional study of 73 public elementary schools conducted by researchers at Texas A&M University found that schools with high proportions of Latino students were significantly more likely to have students living near school and to have more completed sidewalk networks. However, these schools were also significantly more likely to be surrounded by neighborhoods with increased dangers from automobile crashes, crime and less walkable streets, characterized by poor visual quality, lack of physical amenities (e.g., tree shade, enclosures along sidewalks), and poorly maintained sidewalks and buildings.<sup>22</sup>
- **Immigrant Latino children are more likely to be physically inactive compared with both native whites and native Latinos.** According to reports from parents collected by the cross-sectional National Survey of Children's Health, 22.5 percent of immigrant Latino children ages 6-17 were physically inactive, defined as having no days with at least 20 minutes of physical activity in the past week. The same survey found that 9.5 percent of U.S.-born white children with U.S.-born parents were inactive and 14.7 percent of U.S.-born Latino children with U.S.-born parents were inactive. These disparities may be tied, in part, to low household income and neighborhood safety, which contribute to fewer opportunities to be active or pursue sports. However, other cultural influences, such as permission to watch a significant amount of television or emphasis on studying are also likely at play.<sup>23</sup>
- **Latino youth are significantly less likely than their white peers to get involved in organized physical activity outside of school.**<sup>17,18,23,24</sup> Cross-sectional data from the National Survey of Children's Health revealed that 50.3 percent of native

Latino children ages 6-17 (U.S.-born with U.S.-born parents) do not participate in sports after school or on weekends compared with 35.9 percent of native white children. The prevalence of no sports participation is even higher among immigrant Latino children with immigrant parents (66.6%).<sup>23</sup> These differences may partly reflect cultural influences that may not necessarily promote leisure-time physical activity and participation in organized sports (e.g., greater value placed on academic studies or family activities versus physical activity), as well as social environmental factors, such as lack of access to recreational facilities.

FIGURE 3

**U.S. parents of Latino children are significantly more likely to report barriers to their children's participation in physical activities, 2002<sup>17</sup>**



Note: All differences significant at  $P < 0.05$ .

Data source: Youth Media Campaign Longitudinal Survey 2002.

- Latino acculturation to the United States is significantly associated with a lower frequency of physical activity and more time spent watching television.**<sup>23,25</sup> According to a longitudinal study of students attending 24 ethnically diverse middle schools in urban Southern California (69% Latino), Latino adolescents adapted to American culture<sup>i</sup> were less physically active than white adolescents. This association persisted even after controlling for age, gender, socioeconomic status, parents' education and English-language usage.<sup>25</sup> As data from the National Survey of Children's Health illustrate, U.S.-born Latino children are more likely to watch more than 3 hours of television per day

*Cultural and parenting factors can also pose barriers to physical activity or facilitate sedentary behaviors among Latino youth.*

<sup>i</sup> U.S. acculturation was measured with the Acculturation, Habits, and Interests Multicultural Scale for Adolescents (AHIMSA) and a measure of English-language usage.

compared with both immigrant Latino children and U.S.-born white children.<sup>23</sup> The factors underlying these behaviors are unclear, but the findings suggest that Latino youths navigating the acculturation process are more likely to be sedentary, which can increase their risk of obesity.

- **Latino youth spend considerable time using media (watching television, using a computer, playing video games), and their parents set fewer limitations on their children's use of media compared with white or black parents.**<sup>26,27</sup>

According to a recent study by the Kaiser Family Foundation, Latino children spend 13 hours each day engaged in various forms of media—nearly 4.5 hours more than white children who spend about 8.5 hours per day using media.<sup>26</sup> In addition, Latino youth spend almost 5.5 hours per day watching television, about 2 hours more each day than white youth. The same study found that Latino children ages 8-18 are less likely to report that their parents set rules regarding the amount of time they spend on television, computers and video games compared with white or black children. Screen time is linked to sedentary behavior, which is a key risk factor for obesity.

