Original Article

Differences in health-related behaviors between middle school, high school, and college students in Jiangsu province, China

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Background and Objectives: Increasing rates of obesity among Chinese adolescents has become a major public health concern in recent years. Studies have shown that factors such as food choices, physical activity, and screen time play important roles in fostering obesity. We examined a number of biological and social determinants that influence these factors. To determine whether dietary behavior, physical activity, and screen time varied among students in different stages of their education. **Methods and Study Design:** Students in 13 cities across Jiangsu Province completed an anonymous survey assessing demographics and various health-related behaviors in a controlled setting. The survey population ranged from middle school students to undergraduates. 55,361 surveys were returned, and 46,611 (84.2%) were usable for the analysis. Multiple linear regression models were used to investigate the relationship between four behavioral factors (dietary behavior, screen time, physical activity, and moderate exercise) and seven predictors (gender, age, BMI, mother's education, nearsightedness, allowance, and geographic region). **Results:** Baseline characteristics of the survey population analyzed by education level (middle school, high school, college and beyond) showed moderate differences in demographics among the three groups. Physical activity, moderate exercise, and dietary behavior decreased with educational level, while screen time increased. All predictors in the four considered regression models were statistically significant. **Conclusions:** This unique, large-scale survey of Chinese students in a region of contrasting economic development revealed numerous relationships between health-related diet and physical-activity, region, and education level. These findings can inform the development of measures to counteract the rise of obesity in China.

Key Words: diet, nutrition, pediatric obesity, screen time, China

INTRODUCTION

The World Health Organization (WHO) suggests that 60% of a person's health depends on behavior and lifestyle.[1] It is especially important for young people to pay attention to their behavior and lifestyle, which not only affects their current health, but also impacts their future development and wellbeing.[2] In 1991, the United States instituted the world's first Youth Risk Behavior Surveillance System (YRBSS).[2] Increasingly, more developed and developing countries have recognized the importance of behavioral interventions among youth. In 2005, China conducted the National Youth Health Risk Behaviors Investigation (NYHRBI) in one of China's most developed areas, Jiangsu Province.[3] In 2013, NYHRBI follow-up data were gathered with the goal of informing potential intervention measures using cluster-randomized sampling to assess the status of youth health-risk behaviors. The questionnaire was designed by China's Center for Disease Control and Prevention.[4]

Obesity, a largely behaviorally determined health condition, has become one of the greatest public health concerns among school-age students globally.[5,6] Multiple behavioral factors, such as diet, physical activity (PA) and screen time (ST) are all important determinants of obesity risk.[7] Some studies have found that these behavioral factors are interrelated, and often a cluster in statistical analyses.[8,9] For example, one recent study reported that among high school students in the US, students with higher levels of PA tend to exhibit healthier dietary behaviors, while more ST is associated with worse dietary

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habits.[10] However, the association of these risk factors among Chinese students has not yet been reported, and the pattern of these clustering behavioral risk factors remains unclear.[7]

More information on the cluster association of PA, ST and dietary behavior among Chinese students is needed to inform the development of effective obesity prevention strategies in China and other developing countries.[11] In addition, a better understanding of the developing pattern of obesity risk behaviors among middle school, high school and college students is needed to best target and improve the design of health education for different school levels.[12] It is well-established that economic development is positively associated with obesity prevalence, especially in developing countries.[13] As one of the most developed area in China, Jiangsu Province is an area where higher levels of concern for obesity in the student population are necessary.[14] In 2010, 18.3% of students in Jiangsu Province were obese or overweight, and the prevalence increased to over 20% by 2013.[15] By examining a diverse population of students in Jiangsu Province, we sought to investigate the association of PA, ST and dietary behavior with a number of potential modifiers of these behaviors. This study extends beyond the current literature by surveying a wide variety of school levels, ranging from middle school to college. It therefore provides valuable information to compare across the age spectrum, as well as potentially inform the development of age-specific interventions.

