PHYSICAL ACTIVITY AND MORTALITY DUE TO COVID-19 IN THE BRAZILIAN CAPITALS: AN ECOLOGICAL ANALYSIS

ATIVIDADE FÍSICA E MORTALIDADE POR COVID-19 NAS CAPITAIS BRASILEIRAS: UMA ANÁLISE ECOLÓGICA

ACTIVIDAD FÍSICA Y MORTALIDAD POR COVID-19 EN LAS CAPITALES BRASILEÑAS: UN ANÁLISIS ECOLÓGICO

ORIGINAL ARTICLE
ARTIGO ORIGINAL
ARTÍCULO ORIGINAL

Francisco José Gondim Pitanga[1]
(Physical Education Professional)
Carmem Cristina Beck[2]
(Physical Education Professional)
Cristiano Penas Seara Pitanga[3]
(Physical Education Professional)
Cristiano Silva Pinho[4]
(Physical Education Professional)
Antônio Carlos Leal Cortez[5]
(Physical Education Professional)
Dartagnan Pinto Guedes[6]
(Physical Education Professional)
Victor Keihan Rodrigues Matsudo[7]
(Sports Physician)

1. Department of Physical Education. Universidade Federal da Bahia, Salvador, BA, Brazil.
2. Instituto Federal de Santa Catarina, Palhoça, SC, Brazil.
3. Universidade Católica do Salvador, Salvador, BA, Brazil.
4. Medicine and Health - PPGMS/UFBA - Hospital Universitário Professor Edgard (HUPES), Salvador, BA, Brazil.
5. Centro Universitário Santo Agostinho - UNIFSA, Teresina, PI, Brazil. Graduate Program in Nursing and Biosciences at the Universidade Federal do Estado do Rio de Janeiro - UNIRIO - Rio de Janeiro, RJ, Brazil.
6. Center for Research in Health Sciences, Universidade Estadual do Norte do Paraná, Brazil.
7. Center for the Study of the Physical Fitness Laboratory of São Caetano do Sul - CELAFISCS - São Caetano do Sul, SP, Brazil.

Correspondence
Faculdade de Educação – Universidade Federal da Bahia
Av. Reitor Miguel Calmon, s/n - Vale do Canela. Salvador, Bahia, Brazil. pitanga@lognet.com.br

ABSTRACT

Introduction: Few studies have analyzed the association between physical activity and hospitalizations or mortality as a result of the new coronavirus, particularly in Brazil. Objective: To analyze the association between physical activity and deaths by Covid-19 in the Brazilian capitals. Method: An observational cross-sectional ecological study, in which data on the prevalence of physical activity during leisure time, and deaths by Covid-19 were analyzed for twenty-six Brazilian capitals plus the Federal District. Data were collected through the Risk Factor Surveillance System for chronic non-communicable diseases, and SUS Analytical for COVID-19 in Brazil, of the Brazilian Ministry of Health. For the data analysis, simple Pearson correlation and multiple regression were used, with a level of significance of 5%. Results: The data show the existence of an inverse correlation between physical activity during leisure time and accumulated deaths ($r = -0.44$, $p = 0.03$), mortality rate/100,000 inhabitants ($r = -0.43$, $p = 0.02$), and the lethality of the disease ($r = -0.51$, $p = 0.01$). They also show an inverse association between physical activity during leisure time and accumulated deaths ($\beta = -485.1$, $p = 0.04$), as well as with the lethality of the disease ($\beta = -0.21$, $p = 0.02$), even after adjusting for confounding variables. Conclusion: The inverse association observed between physical activity, accumulated deaths, and lethality of Covid-19 can bring important reflections on the actions that have been implemented by government agencies, at both state and municipal levels, in relation to the practice of physical activity by the population. ***Level of evidence III; Cross-sectional ecological study.***

Keywords: Physical Activity; Mortality; COVID-19.

