Physical Activity 2016: Progress and Challenges

Progress in physical activity over the Olympic quadrennium

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On the eve of the 2012 summer Olympic Games, the first *Lancet* Series on physical activity established that physical inactivity was a global pandemic, and global public health action was urgently needed. The present paper summarises progress on the topics covered in the first Series. In the past 4 years, more countries have been monitoring the prevalence of physical inactivity, although evidence of any improvements in prevalence is still scarce. According to emerging evidence on brain health, physical inactivity accounts for about 3·8% of cases of dementia worldwide. An increase in research on the correlates of physical activity in low-income and middle-income countries (LMICs) is providing a better evidence base for development of context-relevant interventions. A finding specific to LMICs was that physical inactivity was higher in urban (*vs* rural) residents, which is a cause for concern because of the global trends toward urbanisation. A small but increasing number of intervention studies from LMICs provide initial evidence that community-based interventions can be effective. Although about 80% of countries reported having national physical activity policies or plans, such policies were operational in only about 56% of countries. There are important barriers to policy implementation that must be overcome before progress in increasing physical activity can be expected. Despite signs of progress, efforts to improve physical activity surveillance, research, capacity for intervention, and policy implementation are needed, especially among LMICs.

Introduction

Every 4 years, the summer Olympic Games divert much of the world's attention from the conflicts and tragedy that regularly dominate the news. The sight of talented athletes pushing their bodies to the limits inspires some viewers to greater achievements in sport and life. Health professionals hope that 2 weeks of exposure to images and stories of athletics will lead viewers to make increased efforts to be physically active in their own lives, even if at a much lower level than the athletes. Although no evidence has shown that the Olympics impact physical activity in the host country or elsewhere,[1] the Olympic Games aim a powerful media spotlight on human movement.

As the London Olympic Games were poised to open in July, 2012, the first *Lancet* Series on physical activity identified physical inactivity as a global pandemic and urgent public health priority. A wide variety of interventions have been shown to be effective, but they have not been widely implemented, so public health agencies were called upon to collaborate with sectors such as transportation, health care, and sport to mount a stronger response to this health challenge.[2] The 2012 Series was widely covered in media worldwide, and the Series papers have been heavily cited. With the imminent inauguration of the 2016 summer Olympic Games in Rio de Janeiro, we ask how much progress has been made during the Olympic quadrennium in research, practice, and policy regarding physical activity.

This first paper in this second *Lancet* physical activity Series provides a progress report on the topics covered in the 2012 Series. Different approaches to identifying progress were taken that were deemed appropriate to each topic. The progress reports on physical activity surveillance and national policies to promote physical activity have strong continuity with papers in the first physical activity Series. Rather than provide an update on deaths from physical inactivity-related non-communicable diseases (NCDs), the present section on health effects summarises new evidence on the link between physical activity and dementia. To complement the papers in the first Series, the sections on correlates of physical activity and intervention studies focus specifically on progress in low-income and middle-income countries (LMICs). Authors of each section used different methods because of the diverse nature of the topics.

Progress on surveillance of physical inactivity worldwide

We used comparable country estimates for physical inactivity from WHO to analyse the evolution of physical activity surveillance over the Olympic quadrennium (panel 1). In 2012, we obtained adult physical inactivity surveillance data from 122 countries representing 88·9% of the world's population.[11] For the present analyses, data were available for 146 countries, representing 93·3% of the world's population (figure 1). The increased global population coverage was mainly due to the addition of populous nations such as Nigeria, Egypt, and Tanzania. Data were available from 82% (40 of 49) of high-income countries (HICs), 75% (41 of 55) of upper-middle-income countries (U-MICs), 69% (38 of 55) of lower-middle-income countries (L-MICs), and 77% (27 of 35) of low-income countries (LICs). The proportion of countries contributing surveillance data among adult populations increased in all regions, except southeast Asia: Africa (72–87%), Americas (43–57%), eastern Mediterranean (43–57%), Europe (68–75%), southeast Asia (82%, no change), and western Pacific (70–89%).

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Key messages

- In the 4 years since the 2012 *Lancet* Series that identified physical inactivity as a global pandemic, progress has been made in the breadth of national surveillance, evidence about physical activity as a protective factor for dementia, adoption of national policies and action plans, and research on correlates and interventions in low-income and middle-income countries. However, progress in the implementation of national actions to address one of the biggest health challenges of the 21st century has been insufficient.

- Most countries have done population surveys of physical activity, with an extra 24 countries providing adult data and 15 countries providing adolescent data since 2012. The global prevalence of physical inactivity was about 23% for adults and about 80% for school-going adolescents, although self-report data have limitations. Few countries provided trend data for adults, and trend data for adolescents showed an increase in proportion of people who were physically inactive in most countries.

- In addition to the major impact of physical inactivity on the global burden of non-communicable diseases documented 4 years ago, evidence now shows that almost 300 000 cases of dementia could be avoided annually if all people were adequately active, and this figure is increasing as the global population ages.

