

1 **Global Matrix 3.0 Physical Activity Report Card Grades for Children and Youth: Results and**

2 **Analysis from 49 Countries**

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4 **Original Research**

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6 **Three to five key words**

7 Global comparison; sedentary behavior; health promotion; international; sport; active transportation

8 **Abstract word count:** 196 words

9 **Manuscript word count:** 11,534

10 **Date of manuscript submission:** 27/08/2018

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23 **Abstract**

24 **Background**

25 Accumulating sufficient moderate to vigorous physical activity (MVPA) is recognised as a key  
26 determinant of physical, physiological, developmental, mental, cognitive, and social health among  
27 children and youth (5-17 years). The Global Matrix 3.0 of Report Card grades on physical activity was  
28 developed to achieve a better understanding of the global variation in child and youth physical activity  
29 and associated supports.

30 **Methods**

31 Work Groups from 49 countries followed harmonized procedures to develop their Report Cards by  
32 grading 10 common indicators using the best available data. The participating countries were divided into  
33 three categories using the United Nations' Human Development Index (HDI) classification (low or  
34 medium, high, and very high HDI).

35 **Results**

36 A total of 490 grades, including 369 letter grades and 121 "INC" grades, were assigned by the 49 Work  
37 Groups. Overall, an average grade of "C-", "D+", and "C-" was obtained for the low and medium HDI  
38 countries, high HDI countries, and very high HDI countries, respectively.

39 **Conclusions**

40 The present study provides rich new evidence showing that the situation regarding the physical activity of  
41 children and youth is a concern worldwide. Strategic public investments to implement effective  
42 interventions to increase physical activity opportunities are needed.

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196 **Introduction**

197 Physical inactivity, defined as engaging in insufficient levels of physical activity and not meeting the  
198 current physical activity recommendations,<sup>1</sup> has been identified as the fourth leading risk factor of  
199 premature mortality in adulthood.<sup>2</sup> In contrast, accumulating sufficient moderate to vigorous physical  
200 activity (MVPA) is recognised as a key determinant of physical, mental, social and environmental  
201 health.<sup>3,4</sup> Among children and youth (5-17 years), several systematic reviews have reported physical  
202 activity benefits on physical, physiological, developmental, mental, cognitive, and social health as well as  
203 academic achievement.<sup>5-10</sup> Despite these benefits, it has been estimated that 80% of youth (11-17 years  
204 old) worldwide do not reach the minimum recommendation of 60 minutes of MVPA per day.<sup>11</sup> This is  
205 alarming given that physical inactivity among school-aged children and youth has been found to be  
206 associated with adverse physical, mental, social and cognitive health outcomes<sup>5,8,12,13</sup>, lower physical  
207 fitness,<sup>14</sup> and lower physical activity levels in later life.<sup>15</sup>

208

209 To achieve a better understanding of the global variation in child and youth physical activity and its  
210 correlates, the Global Matrix of Report Card grades on physical activity was launched for the first time in  
211 2014.<sup>16</sup> Physical activity Report Cards were developed based on the Canadian Report Card model,<sup>17</sup>  
212 using a harmonized process for data gathering, assessing, and assigning grades to indicators. For over a  
213 decade, the Canadian Report Card has been successful in raising awareness and influencing policies for  
214 childhood physical activity promotion. However these efforts have not yet translated into improving the  
215 physical activity levels of Canadian children and youth.<sup>18</sup> Fifteen countries in 2014 (Global Matrix 1.0),  
216 and 38 countries in 2016 (Global Matrix 2.0), developed and launched Report Cards presenting grades for  
217 nine physical activity indicators, allowing for international comparisons and offering insights from global  
218 data.<sup>16,19</sup> The first two Global Matrices enabled the identification of several gaps in surveillance and  
219 research practice. Also, a paradox of higher physical activity and lower sedentary behavior in countries

220 reporting poorer infrastructure, and lower physical activity and higher sedentary behavior in countries  
221 reporting better infrastructure was highlighted.<sup>16,19</sup> While participation in the Global Matrices 1.0 and 2.0  
222 facilitated capacity building, professional networking, research collaborations, and international  
223 comparisons, the Global Matrix framework still needs to be continuously expanded, improved, replicated  
224 and widely disseminated.<sup>19</sup>

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226 The Global Matrix initiative is led by the Active Healthy Kids Global Alliance (AHKGA), which is an  
227 incorporated not-for-profit organization consisting of researchers, health professionals and stakeholders  
228 who collaborate to advance physical activity in children and youth from around the world.<sup>20</sup> In 2017, the  
229 AHKGA invited previous participating countries and called for new countries to register for the Global  
230 Matrix 3.0. As a result, work groups from 49 countries completed the full registration process and  
231 followed the harmonized procedures to develop their Report Cards by grading 10 common indicators  
232 (Overall Physical Activity, Organized Sport and Physical Activity, Active Play, Active Transportation,  
233 Sedentary Behaviors, Physical Fitness, Family and Peers, School, Community and Environment, and  
234 Government) using the best available data.

235

236 Countries in different development stages may have different challenges and priorities to inform  
237 strategies to improve physical activity among children and youth. Countries involved in the Global Matrix  
238 3.0 were classified within three categories using the Human Development Index (HDI): low and medium  
239 HDI ( $<0.70$ ), high HDI ( $\geq 0.70$  to  $<0.80$ ), and very high HDI ( $\geq 0.80$ ). The HDI, ranging from zero to one,  
240 is a composite index calculated using data on education, life expectancy, and income per capita,<sup>21</sup> and was  
241 created by the United Nations Development Programme to rank countries on a scale of human  
242 development conceptualized in terms of capabilities of humans within the countries to function.<sup>22</sup> Nine of  
243 the participating countries were classified as low or medium HDI (Bangladesh, Botswana, Ethiopia,

244 Ghana, India, Nepal, Nigeria, South Africa, and Zimbabwe), 10 as high HDI (Brazil, Bulgaria, China,  
245 Colombia, Ecuador, Lebanon, Mexico, Thailand, Uruguay, and Venezuela), and 30 countries and  
246 territories as very high HDI (Australia, Belgium [Flanders], Canada, Chile, Chinese Taipei [Taiwan],  
247 Czech Republic, Denmark, England, Estonia, Finland, France, Germany, Guernsey, Hong Kong, Japan,  
248 Jersey, Lithuania, Netherlands, New Zealand, Poland, Portugal, Qatar, Scotland, Slovenia, South Korea,  
249 Spain, Sweden, United Arab Emirates, United States, and Wales).

250 This special issue of the *Journal of Physical Activity and Health* includes 49 extended abstracts  
251 documenting the main Report Card findings from each participating country. A manuscript presenting the  
252 international impact of the Report Cards and the Global Matrices on the international scientific  
253 community, on raising awareness among general population and stakeholders, and on powering the  
254 movement to get kids moving closes this special issue.<sup>23</sup> In addition, three papers were developed to  
255 present and discuss results from the Report Cards by pre-determined HDI categories as follows:

- 256 - “The Indicators of Physical Activity among Children and Youth in Nine Countries with Low and  
257 Medium Human Development Indices: A Global Matrix 3.0 Paper”;<sup>24</sup>
- 258 - “Report Card Grades on the Physical Activity of Children and Youth from 10 Countries with  
259 High Human Development Index – Global Matrix 3.0”;<sup>25</sup>
- 260 - “Report Card Grades on the Physical Activity of Children and Youth Comparing 30 Very High  
261 Human Development Index Countries”.<sup>26</sup>

262 The aim of this integrated article is to combine and compare the findings from each of the HDI (low and  
263 medium; high; and very high) papers and present, compare, and discuss further analyses of the results  
264 from the 49 countries participating in the Global Matrix 3.0.

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266

267 **Methods**

268 *Creating the Global Matrix 3.0*

269 In April 2017, the AHKGA invited interested countries to participate in, and register for the Global  
270 Matrix 3.0 through an open call that was distributed via established networks. Between April 2017 and  
271 January 2018, 49 countries from six different continents (Africa, Asia, Europe, North America, Oceania,  
272 and South America) registered and paid a registration fee based on their HDI classification to cover costs  
273 associated with the Global Matrix 3.0 initiative. Three different tiers of registration fees (\$500 USD for  
274 the low HDI countries, \$750 USD for the medium HDI countries, \$1,000 USD for the high HDI  
275 countries, and \$1,500 USD for the very high HDI countries) were offered to encourage equitable  
276 participation from around the world. Individuals who registered on behalf of their country were  
277 responsible for leading the effort to form a multidisciplinary Report Card work group of national physical  
278 activity experts and stakeholders. Furthermore, one to three Report Card leaders/co-leaders per country  
279 were designated officially to manage the national Report Card development, and to ensure effective  
280 communication between the AHKGA Executive Committee and the Report Card work group.

281

282 A mentoring system was developed for the Global Matrix 3.0. New Report Card leaders and teams were  
283 paired with an experienced Report Card leader from a country who participated in the Global Matrix 2.0.  
284 In addition, six members of the Executive Committee of AHKGA were assigned to be regional mentors  
285 for each involved continent to provide help and guidance to the countries when needed and report their  
286 progress to the AHKGA Executive Committee. Finally, the AHKGA Executive Committee served as the  
287 coordinating center of the Global Matrix development, and provided information including background  
288 papers, previous Report Cards and Report Card papers, fundraising suggestions, and a theoretical  
289 framework to support the preparation of grant proposals, scholarship and funding applications. The

290 AHKGA Executive Committee also provided guidance through monthly e-blasts by sharing milestones,  
291 and upcoming deadlines.

292

### 293 *Harmonised Report Card Development*

294 An updated list of indicators (to which grades would be assigned) and corresponding benchmarks were  
295 created based on the previous Global Matrix methods,<sup>19</sup> and feedback received during a workshop after  
296 the Global Matrix 2.0 launch in Bangkok, Thailand (November, 2016). A new indicator, Physical Fitness,  
297 and its corresponding benchmarks were added to the list. The benchmark for Overall Physical Activity  
298 was modified in accordance with the new Canadian 24-Hour Movement Guidelines for Children and  
299 Youth,<sup>27</sup> where “at least 60 minutes of MVPA per day” was changed to “at least 60 minutes of MVPA per  
300 day *on average*”. Further modifications to the benchmarks were made during the development of the  
301 Global Matrix 3.0 to address several issues that were reported by Report Card leaders to the AHKGA  
302 Executive Committee. The final version of the benchmarks for the 10 indicators is presented in Table 1. A  
303 more detailed grading scheme using positive (+) and negative (-) mathematical symbols, was also  
304 developed (Table 2). In some countries, because of the modifications of the benchmarks from previous  
305 Global Matrices, grades for some indicators have changed while in fact, the situation was relatively the  
306 same. Consequently, while the Report Card work groups reported grades based on the revised  
307 benchmarks for the Global Matrix 3.0, some countries reported different grades in their national Report  
308 Grades (i.e., to be consistent with their previous methods). For example, in Colombia, with the new  
309 benchmark, a “D+” was assigned to Overall Physical Activity for the Global Matrix 3.0, while a “D-” is  
310 reported in the Colombian country Report Card, based on the previous benchmark.<sup>28</sup>

311

312 Each country work group identified and complemented the list of indicators to be graded (i.e., the 10  
313 common indicators and potentially additional ones that would be included in their national Report Card

314 but not in the Global Matrix 3.0) and gathered the highest quality of published and unpublished evidence,  
315 or in some cases collected data prospectively. Due to the lack of data concerning physical activity among  
316 children in the early years (0 - 4 years) observed in the previous Global Matrices, consensus was reached  
317 among the AHKGA Executive Committee that the 10 indicator grades should only be informed by data  
318 from school-aged children and youth (~5-17 years-old) for the Global Matrix 3.0 to ensure consistency  
319 across countries. Where possible, countries were also advised to consider and synthesize the best  
320 available evidence from approximately the past five years for each indicator. Through a harmonized and  
321 transparent Report Card development process, each country's work group collected and collated the best  
322 available evidence from local, national or international studies, national surveys, official reports, and  
323 normative documents, and then synthesized findings and reached consensus for the grading of each  
324 indicator. A draft of each country Report Card grades were submitted along with their rationale by Report  
325 Card leaders and were audited by members of the AHKGA Executive Committee to ensure that the  
326 grades were consistent with the harmonized benchmarks and grading scheme. This audit process led to  
327 minor changes of the grades or rationale for most of the countries.

