Theoretical essay on physical activity and health

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Physical activity and health: a historical and conceptual approach

A relação entre atividade física e saúde: uma abordagem histórica e conceitual

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ABSTRACT

This theoretical essay reflects on physical activity (PA) and health and the development of this study area, particularly in Brazil. A historical review is presented based on major research themes in the area since the 1950s and the evolution of PA recommendations for health. Crucial conceptual and operational definitions in the area that have gone through recent updates are addressed. The paper highlights relevant institutions and documents, as well as reflects on future perspectives and challenges in the field. Finally, this essay highlights the need to reduce the gap between the robust scientific knowledge already produced about the health benefits of PA and the real action in the field, especially in the primary health care setting.

Keywords: Epidemiology, Health promotion, Education.

RESUMO

A partir de uma abordagem histórica, conceitual, crítica e didática, este ensaio teórico propõe uma reflexão sobre a relação entre atividade física (AF) e saúde e o desenvolvimento desta área de estudo, com um olhar especial sobre o Brasil. Apresenta-se revisão histórica a partir de grandes temas de pesquisa na área desde os anos 1950 e da evolução das recomendações de AF para a saúde. São abordadas definições conceituais e operacionais que passaram por atualizações recentes e que são cruciais na área. Faz-se destaque a instituições e documentos relevantes, além de reflexões sobre perspectivas e desafios futuros para a área. Por fim, destaca a necessidade da redução na distância entre a solidez do conhecimento já produzido sobre os benefícios da AF para a saúde e os desejados avanços no contexto da promoção da saúde, em especial na atenção primária à saúde.

Palavras-chave: *Epidemiologia, Promoção da saúde, Educação.*

Introduction

The conceptualization of this paper arises from the authors' experiences in teaching, research, and intervention in physical activity (PA) and health. The association between PA and health is an important theme in teaching applied epidemiology and other topics in health courses. In the area of Physical Education, publications such as Guedes & Guedes[1] in the 1990's

and Nahas & Garcia in 2010[2], pioneer authors on the subject since the 1980s, illustrate great contributions in Brazil for the solidification of concepts and the understanding of fundamental topics on PA and health. However, given the need for updates imposed by the knowledge evolution, there is a relative lack of contemporary texts with a didactic approach that add: 1 - a historical view of the main research focuses in PA and health; 2 - an updating of concepts that have emerged in recent years; 3 – a critical reflection on challenges and perspectives, focusing on the new generations.

This theoretical essay proposes a reflection on PA and health in the light of a historical, conceptual, critical, and didactic approach, intending to contribute to the advancement of the field and in training courses in the health area.

Historical contextualization

Considering that this text is not eminently historical, which would require better temporal and context precision, we choose to adopt a panoramic approach on the evolution of PA and health, based on the main research themes in the area since the 1950s. So, we present a chronological timeline, even though many questions overlap temporally. Figure 1 illustrates the following historical milestones (panels A-P)."

A 1953 study published in "The Lancet" is considered a pioneer among the studies on the Epidemiology of PA and Health. Analyzing occupational PA, the authors showed an increased risk of cardiovascular diseases (CVD) in drivers of double-decker London buses, who accumulated little PA and high sedentary behavior (SB), compared to collectors, who performed their job by moving, climbing, and descending stairs to collect the passenger tickets[3] (Figure 1-A). It is noteworthy that three central questions in this study remained, in some way, "dormant" and only recently returned to be highlighted in the area: PA in the worksite, light-intensity PA and SB.

In the following decades, there was significant growth in epidemiological studies in the area. Between 1960 and 1990, several studies were conducted in different populations, comparing more active vs. less active people. At the time, the main outcomes considered were overall mortality, cardiovascular mortality, and the understanding of "active people" was mostly associated with the practice of physical exercise or vigorous-intensity sports and/or the accumulation of high energy expenditure (±2000 KCal/sem)[4] (Figure 1 B-D). Paffenbarger and collaborators' studies may be considered a symbol of this period by demonstrating a lower risk of CVD and mortality among more active Harvard University alumni as compared to less active alumni[4].

In the Medline database, the search for "health-AND-exercise" presents 3.1 times more results than "health-AND-physical activity". In both cases, more than 85% of the results occur between 1980 and 1990, including the publication of the classic article that conceptualizes PA, physical exercise and physical fitness [5] (for details, please consult Guedes & Guedes[1]). However, in a similar search from the 1990s to today, the search for "physical activity-AND-health" exceeds by 13% the search for "health-AND-exercise".