- Research examining reasons why people are and are not physically active has increased substantially in middle-income countries, but not in low-income countries. Unlike evidence from high-income countries, urban (*vs* rural) residence emerged as an inverse correlate of physical activity in low-income and middle-income countries (LMICs), which is a concern given global trends toward urbanisation. These results can be used to design interventions informed by local data.

- Research and evaluation of physical activity interventions has increased in LMICs. Although several examples of effective interventions have been reported, the evidence is still scarce. An important next step is to build capacity for intervention research in LMICs so interventions can be developed or adapted for local conditions, then rigorously assessed.

- Due largely to the inclusion of physical activity in the WHO Global Action Plan on NCDs and the establishment of a global target to reduce inactivity by 10% by 2025, many countries have now adopted national policies or action plans to increase physical activity. However, implementation appears to be weak. Meaningful action will require increasing the infrastructure and resources for physical activity, including providing capacity-building, country technical assistance, creating effective multisector coalitions, and reaching consensus on a few highest-priority actions for each country.

- Overall, physical activity surveillance, research, and policy adoption worldwide improved. However, policy implementation appears to be poor, and evidence of an increasing trend in global physical activity was absent. Thus, the global pandemic of physical inactivity remains, and the capacity for nations to respond is improving too slowly.

Panel 1: **WHO Global Health Observatory physical inactivity estimates**
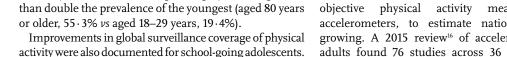
Adult estimates

The WHO Global Health Observatory displays comparable country prevalence estimates for physical inactivity among adults aged 18 years or older that are based on the global recommendations on physical activity for health.[3,4] The recommendations state that adults should do at least 150 min of moderate-intensity, or 75 min of vigorous-intensity aerobic physical activity per week, or an equivalent combination of the two.

Inclusion criteria were that data be from national or subnational cross-sectional population-based surveys undertaken with random sampling, reporting prevalence of inactivity based on the current[3] or former recommendations,[5] and including all domains of activity (work, household, transport, leisure). Through statistical regression modelling, when necessary, adjustments were made for the reported prevalence in case it was based on the former recommendations, known over-reporting of the International Physical Activity Questionnaire (IPAQ),[6–9] survey coverage if a survey only covered urban areas, and age coverage if the survey age range was narrower than 18 years or older. For comparison purposes, final estimates were adjusted to the WHO standard population.[10]

School-going adolescent estimates

The adolescent estimates used here reflect data from the WHO Global Health Observatory for school-going adolescents aged 11–17 years, based on the global recommendations on physical activity for health that indicate that youth should engage in at least 60 min of moderate-intensity to vigorous-intensity physical activity daily.[3,4]

Data were included if they came from national or subnational cross-sectional school surveys covering at least 3 years of the adolescent ages, reporting prevalence for the definition above, or for doing at least 60 min of physical activity on at least 5 days per week. Through statistical regression modelling, when necessary, adjustments were made to harmonise the definition to reflect the current physical activity recommendations, and for survey coverage if only urban areas were included.
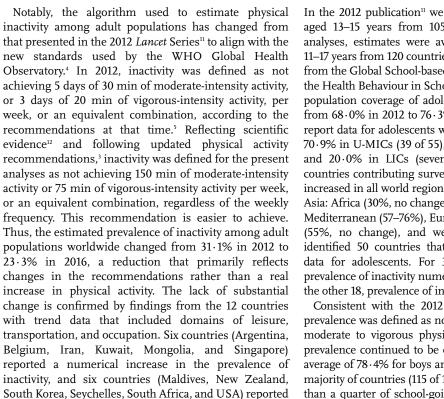
Figure 1: Physical activity data availability for school-going adolescents (aged 11–17 years) and adults (aged ≥18 years)
Data are from WHO Global Health Observatory, 2015.

Notably, the algorithm used to estimate physical inactivity among adult populations has changed from that presented in the 2012 *Lancet* Series[11] to align with the new standards used by the WHO Global Health Observatory.[4] In 2012, inactivity was defined as not achieving 5 days of 30 min of moderate-intensity activity, or 3 days of 20 min of vigorous-intensity activity, per week, or an equivalent combination, according to the recommendations at that time.[5] Reflecting scientific evidence[12] and following updated physical activity recommendations,[3] inactivity was defined for the present analyses as not achieving 150 min of moderate-intensity activity or 75 min of vigorous-intensity activity per week, or an equivalent combination, regardless of the weekly frequency. This recommendation is easier to achieve. Thus, the estimated prevalence of inactivity among adult populations worldwide changed from 31·1% in 2012 to 23·3% in 2016, a reduction that primarily reflects changes in the recommendations rather than a real increase in physical activity. The lack of substantial change is confirmed by findings from the 12 countries with trend data that included domains of leisure, transportation, and occupation. Six countries (Argentina, Belgium, Iran, Kuwait, Mongolia, and Singapore) reported a numerical increase in the prevalence of inactivity, and six countries (Maldives, New Zealand, South Korea, Seychelles, South Africa, and USA) reported a decrease (for references for trends see appendix p 1). Notable disparities remain in the prevalence of physical inactivity between men and women, with 137 of the 146 countries showing higher inactivity among women.[4,13] Older age groups continue to be at higher risk for inactivity, with the oldest age category showing more than double the prevalence of the youngest (aged 80 years or older, 55·3% *vs* aged 18–29 years, 19·4%).