- **Parents of overweight Latino children provide less support for their children to engage in physical activity (e.g., encouraging participation in physical activity, participating in physical activity with children and providing transportation to areas where children can be physically active).** These data come from a study of parents and children at 13 public elementary schools in south San Diego County (Latino enrollment >70%) that was conducted by researchers at San Diego State University before implementing an intervention to prevent childhood obesity.<sup>27</sup> Although these data were collected from only one place in the United States and are not necessarily generalizable to the nation as a whole, the findings may be indicative of potential barriers faced by Latinos within certain segments of the United States.
- **Lack of quality advice from healthcare providers about physical activity and weight issues is a barrier for some Latino parents.** In a study conducted by Harvard Medical School and Harvard Pilgrim Health Care in the greater Boston metropolitan area, Latino parents of overweight or obese children were 2.8 times more likely than their white counterparts to rate as “poor” or “fair” the quality of physical activity and nutrition advice pertaining to their child's weight that they received during a primary care visit—a difference seen even after adjusting for parental education and household income.<sup>28</sup> Again, although these data were collected from only one place in the United States and are not necessarily generalizable to the nation as a whole, the findings may be indicative of potential barriers faced by Latinos within certain segments of the United States.
- **Requiring physical education (PE) in schools can help increase daily physical activity, improve fitness status and reduce obesity rates among youth, particularly in low-income communities.**<sup>29,30</sup> In 2005, the state of Texas passed a measure requiring public middle school students (grades 6-8) to participate in PE for a minimum of 30 minutes each day or 135 minutes per week. A survey of 16 low-resource schools in Texas located along the U.S.-Mexico border found that

*There are effective interventions for overcoming barriers to physical activity among Latino youth.*

these schools exceeded minimum requirements. On average, the schools offered PE instruction about 4.5 days per week with more than 58 minutes of physical activity per class, or more than 250 minutes per week. Based on direct observation, these schools met the Healthy People 2010 objective for having at least 50 percent of PE time devoted to moderate-to-vigorous physical activity (mean time: 54.9%).<sup>29</sup> These findings suggest that schools have the potential to play a key role in supporting physical activity, especially in lower-income Latino communities.

- **Positive parental influence, such as positive reinforcement and monitoring, parental engagement, parent-child communication, and role-modeling, can favorably influence Latino children's physical activity patterns.**<sup>31-34</sup> For example, a study of nearly 700 parents (26% Latino) of 4<sup>th</sup>- and 5<sup>th</sup>-graders from Houston public schools found that children are significantly more likely to be physically active and spend less time watching television and using the computer if their parents enjoy and encourage participation in team or individual sports.<sup>34</sup> As discussed previously, the cost and availability of such recreational programs and transportation problems are likely significant barriers for many Latino families, especially those living in lower-income or unsafe communities.
- **Among the Latino community, aspects of parenting that influence children's risk for obesity and related health outcomes are modifiable with the support of *promotoras*.** A recent San Diego State University study showed that personal visits from *promotoras* (lay health workers) effectively helped Latino parents improve parenting skills that can help reduce childhood obesity risk. More specifically, parents visited by *promotoras* reported significant increases in monitoring of their child's diet and physical activity, use of positive reinforcement for diet and physical activity, and parental support for physical activity. These parents also reported significantly less consumption of away-from-home foods in their families and less television watching during dinner, along with increased use of strategies to help improve diet and increase physical activity.<sup>35</sup>
- **The introduction of physical activity (aerobic or strength exercise) among sedentary and/or overweight Latino youths provides health benefits (e.g., increased insulin sensitivity, greater muscle mass), even in the absence of weight loss.**<sup>36-38</sup> For example, one research study showed that sedentary lean and obese Latino adolescents who participated in a 12-week program of moderate aerobic exercise significantly improved their overall fitness level, increased their lean body mass, and increased their insulin sensitivity, even though there were no significant effects on weight loss.<sup>36</sup> These findings are encouraging given the high risk of obesity-related illnesses among sedentary obese Latinos. These findings further substantiate the need for affordable, culturally-tailored programs that support and encourage physical activity among Latino youth, especially those living in unsafe or lower-income communities.





