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Report Card Grades on the Physical Activity of Children and Youth From 10 Countries With High Human Development Index: Global Matrix 3.0

Silvia A. González, Joel D. Barnes, Patrick Abi Nader, Dolores Susana Andrade Tenesaca, Javier Brazo-Sayavera, Karla I. Galaviz, Marianella Herrera-Cuenca, Piyawat Katewongsa, Juan López-Taylor, Yang Liu, Bilyana Mileva, Angélica María Ochoa Avilés, Diego Augusto Santos Silva, Pairoj Saonuam, and Mark S. Tremblay

Background: The Global Matrix 3.0 brings together the Report Card grades for 10 physical activity indicators for children and youth from 49 countries. This study describes and compares the Global Matrix 3.0 findings among 10 countries with high Human Development Index. **Methods**: Report Cards on physical activity indicators were developed by each country following a harmonized process. Countries informed their Report Cards with the best and most recent evidence available. Indicators were graded using a common grading rubric and benchmarks established by the Active Healthy Kids Global Alliance. A database of grades from the countries was compiled, and letter grades were converted to numerical equivalents. Descriptive statistics and scores for groups of indicators were calculated, and correlation analyses were conducted. **Results**: Grades for the 10 countries clustered around "D" ranging from "F" to "B+." Active Transportation had the highest average grade ("C"), whereas Overall Physical Activity had the lowest average grade ("D–"). Low grades were observed for both behavioral and sources of influence indicators. **Conclusions**: In the context of social and economical changes of high- Human Development Index countries, urgent actions to increase physical activity among children and youth are required. Surveillance and monitoring efforts are required to fill research gaps.

Keywords: advocacy, health promotion, international, policy

Regular physical activity among children and youth (ie, adolescents) has been consistently associated with decreased adiposity, healthy cardiometabolic biomarkers, improved physical fitness, and better bone health, as well as with favorable psychological and cognitive health outcomes.[1] The public health potential of regular physical activity is particularly relevant in the current context in which more than 107 million children are obese worldwide.[2] Despite the broad evidence on the benefits of physical activity, globally, 80% of adolescents are not attaining the minimum recommendation of 60 minutes of daily moderate- to vigorous-intensity physical activity to achieve those benefits.[3] A moderate decline in the cardiorespiratory fitness of children and adolescents has also been observed,[4] and excessive sedentary behaviors among children and youth are highly prevalent.[5–8]

For many countries considered to have emerging economies, a shift toward reduced habitual physical activity is probable and related to broad social changes and economic growth.[9,10] Greater use of motorized transportation, shifts from rural to urban dwelling, and increased use of technology that occur with economic growth may be contributing to decreased active transportation and leisure-time physical activity and to increased sedentary recreational activities.[11,12] Despite the rapidly rising burden of noncommunicable diseases (NCDs) in middle-income countries,[13] there are competing priorities at the policy and structural levels,[14] which can be reflected in lack of investments by governments to prevent NCDs.[15] This is the context of several countries in Latin America, the Middle East, the Eastern Balkan region, and East Asia, regions in the midst of a physical activity[16] and demographic transition.[17]

In response to the physical inactivity crisis and the increase in NCDs[13] as unintended consequences of economic development, multilateral organizations have launched action plans and policy documents that support physical activity promotion as a key strategy. The Bangkok Declaration on Physical Activity for Global

González, Barnes, and Tremblay are with the Healthy Active Living and Obesity Research Group, Children's Hospital of Eastern Ontario Research Institute, Ottawa, Ontario, Canada; González is also with the School of Medicine, Universidad de los Andes, Bogotá, Colombia. Abi Nader is with the Centre de formation médicale du Nouveau-Brunswick, Université de Moncton, Moncton, NB; and the Centre de Recherche du Centre Hospitalier de l'Université de Montréal, Montréal, Quebec, Canada. Susana Andrade Tenesaca and María Ochoa Avilés are with the Departamento de Biociencias, Universidad de Cuenca, Cuenca, Ecuador. Brazo-Sayavera is with the Instituto Superior de Educación Física, Universidad de la República, Rivera, Uruguay; and the Polo de Desarrollo Universitario EFISAL, Universidad de la República, Rivera, Uruguay. Galaviz is with the Emory Global Diabetes Research Center, Hubert Department of Global Health, Rollins School of Public Health, Emory University, Atlanta, GA, USA. Herrera-Cuenca is with the Centro de Estudios del Desarrollo, Universidad Central de Venezuela, Caracas, Venezuela; Fundación Bengoa para la Alimentación y Nutrición, Caracas, Venezuela; and the Observatorio Venezolano de la Salud, Caracas, Venezuela. Katewongsa is with the Institute for Population and Social Research, Mahidol University, Salaya, Thailand. López-Taylor is with the Instituto de Ciencias Aplicadas a la Actividad Física y Deporte, Centro Universitario de Ciencias de la Salud, Universidad de Guadalajara, Guadalajara, Mexico. Liu is with the School of Physical Education and Sport Training, Shanghai University of Sport, Shanghai, China; and the Shanghai Research Center for Physical Fitness and Health of Children and Adolescents, Shanghai University of Sport, Shanghai, China. Mileva is with BG be Active Association, Plovdiv, Bulgaria. Silva is with the Research Center of Kinanthropometry and Human Performance, Federal University of Santa Catarina, Florianopolis, Brazil. Saonuam is with the Promotion of Healthy Lifestyle Section, Thai Health Promotion Foundation (ThaiHealth), Bangkok, Thailand. Tremblay (mtremblay@cheo.on.ca) is corresponding author.

Health and Sustainable Development,[18] the Plan of Action for the Prevention of Obesity in Children and Adolescents[19] (signed by all countries in Latin America), and the World Health Organization's Global Action Plan on Physical Activity[20] are some of the recent policy documents that highlight the key role of physical activity in the prevention of NCDs globally.

