



Contents lists available at ScienceDirect

Journal of Exercise Science & Fitness

journal homepage: www.elsevier.com/locate/jesf

Global Matrix 4.0 physical activity report cards grades for children and adolescents: A comparison among 15 Asian countries and regions

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ARTICLE INFO

Article history:

Received 7 July 2022

Received in revised form

26 August 2022

Accepted 1 October 2022

Available online 9 October 2022

ABSTRACT

Background: /Objective: This paper aimed to compare the report card grades among 15 Asian jurisdictions participating in the Global Matrix 4.0, and to explore differences in regional cultural and policy factors related to physical activity behaviors.

Methods: All participating jurisdictions followed a harmonized process to develop a country report card. Ten required common indicators were assessed, including five behavioral indicators (Overall Physical Activity, Organized Sport and Physical Activity, Active Play, Active Transportation, Sedentary Behavior), four sources of influence indicators (Family and Peers, School, Community and Environment, and Government), and an outcome indicator (Physical Fitness). Letter grades, ranging from A+ to F or incomplete (INC), were assigned to the indicators based on the predefined benchmarks and grading rubric, and were converted to numerical scale for analyses.

Results: The country average scores ranged from F (Indonesia) to B– (Japan), with C+/C/C– the most prevalent grades. The mean behavioral score (D+) was lower than sources of influence score (C+). Poor grades (D or F) were observed for Overall Physical Activity among 73.3% (11/15) of the jurisdictions. Government was the indicator with the highest proportion of A or B grades (66.7%), followed by School (53.3%). Physical Fitness (n = 10) and Active Play (n = 8) were two indicators with the largest number of INC grades.

Conclusions: Poor grades for physical activity and sedentary behavior were generally found in Asian jurisdictions. The better, though modest, grades on the sources of influence have not been translated into favorable behaviors among children and adolescents. The findings also suggested surveillance gaps for physical fitness, active play, and organized sport participation. National-level investments and action plans are needed to ensure physical activity interventions are developed, effectively implemented, and regularly evaluated in multiple settings.

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1. Background

Physical inactivity has been recognized as a risk factor for major non-communicable diseases (NCDs).¹ For children and adolescents, regular physical activity participation is beneficial for physical fitness, cardiometabolic health, bone health, and psycho-cognitive outcomes.² A global estimates from 146 countries, however,

showed that 81% of children and adolescents aged 11–17 years were physically inactive.³ To reverse current trends of physical inactivity, the World Health Organization (WHO)'s Global Action Plan on Physical Activity 2018–2030 was advocated as a framework for action with four strategic objectives set out for all countries.⁴

In response to the call for joint action at global, regional and national levels, the Active Healthy Kids Global Alliance (AHKGA) was established in 2014, with the development of the Global Matrix of country Report Cards as the dominant effort.⁵ The Report Cards synthesize available evidence that fit best with the common indicators relevant to children and adolescents' physical activity and

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their influences, and evaluates national-level performance in these indicators by assigning letter grades.⁶ The Report Card serves as a knowledge transfer tool and has gained international impact in building capacity, creating national and international networks, addressing knowledge gaps, and fostering partnerships to advocate policy changes.⁵ The number of participating countries has steadily grown from 15 in the Global Matrix 1.0 (2014) to 57 in the Global Matrix 4.0 (2022). Notably, the number of Asian countries participating has significantly increased from 9 in the Global Matrix 2.0⁷ to 15 in the Global Matrix 4.0.⁸

Asia accounts for nearly 60% of the world's young people aged between 15 and 24 years.⁹ Many countries in the region have been experiencing rapid transitions with unbridled urbanization and increased use of technology.⁹ These transitions have significant impacts on people's behaviors and have important implications for the rapid rise of the NCD-caused death in the region.¹⁰ Aubert et al. found that children and adolescents in many Asian countries such as South Korea (5.8%) and China (15.7%) demonstrated lower prevalence of meeting the physical activity guidelines than the others.¹¹ Another pooled analysis of 298 population-based surveys showed that the high-income Asia Pacific region showed the highest prevalence of physical inactivity (92.2%) compared with the other parts of world.³ Three in ten adolescents in Asian countries had high sedentary time (≥ 3 h per day) outside of school.¹² To align with the WHO's global strategy to combat NCDs, the Asia-Pacific consensus statement on integrated 24-h activity guidelines for children and adolescents was recently developed to advocate for a healthier lifestyle.¹³

It is noteworthy that countries in the region are diverse in social, cultural, environmental and policy contexts that could have impact on children's physical activity and sedentary behavior.¹⁴ Wide cross-country variability in most of the common indicators has been reported across the 12 Asian jurisdictions participating in the Global Matrix 3.0.¹⁵ Taking Active Transportation as an example,¹⁶ several very high HDI countries (Japan and Hong Kong) in the region had relatively high prevalence of activity transportation which is supported by strong policies and a walkable distance between home and school. In contrast, there was also a group of Asian countries where the urban planning was not conducive to use of active modes for transportation. For example, poorly constructed or badly maintained footpaths in most neighborhoods discouraged walking and cycling in India.¹⁷ With the growing number of Asian countries/regions participating in the AHKGA Global Matrix, it provides a unique opportunity to examine the region's performance in the common indicators, enhancing the understanding of context-specific priorities and strategies to promote a healthy active lifestyle. Therefore, the purposes of this paper were: (i) to compare the report card grades among 15 Asian jurisdictions participating in the Global Matrix 4.0; and (ii) to explore differences in regional cultural and policy factors related to physical activity behaviors.

