**UNIVERSIDADE FEDERAL DE PELOTAS**

**FACULDADE DE MEDICINA**

**PROGRAMA DE PÓS GRADUAÇÃO EM EPIDEMIOLOGIA**

# WORLDWIDE RESEARCH, SURVEILLANCE AND POLICY ON PHYSICAL ACTIVITY:

# THE GLOBAL OBSERVATORY FOR PHYSICAL ACTIVITY – GoPA!

**Ph.D. THESIS**

**ANDREA RAMIREZ VARELA MD, MPH**

**Pelotas, RS**

**2018**

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*To my Family*

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**Resumo**

A inatividade física é um dos quatro principais fatores de risco para doenças não transmissíveis (DCNT). No entanto, apesar de sua importância, não havia nenhum observatório dedicado exclusivamente ao monitoramento de atividade física no mundo. A coleta de dados em nível nacional, juntamente com pesquisa e monitoramento de alta qualidade aplicáveis em contextos locais, são essenciais para informar políticas e planejar intervenções no nível populacional. Em 2012, o Observatório Global de Atividade Física (1) foi lançado em resposta a esta demanda urgente de ação, tornando-se uma resposta mundial para um problema mundial. A lógica por trás da criação do Observatório Global para Atividade Física era fornecer informações que permitissem aos países iniciar ou melhorar sistemas de vigilância, formulação de políticas e desenvolvimento de programas na área de atividade física.

Dado que o desenvolvimento histórico das evidências científicas na área de atividade física e pesquisa em saúde pública era desconhecido, uma revisão estruturada da literatura usando métodos formais de análise de redes de citação para identificar as peças mais influentes ao longo do tempo desde 1950 foi feita (artigo de revisão). Este foi o primeiro estudo a quantificar o desenvolvimento da pesquisa na área de atividade física e saúde, identificar ideias fundamentais citadas ao longo do tempo e determinar as lacunas de comunicação para pesquisa e prática.

Simultaneamente, à medida que os países precisavam determinar e monitorar seu nível de atividade física para promover a melhoria dos mesmos em sua população, o GoPA! criou o “Country Cards” (cartões dos países), que consiste em um documento resumido com os indicadores nacionais de atividade física, incluindo pesquisa, vigilância, políticas públicas e desfechos de saúde. O primeiro conjunto desses cartões de países mostrava perfis nacionais de maneira acessível e abrangente. Uma metodologia padronizada para coleta de dados facilitou a comparação dos indicadores entre países e regiões e forneceu uma visão geral sem precedentes da atividade física e da saúde pública em todo o mundo. Os cartões dos países como ferramentas de defesa de direitos ajudam os países a avançar para uma sociedade mais ativa. A partir da metodologia padronizada de coleta de dados, os países são classificados por seu nível de atividade física que pode ser

utilizado para monitorar os progressos na prevalência, vigilância, política, pesquisa e desfechos de saúde da atividade física ao longo do tempo (artigo original 1).

Com o primeiro set de cartões, o GoPA! coletou, confirmou e publicou dados de 139 (64%) dos 217 países do mundo, representando uma cobertura global de 85,4% com base na população mundial em 2013. Foi lançado um almanaque com estes Country Cards (disponível em: http: / /www.globalphysicalactivityobservatory.com/). As principais descobertas do primeiro conjunto de cartões incluíram: 1) A inatividade física foi altamente prevalente em todas as regiões do mundo, em países ricos e pobres; 2) Em todo o mundo, cerca de 30% dos adultos eram fisicamente inativos; 3) Embora a maioria dos países tivesse pelo menos um levantamento sobre atividade física, menos de um quarto possuía monitoramento contínuo de saúde pública na área de atividade física; 4) 37 países tinham planos nacionais específicos para atividade física e outros 65 incluíram atenção substancial à atividade física em seus planos nacionais de prevenção de doenças não transmissíveis ou de promoção da saúde; 5) Em 2013, foram publicados trabalhos de 105 países sobre atividade física. No entanto, 51% dessas publicações eram provenientes de países de alta renda e o Brasil e a China foram os únicos países de renda baixa e média entre os 20 principais em publicações de pesquisa sobre atividade física e saúde (artigo original 1).

Desde o lançamento, em 2015, os Cartões dos Países foram feitos para serem utilizados como ferramentas de advocacy, para estimular a discussão sobre a vigilância e pesquisa em atividade física e para orientar políticas. A pesquisa translacional demonstrou a importância das evidências de pesquisa para orientar as escolhas políticas ideais para a saúde da população. Esta evidência: 1) orientou o desenvolvimento de um modelo conceitual do GoPA! para a capacidade nacional de promoção da atividade física, incluindo vigilância periódica, implementação de políticas de atividade física e produtividade da pesquisa como os três pilares (Artigo original 2); e 2) destacou a necessidade de avaliar se os cartões estavam sendo usados conforme o esperado, identificar os fatores associados ao seu uso e desenvolver recomendações para apoiar a promoção da atividade física em nível nacional. Para atingir este objetivo, foi realizada uma avaliação do processo (Artigo original 2), demonstrando que a relevância e utilidade dos cartões dos países do GoPA! foi associada a fazer parte da rede do GoPA!, ter conhecimento sobre os

cartões dos países do GoPA!, residir em países de baixa e média renda, e com o estágio de capacidade do país para a promoção da atividade física. Além disso, para que os cartões dos países tenham um impacto mais amplo na promoção da atividade física, o GoPA! precisará de países-alvo com capacidade limitada para promoção de atividade física. O aprimoramento adicional dos cartões e o treinamento sobre seu uso também foram identificados como ferramentas potenciais e relevantes para o avanço da capacidade nacional de promoção da atividade física e podem se mostrar como uma estratégia crítica em países com baixa ou nenhuma capacidade local (Artigo original 2).

Considerando isso e dado o fato de que a produção científica local e regional e a capacidade de pesquisa na área de atividade física foram identificadas como estratégias para melhorar as políticas e programas de saúde pública para a promoção da atividade física, o grupo de trabalho do GoPA! decidiu começar a atualizar o indicador para o próximo conjunto de cartões dos países e o indicador de pesquisa foi selecionado para ser o primeiro. Além disso, uma revisão sistemática para descrever as tendências, padrões e características nacionais, regionais e globais da área de atividade física e pesquisa em saúde de 1950 a 2016 foi conduzida (Artigo original 3). Embora a área de pesquisa em atividade física e saúde tenha tido um enorme crescimento nos últimos 60 anos, com 70% dos países do mundo tendo pelo menos uma publicação na área, há uma distribuição desigual da produtividade da pesquisa por região e nível de renda mundial, particularmente nos países com maior carga devido a doenças não transmissíveis evitáveis e à inatividade física. A pesquisa mundial de atividade física entre 1950 e 2016 variou substancialmente por área geográfica e por grupo de renda, com uma diferença de mais de 20 vezes no número de publicações por 100.000 habitantes entre países de alta e baixa renda, sendo que menos de 5% da população mundial vive nos países com maior produtividade em pesquisa (Artigo original 3).

Este projeto de doutorado mostrou uma distribuição desigual de indicadores de vigilância, pesquisa y pesquisa na área de atividade física. Pelo qual foi demonstrada a necessidade de monitoramento global e regular desses indicadores, particularmente em países com maiores lacunas de dados. Apesar das lacunas de dados significativas, os “Country Cards” representam uma estratégia relevante para a promoção da atividade física, pesquisa, política e vigilância especificamente em

países com capacidade local limitada, falta de dados ou onde a inatividade física ainda não foi totalmente reconhecida como um problema de saúde pública. Para que os cartões de pais de GoPA! tenham um maior impacto devem ser apresentados com recomendações conforme a classificação de capacidade nacional para a promoção de atividade física.

As tendências identificadas na pesquisa de atividade física e saúde oferecem informação importante para fechar as lacunas de pesquisa e guiar ações para otimizar a tradução de pesquisa em politica e vigilância a nível nacional, regional e global focada no impacto na saúde publica. Finalmente, a colaboração e os esforços para melhorar a capacidade local nos países de renda baixa são recomendados.

Nos próximos anos, o GoPA! continuará a ter um papel importante relatando periodicamente o progresso em nível de cada país e o potencial para estimular a pesquisa, o desenvolvimento de capacidade local e advocacy nos níveis nacional e global.

**Palavras-chave:** Atividade física, vigilância, pesquisa, política, capacidade local nos países de todo o mundo, epidemiologia.

**Summary**

Physical inactivity is one of the four main risk factors for non-communicable diseases (NCD). However, an observatory dedicated to the assessment of physical activity worldwide did not exist. Country level data collection together with high quality locally applicable research and monitoring are essential to inform policy and planning of interventions at the population level. In 2012, the Global Observatory for Physical Activity – GoPA! was launched in response to this urgent call for action, becoming a worldwide response to a worldwide problem. The rationale behind the creation of the Global Observatory for Physical Activity was to provide information that enabled countries to initiate or improve surveillance systems, policy making and program development in the area of physical activity.

Given that the historical development of scientific evidence in the physical activity and public health research field was unknown, a structured literature review using formal citation network analysis methods to identify the most influential pieces over time since 1950 was conducted (review article). This was the first study that quantified the development of the research in the field, identified fundamental ideas cited over time, and described communication gaps for research and practice.

Simultaneously, as countries needed to determine and monitor their status of physical activity in order to improve physical activity levels in their population, GoPA! created a summary document with national indicators of physical activity including research, surveillance, policy and health outcomes, “the Country Cards”. The first set of Country Cards displayed national profiles in a publicly accessible, all-inclusive manner. A standardized methodology for data collection facilitated the comparison of indicators between countries and regions, and provided an unprecedented overview of physical activity and public health around the world. Country Cards as advocacy tools help countries moving towards a more physically active society. Countries were ranked by their physical activity status to monitor progress in prevalence, surveillance, policy, research and health outcomes of physical activity over time (original paper 1).

With this first set of Country Cards GoPA! obtained, confirmed and published data from 139 (64%) of the world’s 217 countries, representing a global coverage of 85.4% based on the world´s population in 2013. An almanac was launched with

these Country Cards (available at: http://www.globalphysicalactivityobservatory.com/). Main findings of the first set of Cards included: 1) Physical inactivity was highly prevalent in all regions of the world, in rich and poor countries; 2) Worldwide, around 30% of adults were physical inactive; 3) Although most countries had at least one survey on physical activity, less than a quarter had ongoing public health monitoring of physical activity; 4) 37 countries had specific national plans for physical activity and another 65 include substantive attention to physical activity within their national non-communicable disease prevention or health promotion plans; 5) In 2013, almost 3000 papers on physical activity from 105 countries were published. However, 51% of these publications came from high income countries and Brazil and China were the only low and middle-income countries in the top 20 for research publications on physical activity and health (original paper 1).

Since the launch in 2015, Country Cards were meant to be used as advocacy tools, to stimulate discussion on physical activity surveillance and research and to guide policy. Translational research demonstrated the importance of research evidence for guiding optimal policy choices for population health. This evidence: 1) guided the development of a GoPA! conceptual model for country-level capacity for physical activity promotion, including periodic surveillance, implementation of physical activity policy, and research productivity as three main pillars (Original article 2); and 2) highlighted the need to assess if the cards were being used as intended, to identify associated factors with their use, and to develop recommendations for supporting country-level physical activity promotion. To meet this objective, a process evaluation was conducted (original paper 2), demonstrating that the relevance and usefulness of GoPA! Country Cards was associated with being part of the GoPA! network, knowing about the GoPA! Country Cards, living in low- and middle-income countries, and on the stage of country capacity for physical activity promotion. Also, that the Country Cards could have a broader impact on physical activity promotion if GoPA! targeted countries with limited capacity for physical activity promotion. Further refinement of the cards and training in their use were also identified as potential and relevant tools for advancing country capacity for physical activity promotion and may prove to be a critical strategy in countries with low or no local capacity (original paper 2).

Considering the latter and given that local, regional and global scientific production and research capacity in the area of physical activity were identified as strategies for improving related public health policies and programs, the GoPA! working group decided to start updating indicators for the next set of Country Cards. The research indicator was selected to be first. Therefore, a systematic review to describe national, regional and global trends, patterns and characteristics of the physical activity and health research field from 1950 to 2016 was conducted (Original article 3). Results indicated that even though the physical activity and health research area had a tremendous growth in the last 60 years supported by the fact that 70% of the world's countries had at least one publication in the area, there is an unequal distribution of research productivity by world region and income level, particularly in countries with the highest burden due to preventable non-communicable diseases and to physical inactivity. Worldwide physical activity research between 1950-2016 varied substantially by geographic area and by income group, with more than a 20-fold difference in publications per 100,00 inhabitants between high and low income countries, with less than 5% of the world's population living in the countries with the highest research productivity (Original article 3).

This Ph.D. project showed that an unequal distribution of physical activity surveillance, research and policy indicators exist around the world. Therefore, there is a need of global and regular monitoring of these indicators, particularly in countries with largest data gaps. Despite significant data gaps, the Country Cards represent a relevant strategy for the promotion of physical activity, research, policy and surveillance specifically in countries with limited local capacity, lack of data or where physical inactivity as a public health problem has not been fully recognized. For Country Cards to have a greater impact, they must be disseminated with specific recommendations according to the classification of each country's capacity to promote physical activity.

The identified trends and patterns in physical activity and health research provide important information for closing research gaps and guiding actions to optimize the translation of research into physical activity policy, promotion, and surveillance at the national, regional, and global levels with a focus on the public health impact of research. Finally, long-term cooperation and efforts to build capacity and expand

physical activity-related surveillance, policy, and research networks in lower income countries is recommended.

In the next years GoPA! will continue having an important role in compiling and periodically reporting on country level progress and the potential for stimulating research, capacity building, and advocacy at the national and global levels.

**Keywords:** Physical activity, surveillance, research, policy, worldwide capacity building, epidemiology.

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## Presentation

This PhD thesis was produced under the supervision of Professor Pedro Curi Hallal, and co-supervision of Professor Michael Pratt during a period of study at the University of California San Diego, United States. The document is composed by the PhD research project, a review article and an editorial that was published about it, three original scientific articles and a press release with the main findings of the thesis.

The review article presented in the thesis is entitled “Mapping the historical development of physical activity and health research: A structured literature review and citation network analysis” and was published in Preventive Medicine Journal on October 2017 and along with an editorial entitled” Mapping the historical development of research in physical activity and health: Providing a platform for future research”. The first original article is entitled “Worldwide Surveillance, Policy, and Research on Physical Activity and Health: The Global Observatory for Physical Activity” and was published at the Journal of Physical Activity and Health - JPAH on May, 2017. The second original article, “Worldwide use of the first set of physical activity Country Cards: The Global Observatory for Physical Activity - GoPA!” published at the International Journal of Behavior Nutrition and Physical Activity - IJBNPA on May, 2018. The third original article, “Physical activity and health research monitoring: The Global Observatory for Physical Activity- GoPA! global, regional, and national trends and patterns since 1950” will be submitted to the International Journal of Behavior Nutrition and Physical Activity -IJBNPA. The articles were all formatted according to the journal’s instructions.

PH.D. RESEARCH PROJECT

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## 1. ABREVIATION LIST

**AFRO – PAN** - African Physical Activity Network

**APAN – PAN** - Asia Pacific Physical Activity Network

**CVD –** Cardiovascular Disease

**GAPA** - Global Advocacy for Physical Activity

**GoPA!** - Global Observatory for Physical Activity

**GPAQ** - Global Physical Activity Questionnaire

**HEPA** – European Network for the Promotion of Health Enhancing Physical Activity

**IPAQ** - International Physical Activity Questionnaire

**ISPAH** - International Society of Physical Activity and Health

**JPAH** - Journal of Physical Activity and Health

**LPAS** - Lancet Physical Activity Series

**NCDs** - Non-communicable diseases

**RAFA - PANA** – Physical activity network of the Americas

**STEPS** - WHO STEPwise approach to surveillance

**UN** - United Nations

**UN NCDs** – United Nations high level meeting on non- communicable disease

**WHO** - World Health Organization

**WHO DPAS** - WHO Global Strategy on Diet, Physical Activity and Health

**WHO GAP** - WHO Global Action Plan for the Prevention and Control of NCDs, 2013-2020

**WHO GAPPA** - Global Action Plan for Physical Activity 2018-2030

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## 4. EXECUTIVE SUMMARY


### Background

Despite the importance of physical inactivity as one of the four main risk factors for NCDs, there was no observatory dedicated exclusively to monitor physical activity worldwide. The need for country level data collection, high quality locally applicable research and monitoring to inform policy and planning of interventions at the population level was evident. In 2012, the Global Observatory for Physical Activity – GoPA! was launched in response to this urgent call for action becoming a worldwide response to a worldwide problem.

Although described as urgent in the call to action set by the Lancet Physical Activity Series 1, there is no record of any summarizing document that includes national indicators of physical activity health outcomes, surveillance, policy and research, developed with a standardized methodology and accessible to a diverse public. Neither, a comparison of these indicators at the country and regional levels was ever conducted. In addition, even though research in the area of physical activity and health has increased dramatically in the last years, to date, beyond opinion leaders, little is known about the real structure of the network that led to information dissemination and consequently field development, meaning that the map of the evolution of research in the physical activity and public field is unknown.

### Objective

Evaluate and summarize physical activity health outcomes, surveillance, policy and research, using the data of the Global Observatory for Physical Activity – GoPA!.

### Methods

Using a standardized methodology, physical activity health outcomes, surveillance, policy and research indicators will be collected and summarized in an accessible and all-inclusive public physical activity country profile called the “Country Cards”. Two sets will be part of this thesis: 1) the first set with 2013

data, and 2) the second set with 2015 data. Besides providing a thorough description of the data collection methods, a process evaluation, statistical data analyses, and the creation of a comprehensive physical activity ranking will be conducted allowing countries to track and evaluate their progress in terms of health burden, physical activity prevalence, surveillance, policy and research over time.

In addition, a historical reconstruction of the development of the physical activity and health research field, using formal citation network analysis methods that will identify the most influential pieces over time, will be conducted.

# 5. INTRODUCTION

## 5.1 Global impact of non-communicable diseases and physical inactivity

Non-communicable diseases (NCDs) are the main health threat of the 21st century. More than a decade ago, the World Health Organization (2) warned the global public health community of the rapidly growing epidemic and disease burden due to NCDs (3). At that point, it was estimated that 60% of global deaths were due to these diseases, that included cardiovascular and chronic respiratory diseases, cancers, and diabetes (3).

At that time, tobacco, hypertension, high blood glucose, high cholesterol, harmful alcohol intake and physical inactivity were identified as the main risk factors for NCDs worldwide (4, 5). Due to the devastating health, social and economic outcomes anticipated for this epidemic, a strong call to action was established, encouraging governments to create or strengthen surveillance systems, formulate specific disease prevention and health promotion policies, and to collaborate with other sectors and international partners to reduce exposure to these risk factors (3).

However, after almost a decade of global efforts, strategic initiatives and action plans to stop the preventable epidemic of NCDs (WHO Framework Convention on Tobacco Control; Global Strategy on Diet, Physical Activity and Health; Global Strategy to reduce Harmful Use of Alcohol; United Nations General Assembly resolution on NCDs prevention and, the 2008-2013 WHO NCDs Action Plan) (6-8), WHO reports still showed that most (63% and 68%) annual global deaths were due to NCDs in 2008 and 2012, respectively. Another concern was that more than 80% of NCDs deaths took place in low and middle income countries (9, 10). Trends have shown that by 2020, NCDs will account for 73% of global deaths (11).

The 2012 World Health report focused on four main behavioral risk factors - tobacco use, unhealthy diet, harmful use of alcohol and physical inactivity (9) - that resulted in an overall unhealthy lifestyle. A strong body of scientific evidence related to the health benefits of physical activity across the lifespan has been

published over the last five decades (3, 5, 12, 13). Regular physical activity helps prevent and reduces the risk of over 20 medical conditions, including: hypertension, coronary heart disease, stroke, metabolic syndrome, obesity, type 2 diabetes, colon and breast cancer, depression, anxiety, dementia, injuries and falls. Improved cognitive function in children and musculoskeletal health in older adults were also described as benefits of physical activity practice (12, 14, 15).

Despite the evidence related to the health benefits of physical activity (3, 5, 13), tobacco use, unhealthy diet and harmful use of alcohol have received greater and more prolonged attention from governments in terms of surveillance, prevention, promotion, policy initiatives and resource allocation worldwide, as compared to physical inactivity (16). One of the main reasons for this gap is that physical inactivity has been related directly or indirectly to other risk factors for NCDs, and therefore has been often treated as part of other risk factor's prevention initiatives, and not as a standalone health threat (16).

Although, in 2010 the WHO Global Status report on NCDs provided the first estimates of national physical inactivity prevalence for 122 countries, it was the Lancet Physical Activity Series launched in 2012, that examined first physical inactivity separately and independently from the other risk factors for NCDs (17). Physical inactivity was first declared as a pandemic (17), affecting approximately one third of the adult and three quarters of the adolescent population worldwide (18). Also, it was estimated that addressing physical inactivity could prevent 5.3 million deaths per year worldwide (14).

Parallel to this, and in response to the urgent call for action declared by the World Health Assembly in 2011, WHO released the 2013-2020 Global Action Plan for the prevention of NCDs, where a goal of at least 10% relative reduction in the prevalence of physical inactivity to be achieved by 2025 was set (19).

Most recently, in July 2016, the Second Lancet Physical Activity Series was launched with important contributions to health outcomes and health systems evidence, showing that physical inactivity accounted for about 3·8% of cases of

dementia worldwide and, was estimated to cost 67.5 billions of international dollars per year in health care expenditures and losses of productivity (20).

In addition, improvements in terms of global surveillance and policy were found. An increase on research about correlates and determinants of physical activity in low and middle-income countries (LMIC) was observed, providing better evidence for the development of context-specific interventions. In terms of physical inactivity prevalence, the results showed a very modest progress with no change in the overall estimates and an alarmingly high prevalence of physical inactivity in adolescents.

Therefore, the main conclusion is that despite great efforts over the last 15 years, the prevalence of physical activity is not increasing worldwide (21). Addressing the physical inactivity pandemic remains a public health priority with a need to develop a global response to a global problem.

### 5.2 Physical activity recommendations

The literature shows that even small amounts of physical activity produce health improvements, and that meeting the international recommendations of physical activity provides greater health benefits. Over time, recommendations have been updated and changed substantially as new scientific evidence showed how much moderate and vigorous-intensity physical activity produces health benefits. The 1995 CDC/ACSM recommendation for the American adult population, suggested “30 minutes of moderate-intensity physical activity most days of the week” (22).

Current WHO and CDC physical activity recommendations are age specific (23). The recommendation for children and adolescents is to engage in 60 minutes of daily physical activity, which should be mostly of moderate-to-vigorous intensity, and include muscle strengthening and bone strengthening activities at least three days of the week.

For adults, the recommendation is to accumulate 150 minutes per week of moderate-intensity aerobic physical activity, or 75 minutes of vigorous-intensity aerobic physical activity, in episodes of at least 10 minutes and spread throughout the week. Muscle strengthening activities involving all major muscle groups are also recommended, at least two days a week. In order to obtain greater benefits, adults should engage in 300 minutes of moderate- or 150 minutes of vigorous-intensity aerobic physical activities.

Finally, for older adults, guidelines are the same as for adults. However, there are two specific recommendations: 1) engaging in balance activities, in order to prevent falls and, 2) if there is a chronic condition that limits physical activity, the recommendation is to be as physically active as possible.

It is important to consider that changes in the recommendations have imposed limitations on the comparability of prevalence estimates over time, which are often mistaken as increases or decreases in the population exposure to inactivity (24). This will be discussed in the next section.

### 5.3 Global surveillance on physical activity

Health observatories monitor, produce and deliver health information (25, 26). Social determinants of health, communicable diseases and NCDs and their risk factors are often included as topics of interest (2, 26, 27). As stated in the WHO STEPwise approach to surveillance (STEPS), “surveillance involves ongoing collection of data for better decision making, underpining public health action and health promotion activities” (11). Therefore, surveillance is needed to assess risk factors prevalence and the effectiveness of policies or programs to promote health and prevent disease.

It is not uncommon to find national health observatories around the world. However, only few have included a regular monitoring of physical activity among their indicators. Countries that have health observatories or surveillance systems that include physical activity include: Australia, Belgium, Brazil, Canada, Chile, Colombia, France, Guatemala, Ireland, Portugal, Scotland, Switzerland, United

Kingdom, United States, Wales and the European Union. A good example is the Eurobarometer surveillance system, that has monitored political, economic and some health indicators in all European Union member states since 1974. In 2013, a sports and physical activity module was included (28).

The WHO Global Health Observatory is the largest observatory that monitors physical inactivity among other risk factors for NCDs in more than 120 countries. The WHO STEPS instrument allows comparability across countries and provides a solution to data collection in low resourced LMICs.

Adult estimates are based on self-reported physical activity, collected using the Global Physical Activity Questionnaire - GPAQ, the International Physical Activity Questionnaire - IPAQ or a similar instrument that included the household/work, transport and leisure time physical activity domains. In relation to adolescents, the instruments used to assess physical activity prevalence are the Global School Based Student Health Survey and the Health Behavior in School Aged Children Study (29). These questionnaires are included as part of the data collection instrument - first of three steps in the WHO STEPS framework (11).

In 2013, the WHO NCDs country capacity assessment survey showed that 88% of countries had a national health survey that included assessment of physical activity(30). In addition, data presented in the Lancet series in 2012 (18), included data for adults from 122 countries and showed that surveillance data gaps were concentrated in Sub-Saharan Africa and Central Asia. Furthermore, 37.5% of the low income countries had no surveillance data on physical activity at that time (18). The lack of continuous surveillance was identified as one of the most important barriers for countries to assess progress (18).

Between the Lancet series in 2012 and 2016, there was an improvement in the number of countries with physical activity surveillance for adults and

adolescents. The main improvement was seen in data for adolescents, which increased from 105 countries to 120 countries (21).

5.31 Physical activity prevalence

WHO first estimated comparable prevalence estimates of physical inactivity in 2008 for 122 countries and then in 2014 for 146 countries. There were prevalence estimates available for adolescents and adults according to the international recommendations of physical activity described earlier (23). Figures 1 and 2 show the maps of physical inactivity prevalence in 2014 for adolescents and adults in 5% increments (both sexes).

These prevalence estimates were used in the 2012 Lancet Physical Activity Series (18) and in the 2016 one (21). In 2012, a 31.1% adult prevalence of physical inactivity was estimated worldwide. However, in the 2016 series, the estimated prevalence was 23.3%, which could be mistakenly interpreted as an increase in global physical activity levels. However, authors explained that these "apparent decrease in the prevalence of physical inactivity" was due to a change in the algorithm used to estimate physical inactivity in adult populations, because new population recommendations were launched. In 2012, adults were classified as physically inactive if they did not achieve at least 30 minutes per day of moderate-intensity physical activity during five days of the week, or 20 minutes of vigorous-intensity activity three days of the week, or an equivalent combination (18). Nowadays, an adult is classified as physically inactive if she/he does not achieve 150 minutes of moderate-intensity physical activity or 75 minutes of vigorous-intensity activity per week or an equivalent combination. This new recommendation is easier to achieve since it does not require a periodicity.

In order to confirm this, authors showed trend data from the 12 countries with comparable data, and concluded that there were no changes in the physical activity prevalence. Finally, women and older people remained less active compared to its male and younger counterparts (21).

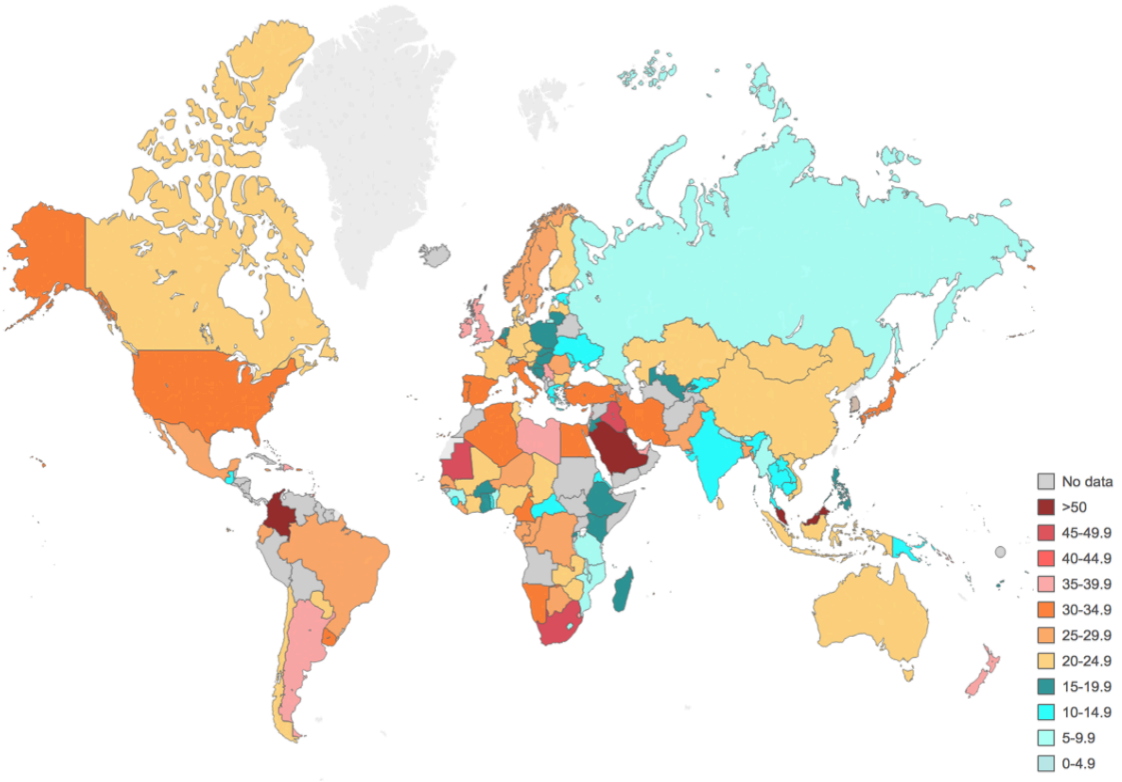



Figure 1. Global physical inactivity prevalence in adults 18+ years (both sexes) in 2014.

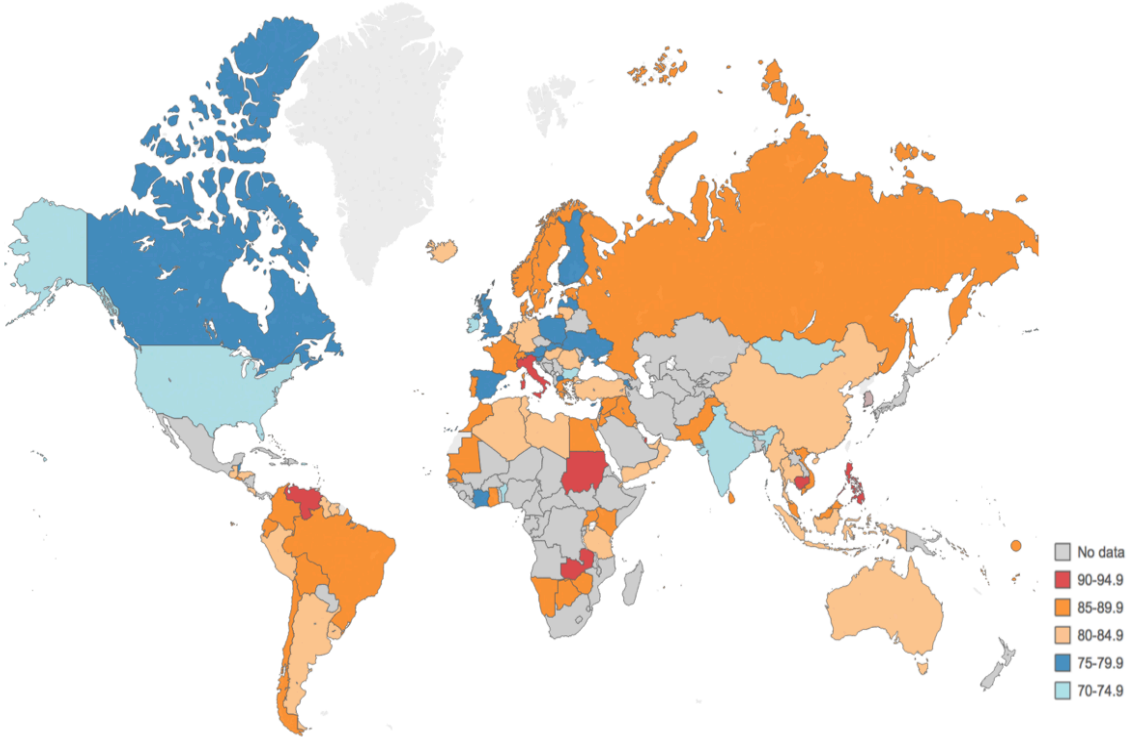



Figure 2. Global physical inactivity prevalence in adolescents 11-17 years, (both sexes) in 2014.

Recently in September 2018, the World Health Organization published updated global age standardized prevalence of physical inactivity showing that one out of three adults worldwide 27.5% (95% CI 25·0–32·2) does not meet physical activity recommendations and estimated to be around 23% and 32% for the last 15 years (31).

The variation between the new estimates and the previous reported by the Lancet Series is due to new population recommendations and to the fact that few countries are systematically and frequently collecting comparable surveillance physical activity data. The strength of the new WHO estimates is that they include data from 358 surveys across 168 countries and include 1·9 million participants.

### 5.4 Global physical activity policy

Increasing population-wide participation in physical activity was identified as one of the health priorities in this century. However, when thinking about the determinants of this behavioral and modifiable risk factor, multiple distal and proximal determinants are involved, and not just individual choices (5, 7, 9). As stated by the World Health Report in 2013 “there persists a widespread belief that these are “lifestyle diseases”, fully under the control of individual decisions” (32). Therefore, government actions and political commitment from multiple sectors (e.g. transport, education, sports, culture and health) are essential in order to reduce physical inactivity worldwide (32).

The fact that NCDs have a long disease path, provides an opportunity to control their risk factors and prevent their development. Due to the great amount of scientific evidence related to the biology and pathophysiology of NCDs, its policy agenda is solid. For example, there are effective context specific policies on tobacco control that have been successful in reducing the prevalence of smoking in the last decades and, nutrition policies that have reduced consumption of trans fat and excessive amounts of sodium. However, in terms of physical inactivity, there is weak political commitment and resources to inform policy (33).

### 5.4.1 Physical activity policy framework and plans

In the last decade, specific frameworks and plans were developed in the attempt to address the gaps and prevent population wide health consequences of physical inactivity. There are four examples worth mentioning: 1) the WHO Global Strategy on Diet, Physical Activity and Health; 2) the Toronto Charter for Physical Activity; 3) the 7 best investments in physical activity; and 4) the WHO Global Action Plan for the Prevention and Control of NCDs, 2013-2020; 5) the WHO Global Action Plan for Physical Activity GAPPA 2018-2030.

1. The WHO Global Strategy on Diet, Physical Activity and Health (13).
   Published in 2004, its main objective was providing guidance to implement sustainable actions at the individual, community, national and global levels that could contribute to a decrease in the health burden caused by unhealthy diets and physical inactivity. The four specific objectives were:

   - Reducing risk factors for chronic diseases derived from unhealthy diets and physical inactivity through public health actions.
   - Increasing awareness and understanding of the influence of diet and physical activity on health, and the positive impact of preventive interventions.
   - Developing, strengthening and implementing global, regional and national policies and action plans to improve diets and increase physical activity that are sustainable, comprehensive and actively engage all sectors.
   - Monitoring science and promoting research on diet and physical activity.

2. The Toronto Charter for Physical Activity (34)
   Published in 2011 by the International Society of Physical Activity and Health (35), the Toronto Charter was written as a call for greater political and social action, and commitment to promote physical activity at the population level. The charter described nine guiding principles.

   - Targeting whole populations.

- Reducing inequities.
- Addressing the environmental, social, individual determinants of physical activity.
- Working in partnerships and across sectors.
- Building capacity in research and policy.
- Using a life-course approach.
- Using advocacy to gain commitment and resources.
- Adapting strategies for cultural and contextual fit.
- Make active choices the easier choices.

*3.* The 7 best investments in physical activity (36).

Published by GAPA, which is the Global Advocacy for Physical Activity Council of ISPAH, it is a complement to the Toronto Charter, that would help countries to apply and disseminate the available evidence about effective interventions. There are 7 best investments that work when promoting physical activity:

- 'Whole-of-school' programs.
- Transport policies and systems that prioritize walking, cycling and public transport.
- Urban design regulations and infrastructure that increase access and opportunities for recreational physical activity, and increase recreational and transport-related walking and cycling.
- Physical activity and NCD prevention integrated into primary health care systems.
- Public education, including mass media to raise awareness and change social norms on physical activity.
- Community-wide programs involving multiple settings and sectors and that mobilize and integrate community engagement and resources.
- Sports systems and programs that promote 'sport for all' and encourage participation across the life span.

4. The WHO Global Action Plan for the Prevention and Control of NCDs, 2013-2020 (19).

   Created after the United Nations General Assembly meeting in 2011. The meeting was about prevention and control of NCDs. Key messages included that an NCD epidemic impairs economic development; is preventable; it affects productive young adults; and there is a need for government action. The Action Plan emphasized, that it is fundamental to acknowledge that LMICs are the most affected, as they have weak surveillance capacities and are already suffering from the double burden of disease.

   This plan lists nine objectives to be met by 2025. One objective is related to physical activity: a 10% relative reduction in the prevalence of physical inactivity.

5. The WHO Global Action Plan for Physical Activity GAPPA 2018-2030 (37).

   Created after the Bangkok Declaration for Physical Activity launched in 2016. The plan advocates for a systems based approach to increasing physical activity and "aims to ensure that all people have access to safe and enabling environments and to diverse opportunities to be physically active in their daily lives, as a means of improving individual and community health and contributing to the social, cultural and economic development of all nations".

   *More active people for a healthier world - GAPPA*

   This plan lists the new objective to be met by 2030 related to physical activity: a 15% relative reduction in the prevalence of physical inactivity in adults and in adolescents by 2030.

### 5.4.2 State of Physical Activity Policy

The WHO NCD country capacity assessment survey of 2013 showed that 80·0% of countries reported having policies, plans or strategies for addressing physical inactivity. However, only 55% of the plans were being implemented (operational), and this proportion dropped to 42% for plans that

were both operational and funded. The future use of more specific physical activity policy audit tools would be an opportunity to understand the link between policy and evidence in more depth (13, 30, 38).

Policy data gaps remained concentrated in Sub-Saharan Africa and Middle East and North Africa, and in LMICs more broadly. Figure 3 shows the percentage of countries by WHO region and income groups with plans or policies for NCDs risk factor prevention, where physical activity is included (2013). Of note is a policy systematic review conducted after the publication of the DPAS and that focused on LMICs, which showed that there was an inadequate policy response to address NCDs challenges through diet and physical activity (39).

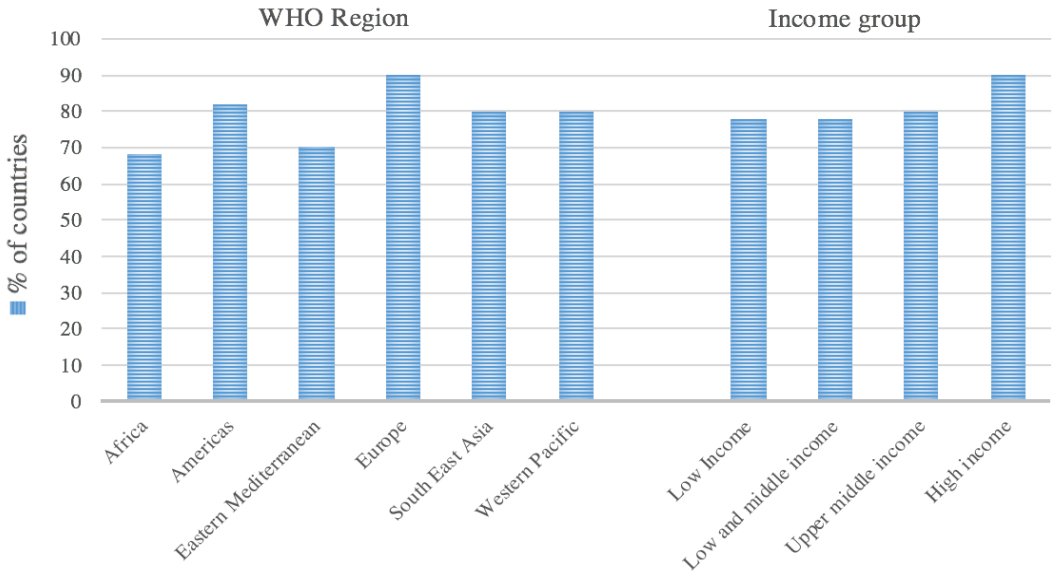



Figure 3. Plans or policies for NCD risk factors prevention that include physical activity (2013).

