



OPINION ARTICLE

REVISED Physical activity promotion in the age of climate change [version 2; peer review: 2 approved]

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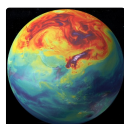
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Abstract

The importance of the global climate crisis requires linking physical activity promotion and climate action. This article provides a first overview of interconnections between physical activity promotion and climate action, potential synergies and discrepancies, aiming to stimulate further discussion about this topic. The analysis is based on the World Health Organization’s Global Action Plan on Physical Activity 2018-2030 (GAPPA). The GAPPA covers five perspectives that are of particular relevance with respect to potential links with climate policy: (1) Infrastructures supporting active transport, (2) green spaces and recreational/exercise facilities, (3) exercise programs, (4) mass communication campaigns and mass participation events and (5) training of professionals. Our analysis demonstrates a considerable alignment between strategies for physical activity promotion and efforts for the reduction of greenhouse gas emissions. However, in some of the areas, this alignment could still be improved. Additionally, more climate-conscious policies, research and surveillance need to be developed in the field of physical activity promotion.

Keywords

physical activity, sport, active transport, exercise, training, recreation, climate change, climate action



This article is included in the [Climate Action gateway](#).

Open Peer Review

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REVISED Amendments from Version 1

Major differences between this version and the previously published version:

- Table 1 was added to provide an overview about the strategic objectives and recommended policy actions of WHO's Global Action Plan on Physical Activity 2018–2030.
- New evidence was added to strengthen the argument of interconnections between physical activity promotion and the climate crisis.
- In the discussion it is now explicitly stated that the implementation of climate-conscious policies for physical activity promotion depends also on economic, political and cultural factors.
- A section about the limitations of this article was added.

Any further responses from the reviewers can be found at the end of the article

Introduction

In recent years, there has been a new wave of recognition regarding the urgency of the global climate crisis. The Intergovernmental Panel on Climate Change (IPCC) has clearly stated that the next ten years will be crucial for limiting global warming to less than 1.5 degrees Celsius¹. Studies by the World Bank predict the devastating impact global warming will have on development of poor countries² and consequently on migration³. The IPCC has also reported on the dramatic implications of climate change on land use⁴. Nonetheless, the United Nations have vividly described the acute failure to curb global greenhouse gas emissions⁵. In light of these sobering prospects, a number of American public health organizations have called on governments, business leaders and civil society to treat climate change as a “health emergency”⁶. Also, there have been calls from scientists to engage in civil disobedience as a mean to put pressure on world leaders to step up efforts to combat the climate crisis⁷.

Likewise, physical activity (PA) promotion has evolved significantly in the past decades and has asserted itself as a stand-alone public health issue⁸. This development was triggered by a robust understanding of the role of PA for the prevention of non-communicable diseases⁹ on the one hand and stubbornly high rates of insufficient physical activity in adolescents (81,0%)¹⁰ and adults (27,5%)¹¹ on the other. The policy response has resulted, among others, in the PA Strategy for the World Health Organization (WHO) European Region 2016–2025 (EuroPAS;¹²), the Global Action Plan on PA 2018–2030 (GAPPA;¹³), the EU Council Recommendation on Health-Enhancing PA across Sectors¹⁴, as well as numerous strategies, action plans and recommendations at the national level^{15–17}.

But are efforts to promote PA in any way linked to the climate crisis, and if so, what are these links? Will the climate crisis dampen efforts for PA promotion or, to the contrary, are there potential synergies, with PA promotion potentially supporting

efforts to combat climate change? What is the carbon footprint of different strategies currently employed or suggested to promote PA? What are potential upcoming research priorities in our field that relate to the climate crisis? These questions are highly relevant given the urgency of climate change and the need to prioritize limited resources. The global-level GAPPA acknowledges this by including a link to the United Nation's Sustainable Development Goals (SDGs), including SDG 13 on climate action. However, the link between PA promotion and climate change plays a rather minor role in the GAPPA and, in our opinion, still needs to be further explored. This article is an attempt to provide a first overview of the available information and stimulate further discussion about these topics. It focuses mainly on climate change mitigation and the relation of rising temperatures and PA promotion.

Interconnections between physical activity promotion and the climate crisis

The recent strategies developed by WHO to support national-level PA promotion provide a good overview of the most common action areas currently proposed. For example, the PA Strategy for the European Region¹² employs a life-course approach with four major action areas (leadership and coordination; children and adolescents; adults; older people; monitoring, surveillance, evaluation and research) and 14 specific objectives. The global-level GAPPA¹³ builds extensively on this earlier strategy and has very similar key messages, but it uses a slightly different structure with four strategic objectives (active societies; active environments; active people; active systems) and 20 specific policy actions (see Table 1). The overview provided in the next sections is based on this most recent WHO policy document, taking a closer look at its different policy actions using five perspectives that bear particular relevance for climate change.

Development of infrastructures to enable active transport

Several actions recommended by the GAPPA¹³ in the strategic objective “Create active environments” stress the need for governments to develop highly connected mixed-land-use neighborhoods (Action 2.1), to create infrastructures to increase active transport by walking and cycling as a means of PA promotion (Action 2.2) and to improve road safety (Action 2.3).