This period is also marked by important contributions of exercise physiology, initiated in the 1950s and 1960s, looking for possible different adaptive mechanisms between athletes and non-athletes. Progressively, the area sought to translate this knowledge to active non-athletes (Figure 1-B and C). A paper from the "father" of exercise physiology, Per-Olof Åstrand, illustrates this period very well [6].

In the 1990s, there was an extraordinary advance in epidemiological studies on the benefits of PA at different ages (Figure 1 – D), besides an expansion of the application of the benefits of a more active life to people with different clinical conditions, especially CVDs (Figure 1 – E). In this period, a paradigm shift was observed since, in previous moments, common sense indicated that in the presence of diseases, the "best medicine" would be to rest. The contributions of Dr. Cooper, with the "Aerobics" method, stand out in a scenario of growing concern about CVDs. [7] A landmark study, however, showed that a better cardiorespiratory fitness (CRF) reduced mortality even in smokers, hypertensive and hypercholesterolemic individuals [8].

The volume and robustness of the scientific evidence produced so far, associated with the high prevalence of inactive people, led to the development of the first recommendations of PA for the public health, published in 1995 by the Centers for Disease Control and Prevention (CDC) and the American College of Sports Medicine (ACSM)[9]. Then, the message of at least 30 minutes of moderate to vigorous-intensity PA (MVPA) per day, on most days of the week, continuously or cumulatively, came out (Figure 1 - F).

In parallel to the expansion of investigations in PA and health for new outcomes and the understanding of barriers and facilitators of PA practice, and the pos-

sible deleterious effects of excessive sitting time, grew (Figure 1 - G)[10]. In the scenario of technological development and the increasing predominance of sedentary jobs, research on the possible benefits of pauses in sitting time also became a priority. (Figure 1 - H)[10].

As a consequence of the continuous scientific and technological evolutions, new recommendations on PA and health were published (Figure 1 I-N). In 2007, the ACSM and the American Heart Association updated the 1995 recommendations, making clearer the 30-minute message of MVPA, on at least 5 days a week; or 3 days of at least 20 min of vigorous PA; or any equivalent combination (http://circ.ahajournals.org). In 2010, the World Health Organization (WHO) published its first recommendation for PA, following the previous ones, but with a significant change: the withdrawal of the requirement of a weekly frequency of 5 days, as a result of new evidence that underlies the practice of ≥150 min/week of MVPA, ≥ 75 min of vigorous PA, or any equivalent combination, regardless of weekly frequency (https://www.who.int/publications/i/item/9789241599979).

In 2018, the U.S. government published the 2nd edition of its recommendations, incorporating important updates, especially with regard to the inclusion of evidence of PA benefits in cognition and mental health, in addition to removing the minimum requirement of 10 consecutive minutes of PA to be accounted for the weekly total PA. This document also highlights the importance of reducing SB (https://health.gov/our-work/nutrition-physical-activity/physical-activity-guidelines). Sequentially, we observed the WHO publication about recommendations on PA and SB for children under 5 years old (https://apps.who.int/iris/handle/10665/311664). This fact draws attention, as the WHO understood that physical inactivity at this age was also a public health concern. In 2020, WHO updated its PA recommendations, following the essence of the 2018 North American one but with a strong emphasis on reducing SB, which is now included in the document title. Also, this document incorporates the message that "any PA is better than none"[11], which was already proposed by the CELAFISCS (Center of Studies of the Physical Fitness Research Laboratory from São Caetano do Sul) since 2013.

In Brazil, after the creation of the Unified Health System and, later, with the expansion of the Family Health Strategy, a space was opened for the insertion of PA practice in the national public health agenda. Especially since the 2000s, interventions initially isolated in some cities were expanded, culminating in the creation of the Academia da Saúde Program by the Ministry of Health. In 2021, the Brazilian Ministry of Health published its first PA Guide as the result of the work of a committee of experts from all regions of Brazil, coordinated by researchers from the Universidade Federal de Pelotas. In essence, the Brazilian Guide follows the 2020 WHO recommendations, adapting the content to the Brazilian context and with a significant difference: a special chapter on promoting PA in the school settings[12].

Finishing this approach to the modern history of PA and health, it is worth commenting on two emerging issues: 1 - the approach to PA in the context of the 24 hours, since time can be a limiting factor for many people to become (or remain) active (Figure 1-O). The Canadian recommendation, for example, includes PA, SB and sleep in recommendations for a healthy lifestyle (HLS) in the context of the 24 hours of the day. (https://csepguidelines.ca). This approach is consistent with a pioneering proposal in Brazil, from the 2000s, to associate PA with other components of the HLS - the Wellness Pentacle;[13] 2 – the analysis of different types of SB, evaluating not only the body posture, but also the degree of muscle activation, depending, for example, whether a sitting position is back supported or is squatted (Figure 1-P).