Improvements in global surveillance coverage of physical activity were also documented for school-going adolescents.

In the 2012 publication[11] we analysed data of adolescents aged 13–15 years from 105 countries. For the present analyses, estimates were available for adolescents aged 11–17 years from 120 countries[4] (figure 1), with data mainly from the Global School-based Student Health Survey[14] and the Health Behaviour in School-aged Children Study.[15] The population coverage of adolescent surveillance increased from 68·0% in 2012 to 76·3% in 2016. Availability of self-report data for adolescents was 81·6% in HICs (40 of 49), 70·9% in U-MICs (39 of 55), 60·0% in L-MICs (33 of 55), and 20·0% in LICs (seven of 35). The proportion of countries contributing surveillance data from adolescents increased in all world regions, except Africa and southeast Asia: Africa (30%, no change), Americas (57–77%), eastern Mediterranean (57–76%), Europe (64–68%), southeast Asia (55%, no change), and western Pacific (33–78%). We identified 50 countries that reported comparable trend data for adolescents. For 32 of the 50 countries, the prevalence of inactivity numerically increased, whereas for the other 18, prevalence of inactivity decreased.

Consistent with the 2012 Series, adolescent inactivity prevalence was defined as not achieving at least 60 min of moderate to vigorous physical activity daily.[3,11] Inactivity prevalence continued to be extremely high, with a global average of 78·4% for boys and 84·4% for girls. In the vast majority of countries (115 of 120 countries with data), more than a quarter of school-going adolescents did not reach the recommended level of activity.[4,13] The apparent higher inactivity prevalence for adolescents than adults was partly a result of the higher recommended level for youth. However, prevalence cannot be compared directly across age groups because the questionnaires differed greatly.

Given known limitations of self-reports, the use of objective physical activity measures, such as accelerometers, to estimate national prevalence is growing. A 2015 review[16] of accelerometer studies in adults found 76 studies across 36 countries that had

See **Online** for appendix

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used devices in at least 400 participants, with 13 identified as national population-based cohorts. From this review, eight studies from seven HICs met our definition of reporting national prevalence.[17–25] Prevalence estimates varied from 1% to 52% for meeting physical activity recommendations. However, estimates were not comparable across countries as a result of large variations in data collection methods, data processing, and scoring. Experts agree that standardised accelerometer methods are needed,[16] and prevalence estimates from accelerometers should not be compared with self-report data.[25]

In children and adolescents (aged 5–19 years) we found accelerometer-based population prevalence estimates of engaging in 60 min or more of physical activity daily in six studies from five HICs.[17,21,23,26–28] Once again, prevalence estimates were not comparable and reflected methodological inconsistencies. The International Children's Accelerometry Database (ICAD) had accelerometry data from 20 studies worldwide, and allowed comparisons because of standardised methods,[29] but most samples were not nationally representative. ICAD data also showed large between-country physical activity prevalence variations ranging between 15% and 28%.[29]

> **Panel 2: Formulae for calculation of population attributable fraction (PAF)**
>
> **Formula 1 (unadjusted PAF)**
> Formula 1 provides an estimate for the PAF assuming no confounding exists between physical inactivity and dementia. It requires prevalence data for physical inactivity in the population (P_e) and an unadjusted relative risk (RR_{unadj});
>
> $$PAF\ (\%) = \frac{P_e(RR_{unadj}-1)}{P_e(RR_{unadj}-1)+1} \times 100$$
>
> Formula 1 provides a crude estimate for the PAF, but calculating an adjusted PAF is indicated because several confounding factors for physical inactivity and dementia have been previously identified (eg, genetic markers).
>
> **Formula 2 (adjusted PAF)**
> Formula 2 provides an estimate for the PAF assuming that confounding exists between physical inactivity and dementia. It requires prevalence data for physical inactivity in people eventually developing dementia (P_d) and the adjusted relative risk (RR_{adj});
>
> $$PAF\ (\%) = \frac{P_d(RR_{adj}-1)}{RR_{adj}} \times 100$$
>
> Formula 2 provides a conservative estimate for the PAF because some of the confounders included in the calculation of the RR_{adj} are exacerbated by physical inactivity (eg, physical function).

Comment

More countries are collecting physical activity surveillance data, although reporting on adolescents in LICs has not improved much. About a quarter of adults and 80% of adolescents were not meeting guidelines according to self-report data. Though trend data were scarce, no evidence has shown that physical inactivity declined globally. More countries are using objective measures for surveillance, demonstrating feasibility. To promote wide use of objective measures for surveillance, methods should be standardised, and data collection in LICs should be supported.

Health consequences of physical inactivity: focus on dementia

In the 2012 *Lancet* Series, Lee and colleagues[30] reported large global population attributable fractions (PAFs) of physical inactivity for coronary heart disease (6%), type 2 diabetes (7%), breast cancer (10%), colon cancer (10%), and all-cause mortality (9%). These estimates have probably changed little, but understanding of other health consequences of physical inactivity has progressed. The most notable of these might be the association between physical activity and cognition.

