Determinants of student’s MVPA level in school and neighborhood environment changing with age: a 12-month follow-up study in Ningxia province

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Abstract

Background

The benefits of physical activity have been identified in children and adolescents. However, the prevalence of physical inactivity in school-aged children and adolescents was high in China. Most time of students spends in neighborhood and school, and these play an important role in student’s MVPA level. Therefore, we will investigate the impact of implementing the national health promotion policy on PA behavior in school-aged children and adolescents and the effects that influence the changes in PA behavior in this study.

Methods

This is a longitudinal study with a 12-month follow-up. The study sample came from 2016 and 2017 Physical Activity and Fitness in China—The Youth Study, total 1611 students (aged 7–18 years) from 31 primary, junior high, and high schools were included in this study. The physical and social environment in school and neighborhood were measured by questionnaire at baseline and after 12 months. Multiple logistic regression was used to examine the relationship of influential factors and moderate- and vigorous MVPA.

Results

There is no significant difference in MVPA level between 2016 and 2017. Student’s attitudes to PA, neighborhood facilities, and organizations were improved significantly after 12 months. The influential factors changed after 12 months. In 2016 the top three contributors were attitude to MVPA (OR 3.08 with 95% CL 1.22, 7.76), neighborhood PA facilities (OR 1.52, 95% CL 1.24, 1.86) and age (OR 1.38, 95% CL 1.13, 1.69), and in 2017 the top three factors were student’s attitude to PA (OR 4.28, 95% CL 1.788, 10.245), school extra time for PA (OR 2.29, 95% CL 1.56, 3.36) and the frequency of sports events in neighborhood (OR 1.84, 95% CL 1.34, 2.53).

Conclusions

The single health policy is not effective for student’s MVPA promotion. There may be some factors mediate the relationship between neighborhood environment and MVPA level with age and grade increasing. In the future, more studies are needed to explore the change of influential factors and mediators with age. The findings of this study may provide some evidence for future policy-making.

Background
Cumulative evidence has proved that physical activity (PA) is beneficial for physical and mental health in children and adolescents, such as reduce the prevalence of overweight/obesity, cardiovascular disease, and Type 2 diabetes and even mental health[1, 2]. In contrast, the disadvantage of sedentary behavior (SED) has also been identified[3–5]. Early PA behavior can be traced to adulthood[6], indicating that PA-related health benefits at adulthood may derive from an active lifestyle in the early lifespan. Although the benefit of PA is obvious, approximately 80% of adolescents globally (13–15 years old) are not meeting the recommended guidelines (Hallal et al., 2012). As early as 2010, the World Health Organization has recommended that children and adolescents aged 5–17 years need at least 60 min moderate- to vigorous-intensity physical activity (MVPA) daily, but only 22.7% of students met the recommendation in China[7]. Until 2016, approximately 70% of Chinese students not met the PA recommendation[8]. At the moment, a national health policy named “Healthy China 2030” is issued in 2016 to promote healthy lifestyles and physical fitness, which asks school-aged children to physical activity 1 h daily and achieve the goal of 25% “excellent” ratio of physical fitness assessment. Even so, only 34.1% of students met the recommendation of 60-minutes moderate- and vigorous- physical activity (MVPA) participation each day[9].

Both school and neighborhood are important for students PA participation[10], lots of researches have explored the factors associated with MVPA to develop an intervention for promoting MVPA. For example, the school environment plays a crucial role for students to engage in physical activity (PA) [11, 12]. The PA-friendly school environment positively associated with student’s PA participation[13]. Meanwhile, the extramural activity also promotes MVPA effectively, which provides more opportunities for students to participate in PA, such as neighborhood-based PA facilities, organization, and so on[14–17]. Moreover, student’s PA behavior also be influenced by others when they are in school and neighborhood, including others’ support for PA or behaviors. The systematic review has revealed that students with physically active parents are more likely to have an active lifestyle[18], as well as peer support [19, 20]. However, most of these studies were cross-sectional investigations. Little is known about whether these factors will change with time and need to be explored. According to the ecological model [21], policy and environment are two important components for behavior changing, which can influence active living through a variety of mechanisms, such as improving neighborhood PA environment[22]. Compared to small scale intervention programs, the policy is more impactive and it will be effective in national wide. A well-known example of policy intervention for health promotion is U.S Surgeon General’s report “Smoking and Health” that adult smoking rate from 50% in 1965 to 18% in 2014 after 50 years of the intervention[23]. A comprehensive health policy named “Health China 2030” issued during follow up that has made a request not only for MVPA but also for the neighborhood PA friendly environment. Therefore, these may also be effective for improving student’s MVPA level.

In the current study, we will investigate the impact of implementing the national health promotion policy on PA behavior in school-aged children and adolescents and the effects that influence the changes in PA behaviors. Further, we will explore the factors contributing to student’s MVPA and the change of factors in a 1-year follow-up. The outcomes of this investigation could help develop effective interventions to
increase PA at this critical life stage and identify the guidance for the next step in policy-making in health for students.