RESUMO

Introdução: Poucos estudos analisaram a associação entre atividade física e hospitalizações ou mortalidade pelo novo coronavírus, principalmente no Brasil. Objetivo: Analisar a associação entre atividade física e óbitos por COVID-19 nas capitais brasileiras. Métodos: Estudo ecológico observacional transversal, no qual foram analisados dados de prevalência de atividade física de lazer e óbitos por Covid-19 em 26 capitais brasileiras e Distrito Federal. Os dados foram coletados por meio do Sistema de Vigilância de Fatores de Risco de doenças crônicas não transmissíveis e SUS Analítico para COVID-19 do Ministério da Saúde do Brasil. Para a análise dos dados, empregou-se correlação de Pearson simples e regressão múltipla com nível de significância de 5%. Resultados: Os dados demonstram existência de correlação inversa entre atividade física de lazer e óbitos acumulados ($r = -0,44$, $p = 0,03$), taxa de mortalidade/100.000 habitantes ($r = -0,43$, $p = 0,02$) e também com a letalidade da doença ($r = -0,51$, $p = 0,01$). Também demonstram associação inversa entre atividade física no lazer e óbitos acumulados ($\beta = -485,1$, $p = 0,04$), bem como com a letalidade da doença ($\beta = -0,21$, $p = 0,02$), mesmo após ajuste para variáveis de confundimento. Conclusão: A associação inversa observada entre atividade física, óbitos acumulados e letalidade da COVID-19 pode trazer reflexos importantes sobre as ações que vêm sendo implementadas por órgãos governamentais, tanto no âmbito estadual quanto municipal, no que diz respeito à prática de atividade física da população. ***Nível de evidência III; Estudo transversal ecológico.***

Descritores: *Atividade Física; Mortalidade; COVID-19.*

RESUMEN

Introducción: Pocos estudios han analizado la asociación entre actividad física y las hospitalizaciones o la mortalidad por el nuevo coronavirus, especialmente en Brasil. Objetivo: Analizar la asociación entre la actividad física y las muertes por COVID-19 en las capitales brasileñas. Métodos: Estudio ecológico observacional transversal, donde se analizaron datos de prevalencia de la actividad física en el tiempo libre y las muertes por COVID-19 en 26 capitales brasileñas y en el Distrito Federal. Los datos fueron recopilados a través del Sistema de Vigilancia de Factores de Riesgo de enfermedades crónicas no transmisibles y SUS Analítico para COVID-19 del Ministerio de Salud de Brasil. Para el análisis de los datos se utilizó la correlación de Pearson simple y la regresión múltiple con un nivel de significancia del 5%. Resultados: Los datos demuestran la existencia de una correlación inversa entre la actividad física en el tiempo libre y las muertes acumuladas ($r = -0,44$, $p = 0,03$), la tasa de mortalidad / 100.000 habitantes ($r = -0,43$, $p = 0,02$) y

Editor responsible for the review process: André Pedrinelli

también con la letalidad de la enfermedad (r = -0,51, p = 0,01). También demuestran una asociación inversa entre la actividad física en el tiempo libre y las muertes acumuladas (β = -485,1, p = 0,04), así como con la letalidad de la enfermedad (β = -0,21, p = 0,02), incluso después del ajuste por variables de confusión. Conclusión: La asociación inversa observada entre la actividad física, las muertes acumuladas y la letalidad de la COVID--19 puede traer consigo importantes reflexiones sobre las acciones que están siendo implementadas por organismos gubernamentales, tanto en el ámbito estatal como municipal, en cuanto a la práctica de la actividad física por parte de la población. ***Nivel de evidencia III; Estudio ecológico transversal.***

Descriptores: *Actividad física; Mortalidad; COVID-19.*

DOI: http://dx.doi.org/10.1590/1517-8692202127062021_0071 Article received on 04/18/2021 accepted on 07/28/2021

INTRODUCTION

The important benefits of physical activity for cardiometabolic,[1] immunological[2] and mental Health[3] are already widely known by the scientific community. Regular physical activity can be very effective in preventing obesity, high blood pressure and other cardiometabolic disorders which are risk factors for the severity of hospital admissions due to Covid-19.[1] Specifically with regard to the immune system, during the infectious process caused by the new coronavirus, individuals whom are more physically active may have more adequate defense mechanisms to reduce the inflammatory process caused by the conflict between the virus and the immune cells of our body. Thus, the reduction of the inflammatory process in the lungs can decrease the severity of the patient's clinical condition, avoiding the use of more drastic interventions, such as, for example, mechanical ventilation.[4]