METHODS

We analyzed data from the 2013 NYHRBI in Jiangsu Province. This NYHRBI used the National Youth Health Risk Behaviors Questionnaire, which was designed by the Chinese Center of Disease Control and Prevention (China CDC.) Systematic randomized cluster sampling was employed to enroll participants. For each of the thirteen major cities in Jiangsu province: six middle schools with a minimum of 150 students per school, seven high schools with a minimum of 200 students per school, and three colleges with a minimum of 50 students per school were enrolled in the study. Students complete the survey anonymously online through the Jiangsu Student Health Surveillance System (JSHSS) with on-site instruction from the Jiangsu CDC's officers; all surveys were completed between September 1, 2013 and September 30, 2013. All participation was voluntary and students provided informed consent prior to completing the surveys. Data generated from the JSHSS was assessed by officers from the Jiangsu Province CDC. Middle school, high school and college students from 13 cities within Jiangsu province were surveyed, totalling 285 schools (115 middle schools, 131 high schools and 39 colleges). Of these 285 schools, 186 were located in urban areas and 99 in rural areas. The dataset was relatively large, with 55,361 students enrolled in the study: 19,035 middle school students, 24,178 high school students and 12,148 college students. Two exclusion criteria were applied: (1) missing results in any of the key questions (the questionnaire is shown in the Appendix,) (2) students who selected, "I do not know" for question five (Mother's Education Level). After applying the exclusion criteria, 46,611 students returned usable questionnaires, for an overall useful response rate of 84% (46,611/55,361).

Primary outcome measures were the three sets of aggregate scores in the categories of dietary behavior, physical activity, and screen time. Questions ten to eighteen in the survey (Appendix A) were divided into positive and negative categories based on the nature of the question, and then compiled into an overall dietary score with increments determined based on the number of choices in each question. For example, question ten asked participants about the frequency in consumption of soft drinks in the past seven days. Here, "0 times" corresponded to a score of 0, "less than once per day" corresponded to a score of +1/6, "once per day" a score of +2/6, and so on. Questions nineteen and twenty asked about the participants' frequency of physical activity and moderate exercise, and these scores were not combined due to the possibility for overlap in the two questions. Questions twenty-one, twenty-two, and twenty-three were compiled into an overall screen-time score and were analyzed in a similar fashion to the dietary score. This scoring system is a tool we designed and developed for the purposes of the study which we believe better reflected dietary behavior and screen time as a whole compared with the individual questions for dietary behavior and screen time. In contrast, we believed that participants might view "physical activity" and "moderate physical exercise" as ambiguous, and so we decided to analyze the two variables separately to avoid potential bias from overlap between these two questions.

A total of six different predictors were considered: gender, age, BMI, mother's education, allowance, and geographic region. BMI was determined based on the self reported height and weight from the survey. Because higher mean BMI was expected with normal development for older age groups (e.g. college versus middle school), a list of China's BMI cutoffs for overweight and obesity by age was included for reference (Appendix B). The variable "allowance" refers to amount of money the parents provided for the student for recreational purposes per month and can be considered a proxy for socioeconomic status. Of these six predictors, gender is a dichotomous variable, age and BMI are continuous variables, and the remaining are all ordinal variables. For example, "Mother's Education" was divided into 5 categories ranging from "Elementary School or below" to "Bachelor's Degree or higher". We originally included nearsightedness as another variable in the analysis, but given its high prevalence in the population (75%) and the lack of significant associations in the model, it was excluded.

Results from the survey were compiled in Excel (Microsoft: Redmond, Washington) and statistical analysis performed in Stata13 (StataCorp Inc: College Station, Texas). Both simple linear regression and multiple linear regression using the backward selection method were used to determine the association between the outcomes of interest and grade level, controlling for the predictors discussed above.

RESULTS

Baseline characteristics of the population by education level are displayed in Table 1. High school students were

the largest surveyed group (n=20,620), while middle school student (n=15,122) and college student (n=10,869) groups are smaller. BMI increased with education level/age of students, though the difference was modest (20.4 kg/m^2 for middle school students compared with 21.8 kg/m^2 for college students). The majority of the survey population was nearsighted, with a prevalence as high as 75% in the college students. Mean screen time increased with increasing educational level, while mean dietary behavior score, mean days of physical activity per week, and mean days of moderate exercise per week all decreased with increasing educational level.