328

329 *Data Analysis*

330 For analysis purposes, the 49 participating countries and regions were divided into three categories using  
331 the United Nations' HDI classification (low or medium, high, and very high HDI) described above.  
332 Sociodemographic data that are available online were compiled to identify the characteristics of the  
333 participating countries. Descriptive statistics (average grade and standard deviation) were calculated after  
334 converting categorical variables (letter grades) to interval variables (see corresponding numbers in Table  
335 2), and the incomplete grades (INC) were converted into "No Grade" which was treated as a missing  
336 value. Averages were calculated by country, indicator, and category of HDI from the interval values and  
337 the floor (the number rounded down) was converted back to a letter grade. Three scores were generated

338 for the analysis: 1) Overall score computed as the sum of interval values for all indicators, 2) Behavioral  
339 score (the sum of Overall Physical Activity, Organized Sport and Physical Activity, Active Play, Active  
340 Transportation, and Sedentary Behaviors interval values), and 3) Sources of influence score (the sum of  
341 Family and Peers, School, Community and Environment, and Government interval values). “INC” grades  
342 were removed, and the scores were re-weighted accordingly (i.e., the missing grade was replaced by the  
343 sum of the interval values divided by the number of letter grades included in the score). Categorical  
344 variables (letter grades) were grouped into four (“A-B”, “C”, “D-F”, and “No Grade”) based on the  
345 overall score. These categories were then used to rank countries by the letter grade/score and category  
346 level in scatter plots. Correlational analyses between the 10 common indicators and sociodemographic  
347 indicators were performed using Spearman's rank correlation coefficients. Only significant moderate to  
348 strong correlations were considered for the discussion in this analysis ( $r \geq 0.30$  or  $r \leq -0.30$ ,  $p < 0.05$ ).<sup>29</sup>  
349 Pairwise deletion was used to treat missing data (INC grades) in order to minimize the number of cases  
350 excluded from the analysis. All statistical analyses were performed, and maps were created in R version  
351 3.4.1 (The R Foundation for Statistical Computing, Vienna, Austria). Several packages were loaded to  
352 extend base R including corrplot,<sup>30</sup> ggplot2,<sup>31</sup> UpSetR,<sup>32</sup> and VIM.<sup>33</sup>

353

## 354 **Results**

355 A total of 52 countries responded to the AHKGA and showed interest in participation in the Global  
356 Matrix 3.0, but only 51 fully registered on time, and later on two countries withdrew. Sociodemographic  
357 characteristics of the 49 countries participating in the Global Matrix 3.0 are presented in Table 3. The  
358 HDI scores ranged from 0.448 (Ethiopia) to 0.985 (Jersey). Ethiopia also scored the lowest for the  
359 following: Growth National Income per Capita (\$1,523 USD), mean years of schooling (2.6 years),  
360 Global Food Security Index (33.3), urban population percentage (17.2%), and prevalence of people using  
361 improved drinking water sources (44%). Qatar scored highest in the Growth National Income per Capita



362 (\$129,916 USD) and the Gender Inequality Index (0.542). Public health expenditure in percentage of  
363 Growth Domestic Product was the highest in Sweden (10.0%) and the lowest in Venezuela (1.5%). Life  
364 expectancy at birth ranged from 53.1 years in Nigeria to 84.2 years in Hong Kong. Hong Kong also had  
365 the highest urban population percentage (100%) and the highest population density (6,987 people/km<sup>2</sup> of  
366 land area). The lowest Gini index (least income inequality) was observed in Slovenia (25.4) and the  
367 highest (greatest income inequality) in Botswana (60.5).

368

369 The physical activity grades for the 10 common indicators are organized by country in alphabetical order  
370 (Table 4). A total of 490 grades, including 369 letter grades and 121 “INC” grades, were assigned by the  
371 49 Report Card work groups. A “Not Applicable” grade was assigned to Active Transportation by Qatar’s  
372 Report Card work group because of unsafe road conditions and a hot climate during most of the year.<sup>34</sup>  
373 The grade count, number of “INC” grades, mean number grade, standard deviation, and mean letter grade  
374 by indicator and group of indicators are presented in Table 5. The indicators with the lowest number of  
375 “INC” grades were Overall Physical Activity and Active Transportation (n = 2), while the indicator with  
376 the highest number of “INC” grades was Active Play (n = 29), followed by Physical Fitness (n = 27), and  
377 Family and Peers (n = 22). The mean letter grades ranged from “D” for Overall Physical Activity to “C”  
378 for Organized Sport and Physical Activity, Active Transportation, School, Community and Environment,  
379 and Government. An average grade of “C-” was obtained for the behavioral indicators combined, “C” for  
380 the sources of influence indicators combined, and “C-” was the overall average grade for the 369 letter  
381 grades. The average letter grades by indicator and group of indicators for the low and medium, high, and  
382 very high HDI countries are presented in Table 6. For the low and medium HDI countries, an average of  
383 “C” was obtained for the behavioral indicators combined and “D+” for the source of influence indicators  
384 combined, while for the very high HDI countries, an average of “D+” was obtained for the behavioral  
385 indicators combined and “C+” for the sources of influence indicators combined. For the high HDI  
386 countries, an average of “D+” was obtained for the behavioral indicators combined and for the sources of

387 influence indicators combined. Overall, an average grade of “C-”, “D+”, and “C-” was obtained for the  
388 low and medium HDI countries, high HDI countries, and very high HDI countries, respectively.

389

390 A plot for the estimated overall score of each country from the 10 indicators is presented in Figure 1 and  
391 the behavioral and sources of influence scores are shown in Figure 2 and Figure 3, respectively. Slovenia  
392 ranked first while China ranked 49<sup>th</sup> for the overall score (full rankings are shown in Figure 1); Nepal  
393 ranked first, and Estonia ranked last for the behavioral score (complete rankings are shown in Figure 2);  
394 and Slovenia ranked first while Venezuela ranked last for the source of influence score (see all country  
395 rankings in Figure 3). The Online Supplementary File S1 presents the correlation coefficients and their  
396 associated p-values between and within the 10 core physical activity indicators and the sociodemographic  
397 indicators. It showed that there were no statistically significant relationships between the Overall Physical  
398 Activity grade and the other core indicator grades with the exception of Sedentary Behaviors for which a  
399 statistically significant positive weak correlation was observed ( $r = 0.39$ ,  $p < 0.05$ ). Finally, presented in  
400 the Online Supplementary File S2 is the distribution of the grades (“A-B”, “C”, “D-F”, or “INC” grades)  
401 for the 10 common indicators and the average grades per country. Slovenia was the only country out of 49  
402 with a very high grade for Overall Physical Activity (“A-”) while most of the other countries had “D-F”  
403 ( $n = 38$ ). A greater variability in grades was observed for Sedentary Behaviors, but poor grades (“D-F”)  
404 were observed in most of the very high HDI countries.

405

## 406 **Discussion**

407 As a result of the efforts of the Report Card work groups, the Global Matrix 3.0 allowed us to present  
408 physical activity-related indicators for children and youth assembled across 49 countries with varying  
409 levels of human development (nine low and medium HDI, ten high HDI, and 30 very high HDI  
410 countries). While the average grades calculated for the indicators were all between “D” and “C” (Table

411 5), a great variety of grades was observed within and across the countries (Table 4), showing that every  
412 country is facing unique challenges and can learn from the successes or difficulties experienced by others.  
413 However, trends and comparable challenges identified across the physical activity indicators were  
414 identified within countries in the same HDI grouping despite their diverse sociodemographic, cultural,  
415 and geographical contexts. A discussion of the most and the least successful countries, followed by the  
416 interpretation of the findings from each indicator is presented in the following section, integrating the  
417 comparison of each HDI grouping.

418

419 *Most successful countries*

420 On the overall score, the very high HDI countries ranked generally higher than the low and medium, and  
421 high HDI countries (Figure 1), but this is not corroborated with results presented in Table 6 where the  
422 overall averages were the same for the low and medium HDI countries and the very high HDI countries.  
423 Slovenia obtained the best grade on average (“B”), followed by two other very high HDI countries (Japan  
424 and Denmark) that both obtained an average grade of “B-”. The specifics of childhood physical activity in  
425 these three countries has already been discussed in the paper presenting the findings from the very high  
426 HDI countries.<sup>26</sup> These three countries were also leading the ranking based on the sources of influence  
427 score (Figure 3). The ranking of the behavioral score was dominated by two low HDI countries (Nepal  
428 and Zimbabwe) and Japan (Figure 2). These rankings should be interpreted with caution given the large  
429 number of “INC” grades in their country Report Cards (two in Japan, three in Denmark, five in Nepal,  
430 and two in Zimbabwe).

431 Nepal lacked data to inform five of the 10 indicators that were assigned an “INC” grade (Organized Sport  
432 and Physical Activity, Active Play, Physical Fitness, School, and Government). A “D+” was assigned to  
433 Overall Physical Activity based on a study that found that only 39.8% of children and youth accumulated  
434 at least 60 minutes of MVPA per day. Nevertheless, Nepal shared the best grade for Active

435 Transportation with Japan and Zimbabwe (“A-”), obtained a high grade for Sedentary Behaviors (“B+”)  
436 and also scored highest for the Family and Peers indicator (“A”). These grades were all informed by local  
437 studies focusing on adolescents.<sup>35</sup> Nepal’s good grades in many of the indicators including Active  
438 Transportation and Sedentary Behavior may be associated with low automobile dependency (e.g., 7.12  
439 vehicles for 1,000 people in 2011),<sup>36</sup> and minimal opportunities and access to screen-based recreational  
440 sedentary pursuits such as television- and computer-time, and time spent using the internet. Nepal had  
441 5.30 televisions per 1,000 people (as of 2003); 4.37 computer (as of 2004), and 4.51 internet subscribers  
442 (as of 2012) for 1,000 people.<sup>37</sup> Due to the concurrent economic development in recent years in Nepal, the  
443 number of motorized vehicles is increasing rapidly with the expansion of road networks in rural areas,<sup>38</sup>  
444 and potentially more people have access to screen devices. These findings should be interpreted with  
445 caution, but they do suggest that the situation can potentially be positive in Nepal in terms of child and  
446 youth’s active transportation and sedentary behaviors at present. Yet, these favorable behaviors might be  
447 threatened by the economic growth and development and these physical activity behaviors may be more a  
448 function of poor economic development than a freely chosen physical activity. Nonetheless, more good  
449 quality research with nationally representative data is needed to obtain more reliable estimates of the  
450 physical activity of children and youth and to inform the grades with “INC” grades.

451  
452 Zimbabwe had the second-best grade for Overall Physical Activity (“C+”) after Slovenia, with high  
453 grades for most of the behavioral indicators (“B” for Organized Sport and Physical Activity, “A-” for  
454 Active Transportation, and “B” for Sedentary Behaviors); however, its sources of influence indicators  
455 were assigned grades between “D” and “C”. In comparison with the previous Report Card in Zimbabwe,  
456 the grades for School, Community and Environment, and Government, have improved due to recent  
457 policy implementations and commitments made by the government to promote physical activity and  
458 nutritional status among Zimbabwean children and youth.<sup>39</sup> However, there is need for caution in  
459 interpreting these grades as they were informed by limited and mostly unpublished data and expert

460 opinion. Thus, more research is needed to obtain a reliable picture of the context of the physical activity  
461 level of children and youth in Zimbabwe.

