Indicators of Physical Activity Among Children and Youth in 9 Countries With Low to Medium Human Development Indices: A Global Matrix 3.0 Paper

Taru Manyanga, Joel D. Barnes, Chalchisa Abdeta, Ade F. Adeniyi, Jasmin Bhawra, Catherine E. Draper, Tarun R. Katapally, Asaduzzaman Khan, Estelle Lambert, Daga Makaza, Vida K. Nyawornota, Reginald Ocansey, Narayan Subedi, Riaz Uddin, Dawn Tladi, and Mark S. Tremblay

Background: This study compares results of physical activity report cards from 9 countries with low to medium human development indices, participating in the Global Matrix 3.0 initiative. **Methods**: Country-specific report cards were informed by relevant data and government policy documents, reporting on 10 core indicators of physical activity for children and youth. Data were synthesized by report card working groups following a harmonized process. Grade assignments for each indicator utilized a standard grading rubric. Indicators were grouped into one of 2 categories: daily behaviors and settings and sources of influence. Descriptive statistics (average grades) were computed after letter grades were converted into interval variables. Spearman's rank correlation coefficients were calculated for all correlation analyses. **Results**: Mean grades for daily behaviors were higher (C) than those for settings and sources of influence (D+). Twenty-nine out of the possible 90 grades were assigned an incomplete. There were moderate to strong positive and negative relationships between different global indices and overall physical activity, organized sport and physical activity, active play, family, community and environment, and government. **Conclusions**: Findings demonstrate an urgent need for high-quality data at the country level in order to better characterize the physical activity levels of children and youth in countries with low to medium human development indices.

Keywords: active living, policy, daily physical activity behaviors, settings and sources of influence

Evidence from studies conducted mainly in countries with high or very high human development indices (HDIs) show that regular physical activity among children and youth is associated with physical, psychosocial, and cognitive well-being,[1] decreased adiposity,[2,3] improved academic achievement,[1,4] and brain health

and development.[5] Despite these known benefits, a significant proportion of children and adolescents do not accumulate the recommended amount of daily physical activity.[6,7] Rhodes et al[6] reported that 4 out of 5 adolescents between the ages of 11 and 17 did not meet the recommended daily minimum of 60 minutes of moderate- to vigorous-intensity physical activity. Furthermore, both insufficient physical activity and sedentary behaviors[8] among children and youth have been increasing globally.[7,9]

Sedentary behaviors[10–12] and insufficient physical activity[2,3] in children and youth pose a significant public health challenge, because these behaviors are independently associated with non-communicable diseases in adulthood.[13] In addition, insufficient physical activity is currently the fourth leading risk factor for mortality globally.[14] Many countries with low to medium HDIs are undergoing industrialization and economic growth along with rural to urban migration; these factors have led to the unintended consequences of rapid urbanization and densely populated cities. The United Nations estimates that within the next few decades, the largest and fastest growth in urban populations will be in Africa and Asia, places that currently remain mostly rural.[15] High population density in cities, particularly in low-income neighborhoods, often reduces walkability.[16] In addition, urbanization itself,[17] and the accompanying increase in motorized transportation[7] use in densely populated cities,[18] may decrease the amount of daily utilitarian or habitual physical activity.[8]

Promoting physical activity and reducing both insufficient physical activity and sedentary behaviors are important for promoting child health. In the context of the ongoing physical activity transition (the behavioral shift from traditionally active to more industrialized and sedentary lifestyles),[8,14,19,20] global strategies

Manyanga, Barnes, and Tremblay are with Healthy Active Living and Obesity Research Group, Children's Hospital of Eastern Ontario Research Institute, Ottawa, Ontario, Canada. Abdeta is with Hiwot Fana Specialized Haramaya University Hospital, Harar, Ethiopia. Adeniyi is with the College of Medicine, University of Ibadan, Ibadan, Nigeria; and Nigerian Heart Foundation, Ibadan and Lagos, Nigeria. Bhawra is with the School of Public Health and Health Systems, University of Waterloo, Waterloo, Ontario, Canada. Draper is with the University of the Witwatersrand, Johannesburg, South Africa; and the University of Cape Town, Cape Town, South Africa. Katapally is with the Johnson Shoyama Graduate School of Public Policy, University of Regina, Regina, Saskatchewan, Canada; and the Department of Community Health and Epidemiology, College of Medicine, University of Saskatchewan, Saskatoon, Saskatchewan, Canada. Khan and Uddin are with the School of Health and Rehabilitation Sciences, University of Queensland, St Lucia, Queensland, Australia. Lambert is with the University of Cape Town Research Centre for Health through Physical Activity, Lifestyle and Sport, Department of Human Biology, Faculty of Health Sciences, University of Cape Town, Cape Town, South Africa. Makaza is with the National University of Science and Technology, Bulawayo, Zimbabwe. Nyawornota is with the School of Education and Leadership, University of Ghana, Accra, Ghana. Ocansey is with the University of Ghana, Accra, Ghana. Subedi is with Maharajgunj Medical Campus, Institute of Medicine, Tribhuvan University, Maharajgunj, Nepal. Uddin is also with the Department of Pharmacy, Stamford University Bangladesh, Dhaka, Bangladesh. Tladi is with the Department of Physical Education, Health and Recreation, University of Botswana, Gaborone, Botswana. Manyanga (tmanyanga@cheo.on.ca) is corresponding author.

