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RESEARCH ARTICLE

CAN REGULAR PHYSICAL ACTIVITY REDUCE SARS-COV-2 SYMPTOMS IN ADULTS COMPARED TO THE VACCINE? A SYSTEMATIC LITERATURE REVIEW

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ABSTRACT

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COVID-19 infection is a public health challenge that also includes the issue of health inequity in the United States and around the world. Populations in underserved communities and those who have underlying conditions (obesity, diabetes, hypertension, etc...) experienced higher rates of SARS-Cov-2 infection, hospitalizations, and even deaths. Traits such as obesity, diabetes, and hypertension associated with the severity of the SARS-Cov-2 pandemic made physical activity interventions a valuable prevention factor. Physical activity improves body composition and patients' metabolic, cardiorespiratory, and mental health, enhancing antibody responses when vaccinated. In addition, it boosts brain health, helps manage weight, reduces the risk of disease, especially chronic diseases (hypertension, diabetes, etc..), strengthens bones and muscles, and improves the ability to do everyday activities. This systematic literature review aims to combine the findings of the currently published articles regarding the change in SARS-Cov-2 infection symptoms among physically active peopleand the association between physical activity before the Coronavirus Disease 2019 infection and the severity of illness and mortality in the adult population. Methods: Information was gathered through the PubMed and Medline databases conducted in November 2023. The inclusion criteria are composed of observational studies examining the impact of regular physical activity on SARS-Cov-2 symptoms in adult populations worldwide. Article reviews, experimental studies, case reports, and series were excluded. A total of 926 articles were found, and only fifteen studies were included in this systematic literature review. Results: Fifteen articles were included in this systematic literature review and the findings demonstrated that physical activity helps patients infected with SARS-Cov-2. Physical activity before infection might reduce the severity and mortality of patients, especially in physical activity ≥ 150 min/week of moderate activity or ≥ 75 min/week of vigorous activity. Engaging in regular and sustained, even in different patterns of physical activity, has beneficial effects on the severity of COVID-19 infection and symptoms in adults. Conclusion: Overall, physical activity contributes to decreasing COVID-19 infection symptoms promotes recovery of physical function, alleviates post-acute COVID-19 syndrome, and improves patients' psychological well-being.

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INTRODUCTION

The Coronavirus 2 (SARS-Cov-2) pandemic has shocked and surprised the world health authorities generating a global health crisis (Malisoux *et al.*, 2022). Physical activity and exercise have been pushed to the forefront of the discussion since it is associated with a reduced risk of developing all the chronic diseases strongly associated with severe cases of SARS-Cov-2 and exercise is considered complementary therapeutics for the treatment of these age-related conditions (Vellas *et al.*, 2021; Malisoux *et al.*, 2022).

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According to Nyberg, et al, physical activity and exercise are considered powerful behaviors for reducing the risk of developing a myriad of chronic diseases and slowing down the age-related progression of the disabling cascade, such as frailty (Nyberg et al., 2020). Exercise before severe acute respiratory syndrome-like SARS-Cov-2 infection has been associated with improved outcomes among individuals with chronic clinical or underlying conditions, especially obesity. As a result, the COVID-19 pandemic has contributed to further raising awareness that obesity is a chronic condition requiring better management tools in clinical practice and is a public health issue that should be prioritized in population-based approaches (O'Rourke et al., 2021). A pandemic of this scale has never been seen since the Spanish Influenza during World War One and has created terrible challenges all over the world in the economy, social interactions, individual lifestyles, and even