It will be evident to most readers that these recommendations line up with actions to promote sustainable mobility proposed elsewhere. For example, the UN Economic Commission for Europe has stated that in many nations, more than 30% of final energy (i.e. energy consumed by end users such as households, industry and agriculture) is consumed in transport¹⁸. The report concludes that cities striving to become carbon neutral should develop a comprehensive cycling/walking infrastructure and better integrate working, shopping and entertainment opportunities¹⁸. Also, the global “C40 Cities Climate Leadership Group” showcases cities around the world that strive to become carbon neutral by supporting active travel¹⁹. Cities such as Copenhagen have demonstrated that it is possible to increase the modal share of walking and cycling (currently 45% of all trips) beyond the share of car use (34%)¹⁹.

Table 1. Strategic objectives and recommended policy actions of the Global Action Plan on Physical Activity 2018–2030.

Strategic objectives	Policy actions (summary)
Create active societies	1.1. Implement best practice communication campaigns (...) to heighten awareness (...) of (...) the multiple health benefits of regular physical activity (...).
	1.2. Conduct national and community-based campaigns to enhance awareness (...) of (...) the social, economic, and environmental co-benefits of physical activity (...).
	1.3. Implement regular mass participation initiatives in public spaces (...).
	1.4. Strengthen pre- and in-service training of professionals, within and outside the health sector (...).
Create active environments	2.1. Strengthen the integration of urban and transport planning policies (...).
	2.2. Improve the level of service provided by walking and cycling network infrastructure (...).
	2.3. Accelerate implementation of policy actions to improve road safety (...).
	2.4. Strengthen access to good-quality public and green open spaces (...).
	2.5. Strengthen the policy, regulatory and design guidelines and frameworks (...) to promote (...) facilities (...) that are designed to enable occupants and visitors with diverse abilities to be physically active in and around the buildings.
Create active people	3.1. Strengthen provision of good-quality physical education (...).
	3.2. Implement and strengthen systems of patient assessment and counselling on increasing physical activity (...).
	3.3. Enhance provision of, and opportunities for, more physical activity programmes and promotion in parks and other natural environments (...).
	3.4. Enhance the provision of, and opportunities for, appropriately tailored programmes and services aimed at increasing physical activity (...) in older adults (...).
	3.5. Strengthen the development and implementation of programmes and services (...) to engage with (...) physical activity in the least active groups (...).
	3.6. Implement whole- of community initiatives (...).
Create active systems	4.1. Strengthen policy frameworks, leadership and governance systems (...) to support implementation of actions aimed at increasing physical activity (...).
	4.2. Enhance data systems and capabilities (...).
	4.3. Strengthen the national and institutional research and evaluation capacity and stimulate the application of digital technologies and innovation (...).
	4.4. Escalate advocacy efforts to increase awareness (...) of (...) joint action at the global, regional and national levels (...).
	4.5. Strengthen financing mechanisms to secure sustained implementation of national and subnational action (...).

In order to do so, however, more concerted action involving public health policymakers, practitioners and researchers on the one side and urban/transport planners on the other would be needed. Environmental and climate activists are another important asset in taking a strong stance against motorized transport. The GAPP recommends to use and further develop the WHO Health Economic Assessment Tool for Cycling and Walking (HEAT)²⁰ to enable an assessment of the health, climate and environment-related benefits of transport and urban design policies (Appendix 2 of the GAPP). On top of that, we would recommend promotion of good practice examples of cities that are already shifting from motorized traffic to active travel such as Copenhagen or Amsterdam. The direct public health burden of motorized transport may serve as an important supporting argument: Globally, there are 1.36 million deaths due to road fatalities (26% pedestrians and cyclists)²¹

and 3.2 million deaths related to ambient air pollution every year²². Scientific models have also shown that the health benefits of switching from car to bicycle for a commute of 5 km/day (one way) are worth about 1,300 € per person and year, while the negative effects of pollution and accidents are much smaller²³.

Green spaces and recreational/exercise facilities to promote PA

Another area of PA promotion with obvious climate connections relates to green spaces and recreational/exercise facilities. The GAPP addresses these in the context of the strategic objective “Create active environments” (Actions 2.4 and 2.5).

Besides binding carbon dioxide, parks and green spaces play an important role in climate-proofing cities by mitigating

urban heat islands²⁴. It has been shown that, in some cities, an additional square kilometer of green space per 1,000 people might prevent up to 7.4 deaths caused by heat²⁵, that parks have an average cooling effect of 0.94 °C²⁶ and that green spaces can directly and positively influence people's health²⁷. Furthermore, a study has shown that trees and non-tree vegetation have different effects on PA levels of different ethnic populations; however, non-tree vegetation was negatively associated with PA across all population groups²⁸. In these areas, public health and PA promotion objectives to create more green spaces align very closely with objectives for counteracting climate change. Some cities have already taken steps to expand green spaces by planting trees, such as Manchester²⁹, or by increasing inner-city vegetation as an important part of climate adaptation, such as Copenhagen³⁰.

By contrast, the “climate case” for other types of recreational and exercise facilities is far less clear. Our knowledge about the carbon footprints of such sites is currently limited. One study by Boussabaine *et al.*³¹ has shown that heated indoor-pools have a much higher energy consumption per square meter and year (1,250–1,750 kWh) than indoor gyms (210–350 kWh). Likewise, the use of fertilizers on the turf grass surfaces needed for many outdoor sports (e.g. football and cricket) causes high nitrogen dioxide emissions when compared to regular pastures, making these compounds a substantial contributor to land consumption³².