(eg, sustainable development goals[21] and the World Health Organization global action plan on physical activity 2018–2030[22]) that identify specific indicators of progress and global interventions, including strategies for countries at different levels of human development that have unique contexts, cultures, challenges, and opportunities, may be needed to prevent accelerated physical activity transitions.[23]

To better understand and develop global strategies for curbing insufficient physical activity among children and youth, reducing sedentary behaviors, and encouraging more active lifestyles, the Active Healthy Kids Global Alliance (AHKGA: www.active healthykids.org) has advocated for and developed a harmonized approach to data synthesis.[23–25] This initiative facilitates the development of report cards[26] on indicators of child and youth physical activity in countries that participate in the global matrix initiatives.[23,24] However, documented variation in physical activity and other lifestyle behaviors across regions and cultures[23,24] and a lack of data regarding the extent of or levels of inequalities in and determinants of movement behaviors among children and youth[27] in many countries with low to medium HDIs continue to make it challenging to draw meaningful global comparisons or conclusions.

Previous studies[18,28] have reported variations in physical activity and active transportation patterns, respectively, in low-income versus high-income countries, suggesting that there may be a need for distinct strategies and priorities in different regions or countries. As such, strategies that group countries with similar challenges and/or priorities into clusters by common indicators such as the HDI[29] or Gini coefficient[29] (a measure of income distribution within a population and an indicator of income inequality, where 0 represents perfect income equality [ie, everyone has the same income] and 1 corresponds to perfect income inequality [ie, one person has all the income while everyone else has zero income]), may lead to an improved understanding of the extent of insufficient physical activity among children and youth. Ultimately, this knowledge can be applied to develop strategies and leverage policies to increase opportunities for and access to safe and enjoyable physical activity. This knowledge may also help to identify priority areas for research and surveillance of activity behaviors in countries with low to medium HDIs, which could further support pragmatic and context-specific strategies to promote active lifestyles among children and youth. This study combines report card results from 9 self-selected countries with low to medium HDIs that agreed and registered to participate in the Global Matrix 3.0 initiative. The main objective of this study was to compare the synthesized data on 10 physical activity indicators for children and youth from Bangladesh, Botswana, Ethiopia, Ghana, India, Nepal, Nigeria, South Africa, and Zimbabwe.

Methods

The 9 participating countries representing low to medium HDIs identified national experts working in various sectors of physical activity and formed country-specific report card working groups that were responsible for rigorous and transparent data and information gathering. Each participating country was assigned an experienced report card mentor, familiar with that country's context. In addition, participating countries received monthly e-blasts from the AHKGA that detailed steps and timelines of the report card development process throughout the year preceding the official launch of the Global Matrix 3.0.

Strategies to gather data included manual or hand searches, online literature searches, and systematic or narrative reviews to obtain the best available peer-reviewed evidence, reporting on the various indicators of physical activity for children and youth ages 5 to 17. In addition, unpublished research (eg, dissertations and theses, government reports) and policy documents were actively sought and gathered through engagement with local stakeholders. These data and information were aggregated and consolidated into report cards following a harmonized process.[23,24,26]

Ten core indicators for the Global Matrix 3.0 (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) were used to develop each country-specific report card. For the purposes of analyses, 9 indicators (excluding physical fitness) were grouped into 1 of 2 categories: daily behaviors (overall physical activity, organized sport and physical activity, active play, active transportation, and sedentary behaviors) and settings and sources of influence (family and peers, school, community and environment, and government). Grades (A = excellent to F = failing) were assigned to each indicator using a standardized grading rubric and participating countries adhered to the same benchmarks for grade assignment.[25] In cases in which data were insufficient to accurately assign a grade, an incomplete was assigned to that indicator.

Although the quality, quantity, and sources of data varied, the report card working groups in each of the 9 countries followed a similar process of appraising, aggregating, consolidating, and harmonizing the total available evidence, discussing discrepancies and reaching consensus before assigning a grade for each indicator. Assigned grades and justifications were submitted to and audited by the scientific subcommittee of the AHKGA. As an example of how indicators were graded, Table 1 presents the methods, instruments, and sample sizes of the studies used to evaluate the overall physical activity indicator. In addition to an abstract and a poster presented at the launch of the Global Matrix 3.0, participating countries consolidated their results into short-form and long-form report cards and were encouraged to develop and publish country-specific manuscripts based on their findings. Furthermore, participating countries had the latitude to include additional indicator(s) that were specific to their context in their report cards. A companion article[25] published in this issue of *The Journal of Physical Activity and Health* provides a detailed description of the methods used by each of the participating countries. In addition, summary papers for each of the participating countries' report cards[30–38] are included in this issue and provide additional details of data sources.