2. Methods

All participating jurisdictions followed a harmonized process to develop a country report card. Details of the development approach has been reported previously¹⁸ and in the Global Matrix 4.0⁸ each jurisdiction formed a research work group to synthesize and evaluate the best available evidence, assign initial grades, and consult with stakeholders. The recent (normally within five years) evidence for each indicator was collated from published journal articles, national surveys, official reports and documents, and then evaluated by the research work group to reach consensus for grading. Ten required common indicators were assessed, including five behavioral indicators (Overall Physical Activity, Organized Sport

and Physical Activity, Active Play, Active Transportation, Sedentary Behavior), four sources of influence indicators (Family and Peers, School, Community and Environment, and Government), and an outcome indicator (Physical Fitness). Additional indicators were added in some countries/jurisdictions. Letter grades, ranging from A+ to F or incomplete (INC), were assigned to the indicators based on the predefined benchmarks and grading rubric (Supplementary File 1).⁸ For example, the benchmark for Overall Physical Activity was the percentage of children and adolescents who accumulate at least 60 min of moderate-to vigorous-intensity physical activity per day on average. Initial grades for each country/jurisdiction and their associated rationale were audited by the AHKGA before they were confirmed. Country report card leaders were also asked to report the top three priorities for improving grades via an online survey in May 2022.

For analysis purposes, letter grades were converted to numerical scales: A+ = 15, A = 14, A- = 13, B+ = 12, B = 11, B- = 10, C+ = 9, C = 8, C- = 7, D+ = 6, D = 5, D- = 4, F = 2, and INC = 0 (treated as a missing value).⁸ Average scores were calculated by jurisdiction and indicator. Overall scores were computed as the average of numerical scores of all indicators. The average of the five behavioral indicators and the four sources of influence indicators were computed to indicate the behavioral score and sources of influence score. INC grades were replaced by mean numerical values of indicators with letter grades assigned within a country.¹⁵ Letter grades were collapsed into four groups, i.e., "A or B", "C", "D or F", and "INC" for analyses.

Sociodemographic characteristics of each country/region were obtained from the latest (2019) Human Development Report from the United Nations (<https://hdr.undp.org/en/countries>). These included Human Development Index (HDI, a composite score of life expectancy index, education index, and gross national income index), Gini coefficient, gender inequality (GII), public health expenditure (% of gross domestic product, GDP), mean years of schooling, total population, population density, life expectancy at birth, individuals using the Internet (% of total population). For Chinese Taipei, the most recent local statistics were used where appropriate. Climate parameters that were available online were collected from national statistics as much as possible, including mean temperature ($^{\circ}$ C), rainfall (mm), day length (daylight hours/year), sunlight (hours/year), and humidity (%). Air pollutant [particulate matter (PM) 2.5 concentration, $\mu\text{g}/\text{m}^3$] was collected from the 2022 WHO Air Quality Database (<https://www.who.int/data/gho/data/themes/air-pollution/who-air-quality-database>). Associations between behavioral indicators and sources of influence indicators, and between indicators and sociodemographic and climate factors were explored using Spearman's rank correlation coefficients. Statistical analyses were performed using the SPSS 26 software (IBM, Armonk, New York). To better understand relevant policies in the region, we searched national physical activity and/or sedentary behavior guidelines, as well as physical education (PE) curriculum policies of the 15 Asian jurisdictions through the Internet and from a published review of physical activity guidelines for children and adolescents.¹⁹

3. Results

Fifteen Asian jurisdictions (11 returning and 4 new, see Fig. 1) participated the Global Matrix 4.0. Their descriptive characteristics are presented in Table 1. Seven out of the 15 jurisdictions were very high HDI countries/regions, while six were classified as high HDI and two as medium HDI. Gini index ranged from 31.6 (South Korea) to 53.9 (Hong Kong SAR, China). Japan had the highest expenditure on health (10.9% of GDP) and mean years of schooling (12.8 years). Hong Kong had the highest population density (7126 people/km²)

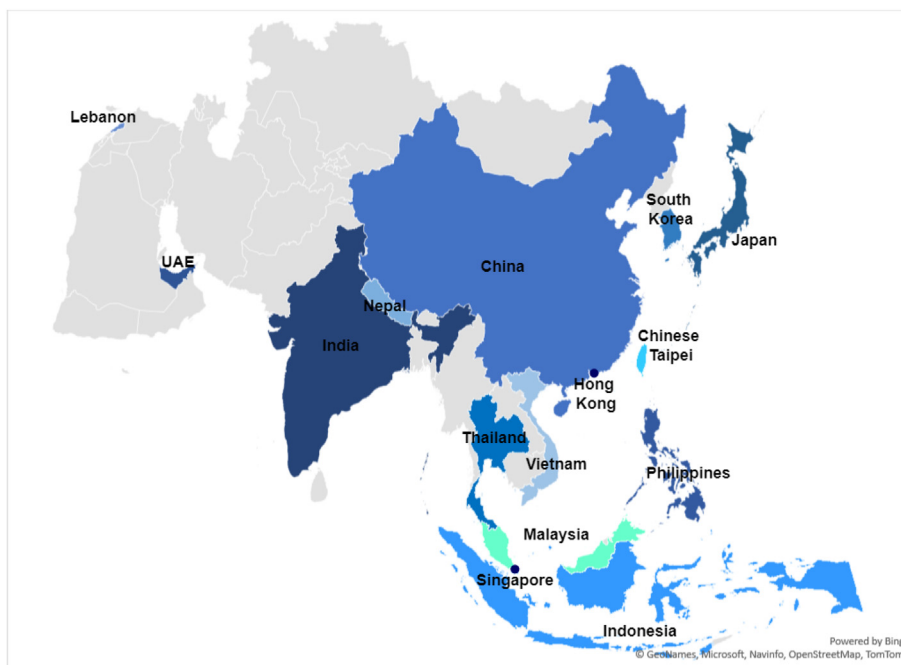


Fig. 1. A map indicating the location of Asian countries/regions participating in the Global Matrix 4.0.

and life expectancy at birth (84.9 years). Lowest population density (99 people/km²) and life expectancy (69.7 years) was observed in Malaysia and India, respectively. Mean yearly temperature ranged from 13.3 °C (South Korea) to 28.6 °C (Thailand). Singapore had the highest annual rainfall (2809.6 mm) and average humidity (84%), while the United Arab Emirates (UAE) had the lowest annual rainfall (54.1 mm) and the highest annual sunlight (3580 h/year). The highest and lowest PM_{2.5} concentrations were found in India (105 µg/m³) and Singapore (11 µg/m³), respectively.