In order to better align efforts for PA promotion in this area with those for limiting global warming, the GAPPa recommends implementing assessments of public and green open spaces and natural spaces to evaluate health, climate and environmental benefits of urban ecosystems (Appendix 2 of the GAPPa). We suggest that, additionally, experts should engage with the urban planning and transport sectors to ensure that parks and green spaces are built in close proximity to people's homes and are easily accessible by active and public transport. Regarding recreational and exercise facilities, land-use and carbon footprint need to be considered in the planning of new facilities and the decision to maintain existing ones. One might also need to reconsider whether new outdoor facilities for sports that require vast land use (e.g. golf, baseball) should be built. Generally, facilities that require extensive heating or cooling are likely to have a higher carbon footprint, i.e. indoor facilities will tend to have a more negative impact on the climate than outdoor facilities. Therefore, newly built indoor infrastructures should preferably be multi-purpose and/or be able to contribute to energy production, e.g. via roof-mounted solar panels.

Physical activity and exercise programs

While many health promoters and researchers are likely to be aware of the potential links between active transport, PA facilities and climate change, other areas of PA promotion may have rarely been considered with respect to their effects on speeding up or slowing down global warming. Importantly, this applies to the GAPPa's strategic objective “Create active people”: Actions 3.3, 3.4, 3.5 and 3.6 recommend for the implementation of PA programs and services to be tailored to different target groups, to take place across different settings

and to be supported in co-development by all stakeholders and grassroots initiatives. This aspect is strongly related to the previous one, as the type of PA and exercise programs that can be offered depends on the availability of green spaces and recreational/exercise facilities.

To our knowledge, there has been very little research on the carbon footprint of different sport and exercise programs. A recent study by Wicker³³ has investigated the travel behavior (e.g. for training, league games, day trips) for German athletes in 20 different sports. The results indicate average carbon emissions of 844 kg per person and year, with stark variation across different sports. Most individual sports, such as climbing/bouldering (1,156 kg CO₂) and surfing (2,074 kg) have higher emissions than team sports such as soccer (337 kg). However, there are also some individual sports (e.g. fitness/gym with 228 kg) with a comparably small carbon footprint. The study found some nature sports, such as alpine skiing, to have a particularly high carbon footprint³³. The environmental impact of these sports has also been pointed out by previous studies^{34,35}.

Future efforts for PA promotion through services and programs should consider carbon emissions. Partly, these emissions are caused by motorized travel to and from such offers, and partly also by the energy consumption of the facilities they take place in. To minimize motorized travel, offers and programs should be easily reachable by active and public transport. Offers should be attractive to multiple target groups, which will help increase local participation and, as a consequence, shorten the distances that teams need to travel for away matches.

To minimize emissions, activities using facilities with comparably low carbon emissions should be promoted with priority (e.g. outdoor Zumba rather than water aerobics in a heated indoor pool). Respecting the seasonality of activities (e.g. winter sports) will certainly help in this regard. If (recreational) league play is involved, strong efforts should be made to limit (motorized) travel. This might be achieved by encouraging tournaments involving multiple teams in a single location rather than round-robin series of individual home/away matches. Where possible, events should be scheduled during daylight hours to avoid the need for artificial lighting.

Mass communication campaigns and mass participation events

Another core element of many policy recommendations to promote PA, including the GAPPa's strategic objective “Create active societies”, are campaigns and events. Actions 1.1 and 1.2 recommend communication campaigns to inform the public about the multiple benefits of PA, and action 1.3 suggests community mass events for PA.

Mass communication campaigns that stress the environmental benefits of active transport line up with objectives for the reduction of carbon emissions. Potentially, future campaigns should place even more emphasis on promoting walking and cycling as an important means for health and environmental benefits. Additionally, they should also (where appropriate)

include advice on being physically active in hot weather. Even though most studies indicate that temperature has a positive correlation with the PA behavior of children and adults³⁶, and adults have been found not to modify their PA behaviour on days with high temperatures³⁷, this topic is of particular relevance for vulnerable groups. There is evidence for older people, that the weather influences PA patterns³⁸ and that PA in hot weather can have detrimental health effects³⁹. Campaigns should also highlight sporting activities that have a comparably low carbon footprint. Additionally, weather service providers could incorporate alerts about unsafe PA conditions into their products (e.g. heat advisory and excessive heat warning).

By contrast, using mass events as a means of PA promotion might be rather a double-edged sword from an environmental perspective. The high carbon footprint of professional events such as the Football World Cup has already been described⁴⁰, while their presumed ‘festival effect’ on PA behavior seems to be very limited⁴¹. Comparable research on amateur mass events or those in which recreational athletes compete alongside professionals is scarce, but there is reason to believe that events such as major marathons also come with considerable carbon emissions. Most of these emissions will be caused by participants’ (air) travel to the venue – for example, around 47% of finishers of the New York Marathon in the 2010s were international participants⁴².

Taking this into consideration, mass events at the community level should be within easy reach of public and active transport in order to limit the climate impact. Organizers of such events might also need to balance the number of participants from other regions or nations and potentially even consider downsizing. Additionally, events would need to be organized in a way that limits detrimental environmental effects, e.g. by avoiding plastic-bottled water, reducing overall waste, offering vegetarian/vegan food options and limiting free giveaways with high carbon footprints such as t-shirts. As a source of inspiration, the Canadian Sport Tourism Alliance has issued guidelines on how to host sustainable sport events⁴³.

Training of professionals

In its strategic objectives “Create active societies” and “Create active people”, the GAPPa advises countries to invest in the training of professionals for PA (Action 1.4), in particular but not limited to (physical education, PE) teachers (Action 3.1) and health professionals (Action 3.2).

