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Physical Activity Among Chinese School Youth 1997–2011: A Longitudinal Study

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Abstract

Purpose: In the last decade, the prevalence of overweight/obesity among Chinese youth increased at an alarming rate along with rapid economic development. Inactivity is often listed as one of the major contributors. However, few studies have examined longitudinal physical activity change among Chinese youth. The purpose of this study was to examine the trend of physical activity engagement among Chinese youth by analyzing secondary data collected from the China Health and Nutrition Survey (CHNS). **Method:** Chinese youth aged 6–18 years were extracted from the CHNS longitudinal data from 1997–2011. Linear mixed models were applied to explore the trend and examine the factors related to physical activity levels among Chinese youth. **Results:** There was a significant but weak increase in the frequency and time spent in Extracurricular Gymnastics, Dancing, and Acrobatics from 1997 to 2011. In addition, there was a significant but weak decrease for the time spent in Extracurricular Sedentary Activity and In-School Physical Activity. **Conclusion**: The overall physical activity pattern among Chinese school youth from 1997–2011 is not clear.

Keywords

physical activity; Chinese school youth; longitudinal study

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China, as the most populous country in the world, has undergone many social and economic changes that have led to a high prevalence of behavior-related noncommunicable diseases, such as obesity and diabetes. For example, Wildman et al. (2008) reported an increase in the prevalence of overweight and obesity among males from 9.6% and 0.6%, respectively, in 1991 to 20.0% and 3.0%, respectively, in 1999–2000. For females, the prevalence of overweight and obesity increased from 14.5% and 1.8%, respectively, in 1991 to 26.5% and 5.2%, respectively, in 1999–2000. Not surprisingly, the overall diabetes prevalence increased as well. Yang et al. (2010) reported an overall diabetes prevalence of 9.7% among a nationally representative sample of 47,325 adults in 2008, which indicated a steady increase compared to the rates of 2.5% in 1994 and 5.5% in 2000–2001 (Gu et al., 2003; Pan, Yang, Li, & Liu, 1997).

Similarly, Chinese youth have also become heavier and bigger. Many researchers have reported the increased overweight/obesity prevalence among Chinese youth (Gordon-Larsen, Wang, & Popkin, 2014; Ji, 2008; Lau, 2004). Because of the differences in sample size, study quality, overweight/obesity criteria, and geographical distribution, the numerical reports varied across studies. To address those issues, Yu et al. (2012) conducted a meta-analysis after screening 1,326 papers and included 35 papers (41 studies), with the majority of medium quality. They reported that the prevalence of overweight/obesity increased from 1.8% and 0.4%, respectively, in 1981–1985 to 13.1% and 7.5%, respectively, in 2006–2010. The average annual increase was 8.3% and 12.4%, respectively. They also reported gender and location effects; specifically, boys or children from urban areas were more likely to be overweight/obese than girls or children from rural areas.

Childhood overweight and obesity are associated with many immediate and long-term health effects (CDC, 2014). Specifically, children who are overweight or obese have a higher risk of experiencing social and psychological problems, heart disease, diabetes, joint problems, breathing problems, and adult obesity, which directly affect those children's mobility and future mortality. Therefore, it is important to examine childhood overweight/obesity contributing factors for prevention purposes.

Though many factors contribute to the rapid increase of obesity/overweight among Chinese youth, inactivity is often listed as one major contributor (Gordon-Larsen, Wang, & Popkin, 2014; Wang & Zhai, 2013). However, there is a lack of research in which researchers have examined the longitudinal physical activity changes among Chinese youth over the years, which may prevent an accurate understanding of the reality of overweight/obesity and make goal setting even more challenging. The purpose of the current study was to understand the longitudinal trend of physical activity among Chinese school youth by analyzing the data from the China Health and Nutrition Survey (CHNS).