Multiple linear regression models with dietary behavior score as the outcome showed (Table 2) that grade level was negatively associated with dietary score (p<0.001), and all other predictors (gender, age, BMI, mother's education, family income, allowance, and geographic region) were also highly significantly associated with dietary score (p<0.001). Models using physical activity and moderate exercise as the outcome presented similar results, but the backward-selection method removed family income from both models, and allowance from the moderate-exercise model. Both models showed that grade level was negatively associated with dietary behavior score (p<0.001). In the screen-time model, grade level was positively associated with screen time (p<0.001), and all other predictors were statistically significant. There appeared to be no signs of collinearity in any of the models based on the variance inflation factors (all mean VIF less than 1.09).

DISCUSSION

Overall, the results from our findings are consistent with our hypothesis. Of the nine questions that make up the dietary behavior score, four reflect positive dietary behaviors (e.g., number of times participants eat fruits/vegetables weekly), while five reflect negative dietary behaviors (e.g., number of times participants eat fast food weekly). Because each question is weighted equally, there is a small score bias in favor of negative scores. However, we found that the average dietary behavior score in all three groups was positive, which suggested that overall students tended to engage in more positive dietary behaviors than negative ones. However, we noted that the dietary behavior score steadily decreased with increasing educational level. A few factors could be contributing to this finding.

First, with the increased emphasis by the Chinese government on improving adolescent health, current middle-school students received a far more comprehensive education on dietary and health behaviors than their high school and college counterparts.[16] With future expansion of these health education efforts, we may find that the relationship between dietary behavior and education level diminishes or disappears. Second, the majority of middle school students and high school students did not attend boarding schools, and thus eat at least two meals (breakfast and dinner) at home every school day. In comparison, the vast majority of college students lived on campus, and will eat either on campus or in restaurants. This may contribute to the lower dietary behavior score observed among college students.

The screen-time score was constructed similarly to the dietary-behavior score, and was comprised of three questions, with a higher score indicating longer screen time. In this part of the analysis, we assumed that students in the

Table 1. Baseline characteristics of survey population by education level

	Middle school (n=15,122)	High school (n=20,620)	College and beyond (n=10,869)
Mean age (SD)	13.6 (1.0)	16.1 (1.1)	19.4 (1.5)
No. women (%)	7392 (49)	10540 (51)	6538 (60)
Mother's education (%)			
Elementary school or below	1592 (11)	3119 (15)	2358 (22)
Middle school	6701 (44)	9993 (48)	5032 (46)
High school/vocational school	4083 (27)	4905 (24)	2385 (22)
Associates degree	1414 (9)	1239 (6)	613 (6)
Bachelor's degree or higher	1332 (9)	1364 (7)	481 (4)
BMI (SD)	20.4 (5.8)	21.7 (6.0)	21.8 (6.1)
No. nearsighted (%)	9287 (61)	15316 (74)	8155 (75)
Allowance per month (%)			
None	2775 (18)	1962 (10)	546 (5)
10-50 RMB	5483 (36)	2532 (13)	278 (3)
50-100 RMB	3255 (22)	3766 (18)	671 (6)
100-150 RMB	1407 (9)	2870 (14)	558 (5)
150-200 RMB	794 (5)	2743 (13)	542 (5)
200-250 RMB	920 (6)	3918 (19)	1784 (16)
500-1000 RMB	334 (2)	2208 (11)	4447 (41)
≥1000 RMB	154 (1)	621 (3)	2043 (19)
Geographic region (%)			
Southern Jiangsu	6808 (45)	7733 (38)	4362 (40)
Central Jiangsu	4282 (28)	6936 (34)	2318 (21)
Northern Jiangsu	4032 (27)	5951 (29)	4189 (39)
Mean dietary behavior score (SD)	2.0 (1.1)	1.7 (1.0)	1.5 (1.0)
Mean screen time score (SD)	3.8 (3.5)	3.9 (4.0)	4.2 (2.8)
Mean days of physical activity per week (SD)	3.8 (2.5)	2.5 (2.4)	2.2 (2.2)
Mean days of moderate exercise per week (SD)	3.4 (2.3)	2.5 (2.3)	1.8 (1.9)

Table 2. Regression coefficients and associated *p*-values for all major outcomes