Research indicates that professionals’ training on PA in general leaves much room for improvement⁴⁴, so that cross-references between PA and climate in curricula can be expected to be even less frequent. A look at current training standards for exercise prescription, such as the ACSM Guidelines⁴⁵, shows that health professionals are provided with information on how to advise patients on PA in hot environments. However, patient advice regarding the environmental benefits of walking and cycling are currently not covered, not to mention guidance regarding activities that come with a comparably low carbon footprint. Implementing such information into future training of

health professionals will more closely align PA promotion with objectives for the reduction of greenhouse gas emissions.

By and large, the same can be said to hold true for the training of PE teachers. In many countries, the climate impact of different exercises and sport tourism might not be explicitly covered. For example, the PE curriculum for secondary schools in the German state of Bavaria requires all pupils to learn winter sports⁴⁶, which is consequently an integral part of the university curriculum for PE teacher education⁴⁷. Both schools and universities often teach the required competences through practical alpine or cross-country skiing courses in the Alps. Studies predict the closure of many ski resorts in the Alps due to lack of snow unless massive amounts of artificial snow are used on a regular basis⁴⁸, thus causing high carbon emissions³⁵. Consequently, re-considering the types of sports and exercise that are taught as part of PE in schools (and by extension in PE teacher training) might be warranted. Preferably, these should be sports/exercises that can be performed locally or regionally, have a low carbon footprint and require little land-use.

Implications for future PA promotion

Our cursory analysis has demonstrated a considerable potential for alignment between strategies for PA promotion and efforts for the reduction of greenhouse gas emissions. The GAPPa acknowledges the importance of this topic by referring to the SDG on climate action. However, the link between climate action and PA promoting policies/interventions remains unspecific as it is limited to a few sentences. Our analysis shows that these links are already widely acknowledged in some action areas of the GAPPa, most notably in the field of active transport (strategic objective “create active societies”) and regarding green spaces and (at least in part) recreational/exercise facilities (strategic objective “create active environments”). In other areas, such as media campaigns, mass events and professional training, however, the alignment of PA promotion with efforts to reduce carbon dioxide emissions could still be improved.

In order to actually give PA promotion a new, more climate-conscious outlook, changes will be required in PA policymaking, research and surveillance. As policy actions, the GAPPa proposes health economic assessments of health, climate and environmental benefits in the areas of active transport and urban design (Action 2.1) and public and green open spaces and natural spaces (Action 2.4). However, these recommendations are just mentioned in the appendix and are not an adequate substitute for a more systematic look at climate-conscious policy development, research and surveillance. The GAPPa’s strategic objective “Create Active Systems” that targets the governance of PA promotion (without linking it to climate change) served as a basis for our following recommendations (Actions 4.1-4.5).

Climate-conscious policy development for PA promotion

For one, it will be important to raise awareness for the potential benefits and hazards of sport and PA for the climate among

policy-makers across all levels of government, the media, the private sector and community leaders (Action 4.4). This does not only pertain to the fields of health and sport but also to other relevant sectors such as transport, environment, urban design, tourism and social care. The transport sector, in particular, has a huge potential for devising policies that combine increased health/quality of life with a reduction in carbon dioxide emissions. Environmental protection groups and climate initiatives should also be considered as potential allies for PA promotion.

As also advocated by the GAPPA (Action 4.1), a logical next step is to increase the integration of the two issues in policy frameworks, leadership structures and governance systems, e.g. via multisectoral coordination mechanisms. Historically, both the health and the environmental sector have called for mainstreaming their concerns into all sectors of government – one in the form of “Health in all policies”⁴⁹, the other under the moniker of “Environmental policy integration”⁵⁰. In practice, however, there still seems to be room for improvement: data on the implementation of the EU Council Recommendation for Health-Enhancing PA across Sectors indicate that the transport and environment sector are integrated into cross-sectoral PA coordination mechanisms in only 17 out of 27 participating EU Member States⁵¹.

Another important action area (Action 4.5) in this context are financing mechanisms. In the future, it will be important to further integrate health and environment-related funding lines to ensure sustainable financial support for activities that promote both the climate and population-level PA. Yet again, data from the EU indicate that it is difficult for governments to even collect information on investments made in sectors other than health that may also help promote PA, be it as an intended or unintended side effect, let alone to act towards a better coordination of sectoral funding⁵².

However, the implementation of climate-conscious policies for PA promotion also depends on economic, political and cultural factors. For example, health spending per capita is lower in low- and middle-income countries⁵³. These financial constraints might severely impact the capacity of these countries to implement policies for climate change mitigation in general and for health promotion in particular.

Climate-conscious PA research and surveillance

Research and surveillance (Actions 4.2 and 4.3) are covered as important cornerstones for future PA policy in the GAPPA. However, with respect to climate change, there are a number of key issues in these areas that should be urgently tackled, including the following:

- Understanding the environmental impact of various forms of sport and exercise in order to tailor promotion efforts towards those with a low carbon footprint.
- Identifying ways to limit the carbon footprint of sport tourism.
- Developing curricula to integrate knowledge on the interconnections of PA promotion and climate protection in the training of health and other professionals.

- Increasing our understanding of how to succeed in transitioning neighborhoods and communities towards high rates of active transport.