## Conclusions

- Environmental and socioeconomic factors involving transportation, infrastructure (e.g., poor sidewalk maintenance, lack of parks and playgrounds, limited local recreation opportunities), and safety concerns limit options for physical activity and may increase sedentary behaviors among Latino youth.
- The strong presence of various forms of media, namely television, in Latino households poses a significant challenge to regular physical activity among Latino youth.
- The family and social environments in which Latino children are raised may play a vital role in establishing physical activity patterns and determining obesity risk. Early promotion of physical activity and limitations on sedentary behaviors, such as television viewing, may help establish positive behavioral patterns that persist as children age.
- State policies that require PE in schools have been successful in promoting physical activity among Latino youth. Given the barriers to physical activity in many lower-income communities, school-based programs may play a critical role in helping Latino children get regular physical activity.
- Moderately increasing physical activity levels can yield important health benefits for Latino youth and may counteract the risk of obesity-related illnesses among sedentary obese Latinos.

## Areas for Future Research

The determinants of overweight and obesity among Latino youth are multifactorial. To effectively address this epidemic, additional research is needed to better discern the link between physical activity, overweight and obesity among Latino youth, including the influence of socioeconomic status, behaviors, and the social and cultural environments. Such studies should address questions concerning:

- The influence of neighborhood and home environments on Latino students' physical activity patterns.
- The influence of traditional Latino culture, particularly as it may vary by country of origin, and American acculturation on the physical activity and sedentary behaviors of Latino youth.
- The effectiveness of public policy for promoting physical activity within racial and ethnic communities at high risk for obesity, including efforts to make communities safer and increase affordable opportunities for physical activity (e.g., developing new or maintaining existing parks, playgrounds and recreation facilities).
- The interactions between behaviors, environments and public policies, along with their combined influences on Latino youth's physical activity and obesity patterns.
- The effectiveness of multifaceted interventions focused on physical activity and healthy eating, especially when adapted to be culturally relevant to Latinos.



## Policy Implications

- Interventions designed to promote physical activity among Latino children should be a health priority among local governments and city councils.
- Given that Latino youth tend to live in neighborhoods with poor sidewalks and unsafe streets and their parents believe police protection is inadequate, local transportation, public works and law enforcement departments should prioritize improvements in these areas to help promote outside physical activity (e.g., walkability).
- State policies that require regular, quality PE classes can be effective if schools are provided sufficient support to implement them. Local leaders and school districts should implement joint-use agreements that would expand school-based physical activity settings for the entire community and support Safe Routes to School or other active commuting programs.
- Interventions to address obesity among Latino children should be culturally relevant (e.g., information should be provided in English and Spanish, sports and recreational activities favored by Latinos should be promoted). Such interventions also should involve family members, including parents and siblings, to engage the full family unit and harness the power of positive role-modeling. Programs involving *promotoras* have proven to be effective and should be expanded.

## ABOUT THE PROGRAM

*Salud America!* The RWJF Research Network to Prevent Obesity Among Latino Children is a national program of the Robert Wood Johnson Foundation. The program aims to unite and increase the number of Latino researchers engaged in research and interventions on childhood obesity among Latinos to seek environmental and policy solutions to the epidemic. The network is directed by the Institute for Health Promotion Research at The University of Texas Health Science Center at San Antonio.

For more information, visit <http://www.salud-america.org>.