Core concepts

In addition to the distinction between PA, physical exercise, and physical fitness,[2,5] new concepts have gained importance along with the evolution of scientific evidence.

A key issue is how the area has handled the intensity of PA. The most widely used unit of measure has been the metabolic equivalent for task (or MET). In essence, 1 MET is equivalent to the energy consumption at rest, or about 3.5 $mL \cdot kg^{-1} \cdot min^{-1}$. Therefore, identifying how many METs are required in a PA implies assigning a multiple of resting energy demands. The preference for this unit of measurement in the area is probably due to the possibility of comparing an unrestricted quantity of PAs. Importantly, for most analyses between PA and health, it matters less if a person is walking, playing volleyball, or gardening; it is more important to know how long of MVPA one performed or how many MET/min/week were accumulated (for details: https://www.sites.google.com/site/compendiumofphysicalactivities/). In

Figure 1 – Infographic with illustrations representing major themes or remarkable facts in the historical evolution of the relationship between PA and Health

this perspective, MVPA are those ≥3 MET, while PA ≥ 6 MET are considered vigorous PA, regardless of individual physical fitness, gender or age. Using absolute values not adjusted for individual characteristics is sub-

ject to criticism. However, the convergence of scientific findings using fixed cut-off points of 3 and 6 MET minimizes the limitations in not relativizing values for sex, age and physical condition. Light-intensity PA, in turn, is that between 1.5 and 2.9 MET. Although not computed in the 150 minutes per week, the increase in light-intensity PA has been recommended with several objectives, including reducing SB, which, in turn, is defined as any behavior during wakefulness with energy expenditure less than 1.5 MET, in the sitting, reclined or lying positions [11].

Another frequent misunderstanding is related to the terms: sedentary, inactive, and insufficiently active. The sedentary term should be used to describe someone that accumulates a lot of SB. On the other hand, a person who accumulates some MVPA during the week but below the minimum recommended, is classified as inactive, although the term "insufficiently active" is also used in the literature. Active people, therefore, are those that accumulate ≥150 minutes of MVPA per week. Of note, it is possible to classify someone simultaneously regarding the level of PA and the accumulation of SB, since they are different concepts. Someone can be active and simultaneously accumulate high SB or be inactive and accumulate little time of SB.

In the 2000s, along with the strong increase in the scientific productivity in the area, the need for standardization of terms and criteria for populational studies in PA[14] was already discussed. Comparisons across studies were frequently restricted due to the incompatibility of measurement instruments, operational definitions, and domains of PA investigated (leisure, transportation, work/study and domestic). At that moment, the importance of using, both in Brazil and in the world, the International Physical Activity Questionnaire (IPAQ) or the GPAQ (*Global Physical Activity Questionnaire*) stood out. The preferential use of this instruments, besides with the development and cost reduction of objective methods such as pedometry and accelerometry, allows, even with its inherent limitations, the comparative analysis of the prevalence of achieving or not, the recommendations for PA in Brazil and worldwide[14] .

Moreover, the recurrent use of the same instrument has allowed the analysis of temporal trends of PA, an essential element for the analysis of changes (or stability) of behaviors associated with PA in certain periods of time, either from the perspective of a natural evolution or with the investigative goal of contributing to policies and programs development. A good example is the case of the Agita São Paulo Program, implemented in 1996. When monitoring PA in the adult population of the state of São Paulo between 2002 and 2008, the Program showed an increased proportion of active individuals and a reduction in the group reporting no MVPA[15]. In this scenario, it is essential to recognize the role of nationwide populational surveys, already configured as public policies, which have been periodically providing valuable data on PA levels in Brazil and, consequently, supporting public policies, such as VIGITEL. (Surveillance System for Risk Factors for Chronic Noncommunicable Diseases), coordinated by the Ministry of Health, PeNSE (National Survey of School Health) and PNS (National Health Survey), both coordinated by the Brazilian Institute of Geography and Statistics (IBGE). It is also important to mention the creation in 2012 *of the Global Physical Activity Observatory* (GoPA - https://new.globalphysicalactivityobservatory.com/) with the innovative proposal monitoring physical activity research, surveillance and policy globally.

