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Cross-Generation Link between Inactive Behavior of Schoolchildren and Metabolic Disease Category of Parents

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Abstract

In this study, we determined the cross-generation link between sedentary behavior of schoolchildren with their 6-year BMI progression pattern and metabolic disease category of their parents. Anthropometric data of 11,190 elementary schoolchildren (aged 13) were retrospectively tracked from 2003 to 2009, and classified into two groups: Normal (N = 9793) and Metabolic Disorders (N = 1397), based on the disease category of their parents (under at least one medication for stroke, coronary heart disease (CAD), diabetes, and hypertension). Schoolchildren's weekly time spending on reading, computer use, video game, music listening, radio listening, TV watching, and movie watching, was reported with parental assistance *via* questionnaires. Baseline BMI and 6 years BMI progression rate in Metabolic Disorders group were significantly higher than those in Normal group. In particular, offsprings from stroke parents exhibited the greatest baseline BMI across 6 years compared to the rest of the disease categories. For Metabolic Disorders group, time spending on computer use, video game, TV watching, and music listening of schoolchildren was significantly longer than Normal group. Reading, which occupied the largest portion of weekly sedentary time, was not contributed to the group difference on the BMI status of schoolchildren. The current study demonstrates that schoolchildren from family with at least one parent having metabolic disorders, particularly stroke, tend to be more sedentary and heavior than their age-matched normal peers. School-based obesity prevention programs are suggested for this specific group by restricting time spent on technology-associated sedentary behaviors and promoting sport activities.

Key Words: physical activity, technological transition, childhood obesity, body weight

Introduction

Similar to Western countries (12), childhood obesity has recently been recognized as a serious public health concern in Asia. This trend is paralleled with the increased multiple adverse health conse-

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quences of children (18). The early onset of obesity can lead to an increased likelihood of obesity in later life as well as an increased prevalence of metabolic disorders in adulthood (8, 9). Since the adverse effects of obesity tend to be delayed, sometimes for decades (9), every elementary school should be placed as a principal site for early obesity prevention.

There is no doubt that genetics plays a role in the development of obesity (2), but genes alone cannot explain the sudden increase of obese population worldwide over the past few decades (4). In Britain, increased sedentary behaviors, such as TV watching and car ownership, have been found to parallel with the increased prevalence of obesity, while total caloric consumption was decreasing over the period of observation (16). Genetic disposition may mediate *via* individual's time preference towards sedentary behaviors. It has been previously reported that children from overweight families tended to have a stronger preference to sedentary behaviors, and spent more time on immobile entertainment (21).

Until recently, the association between offspring body weight and paternal risk of type 2 diabetes has been identified in Swedish (1) and Latino populations (20). Insulin resistance and type 2 diabetes are, to some extent, associated with multiple metabolic conditions such as CAD, hypertension and stroke. Insulin resistance is an early predictor for hypertension, coronary heart disease, stroke, cancer and type 2 diabetes (5). It was unknown whether there is cross-generation link between these insulin resistance-clustered metabolic disorders of parents and time preference towards sedentary behavior of their children. In the present study, 6-year BMI progression was retrospectively tracked for 11,190 elementary schoolchildren of Taipei City, containing ~12% of them with parents having at least one metabolic disorder. Their weekly time spent on a spectrum of sedentary behaviors, sport activities and weight progression was compared with children from normal families. We found that children from families with parental metabolic disorders tend to be more inactive and heavier than their normal peers.

Materials and Methods

Subjects

In this survey, anthropometric data (height, weight, and BMI) were retrospectively tracked by school nurses for 6 years (2003-2009) in grade 6 schoolchildren encompassing all elementary schools of Taipei City. This study was approved by Human Subject Committee of Taipei Physical Education College in Taiwan.