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deaths. The symptoms of this respiratory infection in the airways and lungs may include a severe cough that produces mucous, shortness of breath, chest tightness, and wheezing when you exhale due to lung inflammation. Thus, it can determine the drop in performance in the sports environment. Even though the symptoms are present in the lungs, SARS-CoV-2 infection can cause several clinical manifestations and affect other organs of the human body (Chowdhury et al., 2020). Encouraging physical activity or exercise because of its positive impact on human health can strengthen the immune system and diminish or reduce COVID-19 symptoms in the adult population and even among those with an underlying condition such as obesity. Nevertheless, some findings stated that physical activity does not improve or does not have any impact on acute respiratory disease like SARS-Cov-2 infection capacities. There is a lack of clarity about the effects on individuals infected with SARS-CoV-2 who are physically active. Thus, this systematic literature review aims to combine the findings of the currently published articles regarding the change in SARS-Cov-2 infection among physically active people and the association between physical activity individuals before the infection and the severity of illness and mortality in COVID-19 patients with obesity.

METHODS

Search Strategy: A search was undertaken through the PubMed (National Library of Medicine) and Medline databases using the terms "SARS-Cov-2 and physical activity and SARS-CoV-2, vaccine", "physical activity, vaccine coronavirus, severity, mortality", "COVID-19", "SARS-CoV-2", "COVID-19 syndrome", acute respiratory distress syndrome (ARDS), "physical activity (PA)", "Sports", "physical exercise". Topics for this study were analyzed and synthesized using (PRISMA, 2021). The PICO was used based on the Population (adults individuals with COVID-19), Intervention (Physical activity), Comparison (vaccine), and Outcomes (effects on symptoms of SARS-Cov-2) investigation inquiry was based on: Can Regular Physical Activity reduce SARS-Cov-2 symptoms in adults compared to the vaccine? The process of this search was done in November 2023 and was filtered to include all published articles from January 2020, through November 2023 and exclude all non-English articles. The search compared the severity of symptoms and mortality of SARS-Cov-2 infection among SARS-Cov-2 patients who reported their participation in physical activity with those who did not. A total of 926 articles were found according to the search made and after applying the eligibility criteria fifteen studies were included thirty-five studies were at low to moderate risk of bias.

Eligibility Criteria: The inclusion criteria were articles (four randomized clinical trials, two cross-sectional studies, and nine Cohort studies) that examined the impact of physical activity on SARS-Cov-2 infection symptoms. Exclusion criteria were articles with (30 case reports, 654 commentaries, forty review articles, two journals, and studies published in language other than English) that evaluate the complications of COVID-19 and articles on the effects of SARS-Cov-2-specific drugs on exercise. The student evaluated the full text for the possible meeting criteria for the project to include in the study. Screening the abstract and heading helped identify papers linked to the preferred study. All papers were selected

manually for careful and rigorous analysis. In addition, irrelevant articles were excluded, and the following inclusion criteria were added when filtered articles were published from 2020 - 2023. The information was organized in tables considering each article's study purpose, method, results, and references.

Quality of (risk bias) Assessment: The analysis was based on the original articles, and to ensure the quality of the research, all duplications were examined. Abstracts of the papers were reviewed for assessment, and the papers were cleaned to ensure the quality and relevance of scholastic publications. Moreover, a detailed evaluation was performed for a particular article. The following exclusion criterion was to determine the article to be published in the English language only from 2020-2023. After filtration, five more papers were separated from the study due to not being related to the topic. Fifteen articles were determined after assessing individual articles on the inclusion reported above and exclusion criteria.

Extracted Data: In this case, the main interest was the search for articles that investigated the impact of physical activity on the symptoms of SARS-CoV-2 infection in the adult population. The extraction with fifteen articles selected, and the elements extracted were as follows:

- Papers must be authentic articles, related to the topic published in reports.
- The paper must be in the English Language and from the field of sciences.
- Pulled papers were published between 2020 to 2023.
- The articles were globally pulled.

Statistical analysis: This systematic literature review explores the benefit of physical activity on SARS-Cov-2 symptoms in the adult population from 2020 to 2023. It is done through a systematic literature review with variable data among the included articles studies therefore, statistical studies were not necessary.