**Adapted from the WHO NCD country capacity assessment survey of 2013.*

The Lancet series 1 and 2 also assessed physical activity policy. The main message was that it was not enough to have policies when they were not being implemented. Even though, when comparing the years 2012 and 2016, it was evident that there had been progress. In 2010, 75% of the countries referred having a national physical activity plan, and in 2015, this percentage had increased to 91%. However, the lack of implementation limits and jeopardizes

any efforts to increase population levels of physical activity. Also, there were methodological barriers to be considered, including use of multiple instruments and lack of standardization (17, 21).

## 5.5 Global research on physical activity

"The best health policies are those based in scientific evidence"
Gro Harlem, WHO director in the World Health Report in 2002 (3).

Research in the field of physical activity and health evolved, going from 1 paper in PubMed in 1946 to approximately 200 articles published annually in 1985, and around 5·000+ from 2010 onwards.

The first records of published research in the field appeared in the 1950's.

The classic study of coronary heart disease and physical activity of work in London, led by Morris in 1953, was the first to report a higher incidence of coronary disease in those participants engaged in more sedentary and lighter-intensity occupations compared to the ones in more active and more intense occupations (40).

In the next two decades, the field continued developing around cardiovascular disease (CVD) epidemiology. Soon, physical inactivity started to be described as a risk factor for all-cause mortality. Representative studies included Paffenbarger´s studies of work activity and coronary heart mortality in longshoremen in California, that showed an 80% increase in risk of fatal coronary heart disease in inactive workers compared to their vigorously active counterparts (41). Also, the longitudinal study of physical activity and heart attack in college alumni found that the risk of a first heart attack was inversely related to energy expenditure (42). Other classic studies included Kannel´s Framingham article from 1979, which was the first that analyzed physical inactivity as a risk factor for cardiovascular disease, besides smoking, high blood pressure, glucose intolerance and high blood cholesterol (43).

In the 1980s, there was already evidence of several longitudinal and cross sectional studies on the inverse associations between physical activity and mortality due to cardiovascular disease (43). Methodological advances in the ways of expressing exposure to physical inactivity have also been observed (42). At the time, although most studies had their own methodology to classify physical activity levels, most collected data from official records or used self-reported information (42, 44, 45).

As mentioned by Laporte in 1985, at that moment in the field, “more than 30 different methods had been used to assess physical activity, including calorimetry, job classification, physiological markers, behavioral observation, mechanical and electronic monitors, and self- report and dietary measures. There were no standardized instruments at the time, and objective measurement using movement sensors or monitors were still on an experimental phase. Therefore, a call to standardize instruments and address those gaps was made (46).

In 1985, Caspersen, Powell and Christenson published the first methodological article that standardized the field´s terminology providing definitions of physical activity, physical fitness and exercise. Also, they proposed a classification system (physical activity occurring during sleep, occupation and leisure), which would become what we know today as the physical activity domains (47).

Also in that year, Sallis published one of the first multicenter studies to assess physical activity in the community using a 7-day recall questionnaire, which showed to be reliable and suitable for population health surveys and community interventions. An important contribution of this study was the recommendation to use standard units to measure energy expenditure (metabolic equivalents - METs), to allow comparability across studies (45). Other relevant studies with similar findings and methodologies were led by Blair in 1985 (48) and Paffenbarger in 1986 (49).

One of the first reviews in the field was led by Powell in 1987, and concluded that there was consistent epidemiological evidence of an inverse and causal association between physical activity and incidence of coronary heart disease. It also concluded that physical activity promotion was fundamental, given that the magnitude of the risk of coronary heart disease due to physical inactivity was similar to that of hypertension, hypercholesterolemia and smoking (50). The first meta-analysis in the field based on the results presented by Powell in 1987 was published by Berlin in 1990 with consistent findings (51). Research productivity increased and study types diversified in the 1990´s. Studies about correlates and determinants, interventions and policy were published and studies about health consequences included other outcomes besides CVD. It is important to highlight that in this decade, the first population based guidelines for physical activity were published. In 1992, the American Heart Association launched the exercise recommendations for adults to improve performance capacity and fitness (52). Three years later, in 1995, the Centers for Disease Control and Prevention and the American College of Sports Medicine published a population based recommendation based on the physical activity and health model. The consensus recommended that “Every U.S adult should accumulate 30 minutes or more of moderate-intensity physical activity on most, preferably all days of the week” (22).

Also in this decade, some randomized trials with physical activity were conducted, and the role of physicians in prescribing physical activity was also discussed in the literature (53, 54). Studies evaluating associations with behavior, mental health and environment started to be published in other age groups besides adults, and taking into account gender and socioeconomic differences (55).

From 2000 onwards, research was conducted including all types of studies. Important studies related to measurement, correlates and interventions showed the importance of collaboration between disciplines to be able to explore new topics and understand physical activity practice and population levels. In relation to study types, the studies of Brownson, Sallis and Saelens were among the first studies to mention the associations between physical activity, psychological wellbeing, environment and policy (56-58).

In relation to intervention studies, Khan´s systematic review in 2002, showed the gap in the literature related to which were the most effective interventions to increase physical activity (59). In addition, Craig´s study in 2003 discussing the validity and reliability of the International Physical Activity Questionnaire became a milestone in terms of physical activity measurement (60).

An update of health benefits of physical activity by Bauman in 2004 (12), treatment guidelines (ischemic heart disease, stroke) and position statements reinforced the literature related to health outcomes. In 2006, the Ecological model to explain physical activity and active communities created by Sallis appeared and became one of the most important pieces in the determinants and correlates literature (57). Heath´s study about the state of the art on physical activity interventions (61) and Troiano´s first population based study with objective measurement of physical activity levels in U.S. adults were published.

Since 2005, built environment and global surveillance and policy literatures increased. The built environment area included pivotal studies like the reviews by Badland and Saelens about transport, urban design and walking, respectively (62), a multicounty study by Sallis (63) and a review of evidence related to active travel policies to improve health by DeNazelle (64).

In relation to global surveillance and policy, precursors included Bull´s and Bauman´s studies about the Global Physical Activity and International Physical Activity Questionnaires, respectively (65, 66). In addition, the Lancet Physical Activity Series I papers published in 2012 were the first ever physical activity series of papers, discussing the current global status in the field up to 2012, global burden, correlates and determinants, megatrend and future steps to address physical inactivity. Authors to highlight include Hallal, Lee, Bauman, Pratt, Heath and Kohl (14, 18, 67-70).

As a follow up to the Lancet Series 1, in July 2016, the Lancet Physical Activity Series 2 was published including trends analyses in the area of global surveillance, research and policy, an innovative economic analyses, scalability of

physical activity interventions and a sedentary time and mortality risk analyses (20, 71-75). For the first time, the cost of physical inactivity is estimated in 67.5 billions of dollars per year due to health care costs and losses of productivity. In addition, the risk of dementia due to physical inactivity was estimated. Figure 4, shows in a timeline some of the important papers that were described in this section.

Finally, main key messages can be highlighted from this body of scientific evidence:

1) Strong evidence supports the beneficial health effects of physical activity; 2) International health organizations, such as the World Health Organization – WHO, recognize that physical inactivity is one the main modifiable risk factors for non-communicable diseases worldwide; 3) International physical activity recommendations for all population groups exist and are periodically updated; 4) Most of the world countries have physical activity prevalence estimates that can be used to inform surveillance and policy; 5) There is a global call to action to address physical inactivity, which was declared pandemic in 2012 (16, 17, 19, 75).

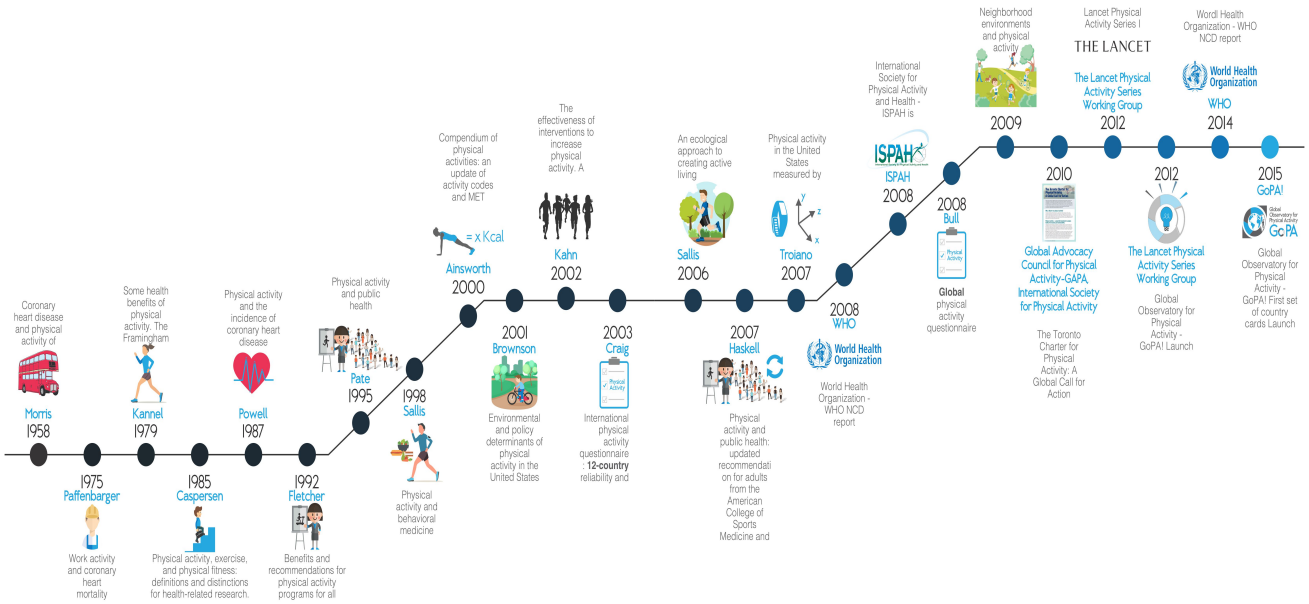



Figure 4. Timeline including relevant research publications in the physical activity and public health field since the 1950's.

## 5.6 Physical Activity promotion and advocacy

Efforts in physical activity advocacy are recent, have been increasing over the last decade, and are a logical next step in response to the consistent evidence showing the health benefits of physical activity. Advocacy means “going from evidence to influence” (76).

There are some reasons why it has been difficult to make the case for physical activity promotion (16, 76). 1) There is dominant focus in policy on the treatment of conditions rather than prevention; 2) Few national physical activity policies are implemented; 3) Many actors still do not know the evidence about the health benefits of physical activity; 4) Different guidelines produce confusion when determining which is the level of physical activity to be achieved; and, 5) the specific local realities are often not considered when designing interventions to promote physical activity (77).

The Global Advocacy for Physical Activity – GAPA started advocating for physical activity in 2007. However, there are still many actions to be taken in order to make an effective case for physical activity advocacy. One of the strategies to address this difficulty was GAPA’s advocacy framework for action, exclusively oriented to translate evidence, generate an advocacy agenda, influence and get support. The main focus is to make the case for physical activity around the world, using consistent messages and making strategic partnerships to raise awareness, gain political commitment and produce action (76).

For advocacy to be effective, partners have to be taken into account and a global infrastructure is needed. Figure 5 shows a timeline updating the global infrastructure for physical activity and public health. GAPA highlighted the important role of media, community, professional societies and political organizations (77).

Between 2002 and 2012, GAPA has achieved milestones in terms of advocacy. Physical activity workshops, participation in regional and international consultations and approximation to WHO and UN and partnerships establishment (78).

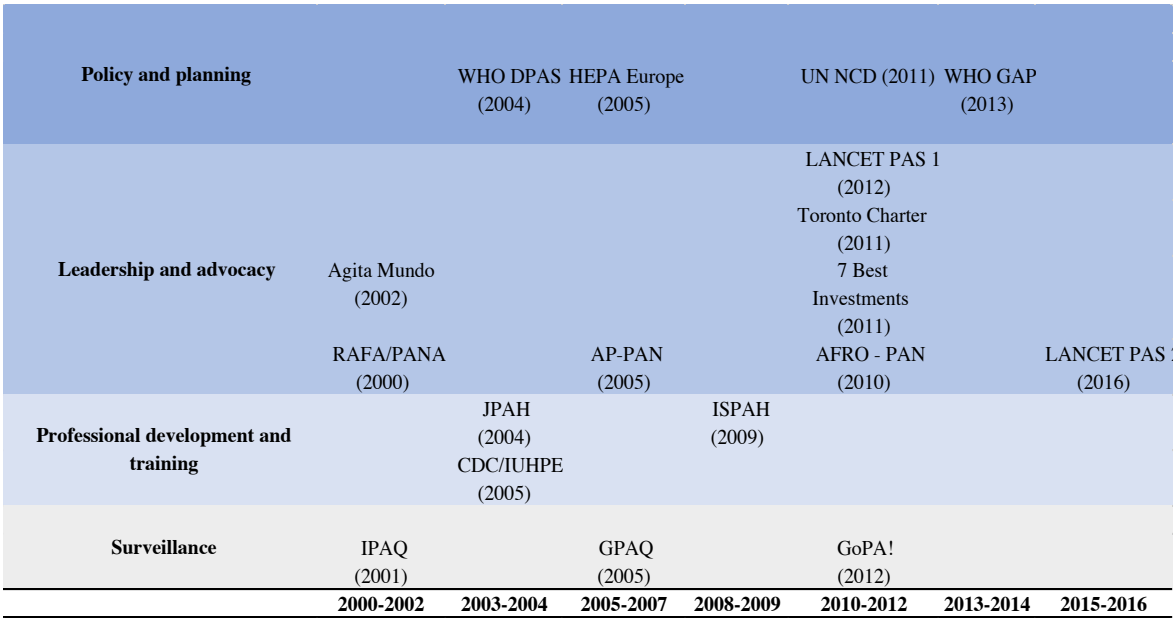



Figure 5. Update of the global infrastructure for physical activity and public health.

**Adapted from the Lancet Physical Activity Series 1, 2012.*

In the Lancet series 2012, a call to action was established, with key actions necessary to advance global health through physical activity (17). Specific messages were sent to UN, WHO, World Bank, international agencies, countries, ministries of health, education, sports, planning, transport, private sector, academics and civil society, with an invitation to become advocates, leaders, partners and collaborators in the fundamental and urgent task of advocating for physical activity.

In 2016 a new physical activity series was launched, and one of the main conclusions was that physical activity promotion is a public health priority since minimal evidence that physical activity was increasing worldwide was found, and, would threaten the achievement of the already modest 10% reduction in physical inactivity worldwide by 2025 (a 10% reduction in the current 23.3% of physical inactivity worldwide is equivalent to 2.3 percentage points, which is too timid when compared to other global millennium development objectives).

Therefore, a new call to action for countries to give priority to physical activity, implement already proven effective programs and strategies was set. International collaboration and special attention needs to be given to low and middle income countries in terms of capacity building, policy implementation and scaling up of interventions (75)

The good news is that physical inactivity was recognized as a public health problem at the 69th World Health Assembly conducted in 2016, and will be part of the resolution of the 70th assembly. For the first time, WHO will be part of the 2016 ISPAH congress to be held in Thailand in November 2016, therefore, global physical activity is starting to be among priority in their agendas.

### 5.7 The Global Observatory for Physical Activity – GoPA!

Despite the importance of physical inactivity as one of the four main risk factors for NCDs, there was no observatory dedicated exclusively to monitor physical activity worldwide. The need for country level data collection, high quality locally applicable research and monitoring to inform policy and planning of interventions at the population level was evident. In 2012, the Global Observatory for Physical Activity – GoPA! was launched in response to this urgent call for action (17, 18, 79-81), becoming a worldwide response to a worldwide problem.

The rationale of creating a physical activity observatory was to provide information that allowed countries to determine which were their needs and opportunities to initiate or improve standardized data collection, surveillance systems, policy making, program development and evaluation in the area of physical activity. It is not enough to determine each of the country's physical activity status, but it is mandatory to observe and follow them closely to encourage improvements and obtain results at the population's physical activity level.

GoPA! has a role as a global physical activity advocate, responsible to encourage international agencies and countries to take action to increase the population's physical activity levels (17). GoPA! is collaborating with other

institutions and governments worldwide working to achieve physical activity goals, as the 10% decrease in physical inactivity levels for all nations by 2025 (82).

The Global Observatory for Physical Activity – GoPA! is a group of physical activity epidemiologists and public health experts producing and analyzing reliable, high quality and current global data on the topic of physical activity and health, and measuring global progress in the areas of surveillance, policy and research (1).

The Global Observatory for Physical Activity (1) is a Council of the International Society of Physical Activity and Health and its principal office is at the Center of Epidemiological Research of the Universidade Federal de Pelotas in the city of Pelotas, southern Brazil (83).

# 6. THEORETHICAL FRAMEWORK, CONCEPTUAL MODEL AND DEFINITIONS

## 6.1 Theoretical framework

***Eco-social theory and related multilevel dynamic frameworks.***

Described by Kriger et al (84), is part of a group of frameworks that aim to explain current and shifting patterns of disease distribution and that do not stay in a single plane, due to their multidimensional and dynamic nature. In the case of the ecosocial theory, it aims to generate a set of principles useful for guiding inquiry and action. It analyses current and changing population patterns of health, disease and well being in relation to each level of biological, social and ecological organization.

## 6.2 Conceptual model

The following conceptual models were put together according to the evidence described in previous sections. The second model was specifically built in order to explain the role of the Global Observatory for Physical Activity - GoPA! in the overall model. All the variables included in this project were selected based on these models.

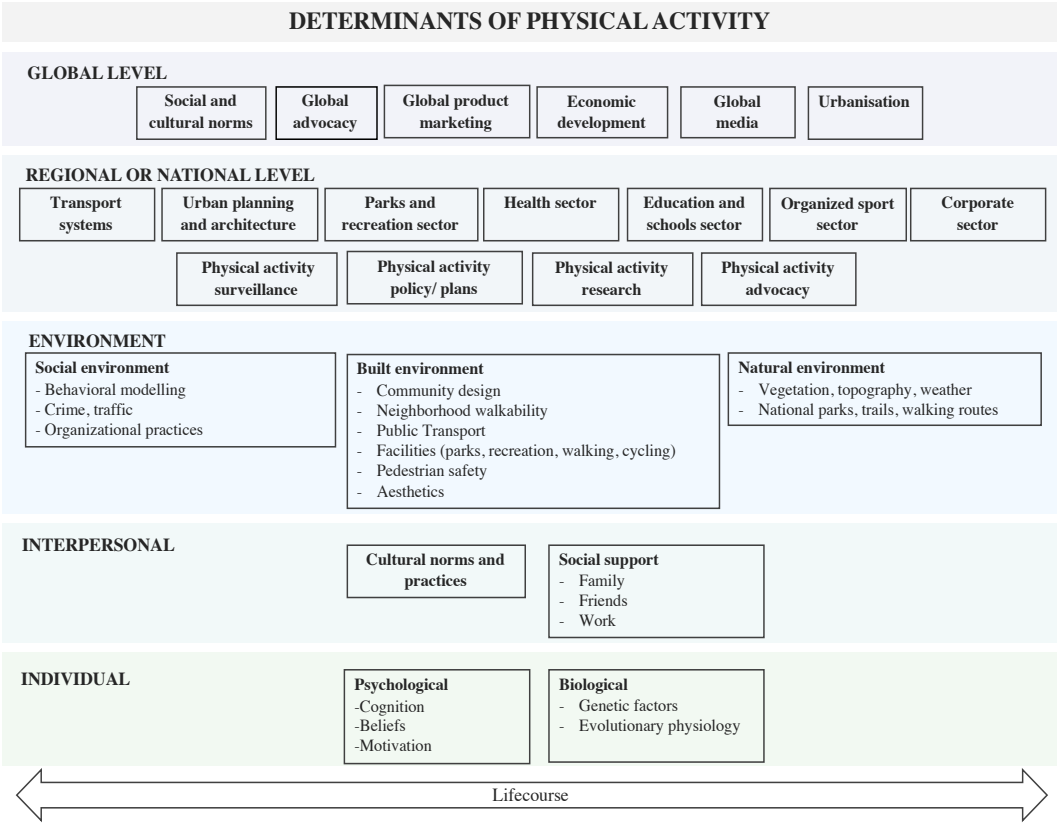


Figure 6. Determinants of physical activity - conceptual model.

**Adapted from the Lancet Physical Activity Series 1, 2012.*

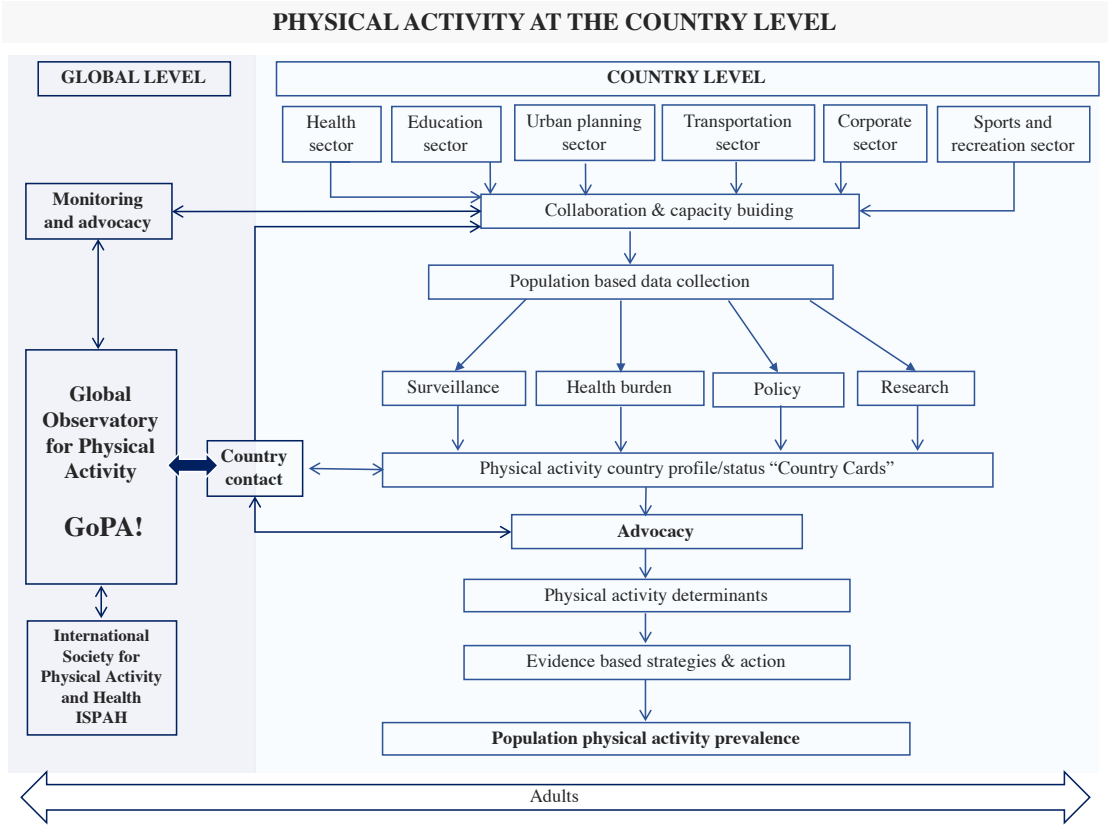



Figure 7. Advocacy for physical activity at the Global Observatory for Physical Activity GoPA!- conceptual model.

## 6.3 Definitions

- **Physical activity:** any bodily movement produced by the contraction of skeletal muscle that increases energy expenditure above a basal level. The term "physical activity" will generally refer to bodily movement that enhances health in public health guidelines (47).

- **Physical activity recommendations for adults:** defined according to the current international Guidelines as aerobic activity at least for 150 minutes (2 hours and 30 minutes) per week of moderate-intensity; or 75 minutes (1 hour and 15 minutes) per week of vigorous-intensity aerobic physical activity; or an equivalent combination of moderate- and vigorous-intensity aerobic activity. Aerobic activity should be performed in episodes of at

least 10 minutes, and preferably, it should be spread throughout the week (85).

- **Non-communicable diseases:** chronic conditions that do not result from an acute/infectious process and hence are “not communicable.” A disease that has a prolonged course, that does not resolve spontaneously, and for which a complete cure is rarely achieved (86).

- **Monitoring:** can be defined as the ongoing process by which stakeholders obtain regular feedback on the progress being made towards achieving their goals and objectives. Involves tracking strategies and actions being taken by partners and non-partners, and figuring out what new strategies and actions need to be taken to ensure progress towards the most important results (86).

- **Surveillance system:** surveillance system is a series of surveys conducted again and again to monitor long-term trends in public health. It is used to examine public health issues across several years, to track the trends, compare health among groups of people, and determine whether something is improving or worsening for a specific group of people (87). Conducts a systematic collection, analysis, and interpretation of outcome-specific data for use in the planning, implementation, and evaluation of public health practice, closely integrated with the timely dissemination of these data to those responsible for preventing and controlling disease and injury (88, 89).

## 7. JUSTIFICATION

Developed to contribute to the knowledge gaps in the field of global physical activity surveillance, policy and research, this PhD project is strongly tied to the purpose and rationale of the Global Observatory for Physical Activity – GoPA!.

Given that before GoPA! there was no observatory dedicated exclusively to monitor physical activity worldwide, this project will document data collection methods, analyze the data and evaluate the processes conducted in GoPA! using statistical and epidemiological methods.

Also, as there is no record of any summarizing document that includes national indicators of physical activity surveillance, policy, research and health outcomes, developed with a standardized methodology and accessible to a diverse public, this project will summarize those indicators in an accessible and all-inclusive public physical activity country profile called the “Country Cards”. These cards will allow a comparison of indicators at the country and regional levels, that was never conducted before.

These Cards will be an advocacy tool to help countries move toward a more physically active population and society. In addition, taking advantage of the standardized methodology for the Country Cards data collection, a comprehensive physical activity ranking will be built allowing countries to track and evaluate their progress in terms of physical activity prevalence, surveillance, policy, research and health outcomes over time.

In addition, even though research in the area of physical activity and health has increased dramatically in the last years, to date, beyond opinion leaders, little is known about the real structure of the network that led to information dissemination and consequently field development, meaning that the map of the evolution of research in the physical activity and public field is unknown. Therefore, this project will provide a historical reconstruction of the development of the physical activity and health research field, using formal citation network analysis methods that will identify the most influential pieces over time.

In conclusion, this thesis is relevant and justified because it will provide a very much needed historical reconstruction using formal methods, and a baseline and bi-annual follow-up description of the global status of physical activity in terms of surveillance, policy, research and health burden at the national and regional level for those countries that are members of the Global Observatory for Physical Activity – GoPA! initiative.

# 8. OBJECTIVES

## 8.1 Main objective

To assess physical activity health outcomes, surveillance, policy and research worldwide, using the data collected by the Global Observatory for Physical Activity – GoPA!

## 8.2 Specific objectives

8.2.1 Describe the historical development of the physical activity and health research field.

8.2.2 Describe the first set of physical activity Country Cards, including information on health outcomes, surveillance, policy, prevalence, research results and ranking of countries.

8.2.3 Estimate the association between the first set of physical activity Country Cards indicators of surveillance, policy, prevalence and research.

8.2.4 Conduct a process evaluation about the first set of physical activity Country Cards, to be used to inform the second set of Country Cards, including information on health outcomes, surveillance, policy, prevalence, research results and a new comprehensive ranking of countries.

8.2.5 Create a comprehensive ranking that includes information on health outcomes, surveillance, policy, prevalence, research, to be used in the second set of Country Cards to rank countries according to overall state in national physical activity.

8.2.6 Describe the second set of physical activity Country Cards, including information on health outcomes, surveillance, policy, prevalence, research results and ranking of countries.

8.2.7 Estimate the association between the second set of physical activity Country Cards indicators of surveillance, policy, prevalence and research and compare results with the first set of Country Cards.

8.2.8 Compare the first and second set of Country Cards health outcomes, surveillance, policy, prevalence and research indicators and provide trends.

8.2.9 Describe a conceptual framework of physical activity advocacy at the country level and advocacy stages according to country profiles.

## 9. HYPOTHESES

9.1 At least 50% of the world countries have information related to health outcomes, surveillance, policy, prevalence and research of physical inactivity at the national level.

9.2 Fifty percent of the world countries have continuous surveillance of physical activity.

9.3 Fifty percent of the world countries have a national physical activity policy.

9.4 Fifty percent of the world countries have at least 1 publication related to physical activity and health in 2013.

9.5 High income countries have a higher prevalence of adults meeting the physical activity recommendation, compared to lower income countries.

9.6 High income countries are more likely to have continuous national surveillance systems that include physical activity, compared to lower income countries.

9.7 Low income countries are less likely to have a standalone national policy on physical activity, compared to higher income countries.

9.8 Low income countries are less likely to have research on physical activity, compared to higher income countries.

9.9 Surveillance, policy and research are moderately correlated.

9.10 A higher national physical activity prevalence is associated with continuous and periodic surveillance.

9.11 A higher national physical activity prevalence is associated with the country having a specific physical activity policy.

9.12 A higher national physical activity prevalence is associated with the country being in higher physical activity research quartiles.

9.13 A higher national physical activity prevalence is associated with a lower population attributable fraction of deaths due to physical inactivity.

9.14 At least 50% of the GoPA! country members have used the Country Card to make the case of physical activity.

9.15 National physical activity prevalence estimates, surveillance, policy, research and health outcomes have the same statistical weight in the physical activity ranking.

9.16 National physical activity prevalence estimates, surveillance, policy, research and health outcomes have the same statistical weight according to the country representative, in the physical activity ranking.

9.17 The second set of Country Cards will show an increase in the proportion of countries with health outcomes, surveillance, policy, prevalence and research indicators, when compared to the first set of Country Cards.

## 10. PROPOSED ARTICLES

**10.1** Mapping the historical development of the physical activity and health field: a network analysis.

**10.2** Worldwide status of physical activity: The Global Observatory for Physical Activity first set of Country Cards (2013).

**10.3** Worldwide status of physical activity and ranking: The Global Observatory for Physical Activity second set of Country Cards (2015).

## 11. METHODS

The methods section will be divided into two main parts. First, we will describe the methods used for the review article. Second, we describe the methodology to be adopted for the original papers.

### 11.1 Review paper

**Objective**

To provide a historical reconstruction of the development of the physical activity and health research field since 1950, using formal citation network analysis methods that identify the most influential pieces over time.

**Methods**

This is a **structured literature review using citation network analysis methods**. A citation network approach to understand the historical development and composition of the physical activity and health research since 1950 will be applied. According to Harris, et.al, citations are a formal measure of scientific communication and this approach is useful because it characterizes the structure of a field while evaluating the relationships among articles, books and other documents that are found within it (90).

- **Previous to data collection**

***Most cited articles list***

Following past research, we will use a two-step process to identify the key articles for the search (91). We will search ISI Web of Knowledge and Google Scholar for the most cited articles in the physical activity field since 1950. The search terms will be “physical activity AND public health”, and keywords can be anywhere in the title, abstract or text. No language, country or study types will be excluded.

A preliminary list will be created including the 40 most cited articles (20 from ISI Web of Knowledge and 20 from Google Scholar). In order to obtain the final list of most influential 15 articles in the field to use to conduct the citation network analysis, experts will be consulted.

***Expert survey***

A separate search will be conducted in **Scopus, google and ISI to** determine the most cited authors in the field, according to the H index. From the most cited authors list, 15 will be selected if they are considered by the working team as having depth in knowledge, recognition and most of their publications related to one of the following five study type categories: 1) Physical activity levels, trends and measurement (deals with the sciences of physical activity surveillance and measurement); 2) Determinants of physical activity (deals with studies helping understand why some people are active and others are not, by using physical activity as the main outcome variable); 3) Health consequences of physical activity (deals with studies on the health consequences of physical activity, by using physical activity as the main exposure variable); 4) Interventions in the field of physical activity (deals with the science on interventions to promote physical activity); 5) Policy and practice in the field of physical activity (deals with the policy and practice of physical activity research).

If the Scopus search provides a list where most of the researchers are from one single country (e.g. United States), we will include at least one non-US author and therefore achieve both US and non-US representation in the five groups.

A letter of request including the list of 40 articles will be sent by email to the 15 representatives asking to choose the 15 most influential articles in the development of the physical activity field in their opinion. They will have a two-week response period and if there is no reply, another author from the list will be chosen. The experts will be able to make suggestions and recommendation of own articles will be allowed as long as other authors vote for that paper.

The final list will include the fifteen most voted articles and that had 4 or more votes from the experts, which will assure the paper being acknowledged as influential by experts from at least two different types of studies (if all three representatives from one study type vote, the publication will have at least one vote from a representative in another area).

- **Sample data collection**

In order to collect the sample of documents that comprise the field of interest, the Citation Network Analyzer-CNA tool will be used. This tool was developed by Lecy et, al (92). One of the main reasons to choose it for data collection in contrast to using a classic systematic review methodology, is that CNA does not use keywords (which can introduce a selection bias in systematic reviews), but a set of previously selected influential papers in the field (seeds).

The CNA uses the Google Scholar citation index feature, which permits to determine cited and citing publications over time, therefore allowing to establish temporal relationships in the network and building a network of documents forward in time using citation links. In addition, CNA selects publications based on the PageRank indicator, which selects the most cited by the most cited publications, leading to the highly influential and referential papers on a field.

In relation to sampling, the CNA will collect data based on a constrained snowball sampling frame, which will warrant obtaining a parsimonious and representative sample including the most cited articles in the literature (93). Two parameters will be considered in order to conduct the constrained snowball sampling: a) number of levels of data collection from the seeds; and b) percentage of articles to be sampled by level.

Given that the number of publications for the selected period of time is estimated to be too large, data will be collected in two levels from the previously selected fifteen seeds (articles that cite the seed and articles that cite those articles), and with a sampling of the top 2% highly cited articles at each level. At least 80% of the seeds will need to be found in the resulting network (93).

- **Main path and network analysis**

***Main Path***

"The main path is a set of articles and the citation links between that integrate information from previous articles and add substantial knowledge to an area of

research, therefore, serving as the structural backbone of a body of knowledge" (91).

Using the search path count strategy (94), we will identify the main path based on a transversal weight cut point that ensures inclusion of at least 80% of the seed articles. Transversal weight is defined as the proportion of all paths between the first/source article (not citing any others in the network) and the last/sink article (not cited by any others in the network) that contains a particular link or article. It is the extent to which a particular article or link is needed for keeping the network connected (91, 94). For example, a transversal weight of 0.3 means that 30% of the paths through the network include the link or vertex of interest. Therefore, this estimate is useful to determine articles that are important to keep the research network together.

Main path abstracts will be coded according to the previously described five study types categories (1- physical activity levels, measurement and trends; 2- determinants of physical activity; 3- health consequences of physical activity; 4- interventions in the field of physical activity and 5- policy and practice in the field of physical activity). Main path abstract coding will be conducted independently by two of the authors. Discrepancies will be solved until 100% agreement is obtained. Also, author´s gender and country according to affiliation will be obtained from the abstracts. Table 1 shows a summary of the variables that will be included in this paper.

Table 1. Review paper variables.

| | |
|---|---|
| General information | – **Most cited articles:** articles with more citations in ISI web of knowledge and Google Scholar<br>– **Most cited authors:** authors with more citations in Scopus, ISI web of knowledge and Google Scholar<br>– **Journals where the most cited articles were published.**<br>– **Type of studies (5 categories):**<br>  – Physical activity levels, measurement and trends<br>  – Determinants of physical activity |

| | |
|---|---|
| | – Health consequences of physical activity<br>– Interventions in the field of physical activity<br>– Policy and practice in the field of physical activity<br>– **First author's sex:** Decided based on affiliation. Female or male. |
| Network analyses | – **Main path:** set of articles and the citation links between that integrate information from previous articles and add substantial knowledge to an area of research, therefore, serving as the structural backbone of a body of knowledge. The main path articles are those nodes with highest out-degree.<br>– **Transversal weight:** the proportion of all paths between the first/source article (not citing any others in the network) and the last/sink article (not cited by any others in the network) that contain a particular link or article. It is the extent to which a particular article or link is needed for keeping the network connected.<br>– **Centrality (**number of relations a given node maintains)<br>a. Centrality in terms of degrees: in and outgoing information flows from each node as a center. Can be:<br>i. in-degree (incoming relations): highest in nodes making more ties.<br>ii. **out-degree (outgoing relations):** highest in nodes receiving more ties (citations) and therefore, more prestigious/influential. These nodes were able to make the nodes who cite them aware of their results and therefore are better known among peers. |

**Statistical analyses**

Traditional and network descriptive statistics and exponential random graph modeling (ERGM) will be conducted to examine network composition and the patterns of ties in the main path (91, 95, 96). ERGM´s predict the likelihood of having a tie between network members based on its characteristics and global network structures. The model will be built to formally test the hypothesis that there is no difference between study types in the probability of being cited and no difference in the probability of clustering (cited between studies with the same

study type). ERGMs provide an odds ratio as an effect measure, similar to logistic regression, and take into account the non-independence between observations (91, 95). For example, ERGMs will estimate the likelihood of one paper classified as an intervention study be cited by a paper classified as a policy manuscript.

To better understand the development of the field an ERGM will be built assessing the citation link between two articles in the main path based on first author sex and topic of the article. Consistent with other citation network studies using ERGM (91, 96), model building will start with a null model, will add main effects terms for sex and topic, will add homophily (citing same gender or categories) terms for sex and topic, and will add geometrically weighted terms to account for the underlying distribution of ties often seen in observed networks (95).

**Methodological challenges**

Some limitations are expected in this study. Given that data collection with the CNA program moves forward, the data collection will start with the earliest seeds selected by experts. Therefore, earlier research will not be included. Also, given that the snowball sampling technique is designed to capture a representative and not exhaustive sample, some relevant publications could end up not being included. In previous papers data quality issues has raised by the use of CNA program, like occasional misspellings which will be detected and corrected.

**Added value of this study**

To our knowledge, this paper will be the first to provide a historical reconstruction of the development of the physical activity and health research field, using citation network analysis methods, which will identify the most influential articles over time and a description of the historical maturity on physical activity promotion. Knowing such a map, will assist tackling knowledge gaps and communication barriers among this field's research community, which will in consequence make the research field move forward.

This study will be able to: (1) Determine what/who were the influential studies and authors in the physical activity and health research field and, (2) Describe the characteristics of the network structure as it developed over time. Figure 8 shows a preliminary result of the most influential articles in the development of the physical activity and public health field over time. These articles comprise the main path, where the size of the nodes is showing the out-degree indicator (centrality indicator), therefore, the bigger nodes have the highest out-degree.