Growing evidence supports the role of physical activity in developing and maintaining cognitive capacity throughout life. Previous work has focused heavily on biophysiological plausibility derived from animal studies and findings from neuroanatomy.[31] Methodological advances have enabled studies that show the impact of physical activity on neurogenesis, neuroelectric potentiation, and neurochemical factors in the hippocampus and areas of the brain responsible for higher levels of executive control during childhood.[32] These findings are consistent with substantial evidence of improved cognitive function and scholastic achievement in physically active children.[31–33]

In adult populations, a large body of observational data[34] suggests that physical activity can contribute to preventing dementia, and some experimental evidence has shown neurobiological changes in response to visuomotor training,[35] which supports the plausibility of a causal relationship. This relationship is of increasing importance in an ageing population globally. WHO estimates that 47·5 million people are living with dementia.[36] Approximately 7·7 million new diagnoses are made each year worldwide, and 58% of existing cases are from LMICs.[36,37] 60–70% of dementia cases are thought to be caused by Alzheimer's disease, and previous estimates suggest that 12·7% of cases could be avoided worldwide if physical inactivity was eliminated.[36,38] Although this calculation was made using an adjusted relative risk (RR), Norton and colleagues[38] applied a formula for unadjusted estimates of PAF. Consequently, assessment of an appropriately adjusted PAF is indicated, and we focused on the broader diagnosis of dementia, which has not been assessed previously.

	Prevalence of inactivity in population	Prevalence of inactivity in people eventually developing dementia	Population attributable fraction with unadjusted relative risk	Population attributable fraction with adjusted relative risk
Overall	23·8% (4·1–65·0)	27·9% (4·8–76·2)	12·3% (2·4–27·7)	3·8% (0·7–10·5)
WHO region				
Africa	20·8% (5·8–46·9)	24·4% (6·8–55·0)	10·9% (3·3–21·7)	3·4% (0·9–7·6)
Eastern Mediterranean	38·2% (15·6–61·0)	44·8% (18·3–71·5)	18·4% (8·4–26·5)	6·2% (2·5–9·9)
Europe	22·8% (9·5–42·9)	26·7% (11·1–50·3)	11·8% (5·3–20·2)	3·7% (1·5–6·9)
Latin America and Caribbean*	31·1% (13·3–63·6)	36·4% (15·6–74·5)	15·5% (7·3–27·3)	5·0% (2·1–10·3)
North America	27·8% (23·2–32·4)	32·6% (27·2–38·0)	14·0% (12·0–16·0)	4·5% (3·7–5·2)
Southeast Asia	14·8% (4·1–30·7)	17·3% (4·8–36·0)	8·0% (2·4–15·3)	2·4% (0·7–5·0)
Western Pacific	24·0% (5·6–65·0)	28·1% (6·6–76·2)	12·4% (3·2–27·7)	3·9% (0·9–10·5)
World Bank income classification				
High	28.7% (9·5–61·0)	33·6% (11.1–71·5)	14·5% (5·3–26·5)	4·6% (1·5–9·9)
Upper middle	27·9% (14·8–65·0)	32·6% (17·3–76·2)	14·1% (8·0–27·7)	4·5% (2·4–10·5)
Lower middle	20·6% (5·6–45·1)	24·1% (6·6–52·8)	10·8% (3·2–21·0)	3·3% (0·9–7·3)
Low	14·8% (4·1–27·5)	17·3% (4·8–32·2)	8·0% (2·4–14·0)	2·4% (0·7–4·4)

Data are median (range of median for all relevant countries); details of country-specific values are provided in appendix p 7. Physical inactivity was defined as insufficient physical activity to meet current recommendations. *WHO region of the Americas split into Latin America and Caribbean, and North America to ensure consistency with previously published paper.[30]

Table 1: Summary of estimates of prevalence of physical inactivity and population attributable fractions for dementia associated with physical inactivity

We applied similar methods to those described for the analysis of disease burden in the 2012 *Lancet* Series to calculate both adjusted and unadjusted PAFs (panel 2).[30] We searched MEDLINE and Embase databases using keywords related to physical activity ("physical activity", "motor activity", "energy expenditure", "walking", "exercise") and dementia ("dementia", "cognitive decline", "cognitive impairment", "cognition", "Alzheimer's disease") as of April 1, 2015. We screened 9396 titles to identify the most recent peer-reviewed meta-analysis reporting an adjusted RR.[34] The unadjusted RR was calculated using crude data, and age-adjusted data from the papers was included in this meta-analysis (appendix p 4).