As the global public health agenda fosters the implementation of policies and action plans to decrease the burden of physical inactivity, surveillance of physical activity, its related behaviors and relevant settings of influence for its promotion, is needed. In response to these needs, Active Healthy Kids Canada and subsequently the Active Healthy Kids Global Alliance (AHKGA) have led the harmonized development of country-specific physical activity Report Cards, synthesizing the best available evidence on how a nation is doing in terms of promoting physical activity among children and youth since 2014.[21,22] The countries involved in the Report Card initiative have graded common indicators related to physical activity in children and youth using a common grading rubric and standardized benchmarks.[21–23] This international effort has been consolidated in the creation of a "Global Matrix" of grades, which has compiled and compared grades across physical activity–related indicators for 15, 38, and 49 countries in its first, second, and third versions, respectively.[21–23]

As the Global Matrix project has grown, greater representativeness of countries from different levels of development and different regions of the world has been achieved. This progress provides a unique opportunity to identify successes and challenges to improve physical activity levels among children and youth from countries with similar levels of development in various regions of the world. For this purpose, the 49 countries involved in the Global Matrix 3.0 were classified into 3 categories based on their Human Development Index (HDI): low and medium, high, and very high HDI, following the cutoff points defined by the United Nations Development Programme. The HDI is a composite index that integrates life expectancy, years of schooling, and gross national income per capita as basic dimensions of human development.[24]

This study focuses on the group of countries with a high HDI, which are susceptible to the aforementioned consequences of economic growth. In this context, it is important to document the current situation of physical activity–related indicators and the priorities for research and advocacy to advance efforts to promote active living in children from these countries and to study the variability in successes and challenges between countries with similar HDI. Therefore, the purpose of this study is to describe and compare the Global Matrix 3.0 findings for 10 physical activity indicators among 10 high-HDI countries: Brazil, Bulgaria, China, Colombia, Ecuador, Lebanon, Mexico, Thailand, Uruguay, and Venezuela.

Methods

Global Matrix Involvement

Countries registered for the Global Matrix 3.0 project between April 2017 and January 2018 and paid a registration fee according to their HDI classification. Eleven high-HDI countries registered and 10 fully participated. According to the mentorship model developed for the Global Matrix 3.0,[23] each country was assigned a mentor from the AHKGA network and from their geographical region to guide the development of their Report Cards following a harmonized process.[25] Four of the high-HDI countries developed their Report Cards for the first time (Bulgaria, Ecuador, Lebanon, and Uruguay).

Report Card Development

Each country formed a working group of national and international experts on physical activity from the academic, private and government sectors, and research staff from the lead organization. These teams were in charged with (1) compiling and synthesizing the best available and most recent evidence for their country, and (2) assessing the available evidence for each indicator and assigning the corresponding grade based on the benchmarks and grading rubric established by the AHKGA (Tables 1 and 2). The evidence was gathered from literature reviews comprising peer-reviewed published and unpublished data, surveys, governmental reports, and policy documents and in some cases, was complemented by experts on the team.

Indicators

The data gathered were summarized in 10 common indicators: Overall Physical Activity, Organized Sport and Physical Activity, Active Play, Active Transportation, Sedentary Behaviors, Physical Fitness, Family and Peers, School, Community and Environment, and Government. To harmonize the process, the AHKGA established benchmarks for each indicator (Table 1) and a standardized grading rubric (Table 2). Every indicator was assigned a grade by the group of experts in each country. The 10 countries submitted their grades with a detailed rationale supporting these indicators, and a scientific committee from the AHKGA audited the submitted grades. Details about the development and findings of the Report Card for each individual country are provided in country-specific articles in this issue.[27–36]

To facilitate comparisons across countries, the Global Matrix 3.0 only includes data for children between 5 and 17 years (school-aged children and youth in most countries) and data for the 10 common indicators; however, each country was free to include a wider age range and additional indicators on their individual Report Cards. It is worth noting that for some countries, the grades reported in the Global Matrix 3.0 may differ from the countries' Report Card, due to the inclusion of additional criteria on the grading scheme (eg, changes over time or evidence of disparities) at the country level.

Statistical Analysis

A database of the grades for high-HDI countries was compiled. For analysis purposes, letter grades were converted to numerical equivalents (Table 2). Descriptive statistics (average grade, SD) were calculated for each indicator. To facilitate comparisons among countries and to draw more general conclusions about the indicator grades, an overall score (combining all the indicators) was computed along with scores for the behavioral indicators (Overall Physical Activity, Organized Sport and Physical Activity, Active Play, Active Transportation, and Sedentary Behaviors) and the sources of influence indicators (Family and Peers, School, Community and Environment, and Government). For score calculations, incomplete grades were removed and the scores were reweighted accordingly. Based on the scores, countries were ranked by letter grade on scatterplots. Associations within indicators and between indicators and sociodemographic indexes were then explored using Spearman's rank correlation coefficients. Strong correlations were defined as coefficients equal to or higher than .7 or –.7.[37] Pairwise deletion was used to treat missing data (ie, incomplete grades). All statistical analyses were performed using R (version 3.4.1; The R Foundation for Statistical Computing, Vienna, Austria). Several

Table 1 Global Matrix 3.0 Indicators and Benchmarks Used to Guide the Grade Assignment Process

Indicator	Benchmarks
Overall Physical Activity	Percentage of children and youth who meet the global recommendations on physical activity for health, which recommend that children and youth accumulate at least 60 minutes of moderate- to vigorous-intensity physical activity per day on average. Or percentage of children and youth meeting the guidelines on at least 4 days a week (when an average cannot be estimated).
Organized Sport and Physical Activity	Percentage of children and youth who participate in organized sport and/or physical activity programs.
Active Play	Percentage of children and youth who engage in unstructured/unorganized active play at any intensity for more than 2 hours a day. Percentage of children and youth who report being outdoors for more than 2 hours a day.
Active Transportation	Percentage of children and youth who use active transportation to get to and from places (eg, school, park, mall, friend's house).
Sedentary Behaviors	Percentage of children and youth who meet the Canadian Sedentary Behavior Guidelines (5- to 17-year-olds: no more than 2 hours of recreational screen time per day). Note: the guidelines currently provide a time limit recommendation for screen-related pursuits but not for non-screen-related pursuits.
Physical Fitness	Average percentile achieved on certain physical fitness indicators based on the normative values published by Tomkinson et al.[26]
Family and Peers	Percentage of family members (eg, parents, guardians) who facilitate physical activity and sport opportunities for their children (eg, volunteering, coaching, driving, paying for membership fees and equipment). Percentage of parents who meet the Global Recommendations on Physical Activity for Health, which recommend that adults accumulate at least 150 minutes of moderate-intensity aerobic physical activity throughout the week or do at least 75 minutes of vigorous-intensity aerobic physical activity throughout the week or an equivalent combination of moderate- and vigorous-intensity activity. Percentage of family members (eg, parents, guardians) who are physically active with their kids. Percentage of children and youth with friends and peers who encourage and support them to be physically active. Percentage of children and youth who encourage and support their friends and peers to be physically active.
School	Percentage of schools with active school policies (eg, daily physical education, daily physical activity, recess, "everyone plays" approach, bike racks at school, traffic calming on school property, outdoor time). Percentage of schools where the majority (≥80%) of students are taught by a physical education specialist. Percentage of schools where the majority (≥80%) of students are offered the mandated amount of physical education (for the given state/territory/region/country). Percentage of schools that offer physical activity opportunities (excluding physical education) to the majority (>80%) of their students. Percentage of parents who report their children and youth have access to physical activity opportunities at school in addition to physical education classes. Percentage of schools with students who have regular access to facilities and equipment that support physical activity (eg, gymnasium, outdoor playgrounds, sporting fields, multipurpose space for physical activity, equipment in good condition).
Community and Environment	Percentage of children or parents who perceive their community/municipality is doing a good job at promoting physical activity (eg, variety, location, cost, quality). Percentage of communities/municipalities that report they have policies promoting physical activity. Percentage of communities/municipalities that report they have infrastructure (eg, sidewalks, trails, paths, bike lanes) specifically geared toward promoting physical activity. Percentage of children or parents who report having facilities, programs, parks, and playgrounds available to them in their community. Percentage of children or parents who report living in a safe neighborhood where they can be physically active. Percentage of children or parents who report having well-maintained facilities, parks, and playgrounds in their community that are safe to use.
Government	Evidence of leadership and commitment in providing physical activity opportunities for all children and youth. Allocated funds and resources for the implementation of physical activity promotion strategies and initiatives for all children and youth. Demonstrated progress through the key stages of public policymaking (ie, policy agenda, policy formation, policy implementation, policy evaluation and decisions about the future).