Importantly, current PA surveillance systems should strive to integrate indicators that have a high relevance for climate change. This could mean that physical activity questionnaires should include dedicated measures for walking and biking, thus enabling governments to monitor changes in active transport behavior more accurately. Currently-utilized questionnaires often either only assess walking (such as the International Physical Activity Questionnaire IPAQ⁵⁴) or walking and cycling in a combined indicator (Global Physical Activity Questionnaire GPAQ⁵⁵). A positive exception is the relatively new European Health Interview Survey Physical Activity Questionnaire EHIS⁵⁶, which does assess walking and biking via separate indicators.

The same holds true for PA policy monitoring. As mentioned above, the regular joint EU/WHO surveys on the implementation of the EU Council Recommendation for Health-Enhancing PA across Sectors^{51,57} already provide information on a set of highly useful indicators such as the level of cycling and walking, and other supplementary WHO tools (such as the HEPA Policy Audit Tool⁵⁸ and the HEAT Tool for the health economic assessment of cycling and walking⁵⁹) may help countries gather additional data. In the years ahead, efforts to strengthen PA policy monitoring and to potentially integrate it with similar efforts in the field of transport, environmental and climate policy should be stepped up.

Limitations

As this article focuses mainly on climate change mitigation, it does not cover the broader perspective of climate change adaptation and resilience. Likewise, it does not address other ecological aspects of sustainability, such as the loss of biodiversity. Additionally, greenhouse gas emissions have several impacts on the climate besides rising temperatures, such as an increase in extreme weather events, a change in precipitation patterns and a rise in sea-levels, which are not addressed in our paper. Future research at the interface of PA promotion and climate change could address these aspects.

Conclusions

There are several interconnections between PA promotion and climate action. While they are most recognizable with regards to active transport, green spaces and – partially – recreational or exercise facilities, these links could be strengthened in other areas (media campaigns, mass events, professional training). Climate-conscious policy development, research and surveillance are needed in the field of PA. Recognizing the close alignment between PA promotion and climate action is an important message for public health professionals and policymakers.

Data availability

No data are associated with this article.

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Reviewer Report 12 February 2021

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Stephanie Levy 

Department of Anthropology, Hunter College, New York, NY, USA

The authors have addressed all of my comments.

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Biological anthropology, human energetics, cardio-metabolic health, climate change

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 07 December 2020

<https://doi.org/10.5256/f1000research.30644.r75122>

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Kevin Lanza 

Michael & Susan Dell Center for Healthy Living at The University of Texas Health Science Center at Houston (UTHealth) School of Public Health in Austin, TX, USA

With revisions, authors have markedly improved the manuscript, which serves as a strong foundation for physical activity promotion in the face of climate change. Inclusion of Table 1 makes for a standalone, cohesive manuscript, and the authors did a fine job stating the focus of this manuscript and its limitations. Organization into subsections permits quick access as a reference document, which I plan to use in future research.

A final, minor suggestion is to decide whether to change "green space" to "greenspace." See below article for use of "greenspace."

Taylor, Lucy, and Dieter F. Hochuli. "Defining greenspace: Multiple uses across multiple disciplines." *Landscape and Urban Planning* 158 (2017): 25-38¹.

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1. Taylor L, Hochuli D: Defining greenspace: Multiple uses across multiple disciplines. *Landscape and Urban Planning*. 2017; **158**: 25-38 [Publisher Full Text](#)

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: climate change; physical activity; health equity; urban heat island adaptation

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Version 1

Reviewer Report 16 October 2020

<https://doi.org/10.5256/f1000research.26223.r70762>

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Stephanie Levy 

Department of Anthropology, Hunter College, New York, NY, USA

The authors argue that many of action points outlined by the recent Global Action Plan on Physical Activity (GAPPA) can be leveraged to also mitigate carbon emissions and global climate change. In particular, the authors highlight how efforts to promote physical activity by establishing active transport and green spaces can also serve to limit carbon emissions. The article is well researched and the argument is clearly presented. However, the paper would benefit from a discussion of the economic, political, and cultural factors that will constrain stakeholders' ability to carry out these synergistic policies. For instance, in middle-income countries there is a simultaneous increase in carbon emissions and growing prevalence of sedentary lifestyles; however, the capacity to implement climate-minded GAPPA policies might be more limited due to financial constraints.

Is the topic of the opinion article discussed accurately in the context of the current literature?

Yes

Are all factual statements correct and adequately supported by citations?

Yes

Are arguments sufficiently supported by evidence from the published literature?

Yes

Are the conclusions drawn balanced and justified on the basis of the presented arguments?

Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Biological anthropology, human energetics, cardio-metabolic health, climate change

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 05 Nov 2020

Sven Messing, Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Erlangen, Germany

We would like to thank the reviewer for her valuable feedback. We have addressed her comments by adding a paragraph to the discussion section.

A1: The authors argue that many of action points outlined by the recent Global Action Plan on Physical Activity (GAPPA) can be leveraged to also mitigate carbon emissions and global climate change. In particular, the authors highlight how efforts to promote physical activity by establishing active transport and green spaces can also serve to limit carbon emissions. The article is well researched and the argument is clearly presented. However, the paper would benefit from a discussion of the economic, political, and cultural factors that will constrain stakeholders' ability to carry out these synergistic policies. For instance, in middle-income countries there is a simultaneous increase in carbon emissions and growing prevalence of sedentary lifestyles; however, the capacity to implement climate-minded GAPPA policies might be more limited due to financial constraints.