During our literature review we also identified relevant cohort studies to estimate the prevalence of physical inactivity in people who eventually developed dementia. This identification involved calculating an adjustment factor for each study by taking a ratio of baseline physical inactivity for subsequent dementia cases to baseline physical inactivity for the entire study population (appendix p 5).[30] The average adjustment factor across studies was 1·17 (SE 0·07). This adjustment factor was applied to the most recent WHO data to estimate the prevalence of physical inactivity in subsequent dementia cases.[13]

The results are summarised in table 1. Blondell and colleagues[34] pooled maximally adjusted RRs for the association between physical activity and dementia. The pooled RR was 0·86 (95% CI 0·76–0·97). Taking the inverse to obtain the adjusted RR for inactivity, we calculated an RR of 1·16 (95% CI 1·03–1·32). Our calculation of the pooled unadjusted RR was 1·59 (95% CI 1·35–1·82). The adjusted PAF of physical

inactivity for dementia ranged from 0·7% (Nepal) to 10·5% (Cook Islands), with an overall median of 3·8%. This finding suggests that 292 600 new dementia cases could be avoided globally each year if all people were active. If physical activity does not improve, this number is likely to increase substantially as the proportion of the global population who are older adults (aged 65 years and older) continues to grow. Table 1 also summarises differences in PAF patterns according to WHO regions and the 2014 World Bank classifications of income status. When considering WHO regions, the median PAF was lowest in southeast Asia (2·4%) and highest in the eastern Mediterranean (6·2%). The median PAF was lowest in LICs (2·4%) and highest in HICs (4·6%). We also calculated PAFs by country and applied 10 000 Monte Carlo simulations to estimate 95% CI (appendix p 7).

The adjusted PAF of physical inactivity for dementia appears to be modest compared with the disease outcomes reported in the 2012 *Lancet* Series, which ranged from about 6% to 10%.[30] However, the previous calculations were based on a higher prevalence of physical inactivity globally, primarily because of the revised 2010 physical activity recommendations[3] (see preceding section on surveillance of physical inactivity). When using the same physical activity data and recommendations as applied by Lee and colleagues,[30] we calculated a median PAF of 5·7% for dementia.

In reporting the PAFs we focused on the adjusted results and consequently might have overadjusted for factors on the causal pathway. The use of underestimated physical inactivity prevalence could have also contributed to conservative PAF estimates. Finally, despite using low versus high physical activity for calculating the RRs, the

comparison group was not truly inactive, and our results might still be conservative relative to estimates for other risk factors (eg, reference group for calculating a PAF for smoking is non-smokers).

Comment

Dementia is growing as a global health priority because of the rapidly increasing numbers of older adults. Evidence about the role of physical inactivity in dementia makes it a timely topic for analysis of global health impact. The PAF of physical inactivity for dementia was 3·8%, which is substantial but lower than PAFs for other NCDs.

Progress in research on correlates and determinants of physical activity in LMICs

Understanding physical activity correlates (cross-sectional) and determinants (prospective) is crucial to designing effective interventions that target evidence-based mechanisms of change. Among recommendations to use objective physical activity measures, apply prospective designs, and target understudied populations,[39] research in LMICs is especially urgent, because almost three-quarters of NCD deaths (28 million) occur in these countries, indicating a large potential for preventive interventions.[4,13] To determine progress since the 2012 *Lancet* Series[39] we systematically searched articles on physical activity correlates in LMICs using similar methods to previous reviews[39,40] (appendix pp 10–13).

We screened 1383 articles and identified 197 relevant papers (appendix pp 13–30). The number of publications from LMICs increased from 7·2 publications per year in 1999–2011 to 32·8 publications per year between 2012 and February, 2015, while the number of countries in which studies were done was stable at 22–23 countries. Most studies were from U-MICs, especially Brazil and China. Improvements to methods included measurements of multiple physical activity domains (eg, transport, recreation) and use of accelerometers, but 94·2% of studies were cross-sectional rather than prospective.

The significance and direction of physical activity correlates reported in five or more studies are summarised in table 2. Studies of adults (aged 18–64 years) and older adults (aged 65 years and older) had mixed evidence of positive associations of younger age and male sex with higher physical activity, with a few studies showing inverse associations. Differences in sociocultural roles for older adults and women in LMICs might explain these different results. Regarding psychological and social factors, most of the directions of association were similar to those from HICs. For physical environmental factors, proximity to destinations, neighbourhood aesthetics, and access to open space were consistent correlates of higher physical activity, similar to results from HICs.

Some inconsistent results with HICs had important implications. In particular, high socioeconomic status and urban (*vs* rural) residence were related to lower physical activity among adults and youth. Rapid urbanisation, access to motorisation, and increases in sedentary work could be potential drivers of inactive lifestyles in LMICs.[41–43] Considering the increasing urbanisation worldwide,[44] activity-friendly urban design could be an effective strategy to mitigate the impacts of urbanisation on physical activity in LMICs.

In studies of children and adolescents, male sex, higher self-efficacy, participating in school sports, higher social support, proximity to destinations, and access to open space were consistent positive correlates. As was the case with adults, high socioeconomic status and urban residence emerged as inverse correlates of physical activity.

Comment

Publications on physical activity correlates from LMICs increased substantially since 2012. However, most studies were from a few U-MICs. The continuing dearth of studies from LICs highlights the gap between where research is done and where the largest public health impacts of physical inactivity are located.[45] Consistent correlates were found at individual, social, and environmental levels of influence, and most of the directions of association were similar to those from HICs. Implications of these results are that interventions should be developed that operate at multiple levels of influence and are informed by correlates of research from LMICs.

