Original Article

The role of familial and sibling factors on abdominal adiposity: a study of south Indian urban children

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Background and Objectives: Childhood obesity is increasing in urban India. This study aimed to examine the associations of younger siblings abdominal adiposity with individual, familial and environmental factors, in urban school aged siblings. **Methods and Study Design:** Weight, height and waist circumference of 2906 siblings aged 3-16 years were measured along with details on demographics, diet, lifestyle, behavior and reported parental anthropometrics. Abdominal adiposity was classified as waist circumference above the age and sex specific 75th percentile value. The associations of various factors with abdominal adiposity in the younger siblings were examined through logistic regression analyses. **Results:** Sibling, familial factors and environmental factors had significant associations with abdominal adiposity. The odds of a younger sibling having abdominal adiposity was greatest (OR=3.16, 95% confidence interval (95% CI): 2.27 to 4.42), when the older sibling had abdominal adiposity, followed by the odds ratio of both parents being overweight (OR=1.63, 95% CI: 1.33 to 1.99) compared to neither being overweight. The influence of abdominal adiposity of the older sibling was greater when the siblings were of the same sex (OR=3.55, 95% CI: 2.24 to 5.65) than when they were of different sex (OR=2.73, 95% CI: 1.67 to 4.46); the odds ratio being highest when both siblings were males. **Conclusions:** The younger sibling's abdominal adiposity is associated with that of his/her sibling and parental obesity, in addition to other known risk factors in urban south Indian families. Interventions to prevent childhood obesity need to also consider the sibling effect along with the other known factors.

Key Words: childhood obesity, anthropometric measurements, waist circumference, lifestyle factors, sibling relationships

INTRODUCTION

The prevalence of overweight/obese children in urban India is rapidly increasing.[1] Childhood obesity often tracks into adulthood, and is linked to an increased risk of later chronic disease.[2-4] Since Asian Indians have more fat for a given Body Mass Index (BMI), particularly visceral fat,[5,6] the waist circumference (WC), rather than BMI, may be a better indicator of risk-related adiposity in Indian children.[7] Urban middle class children in India were found to have higher waist circumference when compared to age-and-sex matched British children, suggesting an early leaning towards the adult South Asian phenotype.[7-9]

The pathogenesis of childhood obesity is multifactorial, combining genetic pre-disposition and environmental factors. Many studies have examined dietary habits, lifestyle behaviors, family-based factors and their association with childhood obesity in developed country populations.[10] One factor that could be important is the family environment, since parental and sibling characteristics appear to have an important influence on childhood obesity.[11-15] Sibling designs have been used earlier to address questions related to family correlation or "familiality" in children's eating behavior and have observed that there is familial association of total energy and macronutrient intakes, independent of anthropometric measures, suggesting genetic or home environmental influences specific to these behaviours.[16] On the other hand, in another set of siblings, overweight/obese siblings had impaired ability to regulate short-term energy intake and consumed more snacks when satiated, when compared with normal-weight siblings.[17] A recent study in Ameri-

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can children examined obesity among siblings and observed that a younger child's obesity status was more strongly associated with the obesity status of an older sibling, than parental obesity status.[18] Siblings provide a unique opportunity to look at both the impact of a shared environment between pairs, alongside the impact of siblings themselves on one another.

The aim of this study was to examine the associations of individual, familial and correlated environmental factors with younger siblings abdominal adiposity, in a group of school-aged siblings of urban South India. This study employed a sibling design, based on stable family context, which exploited the fact that siblings in this study share stable aspects of family context such as parental overweight status, as well as half their genome. To our knowledge, there have been no studies conducted in India, which have examined abdominal adiposity in a sibling design, although there have been some population studies that examined the factors associated with abdominal adiposity in children.[7] The population studies could be confounded by family factors (genes and/or family context), when siblings are part of the sample examined.[19]

SUBJECTS AND METHODS

The sibling sets analyzed in this paper were originally a part of the PEACH cohort (Pediatric Epidemiology and Child Health), conducted by St John's Research Institute, Bangalore, India.[7] Cross-sectional data from 9060 children were collected between August 2008 and January 2010, across a number of urban middle income schools in Bangalore, with annual fees between Rs.24,000 to 30,000 (US$375-470). All normal, healthy children between the ages of 3 to 16 years consenting to participate were included in the study. Any child with significant clinical history or any chronic illness as reported by the parents during the consenting process were excluded. The study was approved by the Institutional Ethical Review Board (IEC Study Ref No. 177/2008) of St. John's Medical College, Bangalore and a parental informed consent was received. Siblings were identified within the cohort by corresponding telephone number followed by cross checking their address for exact matches.

