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The effectiveness of child and adolescent sports engagement in China: an analysis of China's results for the 2016–2022 Global Matrix report cards on physical activity

Changqing Xiang^{1,4}, Jie Zhao², Tengku Fadilah Tengku Kamalden^{1✉}, Wenting Dong³, Hua Luo¹ & Normala Ismail^{1,4}

China strives to become a leading sports nation. Through implemented policies and programs, Chinese children and adolescents have shown notable advancements and improvements in their engagement in physical activity in recent years, indicating an overall positive trend. However, some indicators exhibit a concerning “inversion phenomenon”. This study utilizes data from three surveys conducted between 2016 and 2022 by the Active Healthy Kids Global Alliance. By comparing current ratings with those from 2016 and 2018, both cross-sectionally and longitudinally, significant obstacles in promoting physical activity and health among Chinese children and adolescents are revealed, with persistently low scores. The 2022 Global Matrix 4.0 report ranks Chinese children and adolescents 53rd out of 57 surveyed countries, with an overall average physical activity score of D. Similarly, the average score for sources of influence ranks at 53rd. Consequently, the establishment of an integrated school, family, and social sports promotion mechanism, led by the government, becomes an imperative prerequisite for enhancing the levels of physical activity and overall health among children and adolescents.

¹ Faculty of Educational Studies, Universiti Putra Malaysia, Serdang 43400, Malaysia. ² Department of Physical Education, Guangdong Technology College, Zhaoqing 526100, China. ³ Faculty of Education, University of Malaya, Lembah Pantai, 50603 KL, Malaysia. ⁴ These authors contributed equally: Changqing Xiang, Normala Ismail. ✉email: tengku@upm.edu.my

Introduction

The good health and well-being brought about by regular physical activity (PA) and exercise cannot be ignored. It can not only reduce the risk of premature mortality, but also prevent cognitive decline, depression, and anxiety symptoms (Biddle et al., 2019; Lubans et al., 2016; Panza et al., 2020). According to the Regulations on School Physical Education in China, children and adolescents, as the future of national and social constructions (Xu & Gao, 2018), should receive holistic education and guidance, which includes their physical and mental health development (Ministry of Education of the People's Republic of China, General Administration of Sport of China, 2017). Therefore, the Chinese government has published its Healthy China 2030 plan, which includes numerous policies and proposed approaches to ensure the healthy development of Chinese children and adolescents, with specific focus on the development and promotion of physical activities (Supplementary Material 1). For example, the China Action Plan for Children and Youth Sports Health Promotion (2020–2030), released in December 2020, provides a systematic and complete set of operational sports health promotion implementation strategies for schools, families, communities, and relevant government departments nation-wide. Its aims and suggestions include developing high-quality physical education (PE) and health curricula for schools, creating a strong “vibrant” campus atmosphere, and building a complete “family-school-community” multi-linkage mechanism, to establish a dynamic, ongoing exercise intelligence monitoring system (The Research Project Group on the High Quality Development of School Physical Education under the Background of the Double Reduction Policy, 2023). In August 2021, the Ministry of Education of the People's Republic of China and five other departments formulated their “Opinions on Comprehensively Strengthening and Improving School Health and Hygiene Education in the New Era” to strengthen the standardization and systematization of health education to firmly establish in students the concept that “each person is responsible for their own health” as a motivator for them to learn and master health-related knowledge and skills, laying the foundation for lifelong health and a healthy future for everyone living in China. As a part of these plans, a strict system of extracurricular exercises are to be implemented, ensuring that students receive one hour of PA both on- and off-campus each day, and primary and secondary school students are encouraged to engage in approximately 20 minutes of PA after arriving at school (Ministry of Education of the People's Republic of China, National Development and Reform Commission, Ministry of Finance of the People's Republic of China, National Health Commission of the People's Republic of China, State Administration for Market Regulation, 2021).

To become a stronger participant in the global development of children and adolescents' PA, and to better learn from other nations and identify gaps within the nation, China participated in Global Matrix (GM) 2.0 in 2016 where it developed its first report card on child and adolescent PA (Liu et al., 2016). The third report card was published in 2022. Chinese children and adolescents have achieved a certain level of improvement in their PA scores, with the overall Chinese PA grade going from an F in 2016 to a C in 2022. However, there still remain obvious shortcomings and deficiencies in many indicators (e.g., Organized Sport and Physical Activity, Sedentary Behavior and Government), which are urgent issues to be addressed in future program and policy developments (Xu & Gao, 2018; Chen et al., 2023). With the implementation and enforcement of numerous institutional and normative policies (see Supplementary Material 1), the overall situation of Chinese children and adolescents' PA has improved and shows a good situation overall, however,

China is still lagging behind compared to other countries, such as Japan (GM 4.0 overall average B- in 2022, tied for first place in global rankings), and some European countries (e.g. Denmark, Finland, Slovenia; see Supplementary Material 2). Similar situations also apply to other indicators of a health (e.g., Active Transportation, Community and Environment), and while living standards rise, active transportation is not currently performing well among Chinese populations (Gong et al., 2020); the community and environment dimension also faces similar dilemmas, impacting China's ability to promote PA among children and adolescents in particular (Chen et al., 2020b; An et al., 2019). Therefore, it is important to determine how to promote and develop PA among children and youth better and more sustainably, with consideration of the existing achievements and discrepancies that exist. It is equally important to ensure that physiological and psychological aspects are developed in tandem, as both are essential to a leading a sports nation and Healthy China 2030 (General Office of the State Council of the People's Republic of China, 2019; Central Committee of the Communist Party of China and the State Council, 2016), as both are integral to the future of school sports construction (Central Committee of the Communist Party of China and the State Council, 2020).