Table 2 presents the grades assigned to the 10 common indicators and the average scores by jurisdiction and indicator. The global mean grades from all 57 participating countries were also provided for comparison and more details are reported elsewhere.⁸ Only one jurisdiction (Hong Kong) informed Overall Physical Activity based on device-measured data exclusively, indicated by adding a “***” to the grade. Three countries (India, Singapore, UAE) used a mix of device-measured and subjectively reported data (with a “*” added) and the others relied on subjective measures solely. For the Government indicator, only two countries assigned the grades based on the Health Enhancing Physical Activity (HEPA) Policy Audit Tool v2 and the scoring rubric suggested by Ward et al.,²⁰ whereas the others informed their grades based on qualitative evaluation of the evidence. The country average scores ranged from F (Indonesia) to B– (Japan), with C+ /C– the most prevalent grades. Mean grades for the five behavioral indicators were C– or lower, whereas, the four sources of influence indicators were rated C– or higher. Collectively, the mean behavioral score (D+) was lower than sources of influence score (C+). Comparisons with the global mean scores showed that all indicators were rated the same or lower in the Asian jurisdictions except for Government. Very HDI countries/regions scored higher in School, Community and Environment, and Government, and lower in Family and Peers, compared with the others (statistical results not shown). No differences between these two groups were found for the behavioral indicators.

Distribution of the grades in four categories (“A or B”, “C”, “D or F”, “INC”) are shown in Fig. 2. All jurisdictions assigned letter grades

to Overall Physical Activity, Active Transportation, Sedentary Behavior, and Government. Physical Fitness (n = 10) and Active Play (n = 8) were two indicators with the largest number of INC grades. Government was the indicator with the highest proportion of A or B grades (66.7%), followed by School (53.3%). Poor grades (D or F) were observed for Overall Physical Activity among 73.3% (11/15) of the jurisdictions. Correlations between indicators and sociodemographic and climate variables are presented in Table 3. Overall Physical Activity was not associated with other indicators except for Active Transportation ($r = 0.70$, $p < 0.01$). Positive correlations with Physical Fitness were observed for Organized Sport and Physical Activity ($r = 0.66$, $p < 0.01$) and Active Play ($r = 0.87$, $p < 0.01$). HDI was positively, while GII was negatively, associated with Community and Environment and Government. Positive correlations were observed between mean years of schooling and Community and Environment ($r = 0.61$, $p < 0.05$). Community and Environment was the only indicator that was associated with climate indicators and air pollutant (rainfall: $r = 0.72$, $p < 0.01$; sunlight: $r = -0.59$, $p < 0.05$; humidity: $r = 0.54$, $p < 0.05$; PM_{2.5}: $r = -0.70$, $p < 0.01$).

Top priorities to improve the Overall Physical Activity grade reported by country leaders are described in Table 4 and Supplementary File 2. All leaders identified advocacy for policy changes and calling for action/strategies for physical activity promotion as one of the most important directions. In addition, addressing surveillance gaps and increasing awareness and knowledge among stakeholders were reported in over one third of the jurisdictions. Three countries (Lebanon, Malaysia, and South Korea) mentioned the importance of removing sociocultural barriers for girls. Additional indicators reported in individual jurisdictions are listed in Supplementary File 3. The two most commonly reported additional indicators were Obesity/Weight Status (7 countries) and Sleep (5 countries).

National physical activity and sedentary behavior guidelines and PE curriculum policies of the 15 Asian jurisdictions are collated and summarized in Supplementary File 4. Nine jurisdictions had either developed national-level physical activity guidelines or adopted the WHO guidelines for children and adolescents, while

Table 1
Sociodemographic and weather information of the included Asian jurisdictions (n = 15).

	HDI	Gini index	GDP	EH (% of GDP)	Mean years of schooling	Population (millions)	Population density (people/km ²)	Life expectancy at birth (yr)	Life expectancy at birth (% of population)	Mean temperature (°C)	Rainfall (mm)	Day length (hr/yr)	Sunlight (hr/yr)	Humidity (%)	PM2.5 (µg/m ³)
China	0.761	0.168	38.5	5.2	8.1	1433.784	150.0	76.9	70.64	13.64	686.5	4438.70	2079.8	56	37.04
Chinese Taipei	0.916	0.045	34.0	6.1	NA	23.520	675.0	81.3	NA	24.10	1908.5	4421.58	1692.4	76	15.00
Hong Kong SAR, China	0.949	NA	53.9	3.6	12.3	7.436	7126.0	84.9	92.41	24.60	2307.1	4419.19	2179.9	76	19.83
India	0.645	0.488	37.8	3.5	6.5	1366.418	464.0	69.7	41.00	24.83	616.1	4424.66	2780.0	45	105.00
Indonesia	0.718	0.480	39.0	3.0	8.2	270.626	146.0	71.7	53.73	27.00	1651.1	4405.27	2973.0	80	46.35
Japan	0.919	0.094	32.9	10.9	12.8	126.860	345.0	84.6	92.73	16.60	1326.9	4432.61	2089.8	69	12.91
Lebanon	0.744	0.411	31.8	8.2	11.3	6.856	667.0	78.9	NA	15.00	335.7	4430.50	3000.0	66	19.00
Malaysia	0.810	0.253	41.0	3.9	10.4	31.950	99.0	76.2	89.56	27.50	2105.4	4408.52	2220.0	81	28.27
Nepal	0.602	0.452	32.8	5.6	5.0	28.609	203.0	70.8	NA	18.17	682.8	4423.89	2570.0	74	37.03
Philippines	0.718	0.430	44.4	4.4	9.4	108.117	368.0	71.2	46.88	26.60	1967.0	4413.99	2210.0	78	29.00
Singapore	0.938	0.065	35.0	4.4	11.6	5.804	8019.0	83.6	77.88	27.90	2809.6	4407.96	2032.0	84	11.00
South Korea	0.916	0.064	31.6	7.6	12.2	51.225	532.0	83.0	96.51	13.30	1145.7	4435.51	2270.0	65	21.00
Thailand	0.777	0.359	36.4	3.7	7.9	69.626	137.0	77.2	77.84	28.58	999.2	4413.49	2630.0	73	23.14
United Arab Emirates	0.890	0.079	32.5	3.3	12.1	9.771	139.0	78.0	100.00	27.75	54.1	4420.85	3580.0	62	44.40
Vietnam	0.704	0.296	35.7	5.5	8.3	96.462	314.0	75.4	70.29	24.08	1140.9	4418.25	1590.0	84	52.09