**Methods**

**Study design**

This was a longitudinal survey study. The baseline sample was taken from 2016 Physical Activity and Fitness in China—the Youth Study (PAFCTYS) project, a nationwide survey of PA and fitness among Chinese school-aged children and adolescents. Thirty-one primary, junior-high and high schools were randomly selected from 8 counties/cities at Ningxia province in China. The schools were evenly distributed in urban and rural areas. The students were requested to take the same survey questionnaire again after 12 months. The surveys took place between October and November. Details of the study protocol were described in a previous study[8]. This study was approved by the Ethics Review Committee of Shanghai University of Sport in 2016. Because of the study nature with minimum risk, only verbal assent and consent were required for in the study.

**Study participants**

A total of 1611 school-aged children and adolescents (aged 7–18 years) were included in the baseline survey in 2016 (T0) and were followed to make the same survey after 12 months (T1), 14 of them have been excluded due to the response out of the range. Among them, boys and girls were 48.2% (n = 770) and 51.8% (n = 827), respectively (see Table 1); 725 (45.4%) of them attended the schools in urban area and 872 (54.6%) in rural area; 629 (39.4%) of them were adolescents (13 to 17 years old) and 968 (60.6%) children (9 to 12 years old).
Table 1
Baseline information of students surveyed in 2016.

|                      | Age (years) | BMI (kg/m²) | Number (%) | Overall N (%) |
|----------------------|-------------|-------------|-------------|---------------|
|                      | Boys        | Girls       | Boys        | Girls         | Boys         | Girls       |               |
| Urban children (9 to 12 year. old) | 10.1 ± 1.0  | 10.1 ± 1.0  | 17.7 ± 3.0  | 17.4 ± 2.8    | 213          | 245          | 458 (28.7%)   |
| Rural children (9 to 12 year. old)  | 10.1 ± 1.0  | 10.0 ± 1.0  | 17.8 ± 2.7  | 17.2 ± 2.5    | 255          | 255          | 510 (31.9%)   |
| Urban adolescents (13 to 17 year. old) | 14.9 ± 1.5  | 14.9 ± 1.5  | 20.1 ± 3.2  | 20.3 ± 2.6    | 135          | 132          | 267 (16.7%)   |
| Rural adolescents (13 to 17 year. old) | 14.7 ± 1.4  | 14.5 ± 1.4  | 20.0 ± 2.8  | 19.8 ± 2.6    | 167          | 195          | 362 (22.7%)   |
| Combined              | 12.0 ± 2.5  | 11.9 ± 2.6  | 18.6 ± 3.1  | 18.4 ± 2.9    | 770          | 827          | 1597 (100%)   |

Data present group mean ± standard deviation of the mean.

Study procedure

Two trained research assistants were sent to the participant school for assisting the surveys conducted in 2016 and 2017. Before starting the initial survey, verbal assents from parents and teachers, and verbal consent from students were obtained. Detailed instructions for the survey were provided and all questions were answered. The survey questionnaires were completed in the classroom within ≤ 20 minutes, which included the perceived PA environment of the neighborhood and school. Besides, the parents’ survey including weekly PA days was conducted off-campus by a parent questionnaire. The numeric identification code was assigned to the questionnaire. An experienced research assistant input data into a computer database, which was only accessed by authorized project staff.

Study variables

PA levels

The modified Chinese-version of the International Physical Activity Questionnaire Short Form (IPAQ-SF) was used to assess the PA levels of the students, which has been used in previous studies[8, 16, 24].
Student’s responses to the question “How many days did you have moderate to vigorous physical activity (MVPA), i.e., increased breathing rates and felt sweating, more than 60 minutes in last 7 days” were categorized into three groups: the sedentary group with exercise 0 to 1 day, physically inactive group with exercise 2 to 4 days, and physically active group with exercise 5 to 7 days. Similarly, parent’s PA levels (provided by parent survey) also were categorized into three groups according to their response for MVPA days in the past week more than 30 min, i.e., sedentary, physically inactive, and physically active groups.

**Neighborhood factors**

Students were requested to answer 4 questions about the neighborhood (Qn): Qn-1 “There were game/sport events held for children and/or adolescents in your neighborhood during last year” with possible answers scored from 1 - never, 2 - not often, 3 - so-so, 4 - often, or 5 - very often. Qn-2 “There were free sport and/or exercise skills/training for children and/or adolescents in your neighborhood during last year” with the same 5-score answers as in Qn-1. Qn-3 “Are there sport organizations available for children and/or adolescents in your neighborhood” (1 – yes or 2 – no). Qn-4 “Are there sport facilities for children and/or adolescents conveniently located in your neighborhood” (1 – yes or 2 – no). The answers for Qn-1 and Qn-2 were grouped into three categories, i.e., groups with negative (answers 1 and 2), neutral (answer 3), and positive (answers 4 and 5) neighborhood PA environment for simplicity.