Predictors	Dietary behavior score	*p*-value	Physical activity	*p*-value	Moderate exercise	*p*-value	Screen time score	*p*-value
Gender (0=men, 1=women)	0.156	<0.001	-0.600	<0.001	-0.523	<0.001	-0.604	<0.001
Grade (0=7th grade, 1=8th grade, 2=9th grade, 3=10th grade, 4=11th grade, 5=12th grade, 6=1st year college, 7=2nd year college, 8=3rd year college, 9=4th year college, 10=5th year college and beyond)	-0.034	<0.001	-0.230	<0.001	-0.221	<0.001	-0.107	<0.001
Mother's education level (0=elementary school, 1=middle school, 2=high school/vocational school, 3=associates degree, 4=bachelor's degree or higher)	0.097	<0.001	0.115	<0.001	0.160	<0.001	-0.238	<0.001
BMI	-0.007	<0.001	-0.004	0.017	0.004	0.020	0.022	<0.001
Monthly allowance (0=none, 1=10 to 50 RMB, 2=50 to 100 RMB, 3=100 to 150 RMB, 4=150-200 RMB, 5=200-500 RMB, 6=500-1000 RMB, 7=≥1000 RMB)	-0.087	<0.001	-0.012	0.037	-0.012	0.020	0.313	<0.001
Geographic area (0=southern Jiangsu, 1=central Jiangsu, 2=northern Jiangsu)	-0.123	<0.001	-0.258	<0.001	-0.234	<0.001	-0.432	<0.001

"College and beyond" group do not watch television, since no college dormitories or residence halls provided televisions in their rooms. However, some students may bring their own television sets into dormitories and a few students live off campus. Both are extremely rare occurrences in China. Because of this assumption, the screen-time score for the "College and beyond" group could be modestly underestimated. However, even making this assumption, college students still have a higher screen-time score than both middle school and high school students. This is likely the result of three phenomena. First, college students spend much more time using computers than middle school and high school students. This was due to several reasons, including less parental enforcement of time away from the screen, a significantly lower workload from classes (college students' workload was significantly lower than that of middle school and high school students in China, a distinct characteristic of the Chinese education system), and increased computer exercises.[17,18] Second, with less parental enforcement, the time that college student spend on video games (video game consoles, handheld gaming devices) may also be higher, which also contributed to additional screen time. Third, even without television, college students were exposed to screen time via online streaming from mobile devices, and this is accounted for by the number of hours spent on the internet (question twenty-three) in the survey.

From the questions provided in the NYHRBI, we had planned to construct a physical activity score similar to the dietary behavior score and screen time score described earlier. However, we decided against this for several reasons. First, the questionnaire differed somewhat for the three survey populations, which eliminated several potentially useful questions from consideration. Second, the usefulness of certain questions, such as "number of physical education classes per week" were questionable, because they were mandatory for middle school and high school students, but mostly voluntary for students college and beyond. Lastly, there was some overlap in certain questions, such as those that asked the amount of "physical activity" and those that asked the amount of "moderate exercise". Thus, we looked at physical activity and moderate exercise as separate outcomes.

We found that both physical activity and moderate exercise followed a decreasing trend with increasing educational level. Several factors may contribute to this finding. First, as noted earlier, physical education classes are typically voluntary in college, which explains why the mean days of exercise and physical activity were lowest for this group. Second, the emphasis on physical education in school was drastically different during different stages of education. During middle school, physical education was highly emphasized, because it was a tested subject in the national high school entrance examinations. In contrast, physical education was not a tested subject in the national college entrance examinations, and is thus underemphasized. Furthermore, it has been a regular practice in Chinese high schools to sacrifice physical education class time to make room for additional time in subjects that are on the entrance examinations.