Methods

The GM 1.0 on Physical Activity for Children and Adolescents was released by the Active Healthy Kids Global Alliance in May 2014. China did not participate in the first survey, but it has taken part in three subsequent reports: the GM 2.0 in 2016, the GM 3.0 in 2018, and the GM 4.0 in 2022. Using the data gathered for these three surveys regarding children and adolescents' sports activities in China, this study integrates the data for the 10 indicators included in the report card performances from 2016 to 2022 to compare it both cross-sectionally and longitudinally. The 10 indicators in the report card were developed by the Children's Hospital of Eastern Ontario Research Institute's Healthy Active Living and Obesity Research Group (CHEO-HALO) in collaboration with an interdisciplinary research working group that included leading researchers from across Canada to ensure that the report card contained the most up-to-date evidence on PA in children and youth (Active Healthy Kids Global Alliance, 2014). As such, this study focuses on the results of these 10 indicators to holistically analyze the developmental dynamics of physical activity among children and adolescents in China. By comparing the results of our data analysis with China's results in the three global children's and adolescents PA matrices from 2016 to 2022, the current study aims to provide a comprehensive depiction of the current situation of sports activities for children and adolescents in China.

The GM data was sourced from the results of three surveys conducted in China by Liu et al. (2016, 2019, 2023). The data sources from each year differed slightly, as well as the sample sizes (Table 1), but the information overall is reflective of the development status of PA for children and adolescents in China. With the exception of the physical fitness indicator, which was not available in 2016 or 2022, the remaining nine indicator levels were included in all three surveys. Grades were determined based on meeting established benchmark criteria and through the Physical Activity and Fitness in China – The Youth Study (PAFCTYS), a survey of PA and fitness in Chinese teenagers. Where possible, these data were utilized to explore differences in environment, family status, and regional socioeconomic status. Table 2 shows the percentage intervals for each grade and the corresponding interpretation of the criteria.

Table 1 Data sources used to assign grades.

Version no. (year)	Data sources and methods
GM 4.0 (2022)	Students: 133,006 Chinese school-aged children (boys: 65,971, girls: 67,035, aged 9–17 years) Parents and PE teachers: 1036 Methods: grades were assigned by results derived from the Physical activity and fitness in China - The Youth Study, which was conducted from October to December 2020.
GM 3.0 (2018)	Students: 125,281 Chinese school-aged children (boys: 62,139, girls: 63,142, aged 9–17 years) Parents and PE teachers: 1,398 Methods: representative samples from 1398 schools in 22 provinces, four municipalities, five autonomous regions, and Xinjiang Production and Construction Corps, in mainland China
GM 2.0 (2016)	Students: 71,404 from 711 schools (grades 1–12) Parents: 70,346 Teachers: 1398 Methods: self-report questionnaires from school surveys administered in Shanghai, China

Table 2 Report card grades and their interpretations.

Grade	Meeting criteria (%)	Interpretation
A+	94–100	
A	87–93	We are succeeding with a large majority of children and youth (87–93%)
A-	80–86	
B+	74–79	
B	67–73	We are succeeding with well over half of children and youth (67–73%)
B-	60–66	
C+	54–59	
C	47–53	We are succeeding with about half of children and youth (47–53%)
C-	40–46	
D+	34–39	
D	27–33	We are succeeding with some, but less than half of children and youth (27–33%)
D-	20–26	
F	< 20	We are succeeding with very few children and youth (<20%)
INC	Incomplete	Incomplete, insufficient, or inadequate information to assign a grade

For each indicator, the upper 5% of the grade is marked with a "+", and the lower 5% of each grade is marked with a "-".

The next section will examine the changes observed in the nine indicators (excluding the overall PA scores) from a variety of perspectives. This analysis will help us evaluate the effectiveness of PA infrastructure development for children and youth in China. We will also highlight areas that require further improvements in the later stages of the development process.

Results and analysis

The comparison results show that the overall level of PA among children and adolescents in China has increased significantly, from F in 2016 and 2018 to C in 2022 (Table 3), indicating that the overall PA performance of children and adolescents in China has improved. Notably, the results of 2022 were also impacted by the COVID-19 pandemic, but the combination of numerous national policies supporting PA (Supplementary Material 1), school sports, and particularly the full implementation of the National Fitness Plan (2016–2020) dramatically stimulated and encouraged participation in physical activities. Thus, the overall PA of children and adolescents appears to maintain good momentum.

The results of our analysis focused on the nine indicators considered in the grading of the GM 2.0, 3.0, and 4.0 for Chinese children and adolescents (Table 3). Organized Sport and Physical Activity changing very little, remaining an F in 2022. Active Play also did not change significantly across the various report cards. Active Transportation hovered around a C. Sedentary Behavior improved, from F in 2016 to D+ in 2022. Physical Fitness only had data for 2018 with a D, as 2016 and 2022 did not report

grades due to non-applicability or insufficient evidence. There was a slight downward trend in Family and Peers, improving from a D+ in 2018 to a C in 2022. There was a more pronounced decline in Schools, from B+ in 2016 to D in 2022. Finally, there was also a decreasing trend in the Community and Environment grades, from D+ in 2016 to D- in 2022, while Government sustained a grade D. Specific results for each indicator are explained in more detail below.

Organized sport and physical activity. Organized sports and PA can be said to have remained unchanged from 2016 to 2022; even though the score improved in 2018 to a D-, in 2022 it fell back to an F, the same score as in 2016. However, there are differences in how this indicator has been calculated through the years. In 2016 and 2018, the indicator measured organized sports participation, but in 2022, it now considered organized sports and PA. However, the core intent of the indicator was still to investigate the participation of children and adolescents in organized PA over the previous 12 months, and in this there was no change.

The major reason for the grade reduction in 2022 was the outbreak of COVID-19 in 2019. There were no public health events between 2016 and 2018, and organized sports and PA proceeded as normal. With China’s efforts to promote activities such as the Youth Sunshine Sports Action and campus sports, children and teenagers have more opportunities to participate in sports and PA, and during this time, the grade for this indicator improved from an F in 2016 to a D- in 2018. However, during the three-year epidemic control period, China implemented many

Table 3 China's GM 2.0, 3.0, and 4.0 grades for children and adolescents.