Descriptive statistics (average grade and SD) were computed after converting categorical variables (letter grades) to interval variables (eg, A+ = 15, A = 14, A− = 13, D = 5, D− = 4, F = 2). Once converted to interval variables, scores for each group of indicators (overall, daily behaviors, settings, and sources of influence) were calculated by summing the relevant interval data. Incomplete grades were removed and the scores were reweighted accordingly. Letter grades (categorical variables) were grouped into 4 levels (A–B, C, D–F, and no grade). The categories were then used to rank countries by letter grade/score and category level in scatter plots. For all correlation analyses among the 10 core indicators and global indices and descriptors (HDI, Gini coefficient, gender inequality, mean years of schooling, public health expenditure,[29] and improved drinking water coverage[39]), Spearman's rank correlation coefficients were calculated. Rule of thumb cutoffs[40,41] were applied to define weak, moderate, and strong correlations. Pairwise deletion was used to treat missing data

Table 1   Methods and Instruments Used to Assess Overall Physical Activity

Country	Method(s)	Instrument used	Age group	Sample size(s)
Bangladesh	Subjective	Self-administered questionnaire—GSHS	13–17	2989
Botswana	Subjective	Literature search, gray literature, and anecdotal information	9–18	N/A
Ethiopia	Subjective	Literature, policy documents, and expert interviews	5–17	N/A
Ghana	Subjective	Literature search, focus group interviews on indicators and benchmarks, policy implementation guidelines, and expert opinions	9–15	N/A
India	Objective	Accelerometer	9–11	1002
	Objective	Accelerometer and self-administered questionnaire	12–17	324
	Subjective	Self-administered questionnaire	6–19	27,972
	Subjective	Interviewer-administered questionnaire	3–15	2734
	Subjective	Interviewer-administered questionnaire	8–21	325
Nepal	Subjective	Questionnaire	15–19	241
Nigeria	Subjective	Researcher-administered semistructured questionnaire	3–18	1760
	Subjective	Self-administered questionnaire—Health Risk Behavior Questionnaire	10–21	348
South Africa	Objective	Accelerometer	9–11	453
	Subjective	Self-administered questionnaire	8–14	7348
	Subjective	Self-administered questionnaire	13–14	239
	Subjective	Self-administered questionnaire	8–12	832
Zimbabwe	Subjective	Self-administered questionnaire	8–16	4402
	Subjective	Self-administered questionnaire-GSHS	13–15	5665
Total sample(s)				56,634

Abbreviations: GSHS, global school-based student health survey; N/A, not available.

(incomplete grades). All statistical analyses were performed using R (version 3.4.1; The R Foundation for Statistical Computing, Vienna, Austria). To extend base R, several packages were loaded, including corrplot,[42] ggplot2,[43] UpSetR,[44] and VIM.[45]

Results

Table 2 presents the sociodemographic information of the 9 countries with low to medium HDIs participating in the Global Matrix 3.0 initiative (6 sub-Saharan African and 3 Asian countries), with HDIs[29] ranging from 0.448 (Ethiopia) to 0.698 (Botswana). These countries represent a combined total population of approximately 1.9 billion, with India accounting for 1.3 billion people.[46] Botswana (4 people/km^2) is the least densely populated of the 9 countries, whereas Bangladesh (1252 people/km^2) is the most densely populated of the 9 countries.[47] The physical activity grades for the 10 core indicators, organized by country in alphabetical order, are presented in Table 3. Active transportation is the only core indicator that was assigned a grade by all 9 countries. Physical fitness, which was not a core indicator for the first 2 Global Matrix initiatives,[20,21] was assigned incomplete grades in all countries except India (grade F). Except for sedentary behaviors (grade range A− to F) and family and peers (grade range A to F), there was a relatively narrow spread in grades for all the indicators (overall physical activity C+ to D, organized sport and physical activity B to D, active play B to D−, active transportation A− to C, school C to D−, community and environment C− to F, and government B to D) across the 9 countries.

Grade counts, number of incomplete grades, and mean letter grades for each core indicator are presented in Table 4. In general, the mean grades for daily behaviors were higher (C) than the mean grades for settings and sources of influence (D+), and the overall mean grade for all indicators was a C−. Active transportation and

sedentary behaviors had the highest mean grade (C+), while physical fitness had the lowest (F). Figure 1 provides a comparison of the frequency of letter grades for daily behaviors versus the settings and sources of influence for the 9 countries. The results show that letter grade C (19.8%) was the most frequent for daily behaviors, while INC (13.6%), closely followed by C and D (12.3%), were the most frequent grades for settings and sources of influence. Twenty-nine (32.2%) of the possible 90 grades were assigned as incomplete. A matrix-based plot of incomplete grades is shown in Figure 2. Ethiopia had only 1 incomplete grade; the other 8 countries had at least 2 or more incomplete grades. Three countries (Bangladesh, Botswana, and Nepal) had at least 5 incomplete grades each. Organized sport and physical activity, physical fitness, and family and peers were graded incomplete in at least 4 countries.