## ABOUT THIS BRIEF

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## References

1. Ogden CL, Carroll MD, Curtin LR, et al. Prevalence of high body mass index in US children and adolescents, 2007-2008. *JAMA*. 2010;303(3):242–249.
2. Centers for Disease Control and Prevention. *Obesity and Overweight for Professionals: Childhood Consequences*. Atlanta, GA: Centers for Disease Control and Prevention; 2009. <http://cdc.gov/nccdphp/dnpa/obesity/childhood/consequences.html>. Accessed February 11, 2011.
3. BeLue R, Francis LA, Colaco B. Mental health problems and overweight in a nationally representative sample of adolescents: effects of race and ethnicity. *Pediatrics*. 2009;123(2):697–702.
4. Humes KR, Jones NA, Ramirez RR. Overview of race and Hispanic origin: 2010. *2010 Census Briefs*, C2010BR-02. Washington, DC: US Census Bureau; 2011. <http://www.census.gov/prod/cen2010/briefs/c2010br-02.pdf>. Accessed May 17, 2011.
5. Finkelstein EA, Trogdon JG, Cohen JW, Dietz W. Annual medical spending attributable to obesity: payer- and service-specific estimates. *Health Aff (Millwood)*. 2009;28(5):w822–w831.
6. Thorpe KE. *The Future Costs of Obesity: National and State Estimates of the Impact of Obesity on Direct Health Care Expenses*. Minnetonka, Minn.: United Health Foundation, the American Public Health Association and Partnership for Prevention; 2009.
7. Ricci JA, Chee E. Lost productive time associated with excess weight in the U.S. workforce. *J Occup Environ Med*. 2005;47(12):1227–1234.
8. Goetzel RZ, Hawkins K, Ozminkowski RJ, Wang S. The health and productivity cost burden of the 'top 10' physical and mental health conditions affecting six large U.S. employers in 1999. *J Occup Environ Med*. 2003;45(1):5–14.
9. Mission: Readiness. *Too Fat to Fight: Retired Military Leaders Want Junk Food Out of America's Schools – A Report by Mission: Readiness, Military Leaders for Kids*. Washington, DC: Mission Readiness; 2010. [http://cdn.missionreadiness.org/MR\\_Too\\_Fat\\_to\\_Fight-1.pdf](http://cdn.missionreadiness.org/MR_Too_Fat_to_Fight-1.pdf). Accessed August 17, 2010.
10. Belcher BR, Berrigan D, Dodd KW, Emken BA, Chou CP, Spruijt-Metz D. Physical activity in US youth: effect of race/ethnicity, age, gender, and weight status. *Med Sci Sports Exerc*. 2010;42(12):2211–2221.
11. Matthews CE, Chen KY, Freedson PS, et al. Amount of time spent in sedentary behaviors in the United States, 2003-2004. *Am J Epidemiol*. 2008;167(7):875–881.
12. Whitt-Glover MC, Taylor WC, Floyd MF, Yore MM, Yancey AK, Matthews CE. Disparities in physical activity and sedentary behaviors among US children and adolescents: prevalence, correlates, and intervention implications. *J Public Health Policy*. 2009;30(Suppl 1):S309–S334.
13. Troiano RP, Berrigan D, Dodd KW, Mâsse LC, Tilert T, McDowell M. Physical activity in the United States measured by accelerometer. *Med Sci Sports Exerc*. 2008;40(1):181–188.
14. Butte NF, Puyau MR, Adolph AL, Vohra FA, Zakeri I. Physical activity in nonoverweight and overweight Hispanic children and adolescents. *Med Sci Sports Exerc*. 2007;39(8):1257–1266.
15. Stovitz SD, Steffen LM, Boostrom A. Participation in physical activity among normal- and overweight Hispanic and non-Hispanic white adolescents. *J Sch Health*. 2008;78(1):19–25.
16. Butte NF, Christiansen E, Sørensen TI. Energy imbalance underlying the development of childhood obesity. *Obesity (Silver Spring)*. 2007;15(12):3056–3066.
17. Duke J, Huhman M and Heitzler C. Physical activity levels among children aged 9-13 years – United States, 2002. *MMWR*. 2003;52(33):785–788.
18. Lutfiyya MN, Garcia R, Dankwa CM, Young T, Lipsky MS. Overweight and obese prevalence rates in African American and Hispanic children: an analysis of data from the 2003-2004 National Survey of Children's Health. *J Am Board Fam Med*. 2008;21(3):191–199.
19. Osypuk TL, Roux AV, Hadley C, Kandula NR. Are immigrant enclaves healthy places to live? The Multi-ethnic Study of Atherosclerosis. *Soc Sci Med*. 2009;69(1):110–120.