Abbreviations: EH, expenditure on health; GDP, gross domestic product; HDI, human development index; GII, gender inequality index; Gini, income inequality; PM, particulate matter; NA, not available.

five of them included specific recommendations for recreational screen time in the guidelines. PE lessons are mandated in all the countries/regions.

4. Discussion

The 15 Asian jurisdictions participating in the Global Matrix 4.0 represent approximately one third of member states in the region according to the United Nations, and spread across Eastern (n = 5), Southern-Eastern (n = 6), Southern (n = 2), and Western Asia (n = 2). Low and medium HDI countries were under-represented. Despite diverse social, cultural, environmental, and climate contexts, poor grades were commonly reported in behavioral indicators across jurisdictions. However, some promising policy contexts are observed in the region, which may partially explain the better grades for School and Government indicators. Asian jurisdictions performed comparably with the global average of the 57 countries participating in the Global Matrix 4.0. Comparisons of the findings across countries/regions are presented below, followed by a discussion of region physical activity related policies and major gaps in surveillance.

4.1. Comparisons of grades across countries/regions

The low grades of Overall Physical Activity (D–, corresponding to succeeding with 20%–26% of children and adolescents) and Sedentary Behavior (D+, corresponding to succeeding with 34%–39% of children and adolescents) suggest that most of children and adolescents in the participating countries/regions did not meet the global recommendations for physical activity and sedentary behavior.²¹ These findings were compatible with previous studies reporting physical activity and sedentary time globally or regionally.^{11,12} Of further note, countries from the Asia Pacific had the lowest average grade for Overall Physical Activity compared with countries from the other regions (Europe, Anglosphere, Africa and the Middle East, and Latin America) participating in the Global Matrix 4.0.⁸ In Asia, Japan seems to be the most successful country as it consistently leads the others in all physical activity related indicators (except for Active Play). Most jurisdictions showed both greater and lesser success than others, indicating that they may face different challenges in promoting physical activity among children and adolescents. Jurisdictions with different HDI levels did not perform differently in behavioral indicators, although very high HDI countries seemed to have better grades in Organized Sport and Physical Activity than the others. These findings were not fully compatible with the Global Matrix 3.0 grades of 49 countries,¹⁵ which showed that low and medium HDI countries generally obtained better grades than high or very high HDI countries in behavioral indicators. However, the interpretation should be done with caution given the under-representativeness of low and medium HDI countries in this region.

Active Transportation is the only behavioral indicator that was found to be related to Overall Physical Activity, supporting it as an important source of physical activity.²² Previous studies showed large variability in active transportation in 27 Asia-Pacific countries²³ and among countries participating in the Global Matrix 3.0,¹⁶ with no consistent patterns by sex, age, or HDI. In this region, over three quarters of children and adolescents used active travel modes in some very high HDI countries/regions such as Japan, South Korean, and Hong Kong, which contain compact metropolitan cities but have supportive infrastructure and safe environments to support active travel.^{24–26} There are also high or very high HDI countries in this region (Indonesia and UAE) with less than 25% of children and adolescents using active transportation, while medium HDI countries have >60% of children and adolescents

Table 2
Summary of grades assigned by indicator and group of indicators.

	OPA	SP	AP	AT	SB	PF	FP	SC	CE	GOV	BEH	INF	AVG
China	C	F	C–	C	D+	INC	C–	D	D–	D	D+	D	D
Chinese Taipei	F	D–	F	C–	D+	INC	D–	A–	A–	B+	D–	B–	C–
Hong Kong SAR, China	D–**	B–	D	B+	D	D	INC	B	B	C+	C–	B–	C
India	C*	INC	INC	B–	D–	INC	INC	C	D	C+	C–	C–	C–
Indonesia	F	F	F	D–	D	F	F	F	D+	B–	F	D	F
Japan	B–	B–	INC	A–	C–	B	C–	B+	B	B	B–	B–	B–
Lebanon	D–	INC	INC	D+	C	INC	INC	D	INC	D	D+	D	D
Malaysia	D–	INC	INC	D–	C	B**	INC	A–	INC	B*	D	B+	C
Nepal	D+	C–	C+	C	C	INC	A+	C	C	F	C–	C	C–
Philippines	F	INC	INC	D	B	INC	INC	C–	INC	B	D+	C+	C–
Singapore	C–*	B–	C–	C	C–	INC	C–	INC	A+	B	C–	B	C+
South Korea	D–	INC	INC	B+	D	INC	C–	A	B–	A*	C–	B	C+
Thailand	D	D+	F	C+	F	D–	A–	B–	C–	B	D–	B–	D+
United Arab Emirates	F*	INC	INC	F	D–	INC	D–	A–	INC	B+	F	C+	D+
Vietnam	F	INC	INC	D+	C–	INC	C	A	C	B–	D	B–	C–
Mean (SD) number grade	4.7 (2.6)	6.4 (3.5)	4.9 (2.9)	7.6 (3.2)	6.2 (2.2)	6.6 (4.2)	7.4 (4.0)	9.6 (3.9)	8.9 (3.4)	9.4 (3.1)	6.0 (1.9)	9.0 (2.3)	7.4 (1.7)
Mean letter grade	D–	D+	D–	C–	D+	D+	C–	C+	C	C+	D+	C+	C–
Mean letter grade (global)	D	C–	C–	C–	D+	C–	C–	C+	C+	C	D+	C	C–

Abbreviations: AP, Active Play; AT, Active Transportation; AVG, Average of all indicators; BEH, Behavioral indicators; CE, Community and Environment; FP, Family and Peers; GOV, Government; INC, incomplete; INF, Sources of influence indicators; OPA, Overall Physical Activity; PF, Physical Fitness; SB, Sedentary Behavior; SD, standard deviation; SP, Organized Sport and Physical Activity; SC, School.