Q1: Thank you very much for pointing out this important aspect. We have added it to the discussion by including the following paragraph at the end of the section: "Climate-conscious policy development for PA promotion" that refers to this issue: "However, the implementation of climate-conscious policies for PA promotion also depends on economic, political and cultural factors. For example, health spending per capita is lower in low- and middle-income countries. These financial constraints might severely impact the capacity of these countries to implement policies for climate change mitigation in general and for health promotion in particular."

Competing Interests: No competing interests were disclosed.

Reviewer Report 21 May 2020

<https://doi.org/10.5256/f1000research.26223.r63281>

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Kevin Lanza 

Michael & Susan Dell Center for Healthy Living at The University of Texas Health Science Center at Houston (UTHealth) School of Public Health in Austin, TX, USA

In this timely and clearly written article, the authors describe the relation between physical activity promotion and climate change, and do so through the World Health Organization's Global Action Plan on Physical Activity 2018-2030 (GAPPA). From the four strategic objectives (i.e., create active societies, environments, people, and systems) of GAPPA and each objective's proposed policy actions, the authors offer five perspectives that connect physical activity to climate change: 1) development of infrastructures to enable active transport, 2) green spaces and recreational/exercise facilities to promote PA, 3) physical activity and exercise programs, 4) mass communication campaigns and mass participation events, and 5) training of professionals. The authors conclude with the implications of their overview for future PA promotion, in particular on climate-conscious 1) policy development for PA promotion and 2) PA research and surveillance.

I commend the authors for this article because the link between physical activity and climate change has not been adequately addressed in the literature, and there is potential for public health and environmental sectors in local government to partner on the topic. Before sharing my thoughts on specific sections of the article, I have a few overall comments. The article would benefit from a table that includes each of the GAPPA objectives and a summary of each of the policy actions. This way, readers can refer to GAPPA while the authors share their five perspectives. Second, there are several impacts of greenhouse gas emissions on our climate (e.g., rising temperatures, increase in extreme weather events, change in precipitation patterns, and sea-level rise), but the authors seem to address only rising temperatures and its relation to physical activity promotion. Similarly, the authors focus their perspectives on physical activity and climate change mitigation (i.e., opportunities for the reduction of greenhouse gas emissions), yet less attention is given to climate change adaptation and resilience. Lastly, the authors should review their article for minor issues with grammar (e.g., inconsistent use of the Oxford comma, "the GAPPA" versus "GAPPA," and "build" versus "built") and language choice (e.g., "extremely well" and "less climate-friendly").

Please see below for my comments specific to select sections.

Introduction

The authors state that there are "... stubbornly high rates of physical inactivity in adolescents and adults..." and "PA rates in children are higher but still leave room for improvement." Both of these statements can be refined. There is a difference between physical inactivity (i.e., sedentary behavior) and not being sufficiently active (i.e., failing to reach recommended levels of physical activity for health benefits). This distinction is important, because although children may have

higher PA rates than adults (which depends on method of surveillance and individual-level factors), children in the US are recommended to engage in more PA each week than adults. The authors can be more precise here, and include values.

Development of infrastructures to enable active transport

The authors focus their overview of active transport on the reduction of greenhouse gas emissions and the benefits to human health. The authors conclude this section with a statement on the health burden of motorized transport—I am wondering if the authors can dig deeper into the literature here. Can the authors tease out how many road fatalities involve a non-motor vehicle (e.g., pedestrian and bicycle)? Similarly, can the authors cite research that has modeled the amount of lives saved, injuries prevented, and pollution reduced from switching from vehicular transport to alternative modes?

Green spaces and recreational/exercise facilities to promote PA

The authors focus their overview of green spaces on carbon sequestration, urban heat island mitigation, and climate adaptation; and their overview of recreational/exercise facilities on energy and land consumption. I think this section can be improved by providing further detail on each of the above points. Regarding green spaces, I would mention the amount of cooling offered by parks, which has been found to be 0.94°C, on average:

Bowler, D. E., Buyung-Ali, L., Knight, T. M., & Pullin, A. S. (2010). Urban greening to cool towns and cities: A systematic review of the empirical evidence. *Landscape and urban planning*, 97(3), 147-155¹

The specific vegetation is also worth mentioning, in relation to how trees and non-tree vegetation have different effects on physical activity levels of different populations; and how climate change is impacting what trees are able to be planted in an area with continued global warming:

Lanza, K., Stone Jr, B., & Haardörfer, R. (2019). How race, ethnicity, and income moderate the relationship between urban vegetation and physical activity in the United States. *Preventive medicine*, 121, 55-61².

Lanza, K., & Stone Jr, B. (2016). Climate adaptation in cities: What trees are suitable for urban heat management?. *Landscape and Urban Planning*, 153, 74-82³.

For recreational/exercise facilities, the authors can mention outdoor fitness classes/groups/meet-ups, which do not have the energy use requirements (e.g., air conditioning and lighting) of indoor facilities.

Physical activity and exercise programs

The authors focus their overview of exercise programs on the reduction of greenhouse gas emissions and the benefits to human health. The authors state "...outdoor facilities with comparably low carbon emissions should be promoted with priority (e.g. outdoor Zumba rather than water aerobics in a heated indoor pool)." This recommendation also relates to the authors' previous perspective on recreational/exercise facilities. In organizing the article's content, the authors may want to consider green spaces as a separate perspective, and recreational/exercise facilities and exercise programs as another perspective.

Mass communication campaigns and mass participation events

The authors focus their overview of mass communication and participation on the reduction of greenhouse gas emissions and the benefits to human health. The authors raise the pertinent point that weather conditions may influence physical activity patterns. However, most studies show temperature to have a positive correlation with physical activity, with individuals being more active during summer over other seasons:

Chan, C. B., & Ryan, D. A. (2009). Assessing the effects of weather conditions on physical activity participation using objective measures. *International journal of environmental research and public health*, 6(10), 2639-2654⁴.