**School factors**

Questions for school PA environment (Qs) included Qs-1 “School exercise facilities and equipment can meet my needs for physical activity and exercise”; Qs-2 “PA class plays an important role for me to participate in physical activity and exercise”; Qs-3 “School teachers encourage me to participate in physical activity and exercise”; Qs-4 “School provides extra time for physical activity and exercise”; and Qs-5 “School has a desirable culture/environment for physical activity and exercise”. All these questions had five possible answers: 1 – completely disagree, 2 – disagree, 3 – not sure, 4 – agree, or 5 – completely agree. Also, there were two more questions about student’s friends: Qs-7 “Friends often encourage me to participate in physical activity and exercise training” and Qs-8 “Friends often participate in physical activity and exercise training with me” with 5-score answers from completely disagree (score 1) to completely agree (score 5). These questions were also categorized into three groups: non-desirable/negative (combined answers 1 and 2), neutral (answer 3), and desirable/positive (combined answers 4 and 5) school PA environment groups, respectively.

**Attitude to PA/exercise**

Student’s attitude to PA/exercise was assessed by the survey question “Your attitude to participating in physical activity and/or exercise in future” 1 – don’t like PA/exercise and won’t plan to participate; 2 – will start PA/exercise; 3 – will do more PA/exercise, but not every day; 4 – will try to do PA/exercise every day; or 5 – will keep exercise every day. The responses were grouped into three categories: negative attitude (answer 1); positive attitude (combined answers 2 and 3); and a very positive attitude (combined answers 4 and 5).

**Statistical analysis**
Three-factor analysis of variance (ANOVA) was applied to test the effects of sex, age, and school location on baseline body mass index (BMI). Differences in numeric scores between T0 and T1 were examined using paired t-test. Chi-square test and logistic regression analysis were applied to examine the associations of MVPA with sex (boys vs girls), age (children vs adolescents), and the school location (urban vs rural). In addition, associations of overweight/obesity with time points (2016 vs 2017) were also examined by Chi-square test. Furthermore, multiple logistic regression analysis was applied to predict the neighborhood and school PA/exercise factors for MVPA, i.e., the students who had a physically active lifestyle (exercise ≥ 5 days during the last 7 days). Odds ratios (OR) and 95% confidence limits (CL) were estimated to quantify the difference based on Chi-square test or logistic regression analysis. P-value < 0.05 was taken to indicate statistical significance. All statistical analyses were performed using SPSS (Version 26.0, IBM Corp., Armonk, NY, USA) or SAS software package (version 9.4, Cary, NC, USA).

**Results**

Table 1 summarizes the baseline information surveyed in 2016. The students’ body mass index (BMI) was not affected by sex (p = 0.153) or school location (p = 0.123); but it significantly increased with age (P < 0.001) according to three-factor ANOVA. Children are more likely to be overweight-obese both in 2016 (OR 1.39, 95% CL 1.14, 1.69 p < 0.001) and 2017 (OR 1.49, 95% CL 1.27, 1.74 p < 0.001). Both boys (OR 1.15, 95%CL 1.01, 1.32 p = 0.029) and girls (OR 1.21, 95%CL 1.05, 1.39 p = 0.007) are more likely to have normal weight in 2016 than 2017 (Table 2).
Table 2
of BMI group between boys and girls by years

| BMI group | Count | Year 2016 | Year 2017 | Total |
|-----------|-------|-----------|-----------|-------|
| Sex = 1 boys |       |           |           |       |
| Normal    | N     | 624       | 589       | 1213  |
|           | %     | 40.52     | 38.25     | 78.77 |
| Overweight| N     | 146       | 181       | 327   |
|           | %     | 9.48      | 11.75     | 21.23 |
| Total     | N     | 770       | 770       | 1540  |
|           | %     | 50        | 50        | 100   |
| Sex = 2 girls |     |           |           |       |
| Normal    | N     | 704       | 662       | 1366  |
|           | %     | 42.56     | 40.02     | 82.59 |
| Overweight| N     | 123       | 165       | 288   |
|           | %     | 7.44      | 9.98      | 17.41 |
| Total     | N     | 827       | 827       | 1654  |
|           | %     | 50        | 50        | 100   |

The student’s MVPA days in the last 7 days were not significantly different (P = 0.106) between 2016 (3.8 ± 2.0 days) and 2017 (3.7 ± 2.0 days), see Table 3. In 2016, 36.8% and 6.5% of the surveyed students were physically active and sedentary, respectively (Table 4). These percentages remained similar in 2017 (33.6% and 6.3%). Although there was no significant difference in student’s PA levels between T0 and T1, the group BMI was significantly increased (P < 0.001) from 18.5 ± 3.0 kg/m^2 in 2016 to 19.2 ± 3.7 kg/m^2 in 2017 (Table 3). Furthermore, the overall perceived neighborhood or school PA environment scored significantly higher in 2017 than in 2016. In 2017, the neighborhood was likely to have more children/adolescent sport organizations available (OR 1.32, 95% CL 1.24, 1.42) and more sport facilities for children/adolescents (OR 1.29, 95% CL 1.19, 1.40) as compared to 2016 (Table 5). However, there was no change in the parent’s physical activity levels (p = 0.23).
Table 3
Descriptive statistical analysis of the numeric variables.