Indicators	GM 4.0 (2022)	GM 3.0 (2018)	GM 2.0 (2016)	Instruments
Overall physical activity	C	F	F	Daily moderate-to-vigorous physical activity (MVPA) for at least 60 minutes in the previous 7 days.
Organized sport and physical activity	F	D-	F	Participation in organized sport and/or physical activity (PA) programs during the previous 12 months.
Active play	C-	D+	D-	Participation in unstructured/unorganized PA at least four times during the previous week.
Active transportation	C	C+	C-	Going to or from school by foot or bicycle.
Sedentary behavior	D+	F	F	No more than (\leq) 2 hours sedentary time (SDT) per day; SDT can include watching television, using a smartphone/iPad, using the computer, surfing the Internet.
Physical fitness	INC	D	N/A	Achieved "excellent" or "good" status according to The Physical Fitness and Health Surveillance of Chinese School Students.
Family and peers	C	D+	B	Responds with "very often" for at least two items regarding parents' support, and responds "very true" for at least two items regarding friends' support for PA.
School	D	D+	B+	Meets the benchmark regarding: (1) students' satisfaction with PE and exercise-related opportunities in school; (2) the number of accredited PE teachers with state teacher qualification; (3) participating in PA after school; (4) attending PE classes; (5) sports/exercise facilities and equipment in schools; and (6) school administrator concern regarding students' PA, exercise, and PE.
Community and environment	D-	F	D+	Meets the benchmark regarding: (1) how easy it is to find sports/exercise facilities and equipment in the youths' community; (2) whether there are sports/exercise organizations (e.g., sports club) for youth in the community; (3) whether there are sports/exercise activities organized within the community.
Government	D	F	D	Parental awareness regarding China's national physical activity policies for children.

INC inconclusive due to insufficient evidence available, grade not assigned, N/A not applicable, grade not calculated.

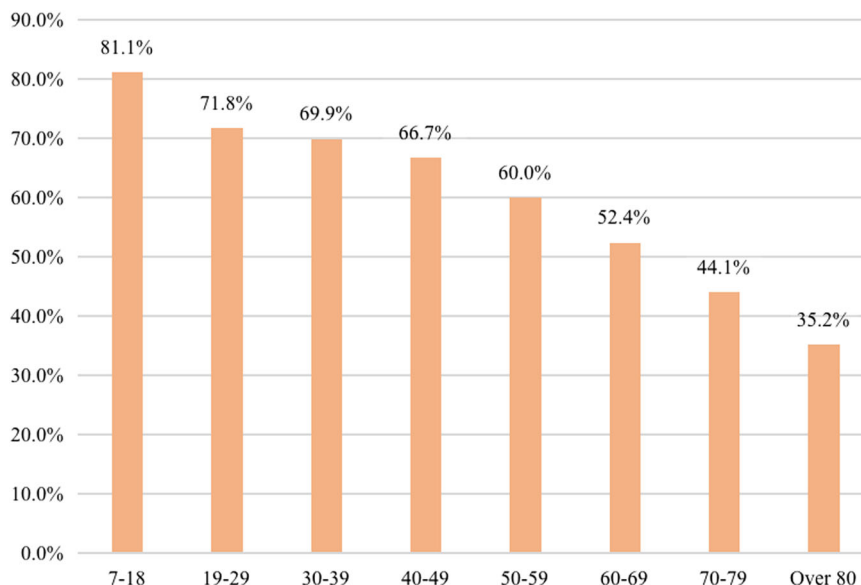


Fig. 1 Percentage of people aged seven and over who participated in PA once per week or more in different age groups in 2020.

quarantine measures, which greatly affected residents' routines and sports activities (Chen et al., 2020a; Xu et al., 2020; Ding & Zhang, 2022). Most children and adolescents became more engaged in home-based activities, and had no opportunity to participate in organized sports or PA. Thus, excluding the countries for which this indicator was INC (i.e., incomplete data), China ranked lowest of all countries surveyed for the GM 4.0 in 2022.

China has been aware of this issue and has worked to actively promote organized sports and PA. According to the "2020 Survey Report on the Status of National Fitness Activities" released by the National Physical Fitness Monitoring Center, the proportion of residents aged 7 and older participating in physical exercise once or more per week in 2020 was 67.5%, with 70.4% in urban areas and 63.1% in rural areas (General Administration of Sport of China, 2022). Compared to the 2014 Survey Report on the Status of National Fitness Activities, the proportion of people participating in PA once a week or more did increase by 18.5 percentage points by 2020. By population, 62.3% of young children participated in PA for an average of over 60 min per day, while 81.1% of children and adolescents, 67.8% of adults, and 48.0% of seniors participated in PA once a week or more. As ages increased, the proportion of people who participated in physical exercise once or more per week showed a decreasing trend (Fig. 1), with the highest proportion being 81.1% among those aged 7–18 years old. A systematic review also showed that children in suburban/rural areas of China tend to have lower activity levels than children in urban areas (Lu et al., 2017). For the purposes of promoting active participation of children and adolescents in fitness activities, improving their health, and deepening the integration of sports and education, multiple government departments including the General Administration of Sport of China and the Ministry of Education have organized various themed fitness activities for children and adolescents nationwide, launching a series of themed activities in various provinces, districts, and cities to promote children's active participation in physical exercise (Supplementary Material 1).

Active play. In a Chinese context, active play refers to unorganized or unstructured PA. During the investigation process, the measurement standard was whether individuals had participated in active play at least four times in the past week. Table 3 shows

that the performance of this indicator is improving steadily, but not by a strong magnitude. Although there was a slight increase from D- in 2016 to D+ in 2018, and to C- in 2022, this indicator continues to score relatively low, and has still not reached 50% of the standard. As half of the countries included in the 2022 GM 4.0 survey were INC for this indicator, we cannot compare China's performance accurately with other nations. However, compared to the countries that did receive a grade for this indicator, China performed moderately, tied for 15th place, with Spain (Region of Murcia) ranking highest with a B+.