In recent work, US adults have been found to not modify their physical activity behavior on days with high temperatures, which suggests cities in hot climates may be placing adults at increased risk of exertional heat illness. The authors recommend incorporating the risk of exertional heat illness in health impact assessments and deploying heat management strategies (i.e., tree planting and installation of reflective building materials):

Lanza, K., Stone, B., Chakalian, P. M., Gronlund, C. J., Hondula, D. M., Larsen, L., ... & Haardörfer, R. (2020). Physical Activity in the Summer Heat: How Hot Weather Moderates the Relationship Between Built Environment Features and Outdoor Physical Activity of Adults. *Journal of Physical Activity and Health*, 1(aop), 1-9⁵.

The authors point about the environmental impact of sports apparel production seems tangential to physical activity promotion and climate change, and therefore may be removed. Instead, I believe this article section would benefit from including content on the increased risk of exertional heat illness from projected temperature increases. The authors could also include content on how weather service providers, such as the National Weather Service in the United States, can incorporate alerts about unsafe physical activity conditions within its heat products (e.g., heat advisory and excessive heat warning).

References

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5. Lanza K, Stone B, Chakalian P, Gronlund C, et al.: Physical Activity in the Summer Heat: How Hot Weather Moderates the Relationship Between Built Environment Features and Outdoor Physical Activity of Adults. *Journal of Physical Activity and Health*. 2020; **17** (3): 261-269 [Publisher Full Text](#)

Is the topic of the opinion article discussed accurately in the context of the current literature?

Yes

Are all factual statements correct and adequately supported by citations?

Yes

Are arguments sufficiently supported by evidence from the published literature?

No

Are the conclusions drawn balanced and justified on the basis of the presented arguments?

Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: climate change; physical activity; health equity; urban heat island adaptation

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 05 Nov 2020

Sven Messing, Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Erlangen, Germany

We would like to thank the reviewer for his valuable feedback. We have addressed his comments by modifying our article in the respective sections as described below.

Q1: In this timely and clearly written article, the authors describe the relation between physical activity promotion and climate change, and do so through the World Health Organization's Global Action Plan on Physical Activity 2018-2030 (GAPPA). From the four strategic objectives (i.e., create active societies, environments, people, and systems) of GAPPA and each objective's proposed policy actions, the authors offer five perspectives that connect physical activity to climate change: 1) development of infrastructures to enable active transport, 2) green spaces and recreational/exercise facilities to promote PA, 3) physical activity and exercise programs, 4) mass communication campaigns and mass participation events, and 5) training of professionals. The authors conclude with the implications of their overview for future PA promotion, in particular on climate-conscious 1) policy development for PA promotion and 2) PA research and surveillance.

I commend the authors for this article because the link between physical activity and climate change has not been adequately addressed in the literature, and there is potential for public health and environmental sectors in local government to partner on the topic. Before sharing my thoughts on specific sections of the article, I have a few overall comments. The article would benefit from a table that includes each of the GAPPA objectives and a summary of each of the policy actions. This way, readers can refer to GAPPA while the authors share their five perspectives. Second, there are several impacts of greenhouse gas emissions on our climate (e.g., rising temperatures, increase in extreme weather events, change in precipitation patterns, and sea-level rise), but the authors seem

to address only rising temperatures and its relation to physical activity promotion. Similarly, the authors focus their perspectives on physical activity and climate change mitigation (i.e., opportunities for the reduction of greenhouse gas emissions), yet less attention is given to climate change adaptation and resilience. Lastly, the authors should review their article for minor issues with grammar (e.g., inconsistent use of the Oxford comma, “the GAPPA” versus “GAPPA,” and “build” versus “built”) and language choice (e.g., “extremely well” and “less climate-friendly”).

Please see below for my comments specific to select sections.

A1: Thank you very much for your positive comment. The link between physical activity and climate change has indeed a high potential for joint action of the public health and environmental sector.

As suggested, we added a table that provides an overview about all GAPPA objectives and policy actions (table 1). Furthermore, we added a sentence at the end of the introduction to clarify that the article focuses on climate change mitigation and the relation of rising temperatures and physical activity promotion. Additionally, we described this focus as a limitation in the discussion section and recommended future research to address these aspects. The minor issues with grammar and language choice were addressed as well.

Introduction

Q2: The authors state that there are “... stubbornly high rates of physical inactivity in adolescents and adults...” and “PA rates in children are higher but still leave room for improvement.” Both of these statements can be refined. There is a difference between physical inactivity (i.e., sedentary behavior) and not being sufficiently active (i.e., failing to reach recommended levels of physical activity for health benefits). This distinction is important, because although children may have higher PA rates than adults (which depends on method of surveillance and individual-level factors), children in the US are recommended to engage in more PA each week than adults. The authors can be more precise here, and include values.

A2: Thank you very much for this helpful comment. We have refined the first statement and included values. We state now that there are “... stubbornly high rates of insufficient physical activity in adolescents (81,0%) and adults (27,5%). ...”. We removed the second statement.