Within this data set, there were 2906 siblings with complete questionnaires. For the purpose of our analysis, each household was restricted to a pair of siblings. The difference in waist circumference percentile between all sibling pairs in the households was calculated and the pair who had the maximum difference was maintained within the set for analysis. Thus, 150 individuals were removed from the data as third or fourth siblings were reduced reducing the final number of siblings to 2756.

Data on patterns of food consumption, physical activity and behaviors related to food intake were obtained using questionnaires. Consent forms along with questionnaires on socio-demographic data (collecting data of age, date of birth, sex, history of medical illness, parental education, occupation and income, height and weight) were sent to parents. For children <10 years, dietary and behavior questionnaires were completed by parents. The data collected included reported monthly frequencies of consumption of various foods (chocolate, ice cream, bakery items, cakes, soft drinks, fruit juices, fried items, non-vegetarian food, vegetables, fruits and milk). The children and parents were provided definitions for the food items and the parents were educated on filling the form before the data collection. The consumption of burgers, pizza, noodles and fries were termed together as "fast food" for the analysis. In addition, information on physical activity patterns, time spent in non-school tuitions, hours spent watching television and on the computer, and duration of sleep, were collected. The frequency of other food-related behaviors such as snacking, skipping breakfast, eating in front of the television or at restaurants was also recorded. Children ≥10 years completed the individual questionnaire in class, supervised by a trained nutritionist.

Anthropometric measurements of weight, height and waist circumference were recorded for all children in the study utilizing standard methodology.[20] Body weight was measured to the nearest 0.1 kg using a calibrated electronic scale (EssaeTeraoka Limited, India). Height was measured to the nearest 0.1 cm using a portable stadiometer (Seca 213, Germany). Reported height and weight were obtained for both parents. Using height and weight, child and parental BMI were calculated as kg/m^2. Parents were classified as overweight if BMI >25 and children were classified based on Cole's cut off for BMI.[21] Waist circumference was measured at the midpoint of the distance between the lowest rib and the iliac crest, to the nearest 0.1 cm, in a standing position during end-tidal expiration.[22] For each child, a waist circumference percentile was calculated based upon age and sex appropriate waist circumference curves, developed from the PEACH study.[7] A waist circumference percentile >75 was considered high waist circumference (high WC- abdominal adiposity). This percentile cut off was taken as the 75th percentile waist circumference in Indian children, which corresponded to the waist circumferences of 90th percentile for children in the UK.[7,9] The anthropometric data were collected by trained and certified nutritionists and the coefficients of variation within and between the nutritionists were 0.2% and 0.3% respectively.

Statistical methods

Continuous data are reported as mean±SD and categorical as n (%). The associations of individual characteristics such as diet, physical activity and behavior with abdominal adiposity of the younger sibling was examined using logistic regression. Initially one independent variable at a time was considered and all variables with p<0.2 in these analyses were included in multiple variable regression. The parental data obtained independently for each child were averaged within sibling pairs and considered for analyses. Parental overweight status was coded as either none, one or both parents being overweight. In order to identify the influence of older sibling's abdominal adiposity status (exposure) on the abdominal adiposity status of the younger sibling (outcome), logistic regression analyses was performed adjusting for individual and parental characteristics. Further similar logistic regression analyses stratified for the same sex siblings (both male and both female) and different sex siblings were performed. There were 671 younger children who had a different sex older sibling, 707 younger children

Table 1. Characteristics of the younger siblings with normal waist circumference and abdominal obesity