Table 5 presents results of the correlation analyses among the core indicators and some key global indices and descriptors for economic development and health. The findings show mostly weak negative and positive relationships among the global indices (HDI, Gini coefficient, improved drinking water coverage, gender inequality index, public health expenditure, and mean years of schooling) and active transportation, sedentary behaviors, and the school indicators. There were moderate to strong[40,41] relationships among global indices with overall physical activity, organized sport and physical activity, active play, family, community and environment, and government. The Gini coefficient[29] had a statistically significant positive (0.70) and negative (−0.83) relationship with overall physical activity and active play, respectively. Public health expenditure[29] had a statistically significant negative (−0.87) relationship with the community and environment indicator. Mean years of schooling[29] had statistically significant positive (0.71) and negative (−0.83) relationships with overall physical activity and active play, respectively. Country-specific infant mortality rate[48] had a statistically significant negative relationship with sedentary

Table 2 Sociodemographic Information of Countries With Low to Medium HDIs in the Global Matrix 3.0

Country	HDI	Life expectancy at birth	Infant mortality rate	Under 5 mortality rate	Expected years of schooling	Mean years of schooling	GNI per capita	Public health expenditure, % of GDP	Improved drinking water coverage, %	GII	Gini coefficient, %	Urban population, %	Population	Population density (no. of people/km²)
Bangladesh	0.579	72	29.7	36.3	10.2	5.2	3341	3.7	81	0.52	32.1	34.28	161,669,751	1252
Botswana	0.698	71.7	33.9	42.1	11.8	11.9	14,663	5.1	96	435	60.5	57.44	2,291,661	4
Ethiopia	0.448	64.6	42.6	61.3	8.4	2.6	1523	4.7	44	0.499	33.2	19.47	104,957,438	102
Ghana	0.579	61.5	36.2	61	11.5	6.9	3839	4.8	86	0.547	42.8	54.04	28,833,629	124
India	0.624	68.3	42.4	45.2	11.7	6.3	5663	3.9	92	0.53	35.2	32.75	1,339,180,127	445
Nepal	0.558	70.25	29.6	36.1	12.2	4.1	2337	5.4	89	0.497	32.8	18.62	29,304,998	202
Nigeria	0.527	53.1	69.0	108	10	6	5443	5.3	58	N/A	43	47.78	190,886,311	204
South Africa	0.666	57.7	35.5	44.1	13	10.3	12,087	8.5	91	0.394	63.4	64.8	56,717,156	46
Zimbabwe	0.516	59.2	42	59.9	10.3	7.7	1588	N/A	80	0.54	43.2	32.28	16,529,904	42

Abbreviations: GDP, gross domestic product; GII, gender inequality index; GNI, gross national income; HDI, human development index; N/A, not available.

Table 3 Report Card Grades for Countries With Low to Medium HDIs: Global Matrix 3.0

Country	Overall physical activity	Organized sport and physical activity	Active play	Active transportation	Sedentary behaviors	Physical fitness	Family and peers	School	Community and environment	Government
Bangladesh	C–	INC	INC	C–	A–	INC	INC	INC	INC	C–
Botswana	INC	INC	D–	C	B–	INC	INC	C–	INC	C
Ethiopia	D	C	B	C	F	INC	F	D	F	D
Ghana	C	C+	B–	C+	INC	INC	F	D	D+	D
India	D	INC	C–	B–	C–	F	D	INC	D	D
Nepal	D+	INC	INC	A–	B+	INC	A	INC	C–	INC
Nigeria	C	C–	C	B	B–	INC	INC	C–	INC	B
South Africa	C	D	INC	C	INC	INC	C–	D–	C–	C
Zimbabwe	C+	B	D+	A–	B	INC	INC	C	D	C–

Abbreviations: HDIs, human development indices; INC, incomplete grade.