In this context, a recents publications demonstrated that physical inactivity can be an important risk factor for hospital and ICU admissions, admission to the ICU and death for COVID-19, and suggests that the adoption of a simple lifestyle can decrease the risk of severe Covid-19 infection.[5,6] There are still points of view, that catch us attention to the importance of continuing physical activity and reducing sedentary behavior during the Covid-19 pandemic,[7] in addition to suggesting to government officials that when publishing decrees on population movement restrictions, consider physical activity essential during the current pandemic.[8] They also suggest that we live in a moment where, in addition to COVID-19, other pandemics are plaguing humanity, such as physical inactivity and obesity wich come with serious consequences for the health of the world population.[9]

In addition, publications on influenza/H1N1, transported to the current pandemic, suggest that the more physically active the population is, the lower the mortality rates and severity of the infection caused by COVID-19 will be.[10,11] In this context, a recent publication when public domain data were analyzed in 45 African countries showed an association between the prevalence of insufficient physical activity and mortality due to COVID-19.[12]

On the other hand, publications draw attention to the importance of regular physical activity as a means of protection against the severity of infection caused by the new coronavírus.[13,14] They even suggest that doses of physical activity be "inoculated" in the population as a means of protection for future pandemics.[15] Furthermore, studies show that the effect of the influenza vaccine has more significant protective effects on physically active elderly people, a fact that may also be present in the current pandemic.[16,17]

Considering there are very few original studies, mainly in Brazil, that relate physical activity to the worsening of the clinical outcome, hospitalizations and mortality due to COVID-19, as well many points of view that draw attention to the importance of physical activity in the context of the new coronavirus, and also, several studies on physical activity and influenza with data transported to the current pandemic, the present work may expand the initial knowledge about the association between physical activity and Covid-19 contributing to a better understanding on the subject.

Thus, the objective of the study was to analyze the association between physical activity and mortality by Covid-19 in Brazilian capitals.

METHODS

Study type

This is an observational cross-sectional ecological study, when data on prevalence of leisure time physical activity (LTPA), accumulated deaths, disease lethality and mortality rate by Covid-19 in 26 Brazilian capitals and the Federal District were analyzed.

Data collect

Data on the prevalence of LTPA, obesity and arterial hypertension collected in 2019 through the Risk Factor Surveillance System for chronic non-communicable diseases[18] were used, available in a document published by the Ministry of Health of Brazil.[18] The information on deaths was related to January 22, 2021, extracted from the Analytical SUS: data on COVID-19 in Brazil, available on the website of the Ministry of Health of Brazil.[19] Information on accumulated deaths by Covid-19, lethality of the disease and mortality rate by Covid-19 per one hundred thousand inhabitants was used, by Brazilian capitals and the Federal District.

Data analysis

Initially, Pearson's simple correlation analysis was performed between LTPA and accumulated deaths by Covid-19, lethality of the disease and mortality by Covid-19 per 100 thousand inhabitants. Subsequently, multiple regression analysis between LTPA and accumulated deaths by Covid-19, lethality of the disease and mortality by Covid-19 per hundred thousand inhabitants was used, adjusted for obesity and arterial hypertension. The adequacy of the final model was tested by analyzing the residuals, the adjusted determination coefficient, sum of the squares of the regression residues, normality test of the regression residues and analysis of the presence of aberrant points. The level of significance used was <0,05). The statistical program STATA 12.0 was used.

RESULTS

Information on the prevalence of the variables analyzed in the study, as well as accumulated deaths by Covid-19, lethality of the disease and mortality rate by Covid-19 per 100 thousand inhabitants in each of the Brazilian capitals are available in Table 1.

The simple correlations between LTPA, accumulated deaths, lethality of the disease and mortality by Covid-19 per 100 thousand inhabitants are shown in Figures 1, 2 and 3. There is an inverse and statistically significant correlation between LTPA, accumulated deaths, mortality rate/100,000 inhabitants and lethality of the disease.

Table 1. Characteristics of the variables analyzed by Brazilian capitals.