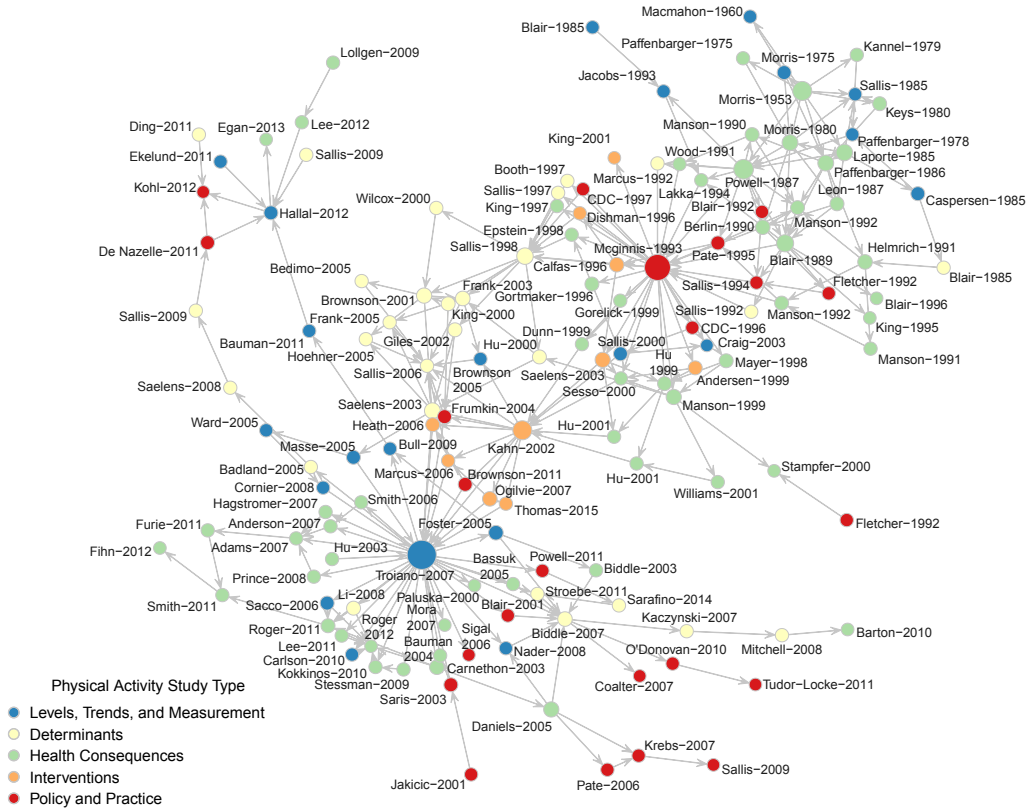



Figure 8. Most influential articles in the development of the physical activity and public health field over time.

## 11.2 Original paper 1

### Objective

Description of the first set of physical activity cards methods and networks of the Global Observatory for Physical Activity – GoPA!, and the status of physical activity worldwide in terms of health outcomes, surveillance, policy and research.

### Methods and data analyses

#### *Identification and classification of countries*

Starting with the World Bank list of 215 countries (97), we divided the United Kingdom into England, Scotland, Wales and Northern Ireland, and we combined information from China and Taiwan, as requested by the contact representatives from these countries. Our final list comprised 217 countries. For some analyses, we classify countries by income level, using the World Bank's classification (97). We also divided countries by world regions, following the World Health Organization (85) regional offices' classification (98).

### Identification of country contacts

We searched for country-level contacts or volunteers who could verify or improve information assembled at the Observatory about their country. Country contacts were identified using a PubMed search of the physical activity literature supplemented by recommendations from public health experts. Country contacts needed to have demonstrated experience in the area of physical activity and public health either as researchers or as members of government institutions. Approval of data by the country contact was required before release of a country's physical activity-related data.

### Country-specific general information

From the World Bank we obtained information on total population, life expectancy, GINI inequality index, literacy rate, and the proportion of all deaths caused by non-communicable diseases (NCDs) (97). From the United Nations, we obtained the Human Development Index (99). Finally, we used the article by Lee and coworkers to show the proportion of all deaths in each country

(population attributable fraction) attributable to physical inactivity (defined as not meeting the international physical activity recommendation of at least 150 minutes of aerobic moderate-intensity physical activity per week) (81, 85).

**Physical activity prevalence among adults (18+years)**

Built based as 1- the physical inactivity percent found at the WHO Global Health Observatory Data, or from the Eurobarometer or other similar questionnaires that covered physical activity at work/in the household, for transport, and during leisure time.

The contacts that decided to use a national estimate had to confirm that the estimates were calculated based on the current physical activity recommendations. The contacts that decided to use Eurobarometer recalculated the physical activity prevalence.

**National surveys of physical activity prevalence**

To obtain information about country-specific physical activity behaviors we conducted surveys of online databases (WHO, PAHO, DHS, Google and PubMed) using the search terms “physical activity”, “national survey”, “physical activity questions”, and the country name as search words. With the help of the country contact we confirmed or modified the information from the online search and obtained information about the survey’s periodicity (year of the first survey, year of the most recent survey, and year of the next survey planned). This information allowed us to create a variable on surveillance divided into four categories: (a) no national physical activity surveillance data; (b) one physical activity survey identified; (c) two surveys identified; (d) three or more surveys identified, and a clear periodicity, with a specific year for the next survey.

Although we obtained information about the existence of population-based country-specific surveys of physical activity behaviors, the initial estimates of the overall and sex-specific prevalence of physical inactivity among adults (18+ years) for each country was obtained from the WHO Repository (98). We did this to enhance comparability of estimates across countries. We replaced WHO data with a country’s independent national estimate if (a) prevalence was estimated

using a standardized self-report instrument covering all-domains of physical activity (i.e. leisure-time, occupation/housework, and transport; and (b) the updated WHO guidelines for physical activity were used to define the prevalence of physical inactivity (85).

**National physical activity plans**

To obtain information about country-specific national plans regarding the status and promotion of physical activity we conducted a survey of online databases (WHO, MiNDbank database, Google) using the search terms “physical activity”, “national policy”, “national plan”, and the country name. We then classified the policy information into one of the following three categories: (a) no clear physical activity policy; (b) physical activity embedded as part of a NCD plan; (c) standalone physical activity plan.

**Research in physical activity**

To estimate the quantity of physical activity-related research done using country-specific data we conducted a PubMed search using the search terms “physical activity” (in title or abstract) and country name (anywhere in the title, abstract, text or affiliation). Dates of publication were restricted to 01/01/2013-31/12/2013. The year 2013 was selected as the first year of monitoring for GoPA! There were no age, study design or language restrictions. To be considered as part of the country’s production the article had to explicitly describe that the research was conducted in the country. All titles and abstracts identified in the PubMed search were read by the first author (AR), and in case of doubts, the senior author (PH) was consulted.

Once the PubMed search was finished a list of authors in all countries was made and duplicates were excluded. The program Matlab was used. Authors were included in the country’s list if they participated in the research related to the country and not merely because of their individual affiliation with a particular country (e.g., an author who is a Brazilian national who participated in a research study using UK data would NOT be counted as contributing, in this instance, a paper credited to Brazil).

Country contacts reviewed the list of articles pertaining to his/her country, recommending deletions or additions that met the original eligibility criteria. We identified 2173 articles that met our eligibility criteria.

We divided studies into one of the following five categories: (a) physical activity levels, trends and measurement; (b) determinants of physical activity; (c) health consequences of physical activity; (d) interventions in the field of physical activity; and (e) policy and practice in the field of physical activity. In addition, the studies that included children and adolescents were determined.

**Research ranking**

Determined as the country contribution (%) to physical activity publications worldwide in 2013. The ranking was based on the PubMed search.

Built in 5 steps:

1. PubMed search for studies on physical activity in each of the world countries during 2013.
2. The number of physical activity articles meeting the inclusion criteria (absolute value) was compared to the total number of physical activity articles obtained in PubMed.
3. The percentage of physical activity related publications per country was determined.
4. Number of expected physical activity publications per country was determined.
5. The number of physical activity articles meeting the inclusion criteria (absolute value) was divided by the expected physical activity publications per country obtaining the country contribution to physical activity publications in 2013 (weighted value).

The softwares Matlab and Tableau were used. The Country Cards appendix was included in this document as Appendix 1.

**Country Cards**

All indicators were presented as a country specific “physical activity profile” called the Country Cards. The cards were developed by the Observatory team and then submitted for public online consultation during http://www.globalphysicalactivityobservatory.com/ one month. The cards were posted in the Observatory´s website in August 2014. After the consultation period ended, the cards were revised according to the comments received from over 50 people representing more than 20 countries.

After the standardized draft of the Country Cards for every country around the world was finished, a potential contact in every country was identified and invited to be the country contact using a formal invitation. The invitation mentioned that the contacts were to be acknowledged in the website as the contact person for their countries, and that they owned the cards along with the Observatory. They were all invited to translate the card into their languages and use it for research and advocacy purposes. There were no costs associated with taking part in the Observatory.

For the Observatory it was very important to have local experts to critically review the card in order to determine if the most recent and accurate information available was presented in the Cards. Also, contacts were free to engage other representatives from their country and create working groups in order to meet the goal of reflecting the country's physical activity status as best as possible. The period to review the cards was 21 days and after the review the cards were ready to be launched. Table 2 shows the variables that were included in this paper. These variables were selected according to the conceptual models previously described.

Table 2. Original paper 1 variables.

| | |
|---|---|
| General information | – Country capital<br>– Inhabitants<br>– Life expectancy<br>– GINI inequality index<br>– Human development index<br>– Literacy rate<br>– Income classification by World Bank<br>– Region classification by World Bank |
| Prevalence of physical activity | – Physical activity prevalence among adults (18+years) |
| Burden of disease | – Deaths by non-communicable diseases (%)<br>– Deaths related to physical inactivity (%) |
| Surveillance | – **Existence of a national survey that includes physical activity questions**, classified as:<br>(a) no national physical activity surveillance data<br>(b) one physical activity survey identified<br>(c) two surveys identified<br>(d) three or more surveys identified, and a clear periodicity, with a specific year for the next survey. |
| Policy | – **Availability of a national or sub-national physical activity plan**, classified as:<br>(a) no clear physical activity policy<br>(b) physical activity embedded as part of a NCD plan<br>(c) standalone physical activity plan |
| Research | – **Number of articles** related to physical activity and public health found in the PubMed search in 2013. Classified in quartiles:<br>(a) none<br>(b) under percentile 25<br>(c) percentiles 25-<50<br>(d) percentiles 50-<75<br>(e) equal or above percentile 75<br><br>– **Ranking**: country contribution to physical activity research worldwide in 2013.<br><br>– **Study types**, classified as:<br>(a) physical activity levels, trends and measurement<br>(b) determinants of physical activity<br>(c) health consequences of physical activity<br>(d) interventions in the field of physical activity<br>(e) policy and practice in the field of physical activity.<br>(f) Number of studies that had children and adolescents as target population. |

### Statistical analyses

Descriptive analyses and the associations (Spearman correlations) among research, policy and surveillance were explored. Four surveillance categories, three policy categories previously described, and five research categories were used.

The GoPA! database and statistical analyses were conducted in Stata 12.

### Methodological challenges

This study tried to collect the best and updated data available at the country level and therefore any comparisons or conclusions have to be interpreted taking into account the following limitations: 1) Due to difficulties in finding country representatives, 85 countries were not included in the first set of Country Cards; 2) A lack of available information and documents related to surveillance and policy at the country level was found. Most of these documents are written in their local languages, which limits finding them in Google; 3) In relation to policy, we only assessed the existence of a physical activity plan, and did not assess whether it was operational or not; 4) The research search was restricted to PubMed, and therefore, some articles published in other databases were not identifiable.

In relation to point 1, table 3 shows the differences in general characteristics comparing GoPA! members with non-GoPA! members.

Table 3. General country characteristics comparison between GoPA! and non-GoPA! members.

| Classification | Number of GoPA! countries (n=139) | Not launched countries (n=78) |
|---|---|---|
| **World region*** | **(% and country n)** | |
| East Asia and Pacific | **88.9 (32)** | 11.1 (4) |
| Europe and Central Asia | 63.9 (39) | 36.1 (22) |

| | | | |
|---|---|---|---|
| Latin America and the Caribbean | 77.5 (31) | 22.5 (9) | |
| Middle East and North Africa | 66.7 (14) | 33.3 (7) | |
| North America | **100.0 (3)** | 0.0 (0) | |
| South Asia | 75.0 (6) | 25.0 (2) | |
| Sub-Saharan Africa | 29.2 (14) | **70.1 (34)** | |
| **Income group*** | | | |
| High Income | **82.1 (64)** | 17.9 (14) | |
| Upper - middle income | 69.1 (38) | 30.9 (17) | |
| Lower - middle income | 56.0 (28) | 44.0 (22) | |
| Lower income | 26.5 (9) | **73.5 (25)** | |
| **Indicators** | | | **p-value*** ** |
| Life expectancy (years) | 74.1 (135) | 65.4 (72) | **<0.001** |
| Literacy rate | 91.0 (132) | 74.3 (69) | **<0.001** |
| Deaths due to NCD's | 73.2 (119) | 53.1 (67) | **<0.001** |
| Deaths due to physical inactivity | 10.3 (90) | 8.40 (37) | **0.03** |
| Physical activity prevalence | 65.6 (115) | 68.2 (37) | 0.36 |
| Surveillance** | | | |
| None | 26.5 (13) | 73.5 (36) | <0.001 |
| One national survey | 68.4 (39) | 31.6 (18) | |
| Two national surveys | 69.6 (55) | 30.4 (24) | |
| Three national surveys | 100.0 (32) | 0.0 (0) | |
| Policy** | | | |
| None | 45.8 (33) | 54.2 (39) | <0.001 |
| NCDs** plan including physical activity | 63.9 (69) | 36.1 (39) | |
| A standalone physical activity plan exists | 100.0 (37) | 0.0 (0) | |
| Research (mean number of papers) | 15.9 (139) | 0.4 (78) | **0.004** |

* World region and income group classifications according to the World Bank.

United Kingdom was divided in its 4 countries (England, Scotland, Wales and Northern Ireland).

**Not launched countries require country card approval from the country representative

*** Chi square or t-test

**Process evaluation**

A process evaluation about the first set of physical activity Country Cards, will be conducted to inform and guide the second set of Country Cards, including information on health outcomes, surveillance, policy, prevalence, research results and new comprehensive ranking of countries. The instrument that we will use to conduct this evaluation is included as Appendix 3.

**Added value of this study**

With two years of operations GoPA! completed data collection for 217 countries and was able to gather and confirm data from 139 (64.1%) countries, and covering 6.1 billion people, which is 85.4% of the world's population in 2013.

The complete set of launched Country Cards will be part of the GoPA! Physical Activity Almanac, which is under construction. See the link to the work in progress in appendix 2.

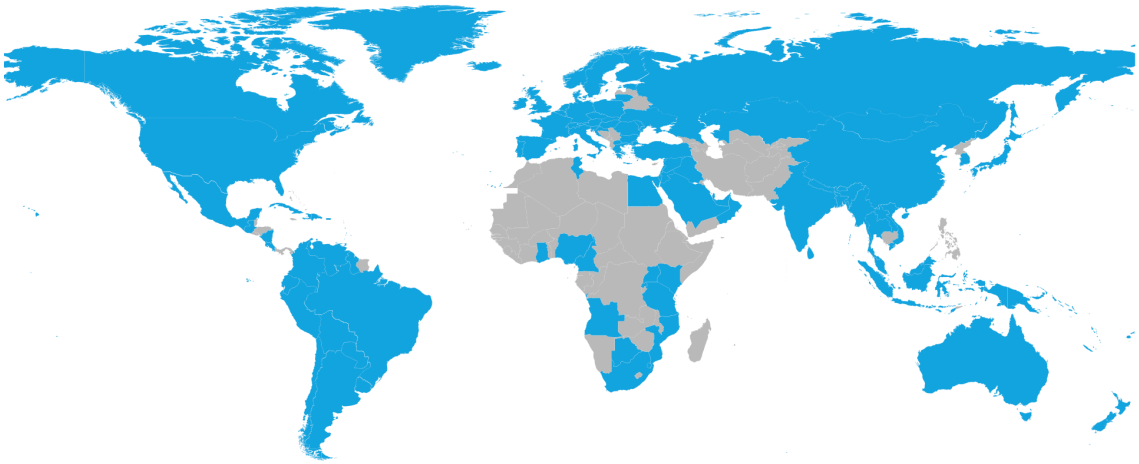


Figure 9. Country members of the Global Observatory for Physical Activity GoPA!. (GoPA! Members in blue).

## 11.3 Original paper 2

**Objective**

Description of the second set of physical activity cards methods and networks of the Global Observatory for Physical Activity – GoPA!, and the status of physical activity worldwide in terms of research, surveillance and policy. This second set of cards will be planned based on the results of the process evaluation that was conducted for the first set of cards.

**Methods**

Data will be collected using the methods used in the first set of cards. The innovative piece in this paper will be the description of the development of a comprehensive physical activity ranking (built to include mortality associated to physical inactivity, surveillance, policy and research indicators). Specific weights will be set to each of these indicators and then the ranking will be created. Weights will be set by GoPA! network members using an online survey in August-September 2016 (survey attached as an appendix).

Survey and preliminary ranking results (estimated with the first set of Country Cards database) will be presented in November to the physical activity community attending to the International Congress of Physical Activity and Health – ISPAH 2016 in Thailand. Table 3 shows the variables that were included in this paper. These variables were selected according to the conceptual models previously described.

Table 4. Original paper 2 variables.

| | |
|---|---|
| General information | – Country capital<br>– Inhabitants<br>– Life expectancy<br>– GINI inequality index<br>– Human development index<br>– Literacy rate<br>– Income classification by World Bank<br>– Region classification by World Bank<br>– Urbanization **(new variable for the second set of** |

| | |
|---|---|
| | **Country Cards)** |
| Prevalence of physical activity | – Physical activity prevalence among adults (18+years) |
| Burden of disease | – Deaths by non-communicable diseases (%)<br>– Deaths related to physical inactivity (%) |
| Surveillance | – **Existence of a national survey that includes physical activity questions**, classified as:<br>(a) no national physical activity surveillance data<br>(b) one physical activity survey identified<br>(c) two surveys identified<br>(d) three or more surveys identified, and a clear periodicity, with a specific year for the next survey. |
| Policy | – **Availability of a national or sub-national physical activity plan**, classified as:<br>(a) no clear physical activity policy<br>(b) physical activity embedded as part of a NCD plan<br>(c) standalone physical activity plan |
| Research | – **Number of articles (a new variable will be built for the second set of Country Cards)** related to physical activity and public health found in the PubMed **and additional databases** search in 2013. Classified in quartiles:<br>(a) none<br>(b) under percentile 25<br>(c) percentiles 25-<50<br>(d) percentiles 50-<75<br>(e) equal or above percentile 75<br><br>– **Study types**, classified as:<br>(a) physical activity levels, trends and measurement<br>(b) determinants of physical activity<br>(c) health consequences of physical activity<br>(d) interventions in the field of physical activity<br>(e) policy and practice in the field of physical activity.<br>(f) Number of studies that had children and adolescents as target population. |
| Ranking | Position in the comprehensive ranking **(New for the second set)** |

### Statistical analyses

Descriptive analyses and the associations (Spearman correlations) among research, policy and surveillance will be explored. We will use four surveillance categories, three policy categories previously described, and five research categories.

In addition, indicators will be compared with the first set of Cards.

## Comprehensive ranking creation

A principal component analyses will be conducted in order to determine the statistical weights to build the new ranking, which will include the surveillance, policy, research, health burden and prevalence variables. In addition, this statistical weights will be compared to the weights determined by the country representatives with question #5 in the process evaluation survey.

These analyses will help determine how the physical activity level varies according to surveillance, policy, research, health burden, world region, income group and other ecological characteristics.

The GoPA! database and statistical analyses will be conducted in Stata 12.

## Added value of this study

This study will provide a follow up to the first set of Country Cards, describe trends since the first set of Country Cards launch in 2015 and, will launch a comprehensive ranking of the physical activity level at the national level. A conceptual framework of physical activity advocacy and advocacy stages (advocacy strategies depend on the ranking results) will be described.

The “7 best investments that work to promote and advocate for physical activity, political and organizational change and mobilize social action will be described as a main product of the second set of Country Cards”.

### Methodological challenges

The same limitations described for the original paper 1 are considered for this paper. In addition, the fact of having only one informant (Country representative) to set the weights for the ranking is a limitation, and therefore having the statistical weights is necessary.

## 12. RESULTS DISSEMINATION

The main results of the thesis will be presented in scientific events and published in indexed academic journals. In addition, these results will be sent to the press in order to communicate the community about the findings.

## 13. ETHICAL CONSIDERATIONS

This study will be submitted to the Ethics Committee at the Federal University of Pelotas.

## 14. TIMELINE

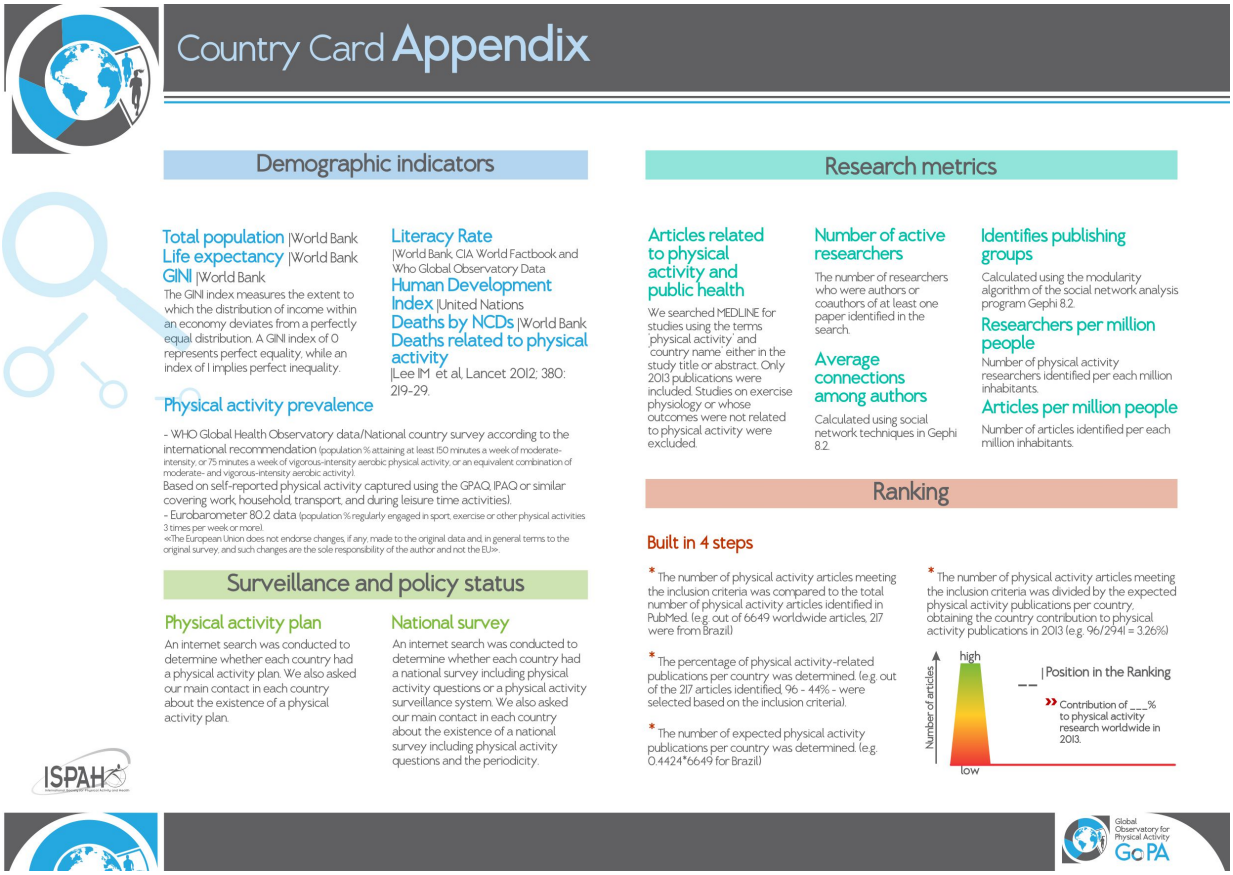
| Year | 2015 | | | | 2016 | | | | 2017 | | | | 2018 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Trimester / Activities | I | II | III | IV | I | II | III | IV | I | II | III | IV | I | II | III | IV |
| PhD mandatory classes | | | | | | | | | | | | | | | | |
| PhD qualification exam | | | | | | | | | | | | | | | | |
| PhD optional classes | | | | | | | | | | | | | | | | |
| GoPA! First set of Country Cards data collection | | | | | | | | | | | | | | | | |
| GoPA! website and Project description documents | | | | | | | | | | | | | | | | |
| GoPA! First set of Country Cards and website launch | | | | | | | | | | | | | | | | |
| GoPA! First set of Country Cards dataset analyses | | | | | | | | | | | | | | | | |
| Review paper data collection planning | | | | | | | | | | | | | | | | |
| Research project proposal | | | | | | | | | | | | | | | | |
| Thesis proposal defense | | | | | | | | | | | | | | | | |
| Original article 1 writing and journal submission | | | | | | | | | | | | | | | | |
| Review article data collection | | | | | | | | | | | | | | | | |
| Review article writing and journal submission | | | | | | | | | | | | | | | | |
| GoPA! First set of Country Cards process evaluation data collection | | | | | | | | | | | | | | | | |
| GoPA! First set of Country Cards process evaluation database analyses | | | | | | | | | | | | | | | | |
| GoPA! First set of Country Cards process evaluation results | | | | | | | | | | | | | | | | |
| GoPA! Atlas launch | | | | | | | | | | | | | | | | |
| GoPA! Second set of Country Cards selection of indicators and new | | | | | | | | | | | | | | | | |
| GoPA! Second set of Country Cards data collection | | | | | | | | | | | | | | | | |
| GoPA! Second set of Country Cards launch | | | | | | | | | | | | | | | | |
| GoPA! Second set of Country Cards dataset analyses | | | | | | | | | | | | | | | | |
| Original article 2 writing and journal submission | | | | | | | | | | | | | | | | |
| Thesis defense | | | | | | | | | | | | | | | | |

## 15. FUNDING

This study was funded by Wellcome Trust.

# 16. APPENDIXES

## 16.1 Appendix A – Country Card Appendix




## 16.2 Appendix B – The Global Observatory for Physical Activity Almanac

Currently in progress. Most updated link:

https://indd.adobe.com/view/a3d1abba-a134-446b-848b-5d10c4f0d58c

## 16.3 Appendix C – Process evaluation and comprehensive ranking questionnaire

**FIRST SET OF COUNTRY CARDS (2013) – PROCESS AND RANKING SURVEY**

**Dear Country Contact**

As part of our global effort to improve physical activity promotion and advocacy worldwide, we are conducting a survey to understand the uses and impact the first set of Country Cards.

We would like to include your valuable opinion as we begin to plan a new comprehensive ranking indicator for our next set of Country Cards.

Keeping in mind that the GoPA! objective is to assess and monitor physical activity research, surveillance and policy worldwide. The Country Cards as the first GoPA! product, are advocacy tools that can help country representatives, governments, researchers, and society improve physical activity promotion.

As a Country Contact, your role and active participation in GoPA! is vital, and your feedback and comments are essential. Therefore, we would like to invite you to complete this survey (**~15min**).

We will share the results with you once they are completed, through a summary report. The results of this survey will be presented during our Council Session at the upcoming International Congress of Physical Activity and Public Health- ISPAH 2016, in Thailand in November.

We greatly appreciate your time and contribution!

Thank you!

**PART 1**

**COUNTRY REPRESENTATIVES AREAS OF INFLUENCE AND ACTION**

1. **Please select the country you represent in GoPA!**
   (There will be a box with the Countries)

2. **Please select your main area of work**
   a) Academia (Universities, Schools, Academic Societies or institutions)
   b) Government
   c) Non-Government
   d) Health (Hospitals, Health Institutions, Health organizations)

3. **As part of your work, how often do you have contact (regular meetings, emails, phone calls) with:**

a) **Physical activity researchers?**

| Never | Occasionally | Approximately (monthly) | Approximately (every week) | Daily or almost daily |
|---|---|---|---|---|
| | | | | |

b) **Government representatives that work in areas related to physical activity promotion?**

| Never | Occasionally | Approximately (monthly) | Approximately (every week) | Daily or almost daily |
|---|---|---|---|---|
| | | | | |

c) **Government representatives that work in areas related to non-communicable disease and physical inactivity prevention?**

| Never | Occasionally | Approximately (monthly) | Approximately (every week) | Daily or almost daily |
|---|---|---|---|---|
| | | | | |

d) **Non-Government Organizations – NGO's representatives?**

| Never | Occasionally | Approximately (monthly) | Approximately (every week) | Daily or almost daily |
|---|---|---|---|---|
| | | | | |

e) **Professionals working in national surveys and surveillance systems?**

| Never | Occasionally | Approximately (monthly) | Approximately (every week) | Daily or almost daily |
|---|---|---|---|---|
| | | | | |

f) **International organization representatives that work in areas related to physical activity promotion (for example WHO)?**

| Never | Occasionally | Approximately (monthly) | Approximately (every week) | Daily or almost daily |
|---|---|---|---|---|
| | | | | |

g) **Other GoPA! country contacts? (we will have a list of the names)**

| Never | Occasionally | Approximately (monthly) | Approximately (every week) | Daily or almost daily |
|---|---|---|---|---|
| | | | | |

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Please move to PART 2

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**PART 2**

**COUNTRY CARD USES**

4. **After the Country Card launch in December 2015, have you engaged in any of the following activities?** (mark one box)

A. Please think of **<u>your daily routine and normal professional activities</u>** that provide an opportunity to mention the Country Card initiative and specifically talk about your country´s Card.

a) **Showed/described/explained the Country Card (your country´s Card) to colleagues?**

| Never | Occasionally | Approximately (monthly) | Approximately (every week) | Daily or almost daily |
|---|---|---|---|---|
| | | | | |

b) **Showed/described/explained the Country Card (your country´s Card) to representatives of academic societies interested in in non-communicable disease prevention and physical activity promotion?**

| Never | Occasionally | Approximately (monthly) | Approximately (every week) | Daily or almost daily |
|---|---|---|---|---|
| | | | | |

c) **Showed/described/explained the Country Card (your country´s Card) to government representatives?**

| Never | Occasionally | Approximately (monthly) | Approximately (every week) | Daily or almost daily |
|---|---|---|---|---|
| | | | | |

d) **Showed/described/explained the Country Card (your country´s Card) to Community/Civil Society representatives?**

| Never | Occasionally | Approximately (monthly) | Approximately (every week) | Daily or almost daily |
|---|---|---|---|---|
| | | | | |

e) **Showed/described/explained the Country Card (your country´s Card) to Non-governmental organizations - NGO representatives?**

| Never | Occasionally | Approximately (monthly) | Approximately (every week) | Daily or almost daily |
|---|---|---|---|---|
| | | | | |

f) **Showed/described/explained the Country Card (your country´s Card) to mass media representatives?**

| Never | Occasionally | Approximately (monthly) | Approximately (every week) | Daily or almost daily |
|---|---|---|---|---|
| | | | | |

g) **Showed/described/explained the Country Card (your country´s Card) in congresses or scientific events?**

| Never | Occasionally | Approximately (monthly) | Approximately (every week) | Daily or almost daily |
|---|---|---|---|---|
| | | | | |

h) **Showed/described/explained the Country Card (your country´s Card) to students?**

| Never | Occasionally | Approximately (monthly) | Approximately (every week) | Daily or almost daily |
|---|---|---|---|---|
| | | | | |

i) **Included/described/explained the data presented in the Country Card (your country´s Card) in a scientific publication?**

| Never | Occasionally | Approximately (monthly) | Approximately (every week) | Daily or almost daily |
|---|---|---|---|---|
| | | | | |

j) **Included/described/explained the data presented in the Country Card (your country´s Card) as part of a fund raising proposal?**

| Never | Occasionally | Approximately (monthly) | Approximately (every week) | Daily or almost daily |
|---|---|---|---|---|
| | | | | |

k) **Included/described/explained the data presented in the Country Card (your country´s Card) in a policy brief?**

| Never | Occasionally | Approximately (monthly) | Approximately (every week) | Daily or almost daily |
|---|---|---|---|---|
| | | | | |

**B.** Now, please think of **activities that would require some planning** in order to provide an opportunity to talk about the Country Card initiative and specifically talk about your country´s Card

a) **Presented/described/used the data presented in the Country Card to advocate for a National surveillance system?**

| Never | Occasionally | Approximately (monthly) | Approximately (every week) | Daily or almost daily |
|---|---|---|---|---|
| | | | | |

b) **Presented/described/ used the data presented in the Country Card to advocate for physical activity inclusion on a National physical activity plan?**

| Never | Occasionally | Approximately (monthly) | Approximately (every week) | Daily or almost daily |
|---|---|---|---|---|
| | | | | |

c) **Presented/described/ used the data presented in the Country Card to engage in research activities?**

| Never | Occasionally | Approximately (monthly) | Approximately (every week) | Daily or almost daily |
|---|---|---|---|---|
| | | | | |

**5. Thinking about barriers to the use and dissemination of your specific Country Card:**

d) The Country Cards are providing information that is already known, therefore I do not have much need to use them.

| Disagree | Partially agree | Agree |
|---|---|---|
| | | |

e) I do not know what I am supposed to do with the Country Card

| Disagree | Partially agree | Agree |
|---|---|---|
| | | |

f) I do not know any strategy or how can I identify/reach partners/decision makers/stakeholders

| Disagree | Partially agree | Agree |
|---|---|---|
| | | |

Please share with us your comments or suggestions on barriers to Country Card dissemination

| |
|---|
| |

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**Please move to PART 3**

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**PART 3**

**COUNTRY CARDS – REACTIONS**

6. **Think about the people you showed the Country Card to. How would you describe this interaction?**

a) **The Country Card provided them new data and they were interested**

| Never | Occasionally | Sometimes | Often | Always |
|---|---|---|---|---|
| | | | | |

b) **The Country Card was useful and helped me making the case for physical activity promotion in my country**

| Never | Occasionally | Sometimes | Often | Always |
|---|---|---|---|---|
| | | | | |

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Please move to PART 4

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**PART 4**

**COUNTRY CARDS RANKING**

**The Country Card indicators of deaths due to physical inactivity, surveillance, policy, national prevalence estimates and research are important to understand and explain the physical activity status of the population, viewed from a Global perspective.**

**7.** If you had to order these indicators sorting by importance to obtain an accurate ranking that reflects the physical activity status of your population, how would you sort them?

If this question is not clear, think about what would affect more the physical activity status of the population? Not having estimates of deaths due to physical inactivity? not having surveillance data? Not having policy? not having research?

**(Please rate from 1 to 5, being 5 most important).**

a) **National estimate of deaths due to physical inactivity**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| | | | | |

b) **National surveillance data**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| | | | | |

c) **National policy data**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| | | | | |

d) **National prevalence data**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| | | | | |

e) **National physical activity research data**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| | | | | |

**********

THANK YOU!

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# 18. PROJECT ADJUSTMENTS ALONG THE COURSE OF WORK

## 18.1 Worldwide use of the first set of physical activity Country Cards: The Global Observatory for Physical Activity - GoPA! (additional article proposal)

After the research project qualification, adjustments in the planned articles were carried out in order to meet the thesis objectives and to explore in depth the study topic of global physical activity surveillance and particularly how The Global Observatory for Physical Activity GoPA! data was being used. Therefore, the process evaluation that was conducted and described in original paper 1 proposal was considered to become an article that would connect original articles 1 and 2.

**Introduction**

Launching the first set of cards represents an important achievement for global physical activity, yet for GoPA! to meet its goals at national and regional levels, the cards acknowledgement, use and dissemination are essential to facilitate communication with decision makers that can assist in physical activity promotion, standardized data collection and monitoring, program development and gain of political commitment. Literature shows that if public health decision makers used research evidence optimally, they could make policy choices with the highest potential to return positive outcomes for populations.

**Objective**

To assess the Country Cards use/performance and the factors associated to its use.

**Methods**

Cross sectional internet-based survey will be conducted between August-October 2016. The instrument is in appendix C. Target study participants will be national physical activity leaders and advocates in academia, government and practice from the GoPA! countries, and members of the International Society of Physical Activity and Health. A Country Card use composite score will be created based on the diversity and frequency of use. Statistical analyses on the associations between the composite score and respondent characteristics, country

characteristics, barriers and opinions will be conducted (including descriptive analyses and a logistic regression with robust standard errors).

**Added value of this study**

This paper will be the first study evaluating the use of a standardized surveillance and advocacy tool such as The Global Observatory for Physical Activity - GoPA! Country Cards for physical activity promotion. It is unique in that it will present a framework of physical activity advocacy and advocacy stages of country-level capacity for physical activity promotion based on the GoPA! surveillance, policy and research indicators.

This study will demonstrate which are the associated factors with the use of the Country Cards and if the stages of country capacity for physical activity promotion is associated with Country Card use. This could provide insights on the further Country Card refinement and training in their use as an important tool for advancing country capacity for contextually-relevant strategies, actions and timelines for physical activity promotion.

**Methodological challenges**

The same limitations described for the original paper 1 are considered for this paper. In addition, the generalizability of the results may be diminished by the response rate of the online survey and variability by geographic region.

### **18. 2** Physical activity and health research monitoring: Global, regional, and national trends and patterns since 1950 (Revised proposal for original article 2)

In relation to original article 2, it was identified that national policy and surveillance indicators were not changing in less than 5 year periods, which represented a challenge for the Country Cards indicators update and creation of the second set of cards in 2017. Therefore, in this paper it was proposed to update only research indicators with a systematic review from 1950 to 2016 to determine trends and patterns that could assist in describing the availability of local, regional and global data and characteristics that could be informative for surveillance, policy implementation, evaluation and scale-up of interventions.

## Introduction

Local, regional and global research capacity and scientific production in the area of physical activity was identified as strategy to improve physical activity (PA) advocacy and promotion.

When analyzing the global physical activity and health research productivity in 2013, GoPA! identified that there was a trend of an increase in number of connections with an increase in income, which could have been related to the capacity to engage and collaborate in research with other groups or researchers. Also that foreign authors frequently participated in publications in all regions and lower income countries did not have foreign author participation in their publications. More native authors compared to foreign authors per paper were found in North America, South Asia and high income groups. In contrast, in the Middle East and North Africa there was more participation of foreign authors compared to native authors. This ratio inversion be revealing the local research capacity in these countries, where high income countries had more native authors contributing to research and upper-middle and lower-middle income countries collaborated with foreign authors to produce their articles.

Therefore, an increase in the number of researchers, scientific production and collaboration between countries to strengthen both local and global physical activity research networks was identified. An increase in research productivity targeting these gaps could help mitigate the effects of the physical inactivity pandemic and overcome region and income inequalities in publications. Describing trends and patterns of PA research worldwide is important to determine availability of local and global data.

In this paper, we present descriptive information on surveillance, policy and research from the first round of data collection by GoPA!,

## Objective

To track the development of the physical activity and health research field since 1950 and, describe global, regional, and national trends and patterns.

## Methods

Information about physical activity and health research will be collected between 1950 to 2016, using the GoPA! standardized methodology. Additional country demographic variables that are important for physical activity promotion at the national level according to the Bangkok Declaration and the WHO SDGs report will be included.

### *Database search and data extraction*

To estimate the quantity of physical activity-related research done using country-specific data we will conduct a systematic search in PubMed, SCOPUS and ISI Web of Knowledge databases, using the search terms “physical activity” (in title or abstract) and country name (anywhere in the title, abstract, text or affiliation). Dates of publication were restricted to 01/01/1950-31/12/2016. There will be no age, study design or language restrictions. **To be considered as part of the country’s production the article will have to explicitly describe that the research was conducted in the country**. All titles and abstracts identified in the search will be read by couples of authors, and in case of doubts, a senior author will be consulted.

### *Search terms*

Physical activity: ‘Physical activity’ terms included both those referring to physical movement, as well as those encompassing the concept of sedentary behaviours. The ‘physical activity’ search terms used were as follows: *physical activity OR physically active OR physical inactivity OR physically inactive OR fitness OR exercis* OR walk OR walking OR sedentary OR active transport* OR active transit OR active travel OR commut* OR active commuting OR bicycle OR bicycling OR bike OR biking OR active living OR active-living*. The search was conducted in December, 2015.

**Table 1 shows the data that will be extracted and the variables that will be used for the analysis.**

| | |
|---|---|
| **Country of publication** | Country |
| | Income classification by World Bank |
| | Region classification by WHO |
| | Population by World Bank |
| **Publication identification** | Article number |
| | Reference |
| | Article title |
| | Year |
| | Decades (1950-1956, 1957-1966, 1967-1976, 1977-1986, 1987-1996, 1997-2006, 2007-2016). |
| | List of Authors |
| **Publication scientific/study details** | **Study classification** |
| | Observational |
| | Longitudinal |
| | Cross sectional |
| | Experimental-RCT |
| | Systematic review /meta-analysis |
| | **Study type** |
| | (a) prevalence, measurement and trends |
| | (b) correlates and determinants |
| | (c) health consequences |
| | (d) interventions |
| | (e) policy |
| | **Study population** |
| | Adult population >=18 years |
| | Children and adolescents <18 years |
| | Elderly population >=60 years (UN/WHO definition) |
| | Pregnant women |
| | **Study topic including PA and:** |
| | Cancer |
| | Cardiovascular disease |
| | NCDs in general |
| | Mental health and illness |

| | |
|---|---|
| | Cognitive function |
| | Earth/environmental/atmospheric sciences (climate change, global warming) |
| | Built and natural environment (Built and green spaces) |
| | Objective measures |
| | Multicountry study |
| **Publication rates** | Physical activity and health articles per 100,000 inhabitants per country |

**Added value of this study**

The innovative piece in this paper will be the description of trends and patterns of research on physical activity and health from 1950 to 2016 (by decades 60's, 70's, 80's, 90's, 2000's, 2010's), for all the world countries and, including descriptive country characteristics drawn from the World Bank and WHO databases. Inequalities by country size, income, geographic region will be described.