| Study variables | Year 2016         | Year 2017         | P value |
|-----------------|-------------------|-------------------|---------|
|                 | Mean ± SD (95% CL) | Mean ± SD (95% CL) |         |
| MVPA days (0–7 days) | 3.83 ± 1.95 (3.73, 3.92) | 3.74 ± 1.93 (3.65, 3.84) | 0.106   |
| Attitude to PA (0–5 score) | 3.73 ± 1.10 (3.68, 3.79) | 3.98 ± 1.05 (3.93, 4.03) | < 0.001 |
| Qn-1 sport events for children/adolescents in the neighborhood | 2.37 ± 1.67 (2.31, 2.43) | 2.70 ± 1.24 (2.64, 2.76) | < 0.001 |
| Qn-2 sport and/or exercise skills/trainings for children/adolescents in the neighborhood | 1.97 ± 1.09 (1.92, 2.03) | 2.34 ± 1.26 (2.28, 2.40) | < 0.001 |
| Qs-1 school exercise facilities and equipment can meet my needs for PA/exercise | 4.11 ± 0.99 (4.06, 4.16) | 4.20 ± 0.97 (4.15, 4.24) | 0.013   |
| Qs-2 PA class plays an important role for me to participate in physical activity and exercise | 4.37 ± 0.88 (4.33, 4.41) | 4.42 ± 0.82 (4.38, 4.46) | 0.042   |
| Qs-3 teachers encourage me to participate in physical activity and exercise | 4.15 ± 1.07 (4.10, 4.20) | 4.27 ± 0.99 (4.22, 4.31) | 0.001   |
| Qs-4 school provides extra time for physical activity and exercise | 3.92 ± 1.14 (3.87, 3.98) | 4.14 ± 1.04 (4.09, 4.19) | < 0.001 |
| Qs-5 school has a desirable culture or environment for physical activity and exercise | 3.94 ± 1.08 (3.89, 3.99) | 4.16 ± 1.02 (4.11, 4.21) | < 0.001 |
| Qs-7 friends often encourage me to participate in physical activity and exercise | 3.92 ± 1.18 (3.87, 3.98) | 4.13 ± 1.05 (4.08, 4.18) | < 0.001 |
| Qs-8 friends often participate in physical activity and exercise with me | 3.96 ± 1.18 (3.91, 4.02) | 4.14 ± 1.07 (4.09, 4.19) | < 0.001 |
| Parent PA days (0–7 days) | 3.06 ± 2.15 (2.95, 3.16) | 3.15 ± 2.15 (3.01, 3.22) | 0.227   |
| Body mass index (kg/m²) | 18.5 ± 3.0 (18.3, 18.6) | 19.2 ± 3.7 (19.0, 19.4) | < 0.001 |

MVPA: moderate and vigorous physical activity

PA: physical activity

All neighborhood and school questions have a score range from 1 to 5.
Table 4
Categorized physical activity levels.

| PA level                  | Count | Year 2016 | Year 2017 | Total |
|---------------------------|-------|-----------|-----------|-------|
| Physically Active (MVPA 5–7 days) | N     | 588       | 537       | 1125  |
|                           | %     | 18.41     | 16.81     | 35.22 |
| Physically Inactive (MVPA 2–4 days) | N     | 800       | 858       | 1658  |
|                           | %     | 20.05     | 26.86     | 51.95 |
| Sedentary (MVPA 0–1 day)   | N     | 209       | 202       | 411   |
|                           | %     | 6.54      | 6.32      | 12.87 |
| Total                     | N     | 1597      | 1597      | 3194  |
|                           | %     | 50        | 50        | 100   |

Table 5. Availability of sport organizations and facilities in neighborhood.

| Qn-3 | Year 2016 | Year 2017 | Total |
|------|-----------|-----------|-------|
| Yes  | N         | 330       | 517   | 847   |
|      | %         | 10.33     | 16.19 | 26.52 |
| No   | N         | 1267      | 1080  | 2347  |
|      | %         | 39.67     | 33.81 | 73.48 |
| Total| N         | 1597      | 1597  | 3194  |
|      | %         | 50        | 50    | 100   |

| Qn-4 | Year 2016 | Year 2017 | Total |
|------|-----------|-----------|-------|
| Yes  | N         | 978       | 1147  | 2125  |
|      | %         | 30.64     | 35.94 | 66.59 |
| No   | N         | 619       | 447   | 1066  |
|      | %         | 19.0      | 14.01 | 33.41 |
| Total| N         | 1597      | 1594  | 3191  |
|      | %         | 50        | 50    | 100   |

Qn-3: Are there sport organizations available for children and/or adolescents in your neighborhood; Qn-4: Are there sport facilities for children/adolescents conveniently located in your neighborhood. Frequency missing = 3 in Qn-4 in 2017 survey.
The FREQ Procedure