Table 4   Grade Counts and Mean Letter Grades for Core Indicators

Core indicator	Grade count	Incomplete grades	Mean number grade	SD	Mean letter grade
Overall physical activity	8	1	7	1.5	C−
Organized sport and physical activity	5	4	8	2.2	C
Active play	6	3	7.7	2.6	C−
Active transportation	9	0	9.7	2.2	C+
Sedentary behaviors	7	2	9.3	3.7	C+
Physical fitness	1	8	2	NA	F
Family and peers	5	4	6	4.9	D+
School	6	3	6	1.5	D+
Community and environment	6	3	5.3	1.9	D
Government	8	1	7	2.1	C−
Behavioral indicators	9	0	8.3	1.3	C
Setting and sources of influence indicators	9	0	6.7	2.1	D+
All indicators	9	0	7.6	1.6	C−

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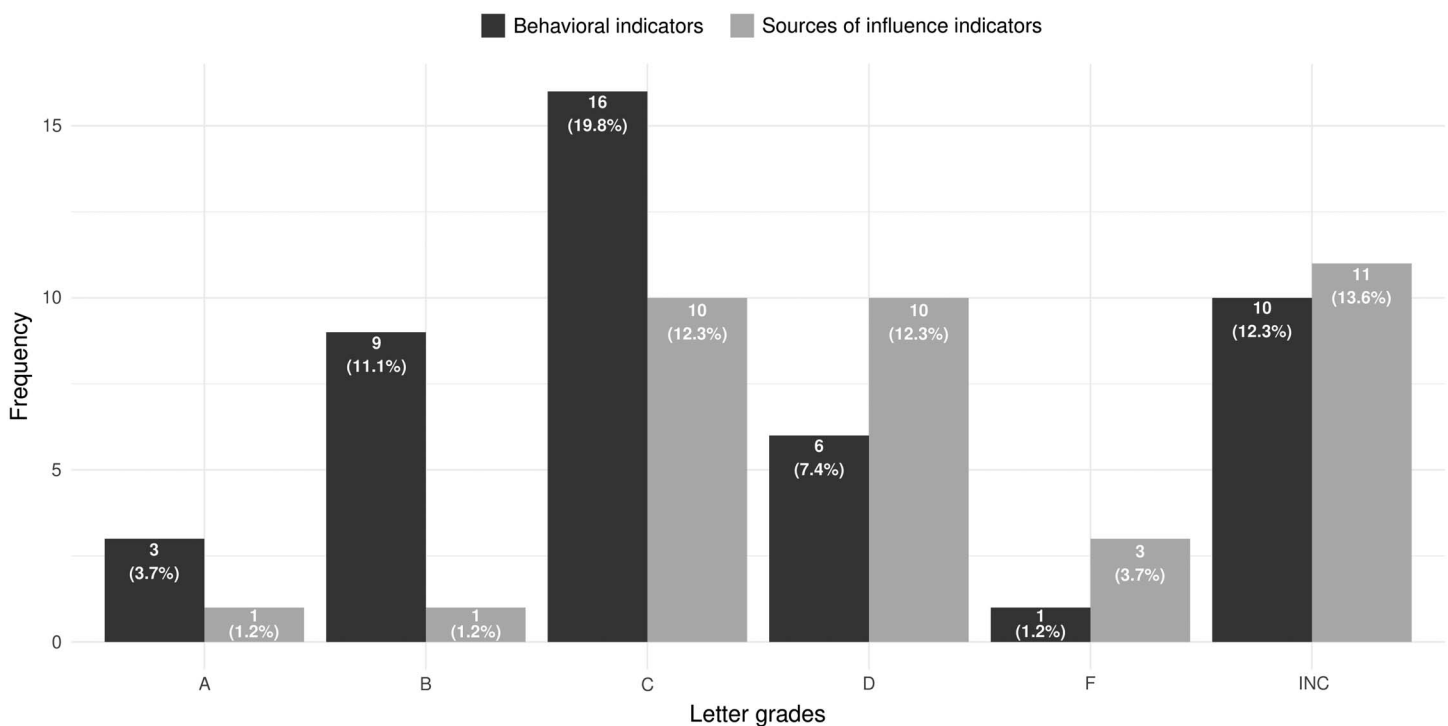

Figure 1 — Frequency of each letter grade for behavioral and settings and sources of influence indicators. INC indicates incomplete grade.

behavior (−0.85). Similarly, the under-five mortality rate[48] had a statistically significant negative relationship with the family and peers indicator (−0.97).