The final data points that will be included in the trend analysis will be chosen according to previous literature highlighting important papers for the field - reference for my review paper "Mapping the historical development of physical activity and health research: a structured literature review and citation network analysis".

The data collected for this paper will allow to update the research indicators to be used in the second set of GoPA! country cards. In addition, the GoPA! ranking will updated and the results will complement the data obtained previously in the GoPA! process evaluation (where the weights of the Country Cards indicators were set) and the principal components analysis.

**Methodological challenges**

The main challenge that is expected is: 1) The research search will be restricted to PubMed & Scopus & ISI web of knowledge, and therefore, some articles published in other databases were not identifiable. Subestimation of number in countries speaking languages different than English, Portuguese, Spanish. Articles in different languages were excluded.

## Review article and editorial

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Review Article

# Mapping the historical development of physical activity and health research: A structured literature review and citation network analysis☆

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ABSTRACT

Little has been published about the historical development of scientific evidence in the physical activity (PA) and public health research field. The study aimed to examine the evolution of knowledge in this field.

A structured literature review using formal citation network analysis methods was conducted in June-2016. Using a list of influential PA publications identified by domain experts, a snowball sampling technique was used to build a compact citation network of 141 publications that represents the backbone of the field. Articles were coded by study type and research team characteristics, then analyzed by visualizing the citation network and identifying research clusters to trace the evolution of the field.

The field started in the 1950s, with a health sciences focus and strong North American and European leadership. Health outcome studies appeared most frequently in the network and policy and interventions least. Critical articles on objective measurement and public policy have influenced the progress from an emphasis on health outcomes research at early stages in the field to the more recent emerging built environment and global monitoring foci. There is only modest cross-citation across types of study. To our knowledge, this paper is the first to systematically describe the development of research on PA and public health. The key publications include fundamental ideas that remain citable over time, but notable research and dissemination gaps exist and should be addressed. Increasing collaboration and communication between study areas, encouraging female researchers, and increasing studies on interventions, evaluation of interventions and policy are recommended.

## 1. Introduction

Physical inactivity is an important risk factor for chronic diseases such as diabetes, coronary heart disease, some cancers, depression and dementia (Bauman, 2004; Ding et al., 2016; Ekelund et al., 2016; Kohl et al., 2012; Lee et al., 2012; Sallis et al., 2016), and costs 67.5 billion dollars globally annually in health care expenditures and lost productivity (Ding et al., 2016). Since the first epidemiologic studies published in the 1950s there has been enormous growth in the number of papers, researchers, study types, and disciplines engaged in research on physical activity. However, little has been published about the historical development of scientific evidence in the field of physical activity and public health. Available publications are in the format of commentaries, review articles, and historic narratives (Blair and Powell, 2014; Paffenbarger et al., 2001; Park, 1995); but all lack a quantitative research approach. Citation analysis is a powerful tool that allows for a visual and objective representation of the past, present, and potential future directions of a research field (Lecy and Beatty, 2012). This information is important to identify knowledge gaps and communication barriers among research and practice communities, and may be helpful in moving the field forward. The aim of this study was to use citation analysis to provide insight into the evolution of knowledge in the field of physical activity and public health.

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## 2. Methods

A structured literature review was conducted from February 2015 to June 2016 using citation network analysis (Lecy and Beatty, 2012). A stepwise protocol (before, during, after) for citation data collection was conducted, through seven steps:

### 2.1. Prior to citation data collection

#### 2.1.1. Identification of most cited publications

In June 2015, the most cited documents in the field since 1950 were searched in ISI Web of knowledge and Google Scholar (Lecy and Beatty, 2012), using the following search criteria: "physical activity AND public health", allowing keywords to be found anywhere in the text. All languages, countries, and study types were included. Documents included published articles, commentaries, books, and others (reports, dissertations). Resulting documents were ranked by number of citations. A final list of the forty most cited publications was derived from ISI Web of Knowledge and Google Scholar, by combining both lists, removing duplicates (n = 11), and leaving the 40 unique most cited articles. Citation counts data was not normalized by publication date.

#### 2.1.2. Identification of most cited authors

To validate the preliminary list generated in Step 1, we undertook a systematic process for expert identification. A separate search for the most cited authors in the field was conducted in Scopus, Google Scholar and ISI Web of Knowledge using the same search criteria from step 1. Lists from each source were combined, duplicates were excluded, and authors were ranked based on their H index. Country of affiliation was included in the list. Authors were divided into five categories based on their expertise: 1) Physical activity levels, trends and measurement – the science of physical activity surveillance and measurement; 2) Determinants and correlates of physical activity – understanding why some people are active and others are not; 3) Health outcomes of physical activity – studies on the health outcomes of physical activity with physical activity as the main exposure variable; 4) Interventions in the field of physical activity that aim to increase physical activity as the primary objective; and 5) Policy and practice in the field of physical activity and public health. This classification system was originally developed for the 2012 Lancet Physical Activity Series (A. E. Bauman et al., 2012; Hallal et al., 2012; Kohl et al., 2012).

A list of the three most cited authors per category was created. To ensure adequate global research representation for each category, if all three authors were from the USA, the top two only were included and a third was identified by selecting the highest cited author from a non-US institution. The final list included academics from USA, Australia, Brazil, Japan, and Norway.

#### 2.1.3. Expert validation of the list of most cited publications

Between April and June 2015 a letter of request including the list of 40 most cited physical activity articles from step 1 was sent by email to the 15 experts identified in step 2. Experts chose the ten articles they considered most influential for the field's development, and ranked by importance (ranking: 1–10). They were encouraged to suggest articles that were not on the list. The final list of most influential articles consisted of 15 articles with 4 or more expert votes each. The response rate from the initial author list was 80% (12/15). Three authors did not reply and therefore the next author in the list was invited to participate until 15 responses were achieved.

### 2.2. Citation data collection

#### 2.2.1. Data collection with Citation Network Analyzer tool

The Citation Network Analyzer-CNA tool developed by Lecy et al. (Lecy and Moreda, 2011) was chosen for data collection because of its functions of citation link identification, citation patterns tracking, and selection of highly influential publications based on the PageRank indicator, which fit the study objectives.

A citation network was collected in August 2015 using the most influential papers (n = 15, step 3) as "seeds" for a snowball sample. The sampling technique builds the network by identifying articles citing the seeds, articles citing those, etc. Since a snowball sample grows exponentially, we utilized a constrained snowball, which collects only a percentage of articles at each level, retaining the highly-cited articles and discarding the rest, resulting in a compact sample that represents the backbone of a literature since it contains the most-cited articles and linkages between them and is not biased by researcher preferences (Lecy and Beatty, 2012).

Two parameters were considered for the constrained snowball sampling: a) number of levels of data collection from the seeds; and b) percentage of articles to be sampled by level. Seed articles constitute the baseline level of data collection. Two levels of data were collected: articles that cite the seeds are in level 1 and articles that cite level 1 are in level 2. For this study, it was estimated that an initial five level selection strategy would produce over 10,000 publications, too many for practical analysis and effective interpretation. Thus, data were collected in two levels from the previously selected fifteen seeds, with a sampling of the top 2% most cited articles at each level (Lecy and Beatty, 2012). This produced a citation network with 5217 articles and 9132 citation links.

This sample was further refined by filtering by the group of those at the 75th percentile and above for total citations, i.e., only articles with at least 674 Google Scholar citations. This subsample contained 1131 articles, including 80% of the original seed articles identified by field experts (step 3). Since this is the most highly-cited set of articles in the network it represents the arterial flows of research through the field (Lecy and Beatty, 2012). Appendix graph A includes a representation of the complete citation network explaining the need for filtering in order to conduct the main path analysis.

### 2.3. After citation data collection

#### 2.3.1. Main path identification

The sample was further refined through main path analysis, a method to identify the set of articles that mathematically represents the optimal path for information to flow through the network between the seed articles and the last level of collected data. Links with the highest transversal weights were retained. Transversal weight is the proportion of all paths between the first/source document (not citing any others in the network) and the last/sink document (not cited by any others in the network) that contain a particular link or article. It represents the extent to which an article or link is needed for keeping the network connected (De Nooy et al., 2011; Harris et al., 2009). Using the search path count strategy to extract the main path (De Nooy et al., 2011), and based on a transversal weight cut point of 0.03 to ensure the inclusion of at least 80% of the seed articles, we obtained a network of 141 articles. This set contains the nodes with strongest citation linkages as you move forward in time from the seeds, representing the strongest path by which knowledge in the field has been generated and disseminated, i.e., it is the backbone of the literature (Harris et al., 2009).

#### 2.3.2. Network data extraction

Abstracts from the main path articles (n = 141) were coded according to the previously described five categories, plus first author gender and country of residence based on affiliation. Main path abstract coding was conducted independently by authors AR and DS, who agreed with a weighted kappa of 0.77 and percent agreement of 82.8%. Discrepancies were resolved until reaching 100% agreement.

#### 2.3.3. Statistical and graphic analyses

Traditional and network descriptive statistics and exponential random graph modeling (ERGM) were conducted to examine network

composition and patterns of ties in the main path (Harris et al., 2011; Harris et al., 2009). Descriptive characteristics included out-degree centrality, defined as the number of ties (citations) received by a node (citations). Nodes with higher out-degree are more prestigious/influential.

ERGMs offer an empirical means of describing citation patterns as a probabilistic function based upon characteristics of articles and their position within the network. They provide an odds ratio as an effect measure, similar to logistic regression, but take into account dependence between observations as a result of network structure (Harris et al., 2009). The model was built to formally test the hypothesis that nodes cluster in a network as a result of common characteristics (in this case, type of study). ERGMs in this context predict the likelihood of one article citing another as a function of either characteristics of the publication, or global network structures.

To better understand the development of the field an ERGM was estimated using the articles from the main path and including first author gender and article topic as covariates. Author's country of residence was not included in the model given the dominance of the US and the large proportion of non-US countries contributing just a single article to the network. Consistent with other citation network studies using ERGM (Harris et al., 2009, 2011), model building started with a null model, added main effects terms for author gender and article topic (model 1), added terms for same sex or same study topic citation (model 2), and added geometrically weighted terms to account for the underlying distribution of ties often observed in networks (model 3) (Harris, 2014). To further identify who the most influential authors of the field are, we ran an additional analysis including all authors and co-authors of the main path of the article citation network analysis, using node size to represent number of publications. This was filtered to only include authors with three or more publications in the main path of the network (n = 141 articles), to facilitate visual interpretation (Appendix graph B). Analyses were conducted in R 3.2, and visualization in the Pajek 4.10 and Gephi 0.9.2 programs.

## 3. Results

The first peer reviewed paper in the field of physical activity and public health was published in 1953: Morris et al., a study of physical activity and mortality at work (Morris et al., 1953). The field gradually evolved, reaching over one thousand publications per year by 2015, and developed with a predominance of US or UK male authors with a health sciences background. Over this period, most studies focused on health outcomes. Intervention studies appeared in the 1990s. Appendix Table A shows the list of most influential physical activity articles (resulting from step 3 and including 1 suggested article from the experts) since 1950 until June 2015, which were used as seeds for the citation network analysis.

The overall identified network included 5217 nodes and its citation links. The median, mean, and 75th percentile for citations were 381, 619 and 674 respectively. Among these 5217 nodes, the most cited article network (≥75th percentile) included 1131 nodes, which were used to identify the main path.

### 3.1. Most influential studies and authors

The main path had 98 lead authors, each contributing an average of 1.43 articles (s.d. = 1.26; range 1–10). Most lead authors (n = 79) contributed one article, and one third were women (29/98). Fig. 1 shows the timeline of the main path publications by study type, year of publication and number of citations.

Appendix Table B shows the 25 most cited articles in the main path network. Most articles had a lead author from the USA (n = 69), followed by the UK (n = 10); Canada (n = 5); Australia (n = 3); Netherlands (n = 3); and Brazil, Finland, Germany, Ireland, Israel, New Zealand, Spain, and Sweden (n = 1).

There were 45 journals contributing an average of 2.71 articles each (s.d. = 3.44). Top-ten journals were: JAMA (n = 16); Circulation (n = 12); American Journal of Preventive Medicine (n = 10); Medicine and Science in Sports and Exercise (n = 10); New England Journal of Medicine (n = 10); The Lancet (n = 7); Journal of the American College of Cardiology (n = 5); Archives of Internal Medicine (n = 3) and Preventive Medicine (n = 3). Fourteen of the 141 documents were books.

### 3.2. What characterized the composition and network structure as it developed over time?

Fig. 2 shows the publication and citation patterns by type of study from 1950 to 2015. Fig. 3 shows the main path publications forming the field of physical activity and health research, organized by type of study and author. Of the 141 articles in the main path, 15.6% were classified as levels, trends, and measurement (n = 22); 19.9% determinants or correlates (n = 28); 41.1% health outcomes (n = 58); 7.1% interventions (n = 10); and 16.3% policy and practice (n = 23).

Physical activity and health outcomes publications represent the beginning of the research field with first publication found in 1953 and 45.0% (26/58) of work published before 2000. In this study category, the median number of citations was 690 with a mean of 1037 (range 127–3530). First author countries included USA (49), UK (4), Finland (1), Australia (1), Germany (1) and Ireland (1) and Israel (1). Female first authors were found in 31% (18/58) of the papers. The Lancet, New England Journal of Medicine and Circulation were the most frequent journals for this category.

The first physical activity measurement and trends publication was in 1960, with 50.0% (11/22) were published between 2000 and 2010. Median and mean citations were 689 and 1041, respectively (range 245–5065). First author affiliations included USA (13), Canada (3), UK (2), Australia (2), Sweden (1), and Brazil (1). Thirty-two percent of authors were female (7).

The first correlates and determinants paper was published in 1985, and 68.0% (19/28) were published between 2000 and 2010. Median citations were 660 with a mean of 1011 (range 153–1118). First author affiliations included USA (20), UK (2), Canada (3), Australia (1), Netherlands (1) and New Zealand (1). A quarter of papers had female first authors (7).

The first policy publications appeared in 1992 and have been regularly distributed over the last 3 decades with 35% (8/23) published in the 1990s, 39.1% (9/23) during the 2000s, and 26% (6/23) after 2010. Median citation counts were 614 with a mean of 940 (range 123–7830). First authors were from USA (19), UK (2), Netherlands (1) and Spain (1). This category had the lowest proportion of female first authors: 13.4% (3).

Intervention publications were the most recent type of study to enter the network, starting in 1996. Half (50.0%, 5/10) of the studies were published during between 2002 and 2007. Median citation count was of 674, with a mean of 1019 (range 403–1753). First author affiliations included USA (8) and UK (2). Half of the first authors were female 50.0% (5), the highest proportion among all categories.

Determinants articles were 49% less likely than physical activity levels, trends, and measurement articles to be cited by other main path articles (0.51, 95% CI 0.32–0.83). No other article type was significantly more or less likely to be cited compared to physical activity levels, trends, and measurement articles.

As shown in Table 1, with the exception of policy and practice articles, articles of all topics were more likely to cite other articles of the same topic. Specifically, two articles about physical activity levels, trends, and measurement had 2.94 times higher odds of being linked by a citation (95% CI: 1.67–5.18) compared to two articles of other types. Odds Ratios of linkage among two articles of the same type, using articles of other types as reference, were as follows: 6.74 for determinants and correlates, 2.44 for health outcomes, and 8.52 for interventions.


**Fig. 1.** Timeline with the main path publications according to type of study, year of publication and number of citations.
On each 5-year period, publications are organized from top to bottom by number of citations in a decreasing order.

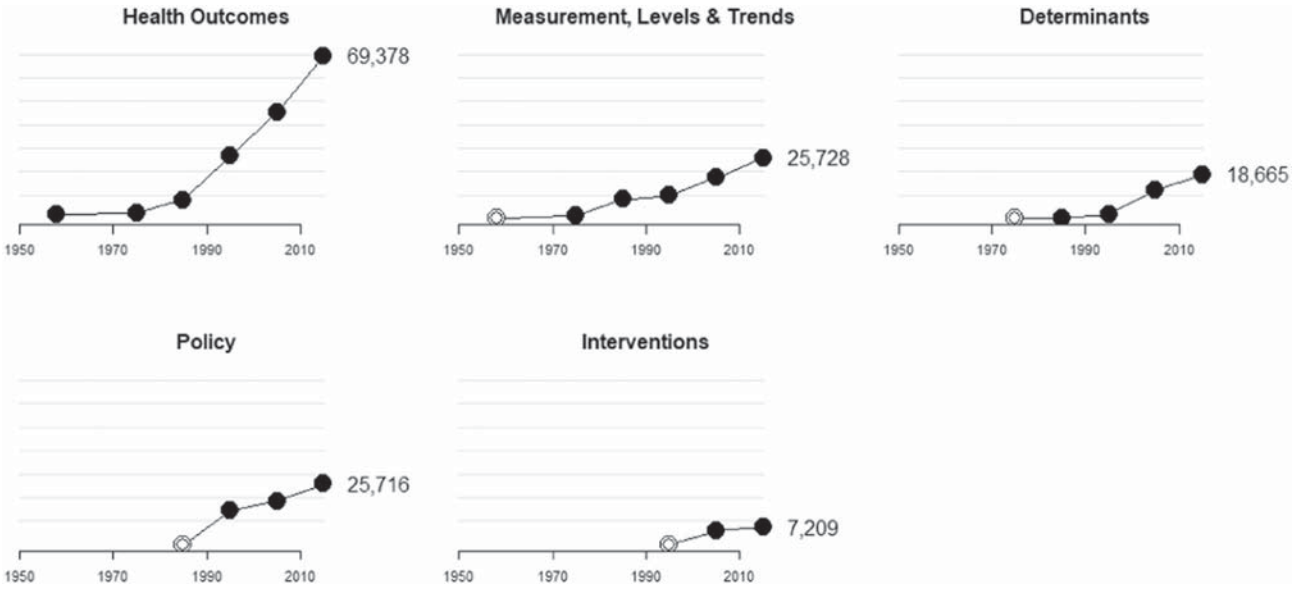


**Fig. 2.** Cumulative number of citations of publications in each type of study over time. (White dot is when the first publications appeared and black dots when the citations start; Y axis is number of citations).

First author gender was not significantly associated with citations (0.91, 95% CI 0.72–1.15).

### *3.3. Brief historical reconstruction according to the citation network analysis*

Fig. 3 shows the main path publications forming the field of physical activity and health research, organized chronologically and by study topic and author. The five largest nodes in the network (most cited articles) are publications by Pate et al. (1995), Troiano et al. (2008), Powell et al. (1987), Morris et al. (1953) and Kahn et al. (2002). Appendix graph B shows the main path author network analysis, showing the most influential authors in the field and the connections among them.

The field developed in the 1950s around the association between physical activity and health with the classic study of coronary heart disease and physical activity of workers in London (Morris et al., 1953; Morris et al., 1958), followed by studies on the same topic in the US (Paffenbarger and Hale, 1975; Paffenbarger et al., 1978).

In the 1980s, important methodological contributions (LaPorte et al., 1985) and standardization of the field's terminology emerged (Caspersen et al., 1985). One of the first reviews in the field (Powell et al., 1987) concluded that there was consistent epidemiological evidence of an inverse and causal relation between physical activity and incidence of coronary heart disease and, that physical activity promotion was fundamental to public health (Powell et al., 1987). This evidence was central to the population based physical activity recommendation launched in 1995 from the Centers for Disease Control and Prevention and the American College of Sports Medicine (Pate et al., 1995).

In the following years, randomized trials with physical activity as the intervention were conducted and the role of physicians in prescribing physical activity began to be discussed in the literature (Calfas et al., 1996; Dunn et al., 1999). By the end of the 1990s, studies evaluating sociodemographic inequalities and physical activity (Sallis and Owen, 1998) and correlates of activity among children, adolescents and the elderly started to be published.

From 2000 onward, research was conducted across all study types.

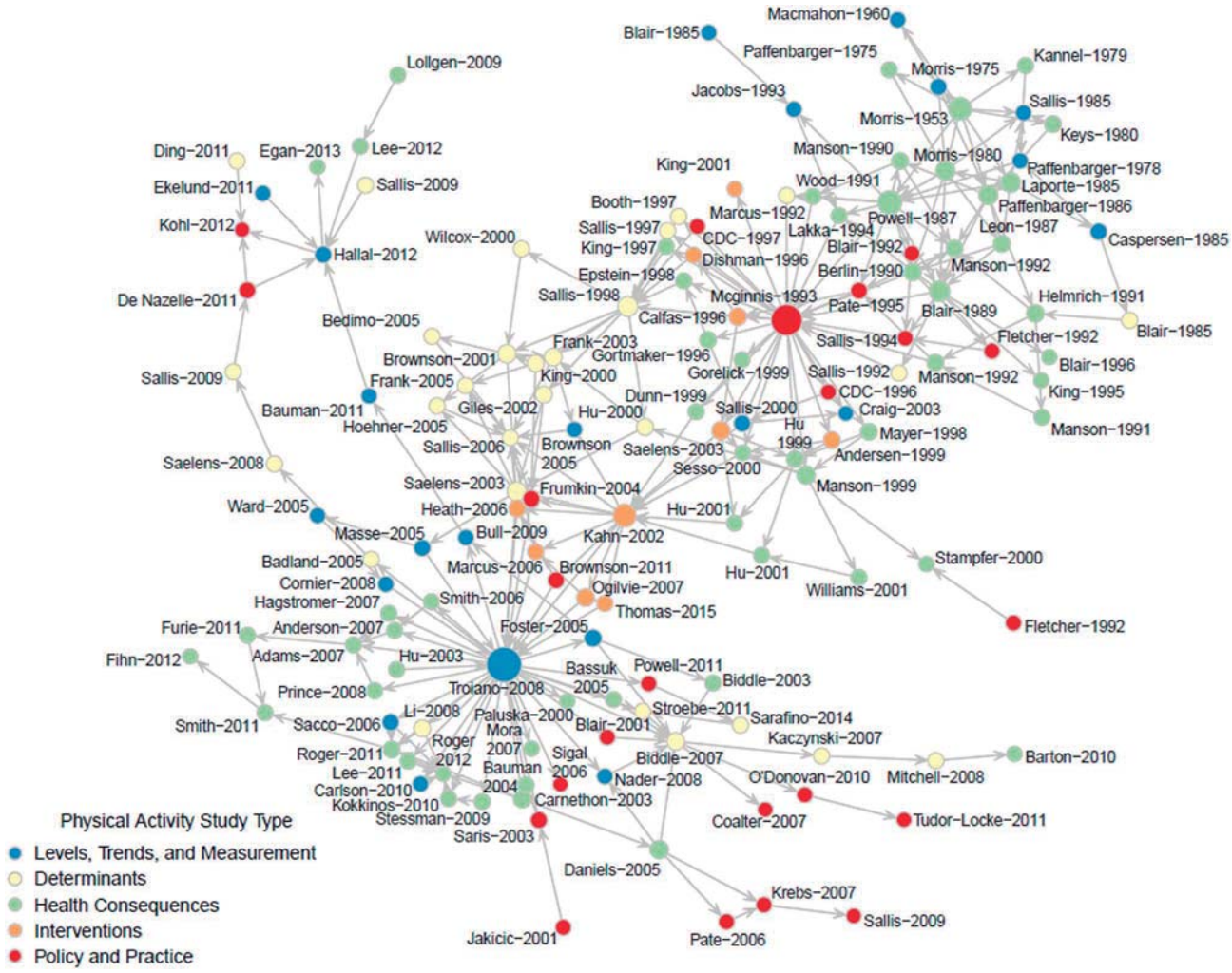


**Fig. 3.** Main path publications forming the field of physical activity and health research, organized by type of study and author (Node size display publication out-degree centrality*). *Out-degree is highest in nodes receiving more citations and therefore are more prestigious/influential. Receiving more citations means that these nodes were able to make the nodes who cite them aware of their results and therefore are better known among peers.

**Table 1**
Predictors of citation patterns estimated with Exponential Random Graph Models - ERGM's.

| | Null | Main effects | Same sex or study type citation | Full |
|---|---|---|---|---|
| | Odds ratio (confidence interval) | | | |
| Characteristics | | | | |
| Edges (relationship among authors) | 0.01 (0.01–0.02) | 0.01 (0.01–0.03) | 0.01 (0.01–0.02) | **0.03 (0.02–0.04)*** |
| Male | – | 0.69 (0.52–0.92) | 1.24 (0.95–1.62) | 0.91 (0.72–1.15) |
| Asymmetric ties by study type (probability of being cited) | | | | |
| Physical activity levels, trends and measurement | – | 1.00 | 1.00 | 1.00 |
| Determinants of physical activity | – | 0.68 (0.46–1.00) | 0.42 (0.24–0.74) | **0.51 (0.32–0.83)*** |
| Health outcomes of physical activity | – | 0.75 (0.54–1.05) | 0.61 (0.39–0.96) | 0.71 (0.48–1.05) |
| Interventions in the field of physical activity | – | 1.18 (0.74–1.88) | 1.07 (0.60–1.89) | 0.98 (0.62–1.55) |
| Policy and practice in the field of physical activity | – | 0.71 (0.47–1.07) | 0.81 (0.50–1.31) | 0.97 (0.66–1.41) |
| Mutual ties by study type (probability of clustering) | | | | |
| Physical activity levels, trends and measurement | – | – | 2.93 (1.65–5.21) | **2.94 (1.67–5.18)*** |
| Determinants of physical activity | – | – | 6.58 (3.67–11.81) | **6.74 (3.75–12.14)*** |
| Health outcomes of physical activity | – | – | 2.42 (1.64–3.58) | **2.44 (1.64–3.64)*** |
| Interventions in the field of physical activity | – | – | 8.14 (3.54–18.72) | **8.52 (3.61–20.15)*** |
| Policy and practice in the field of physical activity | – | – | 1.83 (0.92–3.65) | 1.85 (0.94–3.66) |
| Global terms | | | | |
| Geometrically weighted out-degree[a] | – | – | – | **0.17 (0.11–0.26)*** |
| Models goodness of fit measures | | | | |
| Model AIC | 2941 | 2938 | 2855 | 2808 |
| Model BIC | 2949 | 2985 | 2950 | 2910 |

* $p < 0.05$.
[a] Out-degree is defined as the outgoing relations a node has. It is highest in nodes receiving more citations.

Important work on measurement, correlates and interventions shows the importance of collaboration between disciplines for exploring new topics and understanding physical activity monitoring and practice. Examples worth mentioning include: 1) a milestone study on validity and reliability of the International Physical Activity Questionnaire (Craig et al., 2003); 2) the ecological model for physical activity and active communities (Sallis et al., 2006); 3) studies exploring the associations between physical activity, psychological wellbeing, environment and policy (Brownson et al., 2001; Saelens et al., 2003; Sallis et al., 2006); 4) a systematic review reporting the most effective interventions to increase physical activity (Kahn et al., 2002); and, 5) the first population based study with objective measurement of physical activity levels in U.S. adults (Troiano et al., 2008).

Since 2005, two paths related to the built environment and global physical activity surveillance and policy have emerged. The built environment arm included pivotal studies about transport, urban design and walking (Badland and Schofield, 2005), a multicountry study (Sallis et al., 2009), and a review of evidence on active travel policies for health (de Nazelle et al., 2011). The global surveillance and policy arm included studies about the Global Physical Activity-GPAQ and International Physical Activity-IPAQ Questionnaires (Bauman et al., 2011; Bull et al., 2009), and articles of the first Lancet Physical Activity Series (Hallal et al., 2012; Kohl et al., 2012; Lee et al., 2012) that presented a global perspective on the prevalence, burden, and steps needed to address the pandemic of physical inactivity.

## 4. Discussion

To our knowledge, this is the first systematic historical reconstruction of the development of the physical activity and public health research field. This study is unique in that it is the first to use a quantitative methodology to map the most influential research articles of this field over a 60-year period starting with the first known peer reviewed publication in 1953.

Our findings indicate that the physical activity and health research field started in the 1950s, with a health sciences focus and North American and European leadership. Health outcome studies are most common and policy and intervention studies the least common. Critical articles on policy and objective measurement influenced progression from health outcomes research to more recent foci in built environment and global monitoring.

This body of work of the most influential papers includes important concepts that have remained citable for decades and constitutes the backbone of the physical activity research field (see Appendix graph C, showing citation volumes of seed articles over time). Key concepts identified from these publications include: 1) beneficial health effects of physical activity; 2) international health organizations focus on physical inactivity for chronic disease prevention; 3) physical activity recommendations for all population groups; 4) enhanced understanding of correlates and determinants, especially in low and middle income countries, can reduce inactivity and contribute to global prevention of chronic diseases; 5) effective interventions for increasing physical activity; and 6) most countries have physical activity prevalence estimates for informing surveillance and policy, but physical inactivity is at pandemic levels globally.

Some of the most cited papers connect different study categories around fundamental innovative concepts. For example, the two most central articles in the network (the largest nodes in Fig. 3) are a policy article (Pate et al., 1995) and an objective measurement article (Troiano et al., 2008), each of which introduced a new concept. Fig. 3 shows that these papers are among the first to be published in their category and are cited by papers of all study types, perhaps reflecting multidisciplinary and transdisciplinary communication through publications. Pate et al. (1995) links the predominantly health outcomes body of evidence to an emerging literature on determinants and interventions. This is also the case for Troiano et al. (2008) that links this previous literature to new studies using objective measurement and trends. Surprisingly, the best known authors and papers compromise only a small proportion of the 141 main path papers which are spread across 98 lead authors.

It is interesting to note that through 2012 researchers continued to primarily conduct health outcome studies, and that interventions and policy studies remained the least conducted. This raises the question of how much research provides new insights or fills research gaps in areas that could impact health (i.e., policy change) versus covering familiar ground (Control and Prevention, 1999). The low density of intervention and policy publications in the network also suggests the need to continue to fill the evidence gaps on the effects of large scale interventions and policy on physical activity and the extent to which evidence is being translated into action. This may be in part due to the greater complexity of design, funding requirement and specific training required to conduct intervention, intervention evaluation, policy and translation research. Translational research in physical activity is an important study area with relatively few examples of successful cases of collaboration between scientists and with policy makers (Brownson et al., 2006; Pratt et al., 2016; Reis et al., 2016). Studies on smoking cessation strategies and secondhand smoke have found similar disconnects in how effectively research is being translated into policy (Harris et al., 2009; Harris, 2010).

The citation patterns identified in this study show that studies about the determinants of physical activity are significantly less likely to be cited in the network compared to other types of articles. In addition, with the exception of policy and practice articles, most articles are more likely to cite other articles on the same topic, limiting the flow of information across the subfields of physical activity and public health (Rutter et al., 2017) Limited co-authorship and citations across subthemes within the network may compromise the evolution of the field and limit research translation and advocacy to address the global pandemic of inactivity and the WHO 2030 global health agenda (WHO, 2015).

The study had some limitations. Sampling for citation network analysis captures a representative but not exhaustive sample, and uses very specific search terms, therefore, some relevant publications may not have been identified. This limitation was addressed by inviting experts to add to the final selection of articles. Also, citation rates might not always accurately reflect the importance of the key papers due to differential dissemination, scientific promotion, and popularity of papers. Finally, literature published in non-English languages was not included.

## 5. Conclusion

This study identifies papers forming the backbone of the physical activity and public health research field. These publications include fundamental ideas that remain citable over time, however research and dissemination gaps exist in this network and should be addressed. Understanding the past and present of physical activity and public health research is critical for strategically determining the next steps for growing the field and its reach. The findings highlight the need to achieve more integrated and multidisciplinary collaboration, and to support emerging researchers in becoming a part of the backbone of the network (similar research groups as those that had great influence in the past remain the most influential currently). More emphasis should be placed on achieving gender equity in the field, by supporting female researchers. The results of this work could help in developing streamlined pathways to expedite growth of emerging sub-areas. One of the most pressing needs is capacity building in low and middle income countries. Finally, more studies on interventions, evaluation of interventions, policy, translation and scale-up are needed, as evidence in these areas is scarce, and impacts on population health are likely to be substantial. For this to happen, funding opportunities and research positions favoring this type of work are critical.

## Transparency document

The Transparency document associated with this article can be found, in online version.

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The information presented in this manuscript has not been presented elsewhere.

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## Supplementary data

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Editorial

# Mapping the historical development of research in physical activity and health: Providing a platform for future research

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ABSTRACT

This editorial is a commentary on the review paper by Ramirez Varela et al. entitled "Mapping the historical development of physical activity and health research: a structured literature review and citation network analysis." This editorial highlights the significance and implications of this review, with a particular focus on future research and policy directions.

## 1. Introduction

The paper by Ramirez Varela and colleagues (in press) is the first concerted effort to review the historical development of scientific evidence in the field of physical activity and public health. The authors have used a structured literature review approach and citation network analysis which is both novel and rigorous to assess the evolution of knowledge in this field. Their paper provides not only a narrative review of work in this field but also some quantification of the impact of specific papers through the citation network analysis. The authors have focused their review on five categories: physical activity surveillance and measurement; determinants and correlates of physical activity; health outcomes of physical activity; physical activity interventions; and policy and practice in the field of physical activity. Ramirez Valera and colleagues also identify several critical gaps that remain in this literature and opportunities for future research and policy attention.

## 2. Historical perspective

This review describes the first publications in this field beginning in the 1950s and continues to mid-2016 delineating the major achievements and advances over this 60 year period. The associations between physical activity and coronary heart disease outcomes were the initial focus of research on health outcomes beginning in 1953. By the mid-1990s, there was sufficient evidence for the Centers of Disease Control (CDC) and Prevention and the American of College of Sports Medicine (ACSM) to publish the first population-based physical activity recommendations for health promotion and disease prevention (Pate et al., 1995). These recommendations were based on epidemiologic evidence of associations between physical activity with coronary heart disease, hypertension, type 2 diabetes, colon cancer, anxiety and depression. However, of interest, at that time there was only sufficient epidemiologic evidence to establish an association between physical activity and coronary heart disease. The first studies on the association between physical activity and other chronic conditions (e.g. certain cancers, type 2 diabetes) began emerging in the 1980s (Albanes et al., 1989; Nelson et al., 1988; Severson et al., 1989) and it would take nearly 20 more years before disease-specific recommendations are published. The first physical activity recommendations for cancer prevention and survivorship were published in 2006 by the American Cancer Society (Doyle et al., 2006). At that time, given the lack of evidence on physical activity and cancer survivorship, the ACS recommendations were based on the evidence accumulated in healthy populations for cancer prevention. Although considerable evidence now exists for the role of physical activity and specific health outcomes, more research is warranted for the prevention and treatment of specific chronic diseases.

Ramirez Valera et al. found that the first papers on the correlates and determinants of physical activity were only published in 1985 to be followed by the first policy publications in 1992 and intervention publications in 1996. They noted that through 2012, research in physical activity has been primarily focused on health outcomes. Hence, there is a clear need for additional research focused on policy and physical activity interventions that is emphasized by these authors.

Ramirez Valera and colleagues also identified that the role of physicians in prescribing physical activity was first discussed in the literature in the mid to late 1990s. Furthermore, from 2000 onwards, research collaborations between different disciplines of exercise science, public health and medicine became more prominent. Indeed, the initial physical activity guidelines published by CDC and ACSM involved a planning committee of five

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scientists (Pate et al., 1995), whereas the updated recommendations published in 2007 (Haskell et al., 2007) specifically stated that the expert panel who reviewed the literature included physicians, epidemiologists, exercise scientists and public health specialists. Several governmental agencies worldwide have also contributed to these types of reviews and preparation of physical activity guidelines. A notable contribution has been made by the US National Institutes of Health decanal Physical Activity Guidelines for Americans reports with the second edition to be released in 2018. These reports are comprehensive reviews of the state of evidence on the role of physical activity and all health outcomes that require two years of preparation. They are an authoritative resource for policy makers and health professionals as well as a useful guide for the public seeking the latest knowledge on how physical activity can promote health, including information on exercise dose-response. The involvement of governments, professional societies, non-governmental agencies and health professionals has also contributed to the wide dissemination and acceptance of physical activity guidelines for improved health and well-being in different populations (e.g. children, elderly, persons living with chronic diseases/conditions).

The most recent developments in physical activity and public health research have been in the areas of the built environment and objective physical activity assessment. Progress in technology has led to an increase in the use of physical activity monitors and Global Positioning Systems (GPS) to assess physical activity participation under real-life conditions/within the built environment (Rodriguez et al., 2005; Troped et al., 2010). Findings from these studies support the notion that greater presence of land use mix (combination of residential, commercial, recreational and/or urban public areas), street connectivity and population density are related to higher physical activity participation. The use of these monitoring devices provides objective assessments of all movements (not only planned physical activity) to researchers and reduces participant burden related to self-reported measurements. Research in these emerging areas will provide critical information to urban planners and policy makers to design built environments that promote physical activity participation.

## 3. Significance

This paper is the first ever consideration of how physical activity has been of relevance to public health using quantitative methods that map the most impactful research articles. In so doing, Ramirez Valera and colleagues have provided an excellent overview of the field that will be of interest to trainees and professionals in both physical activity and public health disciplines. A similar methodologic approach was used by Cambrosio et al. (2006) to map the historical use of translational approaches in cancer research from 1980 to 2003. They reported that in the 1980s, research publications were mostly categorized according to whether they used typically laboratory- or clinical-based approaches to study designs and data collection, whereas the 1990s saw an emergence of publications combining work in both clinical and laboratory settings, which was titled the biomedical field. Cambrosio et al. (2006) conclude their article by stating that cancer policy analysts who may draw conclusions based on research performed within a pre-defined discipline (e.g. genetics, clinical) will likely miss the overall interactions between disciplines that form the large domain of cancer research. Ramirez Valera and colleagues do acknowledge that a growing number of collaborations and inter-disciplinary research in the area of physical activity and health has occurred since the year 2000. However, they also report that translational research in physical activity and collaborations between scientists and policy makers is currently infrequent. We re-iterate the conclusions stated by Cambrosio et al. (2006) and encourage policy analysts in the area of physical activity to collaborate closely with scientists to accelerate translation of evidence from recent (and future) inter-disciplinary research into action.

## 4. Implications

These types of review papers provide both retrospective and prospective reflections on how the field has developed and evolved, and which future directions need to be considered to ensure on-going meaningful impact on advancing knowledge to improve health outcomes. Two important areas that have received relatively limited consideration are intervention and policy studies. Ramirez Valera and colleagues have rightly identified the dearth of policy and translational research as significant gaps that will require more sophisticated designs and methods, targeted funding opportunities and highly skilled professionals trained in these fields for significant progress to be achieved. It is important to recognize that advances in data availability and technology allow researchers, trainees and health professionals to disseminate and access physical activity data on a global scale. This capability for data access and dissemination was not possible 10–20 years ago. Future researchers and policy makers should therefore consider global perspectives on monitoring physical activity prevalence and designing interventions with the objectives of implementing physical activity guidelines for different populations and reducing physical inactivity globally.

In conclusion, Ramirez Valera and colleagues have provided a useful summary of evidence on physical activity and public health that is also a call to action for funders, researchers, academics, practitioners and trainees for the future. Their recommendation for multidisciplinary collaboration is to be heeded and should be considered for the development of targeted funding opportunities and research opportunities.

## Transparency document

The Transparency document associated with this article can be found, in online version.