462

463 *Least successful countries*

464 One low HDI country, Ethiopia, and two high HDI countries, Venezuela and China, were the least  
465 successful countries based on the overall and the source of influence score rankings (Figures 1 and 3). An  
466 average grade of “D-” was assigned to China, and an average grade of “D” was assigned to Ethiopia and  
467 Venezuela. China’s Report Card work group developed a national surveillance protocol to collect  
468 nationally representative data for China’s 2018 Report Card.<sup>40</sup> An “F” was assigned to four indicators  
469 (Overall Physical Activity, Sedentary Behaviors, Community and Environment, and Government) and the  
470 remaining indicators were assigned grades between “D-” and “C+”. The small proportions of 9-17-year-  
471 old children in China meeting the physical activity guidelines (13.1%) or the sedentary behavior  
472 guidelines (7.1%) are alarming.<sup>40</sup> With an estimated population of 1.4 billion,<sup>41</sup> China is the most  
473 populated country in the world, and the low prevalence estimates observed here suggest that the majority  
474 of a large number of children and youth (approximately 160 millions of 10-19 year-olds in 2015)<sup>41</sup> are  
475 not engaging in sufficient amounts of MVPA to benefit their health. However, the high levels of air  
476 pollution in China represents a major threat to the promotion of physical activity,<sup>42</sup> and is a potential  
477 barriers stopping the Chinese children and youth from exercising. The recent support from the Chinese  
478 Ministry of Education in conducting national surveillance of children physical activity is however  
479 encouraging, and hopefully this support will be expanded to future investments in the development of  
480 interventions and policies designed to increase physical activity opportunities at community and  
481 environment levels in China.

482 In Ethiopia, an “F” was assigned to Sedentary Behaviors, Family and Peers, and Community and  
483 Environment, and the grades for the remaining indicators ranged between “D” and “C”, with the

484 exception of Active Play that was graded “B”. These findings should be interpreted with caution as the  
485 grades were informed by estimates based on experts opinion when data for an indicator were  
486 unavailable.<sup>43</sup> This method nevertheless did allow the Report Card work group to present an initial broad  
487 picture of childhood physical activity in Ethiopia.

488 Venezuela is currently facing a humanitarian crisis related to its economic and socio-political situation.  
489 Between 2016 and 2017, marked increases in maternal mortality (65%), infant mortality (30%), and cases  
490 of malaria (76%) were observed and the estimated prevalence of severe malnutrition among children  
491 under five years of age increased from 10.2% in February 2017 to 14.5% in September 2017.<sup>44</sup>  
492 Nevertheless, a Report Card was developed, using published and unpublished national survey data, peer-  
493 reviewed literature, government and nongovernment reports and online content, and meetings with  
494 experts working for governmental (municipal) and non-governmental organizations.<sup>45</sup> The Venezuelan  
495 Report Card work group assigned an “INC” grade to five indicators: Active Play, Sedentary Behaviors,  
496 Physical Fitness, Family and Peers, and School. An “F” grade was assigned to the Government indicator  
497 while the remaining indicators were graded “D” or “D-”, with the exception of Active Transportation  
498 which was graded “B-”. Though there were no physical activity data available for those under 15 years of  
499 age, the work group found that the majority of adolescents older than 15 years do not engage in physical  
500 activity regularly. In addition, the high rates of crime were identified as a barrier to physical activity.  
501 Currently, no governmental efforts to ensure safety and promote an active lifestyle in Venezuela are being  
502 implemented.<sup>45</sup>

503

#### 504 *Overall Physical Activity*

505 Only two countries assigned “INC” grades to the Overall Physical Activity indicator: Japan and  
506 Botswana. Slovenia, where more than 80% of children and youth aged between 6 and 19 years (according  
507 to subjective self-reported data), 88% of the 11 year-olds, and 66% of the 14 year-olds (according to

508 objective data) were meeting the physical activity guidelines, was the only country reporting a high grade  
509 for this indicator (“A-”).<sup>46</sup> For this indicator, the grades for the remaining countries ranged from “F”  
510 (Belgium, China, Scotland, South Korea, and Taiwan) to “C+” (Zimbabwe).

511 The Overall Physical Activity grade was informed by various types of data across countries: objective  
512 measurement with accelerometers or pedometers, self-report or proxy-report questionnaire, and expert  
513 opinion. Even among both the subjective and objective data, the methods varied substantially in terms of  
514 instruments, analysis, age range, sample size, and representativeness of samples.<sup>24,25,47</sup> In addition, the  
515 available data in each country did not necessarily allow the Report Card work groups to use either of the  
516 recommended benchmarks (see Table 1) strictly when estimating the prevalence of physically active  
517 children and youth in their sample.<sup>24,25,47</sup> For such reasons, the comparability of these results among the  
518 countries should be interpreted with caution.

519 Overall Physical Activity was the indicator with the lowest average grade: “D”. A distinction was  
520 observed between the low and medium HDI countries and the two other HDI groupings. The average  
521 grade for the low and medium HDI countries was “C-”, whereas both the high and very high HDI  
522 countries obtained an average of “D-”, which could represent a difference of 14-26% in physical activity  
523 guidelines adherence (“D-” = 20-26% vs. “C-” 40-46%). In accordance with this difference of grades, a  
524 significant low negative correlation was observed between the Overall Physical Activity indicator and  
525 several sociodemographic indicators including the HDI ( $r = -0.3, p < 0.05$ ) and the growth national income  
526 per capita ( $r = -0.33, p < 0.05$ ) (see Online Supplementary File, S1). The present study provides new  
527 evidence showing that the situation regarding the physical activity of children and youth is a universal  
528 concern worldwide. This finding is consistent with the results from the previous Global Matrices<sup>16,19</sup> and  
529 recent global estimates.<sup>11</sup> Efforts should be made globally and collectively to develop standardized  
530 physical activity surveillance systems adapted to the national context of each country. Furthermore,  
531 developing effective strategies to increase physical activity opportunities for all should be a national  
532 public health priority in all countries regardless of the HDI background.

533

534 *Organized Sport and Physical Activity*

535 An “INC” grade was assigned for this indicator in seven countries: Bangladesh, Botswana, Ecuador,  
536 India, Jersey, Nepal, and United Arab Emirates. The Organized Sport and Physical Activity grades ranged  
537 from “F” (Lebanon and Uruguay) to “A-” (Denmark), with an average of “C”. The benchmark  
538 recommended for this indicator was the “percentage of children and youth who participate in organized  
539 sport and/or physical activity programs” (Table 1), meaning that this indicator did not provide any  
540 information on the dose (i.e., duration, frequency, intensity) of physical activity while participating in  
541 sport and organized physical activities, because few countries have such data. The grade for this indicator  
542 depends on the availability of organized sport opportunities and the availability of data reporting the  
543 prevalence of children and youth who have taken advantage of these opportunities. This grade was mostly  
544 informed by official reports from governmental and/or public institutions as well as self-reported surveys.

545

546 Organized Sport and Physical Activity was graded “C”, “D+”, and “C+” on average for the low and  
547 medium HDI countries, the high HDI countries, and the very high HDI countries, respectively. Among  
548 the nine low and medium HDI countries, five assigned a letter grade to this indicator, which ranged from  
549 “D” to “B”, with an average of “C”. In these countries, the organized sport opportunities corresponded  
550 mostly to school-based sports or sport teams and recreational sports organized by non-governmental  
551 organizations and communities. Among the high HDI countries, the grades ranged from “F” to “C+” with  
552 an average of “D+”. However, it is not possible to discern from the available data if these low grades  
553 correspond to the limited availability of organized sport opportunities (i.e., distal correlates) or if there are  
554 barriers (e.g., proximal correlates such as motivation, interest, time, or parental support) hindering  
555 children from participating while organized physical activities are readily available to them. In the very  
556 high HDI countries, with an average grade of “C+”, Organized Sport and Physical Activity was the  
557 highest graded behavioral indicator. In these countries, organized sport opportunities are available to



558 children and youth in various settings: sport club and federations, school-based sport teams and organized  
559 sport sessions, municipal sport programs, and sport programs offered by private businesses. In addition,  
560 significant low to moderate positive associations were observed between Organized Sport and Physical  
561 Activity and several sociodemographic indicators including HDI, life expectancy at birth, mean years of  
562 schooling, growth national income per capita, public health expenditure (% of GDP), Global Food  
563 Security index, improved drinking water coverage, and summer Olympic medal count; while significant  
564 low negative associations between this indicator and the two inequality indices (Gini index and Gender  
565 inequality index) (see Online Supplementary File, S1) were observed.

566  
567 More research is needed to examine if affordable and appealing organized physical activity and sport  
568 opportunities are offered to all children and youth equally and equitably—across different age, gender,  
569 socioeconomic, ethnic, and special population groups—and to isolate the missing components of  
570 organized sports opportunities in each country. In addition, it would be interesting to add the  
571 measurement of the dose of physical activity associated with organized sports and physical activities in  
572 national physical activity surveillance systems. Filling these research and surveillance gaps is a necessary  
573 step towards the development of effective strategies to promote physical activity by increasing organized  
574 sport opportunities at the national level.

575

### 576 *Active Play*

577 Among the 20 countries that graded Active Play, this behavior was mostly measured by self- or proxy-  
578 report surveys, assessing the frequency or the time of active play/being active while playing,<sup>46,48–51</sup>  
579 unstructured/unorganized active play,<sup>40,52–58</sup> playing outdoors/outdoors activities/being outdoors,<sup>39,48,56,59–</sup>  
580 <sup>61</sup> and/or was based on expert opinion.<sup>39,43,62,63</sup> A definition for active play was proposed in a recent  
581 systematic review: “a form of gross motor or total body movement in which young children exert energy  
582 in a freely chosen, fun, and unstructured manner”.<sup>64</sup> A consensus definition, however, still needs to be

583 internationally agreed upon and acknowledged to allow the development of standardized measurement  
584 tools for this indicator in varying age groups.

585 Active Play was the indicator with the most “INC” grades where 29 of 49 countries were unable to find  
586 available data to grade this indicator. The grades ranged from “F” (Estonia and Thailand) to “B” (Ethiopia  
587 and The Netherlands) with an average of “D+”. The average grades for the low and medium HDI  
588 countries, high HDI countries, and very high HDI countries were “C-”, “D”, and “D+”, respectively.  
589 Given the amount of “INC” grades and the variability of the data used to inform the grades for the Active  
590 Play indicator, a valid comparison between the three HDI groupings was difficult. The low grades that  
591 were reported for this indicator aligned with the previous Global Matrices findings.<sup>16,19</sup> Such low level of  
592 engagement in active play can potentially be explained by the low detection capacity of instruments  
593 utilized for its measurement. Active play during free time may be slowly disappearing in favour of screen  
594 time in developed countries or is replaced with chores or work in developing countries. Perception of the  
595 environment as unsafe can also be a potential barrier to this behavior. However, no relation was found  
596 between Active Play and the Community and Environment indicators (Online Supplementary File, S1).  
597 Further research is needed for the development of a consensus definition, measurement instruments,  
598 surveillance systems, and to identify the barriers and facilitators of active play.

599

#### 600 *Active Transportation*

601 Only two countries did not assign a letter grade to Active Transportation: Qatar (not applicable) and  
602 United Arab Emirates (“INC”). The average grade for this indicator was D+ and ranged from “F” (Chile)  
603 to “A-” (Japan, Nepal, Zimbabwe). The recommended benchmark for this indicator was “the percentage  
604 of children and youth who use active transportation to get to and from places” (Table 1). For most of the  
605 countries, the grades were informed by data reporting the prevalence of children and/or youth actively

606 commuting between home and school without information on different doses (i.e., frequency, duration,  
607 intensity).

608 Active Transportation was the indicator with the highest average grade for the low and medium HDI  
609 countries (“C+”) and for the high HDI countries (“C”). The average grade for the very high HDI countries  
610 was “C-” for this indicator. In three of the four very high HDI countries from Eastern Asia, very high  
611 grades were assigned to this indicator: Japan (“A-”), Hong Kong (“B+”), and South Korea (“B+”). These  
612 three countries share similar characteristics historically, culturally, and developmentally,<sup>65</sup> and have  
613 shown a high percentage of urban population (83.3% to 100%, Table 3). A specific policy in Japan  
614 (limiting the distance between the children and youth homes and the public elementary and junior high  
615 schools),<sup>66</sup> and the high density of Hong Kong, and Japanese and South Korean cities, allow children and  
616 youth to live a short trip away from their school, which can minimize the use of car or other forms of  
617 motorized vehicles, and promote active travel.<sup>26,67,68</sup>

618

619 High to very high grades for this indicator were also reported in several developing countries: Colombia  
620 (“B”), Nepal (“A-”), Nigeria (“B”), Venezuela (“B-”), and Zimbabwe (“A-”), while poor grades were  
621 reported for 16 of the 30 very high HDI countries (with grades between “F” and “C-”). However, no  
622 statistically significant relation was found between Active Transportation and Community and  
623 Environment indicators or the HDI in the correlational analysis. These findings suggest that, for  
624 developing countries, active transportation may be driven by a necessity (i.e., no access to public or  
625 family/personal motorized transportation) instead of a choice,<sup>69</sup> notwithstanding the safety of the  
626 environment or the long distance to commute. The measurement of the dose and the characteristics of  
627 children’s and youth’s active transportation internationally are necessary to identify the contribution of  
628 active transport to overall physical activity levels, as well as the facilitators and obstacles for this behavior  
629 in order to develop contextually adapted, effective ways to promote it. Strategies to improve safety

630 conditions and to promote active transportation as a desirable mode of transport are required in order to  
631 maintain the high grades in the countries leading this indicator and to improve those that are lagging.