Capitals	LTPA (%)	Death (n)	Lethality (%)	Obesity (%)	Arterial Hypertension (%)	Rate Mortality
Aracajú	41,9	975	1,5	20,6	25,1	148
Belém	43,2	2529	3,9	19,6	19,3	169
BH	39,7	2136	2,6	19,9	25,8	85
Boa vista	39,7	594	1,1	21,2	20,4	149
Cpo. Grande	39,5	1242	1,8	22,5	24,9	139
Cuiabá	38,3	1287	2,8	22,5	22,8	210
Curitiba	41	2117	2,8	19,4	21,1	110
Florianópolis	45,2	387	0,8	17,8	21,6	77
Fortaleza	40,3	4282	4,6	19,9	21,2	160
Goiânia	41	2207	2,5	19,5	24,3	146
João Pessoa	40,1	1244	2,7	20,4	25,6	154
Macapá	44,3	758	2,4	22,9	23,2	151
Maceió	39,9	1189	2,9	20	26,8	117
Manaus	37,1	4617	4,3	23,4	18,4	212
Natal	45,4	1281	3,4	22,5	24,5	145
Palmas	49,9	232	0,9	15,4	17,6	78
Porto Alegre	37,7	2059	2,6	21,6	28,2	139
Porto Velho	37,1	1020	2,2	19,9	19,6	193
Recife	35,6	2860	5,1	21,7	28,4	174
Rio Branco	44,6	533	2,5	23,3	18,5	131
Rio Janeiro	37,8	16608	9,1	21,7	28	247
Salvador	41,3	3305	2,7	18,1	25,2	115
São Luís	37,9	1326	4,8	17,2	16,9	120
São Paulo	34,6	16915	3,8	19,9	24,4	138
Teresina	44,3	1265	2,3	17,6	22,4	146
Vitória	44,2	628	1,9	17,6	24,3	173
Distrito Federal	47,1	4460	1,6	19,6	28,5	148

LTPA, leisure time physical activity; mortality rate per 100 thousand inhabitants; mortality data for the day January 22 2021; information on leisure time physical activity, obesity and high blood pressure obtained from VIGITEL 2019.

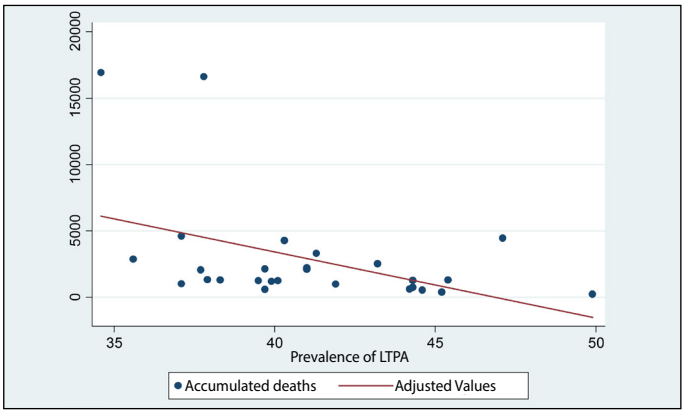

Figure 1. Association between LTPA (%) and accumulated deaths in Brazilian capitals.

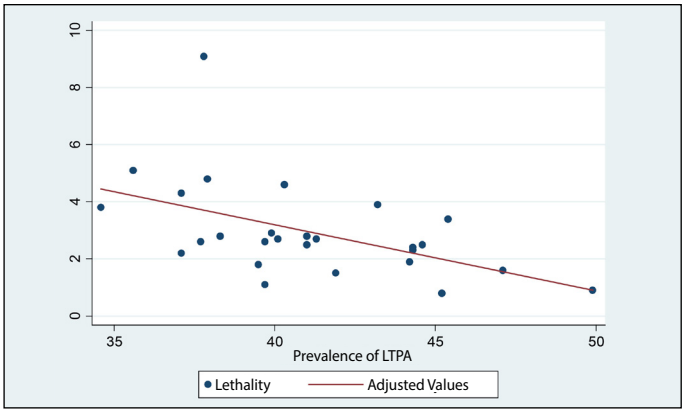

Figure 2. Association between LTPA (%) and lethality of the disease in Brazilian capitals.