Method

CHNS data provided by the Carolina Population Center at the University of North Carolina were used in this study. CHNS is an ongoing study that uses a face-to-face interview approach to collect individual-level information on income, diet, health, and demography for all participants, as well as community-level data on services and infrastructures in nine diverse provinces (Guangxi, Guizhou, Heilongjiang, Henan, Hubei, Hunan, Jiangsu, Liaoning, and Shandong) of China. A multistage random cluster process was used to draw the sample surveyed in each of the provinces (B. Zhang, Zhai, Du, & Popkin, 2014).

The dataset used in this study included six time points of unbalanced data (1997, 2000, 2004, 2006, 2009, and 2011), which meant not all participants were interviewed in every study year. The participants for this study included children who were in school at the point of the data collection and aged between 6 and 18 years old.

Measures

EPA: Extracurricular physical activities (does not include weekend activities). The extracurricular physical activities (EPA) per week included four measures: frequency of physical activity engagement; minutes of gymnastics, dancing, and acrobatics; minutes of track and field and swimming; and minutes of other physical activities, including martial arts, soccer, basketball, volleyball, badminton, tennis, ping pong, and Tai Chi.

ESA: Extracurricular sedentary activities (does not include weekends). Sedentary activities (ESA) per week (do not include weekends) measures included minutes of watching TV and videotapes, VCDs, and DVDs; minutes of extracurricular reading, writing, and drawing; and minutes of other sedentary activities, including playing video games, toy cars, puppets, and board games.

IPA: In-school physical activities. There were three measures examining in-school physical activities (IPA) per week. They were minutes of gymnastics, dancing, and acrobatics; minutes of track and field and swimming; and minutes of other physical activities, including martial arts, soccer, basketball, volleyball, badminton, tennis, ping pong, and board games.

Data Analyses

Data analyses were performed using SPSS 22.0. Descriptive statistics were calculated to inspect the data for distribution. Median values were used to describe the average physical activities per week. Because of the design of the survey, no information regarding physical/sedentary activities over the weekends was collected. For the purpose of this paper, the terms *per week* or *a week* only refers to 5 weekdays, not the regular week of 7 days. Modified Box–Cox

transformations were conducted to improve the normality of the measures. Linear mixed models were applied to the studied variables. Two-level random coefficient models include a time variable at Level 1 (Year) and a subject variable (Individuals) at Level 2. Year serves as a repeated variable and as a random effect. In other words, time is nested within subjects. Level 1 intercept (e.g., mean score of physical activity) and Level 1 slope (e.g., average growth rate in physical activities) were predicted as random effects. Individual-level predictors, including gender and age, were examined for their effects on change over time in physical activities. They were fixed effect predictors.

Results

A total of 18,399 children aged 6 to 18 years old were in the data set. Between 1997 and 2011, a typical Chinese youth engaged in EPA two to three times per week. When the EPA is broken down by type, the engagement duration for Gymnastics, Track, and Other Activities ranged from 14–27.5, 20–30, and 30–40 min/week, respectively during 1997–2011. For ESA, a typical Chinese youth spent 60–84, 30–84, and 24–30 min/week in Watching TV, Reading, and Others from 1997–2011. Compared to EPA, IPA had fewer variations over the years in terms of engagement duration. Specifically, the duration for In-School Gymnastics was 60 min/week for most years, except 70 min/week in 2000. The engagement duration for In-School Track was 40 min/week in 2004, 2009, and 2011, with the exception of 45 min/week in 1997 and 2006 and 60 min/week in 2000. The engagement duration for In-School Other Activity was 60 min/week in 1997, 2004, 2009, and 2011, with the exception of 90 min/week in 2000 and 70 min/week in 2006. When the time for EPA and IPA is added together, a typical Chinese youth spends 90 min/week for physical activities.