Development of infrastructures to enable active transport

Q3: The authors focus their overview of active transport on the reduction of greenhouse gas emissions and the benefits to human health. The authors conclude this section with a statement on the health burden of motorized transport—I am wondering if the authors can dig deeper into the literature here. Can the authors tease out how many road fatalities involve a non-motor vehicle (e.g., pedestrian and bicycle)? Similarly, can the authors cite research that has modelled the amount of lives saved, injuries prevented, and pollution reduced from switching from vehicular transport to alternative modes?

A3: We agree with this suggestion and added additional information on the number of

deaths per year due to road fatalities among pedestrians and cyclists (26% of 1.36 million) and on the health benefits of shifting from car to bicycling (1,300 Euro per person and year for a commute of 5 km per day, effects of pollution and accidents are much smaller).

Green spaces and recreational/exercise facilities to promote PA

Q4: The authors focus their overview of green spaces on carbon sequestration, urban heat island mitigation, and climate adaptation; and their overview of recreational/exercise facilities on energy and land consumption. I think this section can be improved by providing further detail on each of the above points. Regarding green spaces, I would mention the amount of cooling offered by parks, which has been found to be 0.94°C, on average: Bowler, D. E., Buyung-Ali, L., Knight, T. M., & Pullin, A. S. (2010). Urban greening to cool towns and cities: A systematic review of the empirical evidence. *Landscape and urban planning*, 97(3), 147-1551.

The specific vegetation is also worth mentioning, in relation to how trees and non-tree vegetation have different effects on physical activity levels of different populations; and how climate change is impacting what trees are able to be planted in an area with continued global warming:

Lanza, K., Stone Jr, B., & Haardörfer, R. (2019). How race, ethnicity, and income moderate the relationship between urban vegetation and physical activity in the United States. *Preventive medicine*, 121, 55-612.

Lanza, K., & Stone Jr, B. (2016). Climate adaptation in cities: What trees are suitable for urban heat management?. *Landscape and Urban Planning*, 153, 74-823.

For recreational/exercise facilities, the authors can mention outdoor fitness classes/groups/meet-ups, which do not have the energy use requirements (e.g., air conditioning and lighting) of indoor facilities.

A4: We added additional information regarding the cooling effect of parks (Bowler et al 2010) and the influence of trees on physical activity levels (Lanza et al 2019). This evidence strengthens the argument and is highly appreciated.

We did not, however, add the study that analyses what trees are suitable for urban heat management because we felt that it is not closely related to our line of argument. Outdoor fitness classes are mentioned in the next section (physical activity and exercise programs).

Physical activity and exercise programs

Q5: The authors focus their overview of exercise programs on the reduction of greenhouse gas emissions and the benefits to human health. The authors state "...outdoor facilities with comparably low carbon emissions should be promoted with priority (e.g. outdoor Zumba rather than water aerobics in a heated indoor pool)." This recommendation also relates to the authors' previous perspective on recreational/exercise facilities. In organizing the article's content, the authors may want to consider green spaces as a separate perspective, and recreational/exercise facilities and exercise programs as another perspective.

A5: We added the following sentence to the first paragraph of this section: "This aspect is strongly related to the previous one, as the type of PA and exercise programs that can be offered depends on the availability of green spaces and recreational/exercise facilities."

We decided not to reorganize the article's overarching structure because we believe that

this would not have solved the issue completely: Physical activity and exercise programs usually take place either in green spaces or in recreational/exercise facilities. There is an overlap between the GAPPAs strategic objectives “create active environments” and “create active people”.

Mass communication campaigns and mass participation events

Q6: The authors focus their overview of mass communication and participation on the reduction of greenhouse gas emissions and the benefits to human health. The authors raise the pertinent point that weather conditions may influence physical activity patterns. However, most studies show temperature to have a positive correlation with physical activity, with individuals being more active during summer over other seasons:

Chan, C. B., & Ryan, D. A. (2009). Assessing the effects of weather conditions on physical activity participation using objective measures. *International journal of environmental research and public health*, 6(10), 2639-26544.

In recent work, US adults have been found to not modify their physical activity behavior on days with high temperatures, which suggests cities in hot climates may be placing adults at increased risk of exertional heat illness. The authors recommend incorporating the risk of exertional heat illness in health impact assessments and deploying heat management strategies (i.e., tree planting and installation of reflective building materials):

Lanza, K., Stone, B., Chakalian, P. M., Gronlund, C. J., Hondula, D. M., Larsen, L., ... & Haardörfer, R. (2020). Physical Activity in the Summer Heat: How Hot Weather Moderates the Relationship Between Built Environment Features and Outdoor Physical Activity of Adults. *Journal of Physical Activity and Health*, 1(aop), 1-95.

A6: We clarified this section and added both references: “Even though most studies indicate that temperature has a positive correlation with the PA behavior of children and adults, and adults have been found not to modify their PA behaviour on days with high temperatures, this topic is of particular relevance for vulnerable groups. There is evidence for older people, that the weather influences PA patterns and that PA in hot weather can have detrimental health effects”.

Q7: The authors point about the environmental impact of sports apparel production seems tangential to physical activity promotion and climate change, and therefore may be removed. Instead, I believe this article section would benefit from including content on the increased risk of exertional heat illness from projected temperature increases. The authors could also include content on how weather service providers, such as the National Weather Service in the United States, can incorporate alerts about unsafe physical activity conditions within its heat products (e.g., heat advisory and excessive heat warning).

A7: We deleted the sentence about the environmental impact of sports apparel production as it is not closely related to our topic. As suggested, we added a sentence about the incorporation of alerts about unsafe PA conditions into the products of weather service providers.

Competing Interests: No competing interests were disclosed.

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