A questionnaire on time spending on a spectrum of sedentary behaviors for the most recent week was self-reported together with parental metabolic conditions. Parents provided guidance on this survey to ensure accuracy. The questionnaire was filled out by either the father or mother based on their time availability. Only those children who returned and completed the entire survey without missing data were included in the statistical analysis (N = 11,190). Among these cohorts, 1,397 children came from families with parents having at least one metabolic disorder. In this study, metabolic disorders refer to stroke (N = 49), coronary artery disease (CAD) (N = 220), hypertension (N = 924), and diabetes (N = 267). Children with mother and/or father currently having the abovementioned clinical categories were included as Metabolic Disorders group. The rest of the children were designated as Normal group.

Assessments

Students' weights and heights were measured by school nurses annually in September. Parents helped to report children's activities which included time spent on conventional sedentary behaviors (reading) and technology-associated sedentary behaviors (computer use, reading, video game, music listening, radio listening, phone use, TV watching, movie watching) against physical activities (walking to school or indoor/outdoor sport activities) during the latest week of survey.

Data Analysis

Students *t*-test was used to compare the difference of all variables between two groups (Normal and Metabolic Disorders). One-way ANOVA was used to compare the difference of all sub-categorized variables among the 5 groups (normal, stroke, CAD, hypertension, diabetes). Tukey's *post hoc* test was used to distinguish pair differences between groups. Values of all variables are presented as means ± standard error (SE). Significance level was set at type I error less than 5%.

Results

The present study delineates the 6-year BMI progression pattern for Taipei schoolchildren according to the metabolic disease categories of their parents. We also asked the question whether offspring from different groups had different time preference towards sedentary behavior. In this study, the Metabolic Disorders group referred to the schoolchildren with parents currently having medical treatment for the following diseases: stroke, CAD, hypertension, and diabetes. The rest of the schoolchildren were

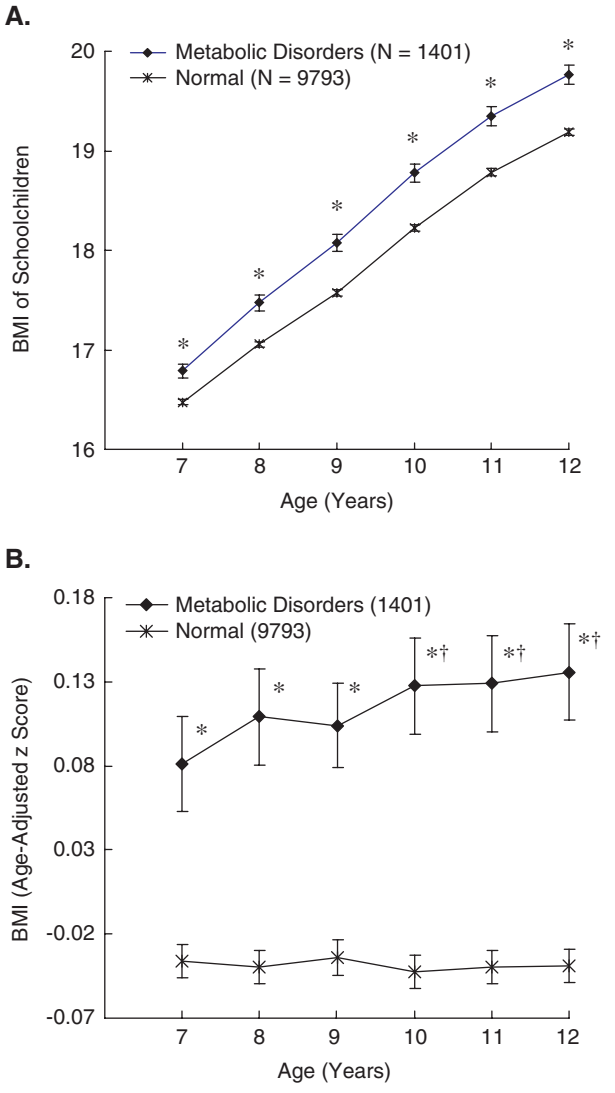

Fig. 1. Six-year BMI progression for schoolchildren from family having at least one parents with metabolic disorders. Baseline BMI in Metabolic Disorder group was significantly greater than Normal group across 6 years of growth (A). Age-matched z score (B) reveals that BMI progression in Metabolic Disorder group increased in greater rate than that in Normal group. *Significance against Normal group ($P < 0.01$); †Significance against age 7 years old ($P < 0.01$).