Fixed Effects

Regarding EPA, the average growth rates per year were .02 points ($p = .00$) for frequency of physical exercise; .05 points ($p = .04$) for gymnastics, dancing, and acrobatics; .01 points ($p = .15$) for track and field and swimming; and .01 points ($p = .68$) for other extracurricular physical activities while controlling for gender, age, random effects, and repeated measure. With respect to ESA, the average growth rates per year were –.03 points ($p = .00$) for watching TV and videotapes, VCDs, and DVDs; –.10 points ($p = .00$) for extracurricular reading, writing, and drawing; and –.03 points ($p = .00$) for other sedentary activities. Within IPA, the average growth rates per year were –.02 points ($p = .00$) for gymnastics, dancing, and acrobatics; –.01 points ($p = .00$) for track and field and swimming; and –.01 points ($p = .01$) for other in-school physical activities (see Table 1).

Table 1
Fixed Effects in Linear Mixed Models

Fixed effects	Estimate	*SE*	*p*	95% CI
Extracurricular physical activities				
1. Frequency (*n* = 2,157)				
Intercept	1.46	.05	.00	1.36, 1.56
Male vs. Female	.14	.03	.00	.08, .20
6–12 vs. 16–18 years	.03	.04	.45	−.05, .11
13–15 vs. 16–18 years	.03	.05	.45	−.06, .12
Year	.02	.003	.00	.01, .02
2. Gymnastics (*n* = 550)				
Intercept	5.08	.36	.00	4.37, 5.79
Male vs. Female	.17	.23	.46	−.28, .62
6–12 vs. 16–18 years	−.43	.32	.18	−1.05, .19
13–15 vs. 16–18 years	−.23	.36	.53	−.93, .47
Year	.05	.02	.04	.002, .09
3. Track (*n* = 1,217)				
Intercept	3.59	.12	.00	3.37, 3.82
Male vs. Female	.17	.08	.03	.02, .32
6–12 vs. 16–18 years	−.04	.10	.70	−.23, .15
13–15 vs. 16–18 years	−.10	.11	.34	−.31, .11
Year	.01	.01	.16	−.005, .03
4. Other activities (*n* = 1,999)				
Intercept	6.44	.19	.00	6.05, 6.82
Male vs. Female	.78	.13	.00	.52, 1.04
6–12 vs. 16–18 years	−.70	.16	.00	−1.01, −.39
13–15 vs. 16–18 years	−.40	.17	.02	−.72, −.07
Year	.01	.01	.65	−.02, .03
Sedentary activities				
1. Watching TV (*n* = 5,442)				
Intercept	8.35	.11	.00	8.13-8.57
Male vs. Female	.13	.07	.07	−.01, .27
6–12 vs. 16–18 years	.34	.10	.00	.14, .53
13–15 vs. 16–18 years	−.60	.11	.00	−.82, −.39
Year	−.03	.01	.00	−.05, −.02

Table 1 continued

Fixed effects	Estimate	*SE*	*p*	95% CI
2. Reading (*n* = 4,695)				
Intercept	6.63	.07	.00	6.49, 6.77
Male vs. Female	−.01	.05	.76	−.10, .08
6–12 vs. 16–18 years	−.37	.07	.00	−.50, −.24
13–15 vs. 16–18 years	−.37	.07	.00	−.52, −.22
Year	−.10	.004	.00	−.11, −.09
3. Other activities (*n* = 1,946)				
Intercept	5.26	.17	.00	4.94, 5.59
Male vs. Female	.06	.10	.53	−.13, .25
6–12 vs. 16–18 years	−.28	.15	.07	−.58, .02
13–15 vs. 16–18 years	−.81	.17	.00	−1.14, −.47
Year	−.03	.01	.00	−.05, −.01
In-school activities				
1. Gymnastics (*n* = 3,550)				
Intercept	4.24	.03	.00	4.17, 4.30
Male vs. Female	−.03	.02	.19	−.06, .01
6–12 vs. 16–18 years	.00	.03	1.00	−.07, .07
13–15 vs. 16–18 years	.04	.04	.31	−.03, .11
Year	−.02	.002	.00	−.019, −.01
2. Track (*n* = 3,658)				
Intercept	3.99	.04	.00	3.92, 4.07
Male vs. Female	.03	.02	.13	−.01, .08
6–12 vs. 16–18 years	−.09	.04	.02	−.16, −.01
13–15 vs. 16–18 years	−.06	.04	.14	−.13, .02
Year	−.01	.002	.00	−.02, −.007
3. Other activities (*n* = 3,518)				
Intercept	4.35	.04	.00	4.27, 4.43
Male vs. Female	.29	.02	.00	.24, .34
6–12 vs. 16–18 years	−.19	.04	.00	−.26, −.12
13–15 vs. 16–18 years	−.06	.04	.14	−.13, .02
Year	−.01	.002	.01	−.012, −.002