In looking at the regression coefficients for the four examined models, we noted that all predictors of behavior examined in the screen time score model yielded statistically significant coefficients that agreed with our hypothesis. For example, females had a higher dietary-behavior score than males (c=0.150; $p<0.001$), but lower physical activity (c=-0.585; $p<0.001$) and moderate exercise scores (c=-0.518; p<0.001).9 Mother's education was positively associated with a higher dietary score (c=0.097; $p<0.001$), physical activity (c=0.115; $p<0.001$), and moderate exer-

cise scores (c=0.160; $p<0.001$), but lower screen time (c=-0.238; $p<0.001$). One predictor specific to Jiangsu province is "geographic area". Here, we coded 0, 1, and 2, respectively, as Southern, Central, and Northern Jiangsu. Jiangsu is historically known to be more economically developed in the south than in the north.[14] We thus predicted that we would be able to detect differences in health-related behaviors based on regions, and did detect significant differences among the three areas. Southern Jiangsu had the highest score in all categories, which is logical because they have access to better nutritional education, but at the same time have more access to devices that contribute to higher screen time scores.

Taking our analysis one step further, we investigated the relationship between the derived outcomes, and found statistically significant relationships between all four. Specifically, dietary-behavior score was positively associated with physical activity and moderate exercise, but negatively associated with screen time. Physical activity was positively associated with moderate exercise, and both physical activity and moderate exercise were negatively associated with screen time. While in an observational study we cannot determine the temporality of these relationships, it is no surprise that positive health behaviors (dietary behaviors, physical activity, and moderate exercise) were positively associated with each other, and were negatively associated with the negative health behavior of screen time.

This study has several distinct strengths. First of all, the sample size for the survey was large, and the quality of the obtained data for a study of this magnitude was excellent. Because the surveys were completed electronically and largely in a classroom setting with clarification available when necessary, very few surveys were discarded because of illegible handwriting and mistakes in interpretation, resulting in an overall useful response rate of 84%. Second, the survey's data collection methodology makes this dataset one that was truly representative of students at all education levels in the entire Jiangsu province. Third, all results from the multiple linear regression analysis were statistically significant and consistent with our hypothesis and the current literature.

There are also several limitations to this study. First and foremost, we relied on a self-reported survey with multiple questions that asked participants to recall past activities, as distant as 12 months prior to taking the survey. While the questions did not involve recalling activities more than 7 days old, answers may be prone to recall bias. Second, the BMI used for the statistical analysis was based on the self-reported height and weight collected from the survey, and therefore may be prone to reporting bias. Third, in the compilation of the mean dietary and screen-time scores, we assigned an equal weight to each question. As a result, our scoring system cannot necessarily be used to predict dietary patterns or screen-time habits. Lastly, we suspected that there may be a small, systematic weight bias caused by misinterpretation of the questionnaire. In asking for the students' weights, the units provided were "kilograms". In sorting through the survey data, we discovered a small portion of participants who provided unusually large numbers for weight resulting in BMIs that were unreasonably large, with some as high as 70. We suspected that these participants wrote their weight in jin (0.5 kilograms) instead, which is a much more commonly used weight unit in China. However, because this was just a suspicion, and seemed to apply only to a small minority of survey responses (<0.5% for BMI >50), it should not affect the overall dataset significantly.

In conclusion, this unique, large-scale survey of Chinese students in a region of contrasting economic development between south and north revealed a number of relationships between health-related diet and physical-activity behaviors, region, and education level. These findings can inform the development and effective implementation of measures to counteract the rising levels of obesity in this part of the world. The importance of continuous and consistent health education throughout a student's entire educational career cannot be underestimated. Policy makers should develop specific guidelines pertinent to students at each educational level to optimize the usefulness and feasibility of each policy.

ETHICS STATEMENT

This study was approved by the ethics committee of Jiangsu Provincial Center for Disease Control and Prevention.

AUTHOR DISCLOSURES

The authors declare of this paper declare no conflicting interests.