Progress in research on physical activity interventions in LMICs

The 2012 *Lancet* Series paper on physical activity interventions identified a paucity of studies in LMICs.[46] Therefore, this update identified intervention studies done in LMICs. We searched the English, Spanish, and Portuguese 2010–15 literature using the same search methods as in our 2012 paper.[46] We identified 147 potential papers using multiple search engines and completed full reviews of 64 relevant papers. The table in the appendix p 31, summarises study characteristics and results for the most relevant and highest-quality 15 papers.

Intervention strategies to increase physical activity in whole populations have been categorised as community-wide, informational, behavioural, social, policy, and built environmental approaches.[39,47,48] Intervention strategies were classified in a manner consistent with our 2012 *Lancet* Series paper.[46,49,50] Multilevel approaches that operate across personal (eg, biological, psychological), social (eg, family, co-workers), and built environmental (eg, neighbourhoods designed so that homes are near shops and services, access to parks, bicycle facilities) levels of influence could be more successful in increasing physical activity than those targeting only one level.[12] In this section we highlight some of the best LMIC interventions in each category. Case studies describing characteristics of several exemplary interventions from LMICs are in the appendix p 35.

Community-wide campaigns

Community-wide campaigns often use multicomponent (eg, media, behavioural, social, policy, and environmental), multisector (eg, public health, transportation, recreation, health care), and multisite (eg, work, school, community organisation) interventions.[46] Campaigns usually represent large-scale, high-intensity programming and often use multiple communication media to raise programme awareness and disseminate health messages. Community-wide interventions among

	Examined direction	Adults and elderly (n=124)		Children and adolescents (n=73)	
		Number of examined papers	Directions of associations	Number of examined papers	Directions of associations
Demographic and biological factors					
Age	Younger	78	+	37	+
Occupation or parent occupation	Manual or blue collar	9	00	..	..
Education	High education	68	+	..	..
Gender	Male	57	+	37	++
Cardiovascular risks	High risk	12	0	..	..
Family income and socioeconomic status	High income or socioeconomic status	52	–	34	–
Marital status	Married	43	0	..	..
Overweight and obesity	Overweight or obese	30	–	21	0
Race and ethnicity	Non-white	18	00	6	00
Parental education	High parental education			29	0
Psychological, cognitive, and emotional factors					
Perceived barriers	Barrier present	7	0	..	..
Perceived benefits	Benefits present	5	++	..	..
Perceived health and fitness	Healthy or high fitness	20	++	..	..
Psychological health and distress	Good psychological health	7	0	..	..
Self-efficacy	High self-efficacy	7	++	8	++
Behavioural attributes and skills					
Alcohol	More drinking	12	0	..	..
Dietary habits	High quality of diet	5	0	..	..
School sports, physical education, and supervised physical activity	Good education	..	..	13	++
Smoking status	Smoker	17	0	6	0
Sedentary behaviour (TV time, screen time, and sedentary time)	Highly sedentary	..	..	19	–
Social and cultural factors					
Exercise and physical activity role models	Role model present	..	..	5	+
Social support from friends and peers	Support present	7	++	8	++
Social support from spouse and family	Support present	5	0	9	++
Physical environment factors					
Access to destinations (land use mix)*: objective measurement	Good access	7	++	..	..
Access to destinations (land use mix): perceived measurement	Good access	12	++	9	++
Lighting	Adequate lighting	..	..	..	..
Enjoyable scenery and aesthetics	Good scenery	7	+	..	..
Traffic	Safe level of traffic	16	00	5	0
Neighbourhood safety from crime	Safe neighbourhood	21	0	7	0
Sidewalks, cycle lanes, and paths	Present	14	00	5	0
Urban location of residence	Urban living	17	–	12	–
Access to open space (eg, parks, trails, green space)	Good access	14	+	5	++
Walkability (composite)	Walkable	..	..	..	..
Street connectivity	High connectivity	6	–	..	..
Residential density	High density	10	0	..	..
Safety of facilities (eg, park safety, trail safety)	Safe facilities	..	..	..	..

Correlates or determinants for which less than five papers were reported were excluded from the table. ++=repeatedly documented positive association with physical activity. +=weak or mixed evidence of positive association with physical activity. 00=repeatedly documented absence of association with physical activity. 0=weak or mixed evidence of no association with physical activity. – –=repeatedly documented negative association with physical activity. –=weak or mixed evidence of negative association with physical activity. ··=not enough data available. *Land use mix refers to homes being near shops, services, and jobs, thus providing destinations within walking distance.

Table 2: Directions and strength of relationship of physical activity correlates or determinants in low-income and middle-income countries

LMICs that used multisector collaborations were reported from Iran,[51] China,[52] South Africa,[53] Vietnam,[54] and India and Indonesia.[55] Some campaigns targeted only physical activity, and others targeted multiple risk factors (appendix p 31). These studies, mostly using quasi-experimental designs, showed that evidence for community-wide campaigns has grown in number and quality among LMICs since our 2012 review.[46] Because of the diversity of approaches, contexts, and assessment methods, we could not identify principles of effective strategies used in these community-wide interventions.