Discussion

Findings from this study provide a broad examination of grades assigned to 10 indicators of physical activity among children and youth from 9 countries with low to medium HDIs that participated in the Global Matrix 3.0 initiative.[25] Although significant effort was made to standardize and gather the best country-specific data, our findings are limited to the overall quality of data and the number of indicators that were examined and assigned grades. As such, caution is needed in interpreting these results. Although the 9 countries included in this study are spread across Africa and Asia, with diverse cultural and geographical contexts within and between them, the narrow spread and similar clustering of grades for most indicators (Table 3) suggest that these countries have comparable challenges, such as a surge in inactive lifestyles among children and youth. The findings point toward a need for increased
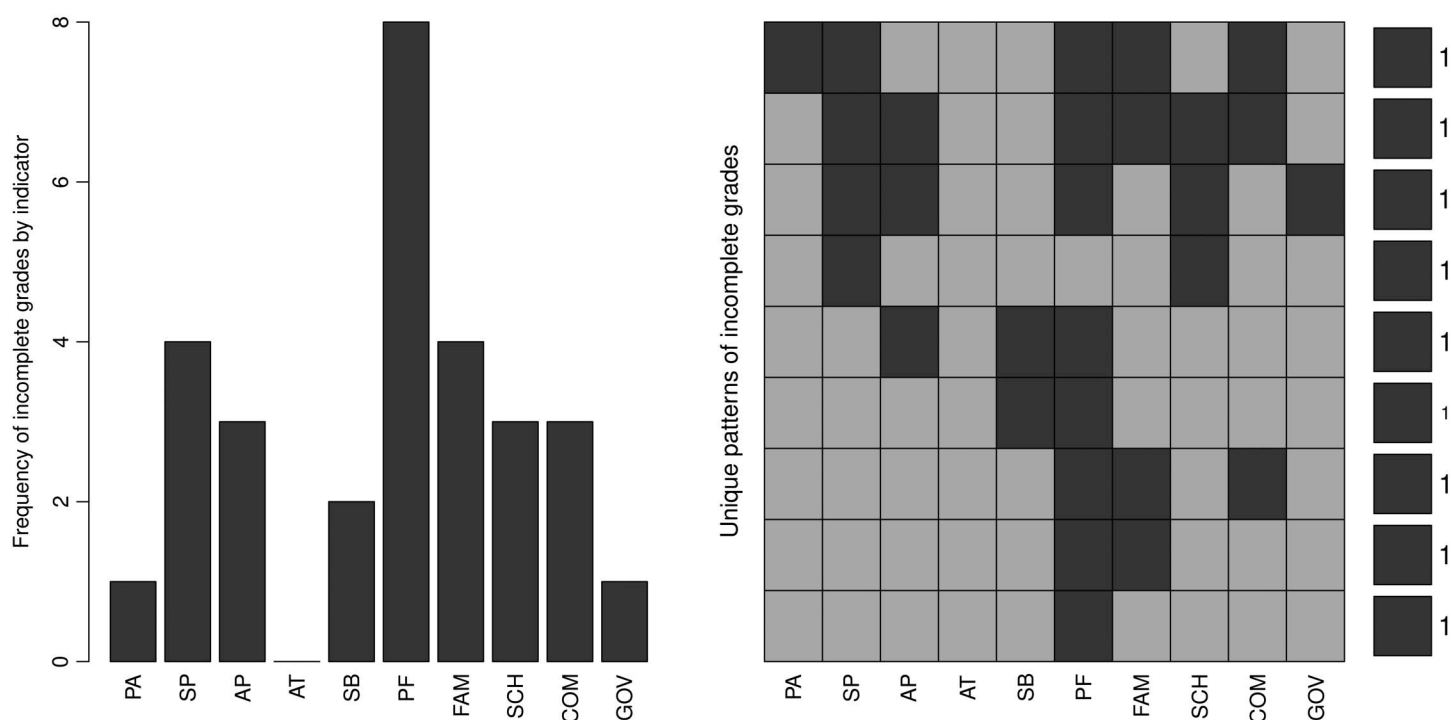
Figure 2 — Matrix-based plot of incomplete grades. Note: In the plot to the right of the figure, dark gray cells represent missing grades. AP indicates active play; AT, active transportation; COM, community and environment; FAM, family and peers; GOV, government; PA, physical activity; PF, physical fitness; SB, sedentary behaviors; SCH, school; SP, organized sport and physical activity.

Table 5   Correlation Matrix (Spearman's Rank Correlation Coefficients) of Mean Physical Activity Grades by Global Indices and Descriptors

Sociodemographic index/descriptor	Core indicators								
	PA	**SP**	**AP**	**AT**	**SB**	**FAM**	**SCH**	**COM**	**GOV**
Human development index[29]	−0.02	−0.5	−0.6	−0.41	0.18	0.31	−0.21	0.62	0.29
Gini coefficient[29]	**0.70**	−0.3	**−0.83**	0.06	−0.36	0.21	0	0.18	0.62
Improved drinking water coverage[39]	−0.16	−0.2	−0.71	−0.11	0.20	0.56	−0.12	0.53	0.06
Gender inequality index[29]	0.29	0.8	0.3	0.37	0.03	−0.72	0.41	−0.44	−0.66
Public health expenditure[29]	0.51	−0.8	−0.2	0.41	0.06	0.56	−0.11	**0.87**	0.67
Mean years of schooling[29]	**0.71**	−0.1	**−0.83**	−0.06	0.02	0.15	0.09	0.44	0.38
Infant mortality rate[48]	−0.03	−0.3	0.54	−0.14	**−0.85**	−0.21	−0.59	−0.26	−0.29
Under 5 mortality rate[48]	0.18	0	0.77	0.16	−0.65	**−0.97**	0.02	−0.79	−0.11
Urban population[49]	0.49	−0.5	−0.43	−0.48	−0.02	−0.21	−0.41	0.26	0.56