Table of Qn3 by YEAR

| Qn3 | YEAR |      |      |      |
|-----|------|------|------|------|
|     |      | 2016 | 2017 | Total|
| 1   |      | 330  | 517  | 847  |
|     |      | 10.33| 16.19| 26.52|
|     |      | 38.96| 61.04|      |
|     |      | 20.66| 32.37|      |
| 2   |      | 1267 | 1080 | 2347 |
|     |      | 39.67| 33.81| 73.48|
|     |      | 53.98| 46.02|      |
|     |      | 79.34| 67.63|      |
| Total|      | 1597 | 1597 | 3194 |
|      |      | 50.00| 50.00| 100.00|

Statistics for Table of Qn3 by YEAR

| Statistic                  | DF | Value   | Prob   |
|----------------------------|----|---------|--------|
| Chi-Square                 | 1  | 56.1852 | <.0001 |
| Likelihood Ratio Chi-Square| 1  | 56.5431 | <.0001 |
| Continuity Adj. Chi-Square | 1  | 55.5859 | <.0001 |
| Mantel-Haenszel Chi-Square | 1  | 56.1676 | <.0001 |
Odds Ratio and Relative Risks

| Statistic               | Value | 95% Confidence Limits |
|-------------------------|-------|-----------------------|
| Odds Ratio              | 0.5441| 0.4636 0.6386         |
| Relative Risk (Column 1)| 0.7217| 0.6582 0.7914         |
| Relative Risk (Column 2)| 1.3265| 1.2375 1.4218         |

Sample Size = 3194

Summary Statistics for Qn3 by YEAR

| Cochran-Mantel-Haenszel Statistics (Based on Table Scores) |
|------------------------------------------------------------|
| Statistic               | Alternative Hypothesis | DF | Value | Prob  |
|-------------------------|------------------------|----|-------|-------|
| 1                       | Nonzero Correlation    | 1  | 56.1676 | <.0001|
| 2                       | Row Mean Scores Differ | 1  | 56.1676 | <.0001|
| 3                       | General Association    | 1  | 56.1676 | <.0001|

Common Odds Ratio and Relative Risks

| Statistic               | Method         | Value | 95% Confidence Limits |
|-------------------------|----------------|-------|-----------------------|
| Odds Ratio              | Mantel-Haenszel| 0.5441| 0.4636 0.6386         |
|                         | Logit          | 0.5441| 0.4636 0.6386         |
| Relative Risk (Column 1)| Mantel-Haenszel| 0.7217| 0.6582 0.7914         |
|                         | Logit          | 0.7217| 0.6582 0.7914         |
| Relative Risk (Column 2)| Mantel-Haenszel| 1.3265| 1.2375 1.4218         |
|                         | Logit          | 1.3265| 1.2375 1.4218         |

Total Sample Size = 3194

The SAS System

The FREQ Procedure
| Qn4 | YEAR |          |          |        |
|-----|------|----------|----------|--------|
|     |      | 2016     | 2017     | Total  |
| 1   |      | 978      | 1147     | 2125   |
|     |      | 30.65    | 35.94    | 66.59  |
|     |      | 46.02    | 53.98    |        |
|     |      | 61.24    | 71.96    |        |
| 2   |      | 619      | 447      | 1066   |
|     |      | 19.40    | 14.01    | 33.41  |
|     |      | 58.07    | 41.93    |        |
|     |      | 38.76    | 28.04    |        |
| Total|      | 1597     | 1594     | 3191   |
|      |      | 50.05    | 49.95    | 100.00 |

Frequency Missing = 3

Statistics for Table of Qn4 by YEAR

| Statistic                        | DF | Value   | Prob     |
|----------------------------------|----|---------|----------|
| Chi-Square                       | 1  | 41.1900 | <.0001   |
| Likelihood Ratio Chi-Square      | 1  | 41.3259 | <.0001   |
| Continuity Adj. Chi-Square       | 1  | 40.7097 | <.0001   |
| Mantel-Haenszel Chi-Square       | 1  | 41.1771 | <.0001   |

Odds Ratio and Relative Risks

| Statistic                     | Value | 95% Confidence Limits |
|-------------------------------|-------|-----------------------|
| Odds Ratio                    | 0.6157| 0.5307 0.7144        |
| Relative Risk (Column 1)      | 0.7926| 0.7399 0.8490        |
| Relative Risk (Column 2)      | 1.2872| 1.1873 1.3956        |
Effective Sample Size = 3191
Frequency Missing = 3

Summary Statistics for Qn4 by YEAR

| Statistic                  | Alternative Hypothesis | DF | Value   | Prob   |
|----------------------------|------------------------|----|---------|--------|
| 1                          | Nonzero Correlation    | 1  | 41.1771 | <.0001 |
| 2                          | Row Mean Scores Differ | 1  | 41.1771 | <.0001 |
| 3                          | General Association    | 1  | 41.1771 | <.0001 |