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Human Kinetics
ORIGINAL RESEARCH

# Worldwide Surveillance, Policy, and Research on Physical Activity and Health: The Global Observatory for Physical Activity

**Andrea Ramirez Varela, Michael Pratt, Kenneth Powell, I-Min Lee, Adrian Bauman, Gregory Heath, Rafaela Costa Martins, Harold Kohl, and Pedro C. Hallal**

**Background:** The Global Observatory for Physical Activity (GoPA!) was launched in response to the physical inactivity pandemic. The aim of this article is to present current information about surveillance, policy, and research on physical activity (PA) and health worldwide. **Methods:** Information was collected for 217 countries. For 139 of these nations we identified a contact who confirmed information's accuracy and completeness. Associations were calculated among surveillance, policy and research categories. **Results:** Of the 139 countries, 90.6% reported having completed 1 or more PA survey, but less than one-third had 3 or more. 106 included PA on a national plan, but only one-quarter of these were PA-specific. At least 1 peer reviewed publication was identified for 63.3% of the countries. Positive associations ($P < .001$) were found between research and policy ($\rho = 0.35$), research and surveillance ($\rho = 0.41$), and surveillance and policy ($\rho = 0.31$). Countries with a standalone plan were more likely to have surveillance. Countries with more research were more likely to have a standalone plan and surveillance. **Conclusions:** Surveillance, policy, and research indicators were positively correlated, suggesting that action at multiple levels tends to stimulate progress in other areas. Efforts to expand PA-related surveillance, policy, and research in lower income countries are needed.

**Keywords:** public health, global health, epidemiology, methods

Physical inactivity is a global pandemic responsible for 5 million deaths per year and has become a global public health priority.[1,2] The need for country-level data, high quality locally applicable research, and monitoring to inform policy and interventions at the population level is clear.[1,3,4] A physical activity (PA) "Observatory" has been created to address this need.[1] The Observatory is a global resource and knowledge translation platform, and it encourages and supports international agencies and countries to take action to increase population levels of PA.[1]

The Global Observatory for Physical Activity[5] (GoPA!) is a Council of the International Society of Physical Activity and Health, and was established to measure global progress in the areas of surveillance, policy, and research.[5] Since 2012, GoPA! has collaborated with other institutions and governments worldwide to track progress in PA, and to achieve the World Health Organization (WHO) target of reducing the prevalence of inactivity by 10% by 2025.[6] A description of the Observatory and information by country can be found at http://www.globalphysicalactivityobservatory.com/.[7]

In this paper, we present descriptive information on surveillance, policy and research from the first round of data collection by GoPA!, which took place from 2012–2014.[7] We also test associations among these indicators.

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## Methods

### Identification and Classification of Countries

Starting with the World Bank (WB) list of 215 countries,[8] we divided the United Kingdom into England, Scotland, Wales, and Northern Ireland, and we combined information from China and Taiwan, as requested by the contact representatives from these countries. Our final list comprised 217 countries. For some analyses, we classified countries by income level, using the World Bank's classification.[8] We also categorized countries by region, following the World Health Organization[9] regional classification.[10]

### Assembling Country-Specific Information

***Identification of Country Contacts.*** We searched for country-level contacts or volunteers who could verify or improve information about their country. Country contacts were identified using a PubMed search of the PA literature, from the list of focal points of international networks [eg, European network for the promotion of health-enhancing physical activity (HEPA); the Americas Physical Activity Network, RAFA PANA; and the African Physical Activity Network (AFPAN)][11–13] and the list of focal points of

WHO regional offices.[14] Recommendations from public health experts supplemented the list. Country contacts needed to have demonstrated experience in the area of PA and public health either as researchers, as members of government institutions or international networks. Country contacts were officially invited to be part of GoPA! and review their country-specific card. Approval of data by the country contact was required before publication of a country's PA-related data.

***Country-Specific General Information.*** From the World Bank we obtained information on total population, life expectancy, GINI inequality index, literacy rate, and the proportion of all deaths caused by noncommunicable diseases (NCDs).[8] From the United Nations, we obtained the Human Development Index.[15] Finally, we used the article by Lee and coworkers to show the proportion of all deaths in each country attributable to physical inactivity (defined as not meeting the international PA recommendation of at least 150 minutes of aerobic moderate-intensity PA per week).[2,9]

***National Surveys of PA Prevalence.*** National survey was defined as a survey conducted with a national or subnational representative sample, and that included PA questions. To obtain information about country-specific PA behaviors we conducted surveys of online databases (WHO, PAHO, DHS, Google, and PubMed) using the search terms "physical activity", "national survey", "physical activity questions", and the country name as search words. With the help of the country contact we confirmed or modified the information from the online search and obtained information about the survey's periodicity (year of the first survey, year of the most recent survey, and year of the next survey planned). This information allowed us to create a variable on surveillance divided into 4 categories: 1) no national PA surveillance data, 2) 1 PA survey, 3) 2 surveys, and 4) 3 or more surveys with a clear periodicity and a specific year for the next survey.

The initial estimates of the overall and sex-specific prevalence of physical inactivity among adults (18+ years) for each country was obtained from the WHO Repository.[10] We did this to enhance comparability of estimates across countries. We replaced WHO data with a country's independent national estimate if a) the country contact suggested the change, b) prevalence was estimated using a standardized self-report instrument covering all-domains of PA (ie, leisure-time, occupation/ housework, and transport), and c) the updated WHO guidelines for PA were used to define the prevalence of physical inactivity.[9]

***National PA Plans.*** To obtain information about national plans regarding the status and promotion of PA we conducted a survey of online databases (WHO, MiNDbank database, Google) using the search terms "physical activity", "national policy", "national plan", and the country name. We then classified the policy information into 1 of the following 3 categories: 1) no clear PA plan, 2) PA plan embedded in NCD plan, and 3) standalone PA plan.

***Research in PA.*** To estimate the amount of PA-related research in each country, we conducted a PubMed search using the search terms "physical activity" (in title or abstract) and country name (anywhere in the title, abstract, text or affiliation). Dates of publication were restricted to 01/01/2013 to 12/31/2013. The year 2013 was selected as the first year of monitoring for GoPA! There were no study design, language, or age-of-subjects restrictions. Studies on exercise physiology and studies where PA was not an outcome were excluded. To be considered as part of the country's research production the article had to explicitly show that the research was conducted in the country. All titles and abstracts identified in the PubMed search were read by the first author (AR), and in case of doubts, the senior author (PH)[16] was consulted.

Once the PubMed search was finished a list of authors in all countries was made and duplicates were excluded. The program Matlab was used. Authors were included in the country's list if they participated in the research related to the country and not merely because of their individual affiliation with a particular country (eg, an author who is a Brazilian national who participated in a research study using UK data would NOT be counted as contributing to research for Brazil).

Country contacts reviewed the list of articles pertaining to his/her country, recommending deletions or additions based on the eligibility criteria. We identified 2173 articles that met our eligibility criteria. We divided studies into 1 of the following 5 categories: 1) PA levels, trends, and measurement; 2) determinants of PA; 3) health consequences of PA; 4) interventions in the field of PA; and 5) policy and practice in the field of PA.

The research component generated the following variables: a) country has at least 1 identifiable publication on PA and health in 2013—yes or no; b) percentage of all studies that included children and adolescents; c) number of unduplicated authors in the 2013 PubMed search; and d) the ratio of number of research articles per capita for each country, WHO region, and WB economic category. The software Matlab and Tableau were used. Finally, descriptive analyses and associations (Spearman correlation) among research, policy, and surveillance indicators were explored. We used 4 surveillance categories and 3 policy categories as previously described, and 5 research categories (none, under percentile 25, percentiles 25 to <50, percentiles 50 to <75, equal or above percentile 75). The statistical analyses were conduced in the statistical program Stata (version 12.0, StataCorp, College Station, TX).

## Results

The GoPA! completed data collection for 217 countries. Collaboration with a country contact who agreed to represent the country and who fully reviewed and approved data for their country card was obtained for 139 countries (64.1%) (hereafter referred to as "active participation" or "participating countries"). Active participation in the Observatory varied among regions, ranging from 29.2% in Sub-Saharan Africa to 88.9% in East Asia and Pacific (Table 1). Participation was also directly related to country income group with only 26.5% of low-income countries participating in GoPA! compared with 82.5% of high-income countries.

The first set of 139 Country Cards and the country contacts list can be found at *The 1st Physical Activity Almanac*, available at the GoPA! website.[5]

### Surveillance

Of the 139 countries participating in GoPA!, 9.4% had no representative national survey with PA questions, 39 (28.1%) had 1, 55 (39.6%) had 2, and 39 (28.1%) had completed 3 or more national surveys with PA questions (Table 2). These findings are consistent with findings reported by the WHO.[17] PA surveillance activities varied by world region and country income classification. High-income (33.3%) and middle-income (21.6%) countries were more likely to have completed 3 or more surveys and have another one scheduled. One-third (33.3%) of participating low-income countries had completed no national survey.

**Table 1 Participation in GoPA! by World Region and Income Group Classification**

| | Number of countries | Number of GoPA! countries | |
|---|---|---|---|
| Classification | Number | Number | Percentage |
| World region* | | | |
| East Asia and Pacific | 36 | 32 | 88.9 |
| Europe and Central Asia | 61 | 39 | 63.9 |
| Latin America and the Caribbean | 40 | 31 | 77.5 |
| Middle East and North Africa | 21 | 14 | 66.7 |
| North America | 3 | 3 | 100.0 |
| South Asia | 8 | 6 | 75.0 |
| Sub-Saharan Africa | 48 | 14 | 29.2 |
| Income group* | | | |
| High income | 80 | 66 | 82.5 |
| Upper middle income | 54 | 37 | 68.5 |
| Lower middle income | 49 | 27 | 55.1 |
| Low income | 34 | 9 | 26.5 |
| Total | 217 | 139 | 64.1 |

* World region and income group classifications according to the World Bank. The United Kingdom was divided in 4 countries (England, Scotland, Wales, and Northern Ireland).

**Table 2 Physical Activity Surveillance Characteristics by World Region and Income Group Classification**

| | GoPA! countries* | No national survey | 1 national survey | 2 national surveys | 3 national surveys |
|---|---|---|---|---|---|
| World region* (n, %) | | | | | |
| East Asia and Pacific | 32 | 3 (9.4%) | 14 (43.8%) | 9 (28.1%) | 6 (18.8%) |
| Europe and Central Asia | 39 | 2 (5.1%) | 6 (15.4%) | 17 (43.6%) | 14 (35.9%) |
| Latin America and the Caribbean | 31 | 3 (9.7%) | 13 (41.9%) | 8 (25.8%) | 7 (22.6%) |
| Middle East and North Africa | 14 | 0 (0.0%) | 3 (21.4%) | 10 (71.4%) | 1 (7.1%) |
| North America | 3 | 0 (0.0%) | 1 (33.3%) | 0 (0.0%) | 2 (66.7%) |
| South Asia | 6 | 0 (0.0%) | 0 (0.0%) | 5 (83.3%) | 1 (16.7%) |
| Sub-Saharan Africa | 14 | 5 (35.7%) | 2 (14.3%) | 6 (42.9%) | 1 (7.1%) |
| Income group* (n, %) | | | | | |
| High income | 66 | 5 (7.6%) | 15 (22.7%) | 24 (36.4%) | 22 (33.3%) |
| Upper middle income | 37 | 3 (8.1%) | 11 (29.7%) | 15 (40.5%) | 8 (21.6%) |
| Lower middle income | 27 | 2 (7.4%) | 11 (40.7%) | 13 (48.2%) | 1 (3.7%) |
| Low income | 9 | 3 (33.3%) | 2 (22.2%) | 3 (33.3%) | 1 (11.1%) |
| Total (n, %) | 139 | 13 (9.4%) | 39 (28.1%) | 55 (39.6%) | 32 (23.0%) |

* World region and income group classifications according to the World Bank. The United Kingdom was divided in its 4 countries (England, Scotland, Wales, and Northern Ireland).

## Policy

Of the 139 countries participating in GoPA!, 69 (49.6%) had a national NCD plan that included PA and 37 (26.6%) had a standalone national PA plan (Table 3). The finding that 76.3% of countries have a plan is in agreement with the estimate of 80.0% by WHO.[17] Sub-Saharan Africa is the region with the highest proportion of countries (85.7%) without a PA plan. The proportion of countries without a plan is less than 36.0% in all other world regions. Two-thirds (66.7%) of low income countries have no plan compared with less than one-third for all other income groups.

## Research

The automated search strategy retrieved 6539 articles of which 2173 met the inclusion criteria. Of the 217 countries, 105 (48.4%) had

**Table 3 Physical Activity Policy Characteristics by World Region and Income Group Classification**

| | GoPA! countries* | No physical activity plan | NCDs plan including physical activity | A standalone physical activity plan |
|---|---|---|---|---|
| World region* (n, %) | | | | |
| East Asia and Pacific | 32 | 6 (18.7%) | 19 (59.4%) | 7 (21.9%) |
| Europe and Central Asia | 39 | 3 (7.7%) | 18 (46.1%) | 18 (46.2%) |
| Latin America and the Caribbean | 31 | 4 (12.9%) | 17 (54.8%) | 10 (32.3%) |
| Middle East and North Africa | 14 | 5 (35.7%) | 9 (64.3%) | 0 (0.0%) |
| North America | 3 | 1 (33.3%) | 0 (0.0%) | 2 (66.7%) |
| South Asia | 6 | 2 (33.3%) | 4 (66.7%) | 0 (0.0%) |
| Sub-Saharan Africa | 14 | 12 (85.7%) | 2 (14.3%) | 0 (0.0%) |
| Income group* (n, %) | | | | |
| High income | 66 | 9 (13.6%) | 32 (48.5%) | 25 (37.9%) |
| Upper middle income | 37 | 10 (27.0%) | 15 (40.5%) | 12 (32.4%) |
| Lower middle income | 27 | 8 (29.6%) | 19 (70.4%) | 0 (0.0%) |
| Low income | 9 | 6 (66.7%) | 3 (33.3%) | 0 (0.0%) |
| Total (n, %) | 139 | 33 (23.7%) | 69 (49.6%) | 37 (26.6%) |

* World region and income group classifications according to the World Bank. United Kingdom was divided in its 4 countries (England, Scotland, Wales, and Northern Ireland).

Abbreviations: NCDs, Noncommunicable diseases.

**Table 4 Physical Activity Research Characteristics by World Region and Income Group Classification**

| | Number of countries* | Countries with publications in PubMed in 2013 (# and %) | Number of articles meeting inclusion criteria | Articles per 100 million population |
|---|---|---|---|---|
| World region** (n, %) | | | | |
| East Asia and Pacific | 36 | 15 (41.6%) | 441 | 20 |
| Europe and Central Asia*** | 61 | 47 (77.0%) | 882 | 98 |
| Latin America and the Caribbean | 40 | 12 (30.0%) | 149 | 24 |
| Middle East and North Africa | 21 | 12 (57.1%) | 31 | 8 |
| North America | 3 | 2 (67.0%) | 612 | 174 |
| South Asia | 8 | 6 (75.0%) | 28 | 2 |
| Sub-Saharan Africa | 48 | 11 (23.0%) | 30 | 3 |
| Income group** (n, %) | | | | |
| High income | 80 | 53 (66.3%) | 1817 | 139 |
| Upper middle income | 54 | 28 (51.9%) | 297 | 12 |
| Lower middle income | 49 | 16 (32.7%) | 46 | 2 |
| Low income | 34 | 8 (23.5%) | 13 | 2 |
| Total (n, %) | 217 | 105 (48.4%) | 2173 | 31 |

* PubMed search was conducted for the 217 world countries GoPA! list.

** Population, world region, and income group classifications according to the World Bank in 2013. The United Kingdom was divided in its 4 countries (England, Scotland, Wales, and Northern Ireland).

*** PubMed search showed the same results for Denmark and Faeroe Islands. Therefore results were counted only once.

1 or more publications (Table 4). Among the 139 GoPA! participating countries, 90 (64.7%) had at least 1 publication compared with only 15 (19.2%) of the 78 nonparticipating countries. The country-specific number of research publications and number of publications per 100 million population per GoPA! participating country varied widely (Webtable 1). Among the 90 participating countries with 1 or more articles, the number per country ranged from 1 to 445 with a median of 4.

Europe and Central Asia (40.6%), North America (28.2%), and East Asia and the Pacific (20.3%) accounted for 89.0% of

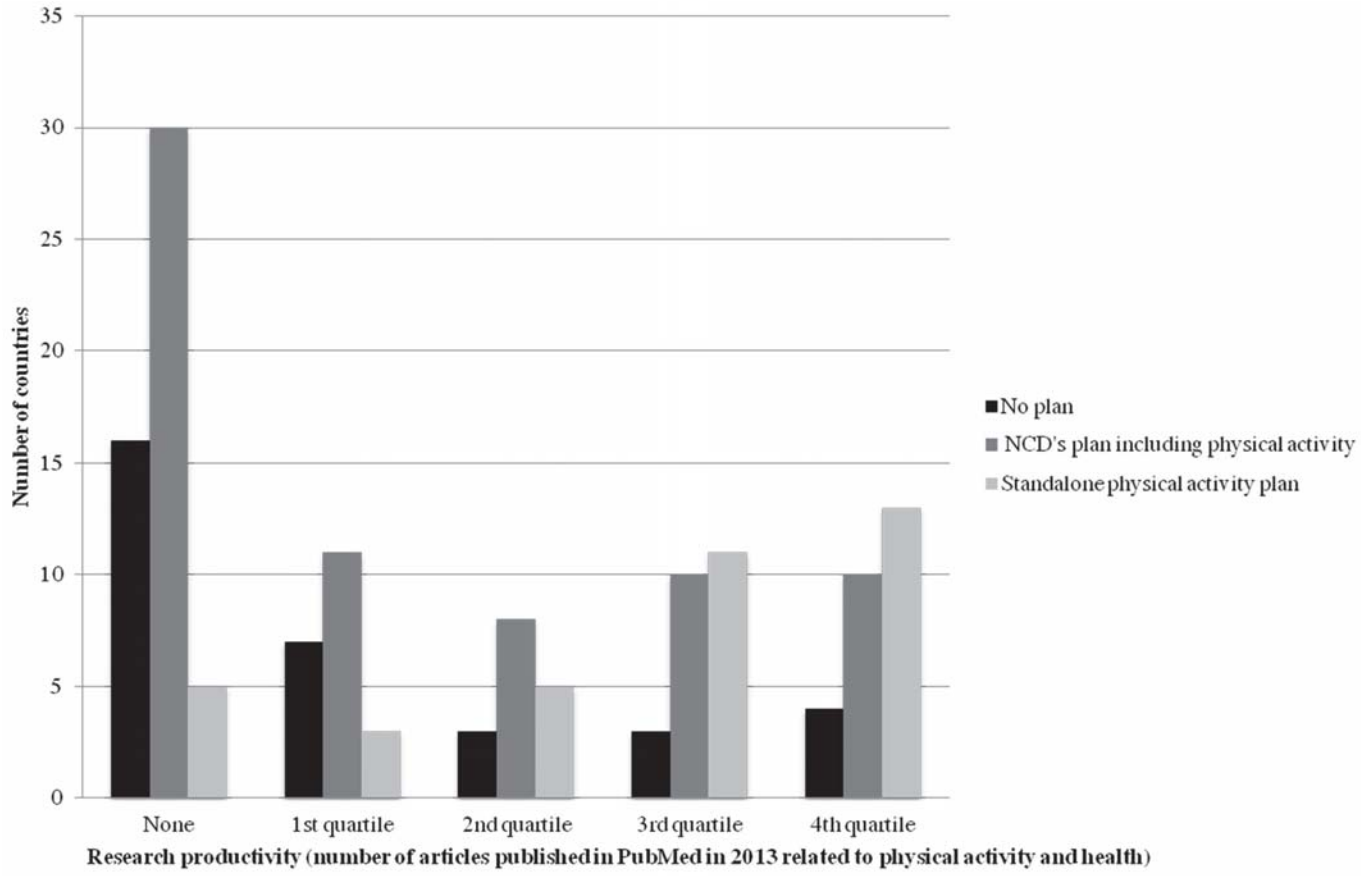


**Figure 1** — Physical activity policy characteristics and research productivity in 2013 by country.

publications (Table 4). Among income groups, high-income countries produced 83.6% of publications.

Among participating countries with ≥500,000 population, the highest rates were found for Australia and several European countries (more than 200 articles per 100 million people). The median number of publications for this group was 19. Thirty-nine GoPA! countries (28.1%) accounting for 44 million inhabitants did not have a research publication in 2013. Figure 1 displays the number of PA and health publications in each country around the world.

Of the 2173 articles, more than 60% were categorized 'prevalence, measurement, and trends' or 'correlates and determinants'. Only 5.3% were classified in the 'policy' category (Table 5). Thirty-one percent of all studies focused on children and adolescents. A total of 7814 authors were identified.

***Association Between PA and Health Research, Policy, and Surveillance.*** Using the information from the 139 countries participating in GoPA!, we explored the associations among research, policy and surveillance categories. Overall, positive and significant Spearman correlations ($P < .001$) that were moderate in size were found between research and policy (rho = 0.35); research and surveillance (rho = 0.41) and surveillance and policy (rho = 0.31).

After stratifying by income level group, in high income countries (n = 66) positive and significant Spearman correlations that were weak to moderate in size were found between research and policy ($\rho = 0.27$; $P = .03$); research and surveillance ($\rho = 0.39$; $P < .001$) and surveillance and policy ($\rho = 0.25$; $P = .04$). In upper middle income countries (n = 37), 1 positive and significant weak to moderate correlation was found: research and surveillance ($\rho = 0.52$; $P < .001$); research and policy ($\rho = 0.23$; $P = .17$); and surveillance and policy ($\rho = 0.24$; $P = .15$). There were no statistically significant associations in lower middle (n = 27) and low (n = 9) income countries (data not presented). Although, the positive correlation between research and policy remained consistent in both groups (lower middle income $\rho = 0.18$ and low income $\rho = 0.19$).

Figure 1 shows the relationship between research and policy characteristics. It was seen that in those countries with no research (no publication in PubMed in 2013) the proportion of countries with no PA plan was the highest (48.5%). In contrast, in the countries in the 4th quartile of research, the number of countries with no PA plan was the lowest (12.1%), and the number of countries with a standalone PA plan was the highest (35.1%). In Figure 2, the association between surveillance and research is presented. Countries in the lowest research quartile were less likely to have 3 or more surveys (9.1%), whereas those in the highest research quartile were more likely to have 3 or more national surveys (51.5%). Finally, of the 37 countries with a standalone PA plan, only 1 had no surveillance. Of the 33 countries with 3 or more surveys, 18 (54.6%) had a standalone PA plan, versus a global proportion of only 26.6% (data not presented in tables or figures).

**Table 5 Topic of Physical Activity Research Publications by World Regions and Income Group Classification**

| | Number of articles meeting the inclusion criteria (n = 2173) | Study type classification | | | | | Contribution to the total (%) |
|---|---|---|---|---|---|---|---|
| | | Prevalence, measurement, & trends | Correlates & determinants | Health consequences | Interventions | Policy | |
| World region** (n, %) | | | | | | | |
| East Asia and Pacific | 441 | 151 (34.2%) | 128 (29.0%) | 64 (14.5%) | 91 (20.6%) | 7 (1.6%) | 17.2% |
| Europe and Central Asia*** | 882 | 273 (30.9%) | 259 (29.3%) | 166 (18.8%) | 134 (15.2%) | 50 (5.7%) | 41.4% |
| Latin America and the Caribbean | 149 | 58 (38.9%) | 40 (26.8%) | 22 (14.8%) | 27 (18.1%) | 2 (1.3%) | 5.3% |
| Middle East and North Africa | 31 | 6 (19.3%) | 18 (58.0%) | 4 (12.9%) | 3 (9.7%) | 0 (0.0%) | 1.6% |
| North America | 612 | 183 (29.9%) | 157 (25.6%) | 106 (17.3%) | 114 (18.6%) | 52 (8.5%) | 32.4% |
| South Asia | 28 | 13 (46.4%) | 8 (28.6%) | 1 (3.6%) | 5 (17.9%) | 1 (3.6%) | 1.6% |
| Sub-Saharan Africa | 30 | 13 (43.3%) | 10 (33.3%) | 2 (6.7%) | 2 (6.7%) | 3 (10.0%) | 1.0% |
| Income group** (n, %) | | | | | | | |
| High Income | 1817 | 578 (31.8%) | 503 (27.7%) | 305 (16.8%) | 326 (17.9%) | 105 (5.8%) | 87.6% |
| Upper middle income | 297 | 94 (31.6%) | 95 (32.0%) | 57 (19.2%) | 44 (14.8%) | 7 (2.4%) | 10.4% |
| Lower middle income | 46 | 19 (41.3%) | 17 (36.9%) | 2 (4.3%) | 6 (13.0%) | 2 (4.3%) | 2.1% |
| Low income | 13 | 6 (46.2%) | 5 (38.5%) | 1 (7.7%) | 0 (0.0%) | 1 (7.7%) | 0.4% |
| Total (n, %) | 2173 | 697 (32.1%) | 620 (28.5%) | 365 (16.8%) | 376 (17.3%) | 115 (5.3%) | 100% |

* PubMed search was conducted for the 217 world countries GoPA! list.

** Population, world region, and income group classifications according to the World Bank in 2013. United Kingdom was divided in its 4 countries (England, Scotland, Wales, and Northern Ireland).

*** PubMed search showed the same results for Denmark and Faeroe Islands. Therefore results were counted only once.

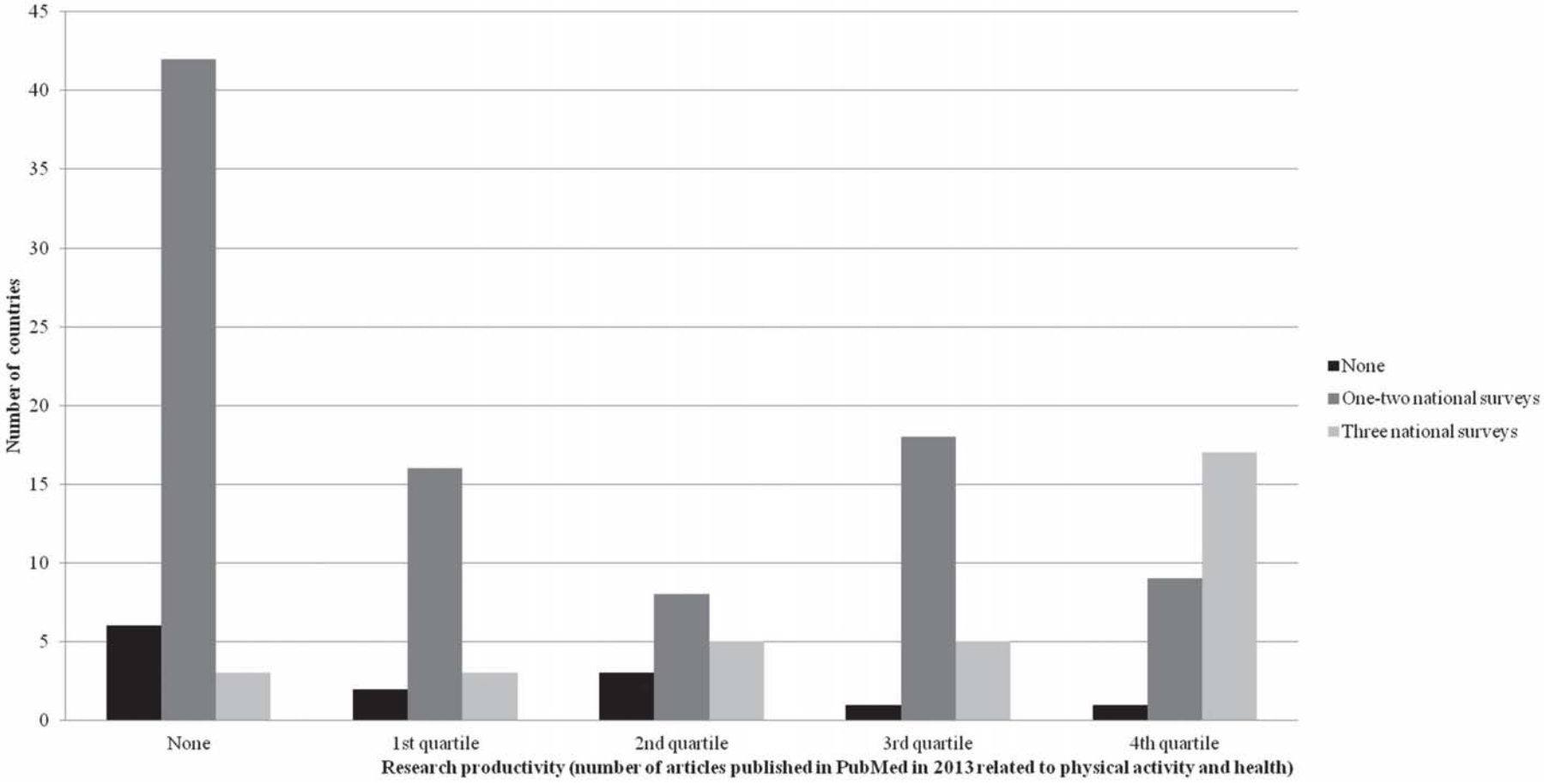


**Figure 2** — Physical activity surveillance characteristics and research productivity in 2013 by country.

## Discussion and Conclusions

GoPA! is the first observatory exclusively dedicated to monitoring and reporting on surveillance, policy, and research indicators related to PA worldwide and has completed data collection for 217 countries in it's first 2 years of operation.[7,18] The data collected by GoPA! is already being used to inform policy.[19]

In the context of health observatories worldwide, the WHO Global Health Observatory, is the largest observatory monitoring risk factors for NCDs. Its data has helped to inform health policy and priorities for tobacco, cardiovascular disease, cancer, diabetes, and air pollution.[20] Tobacco control is an example for which monitoring, has successfully contributed to improved global health.[20] Global prevalence of tobacco use has declined over the last 13 years; among the reasons are a strong tobacco control policy framework, global and multisectorial advocacy efforts, and effective use of global data bases. Important lessons from the tobacco control case relevant for PA include 1) acknowledging physical inactivity as a standalone health threat; 2) disseminating existing policy frameworks including the Toronto Charter for Physical Activity and the WHO Global Action Plan for the Prevention and Control of NCDs, 2013 to 2020; and 3) using existing data to inform policy.

Results must be interpreted acknowledging some limitations:

1. Information about 78 countries is not included. For 37 countries PA prevalence data exist but could not be confirmed by a country representative, and for 41 countries no data could be found. (Webtable 2 shows the comparison of general country characteristics between GoPA! and non-GoPA! members)
2. Policy included only the presence of a plan but not implementation
3. The publication search was restricted to PubMed which may have left out publications from other indices and in other languages
4. Complexity of defining and determining methods for measuring research productivity
5. The cross sectional design provides no information about trends or causal associations
6. Caution is needed when comparing national estimates of PA prevalence due to differences in the sampling frames and data sources.

Our findings indicate that PA surveillance systems, national plans and policies, and research efforts vary substantially by geographic area and by income group. Surveillance data gaps remain concentrated in Sub-Saharan Africa and low income countries as previously reported in the 2012 Lancet series.[21] There is more than a 50-fold difference in publications per 100 million population between high and low income countries, with less than 5% of the world's population living in the countries with the highest research productivity.

An encouraging finding is that PA surveillance, policy and research are positively and significantly correlated. When stratified by income group, associations were no longer significant in lower middle and low income countries, possibly due to the resulting small number of countries per group. The positive association between research and policy remained consistent in all groups.

Although further analyses to study the potential role of national income as an effect modifier of the associations between surveillance, policy and research are warranted, these results are an indication that enhancing any one of them may lead to improvements across the other dimensions. This suggests that action at multiple levels might be more efficient for national PA promotion and advocacy. One of the main strategies may be investing in capacity building for PA research for developing a strong public health response to the global pandemic of inactivity.[17,22,23]These findings are supported by recent literature showing that although complex there is an interplay between research and policy.[24,25]

In conclusion, GoPA! has responded to the global call to tackle the pandemic of physical inactivity by being exclusively dedicated to monitoring and reporting on indicators related to PA. GoPA! is not only a global open access repository, but also a knowledge translation platform that may stimulate progress from information to action. It has a great potential to guide public health and advocacy efforts to increase population levels of PA. Periodic reporting on country-level progress is expected to assist countries develop and implement programs to foster and facilitate PA and thereby, can be an important contributor to global health.

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# Worldwide use of the first set of physical activity Country Cards: The Global Observatory for Physical Activity - GoPA!

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## Abstract

**Background:** The work of The Global Observatory for Physical Activity-GoPA! is the first global effort to compile standardized country-level surveillance, policy and research data for physical activity in order to better understand how countries and regions address promoting physical activity. GoPA! developed standardized country-specific physical activity profiles ("Country Cards") to summarize country-level data through 2013. The aim of this study was to assess use of the Country Cards, identify the factors associated with their use, and develop recommendations for supporting country-level physical activity promotion.

**Methods:** Cross sectional internet-based survey conducted between August–October 2016. Target study participants were national physical activity leaders and advocates in academia, government and practice from the GoPA! countries, and members of the International Society of Physical Activity and Health. A Country Card use composite score was created based on the diversity and frequency of use. Statistical analyses on the associations between the composite score and respondent characteristics, country characteristics, barriers and opinions were conducted (including descriptive analyses and a logistic regression with robust standard errors).

**Results:** One hundred forty three participants from 68 countries completed the survey. Use of the Country Cards was associated with being part of the GoPA! network, knowing about the Country Cards, and on the stage of country capacity for physical activity promotion. Country Card knowledge varied by country income group, region and the country specific context. More diverse and frequent use of the cards (highest tertile of the composite score for use) was associated with: 1. Being a country contact vs general participant (OR 18.32–95% CI 5.63–59.55, $p = 0.002$), and 2. Collaborating with a government representative working in NCDs on a monthly or more frequent contact vs less frequent contact (OR 3.39–95% CI 1.00–11.54, $P < 0.05$).

**Conclusions:** For the Country Cards to have a broader impact, GoPA! will need to widen its reach beyond the academic sector. With further refinement of the cards, and training in their implementation, they could be an important tool for advancing country capacity for contextually-relevant strategies, actions and timelines for PA promotion.

**Keywords:** Global health, Process evaluation, Public health, Surveillance data methods

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## Background

In 2012, in response to the global pandemic of physical inactivity [1, 2] the Global Observatory for Physical Activity - GoPA! http://www.globalphysicalactivityobservatory.com/ [3] was created. At the time, information on the global picture of how well countries across the world were progressing on promoting physical activity was quite limited. Specifically, little standardized information was available on surveillance, policy and research on physical activity [4]. The work of GoPA! is the first attempt to compile standardized country-level data on surveillance, policy and research to better understand how countries and regions are faring in promoting physical activity [5–7]. GoPA! also aims to enhance evidence-informed decision making and to produce meaningful public health actions and policies worldwide to curb the inactivity pandemic. The first step towards fulfilling this goal was the development of standardized country-specific physical activity profiles ("Country Cards") to summarize country-level data up to 2013, and to provide comparable indicators for: demographics, physical activity prevalence, existence of physical activity surveillance systems, policy and research indicators.

Between 2014 and 2016, GoPA! gathered information for 217 countries. Among these, 139 (64%) countries had full, valid and approved (by a country contact) data for all indicators, covering 84% of the 2013 world population. The methods for creating this first standardized set of country cards, and the results by country for surveillance, research and policy indicators have been previously published [7]. These data are also summarized in the "1st Physical Activity Almanac" [3].

An important finding noted in these publications is a significant positive correlation between research productivity, regular surveillance, and standalone physical activity policy indicators [7], suggesting that progress in any of these three areas may stimulate progress in the other two [7]. Previous evidence supporting the importance of physical activity surveillance and policy indicators highlights the need for monitoring levels of physical activity in a country as a key first step in "making the case" for developing a national physical activity strategy and plan [5]. Translational research demonstrates the importance of research evidence for guiding optimal policy choices for population health [8–11].

The aforementioned evidence guided the development of a GoPA! conceptual model for country-level capacity for physical activity promotion, including periodic surveillance, implementation of physical activity policy, and research productivity as the three pillars (Fig. 1).

The aims of this study were to assess the use of the first set of GoPA! Country Cards and to identify the factors associated with their use. The results of this study will guide the development of future sets of Country Cards and future assessment of country-level progress towards reducing physical inactivity, as well as informing country-level physical activity promotion based on the first set of Country Cards.

## Methods

### Study design

This was a cross sectional internet-based survey conducted between August–October 2016. The target study participants were national physical activity leaders and advocates in academia, government and practice from the 139 GoPA! countries with complete Country Cards available by August 2016 (list of GoPA! country members in Additional file 1), members of the International Society of Physical Activity and Health, and subscribers to the GlobalPAnet E-Bulletin.

### Sampling, recruitment and data collection

ISPAH is a professional member-based society which aims to "promote physical activity as a global health priority through excellence in research, education, capacity building and advocacy" [12]. ISPAH supports a website and fortnightly E Bulletin called GlobalPAnet to share knowledge on physical activity related research, practice and policy. Both members and non-members of ISPAH can subscribe to GlobalPAnet. All GoPA! Country Contacts, ISPAH members, and GlobalPAnet subscribers were invited to participate in the study. GoPA! is an ISPAH Council, thus there was overlap between the GoPA!, ISPAH, and GlobalPAnet mailing lists. As GlobalPAnet was the largest mailing list, this was used to estimate the response rate of participants who were non-GoPA! Country Card contacts.

A questionnaire was sent via an electronic data collection system (online questionnaire using the Survey Monkey platform) and was emailed to the representatives of each of the 139 GoPA! countries with Country Cards available up to November 2016. A more general email was sent to the wider e-mail list (more than 1700 email addresses). During a two-month period, four reminders were sent using email and social media (Twitter and Facebook). No confidential, private, or sensitive information was collected and the survey was anonymous, therefore no signed informed consent was required. This study was approved by the Research Ethics Committee of the Faculty of Physical Education (n° 522.064) at the Federal University of Pelotas, Brazil. CAAE n° 67102116.0.0000.5313.

### Measures

The online survey was designed in May 2016 and included eight questions related to Country Card performance/implementation divided in three blocks: 1) Country Card use and frequency of use; 2) Country Card users and country characteristics; and, 3) Perceived barriers and

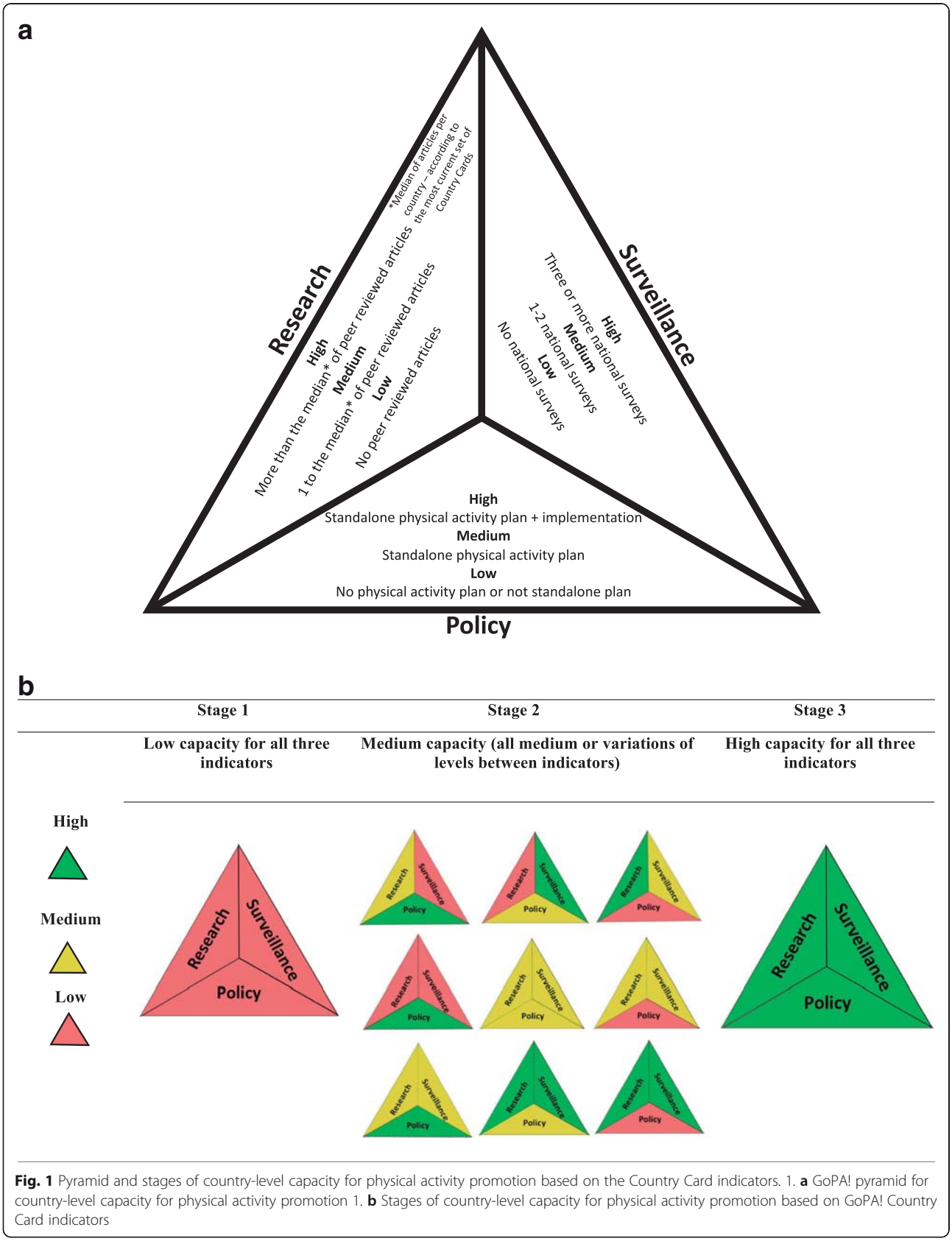


**Fig. 1** Pyramid and stages of country-level capacity for physical activity promotion based on the Country Card indicators. 1. **a** GoPA! pyramid for country-level capacity for physical activity promotion 1. **b** Stages of country-level capacity for physical activity promotion based on GoPA! Country Card indicators

opinions about the Country Cards. The survey was revised and approved by the GoPA! steering committee (http://www.globalphysicalactivityobservatory.com/) and the country contacts from the UK (experts in evaluation of physical activity public health programs) from June to July 2016.