The multiple regression analyzes between the variables involved in the study are shown in Tables 2, 3 and 4. One can observe statistically significant regression coefficients in the association between LTPA, accumulated deaths and lethality of the disease even after adjustments for the confounding variables. With regard to the multiple regression analysis between LTPA and Covid-19 mortality rate for every 100 thousand inhabitants, the association losed statistical significance.

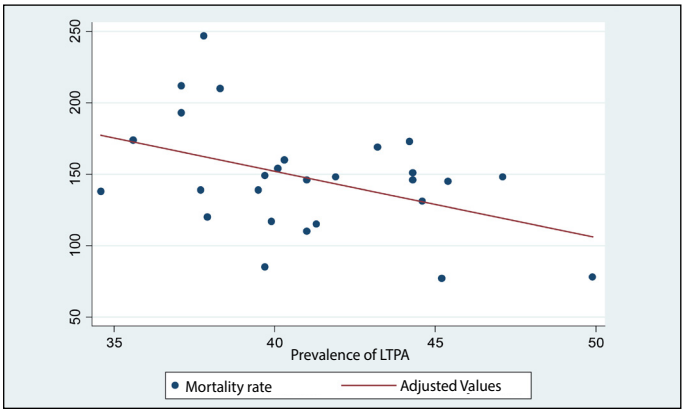

Figure 3. Association between LTPA (%) and mortality rate/100,000 inhabitants in Brazilian capitals.

Table 2. Multiple Regression Analysis between LTPA and accumulated deaths by Covid-19.

Deaths	Coefficient	Standard Error	p value	Confidence Interval (95%)	
LTPA	-485.1158	223.7967	0.041	-948.0746	-22.15704
Obesity	-185.4248	405.1669	0.651	-1023.576	652.7269
Hypertension	285.3133	227.1759	0.222	-184.6359	755.2625
Constant	19933.29	15117.76	0.200	-11340.19	51206.76

Analysis adjusted for confounding variables; LTPA = Leisure Time Physical Activity.

Table 3. Multiple Regression Analysis between LTPA and Lethality by Covid-19.

Deaths	Coefficient	Standard Error	p value	Confidence Interval (95%)	
LTPA	-.2131576	.0882119	0.024	-.3956378	-.0306774
Obesity	.0629409	.1597009	0.697	-.2674256	.3933074
Hypertension	.0314237	.0895438	0.729	-.1538118	.2166592
Constant	9.699197	5.958829	0.117	-2.627581	22.02597

Analysis adjusted for confounding variables; LTPA = Leisure Time Physical Activity.

Table 4. Multiple Regression Analysis between AFTL and the mortality rate due to COVID-19 per 100 thousand inhabitants.

Deaths	Coefficient	Standard Error	p value	Confidence Interval (95%)	
LTPA	-3.010927	1.982317	0.142	-7.111662	1.089807
Obesity	8.00069	3.588834	0.036	.5766218	15.42476
Hypertension	-.134712	2.012249	0.947	-4.297366	4.027942
Constant	112.2483	133.9081	0.411	-164.7618	389.2583

Analysis adjusted for confounding variables; LTPA = Leisure Time Physical Activity.

DISCUSSION

The study analyzed in an ecological way the association between physical activity, accumulated deaths, lethality of the disease and mortality rate by Covid-19 for every 100 thousand inhabitants. The results demonstrate the existence of an inverse association, even after adjusting for confounding variables between LTPA, accumulated deaths and lethality of the disease. Despite the limitations inherent to studies with ecological characteristics, the information obtained based on these analyzes can serve as a basis for further studies.