Social support interventions in community settings
Strategies to increase social support for physical activity include buddy systems, behavioural contracting, and walking groups.[46] Promising interventions in LMICs that represent this approach were found with rural communities in India,[56] health-care workers in South Africa,[57] and women civil servants in Vanuatu, a South Pacific island.[58]

Physical activity classes in community settings
Providing physical activity classes in public settings was shown to be a promising strategy.[46] Parra and colleagues[59] showed the effectiveness of this strategy in Recife, Brazil. These results were supported by studies in Aracaju, Brazil,[60] and Santiago, Chile.[61]

School-based interventions
School-based interventions can increase physical activity among children during and after school.[46] Investigations in LMICs showed mixed results, with a study of classroom physical activity in Beijing, China, showing effectiveness over 2 years,[62] and a physical education intervention with favorable effects at one year[63] but a controlled study of girls in Karachi, Pakistan, showing no effects.[64] Further studies of school-based strategies in LMICs are encouraged to assess co-benefits for cognitive function and school performance given the positive findings for these outcomes in HICs[31–33,65] and their importance for school officials.

Community-wide policies and programmes
Community-wide policies and planning to improve built environments, combined with efforts to promote physical activity, have shown promise in Latin America.[46] This intervention strategy not only uses information to motivate individual behaviour change, but also provides built and social environmental support to sustain physical activity.[46] A study in Bogotá, Colombia, reported modest effectiveness among survey respondents who reported regularly using Ciclovia (streets closed to cars but open to cyclists and pedestrians) and Cicloruta (protected bicycle facilities) compared with irregular users.[66] The use of sport-for-development programmes is an emerging strategy in sub-Saharan Africa, where sport is used to promote physical activity and community cohesiveness, as well as to enhance human capital.[67]

Comment
15 studies of physical activity interventions in LMICs were identified, representing an increase from these resource-constrained contexts. Multiple types of interventions were assessed, and many of the studies reported increased physical activity. Quality of programme assessment was variable, so investigators are encouraged to apply a standard yet flexible approach to programme assessment.[68] These studies provided promising evidence that population-wide physical activity interventions can be effective in LMICs, especially those in which intersectoral collaboration exists. However, documentation of the development, adaptation, and assessment of physical activity interventions among LMICs needs to be improved. Greater implementation of evidence-based interventions could help control NCDs in LMICs.

Progress on national physical activity policies
Increasing physical activity requires multiple strategies, including policies in multiple sectors that lay out the problem, solutions, stakeholders, timelines, and desired outcomes. Without adequate national public policy, public health responses tend to be restricted in scope and strength, uncoordinated, underfunded, and shortterm. Since the 1990s, there has been a call for national physical activity policies and implementation (or action) plans,[69,70] but response was poor. The first global policy outlining national actions to address physical inactivity was not launched by WHO until 2004. The Global Strategy for Diet, Physical Activity and Health[71] laid out the epidemiological rationale for systematic national policy and action to increase physical activity. This call was reinforced in the UN Declaration on NCDs in 2011[72] and further defined in the Global Action Plan (GAP) for the Prevention and Control of NCDs, 2013–20. GAP positioned physical inactivity as one of the key NCD risk factors and set for all countries the target of achieving a 10% decrease in inactivity by 2025 (relative to each country's baseline).[73] Given these notable developments in global policy, it is timely to ask what progress has been made in the adoption and implementation of national physical activity policy in the decade since the WHO global strategy recommendations were made.

Collecting data on physical activity policy is difficult because of publication in different languages, definitional differences, relevance of multiple government ministries, accessibility of government reports, and challenges in verifying content. The development of physical activity policy audit tools[74] allows a more systematic approach, and several initiatives have commenced to track national policy and action initiatives.[75–77] In 2000, WHO initiated an assessment of NCD policy development and country capacity, and since 2013 this survey has formed part of the Global NCD Monitoring and Evaluation framework.[78]

Figure 2A shows the status of national policy on physical activity in 2010, 2013, and 2015 globally and by regions as assessed by WHO. By 2015, 91% of the 160 countries responding at all three timepoints reported having a national physical activity policy. This proportion has increased since 2010 (75%), which might reflect the increased global focus on NCDs and GAP. Notable progress was seen in countries in the African region (from 45% in 2010 to 100% in 2015), such that by 2015 all but the Americas region had over 90% of countries reporting the presence of physical activity in national policy. A decade ago only 29% of the 133 responding countries reported having a physical activity policy (figure 2B). However, having a policy and implementing the policy are distinctly different. Monitoring surveys done in 2010, 2013, and 2015 (figure 2B) included questions on the status of each policy, and results reveal a notable gap in policy implementation. In 2010, 75% of countries reported having a physical activity policy but only 44% reported their countries' policy to be operational—ie, both active and funded (figure 2B). The implementation gap remains clearly visible in 2013 and 2015, albeit narrowing (57% and 71% reported operational plans, respectively). Although this trend is positive, 2015 data reveal that globally approximately a quarter of national policies on physical activity are not being put into practice. Without policy implementation, substantial improvements in population physical activity are unlikely.