China is also positively promoting active play as PA and looking to develop improved measures to do so. As reported in the 2020 Survey Report on the Status of National Fitness Activities (General Administration of Sport of China, 2022), the main PA items that young children participate in are running and jumping (24.2%), riding children's bicycles (9.6%), playing sports (9.6%), riding scooters (9.1%), and jumping rope (7.8%), with differences noted according to gender in that a higher percentage of boys play basketball, while more girls participate in dance.

Active transportation. Active transportation can have substantial health benefits through increased PA such as walking or cycling (Mueller et al., 2015). In the GM, the active transport indicator is measured by how often children and adolescents walk or ride bicycles to and from school. While the indicator has varied slightly in its phrasing over the years, the meaning expressed is similar. In 2016, this indicator looked at going to school by foot or by bicycle, where only transportation to school was considered, but in 2018 and 2022 the measure changed to walking or riding a bike to or from school, including the mode of transportation used to return to home. This may be a reason for the decline in China's performance in this indicator, with a decrease from C+ in 2018 to C in 2022. However, although there may be an objective reason for this change, it should be noted that with the development and popularization of modern transportation modalities, fewer and fewer people choose to walk or ride bicycles, which indirectly leads to children and adolescents rarely going to school by foot or by bike, if they even have the opportunity to do so at all.

With the improvements in living standards and conditions for Chinese residents, a growing number of families are using private cars to send their children to school. Indeed, most parents in China choose to drive their children to school rather than let

them walk to school alone due to time costs and safety concerns (Jing et al., 2023). In some towns, it has become quite common for many parents to drive electric motorcycles to transport their children to and from school (Zhang et al., 2020) because of its convenience for the parents, saving time and costs. This is also consistent with China's results of the three GM reports on children and adolescents. From 2016 to 2022, no significant change was seen in active transportation, with the grades for each fluctuating around the C level. According to data released by the Ministry of Public Security of China, as of 2022, the number of owned cars in the country reached 319 million, an increase of 17.52 million compared to 2021. At this rate of growth, it is expected that car ownership will reach 450 million by 2030. Meanwhile, the per capita car ownership rate reached 22% in 2022, and is expected to reach 30% by 2030; motorcycle ownership reached 80.72 million in 2022, accounting for 19.38% of total motor vehicles in the nation, and an increase of 5.13 million units or 6.79% compared to 2021 (The Ministry of Public Security of the People's Republic of China, 2023). In this way, family factors play an essential role in determining how children travel to and from school (Wang et al., 2022a). As a result of this, however, an increasing number of children and adolescents are being driven to and from school by their parents, resulting in future scores on this indicator unlikely to vary much, and are likely to remain below the C grade.

In contrast, Japan, China's neighboring country, has reached an A- level in the active transportation indicators, reaching a high level of 80% to 86% (GM 4.0). Although the per capita vehicle ownership rate in Japan reached 60% in 2022 (The motor industry of Japan, 2022), Japan places great emphasis on physical health and sports activities, particularly for children and adolescents. Even though transportation is well-developed in Japan, elementary school students go and return from school on their own, and parents almost never transport their children to or from school. Many schools also explicitly prohibit parents from driving their children to school in private cars or motorcycles, except in cases of illness or injury. If a child must to be transported by car, the parents must apply to the school for this permission in advance (Byron, 2013). Instead, for close distances, children will walk to and from school. Students living far away from their school will generally choose between taking public transportation or riding bicycles. The reason why this is possible in Japan is that most schools are within a designated walking distance of children's homes, and there are well-established safety interventions to ensure children's safety. Various district and municipal governments, education committees, school employees, and parents also share responsibilities for safety management (Mori et al., 2012). More importantly, the establishment of elementary schools in Japan is based on population density, ensuring that the vast majority of children are able to reach their school within 15 to 20 minutes of walking, and cross-regional enrollment is not allowed (Mori et al., 2012). If students move to a distant location midway through the school year but still want to attend their original school, a strict approval process is undertaken.

China would benefit from learning from Japan, and perhaps adopting some of these types of measures, such as changing the commonly-used transportation methods, and exercising children's sense of independence so that they can more confidently travel to and from school on their own, and expand their opportunities to engage in more PA.

Sedentary behavior. According to the Sedentary Behavior Research Network (SBRN) Terminology Consensus Project, who published their most recent description of sedentary behavior in

2017, sedentary behavior refers to sitting, reclining, or lying down, characterized by behavior with less energy consumption than one's metabolic equivalent (METs). The terminology consensus project gives specific examples of sedentary behavior for children and adolescents ages 5 to 17, including sitting and using electronic devices (e.g., television, computers, tablets, cell phones), sitting while reading/writing/drawing, sitting in a reclined stroller, sitting while doing homework, sitting in class, and sitting on a bus/car/train (Tremblay et al., 2017). In surveying sports activity engagement among children and adolescents in China for the GM, the measurement of sedentary behavior considered watching television/movies, playing computer/video games, surfing the Internet, and working on homework; doing these activities for more than two hours was considered to be sedentary behavior. As Table 3 shows, there was no change in the sedentary behavior grades of Chinese children and adolescents from 2016 to 2108, with both scoring an F, the lowest possible score. However, the grade increased to D+ in 2022, meaning a range of 34% to 39%. Still, this has not increased much compared to the F in 2018. Thus, sedentary behavior in Chinese children and adolescents continues to remain a serious issue.