** added to the grade when it is based on device-measured data exclusively; *** added to the grade when it is based on a mix of device-measured and self- or parent-reported data or Health-Enhancing Physical Activity Policy Audit Tool version 2 published by Ward et al. (for Government indicator only).

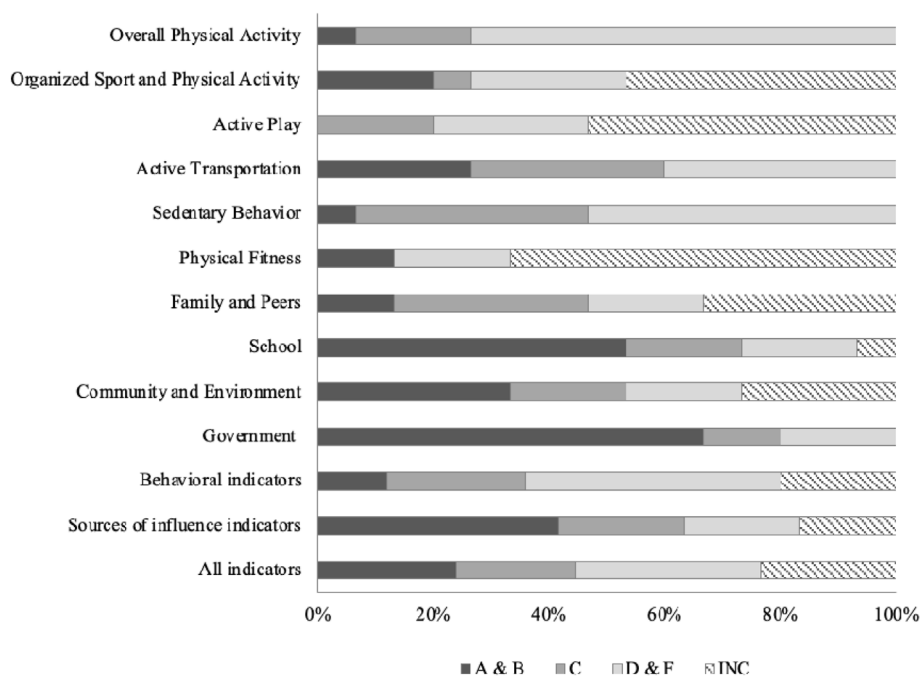


Fig. 2. Grade count by indicator and group of indicators.

Behavioral indicators = average of Overall Organized Sport and Physical Activity Participation, Active Play, Active Transportation, and Sedentary Behavior indicator grades; Sources of influence indicators = average of Family and Peers, School, Community and Environment, and Government indicator grades; INC = incomplete.

using active modes for travel. These findings illustrate a wide range of social, environmental, economic, and policy factors influencing active transportation in Asia.

Physical Fitness was evaluated as one of the common indicators since the Global Matrix 3.0¹⁵ and was graded according to the average percentiles achieved based on global sex- and age-specific normative values.^{27,28} Japan and Malaysia received the highest grade (B) for this indicator. However, they informed the grades using different fitness indicators (cardiorespiratory and muscular fitness used in Japan and flexibility used in Malaysia). Given the

large number of the INC grades, it is premature to comment on the physical fitness data for Asian children and adolescents with confidence. Cross-country data on health-related fitness are limited for Asian children and adolescents. Nevertheless, Hui and colleagues compared aerobic capacity and muscular fitness in adolescents from eight Asian metropolitan cities.²⁹ They found that adolescents performed better in those cities (Tokyo, Singapore, Seoul, and Shanghai) that have a culture of fitness programmes, policy towards PE, and government-initiated sport programmes.²⁹

Multilevel correlates should be targeted to promote active living

Table 3
Correlations between indicators and sociodemographic variables.

	OPA	SP	AP	AT	SB	PF	FP	SC	CE	GOV
OPA	1									
SP	0.29	1								
AP	0.39	0.58*	1							
AT	0.70**	0.48	0.29	1						
SB	-0.05	0.14	0.41	-0.27	1					
PF	0.32	0.66**	0.87**	0.21	0.45	1				
FP	0.32	0.38	0.36	0.30	0.16	0.26	1			
SC	-0.23	0.50	0.34	0.12	-0.15	0.51	0.16	1		
CE	-0.03	0.65**	0.19	0.30	0.21	0.50	0.10	0.58*	1	
GOV	-0.36	0.22	0.02	-0.08	-0.24	0.29	-0.32	0.65**	0.49	1
HDI	0.10	0.47	-0.12	0.34	-0.19	0.13	-0.26	0.41	0.67*	0.54*
GII	0.05	-0.26	-0.05	-0.14	0.11	-0.34	0.35	-0.63*	-0.63*	-0.72*
Gini	-0.08	0.02	-0.26	-0.12	0.02	-0.28	0.30	-0.30	-0.09	-0.24
Expenditure on health	0.23	0.15	0.46	0.35	0.53*	0.47	-0.03	0.21	0.33	0.02
Mean years of schooling	-0.11	0.61*	0.14	0.21	0.05	0.28	-0.41	0.47	0.61*	0.52
Population	0.18	-0.22	0.22	0.10	-0.18	-0.00	0.08	-0.25	-0.48	-0.13
Population density	0.08	0.37	-0.06	0.43	0.13	0.08	-0.22	0.01	0.47	-0.00
Life expectancy at birth	0.13	0.43	-0.12	0.42	-0.14	0.06	-0.29	0.37	0.62*	0.38
Individuals using the Internet	0.05	0.45	0.19	0.18	-0.12	0.32	-0.19	0.65*	0.52	0.60
Mean temperature	-0.21	0.03	-0.43	-0.38	-0.26	-0.20	0.11	-0.01	0.08	0.29
Rainfall	-0.12	0.47	-0.05	0.08	0.26	0.21	0.08	0.15	0.72**	0.30
Day length	0.43	-0.05	0.39	0.49	-0.03	0.18	-0.12	0.05	-0.21	-0.17
Sunlight	-0.08	-0.33	-0.18	-0.26	-0.31	-0.36	-0.15	-0.34	-0.59*	-0.10
Humidity	-0.41	0.26	-0.09	-0.34	0.45	0.15	0.17	0.15	0.54*	0.11
PM2.5	-0.23	-0.37	0.05	-0.38	-0.25	-0.22	0.14	-0.15	-0.70**	-0.31