632

### 633 *Sedentary Behaviors*

634 Sedentary Behaviors is defined as “any waking behavior characterized by an energy expenditure  $\leq 1.5$   
635 metabolic equivalents, while in a sitting, reclining, or lying posture”.<sup>1</sup> Screen time, referring to time spent  
636 in screen-based behaviors<sup>1</sup>, is often used as a proxy for sedentary behavior in research. Screen time can be  
637 performed while being sedentary or physically active,<sup>1</sup> however this behavior has been shown to be  
638 associated with a variety of negative health outcomes among children and youth.<sup>70</sup> This is why guidelines  
639 recommending limiting screen time to two hours daily for 5-17 year-olds were developed for the first time  
640 in Canada.<sup>71</sup> Further, it was also the reason why the benchmark for Sedentary Behaviors focused on  
641 screen time: “percentage of children and youth who meet the *Canadian Sedentary Behaviour Guidelines*  
642 (5- to 17-year-olds: no more than 2 hours of recreational screen time per day)” (Table 1). However, the  
643 comparisons between the countries should be interpreted with caution because of the variability of the  
644 data that were used to inform the grades for this indicator. Several Sedentary Behaviors grades were  
645 partially or totally informed by data reporting time spent sitting or doing other sedentary activities that did  
646 not involve screens, and screen time cut-off points differing from the one in the benchmark (i.e.,  $\leq 1$   
647 hour/day,  $< 2$  used hours/day,  $\leq 3$  hours/day) were also used by some countries because of available data.

648 Three countries assigned an “INC” grade to Sedentary Behaviors: Ghana, South Africa, and Venezuela.  
649 The grades for this indicator ranged from “F” (China, Estonia, Ethiopia, Scotland, and Wales) to “A-”  
650 (Bangladesh), with an average of “D+”. These findings are consistent with international estimates  
651 reporting that at least two thirds of the children exceed 2 hours of recreational screen time per day,<sup>72</sup>  
652 although comparison may be limited by the heterogeneity in Sedentary Behaviors across countries. The  
653 low and medium HDI countries obtained an average of “C+” for this indicator, and only two of the eight

654 countries had a low grade: Ethiopia “F” and India “C-”. The grades for the six remaining low and medium  
655 HDI countries ranged from “B” to “A-”. The high and the very high HDI countries obtained an average  
656 grade of “D” and “D+”, respectively, for Sedentary Behaviors. In 36 out of the 39 high and very high  
657 HDI countries that graded this indicator, a low or very low grade (between “F” and “C-”) was assigned.  
658 Regardless, the Sedentary Behaviors grades were not related to HDI or to the other sociodemographic  
659 indicators except the mean years of schooling ( $r = 0.31, p < 0.05$ ) and the summer Olympic medal count ( $r$   
660  $= -0.57, p < 0.05$ ) in the correlational analysis presented in the Online Supplementary File S1.

661 The results presented here suggest that the situation concerning the childhood screen time is particularly  
662 concerning in high and very high HDI countries. The moderately good grades for Sedentary Behavior in  
663 the low and medium HDI countries are potentially threatened to decrease with their continuing economic  
664 growth and development, which may lead to increased access to electronic devices. Several interventions  
665 to reduce screen time have been developed and tested, and results from systematic reviews and meta-  
666 analyses reported that interventions to reduce children’s screen time can have a small but significant  
667 effect.<sup>73</sup> More research is necessary to accumulate more evidence on the effectiveness of specific  
668 interventions across different contexts and settings, but investment from public health institutions in high  
669 and very high HDI countries to support the implementation of these interventions in the child and youth  
670 population should become a priority.

671

### 672 *Physical Fitness*

673 Physical fitness represents the ability to perform daily activities with vigor, and the demonstration of  
674 traits and capacities that are associated with a lower risk of the premature development of diseases  
675 associated with physical inactivity.<sup>74</sup> Cardiorespiratory endurance, muscular endurance, muscular  
676 strength, body composition, and flexibility are the health-related components of physical fitness.<sup>75</sup> The  
677 Global Matrix 3.0 evaluated the Physical Fitness indicator for the first time, and 27 countries were unable

678 to find available data to inform the grade for this indicator in. In the remaining countries, the grade for  
679 Physical Fitness ranged from “F” (India) to “A” (Japan), with an average of “C-”. India was the only  
680 country from the low and medium HDI countries with a letter grade for this indicator. Among the 10 high  
681 HDI countries, only four had a letter grade reported for this indicator: Brazil (“D”), China (“D”),  
682 Colombia (“D-”), and Uruguay (“C-”), with an average of “D”. A letter grade was assigned to 17 of the  
683 30 very high HDI countries, ranging from “D” (Canada, Chile, Hong Kong, and Jersey) to “A” (Japan).

684 The benchmark for this indicator corresponded to the average percentile achieved on certain health-  
685 related physical fitness components based on the normative values published by Tomkinson et al (Table  
686 1).<sup>76</sup> However, many differences in the data informing the grades for this indicator were observed across  
687 countries in terms of number fitness indicators reported, normative value used, age range and sample size.  
688 Given the amount of “INC” grades and variability in the data informing the grades for this indicator, the  
689 comparison between HDI groupings is difficult. Cardiorespiratory fitness (measured with the 20-meter  
690 shuttle run test) was found to be associated with favourable indicators of adiposity and some indicators of  
691 cardiometabolic, cognitive, and psychosocial health in boys and girls from 32 countries in a recent  
692 systematic review.<sup>77</sup> Therefore, cardiorespiratory fitness is an important indicator of current and future  
693 health among school-aged children and youth, and can be used as a holistic indicator of population health  
694 in this age group.<sup>78</sup> These findings highlight that global surveillance of physical fitness, which represents  
695 a simple and cost-effective assessment<sup>79</sup> that could be integrated in physical education classes, should be  
696 a priority in all countries.

697

### 698 *Family and Peers*

699 The average grade for Family and Peers was the same among the three HDI groupings: “D+”. An “INC”  
700 grade was assigned in 22 countries: four from the low and medium HDI group, six from the high HDI  
701 group, and 12 from the very high HDI group. The grades ranged from “F” (Chile, Ecuador, Ethiopia,

702 Ghana) to “A” (Nepal). This amount of “INC” grades and the letter grades reported are consistent with  
703 the previous Global Matrices.<sup>16,19</sup>

704 Support from parents and peers is recognized as a correlate of physical activity in children and youth;<sup>80</sup>  
705 however, the nature of this interaction is complex and no valid and internationally recognized instrument  
706 exists to measure the influence of family and friends on children and youth’s physical activity at present.  
707 This is why several benchmarks were proposed to capture a picture of the influence of Family and Peers  
708 (Table 1), and variability in the data used to inform the letter grades for this indicator was observed. The  
709 number of “INC” grades and the measurement variation for this indicator limit the comparison and the  
710 interpretation of the letter grades reported. However, these findings highlight the need for the  
711 development of standardized methods for the surveillance of this indicator in various settings and  
712 contexts.

713

#### 714 *School*

715 Given the potentially significant amount of time that children and youth spend at school, this environment  
716 is a strategically important setting for the promotion of physical activity. Physical activity opportunities  
717 can be provided to children and youth in the school environment through physical education, lunch and  
718 recess breaks, in-class physical activities, and in intramural competitive and non-competitive activities  
719 before or after school.<sup>81</sup> However, school physical activity policies, if they exist at all, differ from one  
720 country to another, and are not always mandatory.

721 The average grade for the School indicator was “C”, and Report Card work groups in eight countries  
722 could not assign a letter grade to this indicator (Bangladesh, Ecuador, Guernsey, India, Nepal, Scotland,  
723 Venezuela, Wales). This indicator ranged from “D-” (South Africa, United Arab Emirates, United States)  
724 to “A” (Finland, Portugal, Slovenia). The average grade for this indicator was “D+” for the low and  
725 medium HDI countries. For the high HDI countries, School was the source of influence indicator that

726 obtained the highest average grade (“C-”). The very high HDI countries obtained an average grade of “B-  
727 ”, and it is worth noting that only medium to favorable grades (“C” to “A”) were assigned to European  
728 countries (high and very high HDI countries included). The correlational analysis found a significant  
729 moderate association between the School indicator and six of the sociodemographic indicators: the HDI ( $r$   
730 = 0.53,  $p < 0.001$ ), the mean years of schooling ( $r = 0.51$ ,  $p < 0.001$ ), the Gini Index ( $r = -0.66$ ,  $p < 0.001$ ), the  
731 Gender Inequality Index ( $r = -0.65$ ,  $p < 0.001$ ), the Global Food Security Index ( $r = 0.52$ ,  $p < 0.05$ ) and the  
732 distance to Equator ( $r = 0.55$ ,  $p < 0.001$ ). In other words, the grades for school indicator increased as the  
733 HDI, the mean years of schooling, the food security and the distance to the equator increased, and as the  
734 Gender Inequality Index and the Gini index decreased. These findings align with the results of the Global  
735 Matrix 2.0.<sup>19</sup>

736 These findings further suggest that the quality and/or quantity of physical activity opportunities offered by  
737 the school are associated with the economic and development status of a given country. Cultural values  
738 attributed to sport and or physical activity can also be potential barriers or facilitators for this indicator.  
739 Quality school policies and programs related to physical activity for the three European countries leading  
740 this indicator (Finland, Portugal, Slovenia) have already been highlighted elsewhere.<sup>19,26</sup> While mandatory  
741 physical education classes is part of the school curriculum in most European countries for all school  
742 grades, it is only optional in some other countries from other parts of the world. For example, in the  
743 United States, the percentage of schools delivering mandatory physical education classes, in each grade,  
744 decrease from 97% in 6th grade to 42% in 12th grade.<sup>82</sup> In the United Arab Emirates, only 26% of  
745 adolescents aged 13-17 years reported participating in physical education class on three or more days  
746 each week.<sup>83</sup> In South Africa, 32% of children do not participate in school physical education classes,  
747 and no evidence of progress in the prioritization of physical education in the schools was found by the  
748 Report Card work group.<sup>84</sup> Similarly, two consecutive Report Cards from South Korea highlighted that  
749 the emphasis on important subjects (e.g., math, science) for university admission overrides the importance  
750 of physical activity in the Korean education system.<sup>85,86</sup> Though the new 2018 Korean national curriculum



751 requires schools to provide mandatory physical education, it is regarded as a minor subject and, with  
752 progressing school grades, it is devalued and neglected.<sup>87</sup>

753 Evidence showed that adding more time to academic or curricular subjects by taking time away from  
754 physical education programs was found not to enhance academic achievement in the corresponding  
755 academic subjects and to be potentially detrimental to health.<sup>88</sup> Conversely, allocating more time to  
756 physical activity from other subjects can improve the time children spend engaging in MVPA without the  
757 risk of “hindering students’ academic achievement”.<sup>88</sup> The measure of the dose of physical activity  
758 occurring in school should also be added to the national surveillance systems globally to identify the  
759 needs in terms of policies and interventions aimed at promoting physical activity at school. In addition,  
760 the Global Matrix 3.0 findings suggest that developing interventions or programs targeting schools in low  
761 and medium HDI countries should be a priority on the international public health agenda.