On November 25, 2020, the World Health Organization (WHO) released the latest guidelines on PA and sedentary behavior (WHO 2020 Guidelines on Physical Activity and Sedentary Behaviour). These guidelines provided updated and specific recommendations regarding PA and sedentary behaviors for all different age groups, including children, adolescents, adults, the elderly, pregnant and postpartum women, and those with chronic diseases or disabilities. The part that targets children and adolescents (5–17 years old) is worth pondering. Children are spending more and more time in front of screens, and sedentary behavior can lead to significant physical and psychological harm in children and adolescents. According to Carson et al. (2016), who reviewed global empirical research on sedentary behavior and health indicators, evidence shows that more than two hours of sedentary behavior per day, especially spent watching television or engaged in other screen-time, is related to poor body composition, physical decline, and reduced self-esteem and pro-social behavior scores in school-age children and adolescents (aged 5–17 years), as well as reduced academic performance. Sedentary behavior in children and adolescents has also been closely associated with obesity, metabolic risk factors, and cardiorespiratory health (Mitchell & Byun, 2013). Sedentary behavior has also been found to be responsible for vision-related problems in children and adolescents, with prolonged screen-time and excessive time spent working on homework contributing to myopia (Li et al., 2022). According to the results of the 8th National Survey on Student Physical Fitness and Health in China, the overall myopia rate among adolescents in 2019 was 50.2%, which was a decrease by 3.4 percentage points compared to 2018. However, in 2020, again due to the impacts of the COVID-19 pandemic, the myopia rate was shown to increase by another 2.5 percentage points to 52.7%, although it was still lower than the 2018 rate by 0.9 percentage points.

China has traditionally attached great importance to the education of its future generations. Due to its traditional exam-oriented education style, school-related sedentary behaviors are the primary type of sedentary behavior seen among children and adolescents in China, occupying much of their days (Dong et al., 2021). In response to the issue of excess sedentary behavior among children and adolescents, the Chinese government has also begun to develop and implement numerous policies and programs. For example, in January 2018, the National Children's Center and the Shanghai Children's Center released the "Physical Activity Guidelines for Chinese Children and Adolescents", which for the first time presented a recommended amount of

daily PA for Chinese children and adolescents aged 6 to 17 years. On July 24, 2021, the General Office of the Central Committee of the Communist Party of China (CPC) and the General Office of the State Council issued the “Opinions on Further Reducing the Homework and Off-Campus Training Burden of Students in Compulsory Education”. Meanwhile, the promulgation and implementation of the “Double Reduction” policy has also greatly reduced students’ homework burden, allowing them more time to participate in sports and exercise, and raising awareness of the issues of sedentary behavior and PA in children and adolescents across all sectors of society.

Physical fitness. The U.S. Department of Health and Human Services (2008) separates physical fitness into two categories: health-related fitness and performance-related fitness. This study focuses on the former of these, health-related fitness, specifically referring to endurance, mobility, strength, and flexibility (Roy et al., 2010). Physical fitness is closely related to the future development of children and adolescents, and is tightly linked to their participation in PA overall (Shi et al., 2022; Zheng et al., 2023). As a first-time participant in the GM 2.0 in 2016, this indicator was not applicable to China in 2016 as there was no data to compare to from before, and no grade was calculated. From 2018, however, the indicator has been used as a measurement instrument, using the Physical Fitness and Health Surveillance of Chinese School Students. China received a grade of D in 2018. However, in 2022, due to uncertainty resulting from insufficient evidence, this indicator was once again not graded. Therefore, we cannot use the 2016 to 2022 report cards on children and adolescents’ PA performance as accurate indicators of physical fitness. However, China does actively conduct other physical fitness-related research in its efforts to develop and

improve its PA policies. According to the 5th National Physical Fitness Monitoring (conducted every five years by the General Administration of Sport of China) in December 2020, the average level of the various physical fitness indicators in young children increased with age, showing overall characteristics of growth and development, with the exceptions of body fat rate and sitting height. Moreover, with the exception of body fat rate, the mean values of various physical fitness indicators in male children were higher than those for female children. The specific mean values of body shape indicators are shown in Table 4, while Table 5 shows the average of each physical fitness indicator for male and female toddlers, where the trend of rapid development of agility, coordination, and balance qualities is more evident in toddlers up to the age of 5 years.

Family and peers. As important influences in the growth of children and adolescents, family and peer support has a crucial impact on PA (Niu et al., 2023). In China, this indicator has been measured by how frequently or actively parents and friends support children and adolescents in their sports activities. The report card scores have varied, with a B (67% to 73% of children receive support) in 2016, a D+ (34% to 39%) in 2018, and a C (47% -53%) in 2022. While the grade decreased by five levels in 2018 from the previously higher score in 2016, it then increased by two grades in 2022. A positive family environment helps promote healthy development in children, however many parents rarely engage in their children’s sports activities due to work or a lack of knowledge or skills making it difficult for them to exercise with their children (Ha et al., 2019). One investigation into Chinese families and youth sports activities found that family income is also a mediating variable between PA and health, affecting the PA performance of adolescents (Wang et al., 2022b). A cross-sectional study looking at the relationship between socioeconomic status and PA found that, in families with low socioeconomic status, the children tend to exhibit lower levels of PA, while higher socioeconomic status is positively correlated with higher levels of PA in children and adolescents (Ke et al., 2022). Family characteristics have also been found to have a positive impact on children and adolescents’ athletic training in China (Xiang et al., 2023). Parental attitudes and behaviors towards sports, their level of education, their profession, and their parenting style have also been found to have significant impacts on children and adolescents’ PA (Lian et al., 2021; Guo et al., 2023). Additionally, children’s friends and peers also have a strong impact on their sports activities, manifested in the living and school context, as well as while engaged with sports themselves (Maturro & Cunningham, 2013). If all of one’s peers are participating in sports and exercise, children and adolescents are much more likely to also participate actively in PA, and receive

Table 4 Mean values of body shape indicators for young children in the 5th National Physical Fitness Monitoring.