### Country card use and frequency of use

Questions on the survey related to country card use included the following: 1-Presentation to different audiences (colleagues; students; academic societies; local, state or federal government; non-government representatives; or mass media representatives); 2-How the information was conveyed to these audiences (congresses; scientific events; in scientific publications; fund raising proposals; and policy briefs); and, 3-The motivation/rationale behind the communication with different audiences (to advocate for a national surveillance system or national physical activity plan). The frequency of communication with these audiences was defined as more frequent (at least once a month) or less frequent (less than once a month). A **Country Card composite use score** was created as the main dependent variable, with a maximum score of 48 that combined two aspects: 1- diversification of use (12 possible uses for the Country Card – 1 point for each use); and, 2- frequency of use ("never"-0 points, "less than monthly"-1 point, "approximately monthly"-2 points, "approximately weekly"-3 points and "daily or almost daily"-4 points). The score was divided into tertiles and a dichotomous variable was created (highest tertile of use vs lowest tertiles as the reference category).

### Country card users

The characteristics of the Country Card users included: 1-main area of work (academia, non-academia, local, state or federal government, non-government, other); 2-being a GoPA! Country representative; and, 3- interaction and frequency of contact (meetings, email or phone calls) with other sectors (physical activity researchers, government representatives, non-government representatives, and GoPA! country contacts).

### Country level characteristics

Country characteristics included: 1- Region classification according to the World Health Organization (EURO - European Regional Office of the World Health Organization; AFRO - African Regional Office of the World Health Organization; PAHO - Pan American Health Organization of the World Health Organization; EMRO - Eastern Mediterranean Regional Office of the World Health Organization; WPRO - Western Pacific Regional Office of the World Health Organization; SEARO - South-East Asia Regional Office of the World Health Organization); 2- Income level classification according to the World Bank; Country Card national indicators of deaths related to physical inactivity, surveillance, policy, research and physical activity prevalence estimates.

### Perceived barriers and opinions about the country cards

The extent of agreement or disagreement with potential barriers to Country Card use and feedback on the Country Cards was assessed. Barriers included: 1-presentation of already known information; 2-unclear purpose of the card; and 3-unclear on the recommended strategy to identify and reach relevant partners, decision makers and/or stakeholders. Feedback included: 1-the card was helpful for making the case for physical activity promotion and the feedback participants received about the Country Cards (open ended question). Finally, the respondent ranked the importance/relevance on a scale from 1 to 5 (5 being most important) of the indicators presented in the Country Cards (deaths related to physical inactivity, surveillance, policy, research and physical activity prevalence estimates) to describe the status of physical activity at the national level.

### Analyses

Country was the unit of analysis and the main outcome variable was the *Country Card use composite score* in the highest tertile vs lowest tertiles as reference categories. Statistical analyses were performed in STATA version 12.0. Descriptive analyses were conducted for the sample and the absolute and relative frequencies of dependent and independent variables were calculated.

Bivariate analyses were conducted on the associations between the Country Card use composite score in the highest tertile and respondent and country characteristics and barriers and opinions, using the heterogeneity chi-square test. Possible confounding variables were identified as those associated ($p < 0.20$) with both the exposure and at least one outcome variable, and were included in the final multivariate analytical models. A logistic regression with robust standard errors was used to obtain adjusted effect estimates (including confounding factors). The $p$-value for statistical significance was set at $< 0.05$ in the final model. Open-ended questions were reviewed by an expert in qualitative analyses.

## Results

During the two-month data collection period, 143 participants from 68 countries completed the survey (Table 1). Respondents included GoPA! country contacts (37.1%) and Global PA Network/ISPAH participants (who were not GoPA! country contacts) (62.9%). The GoPA! country contacts response rate was 38.1% (53/139). Additional file 1, shows GoPA! had 139 country members by November 2016. GlobalPANetwork /ISPAH member's response rate was 5.3% (90/1703).

**Table 1** Respondent characteristics

| | Total | | GoPA! Country Contacts | | ISPAH respondents (not GoPA! Country Contacts) | |
|---|---|---|---|---|---|---|
| | n[a] | % | n[a] | % | n[a] | % |
| Participation in the survey | 143 | 100.0 | 53 | 37.1 | 90 | 62.9 |
| Main area of work | | | | | | |
| Academia (universities, schools, societies or institutions) | 117 | 81.8 | 44 | 83.0 | 73 | 81.1 |
| Government | 13 | 9.1 | 3 | 5.7 | 10 | 11.1 |
| Other | 13 | 9.1 | 6 | 11.3 | 7 | 7.8 |
| Frequency of contact with: | | | | | | |
| Researchers by any of the three means (emails, meetings, phone calls) | | | | | | |
| Contact using any mean at least once a month | 119 | 83.2 | 44 | 83.0 | 75 | 83.3 |
| Contact using the three means less than once a month | 24 | 16.8 | 9 | 17.0 | 15 | 16.7 |
| Contact with government representatives working in physical activity promotion at any of the levels | | | | | | |
| Contact with any representative at least once a month | 66 | 46.2 | 32 | 60.4 | 34 | 37.8 |
| Contact with the representatives less than once a month | 77 | 53.9 | 21 | 39.6 | 56 | 62.2 |
| Contact with government representatives working in non-communicable diseases NCD's | | | | | | |
| Contact with any representative at least once a month | 56 | 60.8 | 28 | 52.8 | 28 | 31.1 |
| Contact with the representatives less than once a month | 87 | 39.2 | 25 | 47.2 | 62 | 68.9 |
| Non-government organization representatives working in physical activity promotion | | | | | | |
| More frequent (at least once a month) | 66 | 46.2 | 32 | 60.4 | 34 | 37.8 |
| Less frequent (less than once a month) | 77 | 53.9 | 21 | 39.6 | 56 | 62.2 |
| International organizations representatives working in physical activity promotion | | | | | | |
| More frequent (at least once a month) | 56 | 39.2 | 28 | 52.8 | 28 | 31.1 |
| Less frequent (less than once a month) | 87 | 60.8 | 25 | 47.2 | 62 | 68.9 |
| GoPA! Country Contacts | | | | | | |
| More frequent (at least once a month) | 34 | 23.9 | 21 | 39.6 | 13 | 14.6 |
| Less frequent (less than once a month) | 108 | 76.1 | 32 | 60.4 | 76 | 85.4 |
| World WHO region[b] | | | | | | |
| AFRO | 12 | 8.4 | 6 | 11. 3 | 6 | 6.7 |
| EMRO | 5 | 3.5 | 26 | 49.1 | 26 | 28.9 |
| EURO | 52 | 36.4 | 3 | 5.7 | 2 | 2.2 |
| PAHO | 43 | 30.1 | 11 | 20.8 | 32 | 35.6 |
| SEARO | 5 | 3.5 | 3 | 5.7 | 2 | 2.2 |
| WPRO | 26 | 18.2 | 4 | 7.6 | 22 | 24.4 |
| Country-level Income group | | | | | | |
| High Income | 97 | 67.8 | 32 | 60.4 | 65 | 72.2 |
| Upper Middle Income | 30 | 21.0 | 11 | 20.8 | 19 | 21.1 |
| Lower Middle Income | 10 | 7.0 | 7 | 13.2 | 3 | 3.3 |
| Low Income | 6 | 4.2 | 3 | 5.7 | 3 | 3.3 |

[a]n does not add to total value of 143 due to missing data
[b]EURO - European Regional Office of the World Health Organization; AFRO - African Regional Office of the World Health Organization; PAHO - Pan American Health Organization of the World Health Organization; EMRO - Eastern Mediterranean Regional Office of the World Health Organization; WPRO - Western Pacific Regional Office of the World Health Organization; SEARO - South-East Asia Regional Office of the World Health Organization

### Participant characteristics

Survey respondents were mostly from EURO (36.4%) and PAHO (30.1%) followed by Western Pacific (WPRO) (18.2%), Africa (AFRO) (8.4%), Eastern Mediterranean (EMRO) (3.5%) and, South East Asia (SEARO) (3.5%). The majority of participants were from high- and upper middle-income countries (89%) (Table 1 Most of the participants reported that they worked in academia (81.8%); and most frequently had contact (monthly or more often) with physical activity researchers by email (84.2%) (Table 2).

**Table 2** Country Cards uses referred by respondents

| | Total | | GoPA! Country Contacts | | ISPAH respondents (that are not GoPA! Country Contacts) | |
|---|---|---|---|---|---|---|
| | n[a] | % | n[a] | % | n[a] | % |
| Use of the card (any of the 12 possible uses) | | | | | | |
| One or more uses (mean & SD)[b] | 143 | 6.4 (4.3) | 53 | 8.9 (4.4) | 90 | 4.8 (3.4) |
| Never (mean & SD)[b] | | 7.5 (4.3) | | 4.6 (4.1) | | 9.2 (3.4) |
| Showed/ described/explained the Country Cards to colleagues (Use 1) | | | | | | |
| More frequent (at least once a month) | 39 | 27.3 | 25 | 47.2 | 14 | 15.6 |
| Less frequent (less than once a month) | 104 | 72.7 | 28 | 52.8 | 76 | 84.4 |
| Showed/ described/explained the Country Cards to academic societies representatives working in non-communicable diseases NCD prevention and physical activity promotion (Use 2) | | | | | | |
| More frequent (at least once a month) | 27 | 19.0 | 18 | 34.0 | 9 | 10.1 |
| Less frequent (less than once a month) | 115 | 81.0 | 35 | 66.0 | 80 | 89.9 |
| Showed/ described/explained the Country Cards to non-government organizations representatives (Use 3) | | | | | | |
| More frequent (at least once a month) | 16 | 11.2 | 12 | 22.6 | 4 | 4.4 |
| Less frequent (less than once a month) | 127 | 88.8 | 41 | 77.4 | 86 | 95.6 |
| Showed/ described/explained the Country Cards to mass media representatives (Use 4) | | | | | | |
| More frequent (at least once a month) | 11 | 7.7 | 9 | 17.0 | 2 | 2.2 |
| Less frequent (less than once a month) | 132 | 92.3 | 44 | 83.0 | 88 | 97.8 |
| Showed/ described/explained the Country Cards to students (Use 5) | | | | | | |
| More frequent (at least once a month) | 30 | 21.0 | 21 | 39.6 | 9 | 10.0 |
| Less frequent (less than once a month) | 113 | 79.0 | 32 | 60.4 | 81 | 90.0 |
| Showed/ described/explained the Country Cards in congresses or scientific events (Use 6) | | | | | | |
| More frequent (at least once a month) | 9 | 6. 3 | 7 | 13. 2 | 2 | 2. 2 |
| Less frequent (less than once a month) | 134 | 93. 7 | 46 | 86. 8 | 88 | 97.8 |
| Included/described/explained the Country Cards in a scientific publication (Use 7) | | | | | | |
| More frequent (at least once a month) | 14 | 9.9 | 11 | 21.6 | 3 | 3.3 |
| Less frequent (less than once a month) | 127 | 90.1 | 40 | 78.4 | 87 | 96.7 |
| Included/described/explained the Country Cards as part of a fund raising proposal (Use 8) | | | | | | |
| More frequent (at least once a month) | 4 | 2.8 | 4 | 7.7 | 0 | 0.0 |
| Less frequent (less than once a month) | 137 | 17.7 | 48 | 28.9 | 89 | 100.0 |
| Included/described/explained the Country Cards in a policy brief (Use 9) | | | | | | |
| More frequent (at least once a month) | 7 | 4.9 | 7 | 13.5 | 0 | 0.0 |
| Less frequent (less than once a month) | 135 | 95.1 | 45 | 86.5 | 90 | 100.0 |
| Presented/described/used the data presented in the Country Cards to advocate for a national surveillance system (Use 10) | | | | | | |
| More frequent (at least once a month) | 8 | 5.6 | 8 | 15.0 | 0 | 0.0 |
| Less frequent (less than once a month) | 135 | 94.4 | 45 | 84.9 | 90 | 100.0 |
| Presented/described/used the data presented in the Country Cards to advocate for a national physical activity plan (Use 11) | | | | | | |
| More frequent (at least once a month) | 15 | 10. 5 | 14 | 26.4 | 1 | 1.1 |
| Less frequent (less than once a month) | 128 | 89.5 | 39 | 73.6 | 89 | 98.9 |

**Table 2** Country Cards uses referred by respondents *(Continued)*

| | Total | | GoPA! Country Contacts | | ISPAH respondents (that are not GoPA! Country Contacts) | |
|---|---|---|---|---|---|---|
| | n[a] | % | n[a] | % | n[a] | % |
| Showed/ described/explained the Country Cards to government representatives at any level (local, state, federal) (Use 12) | | | | | | |
| More frequent (at least once a month) | 12 | 8.5 | 10 | 19.2 | 2 | 2.2 |
| Less frequent (less than once a month) | 130 | 91.6 | 42 | 80.8 | 88 | 97.8 |

[a]n does not add to total value of 143 due to missing data
[b]Mean and standard deviation

### Country card diversification of use

There was a broad range of knowledge and use of the Country Cards among the survey respondents. The mean number of ways in which the card was used was 6.4 (SD 4.3) out of the 12 possibilities. Country contacts had a mean number of uses of 8.9 (SD 4.4) and non-Country card contacts a mean of 4.8 uses (SD 3.4). When analyzing mean use by region, PAHO was the region with the highest mean total use (total 7.1 (SD 4.3), followed by EMRO (total 7.0, SD 5.8), EURO (total 6.6, SD 4.4), SEARO (total 5.6, SD 5.6), WPRO (total 5.3, SD 3.9), and AFRO (total 5.3, SD 3.4). In all regions, Country Card use was greater among country contacts than non-Country Card contacts. The ways in which the Country Cards were disseminated ranged from making a reference to the Country Cards within doctoral theses to discussing the results with the Ministry of Health.

### Country card frequency of use

The cards were most frequently shown (on a monthly or more often basis) to colleagues (27.3%), students (21.0%), academics in non-communicable disease (NCD) prevention and/or physical activity promotion (19.0%), and government representatives at the state level (17.7%). Country Cards were most often (at least once) presented in scientific events (37.8%) or included in scientific publications (30.5%), policy briefs (28.8%) or fund raising proposals (20.6%). Approximately one third of the participants (31.5%) used the Country Card to advocate for physical activity surveillance and policy at the national level (Table 2).

### Factors associated with country card composite use score

The following characteristics were significantly ($p < 0.05$) associated with *Country Card composite use score* in the bivariate analysis: 1- positive associations with country contact status; having contact with researchers, government representatives at local, state and federal levels and representatives from international organizations; and, Country Cards indicators of policy, surveillance and research. Negative associations were found with the barriers to Country Cards use.

In the adjusted model, the use of the Country Card in the highest tertile of the composite score was positively and significantly associated with: being a country contact vs non-country contact (OR 18.32–95% CI 5.63–59.55, $p = 0.002$); A monthly or more frequent contact with a government representative working in NCDs vs less frequent contact (OR 3.39–95% CI 1.00–11.54, $P < 0.05$). Agreeing that the card was useful for making the case for physical activity was positively and significantly associated with composite use scores in the highest tertile when compared to the users who thought it was not useful (OR 32. 5–95% CI 5.22–202.21, $P < 0.001$). Table 3 presents the factors associated with the Country Card composite use score according to respondent characteristics.

### Perceived barriers and opinions about the country cards

Perceived barriers to further use of the Country Cards are listed in Table 4. The most frequently reported barrier to Country Card use was that respondents did not know how to identify partners, decision makers or stakeholders (16.4%), followed by the lack of knowledge of what to do with the Country Card (15.1%).

When analyzing barriers by region, respondents from EURO (57.0%) most frequently agreed that the information presented in the cards was already known followed by WPRO (38.5%), PAHO (33.0%), EMRO (25.0%) SEARO (20.0%) and, AFRO (18.2%). More than 50% of respondents from SEARO (80.0%) and WPRO (73.1%) agreed on a lack of knowledge of what to do with the card, followed by PAHO (42.9%), EURO (41.2%), AFRO (36.4%) and EMRO (25.0%). Also, respondents in SEARO (80.0%) predominantly agreed with not having strategies or knowledge to reach partners/decision makers or stakeholders, followed by EMRO (66.7%), WPRO (61.5%), AFRO (50.0%), EURO (48.1%) and PAHO (40.5%).

The open-ended responses provided insights into some of the barriers to Country Card use and varying opinions by region. For example, participants from the EURO region noted: *"The value of the Country Card (…) is limited because we have a very good information system in place, thus makes the added value of the card limited. However, it is of use in comparing my country*

*with other countries".* Respondents from high-income countries (mainly the EURO region) with established physical activity programs policies and with strong physical activity research and surveillance perceived that much of the information was already known and thus the Country Cards were viewed as less useful. A government representative questioned the data collection methods. *"The number of researchers in a country, publishing in the field of physical activity cannot be determined if publications in the local language are not considered".* It was also noted that physical activity data provided on the Country Cards was not as relevant to the country. *"In my opinion, the physical activity data does not reflect the situation of our country. The official data on national physical activity is provided by our institution since 1984". In order to reach high-level officials within each country it was suggested by one respondent that "the Country Cards should be disseminated in collaboration with the WHO".*

However, opportunities for their use in advocacy for physical activity promotion were noted. *"We prepared a document on how to run a physical activity surveillance system (…). The Country Card was a good argument that surveillance is needed". "I have primarily used it as an example of a good advocacy tool aimed at politicians and lay people/media". "The main problem with answering these questions is that there are hardly any officials or professionals (except for those in the WHO country office) who are deemed in charge of physical activity related issues or NCDs in general".*

In contrast, one respondent from AFRO reported that people were surprised to see the scarcity of national data on physical activity and the lack of research teams within the country. Another African respondent expressed disappointment that their country does not have data on the Country Card and this was thought to reflect the need for more research in the country around physical activity promotion *"My country still lacks Country Card details and this is really disappointing and I think a lot of research and publication needs to be done regarding Physical Activity promotion". "There was a very good reception and interest, hard copies were distributed at the National Health Conference (2015) and discussed with the Ministry of Sports and Culture Physical Activity Unit (…) as well as verbally in meetings at the Faculty of Health Science". "In general, the data regarding physical activity and health (…) create interest to those who see the data".*

In two PAHO countries, GoPA! was identified as a critical factor for maintaining national physical activity surveillance efforts. In a country that was considering removing the physical activity module: *"The GoPA! Country Card was very useful in keeping the Global Physical Activity Questionnaire (GPAQ) in the National Health survey 2016–17".*

Reactions from the WPRO Region highlighted the needs for both more accurate information and advocacy. *"Interest was shown by colleagues in academia, recognizing the requirement that surveillance systems use a standardized, validated assessment tool repeatedly and according to consistent protocols". "The Country Cards have been used to advocate for physical activity". "The Country Cards have been part of our advocacy of physical activity to the State Sports Administration (Ministry level)".*

Respondents reported that a ranking of countries on physical activity prevalence would be a useful addition to the cards. One respondent pointed out the challenges in comparing nations due to the varied surveillance systems, but that the Country Cards help make the case for utilizing standardized measurers. Another suggestion was that the Country Cards should contain more detail on the initiatives to promote physical activity within each country.

Participants ranked (with 1 being not important at all and 5 being the most important) the physical activity policy indicator (weighted average 3.78) as most important for describing the physical activity status at the national level, followed by deaths due to physical inactivity (weighted average 3.73), national surveillance (weighted average 3.64), physical activity prevalence (weighted average 3.58) and research (weighted average 3.57).

## Discussion

To our knowledge, this is the first study evaluating the use of a standardized surveillance and advocacy tool such as the GoPA! Country Cards for global physical activity promotion. Key findings indicated that: 1. Being a country representative working in academia and reporting collaboration with a government representative working in NCDs were factors associated with more diverse and frequent use of the Country Cards; 2. The perception of the relevance and usefulness of the Country Cards was greater in low- and middle-income countries than in high-income countries; 3. Country Cards were used in at least half of their possible applications, and specific uses of Country Cards varied by World Bank income group, world region and country-level capacity for physical activity promotion; and, 4. We identified gaps in knowledge and use of Country Cards, providing important information for guiding actions to optimize physical activity promotion, surveillance and research efforts at the national, regional, and global levels.

The fact that GoPA! country representatives were the main users of the Country Cards highlights the importance of engaging local actors from the early stages of the development process of standardized global surveillance initiatives such as GoPA!. Early engagement with the end-users of this advocacy tool appears to have led to a greater familiarity, understanding and use of the Country Cards for physical activity promotion. Among users

**Table 3** Factors associated with the Country Card composite score use in the highest tertile according to respondent's characteristics

| Adjusted model (Highest tertile of use vs lowest tertiles of use)[a] | | | | | | |
|---|---|---|---|---|---|---|
| | n | % | OR (95% CI)[a] | | | *p*-value |
| Main area of work | | | | | | |
| Academia (universities, schools, societies or institutions) | 40 | 85.1 | 1.00 | | | 0.283 |
| Government | 2 | 4.3 | 0.34 | 0.04 | 3.22 | |
| Other | 5 | 10.6 | 4.82 | 0.87 | 26.71 | |
| Country Contact | | | | | | |
| Yes | 36 | 76.6 | 18.32 | 5.63 | 59.55 | 0.002 |
| No | 11 | 23.4 | 1.00 | | | |
| Contact with researchers by any of the three means (emails, meetings, phone calls) | | | | | | |
| Contact using any mean at least once a month | 33 | 70.2 | 1.29 | 0.41 | 4.08 | 0.658 |
| Contact using the three means less than once a month | 14 | 29.8 | 1.00 | | | |
| Contact with government representatives working in physical activity promotion at any of the levels | | | | | | |
| Contact with any representative at least once a month | 43 | 91.5 | 1.47 | 0.33 | 6.66 | 0.612 |
| Contact with the representatives less than once a month | 4 | 8.5 | 1.00 | | | |
| Contact with government representatives working in NCD's | | | | | | |
| Contact with any representative at least once a month | 29 | 61.7 | 3.39 | 1.00 | 11.54 | 0.050 |
| Contact with the representatives less than once a month | 18 | 38.3 | 1.00 | | | |
| Contact with non-government organization representatives working in physical activity promotion | | | | | | |
| More frequent (at least once a month) | 22 | 46.8 | 0.57 | 0.17 | 1.91 | 0.367 |
| Less frequent (less than once a month) | 25 | 53.2 | 1.00 | | | |
| Contact with international organizations representatives working in physical activity promotion | | | | | | |
| More frequent (at least once a month) | 23 | 48.9 | 3.35 | 0.77 | 14.58 | 0.107 |
| Less frequent (less than once a month) | 24 | 51.1 | 1.00 | | | |
| Contact with GoPA! Country Contacts | | | | | | |
| More frequent (at least once a month) | 21 | 44.7 | 2.47 | 0.64 | 9.55 | 0.190 |
| Less frequent (less than once a month) | 26 | 55.3 | 1.00 | | | |
| Country Cards provide information that is already known | | | | | | |
| Agree and partially agree | 15 | 31.9 | 0.33 | 0.09 | 1.17 | 0.086 |
| Disagree | 32 | 68.1 | 1.00 | | | |
| I do not know what I am supposed to do with the Country Card | | | | | | |
| Agree and partially agree | 15 | 31.9 | 0.62 | 0.20 | 1.92 | 0.406 |
| Disagree | 32 | 68.1 | 1.00 | | | |
| I do not know any strategy or how can I identify/reach partners/decision makers/stakeholders | | | | | | |
| Agree and partially agree | 17 | 37.0 | 0.74 | 0.23 | 2.35 | 0.613 |
| Disagree | 29 | 63.0 | 1.00 | | | |
| The Country Card was useful and helped me making the case for physical activity promotion in my country | | | | | | |
| Yes | 45 | 95.7 | 32.49 | 5.22 | 202.21 | < 0.001 |
| No | 2 | 4.3 | 1.00 | | | |
| Country card completion | | | | | | |
| Yes (all 5 indicators presented in the card) | 32 | 37.2 | 1.49 | 0.46 | 4.77 | 0.178 |
| No | 15 | 26.3 | 1.00 | | | |
| Country card indicators | | | | | | |
| National physical activity policy | | | | | | |

**Table 3** Factors associated with the Country Card composite score use in the highest tertile according to respondent's characteristics *(Continued)*

| Adjusted model (Highest tertile of use vs lowest tertiles of use)[a] | | | | | | |
|---|---|---|---|---|---|---|
| | n | % | OR (95% CI)[a] | | | *p*-value |
| Standalone policy for physical activity | 25 | 53.2 | 2.72 | 0.82 | 9.04 | |
| No standalone policy for physical activity | 22 | 46.8 | 1.00 | | | 0.103 |
| Physical activity surveillance | | | | | | |
| Surveillance (at least one national survey including physical activity) | 44 | 93.6 | 1.48 | 0.14 | 15.85 | 0.748 |
| No surveillance (no national survey including physical activity) | 3 | 6.4 | 1.00 | | | |
| Research in physical activity | | | | | | |
| Research in physical activity (at least one publication in 2013) | 41 | 87.2 | 2.83 | 0.47 | 19.19 | |
| No research (no publications in 2013) | 6 | 12.8 | 1.00 | | | 0.287 |
| Deaths due to physical inactivity | | | | | | |
| Equal or more than the worldwide mean of deaths (9%) | 27 | 57.5 | 2.16 | 0.41 | 11.26 | 0.738 |
| Less than the worldwide mean of deaths (9%) | 12 | 25.5 | 1.28 | 0.19 | 8.71 | |
| No indicator | 8 | 17.0 | 1.00 | | | |
| Physical activity prevalence | | | | | | |
| Has a national estimate | 44 | 93.6 | 0.79 | 0.93 | 6.73 | |
| Does not have a national estimate | 3 | 6.4 | 1.00 | | | 0.829 |
| World region[b] | | | | | | |
| AFRO | 3 | 6.4 | 0.15 | 0.06 | 3.85 | 0.030 |
| EMRO | 2 | 4.3 | 0.41 | 0.02 | 10.28 | |
| EURO | 19 | 40.4 | 1.00 | | | |
| PAHO | 17 | 36.2 | 4.77 | 0.84 | 27.03 | |
| SEARO | 2 | 4.3 | 11.98 | 1.64 | 87.37 | |
| WPRO | 4 | 8.5 | 1.48 | 0.30 | 7.44 | |
| Income group | | | | | | |
| High Income | 29 | 61.7 | 1.00 | | | |
| Upper Middle Income | 12 | 25.5 | 0.73 | 0.01 | 39.08 | 0.940 |
| Lower Middle Income | 5 | 10.6 | 1.54 | 0.17 | 14.42 | |
| Low Income | 1 | 2.1 | 0.80 | 0.17 | 3.71 | |

[a]Adjusted by statistically significant variables in the unadjusted model (country contact status, contact with representatives (government, NGOs, International organizations, country contacts) opinions and barriers to country card use, and national policy indicator)
[b]EURO - European Regional Office of the World Health Organization; AFRO - African Regional Office of the World Health Organization; PAHO - Pan American Health Organization of the World Health Organization; EMRO - Eastern Mediterranean Regional Office of the World Health Organization; WPRO - Western Pacific Regional Office of the World Health Organization; SEARO - South-East Asia Regional Office of the World Health Organization

reporting frequent and/or diverse use of GoPA! Country Cards, a substantial proportion had an academic background. In fact, one of the most common ways in which Country Cards were reported to be used was for the development of academic products (peer-reviewed research articles, research proposals, presentations at scientific conferences, and doctoral dissertations). This is not surprising, since GoPA! Country Cards are an evidence-based promotion and advocacy tool likely to appeal especially to academics.

The most positive perceptions of the relevance and usefulness of the Country Cards was reported by users from low- and middle income countries. This is an important finding, as the majority of the world's population lives in these countries with a high NCD burden. These settings also tend to have low capacity for physical activity research and surveillance relative to high-income settings. Our results suggest that it is precisely in these settings with high need and low capacity where GoPA!'s Country Cards have the greatest potential for positively influencing physical activity promotion and policy [13]. These countries may benefit from new sets of Country Cards to assist in the evaluation of surveillance, research and promotion efforts in coming years. On the other hand, for high-income countries with a higher baseline level of research and surveillance capacity in this field, GoPA! Country

**Table 4** Country Cards barriers for use, opinions and suggested periodicity

| | Total | | GoPA! Country Contacts | | ISPAH respondents (not GoPA! Country Contacts) | |
|---|---|---|---|---|---|---|
| | n | % | n[a] | % | n | % |
| Barriers to the use and dissemination of the Country Cards | | | | | | |
| Country Cards provide information that is already known | | | | | | |
| Agree and partially agree | 15 | 15.5 | 7 | 19.4 | 8 | 13.1 |
| Disagree | 82 | 84.5 | 29 | 80.6 | 53 | 86.9 |
| I do not know what I am supposed to do with the Country Card | | | | | | |
| Agree and partially agree | 21 | 22.6 | 1 | 3. 2 | 20 | 32. 3 |
| Disagree | 72 | 77.4 | 30 | 96.8 | 42 | 67.7 |
| I do not know any strategy or how can I identify/reach partners/decision makers/stakeholders | | | | | | |
| Agree and partially agree | 23 | 24.7 | 6 | 17.6 | 17 | 28.8 |
| Disagree | 70 | 75.3 | 28 | 82.4 | 42 | 71.2 |
| Opinions about the Country Card | | | | | | |
| The Country Card provided new information and aroused interest | | | | | | |
| Always | 7 | 13.2 | 7 | 13.2 | – | – |
| Frequently | 41 | 77.4 | 41 | 77.4 | – | – |
| Never | 5 | 9.4 | 5 | 9.4 | – | – |
| The Country Card was useful and helped me making the case for physical activity promotion in my country | | | | | | |
| Always | 19 | 14.7 | 12 | 22.6 | 7 | 9. 2 |
| Frequently | 77 | 59.7 | 32 | 60.4 | 45 | 59.2 |
| Never | 33 | 25.6 | 9 | 17.0 | 24 | 31.6 |

[a]n does not add to total value of 143 due to missing data

Cards may represent a useful tool to complement or optimize existing efforts.

The fact that Country Cards were used in at least half of their possible applications varying by income group, region and country-level capacity for physical activity promotion may be due to the short time between the launch of the Country Cards and survey data collection, which may not have provided sufficient time for full uptake and use of the cards. Also, country contacts came from variable sectors, thus differences in knowledge and use of the country cards may not reflect differences in the countries, but differences in the respondent's situation and perspective.

Up to this point, the GoPA! Country Cards appear to be providing the evidence and messaging for the first (why) and the second (what) steps in the three step model of advocacy for physical activity promotion [14]. Targeted efforts such as the GoPA! pyramid and stages of country-level capacity (Fig. 1) and, the recommended activities for physical activity promotion based on the Country Card indicators (Table 5), are now available and could help optimize use of the cards for the third step of advocacy "HO*W*/WHO" allowing policy makers and government representatives to get involved, plan a strategy and improve national capacity for physical activity promotion.

Finally, gaps in knowledge about the content, potential uses, and ways to distribute and promote and the Country Cards were identified as critical challenges which must be addressed to guide further actions with the Country Cards. The data sources for the indicators included in the Country Cards (described in the Country Card appendix and GoPA! website) were not always well-known to the respondents. A possible explanation for this could be the limited dissemination of the Country Cards outside of the GoPA! network. Some respondents that were familiar with the WHO Country Fact Sheets and with the WHO Global Health Observatory [15] were confused by the discrepancies between the prevalence of physical activity reported by the WHO Global Health Observatory and that of GoPA!. While WHO presents the prevalence of physical inactivity using the last edition of the WHO STEPS surveillance survey, GoPA! Country Cards use the most recent prevalence of physical activity available from either the national surveillance system of each country, or by recalculating the data from the WHO Global Health Observatory to obtain the prevalence of meeting international physical activity recommendations [15]. GoPA!'s use of the most recent and best available country-level data means that there will occasionally be differences from the WHO data bases [1].

Although many respondents reported that the Country Cards provided a succinct approach to presenting the global perspective of physical activity to various audiences, lack of skills to effectively use the Country Cards

**Table 5** Steps to achieve high country-level capacity for physical activity promotion according to country stage based on the GoPA! pyramid for country-level capacity (Fig. 1)

| | Stage 1 | Stage 2 | Stage 3 |
|---|---|---|---|
| Activities recommended according to the stages of country-level capacity for physical activity promotion based on GoPA! Country Card indicators (Fig. 1b) (Activities are listed in hierarchical order) | | | |
| Country Contacts | 1. Estimate the magnitude of the problem.<br>2. Identify and support research groups.<br>3. Report the magnitude of the problem, and identify groups and regions at higher risk.<br>4. Use surveillance and research data to make the case for a stand-alone national physical activity policy document.<br>5. Use the GoPA! Country Card to encourage strategic partners to start building the pyramid for country-level capacity.<br>6. Use the GoPA! "1st Physical Activity Almanac" to identify a) other stage 1 countries, and b) stage 2 and 3 countries – connect with them to problem-solve and develop strategies for pyramid improvement.<br>7. Strengthen regional capacity by reaching out to geographic neighbors.<br>8. Set a realistic timeline, with specific objectives.<br>9. Contact policy makers and researchers to disseminate the Country Card and encourage specific actions. | 1. Maintain the indicators that were identified as high.<br>2. Improve the indicators that were set as medium and low and address specific gaps.<br>3. Address dissemination gaps.<br>4. Approach policy makers with the Country Card to make the case for HEPA promotion and to strengthen local capacity.<br>5. Support countries in Stage 1.<br>6. Contact policy makers and researchers at the country level to disseminate the Country Card and encourage specific actions. | 1. Maintain and scale up the pyramid.<br>2. Identify and address dissemination gaps.<br>3. Focus on an integrated and multidisciplinary collaboration to translate research into policy and to scale up interventions that can lead to equity, social justice.<br>4. Approach policy makers with the Country Card and continue making the case for physical activity promotion to sustain and expand local capacity.<br>5. Set more ambitious goals and concrete timelines to achieve them to strengthen the pyramid.<br>6. Support countries in stages 1 and 2 by sharing experiences in developing and maintaining the pyramid.<br>7. Contact policy makers and researchers at the country level to disseminate the Country Card and encourage specific actions. |
| Government and policy | 1. Support the creation of a national physical activity surveillance system through legislative and budgetary actions.<br>2. Stimulate national physical activity research: provide funds/incentives for physical activity training programs and capacity building.<br>3. Clearly outline political commitment to and resources for physical activity, establish multi-sectoral approaches.<br>4. Review financial and other resources available to implement and monitor appropriate PA policies.<br>5. Engage in fund raising for physical activity policy implementation. | 1. Cooperate with ministries across multiple sectors.<br>2. Initiate a collective meeting with governmental representatives from the transport, housing, health, infrastructure, urban design, planning, environment, sports and recreation and education sectors and present the Country Card as an evidence-based physical activity resource.<br>3. Ensure availability of financial and other resources to implement and monitor appropriate physical activity policies. | 1. Discuss and arrange the implementation of actions geared at sustaining, strengthening, and scaling-up the three pillars, at national, regional and local level.<br>2. Maintain and expand financial commitment to implement and monitor physical activity policies.<br>3. Strive for equity, by reducing social and health inequalities of access to opportunities for physical activity. |
| Researchers | 1. Critically evaluate the data sources for your Country Card and update as needed.<br>2. Identify any local capacity to start high-quality physical activity research.<br>3. Raise awareness and present the Country Cards to colleagues and students, stressing the gaps identified and the potential to drive a new field of work nationally.<br>4. Bring attention to GoPA! through dissemination using existing networks. | 1. Build physical activity capacity and support further training in research, practice, policy, evaluation and surveillance.<br>2. Identify any existing networks, or start one (if necessary). Promote collaboration across research groups with physical activity capacity in the country.<br>3. Bring attention to GoPA! through dissemination using existing networks. | 1. Produce research linking GoPA! to the needs, actions and goals of primary health care, transport, housing, health, infrastructure, urban design, and education sectors.<br>2. Use key supplemental resources to stress the health benefits of physical activity (Lancet Physical Activity series, Bangkok Declaration, Global Action Plan for Physical Activity), and to guide new research. |

as an advocacy tool was identified as a critical barrier for their widespread use. In response, we have identified a sequence steps for countries to achieve high capacity for physical activity promotion, depending on the current stage of each country (see the GoPA! pyramid for country-level capacity in Fig. 1, and steps for increasing capacity in Table 5). Table 5 includes activities for optimizing the use of the Country Cards by countries. We believe that this resource can accelerate the process of increasing country-level capacity for physical activity promotion. Further steps to reduce knowledge gaps should include targeted training efforts to maximize Country Card use, particularly in low- and middle-income countries. These efforts should include strategic dissemination methods and the development and use of additional supporting materials, some of which are available on the GoPA! website [7].

### Limitations

Results should be interpreted with caution given the following limitations. The cross sectional nature of the study limits the ability to establish causality and, it may be possible that associations are due to chance given that the analyses were conducted using a relatively small sample. The generalizability of the results may be diminished by the low response rate and variability by geographic region. The low survey response rate may be due to the short time that the survey was open for response (two months). Previous studies have shown similar or lower response rates for internet-based surveys, especially as compared to traditional survey methods. This is thought to be due to differences in the use of incentives, mode of contact, varying internet access, and the number of contact attempts [16].

## Conclusion

Our study demonstrated that the relevance and usefulness of GoPA! Country Cards was associated with being part of the GoPA! network, knowing about the GoPA! Country Cards, living in low- and middle-income countries, and on the stage of country capacity for physical activity promotion. GoPA's Country Cards may prove to be a critical strategy for tipping the scale in favor of PA promotion, research and surveillance strategies in these countries (LMICs) where historically the recognition of inactivity as a public health problem, as well as the available local capacity to study it, measure it, and promote it, have been quite limited. For the Country Cards to have a broader impact on physical activity promotion and NCD prevention, GoPA! will need to widen its reach beyond the academic sector and target countries with limited capacity for physical activity promotion. Further refinement of the cards and training in their use can be an important tool for advancing country capacity for contextually-relevant strategies, actions and timelines for PA promotion. As a council of the International Society of Physical Activity and Health (ISPAH), GoPA! supports existing global efforts such as the Toronto Charter for Physical Activity and The Bangkok Declaration for Physical Activity [17, 18] and is contributing to the WHO Global Action Plan for Physical Activity -GAPPA [4] to facilitate coherent global efforts for increasing physical activity promotion and advocacy.