RESULTS

Articles found after a search: A total of 926 articles display the flowchart adapted from PRISMA, with details of the article selection process found in these two databases PubMed and Medline. Nine articles were duplicates from the Medline database, 654 Commentary articles were excluded after reading the title, and 72 (case reports, review articles, and journals) after reading the abstract. Thus, following the selection process, twenty studies were identified that met the previously established criteria. Of these, five articles were review articles and were later excluded, leaving fifteen articles for the systematic literature review.Figure 1 below shows the PRISMA 2021 flow diagram for this systematic literature review which included the search of databases and registers.

Characteristics of the included article work: For the included works, four articles were randomized clinical trials (Chastin, *et al*, 2021; Cho, *et al*, 2021; Lee, *et al*, 2022; Kogel, *et al*, 2023) composing 33,8732 participants respectively from the United States, and South Corea, and the United Kingdom. Two were cross-sectional studies (Sallis *et al.*, 2021; Cunningham 2021)

with more than 3328 subjects from the United States, and nine were characterized as Cohort study articles (Christensen *et al.*, 2021; Economos *et al.*, 2021; Andrews *et al.*, 2022; Nieman *et al.*, 2022; Brawner *et al.*, 2021; Rowlands *et al.*, 2021; Ahmadi *et al.*, 2021; Després, 2021; Salgado-Aranda *et al.*, 2021. Spain) Comprising 66,0537 participants respectively from the United States, United Kingdom, Canada, and Spain. The ages of the participants ranged from 18 to 80 years old, and all these studies included both genders (male and female).



Figure 1.

Physical exercise and effects on cardiorespiratory capacity of patients with COVID-19: Researchers realized after the intervention that physical exercise improved lung function (blood oxygen saturation), as well as the occurrence of dyspnea (modified Borg dyspnea scale) and cough (days of occurrence), in patients with severe cases, after performing a qigong exercise and acupressure rehabilitation program (Liu et al., 2021). Moreover, exercise protocols conducted using a telerehabilitation program (TERECO) led to an increase in cardiorespiratory capacity in the 6-min walking test (6MWT) and an improvement in the quality of life of the evaluated patients assessed by the Short Form Health Survey-12 (SF-12) (Li et al., 2021). Physical activity promotes good health and a better quality of life. Furthermore, exercise reduces the risk of severe SARS-Cov-2 outcomes in all age groups and people with chronic conditions or disabilities.

Main outcomes: Two Randomized Control trial studies (Cho *et al.*, 2021; Lee *et al.*, 2022) and three cohort studies (Ahmadi *et al.*, 2021; Nieman *et al.*, 2022; Rowlands *et al.*, 2021) found a positive impact of regular physical activity on SARS-Cov-2 symptoms. On the contrary, one randomized control trial reported that there is not sufficient information to support such results (Kogel *et al.*, 2023). Lee *et al.*, evaluated the benefit of physical activity and the symptoms of SARS-Cov-2 in randomized control trials of 212,768 Korean adult's female and male from January 1, 2020, to May 30, 2020. The authors found a significant benefit in adults who engaged in both aerobic and muscle-strengthening activities and had a lower risk of SARS-CoV-2 infection.

The authors concluded that engaging in physical activity has substantial public health value and demonstrates potential benefits to combat COVID-19 (Lee *et al.*, 2022). Ahmadi *et al.*, in their large United Kingdom cohort study (n=468,569), investigated the epidemiological using a questionnaire of COVID-19 mortality rate among individuals practicing physical activity. Over the follow-up period, 6479 were diagnosed. The authors found a statistically decreased mortality detected (rate ratio:0.70, 95%Cofidential Interval: 0.54-0.89). The authors concluded that in middle-aged and older adults, including those with cardiovascular disease and cancer, healthier lifestyle behaviors may protect against the most severe consequences of infectious disease (Ahmadi *et al.*, 2021).