20. Sen B, Mennemeyer S, Gary LC. The relationship between perceptions of neighborhood characteristics and obesity among children. In: Grossman M, Mocan N, eds. *Economic Aspects of Obesity*. Chicago, IL: University of Chicago Press; 2011:145-180.
21. Burdette HL, Whitaker RC. A national study of neighborhood safety, outdoor play, television viewing, and obesity in preschool children. *Pediatrics*. 2005;116(3):657-662.
22. Zhu X, Lee C. Walkability and safety around elementary schools economic and ethnic disparities. *Am J Prev Med*. 2008;34(4):282-290.
23. Singh GK, Yu SM, Siahpush M, Kogan MD. High levels of physical inactivity and sedentary behaviors among US immigrant children and adolescents. *Arch Pediatr Adolesc Med*. 2008;162(8):756-763.
24. Johnston LD, Delva J, O'Malley PM. Sports participation and physical education in American secondary schools: current levels and racial/ethnic and socioeconomic disparities. *Am J Prev Med*. 2007;33(4 Suppl):S195-S208.
25. Unger JB, Reynolds K, Shakib S, Spruijt-Metz D, Sun P, Johnson CA. Acculturation, physical activity, and fast-food consumption among Asian-American and Hispanic adolescents. *J Community Health*. 2004;29(6):467-481.
26. Rideout V, Foehr U, Roberts D. *Generation M<sup>2</sup>: Media in the Lives of 8- to 18-Year Olds*. Menlo Park, CA: The Henry J. Kaiser Family Foundation; 2010. <http://www.kff.org/entmedia/upload/8010.pdf>. Accessed February 14, 2011.
27. Elder JP, Arredondo EM, Campbell N, et al. Individual, family, and community environmental correlates of obesity in Latino elementary school children. *J Sch Health*. 2010;80(1):20-30.
28. Taveras EM, Gortmaker SL, Mitchell KF, Gillman MW. Parental perceptions of overweight counseling in primary care: the roles of race/ethnicity and parent overweight. *Obesity (Silver Spring)*. 2008;16(8):1794-1801.
29. Barroso CS, Kelder SH, Springer AE, et al. Senate Bill 42: implementation and impact on physical activity in middle schools. *J Adolesc Health*. 2009;45(3 Suppl):S82-S90.
30. Madsen KA, Gosliner W, Woodward-Lopez G, Crawford PB. Physical activity opportunities associated with fitness and weight status among adolescents in low-income communities. *Arch Pediatr Adolesc Med*. 2009;163(11):1014-1021.
31. Arredondo EM, Elder JP, Ayala GX, Campbell N, Baquero B, Duerksen S. Is parenting style related to children's healthy eating and physical activity in Latino families? *Health Educ Res*. 2006;21:862-871.
32. Ornelas IJ, Perreira KM, Ayala GX. Parental influences on adolescent physical activity: a longitudinal study. *Int J Behav Nutr Phys Act*. 2007;2(4):3.
33. Anderson CB, Mâsse LC, Zhang H, Coleman KJ, Chang S. Contribution of athletic identity to child and adolescent physical activity. *Am J Prev Med*. 2009;37(3):220-226.
34. Anderson CB, Hughes SO, Fuemmeler BF. Parent-child attitude congruence on type and intensity of physical activity: testing multiple mediators of sedentary behavior in older children. *Health Psychol*. 2009;28(4):428-438.
35. Ayala GX, Elder JP, Campbell NR, et al. Longitudinal intervention effects on parenting of the Aventuras para Niños study. *Am J Prev Med*. 2010;38(2):154-162.
36. van der Heijden GJ, Toffolo G, Manesso E, Sauer PJ, Sunehag AL. Aerobic exercise increases peripheral and hepatic insulin sensitivity in sedentary adolescents. *J Clin Endocrinol Metab*. 2009;94(11):4292-4299.
37. van der Heijden GJ, Wang ZJ, Chu Z, et al. Strength exercise improves muscle mass and hepatic insulin sensitivity in obese youth. *Med Sci Sports Exerc*. 2010;42(11):1973-1980.
38. HEALTHY Study Group, Foster GD, Linder B, et al. A school-based intervention for diabetes risk reduction. *N Engl J Med*. 2010 29;363(5):443-453.