Abbreviations: AP, Active Play; AT, Active Transportation; CE: Community and Environment; FP, Family and Peers; GII, gender inequality index; Gini, income inequality. GOV, Government; HDI, human development index; OPA, Overall Physical Activity; PF, Physical Fitness; SB, Sedentary Behavior; SP, Organized Sport and Physical Activity; SC, School.

*p < 0.05, **p < 0.01.

according to the ecological model.³⁰ Evidence has demonstrated that socio-cultural and environmental factors are all related to children’s physical activity.³¹ In a study across Europe, country-level economic and policy environmental factors were found to account for 38% of country-level variance in moderate-to-vigorous physical activity (MVPA) among 11-to-15-year-olds.³² Other individual factors, such as taking PE lessons regularly and having support from parents and friends, were all associated with more physical activity for adolescents aged 13–15 years living in low- and middle-income countries.³³ In the current study, the sources of influence indicators were not associated with the Overall Physical Activity or Sedentary Behavior grades, indicating that relevant policies, environments, and infrastructures conducive to physical activity in many Asian jurisdictions have not been translated into favorable behaviors. The gap between policy/supportive infrastructure and implementation observed in this study corroborates the findings from Global Matrix 2.0 and 3.0.^{7,15} Similarly, Klepac Pogrmilovic and colleagues found that although most of the countries had physical activity policies, the levels of their implementation were low.³⁴ It is also possible that how the policy has been working in this region is not well understood due to lack of robust assessment.

It has been suggested that a favorable weather condition (temperate at around 20 °C, less rainfall, and a longer day length) were associated with more physical activity and less sedentary time for children and adolescents.³⁵ However, we did not find any associations between climate variables and physical activity/sedentary behavior. It may be due to the relatively homogenous weather conditions in the included Asian countries/regions (e.g., 2/3 of the jurisdictions with mean yearly temperature >20 °C). The associations of climate variables (mean temperature and precipitation) and air pollutants with physical activity indicators using data from all 57 participating countries in the Global Matrix 4.0 were studied and reported elsewhere.³⁶

4.2. Regional sociocultural and policy contexts

For the countries/jurisdictions with national-level physical activity guidelines available, the recommended amount of MVPA was the same although some countries suggested accumulating 60 min of MVPA per day on average while the other adopted the same cut points daily. The most recent guidelines were published in China³⁷ (2021) and Singapore (2022).³⁸ There was variability in the age specifications of these recommendations across countries. Rigorous and transparent guideline development processes were not adopted in some countries as observed and challenged in a preview systematic review.¹⁹ All the participating countries/jurisdictions had a promising school policy on physical activity³⁹ with mandatory PE lessons but the recommended class time varied from 25 min (Thailand) to 180 min (South Korea) a week. The existence of physical activity guidelines and mandatory PE may partly explain the better grades for School and Government than the behavior indicators in the region. Furthermore, countries from the Asia Pacific had higher average grade for these two indicators than countries from the other regions except for Europe in the Global Matrix 4.0.⁸ Nevertheless, Asian countries/jurisdictions having the guidelines did not show the better grades in Overall Physical Activity or Sedentary Behavior than those without the guidelines. It corroborated the finding of no relationship between the sources of influence indicators and Overall Physical Activity grades.

Evidence-based, high quality physical activity guidelines serve as an important tool for stakeholders. However, existence of the guidelines, in isolation, is not enough for provoking behavior change at the population level.⁴⁰ Effective implementation needs to be contextualized to reflect local cultures, norms and values.²¹ For example, low perceived value of PE compared with other subjects within schools has been commonly documented in many Asian countries despite the importance of PE for children’s health⁴¹ and academic performance.⁴² Although mandated in the whole

Table 4
Top priorities to improve Overall Physical Activity grade.