Common Odds Ratio and Relative Risks

| Statistic                  | Method            | Value | 95% Confidence Limits |
|----------------------------|-------------------|-------|-----------------------|
| Odds Ratio                 | Mantel-Haenszel   | 0.6157| 0.5307 0.7144         |
|                           | Logit             | 0.6157| 0.5307 0.7144         |
| Relative Risk (Column 1)  | Mantel-Haenszel   | 0.7926| 0.7399 0.8490         |
|                           | Logit             | 0.7926| 0.7399 0.8490         |
| Relative Risk (Column 2)  | Mantel-Haenszel   | 1.2872| 1.1873 1.3956         |
|                           | Logit             | 1.2872| 1.1873 1.3956         |

In the 2016 survey, the top three predictors that significantly contributed to MVPA with 5 to 7 days (physically active) were the student's attitude, Qn-4 “sport facilities for children and/or adolescents in the neighborhood”, and age (Table 6). Students who had a very positive attitude to PA/exercise were more likely to be physically active (OR 3.08, 95% CL 1.22, 7.76) as compared to their counterparts who had a negative attitude. Students who answered “yes” to having sport facilities in the neighborhood were 50% more likely to be physically active (OR 1.52, 95% CL 1.24, 1.86). Children were more likely to be physically active as compared to adolescents (OR 1.38, 95% CL 1.13, 1.69).

Table 6. Positive contributors predict students to be physically active.
| Order | 2016                                      | P value | OR    | 95% CL  |
|-------|-------------------------------------------|---------|-------|---------|
| 1     | Attitude: very positive vs negative       | <0.0001 | 3.080 | 1.223   | 7.755  |
| 2     | Qn-4 sport facilities for children/adolescents in the neighborhood: yes vs no | <0.0001 | 1.523 | 1.239   | 1.871  |
| 3     | Children vs Adolescents                   | 0.0016  | 1.383 | 1.131   | 1.692  |
| 4     | Qn-1 sport events held for children/adolescents in the neighborhood: positive vs negative | 0.0017 | 1.701 | 1.257   | 2.303  |
|       | Qn-1: neutral vs negative                 |         | 1.274 | 1.011   | 1.606  |
| 5     | Parents Active vs Sedentary               | 0.0032  | 1.602 | 1.220   | 2.104  |
| 6     | Qs-5 school has a desirable culture/environment for PA and exercise: positive vs negative | 0.0037 | 1.566 | 1.118   | 2.193  |
| 7     | Boys vs Girls                             | 0.0214  | 1.259 | 1.035   | 1.532  |
| 8     | Qn-3 sport organizations for children and/or adolescents in the neighborhood: yes vs no | 0.0277 | 1.350 | 1.034   | 1.764  |
| 9     | Qs-3 teachers encourage me to participate in PA and exercise: positive vs negative | 0.0462 | 1.471 | 1.016   | 2.131  |

| Order | 2017                                      | P value | OR    | 95% CL  |
|-------|-------------------------------------------|---------|-------|---------|
| 1     | Attitude: very positive vs negative       | <0.0001 | 4.280 | 1.788   | 10.245 |
|       | Attitude: positive vs negative            |         | 2.386 | 1.000   | 5.692  |
| 2     | Qs-4 school provides extra time for PA/exercise: completely agree vs complete disagree | <0.0001 | 2.287 | 1.557   | 3.360  |
| 3     | Qn-1 sport events held for children/adolescents in the neighborhood: positive vs negative | 0.0009 | 1.839 | 1.336   | 2.532  |
| 4     | Qn-1: neutral vs negative                 |         | 1.317 | 1.015   | 1.710  |
| 5     | Parent ACT vs SED                         | 0.0010  | 1.524 | 1.145   | 2.029  |
| 6     | Qs-7 friends encourage me to participate in PA and exercise: positive vs negative | 0.0404 | 1.790 | 1.135   | 2.825  |

The order of the effect is determined by P value, Chi-square and odds ratio from multiple logistic regression analysis to predict MVPA 5 – 7 days.

OR: Odds ratio

CL: Confidence Limits
In 2017 survey, the top three positive contributors to MVPA with 5 to 7 days (physically active) were the student’s attitude, Qs-4 “School provides extra time for physical activity and exercise” and Qn-1 “often and/or very often had game/sport events held for children/adolescents in the neighborhood during last year”. The likelihood for students to be physically active was significantly greater for those who had a positive than the negative answer to Qs-4 (OR 2.29, 95% CL 1.56 to 3.36). Furthermore, not only a positive response (OR 1.84, 95% CL 1.34 to 2.53) but also a neutral response to Qn-1 (OR 1.32, CL 1.02 to 1.71) significantly increased a likelihood for students to be physically active as compared to the negative answer (Table 6).