	Normal waist circumference (n=1119) Mean±SD	Abdominal adiposity† (n=259) Mean±SD
Waist circumference (cm)‡	54.5±6.0	66.2±9.0
Waist circumference Percentile‡	36.1±20.3	88.5±7.8
Overweight (n, %)‡	20, 1.8%	85, 32.8%
Fast food consumed (n, %)‡	568, 51%	179, 69%
Bakery food consumed (n, %)‡	891, 80%	233, 90%
Soft drink consumed (n, %)	609, 54%	156, 60%
Duration of sleep per night (hrs)‡	8.6±1.0	8.4±0.9
Gender, male (n, %)	640, 57%	131, 51%
Age (yrs)	8.0±2.7	8.3±2.8
Abdominal adiposity older sibling (n, %)‡	183, 16%	107, 41%
Maternal education level (n, %)‡		
Primary	37, 3%	6, 2%
Secondary	763, 69%	135, 53%
High School	244, 22%	88, 35%
College	61, 6%	24, 9%
Maternal BMI (kg/m^2)‡	22.5±5.2	24.1±4.7
Paternal BMI (kg/m^2)‡	23.8±4.8	25.1±4.6
Maternal Height (cm)‡	156.7±8.3	159.1±7.1
Paternal Height (cm)‡	168.6±8.6	170.1±9.1
Parent overweight (n, %)‡		
One overweight	386, 38%	93, 40%
Both overweight	180, 18%	76, 33%

†Waist circumference percentile >75.
‡p<0.05 for comparison between younger sibling with normal waist circumference and with abdominal obesity, by independent sample t test or Chi square test.

Table 2. Multiple logistic regression of abdominal adiposity in younger children with individual, sibling and familial characteristics (n=1096)†

Independent variables	Abdominal adiposity of younger sibling	
	OR	(95% CI)
Age difference	1.01	0.99, 1.01
Fast food intake	0.98	0.70, 1.36
Bakery food intake	1.62	0.97, 2.70
Soft drink intake	0.94	0.67, 1.30
Duration of sleep (hrs)	0.94	0.82, 1.08
Mother overweight (Yes)	1.81	1.32, 2.46
Father overweight (Yes)	1.45	1.06, 1.99
Maternal Height (cm)	1.02	0.99, 1.04
Paternal Height (cm)	1.02	0.99, 1.04
Older sibling having abdominal adiposity	3.22	2.30, 4.50

†Multiple variable analysis restricted to those with available parental anthropometric data.
OR: adjusted odds ratio from logistic regression of abdominal adiposity in younger siblings.

had same sex sibling. Among the same sex sibling pairs there were 422 pairs of boys and 285 pairs of girls. Adjusted odds ratio (OR) and corresponding 95% CI are reported for the logistic regression analyses. All analyses were performed using Stata 12 (StataCorp LP, College Station, TX, USA). Statistical significance was considered at p<0.05 for all analyses.

RESULTS

There were 1378 sibling pairs, comprising 57% male subjects (n=640). About 19% (n=259) of the younger sibling had abdominal adiposity (WC percentile >75 percentile). A number of individual characteristics were associated with abdominal adiposity in the younger siblings (Table 1). Among the dietary characteristics, fast food, bakery food had higher odds of abdominal adiposity (p<0.001, p<0.001 respectively, Table 2). Decreased duration of sleep per night was the only behavioral characteristic that was associated with abdominal adiposity (OR=1.17, 95% CI: 1.02-1.37). Among familial characteristics, older sibling with abdominal adiposity, parental height and BMI were also higher among younger sibling with abdominal adiposity.