Table 2 Global Matrix 3.0 Grading Rubric

Grade	Interpretation	Numerical equivalents[a]
A+	94%–100%	15
A	We are succeeding with a large majority of children and youth (87%–93%)	14
A–	80%–86%	13
B+	74%–79%	12
B	We are succeeding with well over half of children and youth (67%–73%)	11
B–	60%–66%	10
C+	54%–59%	9
C	We are succeeding with about half of children and youth (47%–53%)	8
C–	40%–46%	7
D+	34%–39%	6
D	We are succeeding with less than half but some children and youth (27%–33%)	5
D–	20%–26%	4
F	We are succeeding with very few children and youth (<20%)	2
INC	Incomplete—insufficient or inadequate information to assign a grade	

[a]Letter grades were converted to numerical equivalents for analyses purposes.

packages were loaded to extend base R including corrplot,[38] ggplot2,[39] UpSetR,[40] and VIM.[41]

Qualitative Assessment

A qualitative appraisal was also conducted to compare the methods used to assess the Overall Physical Activity indicator across countries. For this, we collected information on the main source of physical activity data used by each country, instruments used, data collection methods, and sample size.

Results

Table 3 presents sociodemographic characteristics to provide the context and comparison of countries included in this analysis. Among the included countries, the HDI ranged from 0.727 in Colombia to 0.795 in Uruguay. The country with the highest public health expenditure was Uruguay (6.1% of the GDP), whereas the country with the lowest expenditure was Venezuela (1.5% of the GDP). The prevalence of stunting among children less than 5 years ranged from 7.1% in Brazil to 25.2% in Ecuador. According to the Gini index, the country with the greatest income inequality was Brazil, whereas Lebanon had the lowest income inequality. The gender inequality index, which measures disparities between males and females on measures of reproductive health, empowerment and labor market participation,[24] was greatest in Brazil and lowest in China. Population density ranged from 20 inhabitants/km^2 in Uruguay to 587 inhabitants/km^2 in Lebanon, and the percentage of urban population ranged from 34.4% in Thailand to 93.7% in Venezuela.

The consolidated country grades per indicator are presented in Table 4. Two countries (Brazil and China) assigned grades to all the indicators, whereas 2 other countries (Ecuador and Venezuela) did not assign a grade to 5 of the 10 indicators. About 25 of the possible 100 grades were graded as incomplete (INC). The most common indicators with INC grades due to insufficient evidence were Active Play (Colombia, Ecuador, Lebanon, Mexico, Uruguay, and Venezuela), Physical Fitness (Bulgaria, Ecuador, Lebanon, Mexico, Thailand, and Venezuela), and Family and Peers (Colombia, Lebanon, Mexico, Uruguay, and Venezuela) (Tables 4 and 5). Only 2 indicators, Overall Physical Activity and Active Transportation were graded by all countries (Table 5).

Country grades ranged from "F" to "B+", with most grades clustered around the "D" categories. The mean score for all indicators was equivalent to a "D+", and the same letter grade equivalent was observed when mean scores were computed for indicators grouped by behaviors or sources of influence. Active Transportation was the indicator with the highest average grade across the countries ("C"), whereas Overall Physical Activity obtained the lowest average grade ("D–").

Regarding the overall score for all indicators, Thailand, Colombia, and Bulgaria reported the highest scores, whereas China, Venezuela, and Lebanon had the lowest scores (Figure 1). When the indicators were grouped, the score for behavioral indicators was higher in Bulgaria and Colombia, whereas China, Lebanon, and Thailand had the lowest scores. The highest score for sources of influence indicators was observed in Thailand, whereas Venezuela, China, and Ecuador had the lowest scores (Figures 2 and 3). Details on the country rankings for each indicator are provided in Supplementary Material [available online]. The correlation matrix indicates significant strong positive correlations for Family and Peers with Government ($r = 1.0$), Community and Environment with Government ($r = .91$), and Community and Environment with public health expenditure ($r = .93$). A significant strong negative correlation was found for Active Transportation and life expectancy ($r = –.78$) (Table 6).

The Overall Physical Activity indicator was informed by national health surveys in 6 countries (Brazil, Bulgaria, Colombia, Ecuador, Lebanon, and Mexico), by physical activity or health studies in 3 countries (China, Thailand, and Venezuela), and by the Global School-based Student Health Survey in 2 countries (Lebanon and Uruguay). Most of these surveys and studies used self-reported methods to assess physical activity. Only Brazil reported studies with objective measures using accelerometers and pedometers. The sample size of the studies ranged between 156 youth in Venezuela and 242,259 children and youth in Brazil (Table 7).

Discussion

This study aimed to describe and compare the Global Matrix 3.0 grades among 10 countries with high HDI. Findings indicate these countries have a lot to improve in providing opportunities for children and youth to change behaviors and be more active, as well as in assuring high-quality physical activity surveillance. Grades for the 10 countries clustered around "D", which indicates that these countries, at a similar stage of development, are at similar stages in the physical inactivity crisis.[20] This further highlights the urgent need to take tangible actions to increase physical activity among children and youth. In addition, the Global Matrix 3.0 allowed to identify research gaps that should be addressed for the design and follow-up of initiatives to promote active living among children. In the context of the evidence available, a discussion of the findings for each indicator is presented below, followed by the interpretation of the findings by groups of indicators and the correlations observed.