Note. First-order autoregressive structure with homogeneous variances (AR(1)) for repeated measures.

Regarding EPA, the average initial scores were 1.46 (= 2.60 times/week) for frequency of physical exercise; 5.08 (= 20.89 min/week) for gymnastics, dancing, and acrobatics; 3.59 (= 20.49 min/week) for track and field and swimming; and 6.44 (= 35.08 min/week) for other extracurricular physical activities while controlling for gender, age, and random effects. Within ESA, the average initial scores were 8.35 (= 64.41 min/week) for watching TV and videotapes, VCDs, and DVDs; 6.63 (= 67.08 min/week) for extracurricular reading, writing, and drawing; and 5.26 (= 35.38 min/week) for other sedentary activities. Regarding IPA, the average initial score were 4.24 (= 68.41 min/week) for gymnastics, dancing, and acrobatics; 3.99 (= 53.05 min/week) for track and field and swimming; and 4.35 (= 76.48 min/week) for other in-school physical activities (see Table 1).

Male children participated in more EPA than female children in frequency (b = .14, p = .00), track and field and swimming (b = .17, p = .03), and other activities (b = .78, p = .00) when other variables were held constant. They also had more Other IPA than female counterparts (b = .29, p = .00). As for age, the 16–18 years group was more likely to participate in exercise than were other age groups in other extracurricular physical activities ($b_{6–12}$ = –.70, p = .00; $b_{13–15}$ = –.40, p = .02), in-school track and field and swimming ($b_{6–12}$ = -.09, p = .02), and other in-school activities ($b_{6–12}$ = –.19, p = .00). However, they also reported more ESA than other age groups in extracurricular reading, writing, and drawing ($b_{6–12}$ = –.37, p = .00; $b_{13–15}$ = –.37, p = .00), watching TV and videotapes, VCDs, and DVDs ($b_{13–15}$ = –.60, p = .00), and other sedentary activities ($b_{13–15}$ = –.81, p = .00). Children aged between 6 and 12 years watched more TV and videotapes, VCDs, and DVDs (b = .34, p = .00; see Table 1).

Random Effects

The random effects of subjects and year on the initial scores and growth rates of different physical activities were examined (see Table 2). The random effects were not significant (p > .05) in extracurricular physical activities of gymnastics, dancing, and acrobatics; sedentary activities of extracurricular reading, writing, and drawing; and in-school activities of track and field and swimming; and other in-school activities. The multilevel models may not be proper. Therefore, the linear mixed models analyses were conducted again for those measures with only repeated measures effects and fixed effects modeled.