The individual characteristics were not associated with abdominal adiposity in the multiple regression model. The multiple logistic regression model of abdominal adiposity in younger siblings showed that overweight status of mother and father independently had higher ORs (OR=1.81 and 1.45 respectively, both p<0.05) while it was 1.63 (95% CI: 1.33 to 2.99) when both parents were overweight compared to both parents being normal weight. Younger siblings with older siblings having

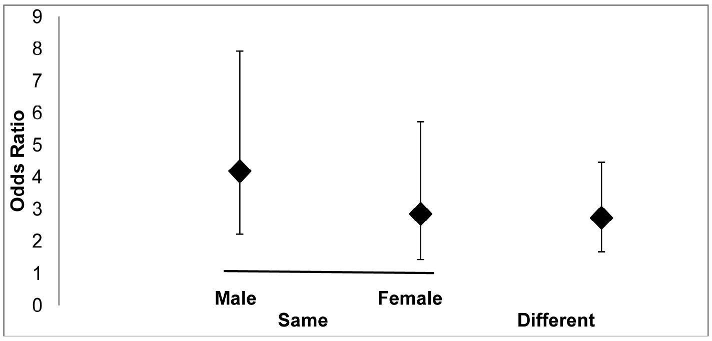

Figure 1. Adjusted odds ratios (95% confidence interval) for the abdominal adiposity of younger sibling for same (Male and Female) and different sex sibling pairs from logistic regression analysis

abdominal adiposity, had 3 times higher odds of having abdominal adiposity (OR=3.22, 95% CI: 2.30 to 4.50). In Figure 1, the odds ratios for the same sex against different sex sibling pairs are presented. When siblings were of the same sex, the abdominal adiposity of the older sibling had a stronger association (OR=3.55, 95% CI: 2.24 to 5.65) than different sex sibling pairs (OR=2.73, 95% CI: 1.67 to 4.46) (Figure 1). Male sibling pairs were more strongly associated (OR=4.18, 95% CI: 2.21 to 7.93) than female pairs (OR=2.85, 95% CI: 1.42 to 5.72, all $p<0.01$).

DISCUSSION

This study aimed to examine, within a sibling group, individual, familial and environmental factors associated with abdominal adiposity in the younger sibling. The findings of the study suggest that the younger sibling's abdominal adiposity was strongly associated with that of his/her older sibling and parental obesity. Literature on the effect of siblings on each other, in terms of obesity is limited and this study, the first in this area in India, where overweight/obesity is a rapidly escalating public health problem, adds valuable information for informing interventions. The effect of an older sibling with abdominal adiposity was the greatest, especially when the siblings were of the same sex, more so in boys. Similar results were observed in American children where, increased risk of second child having obesity (using BMI cut off), was observed when two siblings are of the same sex.[18] The sibling effect was not the only one in the present study, since parental and dietary factors along with decreased sleep were also associated with abdominal obesity in the younger siblings.

Significant correlation in body weight for siblings has been observed in childhood and adulthood.[24,25] While genetic contributions are substantial, studies have also shown that common environmental factors and shared parental and family characteristics, play a significant role in sibling correlated BMI levels.[26-28] A recent study in American children found that there is an increased risk of second child having obesity, when two siblings are the same sex.[18] This study however used gender specific BMI cut offs to define obesity. Literature on the effect of siblings on each other, in the area of abdominal adiposity and related behavior is limited. The unique contribution of the present study is it's examination of the association of older sibling's abdominal adiposity status on the younger sibling and assessing the effect of sibling gender homogeneity versus heterogeneity in this association. We used the waist circumference as an indicator, since we have previously observed that south Indian urban children have greater abdominal obesity when compared to British children,[7] and waist circumference has also been validated as a useful predictor for cardiovascular disease risk factors in children.[4]

Siblings could influence each other by the behavior modelling, which is the ability of older siblings to influence the attitudes in younger siblings, and due to the amount of time spent together.[28] It is likely that the influence is greater in same sex siblings and siblings of same sex had more influence on the weight gain of each other as compared to opposite sex siblings. Siblings influence each other for a variety of healthy and unhealthy behaviors.[29-31] Siblings play an important role in many behavioral outcomes such as academic engagement, smoking, alcohol, substance use and sexual behavior, with younger siblings being likely to follow the older sibling's patterns.[32-35] Therefore, obesity could spread in social networks in a quantifiable and discernable pattern depending on the nature of social ties,[36] and interventions to reduce this spread in public health or school initiatives, or even in clinical practice, should take cognizance of this effect. Although the older siblings effect on younger sibling's abdominal adiposity status was higher than the parents, this study demonstrated that both paternal and maternal BMI have equal effect on the abdominal adiposity status. The odds ratio of the younger child having abdominal adiposity, when one parent is overweight is lower than when two parents are overweight (defined as a BMI >25). Parental BMI, especially maternal BMI was a significant contributor to increased WC in south Indian children.[8] A study in Delhi on urban Bania populations showed the heritability of waist circumference to be approximately 45%, demonstrating the importance of the genetic factors.[12]