Table 3 Sociodemographic Information of High-HDI Countries in the Global Matrix 3.0

Country	HDI[24]	Life expectancy at birth[24]	Expected years of schooling[24]	Mean years of schooling[24]	GNI per capita[24]	Public health expenditure (% of GDP)[24]	Stunting (% under 5 years)[24]	Gini index[42]	Gender Inequality Index[24]	Population density (people per km^2 of land area)[43]	Urban population (%)[44]
Brazil	0.754	74.7	15.2	7.8	14,145	3.8	7.1	51.3	0.414	25	84.9
Bulgaria	0.794	74.3	15.0	10.8	16,261	4.6	8.8	37.4	0.223	66	73.7
China	0.738	76.0	13.5	7.6	13,345	3.1	9.4	42.2	0.164	147	51.9
Colombia	0.727	74.2	13.6	7.6	12,762	5.4	12.7	50.8	0.393	44	75.6
Ecuador	0.739	76.1	14.0	8.3	10,536	4.5	25.2	45.0	0.391	66	68.0
Lebanon	0.763	79.5	13.3	8.6	13,312	3.0	16.5	31.8	0.381	587	87.4
Mexico	0.762	77.0	13.3	8.6	16,383	3.3	13.6	43.4	0.345	66	78.4
Thailand	0.740	74.6	13.6	7.9	14,519	5.6	16.3	37.8	0.366	135	34.4
Uruguay	0.795	77.4	15.5	8.6	19,148	6.1	10.7	39.7	0.284	20	92.6
Venezuela	0.767	74.4	14.3	9.4	15,129	1.5	13.4	46.9	0.461	36	93.7

Abbreviations: HDI, Human Development Index; GNI, gross national income.

Table 4 Grades Assigned to Core Physical Activity Indicators Among Countries With a High HDI

Country	PA	SP	AP	AT	SB	PF	FAM	SCH	COM	GOV
Brazil	D	C+	D+	C	D-	D	C-	C	C-	D+
Bulgaria	D+	C+	C+	B-	D	INC	D	C	C	INC
China	F	D-	D+	C+	F	D	D+	D+	F	F
Colombia	D+	C	INC	B	D+	D-	INC	D	B-	B
Ecuador	D	INC	INC	C-	C	INC	F	INC	D+	INC
Lebanon	D	F	INC	D	C-	INC	INC	D	INC	C+
Mexico	D+	C	INC	C+	D-	INC	INC	D+	D+	C
Thailand	D-	C-	F	C	D-	INC	B	B	B-	B+
Uruguay	D	F	INC	C	C-	C-	INC	C-	INC	D
Venezuela	D	D	INC	B-	INC	INC	INC	INC	D-	F

Abbreviations: AP, Active Play; AT, Active Transportation; COM, Community and Environment; FAM, Family and Peers; GOV, Government; HDI, Human Development Index; INC, incomplete; PA, Overall Physical Activity; PF, Physical Fitness; SB, Sedentary Behaviors; SCH, School; SP, Organized Sport Participation.

Overall Physical Activity

Among the estimated average grades for the 10 countries, the Overall Physical Activity indicator had the lowest grade "D–", indicating that less than one-third of children and youth are enjoying the benefits of being regularly active. This is consistent with global reports[3] and with the results of the Global Matrix 2.0, in which 53% of the countries graded this indicator with a "D".[22] Although Bulgaria, Colombia, and Mexico graded this indicator higher ("D+"), the grades are still low. Compared with the Global Matrix 2.0, the grades remained the same for China, Thailand, and Venezuela, decreased for Brazil (from "C–" to "D") and Mexico (from "C" to "D+"), and increased for Colombia ("D" to "D+"). However, these latter changes are more likely to be the result of changes in the benchmarks, the inclusion of additional evidence, or the change in data collection methods, instead of an actual change in the behaviors.[30] The comparability of these results among the 10 countries should be interpreted with caution because, as observed in Table 7, there was important variation in the methods used to assess the Overall Physical Activity indicator. Objective methods were used only in Brazil, and all other countries used different questionnaires. At the same time, countries reported meeting different benchmarks, according to available weekly data. Brazil and Thailand reported the children meeting physical activity guidelines on average,[27,34] and Colombia, Ecuador, and Venezuela reported those meeting guidelines 4 days or more,[30,31,36] which could be comparable, as observed in previous evidence.[45] By contrast, China, Lebanon, and Mexico reported children meeting the guidelines 7 days,[29,32,33] Bulgaria reported 6 days,[28] and Uruguay reported 5 days or more.[35] These differences highlight the need of consensus in implementing common methods to assess compliance with physical activity guidelines, as well as providing access to raw data for researchers to be able to estimate common indicators. In addition, the comparability of estimates for overall physical activity could be affected by the wide variation in the sample sizes of the surveys or studies that informed this indicator. Specifically, small sample sizes could be affecting the precision of the estimates.

Table 5 Average Grades and Descriptive Statistics by Indicator or Group of Indicators Among Countries With a High Human Development Index

Indicator	Grade count	Incomplete grades	Mean number grade	SD	Mean letter grade
Overall Physical Activity	10	0	4.9	1.2	D-
Organized Sport and Physical Activity	9	1	6.0	2.8	D+
Active Play	4	6	5.8	2.9	D
Active Transportation	10	0	8.5	1.7	C
Sedentary Behaviors	9	1	5.2	1.9	D
Physical Fitness	4	6	5.2	1.3	D
Family and Peers	5	5	6.2	3.3	D+
School	8	2	7.0	2.0	C-
Community and Environment	8	2	6.6	2.8	D+
Government	8	2	6.9	3.8	D+
Behavioral indicators	10	0	6.4	1.2	D+
Sources of influence indicators	10	0	6.5	2.4	D+
All indicators	10	0	6.4	1.3	D+

Note: Physical fitness was not included in the behavioral indicators cluster. There are no missing grades for the bottom 3 rows because these scores are adjusted for missing grades.