762

### 763 *Community and Environment*

764 The Community and Environment indicator obtained an average grade of “C” and had 13 “INC” grades.  
765 The grades ranged from “D-” (Venezuela) to “A” (Sweden). The low and medium HDI countries obtained  
766 an average of “D”, and the high HDI countries obtained a “D+”. Among the very high HDI countries the  
767 Community and Environment indicator was the indicator with the highest average grade (“B-”). The  
768 correlational analysis (see Online Supplementary File, S1) found a positive significant moderate to strong  
769 association between the Community and Environment indicator and the HDI ( $r = 0.73$ ,  $p < 0.001$ ), the life  
770 expectancy at birth ( $r = 0.74$ ,  $p < 0.001$ ), mean years of schooling ( $r = 0.64$ ,  $p < 0.001$ ), Growth National  
771 Income per capita ( $r = 0.80$ ,  $p < 0.001$ ), public health expenditure ( $r = 0.67$ ,  $p < 0.001$ ), Global Food  
772 Security Index ( $r = 0.71$ ,  $p < 0.001$ ), urban population percentage ( $r = 0.51$ ,  $p < 0.001$ ), improved drinking  
773 water coverage ( $r = 0.77$ ,  $p < 0.001$ ) and distance to Equator ( $r = 0.58$ ,  $p < 0.001$ ); and a negative significant  
774 moderate to strong association was found with the Gini Index ( $r = -0.62$ ,  $p < 0.001$ ) and Gender Inequality

775 Index ( $r = -0.83$ ,  $p < 0.001$ ). These findings aligned with the results of the previous Global Matrices<sup>16,19</sup>  
776 and reinforce the importance of income and gender equity for the physical activity and overall population  
777 health.

778 Characteristics of the built environment are recognized as a potential source of influence on the physical  
779 activity level of children and youth.<sup>89-91</sup> Given that a great number of characteristics could potentially  
780 influence the physical activity of children and youth, numerous benchmarks were proposed to evaluate  
781 this indicator. A great variability of data were used to inform the grades for this indicator, limiting direct  
782 comparisons between countries. Yet, the significant correlations suggest that despite the variability of  
783 data available that was used to inform the grade for this indicator, the Report Card work groups assigned  
784 a grade that was coherent with the characteristics of the environment. The available evidence from this  
785 indicator suggests that the characteristics of the built environment potentially influencing the physical  
786 activity of children and youth are already favorable in the very high HDI countries, and that an increase of  
787 the grades for this indicator is expected with the further development of low, medium, and high HDI  
788 countries.

789

#### 790 *Government*

791 The average grade for the Government grade was “C”, and an “INC” grade was assigned in eight  
792 countries. With an average of “C-”, Government was the source of influence indicator with the highest  
793 average in low and medium HDI countries. The high HDI countries obtained an average of “D+”, and the  
794 very high HDI countries a “C+”. The highest grades for this indicator were reported in high and very high  
795 HDI countries. The correlation analysis found significant low associations between the Government  
796 indicator and the growth national income per capita ( $r = 0.48$ ,  $p < 0.005$ ), public health expenditure ( $r =$   
797  $0.48$ ,  $p < 0.005$ ), Gini index ( $r = -0.45$ ,  $p < 0.005$ ), Gender Inequality Index ( $r = -0.45$ ,  $p < 0.005$ ), improved  
798 water coverage ( $r = 0.44$ ,  $p < 0.005$ ), and distance to the equator ( $r = 0.31$ ,  $p < 0.005$ ).

799 Similar to the Community and Environment indicator, a government can potentially influence the  
800 physical activity level of children and youth in multiple ways. As there is no official standardized method  
801 to evaluate this influence, the recommended benchmark for this indicator focused on evidence of  
802 leadership and commitment, allocated funds and resources, and demonstrated progress for the promotion  
803 of physical activity opportunities for all children and youth (Table 1). As a result, the grades were  
804 informed by very different types of data across countries, and the Report Card work groups did not  
805 always have access to relevant quantitative data, and therefore graded this indicator mostly based on  
806 expert opinion when required.

807 The low behavioral grades that were reported broadly in the Global Matrix 3.0 suggest that the  
808 government's efforts and physical activity policies are not reflected in an increase in the prevalence of  
809 MVPA among children and youth, and/or that there is an implementation gap between the strategy level  
810 (source of influence indicators) and individual level (behavioral indicators). More research is needed  
811 globally to identify the potential barriers for the engagement of children at the country and community  
812 level, in different contexts and settings.

813

#### 814 *Integrated discussion*

815 Overall, the average grades obtained for each indicator were low, and a small variation was observed  
816 within the 10 indicators ("D" to "C"). More diversity was observed between the three HDI groupings,  
817 between the countries, and within each country. Higher behavioral grades and lower source of influence  
818 grades were generally observed in the low and medium HDI countries, while the opposite was observed  
819 for the very high HDI countries, and generally low average grades were reported for each indicator in the  
820 high HDI countries. It is important to highlight that the overall concerning levels of physical activity and  
821 sedentary behavior among children and youth may be indicative of a global crisis. Moreover, this  
822 phenomenon may get worse with the economic growth and development of low, medium and high HDI

823 countries, and very high rates of non-communicable diseases can be anticipated when the current  
824 generation of children and youth reaches adulthood unless a major shift to a more active lifestyle happens  
825 soon. Strategies to mitigate the projected reduction in habitual physical activity in developing countries  
826 should learn from countries who have already navigated the physical activity transition.<sup>92</sup>

827

### 828 *Strengths and Limitations*

829 A major limitation of this study was the amount of missing data to inform the grades, resulting in a total  
830 of 121 “INC” grades of the 490 grades in total. In addition, the great variability of the data (e.g., in terms  
831 of benchmark, measurement instrument, age range, sample size, quality, quantity) that were used to  
832 inform the grades was observed between the countries for each indicator, and in many cases the available  
833 data did not permit the Report Card work groups to align strictly with the recommended benchmarks.  
834 Furthermore, a loss of information potentially occurred when translating original prevalence data to a  
835 letter grade, as letter grades provide less information than continuous variables. Consequently, all the  
836 comparisons, correlations and interpretations involving the grades are limited and should be interpreted  
837 with caution, as two identical grades for the same indicator can capture two very different contexts from  
838 one country to another. Excluding the countries with insufficient data and imposing to assign “INC”  
839 grades every time the data did not fit exactly with the benchmarks for each indicator could have been an  
840 alternative strategy. But this approach would have significantly reduced the number of countries and  
841 grades included in the Global Matrix 3.0 and the relevance of conducting international comparisons.  
842 Despite the limitations of the underlying data, this encyclopedia of global information of the physical  
843 activity of children and youth represents the richest source of such information compiled to date.

844 Another limitation of the Global Matrix 3.0 was the lack of representativeness of some areas of the world  
845 and some specific child and youth populations. Indeed, the participation of a total of 49 countries or  
846 nations meant that most of the countries around the world were still missing. In particular, the South

847 Pacific islands nations, where the average body mass indices for child and youth were estimated to be the  
848 highest of the world,<sup>93</sup> are missing, as well as countries from Central Asia, and North Africa.  
849 Additionally, children and youth with disabilities were not explicitly included in this analysis while the  
850 Global Matrix process could help to identify and circulate best-practice strategies in terms of physical  
851 activity promotion for these specific populations.<sup>19</sup> Furthermore, the disparities and inequities across  
852 gender, socioeconomic status, or urban versus rural dwelling were mentioned in only a handful of Report  
853 Card articles, thus they were not analyzed or discussed in this study.

854 The correlation analyses showed that the Overall Physical Activity grade had a low positive association  
855 with Sedentary Behaviors and was not statistically related with the eight remaining indicators (Online  
856 Supplementary File, S1). This can potentially be the consequence of the aforementioned limitations, but  
857 another hypothesis may explain this absence of relation. The absence of statistically significant  
858 correlations between Overall Physical Activity, and Organized Sport and Physical Activity, Active Play,  
859 and Active Transportation, may have resulted from the fact that the physical activity dose related to these  
860 indicators was not measured well. The absence of a relation between the source of influence indicators  
861 and Overall Physical Activity may suggest that a favorable physical and social environment is not enough  
862 to induce individual engagement in sufficient amounts of MVPA. In addition, the absence of choice (i.e.,  
863 children that have no other options than using active transportation regardless of safety and any other  
864 characteristics of the source of influence), child labor, and the cultural values attributed to physical  
865 activity and sports were not evaluated in this study.

866 Major strengths of this work include the large number of countries who adopted the harmonized Report  
867 Card development process and the quantity of data used to inform an international, comprehensive and  
868 meaningful comparison of physical activity behaviors of children and youth. In addition, the AHKGA  
869 facilitated and supported the development of Report Cards from 49 countries, by providing the Report  
870 Card work groups from each participating country with a platform to capture, synthesize, interpret, and  
871 publish the findings with autonomy. With the 49 countries participating and the 10 common indicators

872 being graded by each participating country, the Global Matrix 3.0 represents the most comprehensive and  
873 meaningful comparison of the contexts of the physical activity of children and youth. In addition, the  
874 identification and discussion of major trends concerning the characteristics of the physical activity of  
875 children and youth among the three HDI groupings were realized for the first time.<sup>24-26</sup> Finally, major  
876 research and surveillance gaps, including the need for the development and the international adoption of  
877 standardized methods to conceptualise and measure the ten indicators, were identified and highlighted for  
878 each indicator in the present paper.

879 The launch of the Global Matrix 3.0 is the result of a tremendous amount of work by the AHKGA  
880 Executive Committee members and from the physical activity experts and stakeholders from all over the  
881 world for the past 15 months. The 49 Report Cards were developed by supported and unsupported work  
882 groups of professionals who acknowledge the importance of a healthy and active lifestyle for the present  
883 and the future of the children and youth worldwide. The involvement of governmental and non-  
884 governmental organizations in the development of some of the national Report Cards is a potential sign of  
885 a growing interest in the childhood physical inactivity crisis; and it is hoped that this awareness will be  
886 translated into support for the development of effective interventions increasing physical activity  
887 opportunities for all. In addition, the development of a national Report Card of physical activity for  
888 children and youth, and the participation in the Global Matrix initiative, were found to contribute to  
889 raising awareness on the childhood physical inactivity issue nationally and internationally, building  
890 capacity within participating countries, and potentially influencing the creation of physical activity  
891 opportunities in the future.<sup>23</sup> It is hoped that more physical activity experts and stakeholders will rally  
892 with AHKGA members to pursue and expand the Global Matrix initiative and will help filling the  
893 identified gap in physical activity research and surveillance. The AHKGA, with the contribution of its  
894 international network of researchers, will be available to offer guidance to the countries willing to develop  
895 national surveillance of physical activity, and policies or interventions promoting physical activity among  
896 children and youth.

897

898 **Conclusion**

899 A comprehensive summary of the grades, comparison and interpretation of 10 physical activity indicators  
900 among 49 countries were presented in this Global Matrix 3.0 paper. Higher behavioral grades and lower  
901 source of influence grades were generally observed in the low and medium HDI countries, while lower  
902 behavioral grades and higher source of influence grades were observed for the very high HDI countries,  
903 and generally low average grades for each indicator in the high HDI countries. International research and  
904 surveillance gaps were also identified by the Global Matrix 3.0 and the Report Card initiatives.  
905 Internationally collaborative and collective efforts are needed to redirect the persisting trend of low  
906 physical activity and high sedentary behavior among children and youth worldwide. Strategic public  
907 investments to implement effective interventions within families, communities, and schools to increase  
908 physical activity opportunities are needed. It is hoped that researchers and relevant stakeholders will  
909 collaborate internationally to address the research and surveillance gaps highlighted in this paper and  
910 expand the Global Matrix initiative to include more countries.

911

912 **Acknowledgments**

913 The authors would like to acknowledge the then Active Healthy Kids Canada (now ParticipACTION) for  
914 developing the Report Card methodology, and the AHKGA Executive Committee for modifying and  
915 standardizing the benchmarks and grading rubric and leading this international initiative. We are grateful  
916 for all the hard work by each participating country's Report Card Work Group and Leaders and all other  
917 members of their Report Card Committees. We also want to thank Evan Turner for his work on the  
918 compilation of the sociodemographic characteristics of the participating countries.