Country/region	Top 3 priorities ^a reported by country leaders
Chinese Taipei	<ol style="list-style-type: none"> 1. Change of parents' perception in the benefits of physical activity in physiological/mental health and academic performance/raise the awareness of physical activity and health 2. Reduce school hours (usually 0800–1700 or later in junior and senior high school). 3. Make SH150 policy (150 min physical activity per week at school, excluding PE class) a reality (this policy is reported to be adopted by most schools but the number of students who meet the criteria is low). 4. Increase parents' support, and peer and social influence
Hong Kong SAR, China	<ol style="list-style-type: none"> 1. Enhance parental education for supporting their children to be physically active. 2. Promotion and publicity of physical activity among health professionals. 3. Mitigate the negative impact of COVID-19 pandemic, e.g. reopening of sport facilities.
India	<ol style="list-style-type: none"> 1. Increased resources/investment in child and youth-focused infrastructure and programming (current focus is still on athletes). 2. Improvements to build environment to encourage active transportation, particularly safety for girls. 3. Greater attention in research and education to address current gaps in knowledge, understanding, and awareness of the importance of physical activity and how it is linked to academic performance, etc (i.e., other outcomes that may be of greater priority and interest). 4. Better data 5. Federal strategy to prioritize unstructured play 6. Funding for schools
Indonesia	<ol style="list-style-type: none"> 1. To encourage government of the importance of physical activity for children and youth in terms of health, mental wellness, and its contribution to the academic achievements, so the government's task and duty is in implementing the policy related to the provision of space, programs, and policy in its finance outlay. 2. To encourage academicians to educate government officials, teachers, parents, and also society in general of the importance of physical activity and sport for all person so they could realize that it's important for them to regularly do physical activity in their daily life according to the WHO recommendation. The improvement on their comprehension and their lifestyle from those who could be the positive model for their children is the key for this effort. 3. To encourage the academician to start paying attention on the importance of physical activity and its benefits to be elaborated in their research activity in order to increase society and government awareness that the level of their children is still poor and take action on the efforts to improve it collectively.
Japan	<ol style="list-style-type: none"> 1. An official national physical activity guideline for children and adolescents between 6 and 17 years old is necessary. 2. A national representative monitoring system is needed to evaluate the present state of daily physical activity. 3. A regular monitoring system is needed to evaluate the present state of daily physical activity including regional differences.
Lebanon	<ol style="list-style-type: none"> 1. Prioritize schools as primary intervention sites to offer better quality PE, more opportunities for physical activity during the school day and before and after school. Public schools should receive extra support in this endeavour. 2. Focus on cultural norms to decrease barriers of female participation in PE, and physical activity opportunities. 3. Gather all primary physical activity stakeholders to develop and enact a strategic plan to promote physical activity at a national level.
Malaysia	<ol style="list-style-type: none"> 1. Widely publicize the national physical activity guidelines, promote MVPA of at least 60 min daily and provide support for their implementation/roadshows in different sectors and settings. 2. Start efforts to promote physical activity in Malaysian children as early as possible as physical activity patterns in early childhood continue into late childhood and potentially in adolescence. 3. Provide children and adolescents with opportunities to experience the broad range of physical activities available, both structured and unstructured meeting all population groups (e.g., gender, cultural groups/low household income families).
Nepal	<ol style="list-style-type: none"> 1. Targeted interventions addressing a decline in physical activity during adolescence. 2. Better opportunities to be physically active at school (both primary and secondary schools) and in the community. 3. National level studies for a better understanding of physical activity of children and adolescents. 4. Increase in awareness on importance of physical activity among children and adolescents. 5. Need of targeted physical activity interventions to school and out of school children and adolescents. 6. Need of quality research/data (including objective measurements) at local and national level to better understand physical activity among children and adolescents.
Philippines	<ol style="list-style-type: none"> 1. The Philippines needs to develop a national physical activity plan or strategy to improve the overall physical activity of children and adolescents in the country. 2. We need to invest in physical activity (including sedentary behavior) research. There was a national physical activity guideline for Filipinos developed in 2010, but the extent to which this guideline was communicated and used was unknown. 3. We need to promote physical activity as a positive health behavior and not just focus in promoting competitive sports participation. Efforts to promote physical activity need to go beyond competitive sports.
Singapore	<ol style="list-style-type: none"> 1. Higher quality surveillance data and better access to data. 2. Evidence-based and nationwide strategies to increase physical activity at school. 3. Development of evidence-based strategies targeting out-of-school physical activity.
South Korea	<ol style="list-style-type: none"> 1. Since most children and adolescents go to school, school PE (including extracurricular activity) and physical activity policy should involve school PE. For example, number of hours for school PE should be increased. 2. Intra and intermural sports should be systematically applied to increase more sports related physical activity. 3. Clear and reachable PA guideline, as a result of collaborative efforts among government organization (GO, including ministry of education, health and sports) and NGO should be presented as a national level. 4. We found that the resources, policies, and infrastructure conducive to physical activity are in place (School and Government policies; both received an A grade; community and environment B-); however, it is unknown if physical activity promotion policies are actually working (overall physical activity D-). Evaluation of physical activity promotion policies is critical for effective policy implementation. 5. Removing sociocultural barriers to physical activity for girls and high school students should be the priority, given marked differences in physical activity by gender and age. This effort may be accompanied with promoting physical activity among parents as well. 6. National level physical activity guidelines should be developed in collaboration with international and national scholars/stakeholders and should be implemented nationwide using the school system.
Thailand	<ol style="list-style-type: none"> 1. Designing national strategic plan on physical activity promotion for children and youth. 2. Designing/implementing national school policy on physical activity for children and youth. 3. Disseminating sedentary behavior guidelines. 4. Collaboration from all related policy partner. 5. Integrated strategy for physical activity promotion among children. 6. Advocate the important of physical activity at national level.

Table 4 (continued)

Country/region	Top 3 priorities ^a reported by country leaders
United Arab Emirates	1. Enhancement of the quantity and quality of PE programmes and extra-curricular sport and physical activity clubs in public and private schools across the UAE. 2. Continued development and expansion of green spaces, parks, beaches, and active transport networks including walking and cycling paths. 3. Sustained development of grass roots organized sport leading to talent identification and Olympic athlete training pathways.
Vietnam	1. Develop a guideline on physical activity and sedentary behavior. 2. Increase population awareness on physical activity. 3. Nationwide monitoring and surveillance system of physical activity level.

MVPA, moderate-to-vigorous physical activity; PA, physical activity; PE, physical education.