## Additional file

**Additional file 1:** List of 139 GoPA! members by August 2016 (in bold the new GoPA! members up to September 2017 for a total of 144 GoPA! members). (DOCX 16 kb)

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#### Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

#### Authors' contributions

AR, PH proposed the initial hypothesis and idea for study. AR, DS, KM, KS wrote the first draft of the report. AR conducted the statistical analyses. AR, DS, MP and AB developed the GoPA! conceptual model of pillars and stages of country-level capacity for physical activity promotion based on the Country Card indicators. KM reviewed the open ended questions. AR, DS, MP, KM, KS, AB, IL, GH, BK, CF, KP, PH reviewed this report, provided feedback on drafts, and approved the final version.

#### Ethics approval and consent to participate

The Global Observatory for Physical Activity - GoPA! project is approved by the Research Ethics Committee of the Faculty of Physical Education (n° 522.064) at the Federal University of Pelotas, Brazil. CAAE n° 67102116.0.0000.5313.

#### Consent for publication

Not applicable.

#### Competing interests

The authors declare that they have no competing interests.

## Publisher's Note



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**Original article 3**

**Physical activity and health research monitoring:**

**The Global Observatory for Physical Activity- GoPA! global, regional, and national trends and patterns since 1950**

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**Abstract**

**Background:** National, regional and global scientific production and research capacity in the area of physical activity have been identified as strategies for improving public health policies and programs for physical activity. Unequal distribution of research productivity by world region and income level, particularly in countries with the highest burden of preventable non-communicable diseases and to physical inactivity were described by the Global Observatory for Physical Activity. As part of GoPA! periodic research monitoring, the aim of this study was to describe national, regional and global trends, patterns and characteristics of physical activity and health research from 1950 to 2016.

**Methods:** A systematic review following PRISMA guidelines and searching in PubMed/MEDLINE, SCOPUS and ISI Web of Knowledge databases was conducted in June 2017. GoPA! standardized methodology for data collection was used. Publications on physical activity and health research per 100,000 inhabitants by country was the main outcome variable. Descriptive analyses were conducted. Time-trend analyses were conducted to estimate publication rate by decade, and according to each country, and stratified by WHO region, and World Bank income categories.

**Results:** The search retrieved 500,777 articles of which 69,165 were duplicates, leaving 431,612 eligible articles. After reviewing inclusion and exclusion criteria, 18,906 were selected for data extraction. This study showed an increasing number of publications in the last 60 years with an increasing number of disciplines and diversity of methods becoming apparent over time. However, large inequities exist between geographic regions and income groups, with over a 20-fold difference in publications per 100,00 inhabitants between high and low income countries. 70% of the world's countries had at least one publication in the area, with 82% of the studies being observational, 33% health consequence studies, 20% including objective measurements. Among the 154 countries with one or more articles, the number of articles per country ranged from 1 to 5769. Europe had the highest mean publication rate of 22.39 articles per 100,000 inhabitants, and South East Asia had the lowest (0.03 articles per 100,000 inhabitants). The Chi square test for trend of publication rate per 100,000 inhabitants by income level was not significant >0.05.

**Conclusion:** There is the need for regular global surveillance of physical activity research, particularly in countries with the largest data gaps. A stronger local research capacity where research is most needed can also increase the complexity and methodological robustness of studies allowing to conduct interventions, evaluation of interventions, policy translation, scale-up studies and studies with objective measurement in these countries. It is important to focus on the public health impact of the research that will be conducted in the next years.

**Physical activity and health research monitoring:**

# The Global Observatory for Physical Activity- GoPA! global, regional, and national trends and patterns since 1950

Andrea Ramirez Varela[1], Gloria Isabel Nino Cruz[1], Michael Pratt[2], Cauane Blumenberg[1], Shana Ginar da Silva[1], Rafaela Martins[1], Bruna Gonçalves Cordeiro da Silva[1], Larissa Mielke[1], Alice Manocci[3], Selina Khoo[4], Kar Hau Chong[4], Lucero Ramirez Varela[5], Deborah Salvo[6], Pedro Hallal[1].

## Introduction

Scientific evidence related to the health benefits of physical activity across the lifespan has been published over the last five decades(1-4), including the 2012 and 2016 Lancet Physical Activity Series that constitute a state-of-the-art summary of global knowledge in the field. Among other health benefits, regular physical activity helps prevent and reduce the risk of over 20 medical conditions including: hypertension, coronary heart disease, stroke, metabolic syndrome, obesity, type 2 diabetes, 13 site-specific cancers, depression, anxiety, dementia, injuries and falls(5-16). Despite the evidence, the World Health Organization (WHO) reported that 27·5% of adults worldwide do not meet physical activity recommendations in 2016 and the prevalence has been stable and estimated to be between 23% and 32% for the last 15 years(17). The fact that one out of three people in the world do not meet the physical activity recommendations places physical inactivity as one of the leading underlying causes of current global preventable morbidity and mortality and as a persistent global health priority.

Local, regional and global scientific production and research capacity in the area of physical activity have been identified as important strategies for improving public health policies and programs for physical activity(18-21). However, The Lancet Physical Activity Series in 2012 and GoPA! Almanac(22) in 2016 showed unequal distributions of research productivity by world region and country income level, particularly in countries with the highest burden due to preventable non-communicable diseases and to physical inactivity(13, 23). A first step towards improving research capacity around the world is a better understanding of the

patterns and trends in research publications. To date, no publication has described trends and patterns of worldwide physical activity research since the 1950s decade when the first peer reviewed manuscript in the field was published(24). This information could be helpful in identifying research gaps and needs and the relationship between research and physical activity surveillance, policy implementation, evaluation, and scale-up of interventions.

The work of GoPA! (http://www.globalphysicalactivityobservatory.com/)(23) is a global effort to compile standardized country-level surveillance, policy and research data exclusively for physical activity to understand how countries and regions address promoting physical activity. GoPA! developed standardized country-specific physical activity profiles ("Country Cards") to summarize country-level data through 2013(23, 25, 26).

As part of GoPA! periodic research monitoring, the aim of this study was to describe global, regional, and national trends, patterns and characteristics of research on physical activity and health from 1950 to 2016.

## Methods

### *Study Design*

To estimate the quantity of physical activity-related research conducted using country-specific data and to determine the characteristics of these publications, a systematic review searching in PubMed/MEDLINE, SCOPUS and ISI Web of Knowledge databases was conducted in June 2017. Data extraction and review went until November 2018. These methods were previously used as part of the GoPA! standardized methodology to collect data for the first set of physical activity profiles called the "country cards"(23). This systematic review followed PRISMA guidelines(27) and was registered with the number CRD42017070153 at the PROSPERO website (crd-register@york.ac.uk) (28). EndnoteX8 was used to manage libraries with country references.

*Search terms*

The search terms “physical activity” (in title or abstract) and country name (anywhere in the title, abstract, text or affiliation) were used. ‘Physical activity’ terms included both those referring to physical movement, as well as those encompassing the concept of sedentary behaviors different than TV viewing. The ‘physical activity’ search terms used were as follows: *physical activity OR physically active OR physical inactivity OR physically inactive OR fitness OR exercis* OR walk OR walking OR sedentary OR active transport* OR active transit OR active travel OR commut* OR active commuting OR bicycle OR bicycling OR bike OR biking OR active living OR active-living*.

*Inclusion and exclusion criteria*

The publications included in this study were those described in the title and abstract as physical activity studies, either observational studies or experimental studies, as well as physical activity community interventions. Reviews, meta-analyses, case reports, editorials, commentaries, national plans, surveillance papers, discussions or letters to the editor were included if they were country-specific and the author’s affiliation was from the country of interest as well. Studies on exercise physiology, on athlete or military population were excluded. Dates of publication were restricted to 01/01/1950-31/12/2016. There was no age, study design or language restrictions, however articles written in languages other than English, Spanish, Portuguese and a language that no one in the review team could understand had to be excluded (this was the particular case in China and Japan). To be considered as part of the country’s production the article had to explicitly describe that the research was conducted in the country. All titles and abstracts identified in the search were read by couples of authors (AR, GN, SG, BG, RM, CB, LRV, HKC), and in case of doubts, a senior author was consulted (MP).

## ***Measures***

*Identification and classification of countries*

Identification and classification of countries according to geographic region, population and income level was conducted following GoPA! standardized methodology which have been fully described elsewhere(18, 23).

Country characteristics included: 1- Region classification according to the World Health Organization-WHO (EURO - Europe; AFRO - Africa; PAHO - The Americas and the Caribbean; EMRO - Eastern Mediterranean; WPRO - Western Pacific; SEARO - South-East Asia); 2- Income level classification according to the World Bank included: high income, upper middle income; lower middle income; and low income; 3- Population size estimates were according to the World Bank.

*Physical activity research productivity*

The number of publications on physical activity and health research per 100,000 inhabitants at each country, region and globally from 1950 to 2016, and analyzed by decades 60's, 70's, 80's, 90's, 2000's, 2010's (chosen according to previous literature highlighting the most important papers for the historical development of the field)(24). The variable was built as the number of articles per decade or overall divided by the mean of population per decade or overall shown per each 100,000 inhabitants.

*Characteristics of physical activity research studies*

The characteristics of physical activity studies were described as follows: 1. Study design included one of the following categories: (a) observational, (b) experimental - randomized clinical trial; 2. If observational study: (a) cross sectional, (b) longitudinal, (c) case and controls; 3. Qualitative study (yes/no); 4. Country specific systematic review or meta-analyses; 5. Study's population age group: (a) adult population ≥18 years <60 years, (b) Children and adolescents <18 years, (c) Specific for older adult population ≥60 years, (d) More than one age group; 6. Study including pregnant women (yes/no); 7. Study type dividing the studies into one of the following five categories as previously described(23): (a) physical activity levels, trends and measurement, (b) determinants of physical activity, (c) health consequences of physical activity, (d) interventions in the field of physical activity,

and (e) policy and practice in the field of physical activity; 8. After determining study type in variable 7, further description of the manuscript topic if related to physical activity promotion (according to the Bangkok Declaration and the WHO SDGs report(29, 30)) and: (a) cardiovascular disease (e.g. hypertension, hypercholesterolemia, metabolic syndrome); (b) cancer; (c) mental health and illness (e.g cognition, memory, attention, dementia, depression); (d) Earth/environmental/atmospheric sciences (e.g. climate change, global warming); (e) Built and natural environment (Built and green spaces); (f) Sedentary time (different than TV time only); (g) Population with physical disabilities (disability is an impairment that may be cognitive, developmental, intellectual, mental, physical, sensory, neurological, or some combination of these. ex: cerebral palsy and paraplejia, quadraplejia); (h) Nutrition (e.g. obesity, BMI indices, nutrition assessment); (i) Methods (e.g validation studies and objective measures); (j) WHO Millennium and/or Sustainable development goals/ policy documents like Toronto Charter, Bangkok Declaration, 7 best investments, international recommendations(31, 32); (k) healthy lifestyle studies, or (l) Other; 8. Study including objective measurement of physical activity (yes/no); 9. Study including multiple countries (yes/no).

**Statistical analyses**

Country was the unit of analysis and publications on physical activity and health research per 100,000 inhabitants was the principal variable. Descriptive analyses were conducted for the sample and the absolute and relative frequencies of variables were calculated. The country contribution to physical activity publications from 1950-2016 worldwide was estimated as a percentage of articles per country divided by the total number of articles.

Trend analyses (Chi-square test for linear trend) were conducted with the publication rate per 100,000 inhabitants by World Bank economic categories. Statistical analyses were performed in STATA version 12.0 software (Stata Corp. College Station, TX, USA).

## Results

The automated search strategy retrieved 500,777 articles of which 69,165 were duplicates leaving 431,612 eligible articles. After reviewing inclusion and exclusion criteria 18,906 were selected for data extraction. PAHO was the region with most articles selected for data extraction, whereas EMRO was the region with least articles (Figure 1).

[PLEASE INSERT FIGURE 1 ABOUT HERE]

Of the 217 world countries, 154 (71.0%) had one or more publications in the topic. PAHO (48.4%) and EURO (34.8%) accounted for 83.2% of publications and EMRO for less than 1% (Table 1). Among income groups, high income countries produced 85.7% of publications and low income countries less than 1%.

[PLEASE INSERT TABLE 1 ABOUT HERE]

Overall, of the 18,906 selected articles the distribution by study design was: 81.7% observational and 18.3% experimental. Of the observational studies 65.3% were cross sectional, 14.9% longitudinal and 1.5% case control studies. Only 3.4% were classified as being qualitative studies or having mixed methods with qualitative approaches and less than 1% were country specific systematic reviews. In terms of age group, children and adolescents were the most studied group appearing as specific study population in 26.0% of the studies, followed by adults in 15.0% of the studies. Only 8.6% of the studies focused in population aged 60 or more years and 51.0% of the studies included at least two of the age group categories (data not shown in tables).

The distribution by study type was: 33% health consequence studies, 31% of prevalence measurements and trends, 24.1% of correlates and determinants, 8% of intervention studies and 3.9% of policy studies. The most common topics studied included 12.5% physical activity and cardiovascular health, 9.4% research methods in physical activity, 9.1% physical activity and nutrition, 7.1% built and natural environment, and 5.5% physical activity and mental health and illness. The least studied topics included 4.7% physical activity and cancer, 4.1 physical activity policy, 1.9% physical activity and sedentary time, 1.8% physical activity in populations with

disabilities and 0.4% of physical activity and earth/environmental/atmospheric sciences (data not shown in tables).

Approximately 20% of the studies reported using objective physical activity measures (i.e. accelerometers and pedometers). One out of ten studies (9.7%) reported being part of a multicounty study.

When analyzed by country income level, the distribution of studies in high income countries was: 18.6% experimental and the rest observational studies of which 63.5% were cross sectional, 16.5% longitudinal, and less than 2% case controls. Upper middle income countries had 16.8% of experimental and the rest observational studies of which 75.2% were cross sectional, 5.7% longitudinal and less than 2.3% of case controls. Lower middle income countries had 14.7% of experimental and the rest observational studies of which 79.8% were cross sectional, 3.8% of longitudinal and less than 1.7% of case controls. Low income countries predominantly had observational studies of which 91.9% were cross sectional, 1.4% of longitudinal and less than 1.4% of case controls and 5.4% were experimental (Table 2).

More than 85% of the studies in pregnant women and with objective measures of physical activity were conducted in high income countries. (data not shown in tables).

[PLEASE INSERT TABLE 2 ABOUT HERE]

**Regional trends in publication rates per 100,000 inhabitants by selected characteristics**

Among the 154 participating countries with one or more articles, the number per country ranged from 1 to 5769 articles with a median of 9. Publication rates trends showed EURO as the region with highest publication rates per 100,000 inhabitants with an average of 22.39 articles per 100,000 inhabitants and with an increasing trend and SEARO with the lowest average of 0.03 articles per 100,000 inhabitants and a steady pattern (Figure 2). The country-specific publication rate per 100,000 inhabitants by decade varied widely from less than 1 to 8 articles per 100,000 inhabitants per country (Webtable 1).

When comparing regions, it is seen that publications production increased slowly before the 1990's and more rapidly in the period between 2000-2010 particularly in Europe. SEARO and AFRO have steady patterns (Figure 2). Publication rates trends by income level showed that high income countries had the highest publication rates per 100,000 inhabitants with an average of 9.28 articles per 100,000 inhabitants and for upper middle, lower middle and low income countries were less than 1 per 100,000 inhabitants. The Chi square test for trend of publication rate by income level was not significant >0.05.

[PLEASE INSERT FIGURE 2 ABOUT HERE]

**PAHO**

PAHO is the most productive region in the world with more than 9,000 articles found for 33 out of 44 countries in the region, with an average population of approximately 400 million inhabitants in these 33 countries over the last decades. Particularly because United States (1$^{st}$), Canada (2$^{nd}$) and Brazil (4$^{th}$) that are among the first five countries with most publications in the world. United States is the leading country in scientific production contributing 5769 articles equivalent to 30% of the total publications during the 1950-2016 period. Brazil contributed 912 articles equivalent to 5% was the only upper middle income country in the first ten most productive. United states and Brazil are the most populous countries in the region.

The region's research output indicates that 81% of the studies are observational, with more than a half including multiple age groups and one out of five including only children and adolescents. The most frequent study types are health outcomes and prevalence studies and the least frequent are policy studies in less than 5% of the sample. The most common study topics are related to physical activity and cardiovascular disease, nutrition and methods. Less than 20% have included physical activity objective measures and 4% of the studies have been conducted as part of international projects including multiple countries with standardized methodologies and local teams (Table 2). Countries with no published research in the field were: Aruba, Bermuda, Cayman Islands, Dominica, Guyana, Sint Marteen, St. Martin, St. Kitts and Nevis, St. Vincent and the Grenadines, The Bahamas, showing a data gap in the Caribbean.

The overall publication rate per 100,000 inhabitants was 3 articles per 100,000 inhabitants and the trend by decades of publication shows that it is one of the two regions with publications before 1980 and that publications increased more rapidly in the period between 2000-2010 (Webtable 1 and figures 2, 3a, 4a, 5a). Over time, the most frequent study designs have been cross sectional followed by interventions. PAHO and EURO have a similar pattern of productivity however EURO's population is smaller therefore the rates are higher.

[PLEASE INSERT FIGURE 3a ABOUT HERE]

[PLEASE INSERT FIGURE 4a ABOUT HERE]

**EURO**

EURO is the second most productive region in the world with more than 6,000 articles found for 47 out of the 62 countries in the region, with an average population of approximately 43 million inhabitants in these 47 countries over the last decades. This region has countries in the ten most productive list including Netherlands (5th), Sweden ($6^{th}$), England ($7^{th}$), Germany ($8^{th}$), Spain ($9^{th}$) and Finland ($10^{th}$).

The region's research output indicates that 82% of the studies are observational, with 30% including children and adolescents alone. The most frequent study types are health outcomes and prevalence studies and the least frequent are policy studies in less than 5% of the sample. The most common study topics are related to physical activity and cardiovascular disease, nutrition, methods, mental health and illness and built environment. More than 20% have included physical activity objective measures and 18% of the studies have been conducted as part of international projects including multiple countries with standardized methodologies and local teams (Table 2). Countries with no data were: Andorra, Armenia, Azerbaijan, Belarus, Channel Islands, Faroe Islands, Isle of Man, Kyrgyz Republic, Liechtenstein, Moldova, Monaco, Montenegro, San Marino, Tajikistan, Turkmenistan.

The overall publication rate per 100,000 inhabitants was 22 articles per 100,000 inhabitants and the trend by decades of publication shows that is rapidly increasing (Table 2, Webtable 1 and Figures 2, 3a, 4a, 5a). Over time, the most frequent study designs have been cross sectional followed by longitudinal studies.

Publication rates of health outcomes related studies are the highest over time and more than four-fold when compared to interventions and policy studies.

[PLEASE INSERT FIGURE 5a ABOUT HERE]

**WPRO**

WPRO is among the most populated in the world with an average population of approximately 450 million inhabitants in these 28 countries over the last decades. Also one of the leaders in the area with 2504 articles found for 28 countries out of 31 countries in the region. Particularly because Australia (3rd) is among the first five countries with most publications in the world. China also is the second only upper middle income country after Brazil in the top ten of the most productive.

The region's research output indicates that 82% of the studies are observational, with almost 60% including multiple groups. The most frequent study types are correlates and determinants in 35% of the studies and the least frequent are policy studies in less than 5% of the sample. The most common study topics are related to physical activity and methods and built environment. 16% have included physical activity objective measures and 7% of the studies have been conducted as part of international projects including multiple countries with standardized methodologies and local teams (Table 2). Countries with no data were: French Polynesia, Lao PDR and Tuvalu.

The overall publication rate per 100,000 inhabitants was 1 article per 100,000 inhabitants and the trend by decades of publication shows that is increasing. Over time, the most frequent study designs have been cross sectional. In 1980 longitudinal and case control studies were found and in 1990 interventions started being published. Publication rates of health outcomes related studies are the highest over time and more than four-fold when compared to interventions and policy studies. There is an inflexion point in the trend showing that in 1990 health outcomes studies were fewer than in the 1980's. Prevalence measurements and trends studies have been published since 1960's and all other study types since 1990. (Table 2, Webtable 1 and Figures 2, 3b, 4b, 5b).

[PLEASE INSERT FIGURE 3b ABOUT HERE]

[PLEASE INSERT FIGURE 4b ABOUT HERE]

[PLEASE INSERT FIGURE 5b ABOUT HERE]

**SEARO**

SEARO is among the most populated in the world with an average of 820 million inhabitants over the last decades, however, it is one of the regions where the greatest inequalities between population and research output exist. This region had eight countries out of eleven contributing with 282 articles equivalent to 1.5% of the total research publications found in 6 decades. Articles came predominantly from India.

The region's research output indicates that 78% of the studies are observational, with more than 60% including multiple groups. The most frequent study types are health consequences and correlates and determinants in 30% of the studies and the least frequent are policy studies in less than 2% of the sample. The most common study topics are related to physical activity cardiovascular disease, nutrition, methods and mental health and illness. Less than 10% have included physical activity objective measures and 9% of the studies have been conducted as part of international projects including multiple countries with standardized methodologies and local teams (Table 2). Countries with no data were: Bhutan, Maldives, Timor Leste.

The overall publication rate per 100,000 inhabitants was 0.03 articles per 100,000 inhabitants and the trend by decades of publication shows that is steady with a slight increase in the 2000's decade (Table 2, Webtable 1 and Figures 2, 3b, 4b, 5b). Publication rates have been steady and low over time when compared with regions with similar productivity such as AFRO and EMRO.

**EMRO**

EMRO contributed with 144 articles equivalent to 1.3% of the total research publications found in 6 decades. The region's research output indicates that 94% of

the studies are observational, with 50% including multiple groups and no studies including older adults exclusively, population with disabilities or pregnant women. The most frequent study types are correlates and determinants in 45% of the studies and the least frequent are intervention and policy studies in less than 5% of the sample. The most common study topics are related to physical activity and cardiovascular disease, nutrition and healthy lifestyle. Less than 10% have included physical activity objective measures and 13% of the studies have been conducted as part of international projects including multiple countries with standardized methodologies and local teams (Table 2). Countries with no data were: Afghanistan, Djibouti, Iran, South Sudan, Sudan, Yemen.

The average population is 30 million and the overall publication rate per 100,000 inhabitants was 0.48 articles per 100,000 inhabitants and the trend by decades of publication shows that is steady (Table 2, Webtable 1 and Figures 2, 3b, 4b, 5b).

**AFRO**

AFRO is the least productive over the study period. This region contributed with 244 articles equivalent to 1.3% of the total research publications found in 6 decades. Countries such as South Africa, Kenya and Nigeria are the region leaders with an increase not only in number but in diversity of studies and in participation in multi-country studies in the last decades.

The region's research output indicates that 94% of the studies are observational, with 50% including multiple groups followed by children. The most frequent study types are prevalence measurements and trends in 44% of the studies and the least frequent are intervention and policy studies in 1% of the sample. The most common study topics are related to physical activity methods, nutrition and cardiovascular disease. Almost a quarter have included physical activity objective measures and 24% of the studies have been conducted as part of international projects including multiple countries with standardized methodologies and local teams (Table 2).

Countries with no data were: Angola, Botswana, Burundi, Cape Verde, Central African Republic, Chad, Congo Dem Rep, Congo Rep, Cote d'Ivore,

Equatorial Guinea, Eritrea. The overall publication rate per 100,000 inhabitants was 0.41 articles per 100,000 inhabitants and the trend by decades of publication shows that is increasing (Table 2, Webtable 1 and figures 2, 3b, 4b, 5b).

Publication rates have been constantly increasing over time when compared with regions with WPRO and EMRO that have had fluctuating patterns. Intervention and longitudinal studies were found in the 1990's.

## Discussion

To our knowledge, this is the first systematic review of the global, regional, and national trends, patterns and characteristics of the physical activity and health research field from 1950 to 2016. Key findings indicate that: 1) The field of physical activity and health research has grown tremendously overall in the last 60 years with an increasing number of disciplines and diversity of methods becoming apparent over time. Currently, 70% of the world countries have at least one publication on physical activity and health. 2). Worldwide physical activity research between 1950-2016 varies substantially by geographic region and by country income group, with more than a 20-fold difference in publications per 100,00 inhabitants between high and low income countries. Ten percent of the world's population lives in the five countries with the highest research productivity and that contribute with more than 50% of the research (United States, Canada, Australia, Brazil, Netherlands). 3) Observational studies were the most frequently conducted type of study worldwide, accounting for more than 80% of the studies. This proportion varied by country income with more experimental studies conducted in high income countries compared to low income countries. Cross sectional studies accounted for more than 90% of the total in all country types. 4) Even though global health priorities have evolved over time, in the last decade of publications one third of the studies are about health consequences and fewer than 5% about physical activity policy worldwide; 5) Cross country collaboration and use of advanced technology have been identified as important factors for enhancing research quality and productivity. However, only 20% of the studies reported using objective physical activity measures and 90% of these studies were conducted in high-income countries. Only one out of ten studies reported being part of a multicounty study. 6) The identified

trends and patterns in physical activity and health research provide important information for closing research gaps and guiding actions to optimize the translation of research into physical activity policy, promotion, and surveillance at the national, regional, and global levels.

Even though research has been conducted in many countries in the world, an alarmingly unequal distribution of publications rates over more than sixty years was observed. While 70% of countries had at least one physical activity and health publication, two WHO regions dominated (PAHO (48,4%) and EURO (34,8%)) and accounted for more than 80% of publications. The country-specific publication rate per 100,000 inhabitants by decade varied widely, ranging from 22.39 to 0.03 articles per 100,000 inhabitants. These findings are consistent with a recent network analysis of physical activity and health publications that found that the field started with a health science focus, North American and European leadership(24), and that most of the global population lives in countries with little or no research output(9, 15, 23).

Also, a persistent focus on research areas that have produced enough evidence (e.g the importance of physical activity to health and physical activity correlates and determinants) may be switching the researchers' attention to study areas where evidence is scarce. A possible explanation for this is that in countries where the field started there was and continues to be more focus on linking physical activity to health outcomes as described by the systematic framework to classify phases of research on health promotion and disease prevention(33). However, it is not necessary for countries that started conducting research afterwards to exclusively conduct the same studies and there is a need to conduct policy and intervention studies. As it is known surveillance, policy and research are positively correlated and local capacity is required to produce information, therefore, capacity building is a pressing need in low and middle income countries(18).

**Strengths and limitations**

This study is a thorough review of the research productivity in the physical activity and health field. The number of articles resulting from the database search required a team of ten people to be able to complete the study, which took over a

year from the data selection to extraction.

Results should be interpreted with caution given the following limitations. 1) The quality of the data available per country and per region that was found in this review could have been a result of inequities in country capacity for regular surveillance systems and physical activity not being considered as a relevant public health topic. 2) Even though English is the global scientific language, the working group was fluent in Spanish and Portuguese which was the main reason to also evaluate articles in these languages. We acknowledge an inherent bias when restricting by language and the possibility of having reported more completely the productivity of the Latin American region (and Portugal and Spain), something that was not done for the rest of the non-English speaking regions. There were 157 articles excluded from China and Japan due to language and the non-availability of an English abstract.

## Conclusion

This study showed the need for global and regular surveillance of physical activity research particularly in countries with the largest data gaps. A stronger local research capacity where research is most needed can also increase the complexity and methodological robustness of studies allowing to conduct interventions, evaluation of interventions, policy translation, scale-up studies and studies with objective measurement in these countries. It is important to focus on the public health impact of the research that will be conducted in the next years.

## Declarations

### Ethics approval and consent to participate

The Global Observatory for Physical Activity - GoPA! project is approved by the Research Ethics Committee of the Faculty of Physical Education (nº 522.064) at the Federal University of Pelotas, Brazil. CAAE nº 67102116.0.0000.5313.

### Consent for publication

Not applicable.

### Availability of data and material

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

### Competing interests

The authors declare no conflict of interest.


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### Authors' contributions

ARV, PH, MP proposed the initial hypothesis and idea for study. ARV wrote the first draft of the report. ARV, GN, SG, BG, RM, CB, HKC, LM, LRV collected data. ARV and CB did the analyses. ARV, PH, MP, AR, GN, SG, BG, RM, CB, LM, AM, SK, HKC, LRV and DS reviewed this report, provided feedback on drafts, and approved the final version.


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**Table 1. Physical activity research estimates by world region and income.**

| | World countries (n=217) | Countries with publications (n=154) | Number of articles meeting the inclusion criteria (n=18,906) | Publication rate per 100,000 inhabitants | Contribution to the total (%) |
|---|---|---|---|---|---|
| **World region** | | | | | |
| Africa | 46 | 21 | 244 | 0.41 | 1.29 |
| Eastern Mediterranean | 23 | 17 | 144 | 0.48 | 0.76 |
| Europe | 62 | 47 | 6586 | 22.39 | 34.84 |
| The Americas and the Caribbean | 44 | 33 | 9146 | 3.02 | 48.38 |
| South East Asia | 11 | 8 | 282 | 0.03 | 1.49 |
| Western Pacific | 31 | 28 | 2504 | 0.95 | 13.24 |
| **Income group** | | | | ** | |
| High income | 80 | 64 | 16208 | 9.28 | 85.73 |
| Upper middle income | 56 | 40 | 2203 | 0.61 | 11.65 |
| Lower middle income | 47 | 32 | 421 | 0.07 | 2.23 |
| Low income | 34 | 18 | 74 | 0.26 | 0.39 |

* Database search was conducted for the 217 world countries GoPA! list. Population, world region and income group classifications according to the World Bank. United Kingdom was divided in its 4 countries (England, Scotland, Wales and Northern Ireland).

**Chi square test for trend of publication rate by income level >0.05.

**Table 2. Physical activity research characteristics by world region and income classification, 1950-2016.**

| | *World region* n(%)* | | | | | | *Income group* n(%)* | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Africa (AFRO) | Eastern Mediterranean (EMRO) | Europe (EURO) | South East Asia (SEARO) | The Americas and the Caribbean (PAHO) | Western Pacific (WPRO) | High Income | Upper middle income | Lower middle income | Low income |
| **Total number of articles (n=18,906)** | 244 | 144 | 6586 | 282 | 9146 | 2504 | 16208 | 2203 | 421 | 74 |
| Study design | | | | | | | | | | |
| Observational | 229 (93.9) | 135 (93.7) | 5423 (82.3) | 221 (78.4) | 7422 (81.2) | 2026 (81.9) | 13195 (81,4) | 1832 (83.2) | 359 (85.3) | 70 (94.6) |
| Experimental | 15 (6.2) | 9 (6.3) | 1163 (17.7) | 61 (21.6) | 1724 (18.8) | 478 (19.1) | 3013 (18.6) | 371 (16.8) | 62 (14.7) | 4 (5.4) |
| Study's population age group | | | | | | | | | | |
| Adult population >=18 years <60 years | 28 (11.5) | 21 (14.6) | 956 (14.5) | 30 (10.6) | 1471 (16.1) | 227 (9.1) | 2285 (14.1) | 397 (18.0) | 44 (10.5) | 7 (9.5) |
| Children and adolescents <18 years | 73 (29.9) | 45 (31.3) | 1990 (30.2) | 59 (20.9) | 2140 (23.4) | 605 (24.2) | 4304 (26.6) | 483 (21.9) | 104 (24.7) | 21 (28.4) |
| Specific for older adults population >=60 years | 8 (3.3) | 0 (0.0) | 574 (8.7) | 13 (4.7) | 769 (8.4) | 264 (10.5) | 1432 (8.8) | 187 (8.5) | 9 (2.1) | 0 (0.0) |
| More than one age group | 135 (55.3) | 78 (54.1) | 3066 (46.6) | 180 (63.8) | 4766 (52.1) | 1408 (56.2) | 8187 (50.5) | 1136 (51.56) | 264 (62.7) | 46 (62.1) |
| Studies including pregnant women | 4 (1.6) | 0 (0) | 116 (1.8) | 6 (2.1) | 187 (2.1) | 41 (1.6) | 297 (1.8) | 47 (2.1) | 9 (2.1) | 1 (1.3) |
| Study type classification | | | | | | | | | | |
| Prevalence, measurement & trends | 106 (43.5) | 51 (35.4) | 2272 (34.5) | 84 (29.8) | 2724 (29.8) | 632 (25.2) | 5086 (31.4) | 587 (26.6) | 155 (36.8) | 41 (55.4) |
| Correlates & determinants | 96 (39.4) | 65 (45.1) | 1072 (16.3) | 97 (34.4) | 2369 (25.9) | 863 (34.5) | 3693 (22.8) | 687 (31.1) | 156 (37.0) | 25 (33.8) |
| Health consequences | 25 (10.2) | 16 (11.1) | 2634 (40.0) | 89 (31.6) | 2845 (31.1) | 637 (25.4) | 5410 (33.4) | 735 (33.4) | 95 (22.6) | 6 (8.1) |
| Interventions | 14 (5.7) | 6 (4.2) | 388 (5.9) | 8 (2.8) | 792 (8.7) | 295 (11.8) | 1384 (8.5) | 107 (4.9) | 10 (2.4) | 2 (2.7) |
| Policy | 3 (1.2) | 6 (4.2) | 220 (3.3) | 4 (1.4) | 417 (4.6) | 77 (3.1) | 635 (3.9) | 87 (4.0) | 5 (1.2) | 0 (0.0) |
| Study topic | | | | | | | | | | |
| Cardiovascular disease | 24 (9.8) | 16 (11.1) | 980 (14.9) | 49 (17.4) | 1096 (12.0) | 205 (8.2) | 1993 (12.3) | 314 (14.3) | 54 (12.8) | 9 (12.2) |
| Cancer | 3 (1.2) | 5 (3.5) | 264 (4.0) | 6 (2.1) | 518 (5.7) | 98 (3.9) | 827 (5.1) | 56 (2.5) | 10 (2.4) | 1 (1.3) |
| Mental health and illness | 3 (1.2) | 1 (0.7) | 400 (6.1) | 15 (5.3) | 479 (5.2) | 134 (5.4) | 913 (5.6) | 103 (4.7) | 13 (3.1) | 3 (4.1) |
| Earth/environmental/atmospheric sciences | 0 (0) | 1 (0.7) | 24 (0.4) | 0 (0) | 35 (0.4) | 7 (0.3) | 60 (0.4) | 7 (0.3) | 0 (0) | 0 (0) |
| Built and natural environment | 12 (4.9) | 1 (0.7) | 353 (5.3) | 11 (3.9) | 719 (7.9) | 250 (10.0) | 1163 (7.2) | 165 (7.5) | 16 (3.8) | 1 (1.4) |
| Sedentary time (different than TV time only) | 5 (2.1) | 4 (2.8) | 141 (2.1) | 5 (1.8) | 162 (1.8) | 47 (2.0) | 281 (1.7) | 73 (3.3) | 10 (2.4) | 0 (0) |
| Population with physical disabilities | 0 (0) | 0 (0) | 148 (2.3) | 1 (0.4) | 182 (1.9) | 18 (0.7) | 328 (2.0) | 21 (1.0) | 0 (0) | 0 (0) |
| Nutrition | 28 (11.5) | 15 (10.4) | 649 (9.8) | 17 (6.0) | 846 (9.3) | 165 (6.6) | 1385 (8.6) | 290 (13.2) | 38 (9.0) | 7 (9.4) |
| Methods | 33 (13.5) | 7 (4.9) | 551 (8.4) | 19 (6.7) | 839 (9.2) | 325 (13.0) | 1545 (9.5) | 183 (8.3) | 43 (10.2) | 3 (4.1) |
| International policy documents and recommendations | 9 (3.7) | 8 (5.6) | 214 (3.2) | 6 (2.1) | 433 (4.7) | 105 (4.2) | 672 (4.2) | 97 (4.4) | 6 (1.4) | 0 (0) |
| Healthy lifestyle studies | 2 (0.9) | 15 (10.3) | 183 (2.8) | 10 (3.6) | 216 (2.4) | 97 (3.9) | 377 (2.3) | 121 (5.4) | 23 (5.5) | 2 (2.7) |
| Other | 125 (51.2) | 71 (49.3) | 2680 (40.7) | 143 (50.7) | 3621 (39.5) | 1053 (42.2) | 6664 (41.1) | 773 (35.1) | 208 (49.4) | 48 (64.8) |
| Studies using physical activity objective measures | 50 (20.5) | 12 (8.3) | 1414 (21.5) | 27 (9.6) | 1605 (17.5) | 422 (16.9) | 3245 (20.0) | 218 (9.9) | 56 (13.3) | 11 (14.9) |
| Study including multiple countries | 59 (24.2) | 19 (13.2) | 1182 (17.9) | 25 (8.9) | 373 (4.1) | 166 (6.6) | 1504 (9.3) | 237 (10.8) | 71 (16.9) | 12 (16.2) |

* Database search was conducted for the 217 world countries GoPA! list. Population, world region and income group classifications according to the World Bank. United Kingdom was divided in its 4 countries (England, Scotland, Wales and Northern Ireland).