Abbreviations: AP, active play; AT, active transportation; COM, community and environment; FAM, family and peers; GOV, government; PA, physical activity; SB, sedentary behaviors; SCH, school; SP, organized sport and physical activity. Note: Correlation coefficients in bold show statistically significant ($P < .05$) moderate to very strong[40,41] (negative or positive) relationships between a specific indicator and an index/descriptor. Physical fitness was removed from this analysis due to a majority (8/9) of incomplete grades. Pairwise deletion was used to treat missing data.

knowledge exchange and collaboration between countries to develop common goals and strategies to address insufficient physical activity and increased sedentary behaviors among children and youth. This observation is in line with a recommendation made in the Lancet physical activity series[50] to promote capacity building, workforce training, and intersectoral approaches for physical activity research.

Active transportation was the only indicator assigned a grade by all 9 countries. In resource-limited countries, focusing on the promotion and preservation of behaviors such as active transportation may be the most practical and achievable means to

improve physical activity among children and youth. In most of the participating countries, active transportation is still a necessary part of life for most children and youth. The argument for promoting active transportation is supported by the observation that, in general, grades for daily physical activity behaviors were higher than those for settings and sources of influence. Promoting the benefits of active transportation should be weighed against the unintended safety risks of potential harm to pedestrians and cyclists, especially in less walkable urban areas.[7] Although strong and well-designed settings and sources of influence may be preferred, especially given their reported influence on children's participation

in physical activity,[51] the lack of resources, political will,[52] as well as competing priorities, are a reality that cannot be easily addressed in most countries with low-to-medium HDIs. Moreover, having strong and supportive settings and sources of influence does not guarantee increased physical activity participation, as demonstrated by results from the Global Matrix 2.0,[23] which showed lower levels of overall physical activity among children and youth from countries such as Belgium,[53] Sweden,[54] and Denmark,[55] which have very supportive infrastructure.

Findings from the analyses of this study also demonstrate a dearth of data in the participating countries, which has been previously reported[7,56] for most of the indicators, and we present results that are mainly descriptive and correlational; thus, interpretations need to be made with caution. The information in Table 1 presents the common, objective data limitations that are unique to most countries with low to medium HDIs.[1,27] Except for South Africa and India (2 medium HDI countries with some accelerometer data), the other 7 countries relied on subjective data and/or expert opinions to evaluate overall physical activity. Such reliance on subjective data, which are known to be prone to recall and other biases,[57] may impact the accuracy of the reported results. Furthermore, over one-third of the indicators could not be assigned grades due to the unavailability or insufficiency of relevant data. Such data gaps and the preponderant reliance on subjective measures demands urgent action to invest in objective research in countries with low to medium HDIs.[27] This would be a critical step in providing empirical evidence in order to facilitate not only consistent global comparisons and accurate trends over time but also to inform evidence-based policies. The need to prioritize and strengthen systematic surveillance of the core indicators of physical activity among children and youth in countries with low to medium HDIs is further demonstrated by the fact that 8 out of the 9 participating countries could not assign a grade for physical fitness, a simple and cost-effective assessment,[58] due to lack of data.

Accurately interpreting the findings from the present correlation analyses is challenging because of the potential influence of many mechanisms and/or factors that may confound the relationships. A study[59] among American adults found that state-level income inequality was associated with increased risk of sedentary behavior. Whether or not these findings are generalizable to other countries with low to medium HDIs requires further investigation. Mechanisms through which income inequality may affect overall physical activity or sedentary behavior include its relationship with depression,[60,61] which in turn is reportedly associated with decreased participation in physical activity[60] and increased sedentary behavior among adolescents[62,63] and adults.[59] Income inequality has also been found to be associated with depressive symptoms among adolescent girls.[64] Similar to the Global Matrix 2.0 findings,[23] a recent study[65] found that an increased Gini coefficient was associated with decreased participation in physical activity. Another study of 76 countries[20] showed a positive association between physical inactivity and HDI (ie, countries' physical inactivity increased in tandem with an increasing HDI). Contrary to Dumith et al's[20] findings, a study of 47 countries (mostly low-middle-income countries),[66] reported an inverse relationship between HDI and physical inactivity, indicating that as human development increased, physical inactivity decreased. Findings from this study show a negligible (–0.02) relationship between HDI and grades for overall physical activity, suggesting that there is no relationship between the two. The negligible relationship found in this study may be due to the narrow variance in the HDIs of the participating countries, deliberately selected to create a more homogenous sample. These conflicting results may also be due to differences in the composition of samples, highlighting the possible need to further explore these relationships using larger and more diverse samples of countries.