In this context, considering that the Covid-19 pandemic is very recent, we found in the literature consulted few studies on the association between physical activity and worsening of clinical outcome, hospital admissions and mortality by Covid-19. One of these studies, carried out in England, the authors demonstrated that physical inactivity was a risk factor for hospital admissions by Covid-19, despite the fact that information on physical activity was obtained between 2006 and 2010, approximately 10 years ago.[5]

Another more recent study, including characteristics similar to ours, carried out in 45 African countries demonstrated an association between physical inactivity and mortality due to Covid-19. It is noteworthy that the association was observed only in accumulated deaths, not remaining statistically significant when deaths were adjusted per million inhabitants.[12] In our study, we were able to demonstrate an inverse association between physical activity and accumulated deaths, deaths per 100 thousand inhabitants and Covid-19 lethality. In another recent publication, it was observed that athletes are less likely to be admitted to hospital, go to the intensive care unit or die from Covid-19 than non-athletes.[20]

Furthermore, recent point of views have been published on the topic of physical activity and Covid-19: the first one reported the importance of continuing physical activity during the Covid-19 pandemic and was based in the city of Wuhan in China,[21] the initial epicenter of the disease, where people were recommended to continue the practice of physical exercises even at home. Soon after, researchers from Spain and the USA,[22] with a specific focus on the elderly, emphasized the importance of physical exercise done outdoors or at home as therapy to combat the physical and mental consequences of quarantine due to the Covid-19 pandemic. Following, the position of the American College of Sports Medicine[23] was published when it was suggested to continue the practice of physical activity outdoors or indoors during the pandemic.

It is important to note that the "Manifesto for the Promotion of Physical Activity in Post Covid" was recently published in Brazil, which calls attention to sensitize and mobilize the most distinct population groups, governmental agencies, non-governmental agencies and private initiatives to promote a more active lifestyle, considering its preventive effects on mitigating pandemics such as Covid-19.[24]

In addition, a publication by Italian researchers presents lessons learned from studies on influenza and physical activity in obese patients and suggests that the findings may be considered for Covid-19. In this work, the authors emphasize the importance of physical activity in order to enhance the positive immunomodulation provided by the practice of light to moderate intensity physical exercise, especially in obese individuals.[13]

Also is noteworthy a strong relation between physical exercise and extracellular superoxide dismutase (EcSOD) enzymes, in recent study, it has been demonstrated that moderate intensity exercise increased EcSOD enzymes and reduced the cytotoxic activity of ROS cells EcSOD,[25] a molecular transducer of health benefits of exercise has been associated with lower endothelial tissues damages.[26,27]

And in addition, another important study catch us much attention about the role of Irisin hormone on the imune system. This original study has been conducted by researchers at São Paulo State University (UNESP) and suggests that irisin, a hormone found to be secreted from muscles in response to exercise, in fact, could have an important therapeutic effect on COVID-19 patients. The researchers analyzed adipose cell gene expression and found that irisin modulated genes associated with replication of the novel coronavirus SARS-CoV-2 in human cells. They found in uninfected adipocytes, the irisin has been altered the expression of genes that regulate ACE-2, and this one is found to encode a protein to which the virus binds in order to invade human cells.[28].

Our results demonstrate that physical activity has an inverse association with accumulated deaths by Covid-19, as well as with the lethality of the disease. We also observed, as can be seen in Tables 3 and 4, that for each 1% increase in the prevalence of physical activity, there would be a reduction of approximately 485 deaths by Covid-19, as well as a 0.21% decrease in the lethality of disease. In this regard, it is important to emphasize that the World Health Organization (WHO) published in 2018 the Global Action Plan for physical activity 2018-2030, when actions to reduce physical inactivity by 10% were recommended to all countries in the world by 2025 and 15% by 2030.[29]

The strength of the study lies in the fact that it was one of the first to analyze associations between physical activity and deaths resulting from the current Covid-19 pandemic in Brazil. On the other hand, the present results should be interpreted with caution since the ecological or aggregate study analyzes groups, instead of individuals, a fact that can lead to a lack of information about data in relation to the variables involved in the analysis. In addition, the average age was not found in Vigitel[18], as well as socioeconomic information from Brazilian capitals, a fact that made the use of these variables as possible confounders unfeasible. It should also be noted that the information used is from Vigitel[18], since the data for the year 2020 will be published later in 2021. Regarding the information on deaths, it is important to clarify that the results presented here may undergo changes over time, since the number of deaths is being changed according to the continuity of the pandemic, although we finished our analysis at the time the vaccination started in Brazil, as this fact could impact our results.