Table 2

Covariance Structures in Linear Mixed Models

Random effects	Estimate	*SE*	*p*
Extracurricular activities			
1. Frequency (*n* = 2,157)[a]			
Variance of intercept	.498	.07	.00
Variance of year	.004	.001	.00
2. Gymnastics (*n* = 550)			
Variance of intercept	.00		
Variance of year	.0002	.01	.98
3. Track (*n* = 1,217)			
Variance of intercept	.49	.15	.00
Variance of year	.003	.001	.00
4. Other activities (*n* = 1,999)			
Variance of intercept	1.03	.52	.048
Variance of year	.01	.004	.00
Sedentary activities			
1. Watching TV (*n* = 5,442)[b]			
Variance of intercept	.010	.21	.96
Variance of year	.025	.002	.00
2. Reading (*n* = 4,695)[c]			
Variance of intercept	.28	.20	.15
Variance of year	.004	.02	.08
3. Other activities (*n* = 1,946)[b]			
Variance of intercept	.00		
Variance of year	.01	.002	.00
In-school activities			
1. Gymnastics (*n* = 3,550)[b]			
Variance of intercept	.00		
Variance of year	.001	.0002	.00
2. Track (*n* = 3,658)			
Variance of intercept	.00		
Variance of year	.0001	.0001	.33
3. Other activities (*n* = 3,518)[c]			
Variance of intercept	.02	.04	.51
Variance of year	−.001	.001	.31

Note. Variance components structure for random effects.

[a]Compound symmetry-heterogeneous covariance structure. [b]No intercept model. [c]Unstructured covariance structure.

The intercept effect is the effect of subjects on initial physical activities scores. This effect was not significant ($p > .05$) in sedentary activities of watching TV and videotapes, VCDs, and DVDs; other sedentary activities; and in-school activities of gymnastics, dancing, and acrobatics. However, the year effects were significant in those measures ($p < .05$). Linear mixed models with no random intercept effect were specified. The significant intercept effects ($p < .05$) were presented in extracurricular physical activities of frequency of physical exercise, track and field and swimming, and other extracurricular physical activities. This significant effect means the initial scores of those physical activities vary among school children (see Table 2).

The year effect on the growth rates was also significant ($p < .05$) in the aforementioned measures including all extracurricular physical activities; all sedentary activities except reading; and in-school activities of gymnastics, dancing, and acrobatics, which implies that there is a tendency for school children to experience different growth rates of those physical activities across years (see Table 2).

Discussion

To combat noncommunicable diseases (NCD), the Chinese government has been actively promoting healthy lifestyles by setting national goals and initiating campaigns, such as the China National Plan of NCD Prevention and Treatment 2012–2015 (Chinese Center for Disease Control and Prevention, 2012). The efforts that specifically applied to Chinese youth included the passage of the governmental policy titled Central Opinions on Strengthening Youth Sports to Enhance Youth Physical Fitness (Xinhua News Agency, 2007). In this document, Chinese youth are recommended to have 60 min or more of physical activity each day, which is the same as the recommendation made by the U.S. Department of Health and Human Services (2008). Unfortunately, a typical Chinese youth from 1997 to 2011 who had an average of 90 min physical activity per week failed to meet this recommendation, which echoed other studies in the literature. For example, X. Zhang et al. (2012) conducted a nationwide survey among 166,812 Han ethnicity students aged 9–18 years and reported that only 22.7% of the participants met the recommendation of having physical activities for 60 or more min each day. X. Zhang et al. (2012) further reported that students with higher physical activity desire, physically active parents, and better school sports atmospheres were more likely to meet the recommendation. In addition, students with heavy homework loads and long homework times were less likely to participate in physical activity.

The results of this study indicated that there was a weak but significant increase in the frequency and time spent in Gymnastics, Dancing, and Acrobatics from 1997 to 2011. In addition, there was a weak but significant decrease for the time spent in ESA and IPA. Therefore, it is difficult to draw a conclusion

regarding the overall physical activity pattern from 1997 to 2011. At the same time, the decrease in time spent in ESA was interesting and surprising as many other studies in China and the United States reported contradictory results (Nelson, Neumark-Stzainer, Hannan, Sirard, & Story, 2006; Zong & Li, 2014). Based on secondary data analysis, Zong and Li (2014) reported that time spent in front of a television, video, or computer increased, as did the proportion of children and adolescents who commuted to school in a motorized vehicle between 1991 and 2009. However, all the studies mentioned adopted a subjective approach to quantify the time spent in sedentary activities, that is, self- or proxy-report. This type of reporting left room for bias/errors, especially when these studies were conducted among youth.