Therefore, the risk of hospitalization decreases with individual physical activity who is infected with SARS-Cov-2. Rowlands *et al.*, in their large-scale cohort study of 91,248 adults of both genders, assessed the association between SARS-Cov-2 hospitalization and the use of Conventional Oxygen Therapy. Association between accelerometer-assessed physical activity and severity of COVID-19. Around 297 adult individuals with confirmed COVID-19 and 124 severe. The results showed that the odds of severe COVID-19 were 25% lower for every 30 min/day MVPA. Physical activity was associated with lower odds of severe COVID-19 with stronger associations in women than men (Rowlands *et al.*, 2021). Results support calls for public health messaging highlighting the potential of MVPA for reducing the odds of severe COVID-19.

Contrarily to the above findings, (Kogel *et al.*, 2023) assessed the possible association between physical activity as a persistent symptom post-COVID-19 treatment infection in the United Kingdom with seventy-two patients with symptoms of fatigue persisting over 6 weeks post-COVID infection were screened. Fifty-seven patients consented and were randomized to 4 weeks of supervised personalized strength and endurance training.

The author did not find a significant benefit of physical activity on COVID-19 symptoms meaning that the improvements in fatigue and quality of life were not statistically different between the training and usual care groups (Kogel *et al.*, 2023). On the other hand, physical inactivity affects the cardiovascular, metabolic, respiratory, and neuromuscular systems of individuals with COVID-19 disease and is associated with fat deposition and low-grade systemic inflammation (Malisoux *et al.*, 2022). According to Chastin, *et al*, vigorous exercise reduced mortality risk, whereas moderate to vigorous physical activity reduced the risks of severity and mortality (Chastin *et al.*, 2021). Therefore, practicing simple and regular exercise would alleviate or diminish public health expenditures of billions of dollars and save lives.

DISCUSSION

Physical Activity helps reduce SARS-Cov-2 severity in adults, including a reduced risk of hospitalization, the use of Conventional Oxygen Therapy, and admission to the Intensive Care Unit (Rowlands *et al.*, 2021).