CONCLUSIONS

The results of the present study lead us to believe that the practice of leisure time physical activity can be an important ally in coping with Covid-19. The inverse association observed between physical activity, accumulated deaths and lethality from the disease can bring important reflections on the actions that have been implemented by government agencies, both state and municipal. The information, although preliminary, that each 1% increase in the prevalence of physical activity can mean a reduction of approximately 485 deaths by Covid-19, as well as a decrease of approximately 0.21% in the lethality of the disease, need urgently to be assimilated by our governments, so that they seek concrete and safe measures to increase the levels of physical activity in the population, so that we are better prepared for the current and possible future pandemics with characteristics similar to what we are experiencing at the moment. It should be noted that when designing the results of this study to meet the WHO goal of increasing the prevalence of physical activity in the world population by 10%, in theory, we would observe a 2.1% reduction in the lethality of the disease, which could zero the mortality in some Brazilian capitals. New prospective and retrospective observational studies are suggested, as well as clinical trials that can confirm the results found in this ecological study.

All authors declare no potential conflict of interest related to this article

AUTHORS' CONTRIBUTIONS: Each author made significant individual contributions to this manuscript. FJGP: intellectual concept, data analysis, writing and revision of the manuscript; CCB: writing, bibliographic review and revision of the manuscript; CPSP: statistical analysis and bibliographic review; CSP: writing, bibliographic review and revision of the manuscript; ACLC: writing and revision of the manuscript; DPG: writing and revision of the manuscript; VKRM: writing and revision of the manuscript. All authors reviewed and approved the final version of the manuscript.