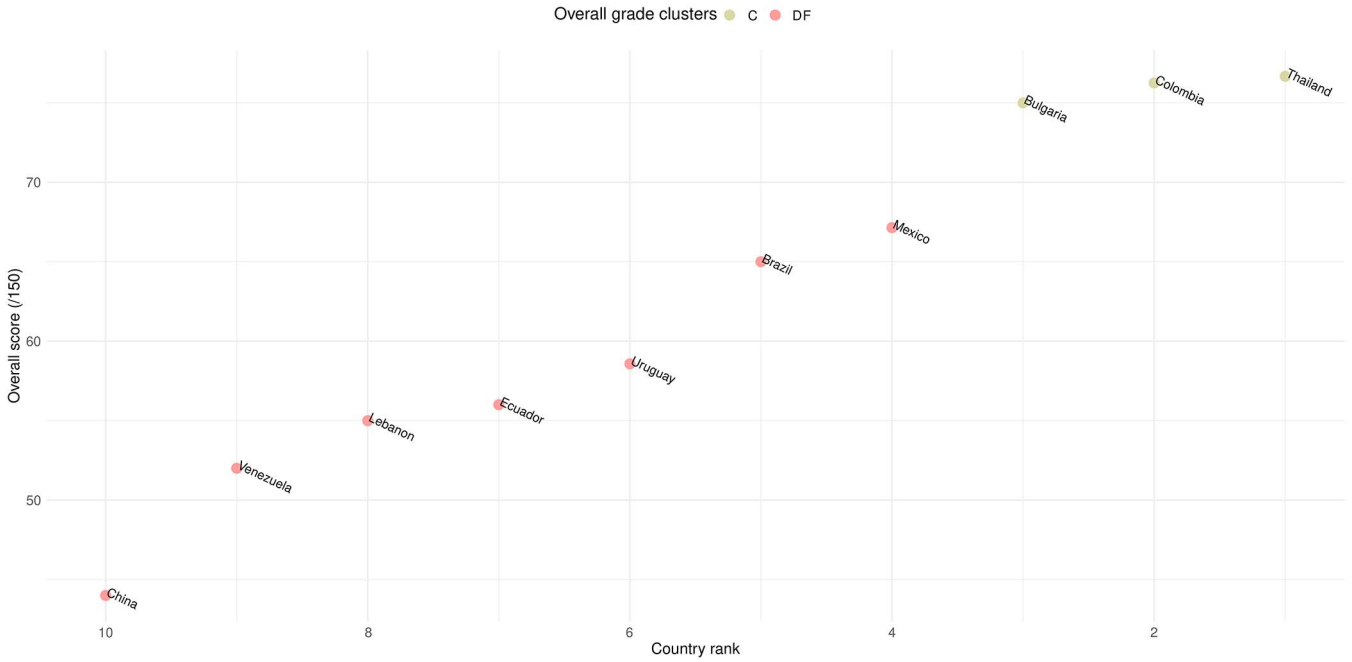

Figure 1 — Scatterplot of the overall score estimated for the 10 core indicators in the Global Matrix 3.0.

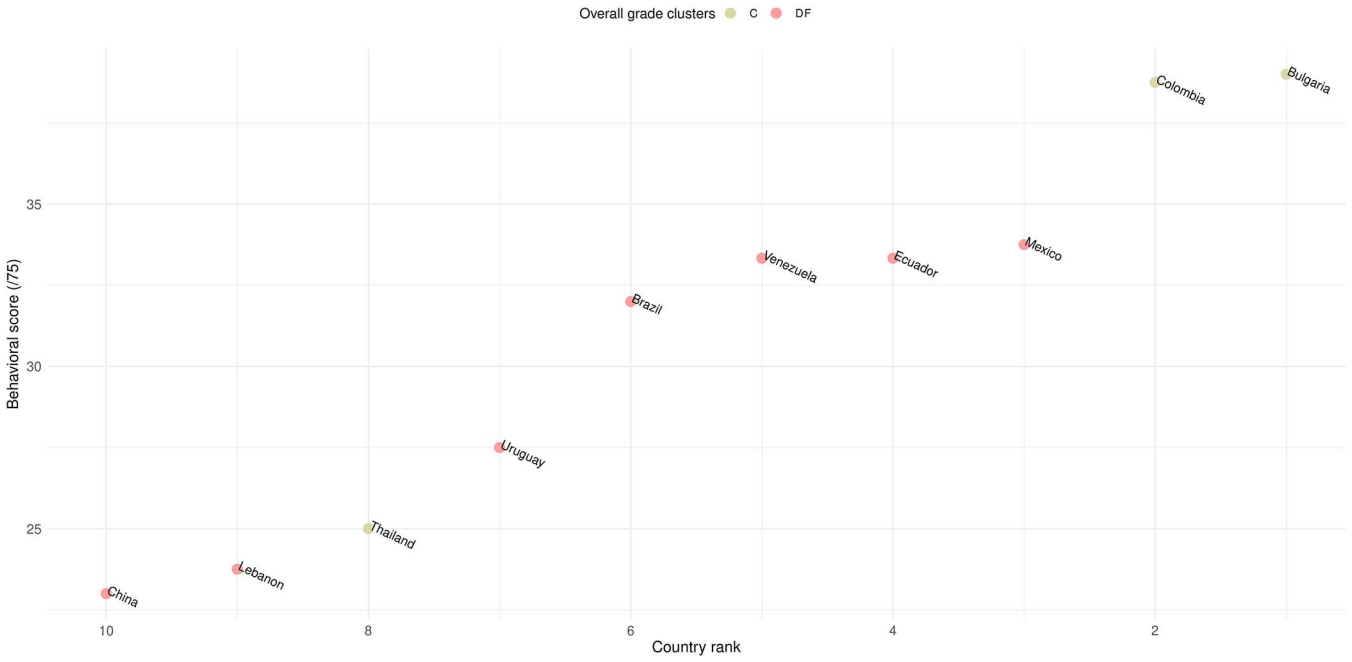

Figure 2 — Scatterplot of the behavioral score across 10 high-HDI countries in the Global Matrix 3.0.

Organized Sport and Physical Activity

According to the estimated average grade, approximately 1 of every 3 children and youth from high-HDI countries in the Global Matrix 3.0 participated in organized sport and/or physical activity programs. These results are slightly lower than those observed for the Global Matrix 2.0.[22] However, this is consistent with the fact that middle-income countries, such as Colombia and Mexico, had lower grades than high-income countries in the Global Matrix 2.0. Among countries that participated in previous Global Matrices, an increase in the grades was observed for Mexico and China. In the case of Mexico, the latest version of the National Health and Nutrition Survey ENSANUT showed an increase in sports participation among girls and children from rural areas.[46] This change could be related to the implementation of programs to promote physical activity at the school level, such as Muevete en 30 Escolar.[46] However, the impact of these programs in Mexico has not been evaluated and a causal relationship cannot be established. In the case of China, the change in the grade could be related to the inclusion of national data compared with mainly Shanghai's