Author, country, and year	Outcome	Type of Study	Participants	Developed Activities	Results	Conclusion
Sallis et al., 2021 USA	Cases of death related to lifestyle	Cross-sectional study	Population > 65 years of age from 186 countries	Increased risk for overweight and insufficiently physically active individuals.	Patients with COVID-19 who were consistently inactive had a greater risk of hospitalization, admission to the ICU, and death due to COVID-19 than patients who were consistently meeting PA.	PA was strongly associated with a reduced risk for severe COVID-19 outcomes among infected adults.
Cunningham 2021. USA	Cases of death	Cross-sectional study	Population > 65 years of age from 3142 countries USA	Regression estimation models	PA rates moderated the relationship between cases and deaths	The benefit of PA during the Pandemic and reduction in cases of death.
Christensen et al. 2021. USA	Symptoms of COVID-19 and physical capacity	Cohort study	2,690 adults aged 40–69 years	Submaximal test on a cycle ergometer. Tests for COVID- 19	lower risk of death in patients with moderate or high cardiorespiratory capacity, but no association with positive tests	Elevated cardiorespiratory capacity. Decreased risk of death from COVID- 19
Chastin, et al., 2021. USA	PA levels on Infectious disease	Randomized Controlled Study	120 participants aged between 20 and 80 years diagnosed with COVID-19	Exercise and Standard Therapy	The PA group showed more significant improvement in the dyspnea scale, duration of cough, and length of hospital stay.	Improved lung function, dyspnea, and cough in patients with severe cases
Economos, et al., 2021. USA	PA on outcomes of COVID- 19 with obesity.	Cohort study	452 participants aged 31– 51 years evaluated for COVID-19	Assessment of PA, Body Mass Index, Comorbidities, and daily habits	Physical activity is associated with a lower risk of moderate cases of COVID-19.	PA can be an effective approach to minimize the severity of COVID-19
Andrews, et al., 2022. USA	History of physical activity on the symptoms of COVID- 19	cohort study	452 participants aged 31– 51 years evaluated for COVID-19	Assessment of weekly physical activity, Body Mass Index, Comorbidities, and daily habits.	A lower risk of moderate illness in the category with the highest Physical Activity Level.	PA can be an effective approach to minimize the severity of COVID-19.
Nieman, et al. 2022. USA	PA lowers the risk of acute respiratory infections	Cohort Study	n = 48,440 adult patients in Kaiser Permanente, California with confirmed COVID-19. USA	Estimated for COVID-19 outcomes, covariates, and PA categories	The lowered risk for severe COVID-19 physically active groups is attributed to exercise-induced immune-protection effects, including enhanced surveillance of key immune cells, and reduced chronic inflammation	The risk for ARIs is lower in cohorts who engage in appropriate levels of moderate-to-vigorous physical activity
Brawner et al. 2021. USA	Inverse Relationship of Maximal Exercise to Hospitalization Secondary to COVID-19	cohort study	Total of $n = 246$ adult patients with maximal exercise capacity test, positive for SARS-CoV-2. USA, 2020	Logistic regression, COVID- 19 hospitalization, and peak METs, with adjustment for covariates	Peak METs were lower among hospitalized patients vs. those not hospitalized.	Improving exercise capacity is associated with a lower risk of complications due to viral infections, such as COVID-19.
Rowlands et al. 2021. UK	Association between accelerometer-assessed PA and severity of COVID-19 in the UK.	Cohort study	n = 91,248 adults, UKBB study; $n = 207$ with confirmed COVID-19, n = 124 severe.	Logistic regression, severe COVID-19 with PA, and sleep/rest variables	The odds of severe COVID-19 were 25% lower for every 30 min/day MVPA.	Physical activity was associated with lower odds of severe COVID-19 with stronger associations in women than men
Després,2021. Canada	Severe COVID-19 outcomes the role of physical activity	Cohort study	sample of 48,440 adult patients with a COVID-19 diagnosis	Obesity has been identified as a contributing factor to morbidity and mortality associated with COVID-19	A sedentary lifestyle is not only a risk factor for chronic diseases but also severe COVID-19 complications and death.	Inexpensive and simple behavior such as a daily 30-minute walk 5 days per week could have a substantial effect on the risk of developing severe COVID- 19 outcomes

Table 1. General characteristics of the included research papers

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Cho, et al. 2021. S. Corea	Physical Activity and the Risk of COVID-19 Infection and Mortality	RCT	(n = 125,772) were randomly selected from the Korean National Health Insurance Service database	PA with Case pts defined as individuals over 18 years old with positive results for the SARS-CoV-2 evaluate	PA has been shown to reduce the risk of serious community-acquired infections as well as mortality.	Regular PA was associated with lower risks of COVID-19 infection and mortality, highlighting the importance of maintaining appropriate levels of physical activity.
Kogel, et al., 2023. UK	PA as a treatment for persisting symptoms post- COVID infection.	RCT	Seventy-two patients with symptoms of fatigue persisting over 6 weeks post-COVID infection were screened. Fifty-seven patients consented and were randomized to 4 weeks of supervised personalized strength and endurance training.	4 weeks of two to three times weekly personalized strength endurance training	The improvements in fatigue and quality of life were not statistically different between the training and usual care groups	Fatigue and quality of life improve over time in individuals who are willing to participate in a training study irrespective of their allocation.
Salgado-Aranda, et al., 2021. Spain	Mortality	Cohort study	520 patients hospitalized COVID-19 infected participants (mean age: 54.6, Range: 42.9-64.6)	All patients were contacted by telephone after hospital discharge. Baseline physical activity level	Patients with a sedentary lifestyle had increased COVID-19 mortality independently of other risk factors previously described (hazard ratio 5.91 (1.80-19.41); p = 0.003).	A baseline sedentary lifestyle increases the mortality of hospitalized patients with COVID-19. This finding may be of great utility in the prevention of severe COVID- 19 disease.
Lee, et al. 2022 South Corea	PA and the risk of SARS- CoV-2 infection, and mortality in South Korea.	RCT	212 768 Korean adults (age ≥20 years)	Data obtained from adults who evaluated for SARS-CoV-2, from 1 January 2020 to 30 May 2020, were obtained from the National Health Insurance Service of South Korea.	Adults who engaged in both aerobic and muscle strengthening activities according to the 2018 physical activity guidelines had a lower risk of SARS-CoV-2 infection (2.6% vs 3.1%; adjusted relative risk severe COVID-19 illness-related death than those who engaged in insufficient aerobic and muscle strengthening activities.	Adults engaged in physical activity were associated with a decreased 1 of SARS- CoV-2 infection, severe COVID-19 illness, and COVID-19-related death. Engaging in physical activity has substantial public health value and demonstrates potential benefits to combat COVID-19.
Ahmadi et al. 2021 United Kingdom	Mortality	Cohort Study	468,569 participants (mean age: 56.5 ± 8.1)	Physical activity Questionnaire (IPAQ short version)	Among physically active individuals decreased mortality was detected (RR: 0.70, 95% CI: 0.54- 0.89)	In middle-aged and older adults, including those with cardiovascular disease and cancer, healthier lifestyle behaviors may protect against the most severe consequences of infectious disease.