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1184 **Table 1: Global Matrix 3.0 indicators and benchmarks used to guide the grade assignment process**

| Indicator                             | Benchmark  |
|---------------------------------------|--|
| Overall Physical Activity             | <p>% 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.</p> <p>Or % of children and youth meeting the guidelines on at least 4 days a week (when an average cannot be estimated).</p>  |
| Organized Sport and Physical Activity | <p>% of children and youth who participate in organized sport and/or physical activity programs.</p>   |
| Active Play                           | <p>% of children and youth who engage in unstructured/unorganized active play at any intensity for more than 2 hours a day.</p> <p>% of children and youth who report being outdoors for more than 2 hours a day.</p>  |
| Active Transportation                 | <p>% of children and youth who use active transportation to get to and from places (e.g., school, park, mall, friend's house).</p>   |
| Sedentary Behaviors                   | <p>% of children and youth who meet the Canadian Sedentary Behaviour 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.</p>   |
| Physical Fitness                      | <p>Average percentile achieved on certain physical fitness indicators based on the normative values published by Tomkinson et al.<sup>76</sup></p>   |
| Family and Peers                      | <p>% of family members (e.g., parents, guardians) who facilitate physical activity and sport opportunities for their children (e.g., volunteering, coaching, driving, paying for membership fees and equipment).</p> <p>% 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 physical activity.</p> <p>% of family members (e.g., parents, guardians) who are physically active with their kids.</p> <p>% of children and youth with friends and peers who encourage and support them to be physically active.</p> <p>% of children and youth who encourage and support their friends and peers to be physically active.</p> |

RUNNING HEAD: Global Matrix 3.0 of Report Card Physical Activity Grades

|                                  |  |
|----------------------------------|--|
| <p>School</p>                    | <p>% of schools with active school policies (e.g., daily PE, daily physical activity, recess, “everyone plays” approach, bike racks at school, traffic calming on school property, outdoor time).</p> <p>% of schools where the majority (<math>\geq 80\%</math>) of students are taught by a PE specialist.</p> <p>% of schools where the majority (<math>\geq 80\%</math>) of students are offered the mandated amount of PE (for the given state/territory/region/country).</p> <p>% of schools that offer physical activity opportunities (excluding PE) to the majority (<math>&gt; 80\%</math>) of their students.</p> <p>% of parents who report their children and youth have access to physical activity opportunities at school in addition to PE classes.</p> <p>% of schools with students who have regular access to facilities and equipment that support physical activity (e.g., gymnasium, outdoor playgrounds, sporting fields, multi-purpose space for physical activity, equipment in good condition).</p> |
| <p>Community and Environment</p> | <p>% of children or parents who perceive their community/municipality is doing a good job at promoting physical activity (e.g., variety, location, cost, quality).</p> <p>% of communities/municipalities that report they have policies promoting physical activity.</p> <p>% of communities/municipalities that report they have infrastructure (e.g., sidewalks, trails, paths, bike lanes) specifically geared toward promoting physical activity.</p> <p>% of children or parents who report having facilities, programs, parks and playgrounds available to them in their community.</p> <p>% of children or parents who report living in a safe neighbourhood where they can be physically active.</p> <p>% of children or parents who report having well-maintained facilities, parks and playgrounds in their community that are safe to use.</p>   |
| <p>Government</p>                | <p>Evidence of leadership and commitment in providing physical activity opportunities for all children and youth.</p> <p>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 policy making (i.e., policy agenda, policy formation, policy implementation, policy evaluation and decisions about the future).</p>   |

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1187 **Table 2: Global Matrix 3.0 grading rubric**

| Grade | Interpretation  | Corresponding number for analysis |
|-------|---|-----------------------------------|
| 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         | No Grade                          |

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1190 **Table 3: Sociodemographic information of the 49 countries in the Global Matrix 3.0**

| Country (in alphabetical order) | HDI <sup>a</sup> | GNI per capita (USD) <sup>a</sup> | Public Health Expenditure (% of GDP) <sup>a</sup> | GII <sup>a</sup> | Life expectancy at birth (years) <sup>a</sup> | Mean years of schooling (years) <sup>a</sup> | Gini index <sup>b</sup> | Global Food Security Index <sup>c</sup> | Urban Population Percentage <sup>d</sup> | Improved drinking water coverage (%) <sup>d</sup> | Population Density (people / km <sup>2</sup> of land area) <sup>e</sup> | Summer Olympic Medal Count <sup>f</sup> | Distance to the Equator (km) <sup>g</sup> |
|---------------------------------|------------------|-----------------------------------|---|------------------|---|--|-------------------------|---|--|---|---|---|---|
| Australia                       | 0.939            | 42822                             | 6.3   | 0.12             | 82.5  | 13.2   | 34.7                    | 83.3                                    | 89.4                                     | 100   | 3   | 497                                     | 2796                                      |
| Bangladesh                      | 0.579            | 3341                              | 3.7   | 0.52             | 72  | 5.2  | 32.4                    | 39.7                                    | 28.9                                     | 81  | 1252  | 0                                       | 2620                                      |
| Belgium (Flanders)              | 0.896            | 41243                             | 8.3   | 0.073            | 81  | 11.4   | 27.7                    | 79.8                                    | 97.5                                     | 100   | 374   | 148                                     | 5597                                      |
| Botswana                        | 0.698            | 14663                             | 5.1   | 0.435            | 71.7  | 11.9   | 60.5                    | 59.4                                    | 62.3                                     | 96  | 4   | 1                                       | 2470                                      |
| Brazil                          | 0.754            | 14145                             | 3.8   | 0.414            | 74.7  | 7.8  | 51.3                    | 67.7                                    | 84.9                                     | 98  | 25  | 128                                     | 1574                                      |
| Bulgaria                        | 0.794            | 16261                             | 4.6   | 0.223            | 74.3  | 10.8   | 37.4                    | 62.9                                    | 73.7                                     | 100   | 66  | 218                                     | 4733                                      |
| Canada                          | 0.92             | 42582                             | 7.4   | 0.098            | 82.2  | 13.1   | 34                      | 82.2                                    | 80.8                                     | 100   | 4   | 302                                     | 6223                                      |
| Chile                           | 0.847            | 21665                             | 3.9   | 0.322            | 82  | 9.9  | 47.7                    | 74.7                                    | 89.4                                     | 96  | 24  | 13                                      | 3949                                      |
| China                           | 0.738            | 13345                             | 3.1   | 0.164            | 76  | 7.6  | 42.2                    | 63.7                                    | 51.9                                     | 91  | 147   | 546                                     | 3970                                      |
| Colombia                        | 0.727            | 12762                             | 5.4   | 0.393            | 74.2  | 7.6  | 50.8                    | 60.1                                    | 75.6                                     | 92  | 44  | 28                                      | 505                                       |
| Czech Republic                  | 0.878            | 28144                             | 6.3   | 0.129            | 78.8  | 12.3   | 25.9                    | 75.8                                    | 73.4                                     | 100   | 137   | 56                                      | 5521                                      |
| Denmark                         | 0.925            | 44519                             | 9.2   | 0.041            | 80.4  | 12.7   | 28.2                    | 80.3                                    | 87.1                                     | 100   | 136   | 194                                     | 6238                                      |
| Ecuador                         | 0.739            | 10536                             | 4.5   | 0.391            | 76.1  | 8.3  | 45                      | 55.2                                    | 68                                       | 94  | 66  | 2                                       | 202                                       |
| England                         | 0.909            | 37931                             | 7.6   | 0.131            | 80.8  | 13.3   | 33.2                    | 84.2                                    | 79.7                                     | 100   | 271   | NA                                      | 5803                                      |
| Estonia                         | 0.865            | 26362                             | 5   | 0.131            | 77  | 12.5   | 32.7                    | NA                                      | 69.5                                     | 98  | 31  | 34                                      | 6498                                      |
| Ethiopia                        | 0.448            | 1523                              | 4.7   | 0.499            | 64.6  | 2.6  | 39.1                    | 33.3                                    | 17.2                                     | 44  | 102   | 53                                      | 1011                                      |
| Finland                         | 0.895            | 38868                             | 7.3   | 0.056            | 81  | 11.2   | 27.1                    | 81                                      | 83.8                                     | 100   | 18  | 303                                     | 6868                                      |
| France                          | 0.897            | 38085                             | 9   | 0.102            | 82.4  | 11.6   | 32.7                    | 82.3                                    | 86.4                                     | 100   | 122   | 716                                     | 5121                                      |
| Germany                         | 0.926            | 45000                             | 8.7   | 0.066            | 81.1  | 13.2   | 31.7                    | 82.5                                    | 74.1                                     | 100   | 236   | 1346                                    | 5671                                      |
| Ghana                           | 0.579            | 3839                              | 4.8   | 0.547            | 61.5  | 6.9  | 42.4                    | 47.9                                    | 52.6                                     | 86  | 124   | 4                                       | 879                                       |
| Guernsey Channel Islands*       | 0.975            | NA                                | NA  | NA               | 82.6  | NA   | 40                      | NA                                      | 31.7                                     | NA  | 850   | NA                                      | 5481                                      |
| Hong Kong                       | 0.917            | 54265                             | NA  | NA               | 84.2  | 11.6   | NA                      | NA                                      | 100                                      | NA  | 6987  | 3                                       | 2478                                      |
| India                           | 0.624            | 5663                              | 3.9   | 0.53             | 68.3  | 6.3  | 35.1                    | 48.9                                    | 31.6                                     | 92  | 445   | 28                                      | 2278                                      |
| Japan                           | 0.903            | 37268                             | 8.6   | 0.116            | 83.7  | 12.5   | 32.1                    | 79.5                                    | 91.9                                     | 100   | 348   | 439                                     | 4008                                      |
| Jersey**                        | 0.985            | NA                                | NA  | NA               | 81.9  | NA   | 41                      | NA                                      | 31.7                                     | NA  | 845   | NA                                      | 5453                                      |
| Lebanon                         | 0.763            | 13312                             | 3   | 0.381            | 79.5  | 8.6  | 31.8                    | NA                                      | 87.4                                     | 100   | 587   | 4                                       | 3748                                      |
| Lithuania                       | 0.848            | 26006                             | 4.4   | 0.121            | 73.5  | 12.7   | 37.4                    | NA                                      | 67.2                                     | 92  | 46  | 25                                      | 6116                                      |
| Mexico                          | 0.762            | 16383                             | 3.3   | 0.345            | 77  | 8.6  | 43.4                    | 65.8                                    | 78.4                                     | 96  | 66  | 69                                      | 2615                                      |