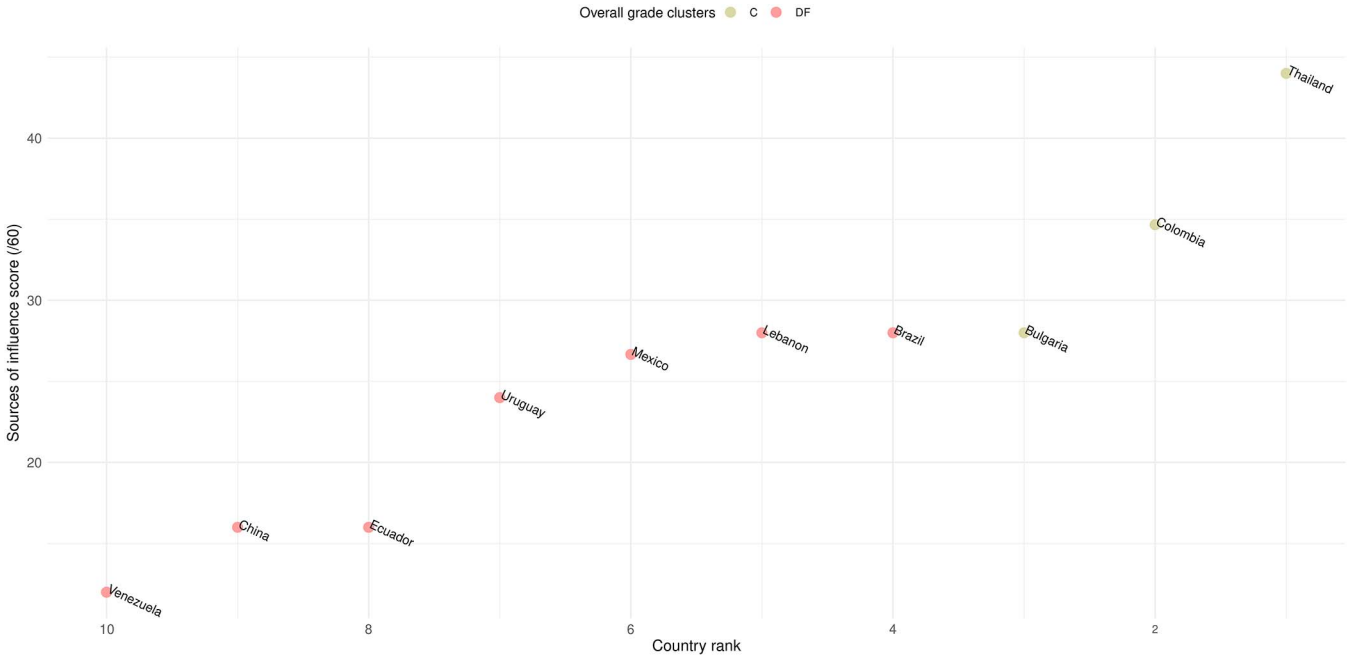

Figure 3 — Scatterplot of the sources of influence score across 10 high-HDI countries in the Global Matrix 3.0.

Table 6 Correlation Matrix (Spearman's Rank Correlation Coefficients) of Core Indicators and Sociodemographic Indexes

	Core indicators								
Sociodemographic index/core indicator	**PA**	**SP**	**AP**	**AT**	**SB**	**FAM**	**SCH**	**COM**	**GOV**
PA									
SP	.53								
AP	.63	.50							
AT	.46	.45	**.83**						
SB	.28	−.38	.50	−.44					
FAM	−.46	−.21	**−.95**	.05	−.67				
SCH	−.26	.38	−.50	−.15	−.36	.63			
COM	.38	.51	−.32	.12	.36	.50	.24		
GOV	.28	.29	**−.87**	−.22	.24	**1.00***	−.04	**.91***	
HDI	.22	−.21	.63	−.09	.26	.10	.21	−.10	−.40
Life expectancy at birth	−.26	−.64	−.32	**−.78***	.33	−.40	−.29	−.55	−.13
Mean years of schooling	.38	.00	.32	.03	.39	−.50	.23	−.09	−.23
GNI per capita	.19	.03	.32	.23	−.31	.40	.55	−.02	−.35
Public Health Expenditure	.13	.16	−.32	.01	.24	.20	.50	**.93***	.43
Stunting	−.10	−.49	−.63	−.48	.53	−.30	−.38	−.01	.56
Gini index	.15	.42	−.32	.33	−.13	.00	−.06	−.05	−.24
Gender Inequality Index	.13	.15	−.32	.00	.32	.10	−.12	.12	.11
Population density	−.31	−.23	−.32	−.28	−.21	.15	−.24	−.12	.31
Urban population	.28	−.35	.63	.01	.40	−.30	−.35	−.21	−.50

Abbreviations: AP, Active Play; AT, Active Transportation; COM, Community and Environment; FAM, Family and Peers; GNI, gross national income; GOV, Government; HDI, Human Development Index; PA, Physical Activity; SB, Sedentary Behaviors; SCH, School; SP, Organized Sport and Physical Activity. Note: Correlation coefficients in bold show strong (negative or positive) relationships between a specific indicator and an index/indicator. Physical Fitness was removed from this analysis due to incomplete grades. Pairwise deletion was used to treat missing data.
*Correlations that were statistically significant ($P < .05$).

Table 7 Methods Implemented to Assess the Overall Physical Activity Indicator Across 10 High-HDI Countries

Country	Study or survey	Method to assess physical activity	Questionnaire or device	Respondent	Sample
Brazil	National Survey of School Health—PeNSE and 89 regional surveys.	Subjective and objective	Physical Activity Questionnaire for Older Children Physical Activity Questionnaire for Adolescents Physical Activity Questionnaire for Children and Adolescents Global School-based Student Health Survey Youth Risk Behavior Survey Good Health Questionnaire (Good Health) Physical Activity Questionnaire for Adolescents List of Physical Activities Physical Activity Questionnaire Risk Behaviors in Adolescents from Santa Catarina Previous Day Physical Activity Questionnaire International Physical Activity Questionnaire Accelerometers Pedometers	Self-reported	242,259 children and youth between 6 and 19 y old
Bulgaria	Active Kids National Representative Survey 2016	Subjective	Youth Risk Behavior Survey Questionnaire	Self-reported	1014 children and youth between 6 and 18 y old
China	Physical Activity and Fitness in China—The Youth Study	Subjective	Health Behavior in School-age Children Study Questionnaire	Self-reported	125,281 children and youth between 9 and 17 y old
Colombia	National Nutrition Survey ENSIN 2015	Subjective	Youth Risk Behavior Survey Questionnaire	6–12 y: reported by parents 13–17 y: self-reported	12,106 children and youth between 6 and 17 y old.
Ecuador	National Health and Nutrition Survey 2012	Subjective	Modified version of the International Physical Activity Questionnaire	Self-reported	10,910 children and youth between 10 and 17 y old.
Lebanon	Lebanese-Food and Nutrition Security Study	Subjective	Modified version of the Children and Youth Physical Activity Questionnaire	Self-reported	1079 children and youth between 5 and 17 y old
	Global School-based Student Health Survey 2017	Subjective	Global School-based Student Health Survey Questionnaire	Self-reported	5708 youth between 13 and 17 y old
Mexico	National Health and Nutrition Survey ENSANUT 2016	Subjective	Health Behavior in School-age Children Study Questionnaire	Self-reported, with assistance from parents/tutors	1843 children between 10 and 14 y old
		Subjective	International Physical Activity Questionnaire short version	Self-reported	1440 youth between 15 and 19 y old
Thailand	Thailand Physical Activity Surveillance System 2015–2017	Subjective	Thailand Physical Activity Children Survey—Student Questionnaire and 24-h clock	6–9 y-old children: self-reported, with assistance from parents/tutors 10–17 y-old pupils: self-reported	1287 children and youth between 6 and 17 y old
Uruguay	Global School-based Student Health Survey 2012	Subjective	Global School-based Student Health Survey Questionnaire	Self-reported	3524 youth between 13 and 15 y old
Venezuela	Latin American Study of Nutrition and Health	Subjective	International Physical Activity Questionnaire	Self-reported	156 youth between 15 and 19 y old

data in the Global Matrix 2.0.[9,29] The availability of data for countries that had INC grades in previous versions of the Global Matrix for this indicator could be considered an improvement in surveillance or in the methodology to gather the evidence, which is the case for Brazil[27,47] and Venezuela.[36,48]