MVPA = Moderate to Vigorous Physical Activity; PA= Physical Activity RCT = Randomized Control Trial

In this regard, epidemiologists have explored the probable benefit of moderate to vigorous physical activity on SARS-Cov-2 symptoms and stated positive results (Sallis et al., 2021; Lee et al., 2022; Cunningham et al., 2021; Chastin et al., 2021). As a result, this systematic literature review summarizes and appraises the available evidence regarding the possible benefit of moderate to vigorous physical activity on SARS-Cov-2 symptoms. In sum, the results of the present systematic literature review show a large benefit of physical activity on COVID-19 symptoms. Mainly, two Randomized Control trial studies (Cho et al., 2021; Lee et al., 2022) and three cohort studies (Ahmadi et al., 2021; Nieman et al., 2022; Rowlands et al. 2021) have reported that aerobic and muscle-strengthening activities were associated with a lower risk of SARS-CoV-2 infection and severe COVID-19 outcomes in adults' population. In contrast, one randomized control trial reported that there is not sufficient information to support such results (Kogel et al., 2023). According to this author, the improvements in fatigue and quality of life were not statistically different between the training and usual care groups (Kogel et al., 2023).

It is important to note that this Randomized control trial has a small sample size and the study lasted only four weeks. On the other hand, all the studies that reported positive outcomes such as two Randomized Control trial studies (Cho et al., 2021; Lee et al., 2022) and three cohort studies (Ahmadi et al., 2021; Nieman et al., 2022; Rowlands et al. 2021) have a large sample size (n=125,772, n=212768, and n=468,569, n=48440, n=91248, respectively). With the proven result regarding this large sample size, physical activity is proven to boost the immune system because strong immunity offers more potent protection and a better response against viral illnesses. Moreover, being physically active is an effective modality in managing chronic diseases such as diabetes, and hypertension. According to Cunningham, aerobic exercises and strength training can help stay physically active and improve individual health and it is a contributing factor in the prevention and treatment of SARS-Cov-2 (Cunningham, 2021). 150 min of moderate or 75 min of high-intensity physical activity, with a frequency of 3 to 5 days, is enough for better mental and physical well-being and a lower prevalence of COVID-19 symptomatology (Malisoux et al., 2022). Cardiovascular physical activity such as walking, climbing stairs, and running among others is encouraged with a strength training frequency of 2 to 3 sessions per week (Tsenoli, et al, 2021). Individuals, who were physically active and diagnosed with COVID-19, have attenuation of clinical outcomes, such as the decreased risk of hospitalization, recovery time, number of symptoms, severity, and ICU and death when compared to individuals with low levels of PA or classified as sedentary (Woods et al., 2021). High-intensity exercise alters the morphology of the cardiac system and function in long-term symptoms, by improving glucose metabolism and reducing muscle wasting and inflammatory response (Rasmussen et al., 2021). During this pandemic, sedentarism and physical inactivity have increased; as a result, it compromises immune functions, decreases recovery, and increases the infection rate, suggesting that physical activity such as walking 30 to 45 minutes a day is one of the most complementary tools in preventing SARS-Cov-2 infection and reducing symptoms (Park et al., 2020). It is effective for both preventing and treating hypertension, obesity, heart diseases, diabetes, and eight types of cancers, all