Our study identified individual factors such as increased fast food and bakery consumption along with decreased sleep to be significantly associated with abdominal adiposity in the younger sibling. Prior studies conducted in western countries have suggested that fast food consumption plays a significant role in the rise of childhood obesity.[37-39] In India, the quick service restaurant (QSR) industry is rapidly growing, serving either foreign cuisine or adapted Indian cuisine in a fast food service style and is expected to reach a turnover of about

70 billion by 2015-2016, growing at an annual rate of 27 percent.[40] Similar increasing trend is observed in cafeterias serving baked items. The affordability and accessibility of QSR food in urban India may well be contributing to the childhood obesity epidemic. Epidemiological evidence suggests that decreased sleep duration is associated with a higher risk of chronic diseases including obesity through various mechanisms, including modulation of hormones such as leptin and ghrelin.[41,42] We have also earlier demonstrated that decreased sleep was related to waist circumference[8] in south Indian urban children. Longitudinal studies are however needed to confirm these findings.

The present study is limited by its cross sectional nature in examining siblings across a wide age range (3-16 years). We also did not measure pubertal stage in this wide age range of our sample, and it is likely that puberty had a role to play in the onset of abdominal adiposity and also in the selection of health behaviors. The parental anthropometry in the present study was reported by the parents themselves and could have caused some bias, however it is likely that the bias would have been minimal since the siblings in the present study had shared parental anthropometry. Longitudinal studies across the full span of childhood and adolescence are needed before definitive conclusions can be reached.

These findings can still be considered as a starting point to plan the longitudinal studies. While parents need to be role-models for healthy eating and adequate physical activity, providing a safe environment for play and monitoring screen time at home, it appears that sibling behaviors may be of a greater influence on a younger sibling's waist circumference. This key finding of the present study can play an important role in daily clinical practice, while planning effective interventions to reduce/control the prevalence of childhood obesity. Diet, physical activity and behavioural modifications are the common approaches to the treatment of childhood obesity in clinical practice. Since older siblings often become role models and have the ability to influence the attitudes and behaviour of younger siblings, strategies considering and involving the sibling component in the treatment approach may result in effective strategies in prevention and treatment of childhood obesity.

