Strong Parent–Offspring Association of Metabolic Syndrome in Korean Families

Eun-Gyong Yoo, MD, PHD[1]
Sang Shin Park, DVM, MPH[2]
Sang Woo Oh, MD, PHD[3]
Gi-Byoung Nam, MD, PHD[4]
Mi Jung Park, MD, PHD[5]

OBJECTIVE—To investigate the associations of metabolic syndrome (MetS) and its components between adolescents and their parents in Korea.

RESEARCH DESIGN AND METHODS—We analyzed data for 4,657 subjects (1,404 fathers, 1,404 mothers, 957 sons, and 892 daughters) from the Korean National Health and Nutrition Examination Surveys conducted between 1998 and 2008.

RESULTS—Compared with adolescents whose parents did not have MetS, the odds ratio (95% CI) for MetS in adolescents with MetS in one parent was 4.2 (2.1–8.5) and 8.7 (3.4–22.3) in those with MetS in both parents. Among obese adolescents, the prevalence of MetS was 18.2% without parental MetS, whereas 29.2% of obese adolescents with MetS in one parent and 53.9% with MetS in both parents also had MetS (P = 0.01 for trend).

CONCLUSIONS—The risk of MetS increased significantly in adolescents with parental MetS and was especially high in those with coexisting obesity and parental MetS.

Diabetes Care 35:293–295, 2012

Metabolic syndrome (MetS) has been reported to be associated with the future development of type 2 diabetes and cardiovascular disease (CVD) in children (1) as well as in adults (2). Identifying children with a higher risk of developing MetS is very important because early interventions, such as lifestyle modification, may reduce future cardiovascular mortality (2).

Parents influence their children both genetically and environmentally, and a significant familial aggregation of MetS has been reported among twins (3), siblings (4), and parents and offspring (5). However, studies that have directly measured the components of MetS in large numbers of matching parent–children pairs are limited.

RESEARCH DESIGN AND METHODS

The data in this study came from the Korean National Health and Nutrition Examination Survey (KNHANES) conducted by the Korean Ministry of Health and Welfare between 1998 and 2008. This study enrolled 4,657 subjects (1,404 fathers, 1,404 mothers, 957 sons, and 892 daughters; Supplementary Fig. 1). This study was approved by the Ministry of Health and Welfare, Korea.

The adolescent subjects were classified as obese (BMI ≥95th percentile for age and sex), overweight (85–94th percentile), or nonobese (<85th percentile) using Korean BMI reference charts (6). The International Diabetes Federation criteria for MetS in children and adolescents were used to define MetS in the offspring (7,8). For parents, MetS was defined using a recently harmonized definition (9,10) (Supplementary Table 1).

All statistical analyses were performed using SAS 9.2 software (SAS Institute, Cary, NC). A value of $P < 0.05$ was considered significant.

RESULTS

Baseline characteristics of the study population are summarized in Supplementary Table 2. The prevalence for central obesity ($P < 0.0001$), hypertension ($P < 0.0001$), hypertriglyceridemia ($P = 0.0270$), low HDL cholesterol ($P < 0.0001$), and hyperglycemia ($P = 0.0008$) in adolescents increased significantly with increasing number of parents with MetS. The prevalence of MetS was 1% in adolescents without parental MetS, 4.1% in adolescents with one parent with MetS, and 8.2% in adolescents with MetS in both parents ($P < 0.0001$). The odds ratio (OR) for MetS was 4.2 (95% CI 2.1–8.5) in adolescents with one parent with MetS and was 8.7 (3.4–22.3) in adolescents with MetS in both parents compared with that in those without parental MetS (Supplementary Table 3).

Among obese offspring (n = 140), the prevalence of MetS was 18.2% without parental MetS, 29.2% with MetS in one parent, and 53.9% with MetS in both parents (P = 0.0112; Fig. 1).

The prevalence of hypertension and hyperglycemia in nonobese offspring (n = 1,520) increased significantly with the increasing number of parents with MetS (P = 0.0036 and P = 0.0001, respectively, after adjusting for age and BMI; Supplementary Table 4). The prevalence of hypertension, hypertriglyceridemia, low HDL cholesterol, and hyperglycemia in nonobese offspring increased significantly with increasing numbers of parents with an abnormality in each component (all $P < 0.0001$; Supplementary Table 5).

Subgroup analysis of 359 families with two children showed strong association of MetS between parent–offspring (P = 0.0002) and sibling (P = 0.0279) pairs (Supplementary Table 6).