Both surveys in 2016 and 2017 had student’s attitudes to PA/exercise as the most significant contributor for MVPA 5–7 days, i.e., physically active lifestyle (Table 6). Overall, about 60% of the children/adolescents had a very positive attitude to PA/exercise, and only ~1% had a negative attitude (Table 7). Inconsistent with a descriptive analysis of MVPA days (see Table 3), the proportion of the students with a very positive attitude was significantly greater (p < 0.001) in 2017 (65.8%) than 2016 (53.8%) as indicated by OR 1.63, 95% CL 1.41 to 1.88 based on logistic regression analysis. In addition, the attitude factor was significantly affected by age, i.e., children vs adolescents in both 2016 (OR 1.34, 95% CL 1.10, 1.64) and 2017 (OR 1.51, 95% CL 1.23, 1.85), not by the student’s sex or school location. The other significant contributors shared in 2016 and 2017 were Qn-1 (sport events held for children/adolescents in the neighborhood during last year) and parent PA/exercise days during the last 7 days (Table 6).

| Table 7 | Attitude to physical activity. |
|---------|-------------------------------|
|         | 2016 | 2017 | Total |
| Very Positive | N  | 859 | 1050 | 1909 |
|            | %  | 26.91 | 32.89 | 59.81 |
| Positive | N  | 720 | 523 | 1243 |
|           | %  | 22.56 | 16.38 | 38.94 |
| Negative | N  | 18 | 22 | 40 |
|          | %  | 0.56 | 0.69 | 1.25 |
| Total | N  | 1597 | 1595 | 3192 |
|        | %  | 50 | 50 | 100 |

**Discussion**

In our knowledge, this is the first longitudinal study to explore the change of influential factors of student’s MVPA level in school and neighborhood with age in China. Our result demonstrated that there
was no significant improvement in MVPA level after a 12-month follow-up. The likelihood of overweight/obesity will increase with age. Boys and children were more likely to be active lifestyles than girls and adolescents at baseline, but the difference was disappeared at follow-up. However, there was a significant increase in student’s attitudes to PA, especially in children. Moreover, the PA environment in neighborhoods was also improved after “Healthy China 2030” issued, reflected by PA facilities and sport clubs/organizations in the neighborhood, but these factors were not translated into MVPA level evaluating. Student’s attitude for PA and their parental PA behavior were the most important factors to predict the MVPA level at both time points in our study. In addition, influential factors in neighborhood and school were changed in follow-up compared to 1 year before.

In the present study, we have not found decreasing in MVPA with time significantly. This is different from the previous study, which found that MVPA decreasing with age in children and adolescent[25–27]. Maybe, this is the reason for overweight/obesity increasing after a 12-month follow-up. Nevertheless, two large-scale questionnaire investigation studies have shown that the proportion of students met the MVPA guideline from 29.9% in 2016 to 34% in 2017 in China[8, 9]. This may be affected by “Healthy China 2030”, which has appealed that students should participate MVPA more than 60 min/day and having more than 25% of them achieve an “excellent” rating in fitness. Accordingly, the health policy may be effective to prevent MVPA from decreasing with age. Nevertheless, those two were cross-sectional design study.

Our results manifested that boys were more physically active than girls, this has been identified by previous studies[28, 29]. Meanwhile, children were more active than adolescents which consistent with many studies that MVPA was decreasing with age[27, 30]. In the current study, this phenomenon can be explained partially by the attitude toward PA that children have a more positive attitude than adolescents, and attitude to PA was a mean contributor for the MVPA level. This has been identified by the previous study, which found that students who think PA is good and engage in PA enjoyable spent more time in MVPA at school[31]. Nevertheless, the role of attitude for MVPA participation needs to be explored more depth. Neighborhood PA facilities were also a significant contributor to student’s MVPA level. This is consistent with other studies that available PA facilities are positively associated with MVPA[17, 32]. In addition, students live in a neighborhood with sport organization and events are more likely to be physically active, which will provide more PA opportunities for children and adolescents. A study from the UK suggested that neighborhood-based PA is critical for helping students to increase MVPA, but not for sedentary behavior reduction [15]. Therefore, neighborhood-based activity may be an effective measurement to increase student’s MVPA out of school. As for the school environment, the results demonstrated that school PA climate and teacher support for PA affected MVPA significantly, but school PA facilities and PE classes were not. These results were supported by the previous system review[12]. A possible reason may be that these two factors were similar among different schools, as a unique request for numbers of PE class and the infrastructures of PA, such as basketball and football court, were similar in Chinese primary and middle school. These factors should be considered for future intervention to increase student’s MVPA. Finally, we found students with active parents are more likely to be physically active, which has been identified by a meta-analysis [33]. Yet we have not found the promoting role of
friends in MVPA level, neither support nor accompany. This finding differs from previous studies that 
friend's encouragement and engagement were positively associated with MVPA [20], but a recent study 
found that the relationship between friends support and MVPA mediated by self-efficacy and 
enjoyment[34] This may signify that the difference of MVPA level in school-aged children may from 
family rather than school by bringing together these evidence.