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REFERENCES

1. Midha T, Nath B, Kumari R, Rao YK, Pandey U. Childhood obesity in India: a meta-analysis. Indian J Pediatr. 2012;79: 945-8. doi: 10.1007/s12098-011-0587-6.
2. Ezzati M, Lopez AD, Rodgers A, Murray CJL editors. Comparative quantification of health risks. Global and regional burden of disease attributable to selected major risk factors. Geneva: World Health Organization; 2004.
3. Food, Nutrition and the Prevention of Cancer: a Global Perspective. Washington DC: American Institute for Cancer Research and World Cancer Research Fund (AICR, WCRF); 2007.
4. Freedman DS, Serdula MK, Srinivasan SR, Berenson GS. Relation of circumferences and skin fold thicknesses to lipid and insulin concentrations in children and adolescents: The Bogalusa Heart Study. Am J Clin Nutr. 1999;69:308-17.
5. Prasad DS, Kabir Z, Dash AK, Das BC. Abdominal obesity, an independent cardiovascular risk factor in Indian subcontinent: a clinical epidemiological evidence summary. J Cardiovasc Dis Res. 2011;2:199-205. doi: 10.4103/0975-3583.89803.
6. Yajnik CS, Fall CH, Coyaji KJ, Hirve SS, Rao S, Barker D, Joglekar C, Kellingray S. Neonatal anthropometry the thin-fat Indian baby. The Pune Maternal Nutrition Study. Int J Obes Relat Metab Disord. 2003;27:173-80.
7. Kuriyan R, Thomas T, LokeshDP ,Sheth NR, Mahendra A, Joy R, Sumithra S, Bhat S, Kurpad AV. Waist circumference and waist for height percentiles in urban South Indian children aged 3-16 years. Indian Pediatr. 2011; 48:765-71.
8. Kuriyan R, Thomas T, Sumithra S, Lokesh DP, Sheth NR, Joy R, Bhat S, Kurpad AV. Potential factors related to waist circumference in urban South Indian children. Indian Pediatr. 2012;49:124-8.
9. McCarthy HD, Jarrett KV, Crawley HF. The development of waist circumference percentiles in British children aged 5.0-16.9 y. Eur J Clin Nutr. 2001;55:902-7.
10. Reed DR, Bachmanov AA, Beauchamp GK, Tordoff MG, Price RA. Heritable variation in food preferences and their contribution to obesity. Behav Genet. 1997;27:373-87.
11. Rozin P, Millman L. Family environment, not heredity, accounts for family resemblances in food preferences and attitudes: a twin study. Appetite. 1987;8:125-34.
12. Gupta S, Kapoor S. Gender differences in familial aggregation of adiposity traits in Aggarwal Baniya families. Eurasian J Anthropol. 2012;2:85-95.
13. Mushtaq MU, Gull S, Shahid U, Shafique MM, Abdullah HM, Shad MA, Siddiqui AM. Family based factors associated with overweight and obesity in Pakistani primary school children. BMC Pediatr. 2011;11:4. doi: 10.1186/1471-2431-11-114.
14. Lamerz AA, Kuepper-Nybelen J, Wehle C, Bruning N, Trost-Brinkhues G, Brenner H, Hebebrand J, Herpertz-Dahlmann B. Social class, parental education, and obesity prevalence in a study of six-year-old children in Germany. Int J Obes (Lond). 2005;29:373-80.
15. Hawkins SS, Cole TJ, Law C. The Millennium Cohort Study Child Health Group An ecological systems approach to examining risk factors for early childhood overweight: findings from the UK Millennium Cohort Study. J Epidemiol Community Health. 2009;63:147-55.
16. Faith MS, Keller KL, Johnson SL, Pietrobelli A, Matz PE, Must S, Jorge MA, Cooperberg J, Heymsfield SB, Allison

DB. Familial aggregation of energy intake in children. Am J Clin Nutr. 2004;79:844-50.