From the [1]Department of Pediatrics, College of Medicine, CHA University, Sungnam, Korea; the [2]Department of Veterinary Integrative Biosciences, College of Veterinary Medicine and Biomedical Sciences, Texas A&M University, College Station, Texas; the [3]Center for Obesity, Nutrition, and Metabolism, Department of Family Medicine, Dongguk University Ilsan Hospital, Gyeonggi, Korea; the [4]Department of Internal Medicine, Asan Medical Center, University of Ulsan College of Medicine, Seoul, Korea; and the [5]Department of Pediatrics, Sanggye Paik Hospital, Inje University College of Medicine, Seoul, Korea.
Corresponding author: Mi Jung Park, pmj@paik.ac.kr.
Received 6 July 2011 and accepted 7 November 2011.
DOI: 10.2337/dc11-1283
This article contains Supplementary Data online at http://care.diabetesjournals.org/lookup/suppl/doi:10.2337/dc11-1283/-/DC1.

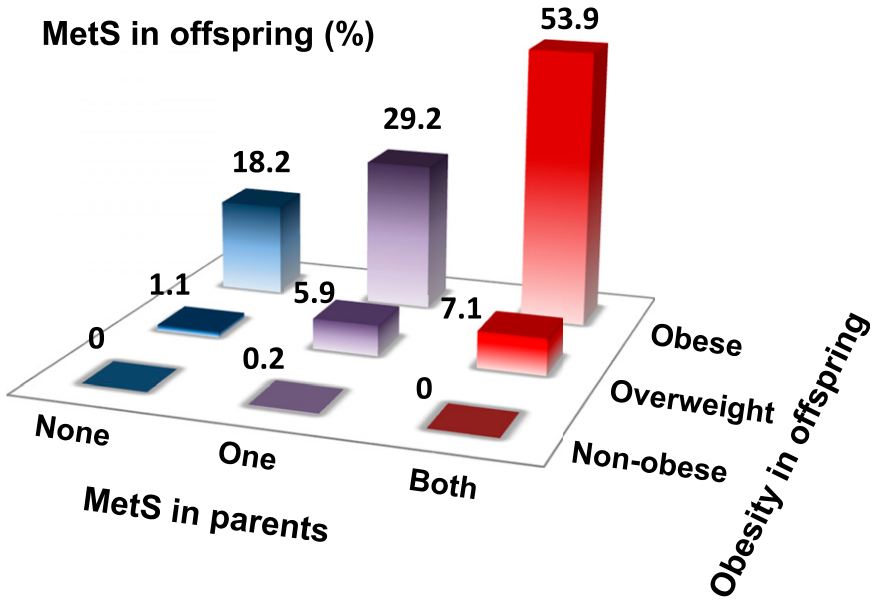

Figure 1—*Prevalence of MetS in offspring according to obesity and parental MetS. (A high-quality color representation of this figure is available in the online issue.)*

CONCLUSIONS—In this study, we found a strong parent–offspring association for MetS between Korean adolescents and their parents. The OR for MetS was 8.7 in offspring with MetS in both parents compared with those without parental MetS. Furthermore, 53.9% of obese adolescents with MetS in both parents also had MetS, which is notable considering their age.

Asians develop the adverse consequences of obesity at lower BMIs, and lower cutoffs are used to define obesity in Asian adults (11). Asian adolescents likely also develop the adverse effects of obesity at lower BMIs. However, as yet there is no consensus on using a different cutoff for Asian adolescents, and the standard percentile was used in this study to define obesity.

The Bogalusa Heart Study identified that childhood parental history of type 2 diabetes, along with adiposity, glucose, and lipoprotein variables, were associated with an increased risk of diabetes in adulthood (12). MetS was already common in obese adolescents without parental MetS, but the prevalence of MetS increased greatly with the presence of parental MetS in our study.

In this study, MetS was rare in nonobese adolescents irrespective of parental metabolic status. This could have been partially due to the International Diabetes Federation criteria, the only official criteria available for adolescents until now, that mandates the presence of central obesity. Parental MetS may affect some components of MetS in lean children. Our subgroup analysis showed significant impact of parental MetS on hypertension and hyperglycemia in nonobese children.

MetS is closely related to obesity, and it is likely that parental factors may increase MetS in offspring by increasing obesity. However, every component of MetS, except for central obesity, showed significant concordance between nonobese offspring and their parents in the current study, suggesting direct parent–offspring associations of each metabolic component before the development of obesity.

The strong parent–offspring association could be due to hereditary or environmental factors. It is widely recognized that genetic and environmental factors both contribute to the development of MetS (13). Data from the Framingham Heart Study showed significant parent–child and sibling correlations for the components of MetS, suggesting genetic influences; significant spousal correlations were observed for BMI, suggesting environmental influences for obesity (14). The strong parent–offspring association of MetS in our study might be more related to hereditary factors than environmental factors. Subgroup analysis that included families with two children showed strong association of MetS between parent–offspring and sibling pairs, whereas there was no significant spousal association.