Despite good progress in developing national physical activity policy, the substantial implementation gap indicates countries are having difficulties in translating policy intent into action. Many local contextual challenges could occur, but three common barriers to policy action are highlighted here. The first barrier is an insufficient workforce to implement physical activity policies. WHO 2013 data show that 94% of countries now have an NCD unit within their ministry of health, an increase from 89% of countries in 2010 and 61% in 2000.[79] However, virtually no data are available on dedicated resources for implementation of physical activity strategies. Insufficient numbers of trained workers with knowledge and skills to develop, implement, and assess programmes and to build intersectoral partnerships will hinder a country's ambitions to increase physical activity. Experience in training a professional workforce and strengthening research capacity on physical activity has been accumulating, especially in the Americas. More than 50 physical activity and public health training courses coordinated by the US Centers for Disease Control and Prevention have produced over 3500 graduates who can develop and deliver national, state, and local actions.[80]

A second barrier to progress is the need to form and sustain effective multisector partnerships, deemed necessary because the policies that hinder physical activity are within transport, education, sport, recreation, and urban planning sectors.[81] Countries are showing
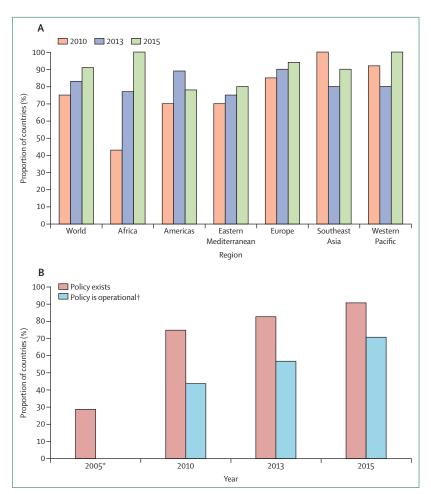

Figure 2: Progress on national physical activity policies
(A) Presence of national policy, strategy, or action plan (ie, physical activity plan or have physical activity incorporated in an integrated non-communicable disease plan) on physical activity in 160 countries by WHO region. Data were provided by WHO from Country Capacity Surveys done in 2010, 2013, and 2015; analysis includes only 160 countries with responses at all three timepoints. (B) Global progress and implementation of national policy and action plans on physical activity. Data are from WHO Country Capacity Survey Reports 2005, 2010, and 2013; unpublished data for 2015 were provided by WHO; n=160 countries included except in 2005 in which n=133 countries. *2005 survey item not identical to later years. †Operational refers to reporting the plan is being implemented and funded.

signs of establishing multisector collaborations to address NCDs. In 2013, 94% of countries reported such a mechanism, an increase from 61% in 2010.[78] However, only 33% of these countries reported that the committees remained operational in 2013, which is further evidence of the implementation gap and that securing cross-sectoral engagement in physical activity policies is a common challenge.

The third barrier to policy progress is the absence of clarity on the actions most likely to be effective and feasible in a given context. Until the global action plan on NCDs in 2013,[73] most of the national policies on physical activity came from Europe, North America, and Australasia. These policies drew on extensive scientific evidence, largely from the same regions. A frequent request from other regions is for support to develop the

evidence and select, adapt, and implement solutions that fit local cultural, religious, geographical, and economic contexts. Although the preceding section of this paper reports progress in physical activity intervention studies in LMICs, a stronger emphasis on physical activity interventions is needed, linked with national policies, to accelerate implementation of effective and promising strategies on a large scale. A clear consensus on effective interventions will support national policy making, and practical resources and toolkits can support implementation, particularly in LMICs. Civil society developed a consensus document of the seven best investments for increasing physical activity,[82] and a toolkit to guide implementation that is tailored to national contexts is warranted. The rapid adoption of national physical activity policies creates an opportunity and the need to create tools and resources to support improved implementation in each country, with a special focus on LMICs.

Comment

Almost all ministries of health now have NCD units, and most countries have a physical activity policy or action plan. However, implementation of physical activity policies appears to be scarce, probably because of an insufficient workforce with relevant skills, multisector partnerships, and clarity on the most effective interventions. Training programmes in physical activity and public health are available but need to be expanded.

Conclusion

In the 4 years since the 2012 *Lancet* Series on physical activity,[2] global progress on the topics covered in the present paper has been modest, yet each sign of progress indicates the shortcomings of current actions. More countries are collecting physical activity surveillance data than in previous years, but physical activity is not increasing worldwide. Although many studies show physical activity enhances brain health, this new knowledge has not yet been translated into action. Evidence on correlates of physical activity is increasing in LMICs, but few studies have been done in LICs. Although it is encouraging that effective interventions are being assessed in LMICs, strong assessment methods and tailoring to local contexts are needed. National physical activity policies and plans have been adopted by almost all countries, yet major challenges with implementation remain.

Progress on physical activity has been far from proportionate to the documented burden of disease from physical inactivity in countries of all income levels.[13,30] The most progress might have been made in putting physical activity on the health agenda of LMICs. LMICs are laying the groundwork for effective public health action on physical activity, but it is not clear where the resources will be found to scale up effective interventions, build a physical activity workforce in public health, expand research in LMICs, and take bold initiatives to alter policies that will increase physical activity in all countries.

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