Active Play

The average "D" grade for Active Play indicates that only around 30% of children and youth are involved in unstructured active play. This could be considered as a low engagement with a behavior that could be relatively easier to promote than organized physical activity, from a public health perspective,[49] and that contributes to improved physical, emotional, social, and cognitive development.[50] It is worth noting that the frequency and time reported for these activities varied from 1 country to another, which makes it difficult to compare the situation between countries. Furthermore, the average grade was based on the data available for the 4 countries that graded this indicator (Brazil, Bulgaria, China, and Thailand). The lack of data for more than half of the countries in this analysis is an indication of the need to include active play and unstructured physical activity in the surveillance agenda of these countries.

Active Transportation

The Active Transportation indicator obtained the highest average grade ("C") suggesting that around 50% of children and youth in the 10 countries use some mode of active transportation to get to and from places. This prevalence is not negligible, and in the context of the physical inactivity crisis, it is encouraging that at least half of the population of children and youth are enjoying the multiple benefits of active transportation[51–54] on a regular basis. However, it is important to notice that for some of the countries in this analysis, as in other high-HDI countries, the high prevalence of active transportation may be the result of a daily need instead of a choice.[22,53,55] For this reason, the challenge with high-HDI countries is to maintain these behaviors in the current context of rapid economic growth and increased access to motorized transportation.[10] In countries such as Brazil and China, trends analyses show important declines in active transportation,[56,57] which are indicative of the urgency to design and implement strategies to make cycling and walking a desirable, safe, accessible, and sustainable mode of transport for children and youth.

Sedentary Behaviors

The average grade for the Sedentary Behaviors indicator was "D" and suggests that in high-HDI countries participating in the Global Matrix 3.0, only one-third of children and youth engage in 2 or less hours of recreational screen time, meeting the Canadian Sedentary Behavior Guidelines.[58] This proportion is consistent with international estimates that indicate at least two-thirds of the children in the International Children's Accelerometry Database exceeded 2 hours of recreational screen time per day.[59] These findings are concerning given the associations of excessive screen time with reduced fitness, unfavorable body composition, and lower scores for self-esteem and prosocial behavior.[60] In the current analysis, the proportion of children meeting the guidelines ranged from 7.1% in China[29] to 55.4% in Ecuador.[31] However, there are methodological differences that limit the comparability of these data. For example, China reported sedentary behaviors, including homework time,[29] which could underestimate the proportion of children meeting the sedentary behavior guidelines, which are focused on recreational screen time. Similarly, the behavior reported by Brazil in this indicator was watching television, which according to longitudinal international data seem to be decreasing in many countries, whereas other screen time-related behaviors are increasing.[61] Therefore, to improve comparability of data, standardization of methods and tools to measure sedentary behaviors is required.

Physical Fitness

An average "D" grade was assigned to the Physical Fitness indicator based on the grades available for Brazil, China, Colombia, and Uruguay. This grade is difficult to interpret, given the differences in the information and samples reported for this indicator among countries. Although Brazil reported data for cardiorespiratory fitness, muscular strength, endurance and flexibility,[27] China reported a physical fitness score estimated from 11 fitness indicators,[29] Uruguay reported cardiorespiratory fitness and handgrip strength,[35] and Colombia only reported handgrip strength.[30] Despite this limitation, the grades are consistent with previous evidence indicating low performance on physical fitness in South American countries.[62] Considering the potential of cardiorespiratory fitness as an indicator of current and future health,[63] and the high proportion of INC grades for this indicator, surveillance on fitness should be a priority in the research and health monitoring agenda for high-HDI countries.

Family and Peers

The average grade for this indicator was "D+". Compared with other indicators, more variability is observed among the 5 countries that graded the influence of family and peers. The grades ranged from "F" in Ecuador, to "B" in Thailand. The low grade in Ecuador is based on the fact that only 11.6% of the adults in the households are meeting the Global Recommendations on Physical Activity for Health.[31] Higher grades and different benchmarks were reported in Brazil and Thailand, where more than 50% and 70% of family members, respectively, facilitated physical activity and sport opportunities for their children through volunteering, coaching, driving, or investing resources. Compared with the Global Matrix 2.0, the grades for this indicator remained the same for Brazil and Thailand.[22] For China, the grade decreased as a reflection of the differences between the data for the national level and the data exclusively for Shanghai, reported in the Global Matrix 2.0.[9,29] As in previous versions of the Global Matrix, research gaps for this indicator are evident across countries.[21,22] The research network created around the Global Matrix 3.0 could lead to opportunities to share methodologies and tools used by countries that are monitoring the influence of family and peers on physical activity of children and youth, with countries where this evidence is lacking.

School

Among the sources of influence indicators, the school environment obtained the highest average grade "C–", ranging from "D" in Lebanon and Colombia to "B" in Thailand. The low grades in Lebanon and Colombia are based on the report of physical education participation.[30,32] In Colombia, 81.4% of children and adolescents reported attending physical education classes once per week. Though this proportion seems high, the rationale to assign a low grade was based on the fact that physical education is mandatory and almost 20% of school-attending children and youth did not report participation in the last week.[30] The high grade in Thailand is

based on the fact that 70% of schools in Thailand provide their students access to facilities and equipment that support physical activity.[34] Comparing results between countries is challenging given the variety of information reported due to the complex nature of this indicator and the variety of factors at school that can influence physical activity among children and youth.[64] However, the low grades for the behavioral indicators are indicative of the need for implementation of the available policies, as well as the importance of assuring the provisioning of high-quality physical education classes. International efforts such as the UNESCO core principles for quality physical education indicators[65] could guide countries in the definition and monitoring of the quality of physical education.