Gender	Age	Body shape				
		Height (cm)	Weight (kg)	Sitting height (cm)	Chest circumference (cm)	Body fat (%)
Male	3	101.9	16.4	58.5	52.3	19.2
	4	108.0	18.4	61.4	54.1	18.7
	5	115.3	21.4	64.8	56.3	19.7
	6	119.6	23.1	66.7	58.1	19.2
Female	3	100.9	15.8	57.9	51.2	23.0
	4	107.0	17.7	60.9	52.7	22.0
	5	114.1	20.2	64.3	54.6	22.1
	6	118.5	21.9	66.2	56.1	21.2

Table 5 Mean values of the various physical fitness indicators for young children in the 5th National Physical Fitness Monitoring.

Gender	Age	Physical fitness					
		Grip strength (kg)	Standing long jump (cm)	Sit-and-reach (cm)	15-meters obstacle run (s)	Continuous jumping with both feet (s)	Walk the balance beam (s)
Male	3	4.5	57.9	9.9	9.8	9.6	12.4
	4	5.7	77.2	9.6	8.7	7.5	10.2
	5	7.2	93.8	8.6	7.8	6.3	8.2
	6	8.3	101.2	8.1	7.5	5.9	7.1
Female	3	4.0	56.4	10.9	10.0	9.8	12.3
	4	5.0	73.8	11.4	8.8	7.6	10.0
	5	6.2	88.8	11.6	8.1	6.5	8.3
	6	7.2	94.9	11.4	7.7	6.0	7.1

increased support from their peers as they participate in various sports activities (Khan et al., 2020).

School. As an essential part of school education, PE impacts the physical and mental health of youth, and is fundamental to their overall development (Kohl & Cook, 2013; Andermo et al., 2020). PE in schools is intended to help meet students' sports and PA needs. School-based PE promotes the development of students' moral, intellectual, and aesthetic knowledge and experience, that is, the development of non-intrinsic functions of school sports, and PE classes work to make sports more suitable for the school setting, and to better meet students' overall developmental needs (Kohl & Cook, 2013). Systems theory suggests that the function of school-based PE is satisfying student's desires for movement through sports engagement, promoting physical and mental development, and fostering habits that support students' well-being (Sierra-Díaz et al., 2019; Leisterer & Gramlich, 2021; Fairclough & Stratton, 2004). Table 3 shows that, from 2016 to 2022, there has been a significant decrease in the grades China has received for the school indicator. Despite receiving a B+ in 2016, the grade dropped to a D+ in 2018, and then to a D in 2022. These scores are inconsistent with the country's ongoing emphasis on the development of school sports, which suggests that there continue to be significant obstacles in China's process of promoting school sports development.

In recent years, China has reported increasingly serious cases of physical problems such as myopia, obesity, and scoliosis in children and adolescents (Yin et al., 2022; Hu & Ma, 2023), and the physical condition of Chinese students has long been a point of concern for parents and policy-makers across sectors, and schools have placed growing importance on PE. China has published a series of policies and plans, such as the "Outline of Healthy China 2030 Plan", "Healthy China Action (2019–2030)", the "13th Five-Year Plan" for youth sports, and the "14th Five-Year Plan" for sports development. In 2020, the General Office of the CPC and the General Office of the State Council issued the "Opinions on Comprehensively Strengthening and Improving School Sports Work in the New Era", which required all schools to provide students with sufficient PE classes, encouraging primary schools to offer students one PE class per day, and focusing on ensuring that students of all ages have at least one hour of PA time both on- and off-campus daily to encourage students to develop a lifelong habit of exercise. On 24 June 2022, the "Law of the People's Republic of China on Physical Culture and Sports" was amended and adopted during the 35th meeting of the Standing Committee of the 13th National People's Congress. In Article 10 of the General Provisions, the revised Sports Law now stipulates, "The state prioritizes the development of PE for youth and schools, commits to the integration of PE and education, coordinates cultural learning and PE, places equal emphasis on physical fitness and personality, and promotes the all-round development of teenagers". After such rapid development of sports-related policies and the inclusion of sports scores in middle school entrance examinations, the revision of the new Sports Law will undoubtedly provide strong legal protection and support for the further development of sports in schools, to the benefit of children and adolescents.

Community and environment. Community refers to the wider social spaces where children and adolescents spend time outside of their schools and homes, and can have an essential, unique value in increasing their PA participation, improving their physicality, promoting their physical and mental health, and facilitating their social learning (Eime et al., 2013; Castillo et al., 2019; Van der Veken et al., 2020). A favorable community sports

environment can promote youth PA participation and help them improve their physical fitness, particularly during school breaks and vacation periods. Community sports play an essential supplementary role to school-based sports (Centers for Disease Control and Prevention, 1997; De Meester et al., 2014). As a form of extracurricular activity for students, community sports provide students with a space to practice sports outside of school, and greatly contribute to their development in school sports (Hylton & Totten, 2008). Community sports can be a vehicle for the integration of school, family, and society. As individuals, students should not only participate in various sports activities at school but also in extracurricular sports activities (Buckley & Lee, 2018). By participating in community sports activities, students can make up for insufficiencies in school sports, which can help to create more opportunities for exercise and the development of new trends promoting PE in schools, tying school sports and community sports closer together. Moreover, community sports help students fully utilize their school-developed talents and knowledge, while students' increasing abilities create new opportunities in both environments.

The community sports environment refers to the various types of pre-existing or established physical and social environments within a community to meet the sports needs of community residents (Chen & Liu, 2020). Their function is not only to provide an space for activity or nurture the cultural atmosphere, but also to be an open educational space that allows children and adolescents to improve continuously through various means of self-development within their wider community, allowing them to freely engage in activities without pressure from family or the constraints of school. The report card grades indicate that China's current performance in the Community and Environment indicator remains relatively low: despite receiving a D- in 2022, an increase from an F in 2018, this is only one grade higher, and below the 2016 indicator grade of D+. Furthermore, none of these meet the 50% standard.