^a More than 3 items for countries/jurisdictions having more than one leader.

curriculum, PE is still regarded as a minor subject area in China,³⁴ Chinese Taipei,⁴³ Hong Kong,⁴⁴ South Korea,⁴⁵ and UAE.⁴⁶ In Vietnam, overemphasis on sport training of the PE lessons have been identified as barriers for effective implementation.⁴⁷ In addition, the effectiveness of mandated PE lessons is compromised by the low percentage (40.5%) of physically active lesson time within the classes.⁴⁸

The lower value placed on PE lessons may be related with the examination-oriented education system in the region. The “Asian education model” observed in jurisdictions such as China, Hong Kong, Chinese Taipei, Singapore, South Korea, and Japan is characterized by a national curriculum which places high emphasis on academic performance (excluding PE).⁴⁹ According to the results of the Programme for International Student Assessment (PISA) 2015, students in East Asia (except Japan) had longer weekly study hours (46–57 h) compared with their counterparts in OECD countries.⁵⁰ Putting too much emphasis on studying may also negatively affect parents’ intention and willingness to support their children’s physical activity participation. We found that children and adolescents in very HDI countries had less family and peers support compared with their counterparts in the other countries. Echoed by many report card leaders, putting more efforts to advance knowledge among parents, teachers, health professionals, and decision-makers about the important of physical activity for children’s health is one of the top priorities to improve the grade in the region. It is particularly important for girls given the observed gender inequality in physical activity and the support girls received from parents.³³

4.2.1. Evidence gaps

Indonesia and Thailand were the only two countries that had sufficient data to inform all indicators. Most of the jurisdictions face challenges in informing grades for at least two indicators. Lack of nationally representative evidence, data derived from small sample size studies, and outcomes misaligned with the benchmarks were common barriers. For instance, national physical fitness tests were available in several jurisdictions such as China, however, the outcomes are not aligned with the benchmark so a letter grade could not be assigned. Valid and reliable measurement tools to capture different aspects of Active Play are warranted. A recently published international consensus paper in the field of play, learn, and teach outdoors represents an evolving effort in developing standardized terms and definitions relevant to play.⁵¹ Furthermore, most countries still relied on subjectively reported measures of physical activity which are prone to assessment bias.⁵² A notable success in Thailand was a result from the participation in the Global Matrix⁵³: a national survey was developed to collect data for each indicator since 2015 and the results from the 2021 Thailand Report Card Survey was used to inform the latest grades. Participation in other international survey projects, such as Global School-based Student Health Survey, provided useful data sources in four countries (Indonesia, Lebanon, Philippines, Vietnam) to inform grades for 3 or 4 indicators. However, reliance on international surveys solely

prevented Lebanon from assigning grades to the other indicators that were not assessed in the survey. A call for national surveillance data has been identified as one of the top priorities to improve the grades in 6 countries covering all HDI levels. It is obvious that surveillance gaps cannot be addressed without concerted efforts of researchers and stakeholders with essential funding support by the governments in the region.

4.3. Additional indicators

In addition to the 10 common indicators, 60% of participating Asian jurisdictions included at least one additional indicator in their report cards. The two most commonly reported indicators were Obesity/Weight Status (7 countries) and Sleep (5 countries), indicating the shared view of the importance and relevancy of these two indicators to children’s physical activity and health, as well as the growing interest for the global 24-h movement behaviors guidelines. The grades for Obesity/Weight Status ranged from “C–” to “A”, while Sleep ranged from “F” to “A–”. The other indicators, including Yoga, Diet, Physical Literacy, Student Engagement, Anxiety and Stress, and Bullying, were reported in one country only. Direct comparison of Obesity grades across jurisdictions is difficult due to the different criteria for defining overweight or obesity, and lack of standardized benchmark and grading rubric. Given the increasing popularity of including Obesity and Sleep indicators in countries participating in the Global Matrix, transparent, harmonized methods, and potentially official AHKGA Global Matrix benchmarks, should be established to facilitate cross-country comparisons in the future.

4.4. Strengths and limitations

This study is the first attempt to compare the Report Card grades across Asian jurisdictions participating in Global Matrix. The development of Report Cards was guided by the harmonized AHKGA approach and conducted by a group of experts within each participating country. Nevertheless, some limitations should be noted. First, although the Region’s contribution to the Global Matrices has been increasing, only 15 Asian countries/jurisdictions were included in Global Matrix 4.0 so the generalization of the findings is limited. In particular, participation from low and medium HDI countries should be encouraged in the future Global Matrices. Second, data sources used to inform grades were diverse across countries, including age range of the study population, measurement of the indicators, time of data collection, and number of benchmarks adopted for grade assignments. Third, the large number of INC grades for Physical Fitness, Organized Sport and Physical Activity, and Active Play limited comparisons and interpretation of their relationships with other indicators. Finally, the COVID-19 pandemic has been associated with negative movement behavior changes for children and adolescents globally.⁵⁴ The influence of the pandemic on the grades is beyond the scope of this paper and is discussed elsewhere.⁸ Nevertheless, a mix of pre-

pandemic and during pandemic data were used to inform the grades across countries and may further compromise comparability.

5. Conclusions

The comparison of Global Matrix 4.0 report card grades across 15 Asian jurisdictions showed poor grades for physical activity and sedentary behavior in general. The better, though modest, grades on the sources of influence have not been translated into favorable behaviors among children and adolescents. The findings also identified surveillance gaps for physical fitness, active play, and organized sport participation. To achieve the global target of a 15% relative reduction in the prevalence of physical inactivity by 2030,⁴ national-level investments and action plans are needed to ensure physical activity interventions are developed, effectively implemented, and regularly evaluated in multiple settings. For many Asian countries, gender inequality should be addressed by removing barriers and expanding opportunities for girls to participate in physical activity.

Author statement

W.Y. Huang: Conceptualization, data curation, formal analysis, methodology, writing-original draft; S. Aubert: Conceptualization, data curation, methodology, writing – review and editing; M.S. Tremblay: Conceptualization, methodology, writing – review and editing; S.H.S. Wong: Conceptualization, supervision, writing – review and editing.

Acknowledgments

The authors are grateful for all the hard work by each participating Asian country's Report Card team members and Leaders and all other members of their Report Card Committees.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jesf.2022.10.002>.

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