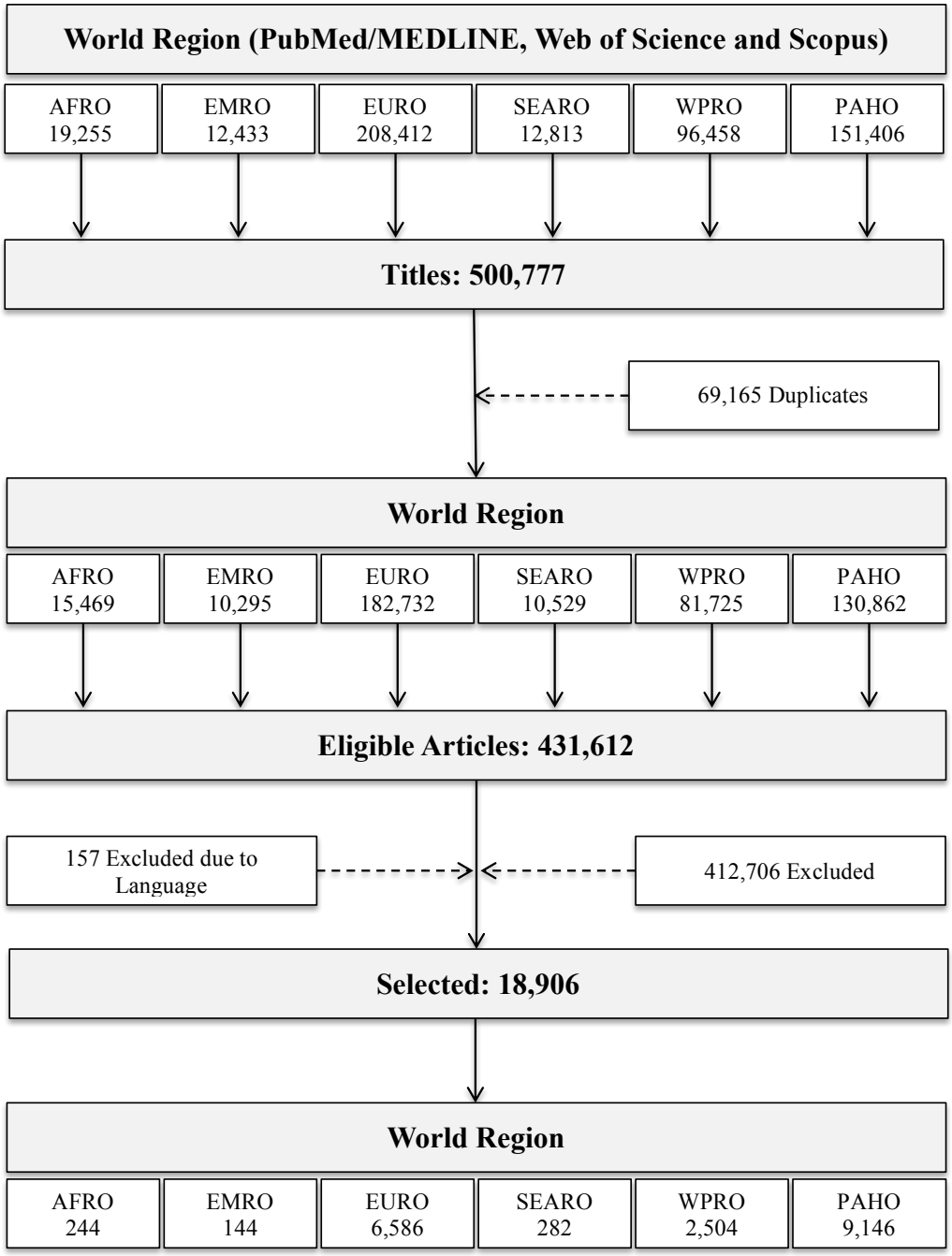


**Figure 1. Flowchart reporting the systematic review process.**

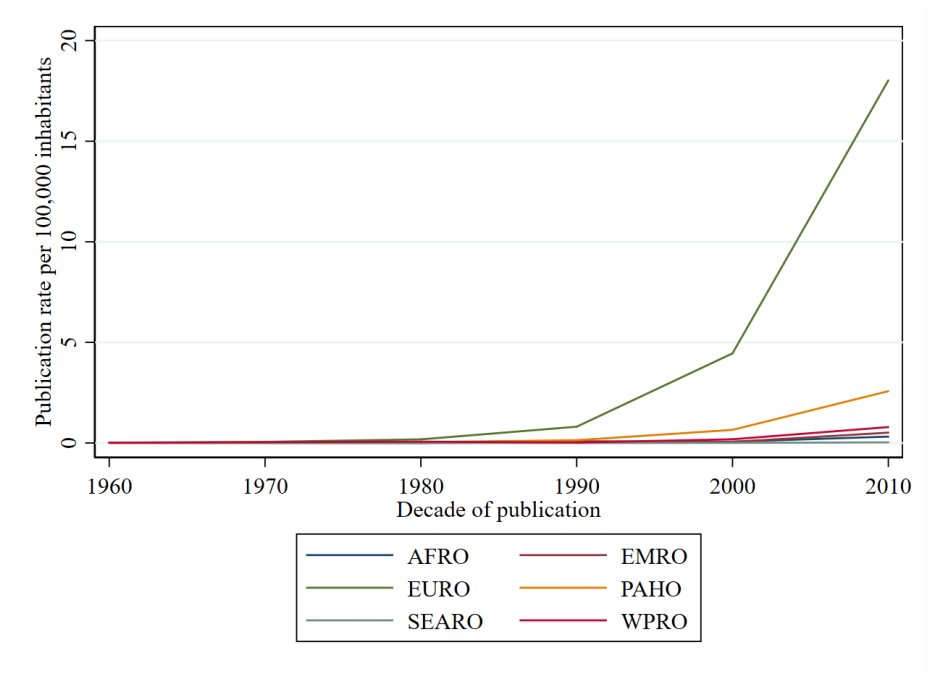


**Figure 2. Publication rate per 100,000 inhabitants by decade of publication by world region.**

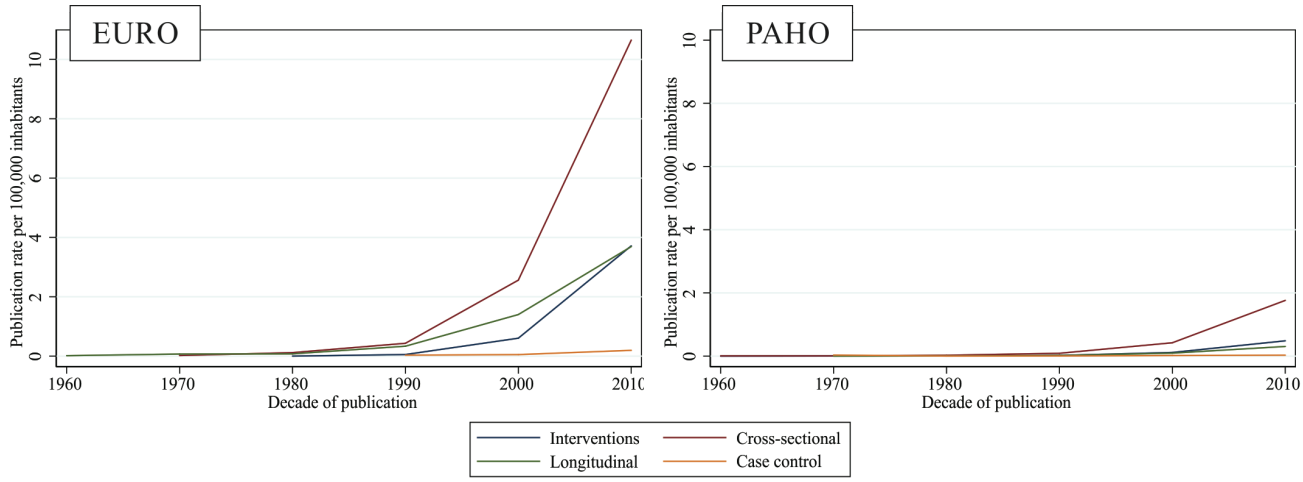


**Figure 3a. Publication rate per 100,000 inhabitants by decade of publication by study design in EURO and PAHO.**

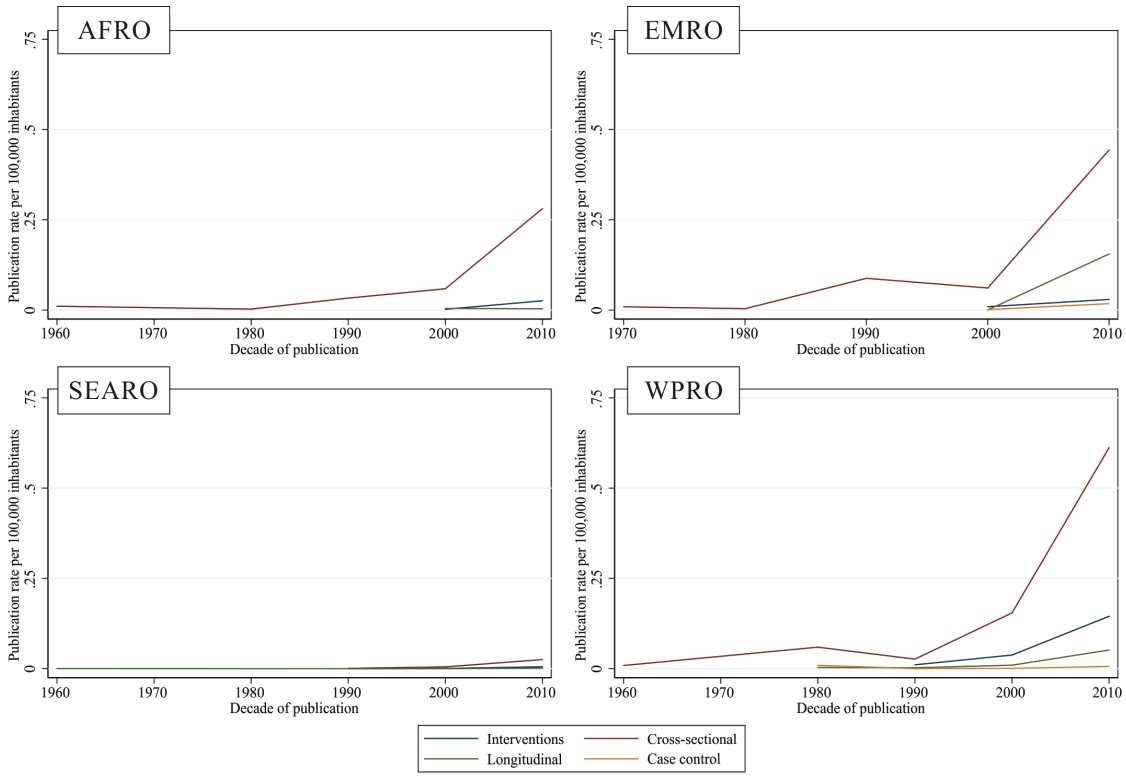


**Figure 3b: Publication rate per 100,000 inhabitants by decade of publication by study design in AFRO, SEARO, EMRO, WPRO.**

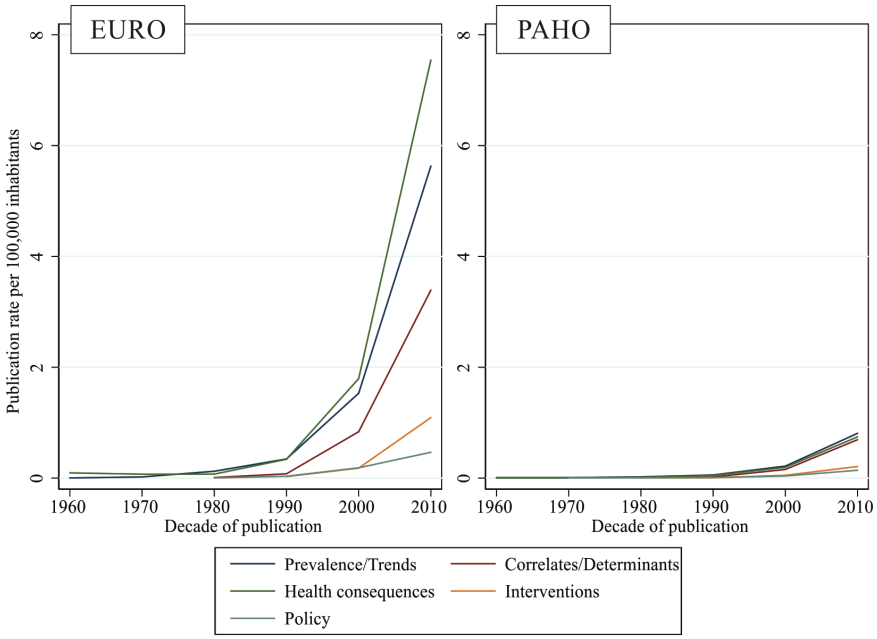


**Figure 4a: Publication rate per 100,000 inhabitants by decade of publication by study type in EURO and PAHO.**

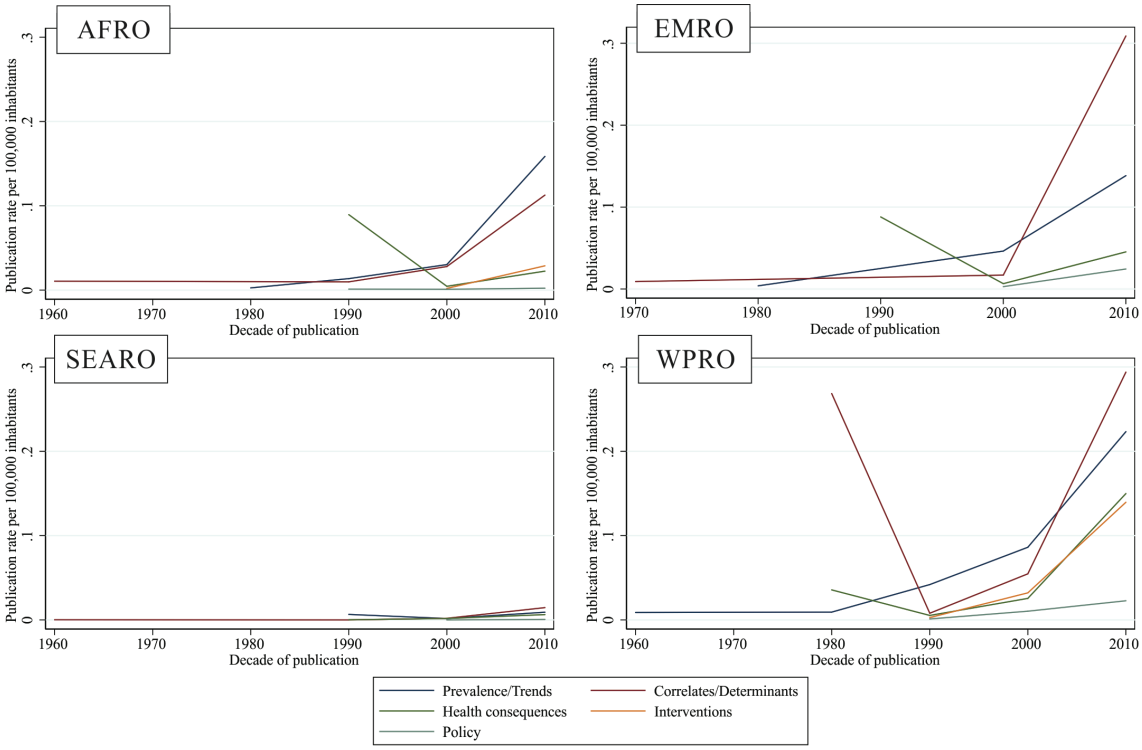


**Figure 4b: Publication rate per 100,000 inhabitants by decade of publication by study type in AFRO, SEARO, EMRO, WPRO**

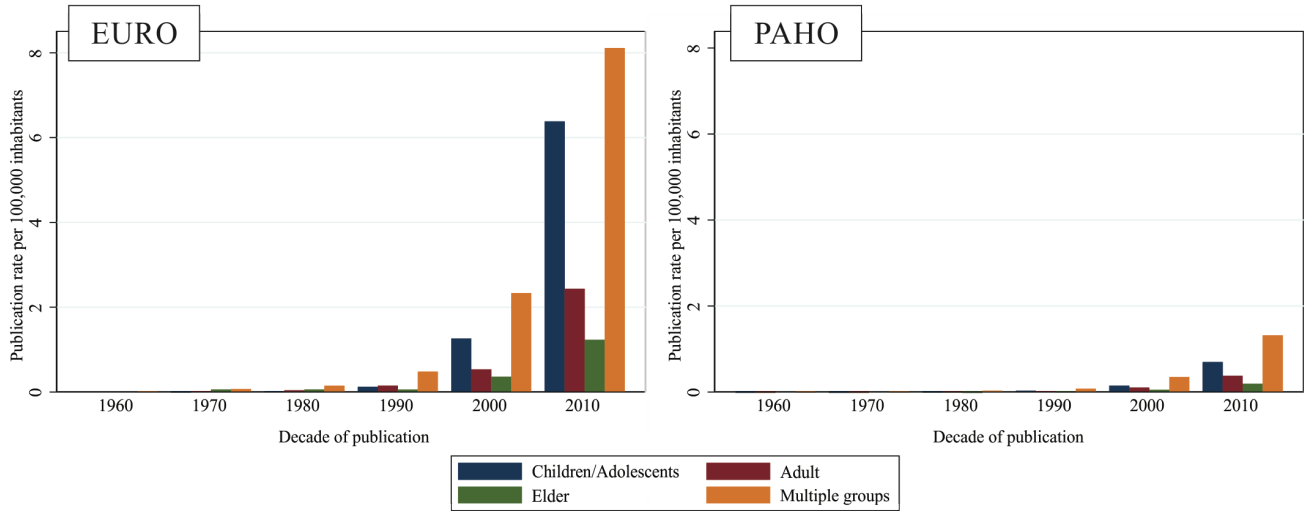


**Figure 5a: Publication rate per 100,000 inhabitants by decade of publication by study's population age group in EURO and PAHO the two most productive regions.**

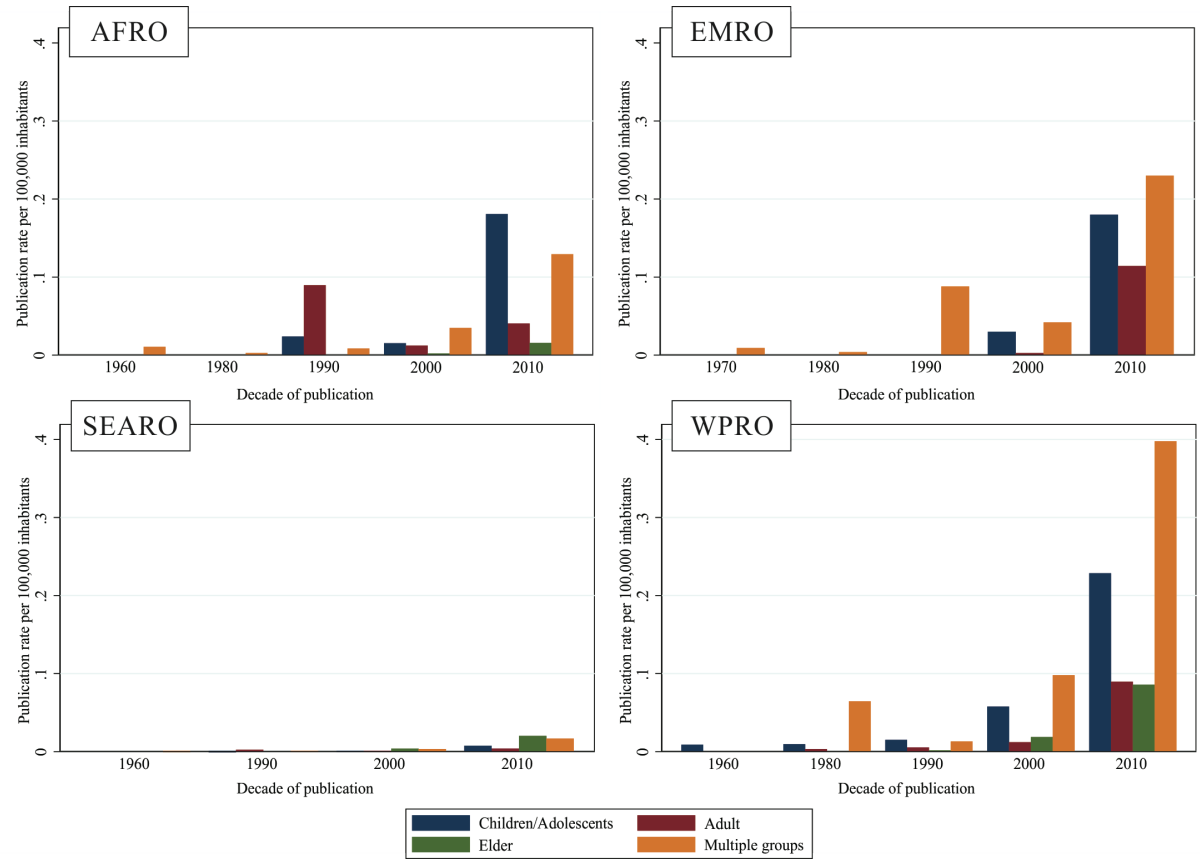


**Figure 5b: Publication rate per 100,000 inhabitants by decade of publication by study's population age group in AFRO, SEARO, EMRO, WPRO**

**Webtable 1: Number of published articles per 100,000 inhabitants and country contribution in % to physical activity research worldwide.**

| Country Name | Mean population for the period 1950-2016 | Number of articles | Country contribution (%) | Articles per 100,000 inhabitants |
|---|---|---|---|---|
| United States | 424800000.0 | 5769 | 30.51 | 1.36 |
| Canada | 45202214.0 | 1845 | 9.76 | 4.08 |
| Australia | 27159435.0 | 1075 | 5.69 | 3.96 |
| Brazil | 222400000.0 | 912 | 4.82 | 0.41 |
| Netherlands | 19997671.0 | 671 | 3.55 | 3.36 |
| Sweden | 11236320.0 | 552 | 2.92 | 4.91 |
| England | 53482853.0 | 536 | 2.84 | 1.00 |
| Germany | 84276381.0 | 517 | 2.73 | 0.61 |
| Spain | 45024498.0 | 481 | 2.54 | 1.07 |
| Finland | 7118275.5 | 449 | 2.37 | 6.31 |
| Denmark | 6544061.5 | 430 | 2.27 | 6.57 |
| Japan | 175200000.0 | 422 | 2.23 | 0.24 |
| Belgium | 10259789.0 | 396 | 2.09 | 3.86 |
| China | 1540000000.0 | 353 | 1.87 | 0.02 |
| Norway | 6163550.4 | 293 | 1.55 | 4.75 |
| Italy | 70352305.0 | 291 | 1.54 | 0.41 |
| France | 84417755.0 | 276 | 1.46 | 0.33 |
| Malaysia | 31561006.0 | 206 | 1.09 | 0.65 |
| Switzerland | 9411085.5 | 201 | 1.06 | 2.14 |

| | | | | |
|---|---|---|---|---|
| Portugal | 11115428.0 | 198 | 1.05 | 1.78 |
| Colombia | 45202304.0 | 163 | 0.86 | 0.36 |
| India | 1422000000.0 | 156 | 0.83 | 0.01 |
| Scotland | 4970394.3 | 154 | 0.81 | 3.10 |
| New Zealand | 5604547.9 | 153 | 0.81 | 2.73 |
| Poland | 41137969.0 | 150 | 0.79 | 0.36 |
| Mexico | 126400000.0 | 143 | 0.76 | 0.11 |
| Greece | 12068120.0 | 136 | 0.72 | 1.13 |
| Hong Kong SAR, China | 8314176.2 | 130 | 0.69 | 1.56 |
| South Africa | 53990746.0 | 86 | 0.45 | 0.16 |
| Hungary | 6637901.1 | 85 | 0.45 | 1.28 |
| Chile | 19099682.0 | 83 | 0.44 | 0.43 |
| Ireland | 4560763.0 | 82 | 0.43 | 1.80 |
| Estonia | 1766775.3 | 76 | 0.40 | 4.30 |
| Czech Republic | 8506374.6 | 74 | 0.39 | 0.87 |
| Israel | 9753663.6 | 64 | 0.34 | 0.66 |
| Austria | 6446493.9 | 61 | 0.32 | 0.95 |
| Turkey | 89765446.0 | 60 | 0.32 | 0.07 |
| Northern Ireland | 1785013.2 | 57 | 0.30 | 3.19 |
| Nigeria | 148200000.0 | 51 | 0.27 | 0.03 |
| Korea, Rep. | 54261474.0 | 43 | 0.23 | 0.08 |
| Thailand | 79517116.0 | 43 | 0.23 | 0.05 |
| Wales | 3008266.7 | 43 | 0.23 | 1.43 |
| Argentina | 38441337.0 | 40 | 0.21 | 0.10 |

| | | | | |
|---|---|---|---|---|
| Singapore | 6257498.8 | 39 | 0.21 | 0.62 |
| Iceland | 557803.6 | 36 | 0.19 | 6.45 |
| Croatia | 5388728.4 | 32 | 0.17 | 0.59 |
| Lithuania | 3277207.4 | 32 | 0.17 | 0.98 |
| Puerto Rico | 3870819.3 | 32 | 0.17 | 0.83 |
| Cyprus | 1748943.0 | 30 | 0.16 | 1.72 |
| Kenya | 17404968.0 | 26 | 0.14 | 0.15 |
| Vietnam | 106000000.0 | 26 | 0.14 | 0.02 |
| Saudi Arabia | 30089901.0 | 25 | 0.13 | 0.08 |
| Cuba | 14581664.0 | 21 | 0.11 | 0.14 |
| Costa Rica | 4728564.9 | 18 | 0.10 | 0.38 |
| Philippines | 92917794.0 | 18 | 0.10 | 0.02 |
| Peru | 31134395.0 | 16 | 0.08 | 0.05 |
| Slovenia | 2033385.6 | 15 | 0.08 | 0.74 |
| Bulgaria | 4505271.6 | 14 | 0.07 | 0.31 |
| Fiji | 1126786.4 | 14 | 0.07 | 1.24 |
| Jamaica | 2950733.0 | 14 | 0.07 | 0.47 |
| Jordan | 7829218.4 | 14 | 0.07 | 0.18 |
| Nepal | 30288825.0 | 14 | 0.07 | 0.05 |
| United Arab Emirates | 8151643.1 | 14 | 0.07 | 0.17 |
| Venezuela, RB | 36305078.0 | 14 | 0.07 | 0.04 |
| Ecuador | 14320677.0 | 13 | 0.07 | 0.09 |
| Sri Lanka | 19076800.0 | 13 | 0.07 | 0.07 |
| Cameroon | 26119429.0 | 12 | 0.06 | 0.05 |

| | | | | |
|---|---|---|---|---|
| Russian Federation | 217400000.0 | 12 | 0.06 | 0.01 |
| Serbia | 8643510.8 | 12 | 0.06 | 0.14 |
| Ghana | 12694500.0 | 11 | 0.06 | 0.09 |
| Guatemala | 12597812.0 | 11 | 0.06 | 0.09 |
| Oman | 3475170.8 | 11 | 0.06 | 0.32 |
| Pakistan | 171800000.0 | 11 | 0.06 | 0.01 |
| Luxembourg | 1368356.5 | 10 | 0.05 | 0.73 |
| Uganda | 34581465.0 | 10 | 0.05 | 0.03 |
| Virgin Islands (U.S.) | 1562456.8 | 10 | 0.05 | 0.64 |
| Bangladesh | 104700000.0 | 9 | 0.05 | 0.01 |
| Egypt, Arab Rep. | 81328267.0 | 9 | 0.05 | 0.01 |
| Guam | 247427.5 | 9 | 0.05 | 3.64 |
| Morocco | 36277693.0 | 9 | 0.05 | 0.02 |
| Mozambique | 22056695.0 | 9 | 0.05 | 0.04 |
| Slovak Republic | 3771329.1 | 9 | 0.05 | 0.24 |
| Trinidad and Tobago | 1475889.3 | 9 | 0.05 | 0.61 |
| Tunisia | 10351643.0 | 9 | 0.05 | 0.09 |
| Kuwait | 3380208.3 | 8 | 0.04 | 0.24 |
| Latvia | 1762507.1 | 8 | 0.04 | 0.45 |
| Qatar | 2051554.1 | 8 | 0.04 | 0.39 |
| Romania | 4012192.0 | 8 | 0.04 | 0.20 |
| Senegal | 19397975.0 | 8 | 0.04 | 0.04 |
| Lebanon | 5762384.9 | 7 | 0.04 | 0.12 |
| Vanuatu | 882111.7 | 7 | 0.04 | 0.79 |

| | | | | |
|---|---|---|---|---|
| American Samoa | 73199.2 | 6 | 0.03 | 8.20 |
| Bahrain | 1653824.7 | 6 | 0.03 | 0.36 |
| Barbados | 762782.9 | 6 | 0.03 | 0.79 |
| Bolivia | 12033420.0 | 6 | 0.03 | 0.05 |
| Greenland | 75092.4 | 6 | 0.03 | 7.99 |
| Mongolia | 3206758.5 | 6 | 0.03 | 0.19 |
| Ukraine | 30917653.0 | 6 | 0.03 | 0.02 |
| Albania | 4146370.5 | 5 | 0.03 | 0.12 |
| Kosovo | 2134899.7 | 5 | 0.03 | 0.23 |
| Malta | 1006965.8 | 5 | 0.03 | 0.50 |
| Micronesia, Fed. Sts. | 427924.4 | 5 | 0.03 | 1.17 |
| Papua New Guinea | 10133731.0 | 5 | 0.03 | 0.05 |
| Samoa | 577154.2 | 5 | 0.03 | 0.87 |
| Tanzania | 51425277.0 | 5 | 0.03 | 0.01 |
| Tonga | 1821470.0 | 5 | 0.03 | 0.27 |
| Ethiopia | 98216761.0 | 4 | 0.02 | 0.00 |
| Mauritius | 2106631.5 | 4 | 0.02 | 0.19 |
| Benin | 14190206.0 | 3 | 0.02 | 0.02 |
| Guinea | 14370575.0 | 3 | 0.02 | 0.02 |
| Kiribati | 131048.1 | 3 | 0.02 | 2.29 |
| Korea, Dem. People's Rep. | 32289898.0 | 3 | 0.02 | 0.01 |
| Libya | 3240775.6 | 3 | 0.02 | 0.09 |
| Macedonia, FYR | 2622024.9 | 3 | 0.02 | 0.11 |
| Marshall Islands | 69972.8 | 3 | 0.02 | 4.29 |

| | | | | |
|---|---|---|---|---|
| Northern Mariana Islands | 634030.4 | 3 | 0.02 | 0.47 |
| Paraguay | 3290717.3 | 3 | 0.02 | 0.09 |
| Somalia | 12357953.0 | 3 | 0.02 | 0.02 |
| Uruguay | 1724400.0 | 3 | 0.02 | 0.17 |
| West Bank and Gaza | 4551566.0 | 3 | 0.02 | 0.07 |
| Comoros | 1724400.0 | 2 | 0.01 | 0.12 |
| Dominican Republic | 5970191.8 | 2 | 0.01 | 0.03 |
| Gambia, The | 1604958.5 | 2 | 0.01 | 0.12 |
| Georgia | 8396300.0 | 2 | 0.01 | 0.02 |
| Indonesia | 349800000.0 | 2 | 0.01 | 0.00 |
| Iraq | 33582932.0 | 2 | 0.01 | 0.01 |
| Mauritania | 1724400.0 | 2 | 0.01 | 0.12 |
| Myanmar | 27255567.0 | 2 | 0.01 | 0.01 |
| Palau | 872628.3 | 2 | 0.01 | 0.23 |
| Panama | 1724400.0 | 2 | 0.01 | 0.12 |
| Rwanda | 10949459.0 | 2 | 0.01 | 0.02 |
| Solomon Islands | 1218784.0 | 2 | 0.01 | 0.16 |
| Suriname | 530798.0 | 2 | 0.01 | 0.38 |
| Syrian Arab Republic | 10678701.0 | 2 | 0.01 | 0.02 |
| Algeria | 1724400.0 | 1 | 0.01 | 0.06 |
| Belize | 340449.2 | 1 | 0.01 | 0.29 |
| Bosnia and Herzegovina | 3824581.7 | 1 | 0.01 | 0.03 |
| Brunei Darussalam | 408389.7 | 1 | 0.01 | 0.24 |
| Burkina Faso | 16851509.0 | 1 | 0.01 | 0.01 |

| | | | | |
|---|---|---|---|---|
| Cambodia | 14962257.0 | 1 | 0.01 | 0.01 |
| Curaçao | 284828.0 | 1 | 0.01 | 0.35 |
| El Salvador | 6081613.3 | 1 | 0.01 | 0.02 |
| Grenada | 1724400.0 | 1 | 0.01 | 0.06 |
| Haiti | 10357947.0 | 1 | 0.01 | 0.01 |
| Honduras | 7791203.2 | 1 | 0.01 | 0.01 |
| Kazakhstan | 16923039.0 | 1 | 0.01 | 0.01 |
| Macao SAR, China | 562107.8 | 1 | 0.01 | 0.18 |
| Malawi | 15966281.0 | 1 | 0.01 | 0.01 |
| Mali | 1724400.0 | 1 | 0.01 | 0.06 |
| New Caledonia | 458230.0 | 1 | 0.01 | 0.22 |
| Nicaragua | 1724400.0 | 1 | 0.01 | 0.06 |
| St. Lucia | 181419.0 | 1 | 0.01 | 0.55 |
| Turks and Caicos Islands | 32722.0 | 1 | 0.01 | 3.06 |
| Uzbekistan | 52417800.0 | 1 | 0.01 | 0.00 |

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**Press release**

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Physical inactivity is one of the four main risk factors for non-communicable diseases (NCD). However, an observatory dedicated to the assessment of physical activity worldwide did not exist. Country level data collection together with high quality locally applicable research and monitoring are essential to inform policy and planning of interventions at the population level. In 2012, the Global Observatory for Physical Activity – GoPA! was launched in response to this urgent call for action, becoming a worldwide response to a worldwide problem. The rationale behind the creation of the Global Observatory for Physical Activity was to provide information that enabled countries to initiate or improve surveillance systems, policy making and program development in the area of physical activity.

As countries needed to determine and monitor their status of physical activity in order to foster the improvement of physical activity levels in their population, GoPA! created the “Country Cards”, a summary document with national indicators of physical activity including research, surveillance, policy and health outcomes. The first set of Country Cards displayed national profiles in a publicly accessible, all-inclusive manner.

*"Having the profile of each country is the starting point. The cards are user friendly tools to forcefully make the case for real commitment with physical activity surveillance, research and policy" says epidemiologist and project leader,*

*Pedro Curi Hallal, from Brazil.*

A standardized methodology for data collection facilitated the comparison of indicators between countries and regions, and provided an unprecedented overview of physical activity and public health around the world. Country Cards as advocacy tools help countries moving towards a more physically active society. From the standardized methodology for data collection, countries are ranked by their physical

activity status that can be used to monitor progress in prevalence, surveillance, policy, research and health outcomes of physical activity over time.

In 2016 GoPA! obtained, confirmed and published data from 139 (64%) of the world's 217 countries, representing a global coverage of 85.4% based on the world´s population in 2013 and a regional coverage as follows: 28.3% in Africa, 28.3% in Eastern Mediterranean, 66.1% in Europe, 77.3% in the Americas and the Caribbean, 81.8% in South East Asia and 93.5% in the Western Pacific. An almanac was launched with these Country Cards (available in English and 31 languages for individual country-specific cards at: http://www.globalphysicalactivityobservatory.com/).

Main findings of the first set of Cards included: 1) Physical inactivity was highly prevalent in all regions of the world, in rich and poor countries; 2) Worldwide, around 30% of adults were physical inactive; 3) Although most countries had at least one survey on physical activity, less than a quarter had ongoing public health monitoring of physical activity; 4) 37 countries had specific national plans for physical activity and another 65 include substantive attention to physical activity within their national non-communicable disease prevention or health promotion plans; 5) In 2013, papers on physical activity from 105 countries were published. However, 51% of these publications came from the United States, Australia, Canada, Netherlands, Spain and the United Kingdom. Brazil and China are the only low and middle-income countries in the top 20 for research publications on physical activity and health.

Since the launch in 2015, Country Cards were meant to be used as advocacy tools, to stimulate discussion on physical activity surveillance and research and to guide policy. The relevance and usefulness of GoPA! Country Cards was associated knowing about the GoPA! Country Cards, living in low- and middle-income countries, and on the stage of country capacity for physical activity promotion. Further refinement of the cards and training in their use were also identified as potential and relevant tools for advancing country capacity for physical activity promotion and may prove to be a critical strategy in countries low or no local capacity.

Specific information related to historical trends and patters of publications in the field showed that even though the physical activity and health research area has

had a tremendous growth in the last 60 years with 70% of the world's countries having at least one publication in the area, there is an unequal distribution of research productivity by world region and income level, particularly in countries with the highest burden due to preventable non-communicable diseases and to physical inactivity exist. Worldwide physical activity research between 1950-2016 vary substantially by geographic area and by income group, with more than a 20-fold difference in publications per 100,00 inhabitants between high and low income countries, with less than 5% of the world's population living in the countries with the highest research productivity. Trends and patterns in physical activity and health research gaps were identified, providing important information for guiding actions to optimize physical activity promotion, surveillance and research efforts at the national, regional, and global levels.

Despite the simplicity of the indicators and some significant data gaps, Country Cards represent a relevant strategy for the promotion of physical activity, research, policy and surveillance specifically in countries with limited local capacity, lack of data or where physical inactivity as a public health problem has not been fully recognized.

In the next years GoPA! will continue having an important role periodically reporting on country level progress and the potential for stimulating research, capacity building, and advocacy at the national and global levels.

"GoPA! showed the need of global and regular surveillance of physical activity research particularly in countries with largest data gaps" *says epidemiologist and project coordinator, Andrea Ramirez Varela, from Federal University of Pelotas, Brazil.*

**Nota da imprensa**

A inatividade física é um dos quatro principais fatores de risco para doenças não transmissíveis (DCNT). No entanto, um observatório dedicado à avaliação da atividade física em todo o mundo não existia. A coleta de dados em nível nacional, juntamente com pesquisa e monitoramento de alta qualidade aplicáveis em contextos locais, são essenciais para informar políticas e planejar intervenções no nível populacional.

Em 2012, o Observatório Global para Atividade Física - GoPA! foi lançado em resposta a esta demanda urgente de ação, tornando-se uma resposta mundial para um problema mundial. A lógica por trás da criação do Observatório Global para Atividade Física era fornecer informações que permitissem aos países iniciar ou melhorar sistemas de vigilância, formulação de políticas e desenvolvimento de programas na área de atividade física. Como os países precisavam determinar e monitorar a atividade física na população para promover a melhora dos seus níveis, o GoPA! criou os "Country Cards" (cartões dos países), que consistem em um documento resumido com os indicadores nacionais de atividade física incluindo pesquisa, vigilância epidemiológica, políticas públicas e desfechos de saúde. O primeiro conjunto desses cartões dos países mostrava perfis nacionais de maneira acessível e abrangente.

*"Ter o perfil de cada país é o ponto de partida. Ao apresentar os dados de forma fácil e direta, o Observatório gera o compromisso dos países com a pesquisa, o monitoramento e a aplicação de políticas públicas em atividade física", afirma o integrante do comitê gestor do Observatório, Pedro Curi Hallal, da Universidade Federal de Pelotas.*

Uma metodologia padronizada para coleta de dados facilitou a comparação dos indicadores entre países e regiões e forneceu uma visão geral sem precedentes da atividade física e da saúde pública em todo o mundo. Os cartões dos países como ferramentas de *advocacy* ajudam os países a avançar para uma sociedade

mais ativa. Os países são classificados por seu nível de atividade física, que pode ser utilizado para monitorar os progressos na prevalência, vigilância, política, pesquisa e desfechos de saúde da atividade física ao longo do tempo.

Em 2016, o GoPA! coletou, confirmou e publicou dados de 139 (64%) dos 217 países do mundo, representando uma cobertura global de 85,4% com base na população mundial em 2013 e uma cobertura regional de 28,3% na África, 28,3% no Mediterrâneo Oriental, 66,1% na Europa, 77,3% nas Américas e no Caribe, 81,8% no Sudeste Asiático e 93,5% no Pacífico Ocidental. Um almanaque foi lançado com os cartões dos países e está disponível, em inglês e, ainda, em 31 línguas nativas de alguns países, no site do projeto http://www.globalphysicalactivityobservatory.com/.

As principais descobertas do primeiro conjunto dos cartões dos países incluíram: 1) A inatividade física foi altamente prevalente em todas as regiões do mundo, em países ricos e pobres; 2) Em todo o mundo, cerca de 30% dos adultos eram fisicamente inativos; 3) Embora a maioria dos países tivesse pelo menos um levantamento sobre atividade física, menos de um quarto possuía monitoramento contínuo de saúde pública na área de atividade física; 4) 37 países tinham planos nacionais específicos para atividade física e outros 65 incluíam atenção substancial à atividade física em seus planos nacionais de prevenção de doenças não transmissíveis ou de promoção da saúde; 5) Em 2013, foram publicados trabalhos de 105 países sobre atividade física. No entanto, 51% dessas publicações eram dos Estados Unidos, Austrália, Canadá, Holanda, Espanha e Reino Unido. O Brasil e a China foram os únicos países de renda baixa e média incluídos entre os 20 com maior número publicações de pesquisa sobre atividade física e saúde.

Desde o lançamento em 2015, os Cartões dos Países foram feitos para serem usados como ferramentas de *advocacy*, para estimular a discussão sobre a vigilância e pesquisa em atividade física e para orientar políticas públicas. A relevância e utilidade dos Cartões dos países do GoPA! foi associada a ter conhecimento sobre o GoPA!, residir em países de baixa e média renda e com o estágio de capacidade do país para a promoção da atividade física. O aprimoramento adicional dos cartões e o treinamento sobre sua utilização também

foram identificados como ferramentas potenciais e relevantes para o avanço da capacidade dos países em promoção da atividade física e podem se mostrar como uma estratégia crítica nos países com baixa ou nenhuma capacidade local.

Informações específicas relacionadas a tendências históricas e padrões de publicações na área mostraram que, embora a área de atividade física e saúde tenha tido um crescimento significativo nos últimos 60 anos, com 70% dos países do mundo tendo pelo menos uma publicação na área, há uma distribuição desigual da produtividade em pesquisa por região do mundo e nível de renda, particularmente em países com maior carga devido a doenças preveníveis e não transmissíveis e à inatividade física existente. A pesquisa mundial de atividade física entre 1950 e 2016 variou substancialmente por área geográfica e por grupo de renda, com uma diferença de mais de 20 vezes no número de publicações por 100.000 habitantes entre países de alta e baixa renda, sendo que menos de 5% da população mundial vive nos países com maior produtividade em pesquisa. Tendências e padrões de atividade física e lacunas na pesquisa em saúde foram identificados, fornecendo informações importantes para orientar ações visando otimizar os esforços de promoção, vigilância e pesquisa da atividade física nos níveis nacional, regional e global.

Apesar da simplicidade dos indicadores utilizados e de algumas lacunas de dados significativas, os cartões dos países representam uma estratégia relevante para a promoção da atividade física, pesquisa, política e vigilância especificamente em países com capacidade local limitada, falta de dados ou onde a inatividade física como problema de saúde pública ainda não foi totalmente reconhecida.

Nos próximos anos, o GoPA! continuará a ter um papel importante, relatando periodicamente o progresso em nível de cada país e o potencial para estimular a pesquisa, o desenvolvimento de capacidade e a *advocacy* nos níveis nacional e global.

*“GoPA! mostrou a necessidade de vigilância global e regular da pesquisa em atividade física, particularmente em países com maiores lacunas de dados”, diz a epidemiologista e coordenadora do projeto, Andrea Ramirez Varela, da Universidade Federal de Pelotas.*