According to data from the Deep Research on the Current Situation of China's Sports Community Service Market and Investment Trend Prediction Report (2023–2030), the number of investment and financing events in China's sports community services showed an overall decreasing trend during the 2016 to 2022 period, from 51 events in 2016 to nine in 2021, and only three investment events occurring in 2022 (see Fig. 2). Accessibility to community sports facilities and safe neighborhoods are major influencing factors in children and youth participation in community sports (Hu et al., 2021). The community sport needs of children and adolescents should be taken more seriously, and should be a required consideration in top-level planning, design, and promotion within numerous government departments, not only those focused on sports but also those focused on housing, urban development, and transportation. The COVID-19 pandemic magnified the issues of insufficient community sports spaces and facilities, as currently, most public sports spaces and facilities in urban and rural communities more oriented to adults. Few of these are able to meet the needs of youth, and there are few or no facilities specifically geared towards children and adolescents. As China focuses on building itself up as a leading sports country, community-based sports activities are indispensable and vital to this vision, playing crucial roles in the healthy growth of children and adolescents (Chen et al., 2020b). Meanwhile, a favorable sports environment is a prerequisite for teenagers to participate in community sports activities. The availability of different sports environments can also encourage diverse PA interests in youth. Teenagers are in a stage of growth where they are developing their thinking abilities and interested in new ideas; providing adolescents with space or a chance to participate in a project or

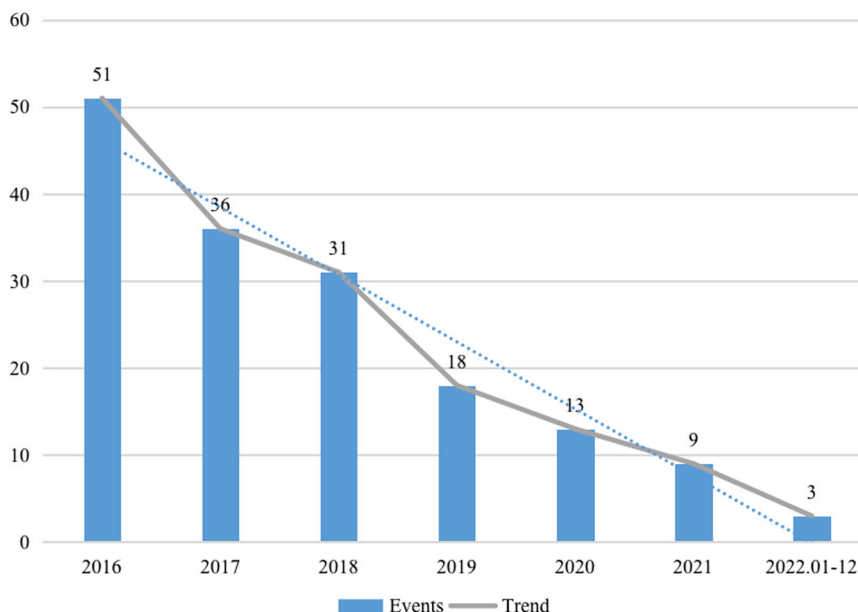


Fig. 2 Investment and financing situation of China's sports community service industry from 2016–2022. Data source: Deep Research on the Current Situation of China's Sports Community Service Market and Investment Trend Prediction Report (2023–2030).

idea is to encourage and develop their interest in it (Backes & Bonnie, 2019). As such, the construction of a better environment for community PA is a key strategic element developing a leading sports nation and a healthier future for China. However, this requires more coordination and collaborative construction between multiple sectors to promote sustainable PA development for children and adolescents.

Government. The Chinese government has stated that the development of PA in children and adolescents is of high priority (Chen et al., 2022a). Whether at a theoretical level, developing new policies and regulations, or in practice, developing “youth sunshine sports”, China today has been actively promoting and cultivating good exercise habits among children and adolescents. Since 2002, various policy documents have been released relating to youth sports, including “Opinions on Further Strengthening School Sports Work and Effectively Improving Students’ Health Quality”, “Opinions of the Central Committee of the Communist Party of China and the State Council on Strengthening Youth Sports and Enhancing Youth Physical Fitness”, “Notice on the Comprehensive Launch of the National Sunshine Sports for Hundreds of Millions of Students” and the “13th Five-Year Plan for Youth Sports”. All of these have attempted to further clarify and refine efforts to develop physical health literacy among children and adolescents in China, and to place importance on the development of PE for children and youth. Table 6 highlights key relevant policies that have been issued by the national government regarding the PA of children and adolescents during the 2016–2022 period.

Through its implementation of numerous policies to strengthen the standardization and systematization of health education for children and adolescents, China is placing increasing emphasis on effectiveness and has provided clear policy support for the development of PA in children and adolescents. However, the low grades (ranging between D and F) China has received on the three GM reports on PA in children and adolescents, from 2016, 2018, and 2022, indicate an ongoing discrepancy between the intentions of these national PA policies and wider PA understanding and awareness among Chinese parents and the general population. In the current environment of exam-oriented education in China, parents are generally more

concerned about their children’s academic exam scores and the current state of exam policies than they are about their children’s PA levels or national PA policies (Zhao et al., 2015; Chen et al., 2022b). Therefore, in the ongoing development process of PA for children and adolescents, while emphasis should continue to be placed on policy formulation, focus is also necessary on strengthening parental guidance, making policies easier to understand, appreciate, and follow, and improving the effectiveness of the implementation and enforcement of these policies.