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Appendix A. Jiangsu youth health related behavior investigation (translated)

General Information

1. Gender: a1 (1) Male (2) Female
2. Date of birth: b2 _____year_____month_____day
3. Today's date: b3 _____year_____month_____day
4. Grade: a3 (1) 7th grade (2) 8th grade (3) 9th grade (4) 10th grade (5) 11th grade (6) 12th grade (7) 1st year college (8) 2nd year college (9) 3rd year college (10) 4th year college (11) 5th year college and beyond
5. Mother's education level: a6 (1) Elementary school (2) Middle school (3) High school/vocational school (4) Associates degree (5) Bachelor's degree or higher
6. Height: a10 (1) __cm (2) Unknown
7. Weight: a11 (1) __kilograms (2) Unknown
8. Are you nearsighted: d12 (1) Yes (2) No
9. Monthly allowance from parents d14: (1) 10~50 RMB (2) 50~100 RMB (3) 100~150 RMB (4) 150~200 RMB (5) 200~500 RMB (6) 500~1000 RMB (7) ≥1000 RMB (8) None

Health Related Behaviors

10. Over the past seven days, how many soft drinks (such as Coca-Cola, Pepsi, or Sprite) have you drank on average per day? a12 (1) None (2) Less than once per day (3) Once per day (4) Twice per day (5) Three times per day (6) Four times per day (7) Five times or more per day
11. Over the past seven days, how many times have you eaten dessert items (such as candy, chocolate, or pastries)? a13 (1) None (2) Once (3) 2~6 times (4) Once per day (5)Twice or more per day
12. Over the past seven days, how many times have you eaten fried food (such as French fries, fried chicken, or egg rolls)? a14 (1) None (2) Once (3) 2~6 times (4) Once per day (5) Twice or more per day
13. Over the past seven days, how many times have you eaten fresh fruit? a15 (1) None (2) Once (3) 2~6 times (4) Once per day (5) Twice or more per day
14. Over the past seven days, how many times have you eaten vegetables? a16 (1) None (2) Once (3) 2~6 times (4) Once per day (5) Twice or more per day
15. Over the past seven days, how many days have you had breakfast? a17 (1) Zero days (2) One day (3) Two days (4) Three days (5) Four days (6) Five days (7) Six days (8) Seven days
16. Over the past seven days, on how many days have you had at least one glass of milk (or yogurt/soymilk)? a18 (1) Zero days (2) One day (3) Two days (4) Three days (5) Four days (6) Five days (7) Six days (8) Seven days
17. Over the past seven days, on how many days have you eaten at a fast food restaurant (such as McDonalds, KFC, or Pizza Hut)? a19 (1) Zero days (2) One day (3) Two days (4) Three days (5) Four days (6) Five days (7) Six days (8) Seven days
18. Over the past seven days, on how many days have you eaten food at a roadside stand? a20 (1) Zero days (2) One day (3) Two days (4) Three days (5) Four days (6) Five days (7) Six days (8) Seven days
19. Over the past seven days, on how many days have you engaged in at least 60 minutes of physical activity (such as walking, running, swimming, or biking)? a24 (1) Zero days (2) One day (3) Two days (4) Three days (5) Four days (6) Five days (7) Six days (8) Seven days
20. Over the past seven days, on how many days have you engaged in moderate physical exercises (exercising for at least 30 minutes and felt, including but not limited to, shortness of breath, increased heart rate, and tiredness)? a25 (1) Zero days (2) One day (3) Two days (4) Three days (5) Four days (6) Five days (7) Six days (8) Seven days
21. Over the past seven days, how many hours of television have you watched on average per day? a69 (1) None (2) Less than an hour (3) One hour (4) Two hours (5) Three hours (6) Four hours or more
22. Over the past seven days, how many hours of video games have you played on average per day? a71 (1) None (2) Less than an hour (3) One hour (4) Two hours (5) Three hours (6) Four hours or more
23. Over the past seven days, how many hours do you spend on the internet on average per day? a72 (1) None (2) Less than an hour (3) One hour (4) Two hours (5) Three hours (6) Four hours or more

Appendix B. China's BMI cutoffs for overweight and obese, by age

	Men		Women	
Age	Overweight	Obese	Overweight	Obese
7	17.4	19.2	17.2	18.9
8	18.1	20.3	18.1	19.9
9	18.9	21.4	19.0	21.0
10	19.6	22.5	20.0	22.1
11	20.3	23.6	21.1	23.3
12	21.0	24.7	21.9	24.5
13	21.9	25.7	22.6	25.6
14	22.6	26.4	23.0	26.3
15	23.1	26.9	23.4	26.9
16	23.5	27.4	23.7	27.4
17	23.8	27.8	23.8	27.7
18	24.0	28.0	24.0	28.0