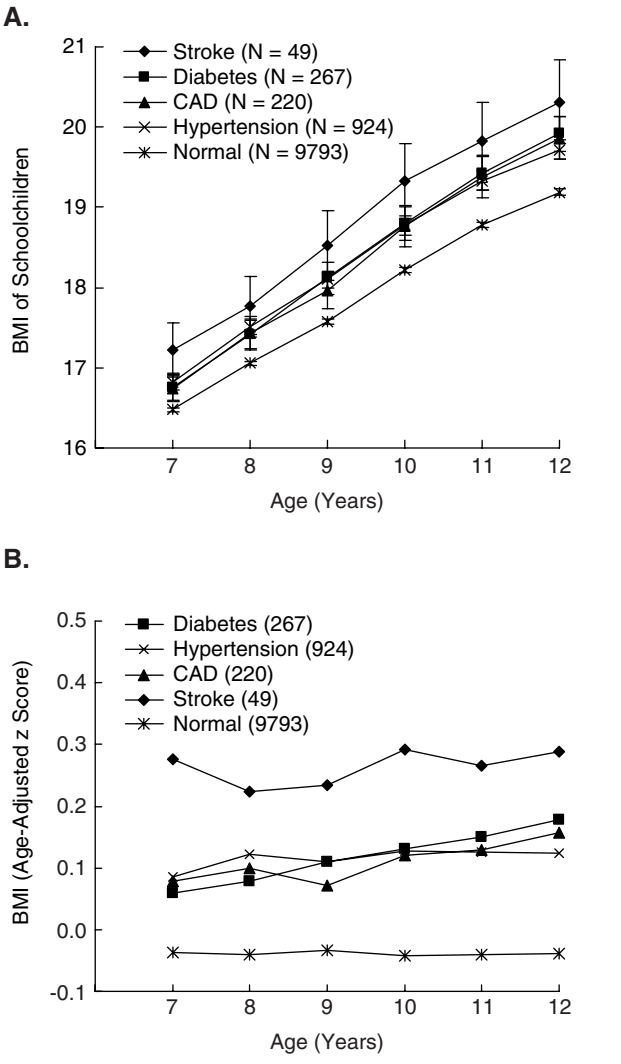

Fig. 2. Six-year BMI progression for schoolchildren from family having at least one parents with stroke, coronary heart disease, hypertension, and diabetes. Baseline BMI in Stroke group was significantly greater than those in the rest of groups across 6 years of growth (A). Age-matched z score (B) reveals that BMI progression in coronary heart disease (CAD), hypertension and diabetes groups increased in greater rate than those in Normal group. All disease groups are significantly different against Normal group ($P < 0.01$).

designated as the Normal group. Among the cohorts investigated in the study, ~12.5% of their parents were reported having metabolic diseases. The baseline BMI and BMI slope of schoolchildren in the Metabolic Disorders group were significantly greater than those in the Normal group during the 6-year growing period (Fig. 1A). Since BMI is a function of age, the age-adjusted z score of BMI is also presented in Fig. 1B to distinguish the group difference during the growing period.