When analyzed the follow-up data, student's attitude to PA was significantly improved after 12 months 
compared to 1-year before, but the improvement was not translated into increasing MVPA level of 
students, which were not significantly different between the surveys in 2016 and 2017. A similar situation 
also appeared in the other two neighborhood variables, sport facilities, and sport organizations in the 
neighborhood. According to the ecological model, the policy is the highest-level factor in four domains, 
which can influence PA through change lower-level variables [21]. As positive predictor for MVPA, 
student's attitude to PA and neighborhood environment (sport facilities and sport organizations in the 
neighborhood) have improved significantly after “Healthy China 2030” issued, partially proved its' validity 
as a national health promotion policy. Accordingly, we can infer that there are some influential factors we 
have not investigated mediated the relationship between attitude, sport facilities, and organizations and 
MVPA of children [35]. It is likely associated with increased study-load with one year more senior in 
school, as indicated by the second most significant contributor to MVPA in 2017 survey is extra time for 
PA/exercise. Combining with friend support as a contributor for MVPA level indicated that children more 
likely participated in MVPA in school. Moreover, this phenomenon also might explain the sex factor (boys 
vs girls) and age factor (children vs adolescents) both of which are significant contributors to MVPA level 
in 2016, are removed from the logistic regression fitting in 2017. In China, every student has to face the 
stress for entering a higher school, this may explain the phenomenon above.

Our study has some obvious weaknesses. First, we assess the MVPA level by self-report, which will cause 
bias of MVPA assessment and we can’t distinguish the school-day and after-school MVPA by this 
method. Second, we measure the school and neighborhood PA environment by self-perceived instead of 
the objective assessment instruments, this may limit the implementation of environmental improvement. 
Third, we can't build the causal relationship between the evaluation of influential factors and “Healthy 
China 2030”. Therefore, we should interpret findings carefully due to these limitations. Future studies 
should apply the objective assessment instrument to examine the association between these influential 
factors and MVPA in detail. Consequently, we can understand the association between different 
influential factors and the distribution of geography and time of PA behavior. In addition, more studies 
need to explore the transformation of influential factors of PA behavior with age, this will be more 
effective for precise intervention for PA behavior.

Findings from our study provide epidemiological evidence for children and adolescents MVPA 
intervention in the future. Moreover, this evidence is also important for developing policies for promoting 
school-aged children MVPA participating. In our results, improvement of neighborhood PA environment 
and attitude can't translate to MVPA level evaluating, indicated that there are some influential factors 
impacted MVPA of school-aged children significantly with age and school grade increasing. A study from
China has reviewed the role of policy to prevent fitness decreasing, and revealed that the policy alone did not seem to work[36]. Therefore, a single health policy can't improve the MVPA level of school-aged children. In China, the study is the top priority for school-aged children, result that most of their time is used in the study rather than PA. In the future, concurrent education and health policy may be effective for increasing MVPA level of school-aged children. Furthermore, change of behavior is not an isolated problem, as it influenced by many factors and from a distinct level[21, 22]. Future studies should explore influential factors more comprehensively, and the intervention should be full-scale and multilevel.

**Conclusion**

In conclusion, physical and social environments are important for student's MVPA participation, but it will change with age and grade. Neighborhood sport events and parent's physically active lifestyle are two persistent contributors for MVPA, these may be the measurements for promoting MVPA in the future. Our findings proved the validity of the national health policy to improve influencing factors of student's PA behavior, but it will not increase MVPA alone. Some factors that impacted student's MVPA level are not affected by the health policy, which needs to be explored and intervened in the future.

**Abbreviations**

PA: physical activity; MVPA: moderate and vigorous physical activity; SED: sedentary behavior; BMI: body mass index; OR: odds ratio; CL: confidence limits; Qn: question about neighborhood; Qs: questions for school PA environment; ANOVA: analysis of variance; PAFCTYS: Physical activity and fitness in China-The Youth Study

**Declarations**

**Ethics approval and consent to participate**

This study protocol has been approved by the Ethics Review Committee of Shanghai University of Sport(ERCSUS)(#2017037). We have been approved by ERCSUS for students to participate in this study just need the verbal consent by their teacher, principal of participating school, and student's parents instead of written consent, due to the minimal risk for participants and the enormous sample size. The verbal consent was approved by ERCSUS required researchers to get permission to conduct the study from teachers and principals of the participating school by elaborated on the potential risks and benefits for participants before data collection. The same protocol has been declared for student's parents/guardians and their consent for student's participation was sought. Finally, the details about the project were informed to all participants before their consent and participation.

**Availability of data and materials**
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

**Competing interests**

We have no competing interests.

**Consent for publication**

Not applicable.

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**Authors' contributions**

WH analyzed the data and drafted the manuscript. XS help analyze the data, and revised the manuscript. YW clear up the data. XL, PG, JL help collected the data. JZ conceived and designed the study, supervised all aspects of its implementation, interpreted the data, and revised the manuscript. All authors read and approved the final manuscript.

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- ModifiedQuestionnaire.docx