REFERENCES

1. Lin X, Alvim SM, Simoes EJ, Bensenor IM, Barreto SM, Schmidt MI, Ribeiro AL, Pitanga F, Almeida MC, Liu S, Lotufo PA. Leisure Time Physical Activity and Cardio-Metabolic Health: Results From the Brazilian Longitudinal Study of Adult Health (ELSA-Brasil). J Am Heart Assoc. 2016;5(6):e003337.
2. Gonçalves CAM, Dantas PMS, Dos Santos IK, Dantas M, da Silva DCP, Cabral BGAT, Guerra RO, Júnior GBC. Effect of Acute and Chronic Aerobic Exercise on Immunological Markers: A Systematic Review. Front Physiol. 2020;10:1602.
3. Jonsdottir IH, Rödjer L, Hadzibajramovic E, Börjesson M, Ahlborg G Jr. A prospective study of leisure-time physical activity and mental health in Swedish health care workers and social insurance officers. Prev Med. 2010 Nov;51(5):373-7.
4. Sallis JF, Pratt M. Multiple benefits of physical activity during the Coronavirus pandemic. Rev Bras Ativ Fís Saúde. 2020;25e0112.
5. Hamer M, Kivimäki M, Gale CR, Batty GD. Lifestyle risk factors, inflammatory mechanisms, and COVID-19 hospitalization: A community-based cohort study of 387,109 adults in UK. Brain Behav Immun. 2020;87:184-187.
6. Sallis R, Young DR, Tartof SY, et al. Physical inactivity is associated with a higher risk for severe COVID-19 outcomes: a study in 48 440 adult patients. Br J Sports Med. Epub ahead of print: [April, 14, 2021].
7. Pitanga FJG, Beck, CC, Pitanga CPS. Physical Activity And Reducing Sedentary Behavior During The Coronavirus Pandemic. Arq Bras Cardiol. 2020;114(6):1058-1060.
8. Pitanga FJG, Beck, CC, Pitanga CPS. Should physical activity be considered essential activity during the covid-19 pandemic? Int J Cardiovasc Sci. 2020;33(4):401-403.
9. Pitanga FJG, Beck CC, Pitanga CPS. Inatividade física, obesidade e COVID-19: perspectivas entre múltiplas pandemias. Rev Bras Ativ Fis Saúde. 2020;25:e0114.
10. Siu E, Campitelli MA, Kwong JC. Physical activity and influenza-coded outpatient visits, a population-based cohort study. PLoS One. 2012;7(6):e39518.
11. Wong CM, Lai HK, Ou CQ, et al. Is exercise protective against influenza-associated mortality?. PLoS One. 2008;3(5):e2108.
12. Okeahalam C, Williams V, Otwombe K. Factors associated with COVID-19 infections and mortality in Africa: a cross-sectional study using publicly available data. BMJ Open. 2020;10(11):e042750.
13. Luzi L, Radaelli MG. Influenza and obesity: its odd relationship and the lessons for COVID-19 pandemic. Acta Diabetol. 2020;57(6):759-764.
14. Carter SJ, Baranauskas MN, Fly AD. Considerations for Obesity, Vitamin D, and Physical Activity Amid the COVID-19 Pandemic. Obesity (Silver Spring). 2020;28(7):1176-1177.
15. Laddu DR, Lavie CJ, Phillips SA, Arena R. Physical activity for immunity protection: Inoculating populations with healthy living medicine in preparation for the next pandemic. Prog Cardiovasc Dis. 2020:S0033-0620 (20) 30078-5.
16. Song Y, Ren F, Sun D, et al. Benefits of Exercise on Influenza or Pneumonia in Older Adults: A Systematic Review. Int J Environ Res Public Health. 2020;17(8):E2655. Published 2020 Apr 13.
17. Pitanga FJG, Pitanga CPS, Beck CC. Can physical activity influence the effect of the COVID-19 vaccine on older adults? Rev Bras Cineantropom Desempenho Hum. 2020; 22:e76586.
18. Vigitel Brazil 2019: surveillance of risk and protective factors for chronic diseases by telephone survey: estimates of frequency and sociodemographic distribution of risk and protective factors for chronic diseases in the capitals of the Brazilian states and the Federal District in 2019. Brasília, 2020.
19. Ministry of Health of Brazil. Analytical SUS: data on COVID-19 in Brazil. 2020. [accessed 22 jan 2021]. Available in: https://susanalitico.saude.gov.br/extensions/covid-19_html/covid-19_html.html.
20. Halabchi F, Mazaheri R, Sabeti K, Yunesian M, Alizadeh Z, Ahmadinejad Z, Aghili SM, Tavakol Z. Regular Sports Participation as a Potential Predictor of Better Clinical Outcome in Adult Patients With COVID-19: A Large Cross-Sectional Study. J Phys Act Health. 2020:1-5.
21. Chen P, Mao L, Nassis GP, Harmer P, Ainsworth BE, Li F. Coronavirus disease (COVID-19): The need to maintain regular physical activity while taking precautions. J Sport Health Sci. 2020 Mar;9(2):103-104.
22. Jiménez-Pavón D, Carbonell-Baeza A, Lavie CJ. Physical exercise as therapy to fight against the mental and physical consequences of COVID-19 quarantine: Special focus in older people. Prog Cardiovasc Dis. 2020;63(3):386-388.
23. American College of Sport Medicine. Staying Physically Active During the COVID-19 Pandemic. [accessed 11 abr 2020]. Available in: https://www.acsm.org/.
24. Centro de Estudos do Laboratório de Aptidão Física de São Caetano do Sul. Manifesto to Promote Physical Activity Post-COVID-19: An International Call for Urgent Action. Rev Bras Ativ Fís Saúde. 2020;25:e0175.
25. Pinho CS. Isolamento Social e Imunomodulação através do Exercício Físico. Social Isolation and Immunomodulation by Physical Exercises. 2020. E-book Ed. CBL/Amazon. p. 99-100.
26. Yan Z, Spaulding HR. Extracellular superoxide dismutase, a molecular transducer of health benefits of exercise. Redox Biology. 2020;32:101508.
27. Call JA, et al. Muscle-derived extracellular superoxide dismutase inhibits endothelial activation and protects against multiple organ dysfunction syndrome in mice. Free Radical Biology and Medicine. 2017; 113: 212-223.
28. de Oliveira M, De Sibio MT, Mathias LS, Rodrigues BM, Sakalem ME, Nogueira CR. Irisin modulates genes associated with severe coronavirus disease (COVID-19) outcome in human subcutaneous adipocytes cell culture. Molecular and Cellular Endocrinology. 2020 Sep 15;515:110917.
29. World Health Organization. Global action plan for physical activity 2018-2030. Geneva, 2018.