To compare the BMI progression pattern among different disease categories during the 6-year growing period, the BMI of schoolchildren in each group (stroke, coronary heart disease, hypertension, diabetes, and normal) were plotted in both absolute scores (Fig. 2A) and age-adjusted z scores (Fig. 2B). The result shows that the BMI values across 6 years in the Stroke group were significantly greater than that in the rest of disease groups ($P < 0.05$). Furthermore, the BMI values across 6 years in the Diabetes, Hypertension and CAD groups were significantly greater than those in the Normal group ($P < 0.05$). No difference was

Table 1. Time share on active and sedentary activities for schoolchildren from family having parents with metabolic disorders

Time share (min/wk)	Normal	Metabolic disorders
Walk to school	9.6 ± 0.08	9.5 ± 0.2
Reading	434.5 ± 4.7	428.9 ± 12.1
Computer use	197.2 ± 2.9	222.98*
Video game	93.5 ± 2.0	105.3 ± 6.2*
Music listening	138.8 ± 2.5	170.4 ± 8.3*
Radio listening	35.7 ± 1.4	39.0 ± 4.4
Phone use	35.5 ± 0.9	37.6 ± 2.2
TV watching	268.2 ± 3.3	287.5 ± 9.5*
Movie watching	20.4 ± 0.7	21.4 ± 2.2
Indoor sports	168.1 ± 2.7	154.4 ± 6.9*
Outdoor sports	203.3 ± 2.7	193.9 ± 6.7
Sport frequency	1.82 ± 0.01	1.70 ± 0.03*

*Significance against Normal ($P < 0.05$).

Table 2. Time share on active and sedentary activities for schoolchildren from family having parents with stroke, coronary heart disease, hypertension, and diabetes

Time spent (min/wk)	Normal	Diabetes	Hypertension	CAD	Stroke
Reading	434.5 ± 4.7	394.8 ± 26.7	448.2 ± 15.4	392.0 ± 28.2	384.4 ± 50.6
Walk to school	9.6 ± 0.1	9.1 ± 0.4	9.4 ± 0.2	9.8 ± 0.6	11.1 ± 0.9
Computer use	197.2 ± 2.9	230.5 ± 22.1	218.2 ± 10.3	221.6 ± 20.8	263.1 ± 55.5
Video game	93.5 ± 2.0	127.6 ± 18.7	95.3 ± 7.0	113.3 ± 14.3	126.4 ± 33.9
Music listening	138.8 ± 2.5	178.0 ± 21.0	158.8 ± 9.4*	211.2 ± 24.4*	149.8 ± 34.0
Radio listening	35.7 ± 1.4	33.4 ± 9.4	38.8 ± 4.9	44.5 ± 14.4	30.8 ± 18.7
Phone use	35.5 ± 0.9	37.2 ± 3.5	36.9 ± 2.6	36.8 ± 7.7	38.7 ± 10.4
TV watching	268.2 ± 3.3	292.1 ± 21.7	285.0 ± 11.7	314.4 ± 26.1	259.0 ± 54.6
Movie watching	20.3 ± 0.7	18.6 ± 3.0	20.3 ± 2.3	27.7 ± 8.9	20.9 ± 9.4
Indoor sports	168.1 ± 2.7	128.8 ± 11.5*	156.9 ± 8.3	179.0 ± 22.6	105.6 ± 22.7*
Outdoor sports	203.3 ± 2.7	166.7 ± 12.9	197.6 ± 8.3	210.0 ± 19.0	197.0 ± 40.5
Sport frequency	1.82 ± 0.01	1.63 ± 0.09*	1.74 ± 0.04*	1.64 ± 0.10*	1.53 ± 0.22

*Significance against Normal ($P < 0.05$).

detected in BMI and its slope among the Diabetes, Hypertension and CAD groups.

With regard to sedentary behavior, time allocation for computer use, video game playing, music listening and TV watching, but not reading, in the Metabolic Disorder group was significantly greater than those in the Normal group (Table 1, $P < 0.05$). In particular, time allocation for indoor sports in the Stroke group was significantly lower than that in the Normal group (Table 2, $P < 0.05$). The frequency for participating sports in the Diabetes, Hypertension, and CAD groups was significantly lower than that in the Normal group (Table 2, $P < 0.05$).