Although there was a small decrease in IPA compared to EPA across years, the results revealed that Chinese school youth spent more time doing in-school activities than extracurricular activities. In China, academic success is strongly emphasized. Chinese youth typically have a heavy load of homework and are free of home chores (Tudor-Locke, Ainsworth, Adair, Du, & Popkin, 2003), which may lead to a low amount of extracurricular physical activity. Fortunately, Chinese school children receive additional physical activity through mandatory physical education in schools. The schools not only provide an environment for different activities, but also can supervise and assure the quality of and time spent in those activities. Given that Chinese school youth receive more physical activity time through school and that they fail to meet the recommendation of having physical activities for 60 min or more per day, the mandatory physical education seems particularly necessary and crucial. At the same time, more effort is needed to educate parents about the importance of getting their children involved in extracurricular activities.

It is common to see a gender difference in terms of the involvement in physical activities; specifically, girls tend to be less active compared to boys (X. Zhang et al., 2012). The results of this study once again reiterated the same theme in the literature. C. Zhang and Li (2008) reported that concern for getting sweaty and smelly, concern for becoming tan after exposure to sun, and lack of female-oriented equipment and facilities contributed to the gender difference. Though boys tend to be more physically active (X. Zhang et al., 2012), they are more likely to be obese/overweight (Yu et al., 2012). This paradox again suggests that obesity/overweight is a complicated issue that requires a multifaceted approach to understand fully and address successfully.

In China, children usually start elementary school, middle school, and high school at the ages of 8, 13, and 16, respectively. The results of this study indicated that high school students were more likely to engage in Other Extracurricular Activities and all ESA (including watching TV, reading, and others) compared to other age groups. At the same time, high school students were more likely to engage in some IPA, specifically Track and Other In-School

Physical Activities, compared to the 6-12 age group, but not the middle school students. In this study, high school students were a reference group, which means that results were based on the comparisons between all other groups and this reference group. Students in high school seem more active, but also spent more time in activities such as reading and writing. Stronger coefficients can be seen in other extracurricular activities, including team sports and other sedentary activities, such as playing video games and playing with toy cars. These contradictions require future quantitative studies to shed light on the reason of this phenomenon.

Significant random intercept and year effects were found in all EPA, except gymnastics, dancing, and acrobatics. Those effects indicated that there were individual differences in those activities in 1997 (the baseline year) and that school children might have experienced different growth rates across years, while controlling for gender and age. The results imply that children have more control over the type and the length of time spent participating in extracurricular activities. From a health educator's point of view, this increases the difficulty of intervention for improving extracurricular physical activities. It is surprising that there were no random year effects on individual growth rate with in-school activities except on gymnastics, dancing, and acrobatics when great changes have occurred throughout the country in many aspects of life. The schools have the authority to control the type and the length of in-school physical activities, which could explain the homogenous growth rates among school children in those activities.

Limitations and Implication

Missing data are common in longitudinal studies; this study is no exception. To address this issue, linear mixed models were adopted because they are good for unbalanced designs. Still, the representativeness may be challenged. Considering that huge social economic changes have occurred in China, more data points could be used to reveal a better picture of the physical activities among Chinese school youth.

The average growth rates of different physical activities were obtained while controlling for gender, age, and random effects, which complicates the interpretation of the results. This is due to the diversity of the participants who were from different provinces. It is not uncommon that the in-school situation and the out-of-school situation are different across villages, cities, and provinces. Many factors could contribute to the physical activity patterns in these different environments. To have a better understanding of physical activity patterns among Chinese school youth, both nationwide studies and studies targeting homogeneous groups should be initiated. The nationwide studies would help researchers have a comprehensive view of physical activity among children, and homogeneous group studies would help remove confounding variables, making results less complex and more meaningful.

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