The significantly positive relationships between grades for overall physical activity and the Gini coefficient, overall physical activity and mean years of schooling, and community and environment with public health expenditure, and the significantly negative relationships between active play and Gini coefficient, and active play and mean years of schooling need to be interpreted with caution. First, the sample of countries included in this study (n = 9) is very small. Second, missing data were treated using pairwise deletion under the missing at random assumption. Third, data to compute the Gini coefficient, the mean years of schooling, and public health expenditure,[29] were from 2016, while country-specific data and evidence used to assign grades may have been obtained from different years. Fourth, the present correlation analyses did not account for potential confounders. Furthermore, the quality, sources, and quantity of the data informing the grades varied from country to country. Active play among children and youth can be culture and context specific; given the inevitable cultural and contextual variability among the included countries, the significant correlational results should be interpreted with caution. In addition, given the reported relationships between income inequality and sedentary behavior[59] and physical activity,[65] the negligible to weak relationships observed among sedentary behaviors and the indices and descriptors may be spurious. Alternatively, these findings may suggest that recreational screen time is low in countries with low to medium HDIs, or that the weak relationships observed may be emblematic of the weaknesses in the measurement of sedentary behaviors.

Some studies from high-income countries have reported inverse relationships between income inequality and general health,[67,68] physical activity,[69] and leisure-time physical activities.[70] Furthermore, Tomkinson et al[71] reported a strong inverse relationship between cardiorespiratory fitness and the Gini coefficient in 18 mostly high-income countries. However, care should be taken not to overgeneralize based on these findings given the need for research to determine if such results can replicated using samples from countries with low-medium HDIs. The strong positive relationship between the Gini coefficient and overall physical activity in the present analyses is in contrast to findings by Elgar et al[69] and the Global Matrix 2.0,[23] which showed negative relationships between these two, indicating that higher national income inequality is related to less physical activity among adolescents. The explanation for these differences may lie in differences in measurement methodologies or contexts. Alternatively, our findings may be subject to the ecological fallacy (ie, we cannot attribute findings observed at the population level to an individual).[20] However, our findings might also reflect the substantial needs-based physical activity[72] (eg, household chores, farming, and active transportation) among the low-income families who are the majority in countries with low to medium HDIs; in such environments, opportunities for active play may be few, deemed a luxury, and may possibly be unsafe.

Higher grades for daily behaviors for countries with low to medium HDIs participating in the Global Matrix 3.0 is comparable with results for low- to medium-income countries[73–78] that participated in the 2016 Global Matrix 2.0 initiative.[23] These findings demonstrate that, although there may be ongoing physical activity transitions[8,19] in countries with low to medium HDIs, there may still be an opportunity to reduce the transition acceleration. To this

end, it may be reasonable to employ the common global[79,80] and/or regional[81] strategies that have been proposed and other recommendations,[50,56] including those for improving grades from initiatives such as the Global Matrix,[23–25] in the fight against insufficient physical activity among children and youth. Perhaps it is time to capitalize on the momentum created by such a collective search for practical and realistic solutions. Therefore, investing resources in initiatives such as the Global Matrix[23,24] and the recent push for 24-hour movement guidelines for the early years,[82,83] including those currently being developed by the World Health Organization, the United Kingdom, and South Africa,[27] should be vigorously pursued. For example, organizations such as the African Physical Activity Network[81] and the AHKGA, must be empowered to act either as conduits or as the primary drivers of collaborative efforts among academics, researchers, and policymakers in their respective regions.

Strengths and Limitations

The strengths of this study include providing the most comprehensive assessment of physical activity levels among children and youth in the 9 participating countries with low to medium HDIs. Grade assignments for the core indicators were informed by the best available data from each of the participating countries, gathered and synthesized using a transparent and harmonized approach. The Global Matrix 3.0 initiative and the development of this study provided an opportunity for cross-fertilization of ideas from academics, researchers, and policymakers alike, and the possibility to generate common strategies to address the insufficient physical activity epidemic among children and youth in countries with low to medium HDIs. However, there are some key limitations that are important to mention. The quality and quantity of data varied significantly across the countries. Due to insufficient data, many indicators could not be assigned grades, which limits the comparisons and inferences that can be made. The composition and expertise of the country-specific report card working groups varied. This study only includes data from 9 countries with low to medium HDIs, and as such, may not be representative of all other countries with similar challenges and opportunities.

Conclusions

This study provides a comprehensive assessment of physical activity and related behaviors among children and youth and the settings and sources of influence in 9 countries with low to medium HDIs participating in the Global Matrix 3.0 initiative. The study provides clear evidence that there is a need for high quality, nationally representative data at the country and regional level in order to better understand the levels of physical activity in countries with low to medium HDIs. Findings from the present analyses show that most of the 9 participating countries had higher grades for behavioral indicators despite having lower grades for indicators of settings and sources of influence, suggesting that favorable community environments may not be the only driver of increased physical activity levels. Findings also show that, in general, levels of physical activity among children and youth in the 9 countries with low to medium HDIs are lower than desired. The lack of objective data and the overall low quality of the data among the participating countries presents collaborative research opportunities for the AHKGA and other organizations to develop strategies to collectively address the existing data gaps.

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