Community and Environment

An average "D+" grade was estimated for the Community and Environment indicator. The grades ranged from "F" in China to "B−" in Colombia and Thailand. The low grades in China are based on the limited access to sports facilities, equipment, and activities at the community level for children and youth (14.8%).[29] By contrast, Colombia and Thailand assigned a relatively high grade based on the fact that around 64% of children and youth reported having access to facilities, programs, and parks to be physically active.[30,34] Low grades in Mexico ("D+") and Venezuela ("D−") are mainly influenced by safety perceptions. In Mexico, according to the latest National Survey on Safety Perception, 74% of Mexican adults stopped allowing their children to go outside.[33] Similarly, in Venezuela, 75.5% of adolescents consider insecurity as an obstacle for being physically active.[36] The evidence available for this indicator in high-HDI countries in the Global Matrix is consistent with the findings of a review on built environment and physical activity in developing countries. This review highlighted that the evidence on the built environment in Latin America has focused on crime, traffic safety, and availability of parks and open spaces, while the evidence from Middle Eastern countries and middle-income countries in Europe is limited.[12]

Government

A "D+" average grade was estimated for the Government indicator in high-HDI countries. However, the grades ranged from "F" in China to "B+" in Thailand. The failing grade in China is based on the low proportion of parents that reported being aware of the existence of national policies to promote physical activity among children.[29] In the case of Thailand, the "B+" grade was based on the fact that 74.4% of policymakers reported that existing policies to promote physical activity are being implemented.[34] For example, since 2015, the "Teach Less Learn More" policy has been implemented in both primary and secondary schools nationwide to provide more opportunities for students to move outside of the classroom. Although most of the countries in this group reported the existence of programs, national plans, or policies, the implementation and impact of these initiatives are unknown.[27,30,31,33]

Sources of Influence and Behavioral Indicators

Previous versions of the Global Matrix showed higher grades for the sources of influence indicators compared with the behavioral indicators.[21,22] The findings from our analysis differ from those, given that there is no apparent difference among sources of influence and behavioral indicators, all of them have low average grades (D+), which suggests that beside the low engagement in active behaviors, the current opportunities provided by families, schools, communities, and governments to engage in physical activity are limited. According to the estimated scores, Bulgaria is leading the behavioral indicators and Thailand leads the sources of influence. Bulgaria's lead seems to be due to a relatively high participation in organized sports outside of school (56%), active play (55% of children involved in outdoor activities 3 or more days per week), and active transportation (64%).[28] In the case of Thailand, there is a high involvement of parents in facilitating physical activity for their children, high accessibility to school facilities to engage in physical activity, and a high perception of access to supportive environments for being active.[34] At the same time, Thailand's government has demonstrated commitment and leadership in implementing policies to promote physical activity among children.[34] However, the low ranking of Thailand for the behavioral score suggests that the success in the sources of influence indicators is not yet reflected in improved behaviors.

The correlational analysis revealed statistically significant positive or negative correlations between sociodemographic factors and physical activity indicators, as well as within physical activity indicators. We found that as grades for Community and Environment indicator increased, grades for Government indicator and the yearly public health expenditure increased. These are intuitive correlations, considering the significant power of governments in the design of the built environment (sidewalks, walking and cycling trails, and green space), the maintenance of infrastructure, and their role in the provision of resources for community programs that promote physical activity.[66] An opposite pattern was observed between Active Transportation and life expectancy indicating that as Active Transportation grades increased, life expectancy decreased. This may be related to the conditions in which active transportation is performed, considering that developing countries have the highest burden of road traffic accidents[67] and pedestrians and cyclists are more vulnerable. In Lebanon, for example, pedestrian deaths represented 40% of all reported road traffic deaths in 2013.[68] Evidence from China suggest that improvements in road safety conditions could lead to a gain in life expectancy.[69] Therefore, the promotion of active transportation in developing countries should include policies to improve road safety. Finally, the association observed between Family and Peers with Government should be interpreted with caution as only 3 countries graded both of the indicators. Missing data and the small sample size highlight the need to interpret these correlations with caution.

Gaps in Knowledge

Evidence is limited to provide a comprehensive description of the Global Matrix 3.0 indicators among the 10 high-HDI countries. Only Brazil and China had evidence available to grade all the indicators. This suggests that these countries are leading the research development in physical activity in this group and their efforts in surveillance could guide other countries. As described by the Global Observatory of Physical Activity, these are the only middle-income countries in the top 10 of scientific publications in the field.[70] One quarter of the total matrix of indicators could not receive a grade because of insufficient evidence. As observed in the previous versions of the Global Matrix,[21,22] Active Play and Family and Peers remain the indicators where the evidence is lacking for most of the countries. These gaps point out the need for consensus on definitions and measures to assess these indicators. Physical fitness was included in the Global Matrix for the first time, and the absence of data for more than half of the high-HDI countries supports the call to improve fitness surveillance among children and youth worldwide.[63]

Some limitations should be taken into account for this analysis. First, we only included 10 high-HDI countries out of the 55 total countries under this classification, so the representativeness of countries at this level of development is limited. Among these 10 countries, 60% belong to the Americas region, which could also limit the external validity of our results. Second, the sources of data, as well as the quality of the evidence varied widely between countries, which could limit the comparability of data. Third, the variability in sociodemographic variables suggests heterogeneity in this group of countries, which makes difficult to infer clear relationships between physical activity indicators and contextual variables at the group level. Fourth, there are important contextual differences between the countries that HDI might not capture at the moment of this research, such as political and cultural dimensions, as well as disparities that can influence the determinants of physical activity. The absence of these dimensions can compromise the comparability of the overall physical activity scenario for all 10 countries. Fifth, there was a considerable amount of INC grades or missing data, which makes it difficult to rank and compare the indicators among countries. However, this paper also has several strengths. It provides a comprehensive assessment of the physical activity evidence for children and youth from countries experiencing a physical activity transition, compiling the best available national data. The harmonized process to develop the individual report cards that informed the Global Matrix represents an advance in standardization and accountability in physical activity surveillance, as well as an important methodological effort to structure a global vision on physical activity of the young population. Finally, the leadership and commitment from researchers from every country participating, in each of the stages of the project, provide assurance of the inclusion of relevant and accurate information for each country.

Conclusion

This analysis of Global Matrix 3.0 grades shows that high-HDI countries are lagging in both physical activity behaviors and sources of influence indicators. The main challenge for high-HDI countries is to provide opportunities to increase physical activity, in the context of concurrent social and economical changes occurring, appropriate for the stages of development that these countries are experiencing. This analysis identified the main gaps in physical activity surveillance and could guide future initiatives to define indicators and measures in a standardized manner. Filling the research gaps and involving more high-HDI countries in future versions of the Global Matrix may provide a better understanding of the situation of physical activity among children in the context of a physical activity transition.

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