Institutions, dates and featured documents

The development of the area of PA and health in Brazil in recent years is remarkable, and a consequence of the work of many pioneers linked to important Centers, Laboratories or Research Groups, either for their scientific contributions, leadership in intervention projects in the promotion of PA or in the training of human resources. Contributions from institutions such as Labofise of the Universidade Federal do Rio de Janeiro (UFRJ), the Laboratory of the School of Physical Education of the Universidad de São Paulo (USP), the CELAFISCS, from São Caetano do Sul, the Research Center on Physical Activity and Health (NuPAF) of the Universidade Federal de Santa Catarina (UFSC), as well as the research groups based in Londrina, Pelotas, Curitiba and Recife (for details, please consult Nahas & Garcia[2]) .

Other milestones of the growth of the area in Brazil and the world were: a) the WHO's choice in 2002 *of the theme Move for Health*, for the celebration of World Health Day. Since then, world PA Day has been celebrated on April 6, under the leadership of the Agita Mundo network (Global Physical Activity Promotion Network - www.portalagitasp.org); b) the creation, in 2005, of the GUIA Project, a proposal for a multidisciplinary commitment of universities and health-related

institutions in Brazil, the United States and other Latin American countries and c) the creation, in 2007, of the Brazilian Society of Physical Activity and Health (SBAFS – sbafs.org.br), with its successive growth with the realization of the Brazilian Congress of Physical Activity and Health every 2 years and the publication of the Brazilian Journal of Physical Activity and Health (rbafs.org.br), as the main journal specialized in this theme in the country.

Thanks to the pioneers and the growing international exchange of the new generations, the Brazilian science in the area of PA and health occupies a prominent position in the world, being among the most productive countries in the area (top 5%), according to the second Almanac of GoPA (https://new.globalphysicalactivityobservatory.com/). This high level is due to the efforts of Brazilians in different regions of the country, organized in research groups, usually linked to the SBAFS (for details, please consult the directory of CNPq research groups).

As documents illustrating the enormous development of the area in the last 30 years, in Brazil and worldwide, we mention the different recommendations of PA already commented and the three series on PA and health published in "*The Lancet*" every 4 years, since 2012. These series illustrate the highlight that the area of PA has had in the context of public health and, more recently, the economic impact of physical inactivity (https://www.thelancet.com/series).

Future perspectives for the area

As it turned out, the area has developed extraordinarily over the past 40-50 years and continues to expand. The progress of research on the impact of PA on morbidity and mortality processes contributes to an evolution of recommendations that point to the importance of weekly accumulation of MVPA for at least 150 minutes, regardless of weekly frequency, increase in light-intensity PA (any PA is important) and reduction of SB[12]. Also important are the health benefits related to the practice of PA at levels higher than the recommended minimum and the addition of activities aimed at developing muscle and bone health[11]. In addition, today, there are specific recommendations for different age groups, such as children, adolescents and the elderly[11,12].

While the message of the benefits of PA for health has been shown to be more accurate and scientifically supported, several challenges still persist: a) the development of more accurate, low-cost and applicable PA instruments and methods of measurement in all domains of PA; b) a better understanding of the effect of light-intensity PA and respective cut-off points; c) a better understanding of SB, with indication of maximum accumulation time; d) a comprehensive understanding of the interrelations between PA and SB; e) the understanding of genetic and molecular mechanisms and/or determinants associated with PA and SB, as well as their health effects; f) the best way to communicate PA recommendations to the population; g) the expansion of large-scale intervention studies, with evaluation of effectiveness and effect on different outcomes; h) a better understanding of the impact of PA on mental health, and i) further analyses of the economic impacts of physical inactivity and the cost-benefit ratio of health PA promotion .

Conclusions

This essay aimed to contribute, with a panoramic and didactic overview, highlighting important themes and challenges, both in research and intervention, in a fundamental public health area. The imperative need for a collective (and urgent) effort to reduce the gap between the robustness of scientific evidence of the benefits of PA for health, including (or above all) in primary health care, and its effective implementation is emphasized. The set of actions, strategies, or public policies to promote PA is, at the very least, timid, given the solid understanding of its health benefits. Thus, a call to action is crucial, to urgently place this immense scientific framework in practical actions to promote PA and combat sedentary behavior.

Finally, we highlight the imperative need for the promotion of PA for health to be increasingly incorporated as a public policy, with broad and continuous funding, both for research and intervention actions.

Conflict of interest

The authors declare that there is no conflict of interest.

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Authors' contribution

Porto LGG was responsible for the initial conception of the manuscript. Porto LGG and Azevedo MR shared the first authorship of the article and were responsible for the preliminary writing and

compiling the collaborations of the other authors. Molina GE, Nahas MVN, Guedes DP, Hallal PC and Matsudo VKR were also responsible for writing the manuscript. All authors were involved in the critical review of the final version of the article. All authors read and approved the final version of the article for submission.

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