According to the American Diabetes Association consensus statement, family history of type 2 diabetes is a component of the screening criteria for type 2 diabetes in adolescents (15). We suggest that family history of MetS should also be considered as one of the criteria for MetS screening in adolescents.

Our study has some limitations: First, this was a cross-sectional study, so causation could not be inferred. Second, it lacked correction for lifestyle factors. Nonetheless, this study has particular strengths, among them its use of data for a large, nationwide, adolescent study population, in which each component was directly measured between matching parent–offspring pairs.

In conclusion, the risk of MetS in adolescents is highly associated with parental MetS and increases further with coexisting obesity and parental MetS.

Acknowledgments—This work was partially supported by Grant 2010 from the Korea Medical Institute, Seoul, Korea, to M.J.P.

No potential conflicts of interest relevant to this article were reported.

E.-G.Y. wrote the manuscript. S.S.P. conducted the statistical analysis. S.W.O. and G.-B.N. reviewed and edited the manuscript. M.J.P. designed the study, contributed to discussion, and is the guarantor of this article.

The authors thank Alberto Hayek, Pediatric Diabetes Research Center, University of California San Diego, San Diego, California, and Gerald S. Berenson, Tulane University Health Sciences Center, New Orleans, Louisiana, for critical review of the manuscript.

References

1. Morrison JA, Friedman LA, Gray-McGuire C. Metabolic syndrome in childhood predicts adult cardiovascular disease 25 years later: the Princeton Lipid Research Clinics Follow-up Study. Pediatrics 2007;120:340–345
2. Wilson PW, D'Agostino RB, Parise H, Sullivan L, Meigs JB. Metabolic syndrome as a precursor of cardiovascular disease and type 2 diabetes mellitus. Circulation 2005;112:3066–3072
3. Sung J, Lee K, Song YM. Heritabilities of the metabolic syndrome phenotypes and related factors in Korean twins. J Clin Endocrinol Metab 2009;94:4946–4952
4. Feng Y, Zang T, Xu X, Xu X. Familial aggregation of metabolic syndrome and its components in a large Chinese population. Obesity (Silver Spring) 2008;16:125–129
5. Park HS, Park JY, Cho SI. Familial aggregation of the metabolic syndrome in Korean

families with adolescents. Atherosclerosis 2006;186:215–221
6. Korea Centers for Disease Control and Prevention, The Korean Pediatric Society, The Committee for the Development of Growth Standard for Korean Children and Adolescents. *2007 Korean Children and Adolescents Growth Standard (Commentary for the Development of 2007 Growth Chart). Government report online*. Seoul, Division of Chronic Disease Surveillance, 2007. [in Korean]
7. Zimmet P, Alberti G, Kaufman F, et al.; International Diabetes Federation Task Force on Epidemiology and Prevention of Diabetes. The metabolic syndrome in children and adolescents. Lancet 2007; 369:2059–2061
8. Lee CG, Moon JS, Choe BK, Son CS, Yang SW. *2005 Korean National Survey of Children and Adolescents to Establish the Reference Standard of Growth*. Gwacheon, Ministry of Health and Welfare, 2006
9. Alberti KG, Eckel RH, Grundy SM, et al.; International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; International Association for the Study of Obesity. Harmonizing the metabolic syndrome: a joint interim statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and International Association for the Study of Obesity. Circulation 2009; 120:1640–1645
10. Lee SY, Park HS, Kim DJ, et al. Appropriate waist circumference cutoff points for central obesity in Korean adults. Diabetes Res Clin Pract 2007;75:72–80
11. Tan CE, Ma S, Wai D, Chew SK, Tai ES. Can we apply the National Cholesterol Education Program Adult Treatment Panel definition of the metabolic syndrome to Asians? Diabetes Care 2004;27:1182–1186
12. Nguyen QM, Srinivasan SR, Xu JH, Chen W, Berenson GS. Influence of childhood parental history of type 2 diabetes on the prediabetic and diabetic status in adulthood: the Bogalusa Heart Study. Eur J Epidemiol 2009;24:537–539
13. Loos RJ, Katzmarzyk PT, Rao DC, et al.; HERITAGE Family Study. Genome-wide linkage scan for the metabolic syndrome in the HERITAGE Family Study. J Clin Endocrinol Metab 2003;88:5935–5943
14. Lee KE, Klein BE, Klein R. Familial aggregation of components of the multiple metabolic syndrome in the Framingham Heart and Offspring Cohorts: Genetic Analysis Workshop Problem 1. BMC Genet 2003;4(Suppl. 1):S94
15. American Diabetes Association. Standards of medical care in diabetes—2010. Diabetes Care 2010;33(Suppl. 1):S11–S61