17. Kral TV, Allison DB, Birch LL, Stallings VA, Moore RH, Faith MS. Caloric compensation and eating in the absence of hunger in 5-to 12-y-old weight-discordant siblings. Am J Clin Nutr. 2012;96:574-83. doi: 10.3945/ajcn.112.037952.
18. Pachucki MC, Loveheim MF, Harding M. Within-family obesity associationsevaluation of parent, child and sibling relationships. Am J Prev Med. 2014;47:382-91. doi: 10. 1016/j.amepre.2014.05.018.
19. Donovan SJ, Susser E. Commentary: advent of sibling designs. Int J Epidemiol. 2011;40:345-9. doi: 10.1093/ije/dyr057.
20. Gordon CC, Chumlea WC, Roche AF. Stature, Recumbent length and weight. In: Lohman TG, Roche AF, Martorell R, editors. Anthropometric Standardization Reference Manual. Illinois: Human Kinetics Book; 1998. pp. 3-8.
21. Cole TJ, Lobstein T. Extended international (IOTF) body mass index cut-offs for thinness, overweight and obesity. Pediatr Obes. 2012;7:284-94. doi: 10.1111/j.2047-6310.201 2.00064.x.
22. World Health Organisation. Physical Status: the use and interpretation of anthropometry: a report of a WHO expert committee. Geneva: WHO publications; 1995.
23. Katzmarzyk PT, Malina RM, Perusse L, Rice T, Province MA, Rao DC, Bouchard C. Familial resemblance in fatness and fat distribution. Am J Hum Biol. 2000;12:395-404.
24. Schousboe K, Willemsen G, Kyvik KO, Mortensen J, Boomsma DI, Cornes BK et al. Sex differences in heritability of BMI: a comparative study of results from twin studies in eight countries. Twin Res. 2003;6:409-21.
25. Segal NL, Feng R, McGuire SA, Allison DB, Miller S. Genetic and environmentalcontributions to body mass index: comparative analysis of monozygotic twins, dizygotic twins and same-age unrelated siblings. Int J Obes. 2009;33:37-41. doi: 10.1038/ijo.2008.228.
26. Berge JM. A review of familial correlates of child and adolescent obesity: what hasthe 21st century taught us so far? Int J Adolesc Med Health. 2009;21:457-83.
27. Haberstick BC, Lessem JM, McQueen MB, Boardman JD, Hopfer CJ, Smolen A, Hewitt JK. Stable genes and changing environments: body mass index across adolescence and young adulthood. Behav Genet. 2010;40:495-504. doi: 10. 1007/s10519-009-9327-3.
28. Kramer L, Conger KJ. What we learn from our sisters and brothers: For better or for worse. New Dir Child Adolesc Dev. 2009;2009:1-12. doi: 10.1002/cd.253.
29. Salvy SJ, Vartanian LR, Coelho JS, Jarrin D, Pliner PP. The role of familiarity on modeling of eating and food consumption in children. Appetite. 2008;50:514-8.
30. Sallis JF, Prochaska JJ, Taylor WC. A review of correlates of physical activity of children and adolescents. Med Sci Sports Exerc. 2000;32:963-75.
31. Fuemmeler BF, Anderson CB, Masse LC. Parent-Child relationship of directly measured physical activity. Int J Behav Nutr Phys Act. 2011;8:17. doi: 10.1186/1479-5868-8-17.
32. Slomkowski C, Rende R, Novak S, Lloyd-Richardson E, Niaura R. Sibling effects on smoking in adolescence: evidence for social influence from a genetically informative design. Addiction. 2005; 100:430-8.
33. Bouchey HA, Shoulberg EK, Jodl KM, Eccles JS. Longitudinal links between older sibling features and younger siblings'academic adjustment during early adolescence. J Educ Psychol. 2010;102:197-211.
34. Slomkowski C, Manke B. Sibling relations during childhood. Multiple perceptions from multiple perspectives. In: Conger RD, Lorenz FO,Wickrama KAS, editors. Continuity and Change in Family Relations: Theory, Methods, and Empirical Findings. Hillsdale, NJ: Erlbaum; 2004; pp. 293-317.
35. McHale SM, Updegraff KA, Whiteman SD. Sibling relationships and influences in childhood and adolescence. J Marriage Fam. 2012;74:913-30.
36. Christakis NA, Fowler JH. The spread of obesity in a large social network over 32 years. N Engl J Med. 2007;357:370-9.
37. St-Onge MP, Keller KL, Heymsfield SB. Changes in childhood food consumption patterns: a cause for concern in light of increasing body weights. Am J Clin Nutr. 2003;78: 1068-73.
38. Anderson B, Rafferty AP, Lyon-Callo S, Fussman C, Imes G. Fast-food consumption and obesity among Michigan adults. Prev Chronic Dis. 2011;8:A71.
39. Poti JM, Duffey KJ, Popkin BM. The association of fast food consumption; with poor dietary outcomes and obesity among children: is it the fast food or the remainder of the diet? Am J Clin Nutr. 2014;99:162-71. doi: 10.3945/ajcn. 113.071928.
40. Organized fast food in the fast lane. CRISIL Report, September 2013 [cited 2014/12/09]; Available from: http://www.crisil.com/pdf/research/CRISIL%20Research_Article_QSR_17Sep2013.pdf.
41. Cappuccio FP, Taggart FM, Kandala NB, Currie A. Meta-analysis of short sleep duration and obesity in children and adults. Sleep. 2008;31:619-26.
42. Chen X, Beydoun MA, Wang Y. Is sleep duration associated with childhood obesity? A systematic review and meta-analysis. Obesity (Silver Spring). 2008;16:265-74. doi: 10. 1038/oby.2007.63.