of which increase the risk of severe illness and death among those infected with SARS-Cov-2. Therefore, it is widely recommended by health authorities throughout the world, and efforts to promote active lifestyles are minimal (Cerasola et al., 2022). Encouraging and assisting individuals, especially those with chronic conditions such as diabetes, hypertension, and obesity, to be moderately active to reduce SARS-Cov-2 symptoms and severity. Moreover, one study reported physical activity's immunity and inflammation benefits are seen in most of the high-risk groups listed above (Kogel et al., 2023). In the same context, each session of physical activity has acute effects on immune functioning and inflammation, like taking medication daily, people can reduce their risk of severe viral infections and their risk from multiple chronic diseases by walking. It is not too late for people to benefit from modest increases daily in their physical activity. Visceral obesity represents one of the strongest predictors of hospitalization in COVID-19-infected patients and intensive care units. According to Ahmadi, et al, visceral adipose tissue increased systemic and local inflammation due to the enhancement of expression of pro-inflammatory cytokines, determining health status changes (Ahmadi et al., 2021). This also applies to childhood obesity. Physical inactivity has been identified as a risk factor along with biological, psychosocial, and behavioral aspects (Rowlands et al., 2021). Adolescents who did less physical activity were more likely to be overweight or obese and less likely to have strong prior physical activity habits (Sallis et al., 2021). Staying active should help minimize these risks and may help adults with underlying conditions (obesity) recover from SARS-Cov-2 if they become infected.

Impact of physical inactivity on the response of the immune system during COVID-19: Physical inactivity can lead to heart disease even for people who have no other risk factors. It can increase the likelihood of developing other heart disease risk factors, including obesity, high blood pressure, high blood cholesterol, and type 2 diabetes (Brawner, et al, 2021; Després, 2021). Habitual outdoor physical activity is known to promote vitamin D synthesis through the interaction between ultraviolet radiation and 7-dehydrocholesterol in the skin (Carter et al., 2020). Cloosterman, et al, found that physical exercise did not increase the risk of contamination in street runners or show an association with symptoms caused by COVID-19 (Cloosterman et al., 2020). In addition, a 2-week exercise protocol, at moderate intensity, led to an improvement in the immune response such as leukocytes, lymphocytes, and immunoglobulin A in 30 patients from 24 to 45 years old (15 males and 15 females), in addition to decreased progression of the disease, from the score obtained by the Wisconsin upper respiratory symptom survey (Mohamed et al., 2021; Gomide et al., 2022). Finally, the findings showed that physical exercise was negatively associated with cases of death caused by COVID-19, in addition to a lower risk of contamination by SARS-Cov-2 disease.