Discussion

Implication. With the advent of the information age and the networking of office work, the “seated” state of modern society has become a dominant mode of daily life, and PA has instead become a “compulsory course” that must be strengthened deliberately. The risks associated with a sedentary lifestyle are serious (e.g., cardiovascular diseases, cancer, premature mortality), while active PA not only promotes physical and mental health but also brings about long-term well-being (Park et al., 2020). The general consensus in China across work, research, and government sectors who care for the health of children and adolescents is that it is important to limit unnecessary sitting and other such sedentary behaviors, and work to strengthen PA. In the past, schools were the primary venue for promoting PA for overall child and youth development. However, given the current rates of sedentary behavior, relying solely on the unilateral efforts of schools is far from enough. From the perspective of comprehensive spatio-temporal growth, family relationships are just as important to children and adolescents as their school relationships (Huebner, 1991). As their first guardians, it is crucial that parents supervise the daily arrangements and behaviors of children and adolescents, with the inclusion of sports or PA in mind. Parents should encourage their children to participate in more outdoor activities, and frame exercising and enhancing physical fitness as a voluntary and enjoyable action of self-conscious awareness. Meanwhile, school-based PE and school management are closely related to the development of children and adolescents’ sports activities, and school is an equally important place to promote PA participation. Finally, as a provider of extracurricular PA which can complement school-based PA, the community also has a

Table 6 Policies on PA for Children and Adolescents issued by the Chinese Government from 2016 to 2022.

Time	Policies	Department	Main Contents
09/2016	The 13th Five-Year Plan for Youth Sports	General Administration of Sport of China	Actively develop youth sports, promote the combination of science and training, improve scientific detection, strengthen the cultivation of youth sports talents
12/2017	Guiding Opinions on Strengthening Training of Reserve Talents in Competitive Sports	General Administration of Sport of China and Ministry of Education	Improve the sports reserve personnel training system, strengthen youth sports training, develop the youth sports competition system
01/2018	Youth Physical Activity Promotion Program	General Administration of Sports of China, Ministry of Education, Central Civilization Office, National Development and Reform Commission, Ministry of Civil Affairs, Ministry of Finance, and Central Committee of the Communist Youth League	Better meet the growing demand for physical activities of the majority of teenagers, further strengthen adolescent sports
09/2020	Opinions on Deepening the Integration of Sports and Education to Promote the Healthy Development of Adolescents	General Administration of Sport of China and Ministry of Education	Establish a diversified, modern, high-quality school PE system to promote the all-around quality of student development
09/2021	Opinions on Comprehensively Strengthening and Improving School Health and Health Education in the New Era	Ministry of Education, National Development and Reform Commission, Ministry of Finance, National Health Commission, and State Administration of Market Regulation	Strengthen the standardization and systematization of health education for children and adolescents, increase focus on effectiveness, provide clear policy support for the development of physical activities for children and adolescents
06/2022	Law of the People's Republic of China on Physical Culture and Sports	Standing Committee of the National People's Congress	Implementation of a program to promote youth and school sports activities, improve the system of adolescent and school sports work, enhance awareness of youth sports and fitness, promote development and popularization of youth and school physical activities

responsibility to provide support for children and adolescents' with sports and create favorable PA environments, while the involvement of social capital and effective implementation of policies are indispensable and important forces in the comprehensive development of children and adolescents. In short, the healthy development of PA and sports engagement in children and adolescents relies on the support of three bases: family, school, and society. Going forwards, we should focus on improving the cooperation and collaborative efforts of these three areas in promoting PA for children and adolescents.

Limitations. This study compared the results of three PA report cards on the PA of Chinese children and adolescents, with consideration of current Chinese policies regarding sports and PA for children and adolescents. We examined only the effectiveness of developing PA in children and adolescents under Chinese policy features, however, rather than considering cross-sectional characteristics (e.g., geographic, demographic, economic, environmental), which could provide more insight. Additionally, data sources, data availability, and baseline test standards and thresholds vary according to instrument and country. Consequently, in some cases, differences may be positive in that they reflect improvements in data quality or standards (e.g., the National Student Physical Health Standards for School Children), however report card grades only assess the data received, and do not note or consider these explanations, nor will improved data collection abilities change the ratings given in previous report cards. As such, caution is required when comparing the results of the GM report cards between different countries and time points. Also, the 2016 GM data came only from students in Shanghai, and the sample number was relatively small. For a more comprehensive overviews of the development of PA in children and adolescents in China, cooperation should be strengthened between provinces and municipalities to popularize the

survey going forwards, thereby creating the possibility of expanding data resources for future assessments, as well as to formulate improved and more targeted policies and recommendations.

Conclusion

Sports and PA during childhood and adolescence are the social foundation of sports involvement later in life, and the starting point for leapfrog development into competitive sports. By analyzing the effectiveness of current PA policies and programs in China, as well as noting current problem areas in PA development for children and adolescents through longitudinal comparison of the results of GM report cards and other reports published between 2016 and 2022, we found that there is still great room for improvement in several PA indicators (e.g., Organized Sports and Physical Activity, Community and Environment). China must draw upon the experience of other countries which have done well in these areas (e.g., Japan) for developmental direction as to how to improve China's the overall average PA levels in children and adolescents. One of the current issues at play in improving youth engagement in sports and PA is the insufficient integration of social forces in China; as such, China must work to unite the strengths of the three main influencers of children and youth – family, school, and society. PA and its development must also be normalized and diversified for children and adolescents, with continuous efforts made to improve policies to guarantee PA opportunities specifically for children and adolescents. Urban, educational, and social design should consider the PA needs of children and adolescents from the top down, to cultivate the idea of lifelong fitness and sports engagement from an early age, ensuring and accelerating the development of a healthy China by 2030.

Data availability

Please refer to supplementary materials for relevant data.

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Author contributions

CX and JZ: conceptualization. CX and JZ: methodology, resources, writing – original draft preparation and visualization. CX, DW, and TK: validation, and revisions. JZ, HL, and NI: formal analysis and data compilation. NI and TK: review, editing, and supervision.

Competing interests

The authors declare no competing interests.

Ethical approval

Ethical approval was not required as the study did not involve human participants.

Informed consent

Informed consent was not required as the study did not involve human-related content.

Additional information

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Correspondence and requests for materials should be addressed to Tengku Fadhilah Tengku Kamalden.

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