RUNNING HEAD: Global Matrix 3.0 of Report Card Physical Activity Grades

|                      |       |        |     |       |      |      |      |      |      |     |     |      |      |
|----------------------|-------|--------|-----|-------|------|------|------|------|------|-----|-----|------|------|
| Nepal                | 0.558 | 2337   | 5.4 | 0.497 | 70   | 4.1  | 32.8 | 44.5 | 17.3 | 89  | 202 | 0    | 3142 |
| Netherlands          | 0.924 | 46326  | 9.5 | 0.044 | 81.7 | 11.9 | 29.3 | 82.8 | 83.6 | 100 | 506 | 285  | 5778 |
| New Zealand          | 0.915 | 32870  | 9.1 | 0.158 | 82   | 12.5 | NA   | 81   | 86.3 | 100 | 18  | 117  | 4530 |
| Nigeria              | 0.527 | 5443   | 5.3 | NA    | 53.1 | 6    | 43   | 38.4 | 50.3 | 58  | 204 | 25   | 1004 |
| Poland               | 0.855 | 24117  | 4.5 | 0.137 | 77.6 | 11.9 | 31.8 | 74.1 | 60.8 | NA  | 124 | 284  | 5754 |
| Portugal             | 0.843 | 26104  | 6.2 | 0.091 | 81.2 | 8.9  | 35.5 | 79   | 61.6 | 99  | 113 | 24   | 4363 |
| Qatar                | 0.856 | 129916 | 1.9 | 0.542 | 78.3 | 9.8  | NA   | 73.3 | 98.9 | 100 | 221 | 5    | 2805 |
| Scotland             | 0.909 | 37931  | 7.6 | 0.131 | 80.8 | 13.3 | 33.2 | 84.2 | 79.7 | 100 | 271 | NA   | 6263 |
| Slovenia             | 0.89  | 28664  | 6.6 | 0.053 | 80.6 | 12.1 | 25.4 | NA   | 49.8 | 99  | 103 | 23   | 5113 |
| South Africa         | 0.666 | 12087  | 8.5 | 0.394 | 57.7 | 10.3 | 63   | 64   | 62.4 | 91  | 46  | 86   | 3382 |
| South Korea          | 0.901 | 34541  | 4   | 0.067 | 82.1 | 12.2 | 31.6 | NA   | 83.5 | 98  | 526 | 267  | 3975 |
| Spain                | 0.884 | 32779  | 6.4 | 0.081 | 82.8 | 9.8  | 36.2 | 78.1 | 77.6 | 100 | 93  | 150  | 4481 |
| Sweden               | 0.913 | 46251  | 10  | 0.048 | 82.3 | 12.3 | 29.2 | 81.7 | 85.4 | 100 | 24  | 494  | 6668 |
| Taiwan***            | 0.885 | 45582  | NA  | NA    | 80.2 | NA   | 33.6 | NA   | NA   | NA  | NA  | 24   | 2622 |
| Thailand             | 0.74  | 14519  | 5.6 | 0.366 | 74.6 | 7.9  | 37.8 | 58.3 | 34.4 | 96  | 135 | 33   | 1755 |
| United Arab Emirates | 0.84  | 66203  | 2.6 | 0.232 | 77.1 | 9.5  | NA   | 70.9 | 84.7 | 100 | 111 | 2    | 2592 |
| United States        | 0.92  | 53245  | 8.3 | 0.203 | 79.2 | 13.2 | 41.5 | 84.6 | 82.6 | 99  | 35  | 2522 | 4107 |
| Uruguay              | 0.795 | 19148  | 6.1 | 0.284 | 77.4 | 8.6  | 39.7 | 69.7 | 92.6 | 100 | 20  | 10   | 3600 |
| Venezuela            | 0.767 | 15129  | 1.5 | 0.461 | 74.4 | 9.4  | 46.9 | 50.2 | 93.7 | 93  | 36  | 15   | 710  |
| Wales                | 0.909 | 37931  | 7.6 | 0.131 | 80.8 | 13.3 | 33.2 | 84.2 | 79.7 | 100 | 271 | NA   | 5778 |
| Zimbabwe             | 0.516 | 1588   | NA  | 0.54  | 59.2 | 7.7  | 43.2 | NA   | 39.1 | 80  | 42  | 8    | 2103 |

1191 Note: HDI = Human Development Index, GNI = Gross National Income, GDP = Gross Domestic  
1192 Product, GII = Gender Inequality Index, NA= not available. Sources of information: a., United Nations  
1193 Development Programme;<sup>21</sup> b. and e., the World Bank;<sup>94,95</sup> c., the Economist Intelligence Unit;<sup>96</sup> d.,  
1194 United Nations, Department of Economic and Social Affairs,<sup>97</sup> f., the Wikimedia Foundation,<sup>98</sup> and g., the  
1195 distance to the Equator was calculated from the latitude and longitude from *Latlong.net*.<sup>99</sup> \* For  
1196 Guernsey, the HDI sourced from the United Nations Economic and Social Commission for Asia and the  
1197 Pacific,<sup>100</sup> the life expectancy at birth, population size, and the population density sourced from the  
1198 United States Central Intelligence Agency,<sup>101</sup> and the Gini index sourced from the State of Guernsey.<sup>102</sup>



1199 \*\*For Jersey, the HDI sourced from<sup>100</sup>, the life expectancy at birth, population size, and the population  
1200 density sourced from the United States Central Intelligence Agency,<sup>101</sup> and the Gini index sourced from  
1201 the State of Jersey.<sup>103</sup> \*\*\*For Taiwan, the HDI, the GNI per Capita, the life expectancy at birth and the  
1202 Gini index come from the National Statistics, Republic of China (Taiwan).<sup>104</sup> For England, Scotland, and  
1203 Wales, the official data for UK were reported.

1204

1205

1206 **Table 4: Grades assigned to the 10 core physical activity indicators for the 49 countries of the**  
 1207 **Global Matrix 3.0**

|                       | PA  | SP  | AP  | AT | SB  | PF  | FAM | SCH | COM | GOV | AVG |
|-----------------------|-----|-----|-----|----|-----|-----|-----|-----|-----|-----|-----|
| Australia             | D-  | B-  | INC | D+ | D-  | D+  | C+  | B+  | A-  | D   | C-  |
| Bangladesh            | C-  | INC | INC | C- | A-  | INC | INC | INC | INC | C-  | C   |
| Belgium<br>(Flanders) | F   | B   | INC | C+ | C   | INC | C+  | B-  | B   | B   | C   |
| Botswana              | INC | INC | D-  | C  | B-  | INC | INC | C-  | INC | C   | C-  |
| Brazil                | D   | C+  | D+  | C  | D-  | D   | C-  | C   | C-  | D+  | D+  |
| Bulgaria              | D+  | C+  | C+  | B- | D   | INC | D   | C   | C   | INC | C-  |
| Canada                | D+  | B+  | D   | D- | D+  | D   | C+  | B-  | B+  | C+  | C-  |
| Chile                 | D-  | D-  | INC | F  | C-  | D   | F   | D   | B   | B-  | D   |
| China                 | F   | D-  | D+  | C+ | F   | D   | D+  | D+  | F   | F   | D-  |
| Colombia              | D+  | C   | INC | B  | D+  | D-  | INC | D   | B-  | B   | C-  |
| Czech Republic        | D   | B-  | D-  | C+ | D-  | C+  | C+  | B+  | B   | C+  | C   |
| Denmark               | D-  | A-  | INC | B+ | D+  | INC | INC | A-  | B+  | A-  | B-  |
| Ecuador               | D   | INC | INC | C- | C   | INC | F   | INC | D+  | INC | D   |
| England               | C-  | D+  | INC | C- | D+  | C-  | INC | B+  | C   | INC | C-  |
| Estonia               | D-  | C   | F   | D  | F   | INC | D   | C+  | B   | B   | D+  |
| Ethiopia              | D   | C   | B   | C  | F   | INC | F   | D   | F   | D   | D   |
| Finland               | D   | C+  | C   | B+ | D-  | C   | B-  | A   | B+  | A-  | C+  |
| France                | D   | C-  | INC | C- | D-  | B-  | INC | B   | INC | C   | C-  |
| Germany               | D-  | B   | D-  | C- | D-  | INC | B-  | B+  | B+  | INC | C   |
| Ghana                 | C   | C+  | B-  | C+ | INC | INC | F   | D   | D+  | D   | D+  |
| Guernsey              | D   | C+  | INC | D  | C   | INC | INC | INC | INC | D   | D+  |
| Hong Kong             | C-  | C   | INC | B+ | C-  | D   | D-  | C   | B   | C   | C-  |
| India                 | D   | INC | C-  | B- | C-  | F   | D   | INC | D   | D   | D   |
| Japan                 | INC | B-  | INC | A- | C-  | A   | C-  | B+  | B-  | B   | B-  |
| Jersey                | D-  | INC | INC | D+ | C   | D   | C   | B-  | C   | D   | D+  |
| Lebanon               | D   | F   | INC | D  | C-  | INC | INC | D   | INC | C+  | D   |

RUNNING HEAD: Global Matrix 3.0 of Report Card Physical Activity Grades

|                      |    |     |     |     |     |     |     |     |     |     |    |
|----------------------|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|----|
| Lithuania            | C- | C   | INC | C-  | C-  | C+  | D   | C+  | C   | C   | C- |
| Mexico               | D+ | C   | INC | C+  | D-  | INC | INC | D+  | D+  | C   | D+ |
| Nepal                | D+ | INC | INC | A-  | B+  | INC | A   | INC | C-  | INC | B- |
| Netherlands          | C  | B   | B   | B-  | C-  | INC | INC | C   | INC | INC | C+ |
| New Zealand          | D- | B   | C+  | C-  | D   | INC | C-  | B-  | B   | B+  | C  |
| Nigeria              | C  | C-  | C   | B   | B-  | INC | INC | C-  | INC | B   | C  |
| Poland               | D- | D   | INC | C   | D   | C-  | C-  | B   | C   | C+  | C- |
| Portugal             | D  | B-  | INC | C-  | C-  | C   | C   | A   | B   | B   | C+ |
| Qatar                | D  | D+  | INC | N/A | D+  | INC | INC | C   | INC | B+  | C- |
| Scotland             | F  | B   | INC | C   | F   | INC | INC | INC | B-  | C   | D+ |
| Slovenia             | A- | C+  | D   | C   | B+  | A-  | B+  | A   | B   | A   | B  |
| South Africa         | C  | D   | INC | C   | INC | INC | C-  | D-  | C-  | C   | D+ |
| South Korea          | F  | C   | INC | B+  | D   | D+  | INC | D+  | INC | D   | D+ |
| Spain                | D  | B   | C-  | B-  | B+  | INC | INC | C+  | INC | INC | C+ |
| Sweden               | D+ | B+  | INC | C   | C+  | INC | INC | C+  | A   | B   | C+ |
| Taiwan               | F  | D-  | INC | C-  | C-  | B-  | INC | B+  | B+  | B+  | C  |
| Thailand             | D- | C-  | F   | C   | D-  | INC | B   | B   | B-  | B+  | C- |
| United Arab Emirates | F  | INC | INC | INC | C-  | INC | INC | D-  | INC | B+  | D+ |
| United States        | D- | C   | INC | D-  | D   | C-  | INC | D-  | C   | INC | D  |
| Uruguay              | D  | F   | INC | C   | C-  | C-  | INC | C-  | INC | D   | D  |
| Venezuela            | D  | D   | INC | B-  | INC | INC | INC | INC | D-  | F   | D  |
| Wales                | D+ | C+  | C-  | D+  | F   | INC | D   | INC | INC | C+  | D+ |
| Zimbabwe             | C+ | B   | D+  | A-  | B   | INC | INC | C   | D   | C-  | C  |

1208

1209 Note: PA = Physical Activity, SP = Organized Sport and Physical Activity, AP = Active Play, AT =

1210 Active Transportation, SB = Sedentary Behaviors, PF = Physical Fitness, FAM = Family and Peers, SCH

1211 = School, COM = Community and Environment, GOV = Government, AVG = Average, INC =

1212 incomplete grade, and N/A = not applicable.

1213

1214 **Table 5: Descriptive statistics of the grades by indicator and groups of indicators for the 49**  
 1215 **countries of the Global Matrix 3.0**

|                                       | Grade count | Incomplete grades | Mean number grade | SD  | Mean letter grade |
|---------------------------------------|-------------|-------------------|-------------------|-----|-------------------|
| Overall Physical Activity             | 47          | 2                 | 5.2               | 2.1 | D                 |
| Organized Sport and Physical Activity | 42          | 7                 | 8.2               | 2.7 | C                 |
| Active Play                           | 20          | 29                | 6.5               | 2.7 | D+                |
| Active Transportation                 | 47          | 2                 | 8.3               | 2.5 | C                 |
| Sedentary Behaviors                   | 46          | 3                 | 6.4               | 2.8 | D+                |
| Physical Fitness                      | 22          | 27                | 7.1               | 2.9 | C-                |
| Family and Peers                      | 27          | 22                | 7.0               | 3.1 | D+                |
| School                                | 41          | 8                 | 8.8               | 3.0 | C                 |
| Community and Environment             | 36          | 13                | 8.9               | 3.0 | C                 |
| Government                            | 41          | 8                 | 8.6               | 3.1 | C                 |
| Behavioral indicators                 | 49          | 0                 | 7.0               | 1.6 | C-                |
| Sources of influence indicators       | 49          | 0                 | 8.3               | 2.5 | C                 |
| All indicators                        | 49          | 0                 | 7.5               | 1.6 | C-                |

1216 Note: Behavioral indicators = Average of Overall Physical Activity, Organized Sport and Physical  
 1217 Activity, Active Play, Active Transportation, Sedentary Behavior indicator grades; Source of influence  
 1218 indicators = Average of Family and Peers, School, Community and Environment, and Government  
 1219 indicator grades. Physical Fitness was not included in the behavioral indicators cluster. There are no  
 1220 missing grades for the bottom three rows because these scores are adjusted for missing grades.