In sum, the findings of the present review are consistent with the previous studies revealed that moderate to vigorous physical activity was associated with a 10% lower risk of COVID-19 infection and a 53% lower risk of COVID-19 infection-related mortality, independent of confounding factors (Cho, *et al.* 2021; Cerasola *et al.*, 2022; Andrews *et al.*, 2022). Furthermore, the highest quintile of physical activity (\geq 1500 MET-min/week) was associated with a 25% and 77% lower risk of COVID-19 infection and mortality, respectively, compared with the physically inactive group (Cho, et al. 2021). Physical activity has favorable effects on these physiological mechanisms. During physical activity, muscles produce compounds that improve the functioning of the immune system and reduce inflammation. Thus, physical activity strengthens the two biological processes that react to the infection (Sallis et al., 2020). The findings of the present review also support previous studies that revealed physical activity enhances immune function and reduces inflammation, which directly reduces infectious disease severity (Economos et al., 2021). Antibody responses to hepatitis A, hepatitis B, influenza A, tetanus, and rabies vaccines suggest a decrease in immune responsiveness among people with obesity. For, Chastin et al., suggested that physical activity increases the percentage of older adults who have a sufficient antibody response to certain vaccines (Chastin et al., 2021). It is well recognized that moderate to vigorous physical activity is associated with reduced risk of SARS-Cov-2 symptoms, hospitalization, and mortality, enhances the first line of defense of the immune system, and increases the potency of vaccination.

Increased isolation is worsening mental health and inactivity, both of which impair immune function, further increasing susceptibility to COVID-19 infections and making the symptoms severe followed by hospitalization and even death. Therefore, it is vital for human well-being around the world, and it is the best health and free health insurance that everyone can have. In addition, the relationship between physical activity and immune function has the potential to mitigate and reduce the effects of COVID-19 and improve vaccine response in all people, including those with obesity. The authors also found a significant association between emphasizing that moderate-intensity activities, such as walking, could have immediate beneficial immune function, impacts on inflammatory responses, mental health, and vaccine responsiveness, all of which could reduce the severity of COVID-19 in people with obesity (Meyer et al., 2020). Evaluation of vaccine efficacy was needed in a setting of ongoing SARS-CoV-2 transmission. Vaccine effectiveness against symptomatic disease caused by the omicron variant is lower than with the Delta variant. After two doses, vaccine effectiveness waned rapidly, with limited vaccine effects seen from 20 weeks after the second dose of any vaccine (Andrews et al., 2022). The benefits of physical exercise include improvements in cardiovascular and respiratory health, better regulation of blood sugar, the potential to reduce or eliminate prescription medications (diabetes or blood pressure), weight loss, reduction in cancer risk, and improved musculoskeletal strength as well as spirituality. In addition, individuals who regularly practice physical activity and are diagnosed with SARS-Cov-2 presented positive outcomes like reduced risk of hospitalization, rapid recovery time, reduced number of symptoms, severity, and even death when compared to those with low levels of physical activity.

Strengths and Limitations: The current review has some strengths worth mentioning, first, this research included a strategy focused on convincing evidence obtained from these different methods and prospective studies with a thorough check for duplicate data, the comprehensive quality assessment of the primary studies, the extensive range of outcomes analyzed, and the focus on objectively measured outcomes.

Second, nine out of the fifteen included studies were cohort studies with a long follow-up period as large sample sizes in most of the studies. Third, the included studies were conducted on populations from the entire world. The limitation of this research is that multiple types of research papers were combined with information without the precise source and there were not enough clinical trials. In addition, the evidence base is not large enough currently to be able to understand more precisely the impact of time, duration, frequency, and intensity of physical activity in different populations and for different infectious diseases and vaccinations.

CONCLUSION

Regular physical activity is strongly associated with a reduced risk for severe COVID-19 outcomes among infected adults. Exercising continuously improves mental and physical health. It boosts the immune system, helps maintain weight, prevents chronic conditions, reduces symptoms of stress and anxiety, and will even help defend against COVID-19. Therefore, public health authorities should develop strategies and initiatives that promote safe physical activity environments to improve the clinical prognosis of people diagnosed with COVID-19. It can reduce high blood pressure, help manage weight, and reduce the risk of heart disease, stroke, type 2 diabetes, and various cancers; as a result, all conditions can increase susceptibility and severity to COVID-19 infection (Nieman et al., 2022). Regular and appropriate intensity levels of exercise reinforce the immune system in respiratory infections such as COVID-19 including increased immune vigilance and improved immune competence.

Declaration

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