Discussion

It has been reported that diabetes and high BMI parents are associated with children's overweight status (3, 20). By 8 years of age, half of the offspring of diabetic mothers had weights greater than 90th percentile among the age population (19). Since insulin resistance is pathogenically clustered with stroke, CAD and hypertension (5), secondary to reduced physical activity (7, 11), the current study was undertaken to examine whether these diseases had the same cross-generation link on children's BMI and sedentary behaviors. In this study, we found that: [1] Schoolchildren from families with at least one parent having aforementioned metabolic disorders had significantly higher baseline BMI and faster BMI progression rate during the 6-year growing period in the elementary school; [2] Among these metabolic disorders, schoolchildren with parents who had suffered stroke had the greatest baseline BMI level against all other disease categories; [3] Schoolchildren from metabolically abnormal parents spent significantly

more time on technology related sedentary activities and lesser time on sport activities compared to age-matched normal peers. The results of the study highlight the importance of family influence on children's weight progression. This cross-generation familial factor mediated, at least in part, *via* their time preference towards sedentary behaviors versus sport activities.

Technological advance leading to increasing sedentary activities has been proposed to be associated with the increased prevalence of obesity worldwide (7, 16). In this study, we further found that Taipei schoolchildren from parents with metabolic disorders had significantly greater time spending on computer use, video game, music listening and TV watching, but not reading. Except for reading, the rest of the activities are new sedentary behaviors created by recent technological invention in human history. In the United Kingdom (16), the prevalence of obesity was increased significantly since 1980, paralleled with car ownership and TV watching, but not with the amounts of high-fat diet and total caloric consumption. It is surprising that reading as a conventional sedentary behavior which occupies a significant amount of time for schoolchildren was unrelated to high BMI in the schoolchildren with parents having metabolic disorders. Reading habit is positively associated with socioeconomic status (SES) of the parents (6). A strong association between low SES and obesity has been demonstrated previously (13). It is likely that parents with higher education tend to restrict sedentary behaviors of their children.

Obesity-associated insulin resistance has been proposed as a pathogenic ground for stroke, hypertension, CAD and type 2 diabetes (5, 7, 17). Increasing fat accumulation subsequently leads to insulin resistance and low-grade chronic inflammation (15) resulting in the development of aforementioned metabolic disorders (5, 17). In Atherosclerosis Risk in Communities Study of middle-aged adults (10), a parental history of diabetes and hypertension was associated with the greatest increase in odds of co-occurrence in diabetes, hypertension and dyslipidaemia. Since the adverse health effects of this clustered metabolic condition tend to be delayed before manifestation into clinical stage (5, 9), elementary schools can be regarded as a place for primary obesity prevention to counterbalance the negative influence from the family. In this study, we found a strong cross-generation effect on children's BMI from parents having stroke, which is probably linked with their parents' weight. However, BMI of parents was not reported. Their time shared on technology-associated sedentary behaviors, such as TV watching and computer use, in contrary to reading, was significantly greater than normal peers. Schoolchildren from families with parental metabolic disorders should be given more attention by schools through the promotion of sport activities. Communication with their parents concerning the appropriate restriction of time spent on technology-associated sedentary behaviors should also not be missing.

In this study, BMI data were retrospectively collected for 6 years, yet the time spending on sedentary behaviors and sport activities were assessed during the most recent week of the survey. It is thus not possible to know whether the greater amounts of time spent on sedentary behaviors in schoolchildren from Metabolic Disorder group occurred before high BMI was developed, or it was the consequence of overweight. High BMI is a known barrier for sport participation since the physical fitness level is generally lower in overweight children (14).

The results of the study provide evidence of a cross-generation link between BMI progression pattern of children and metabolic disease category of parents. This cross-generation link appears to be mediated by time preference in participating technology-related sedentary activities or sport activities. Our results also suggest that schoolchildren with parents having metabolic disorders, particularly stroke, should be targeted as a special group for early obesity prevention by restricting sedentary behaviors and encouraging sport participation.

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