1221

1222

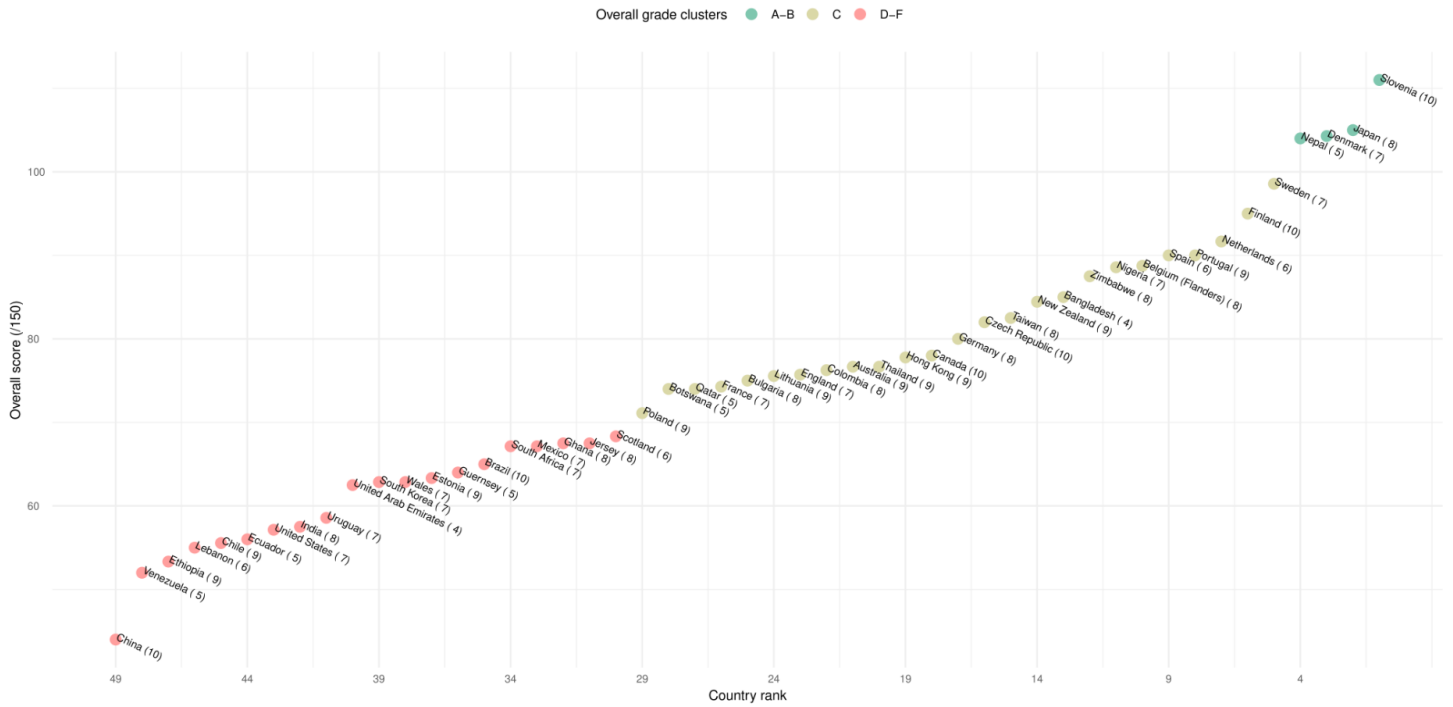
1223 **Table 6: Average grades by indicator and group of indicators for the three HDI categories (low and**  
 1224 **medium, high, and very high)**

|                                       | Low and medium HDI | High HDI | Very high HDI |
|---------------------------------------|--------------------|----------|---------------|
| Overall Physical Activity             | C-                 | D-       | D-            |
| Organized Sport and Physical Activity | C                  | D+       | C+            |
| Active Play                           | C-                 | D        | D+            |
| Active Transportation                 | C+                 | C        | C-            |
| Sedentary Behaviors                   | C+                 | D        | D+            |
| Physical Fitness                      | F                  | D        | C-            |
| Family and Peers                      | D+                 | D+       | C-            |
| School                                | D+                 | C-       | C+            |
| Community and Environment             | D                  | D+       | B-            |
| Government                            | C-                 | D+       | C+            |
| Behavioral indicators                 | C                  | D+       | D+            |
| Sources of influence indicators       | D+                 | D+       | C+            |
| All indicators                        | C-                 | D+       | C-            |

1225 Note: HDI = Human development index; Behavioral indicators = Average of Overall Physical Activity,  
 1226 Organized Sport and Physical Activity, Active Play, Active Transportation, Sedentary Behavior indicator  
 1227 grades; Source of influence indicators = Average of Family and Peers, School, Community and  
 1228 Environment, and Government indicator grades. Physical Fitness was not included in the behavioral  
 1229 indicators cluster. There are no missing grades for the bottom three rows because these scores are  
 1230 adjusted for missing grades.

1231

1232 **Figure 1: Plot of the overall score estimated for the 10 core indicators for the 49 countries of the**  
 1233 **Global Matrix 3.0**



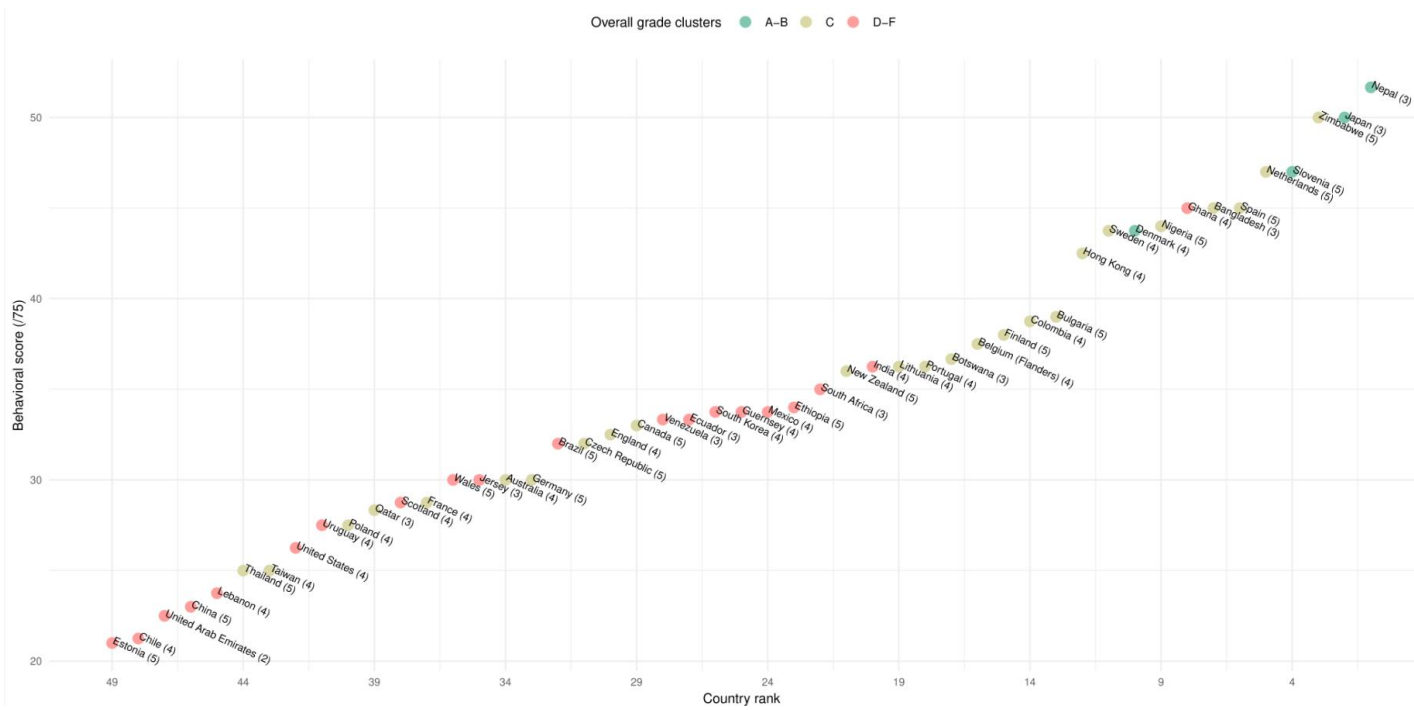
1234

1235 Note: The overall score was adjusted for missing and incomplete grades. The number in parenthesis

1236 shows the number of grades available for the calculation of the score.

1237

1238 **Figure 2: Plot of the behavioral score estimated for the 49 countries of the Global Matrix 3.0**



1239

1240 Note: The behavioral score was adjusted for missing and incomplete grades. The number in parenthesis

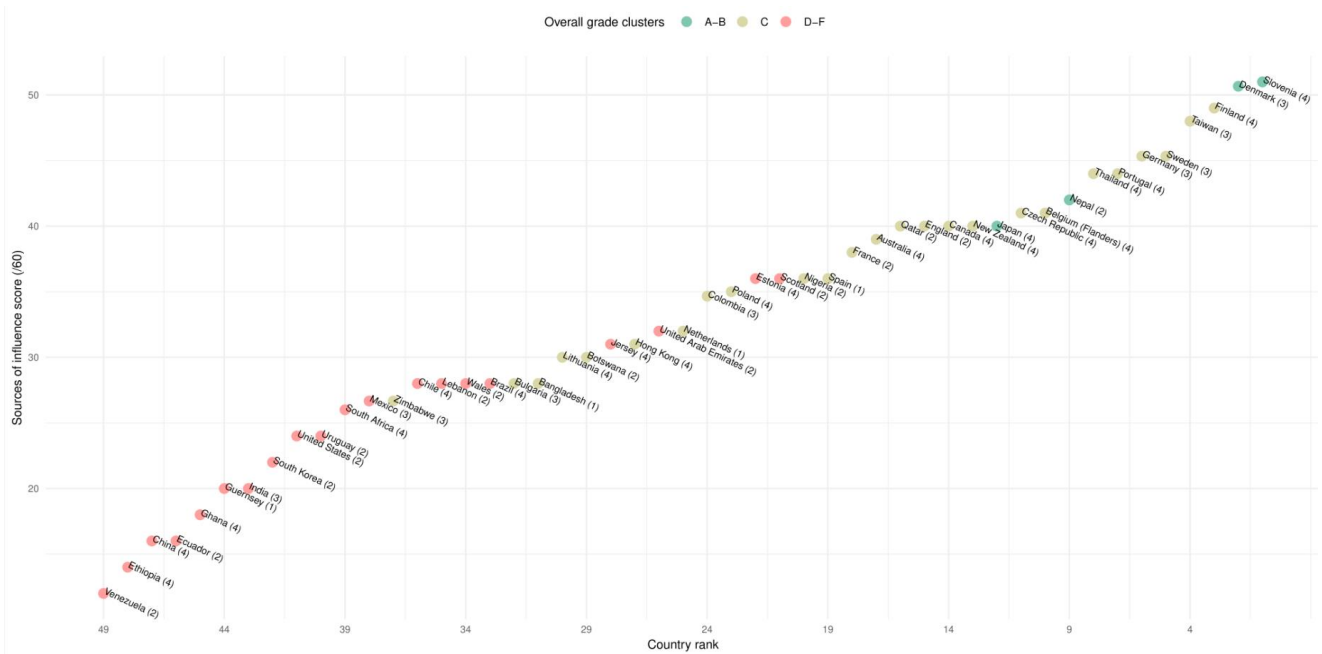
1241 shows the number of grades available for the calculation of the score.

1242



1243 **Figure 3: Plot of the source of influence indicators score for the 49 countries of the Global Matrix**

1244 **3.0**



1245

1246 Note: The source of influence score was adjusted for missing and incomplete grades. The number in  
 1247 parenthesis shows the number of grades available for the calculation of the score. These estimates of  
 1248 sources of influence score are interpreted with a high degree of caution as they are likely imprecise  
 1249 estimates of sources of influence due to the level of missing data used to determine this score.