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Yoga and Physical Exercises as Immunogenic Fortifiers for Coronavirus Vaccine Responses

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Abstract Background and aim: Coronavirus has emerged as a pandemic leading to pneumonia and death in susceptible populations, especially in immunocompromised hosts and the elderly. Though national governance and drug firms work in cohesion to develop vaccines, the fear and anxiety towards misconceptions about vaccine efficacy and adverse effects lead to underutilization of the vaccines. Though known for its immunogenic responses against infections, conservative lifestyle modifications such as Yoga and physical exercise's synergistic effects with coronavirus vaccine's immunogenic response remains unknown. **Methods:** We administered a systematic search on the contemporary evidence investigating the immune responses of physical activity or Yoga in three databases: PubMed, Embase and

Web of Science. In the present review, we reviewed the empirical evidence that explored the role of Yoga and physical exercise as an immunity booster and extrapolated their effects against coronavirus infection. **Results:** We found sixteen articles emphasizing physical activity to augment immune responses towards Coronavirus. **Discussion and Conclusion:** Considering the contemporary evidence, complementary therapies such as Yoga or physical activity are speculated to improve the influenza vaccines' immune responses. We recommend that Yoga and physical exercises be affordable, practical and effective strategies that could be advocated along with vaccination doses. We hope the present review may help readers and policymakers explore complementary therapies that could be administered as adjuncts to vaccine-

mediated immunity in combating the deadly pandemic.

Keywords Coronavirus, Vaccine, Physical Exercises, COVID-19, Yoga

1. Introduction

Since its outbreak in December 2019, the Covid-19 virus has caused substantial morbidity and mortality globally. In spite of consecutive six weeks of decline and global vaccination drives, over 2.6 million new cases have been reported with a 7% increase compared to the previous weeks, but the death rate is dropped down [1]. The goal of global vaccination, which is underway, is to attain herd immunity and protect against the transmission in susceptible individuals. Physical activity in any form is speculated to protect against COVID-19 through increased adapted immunity mechanisms. Physical activity may include sports activities, Yoga, aerobics, running and other outdoor games [2]. Yoga is a traditional form of physical activity, and an ancient art of mindbody balance practiced in India for centuries. Yoga and physical exercises are advocated globally for achieving physical and mental fitness, which are recommended for balanced living. Anecdotal evidence claims that the physical activities for maintaining homeostasis in noncommunicable diseases also reduce stress levels and boost the body's immune power [3]. The dearth of evidence behind the efficacy and delayed response to ongoing vaccination drives has forced various health agencies to continue preventive measures such as universal masking, social distancing and personal hygienic measures to prevent COVID-19 infection.

Further the immunogenic responses offered by COVID-19 vaccines may be further fortified by the immunogenic diet and active lifestyle behaviours such as Yoga or any

form of physical activities such as Tai-chi and calisthenics. Hence there is an urgent need to better understand the immune responses associated with COVID-19 virus and its vaccines. This may offer important insights into adaptive immune responses with the COVID-19, its vaccines and the physiological process by which active lifestyle behaviours can offer protection against the virus and its consequences.

We hypothesize that if Yoga and physical exercises are advocated along with vaccination trials, it may boost the immunogenic response to the COVID-19. In the present review, we analyzed the role of physical activity and Yoga as complementary therapies in augmenting and underlying immunity to coronavirus infection.

2. Methods

2.1. Search Strategy and Selection Criteria

We administered a search strategy designed with the help of a multidisciplinary team including a librarian MeSH terms "Coronavirus," "COVID-19," "SARS-CoV-2," and "Yoga and physical exercise and immunity" on January 12th, 2021. To be included, the studies should have administered physical activity or Yoga for improving immunity in any population. We have not excluded the studies based on the diseased population as we wished the present study findings should be generalized for the global population. Articles published in a language other than English were not included in the present review. Our sample search strategy administered in the Embase is "(physical activity/exp OR 'physical activity OR 'exercise'/exp OR exercise OR 'yoga'/exp OR yoga) AND ('immune system' OR immunity) AND 'coronavirus disease 2019'". We found 16 articles relevant and included for the final analysis and narrative synthesis (fig.1)

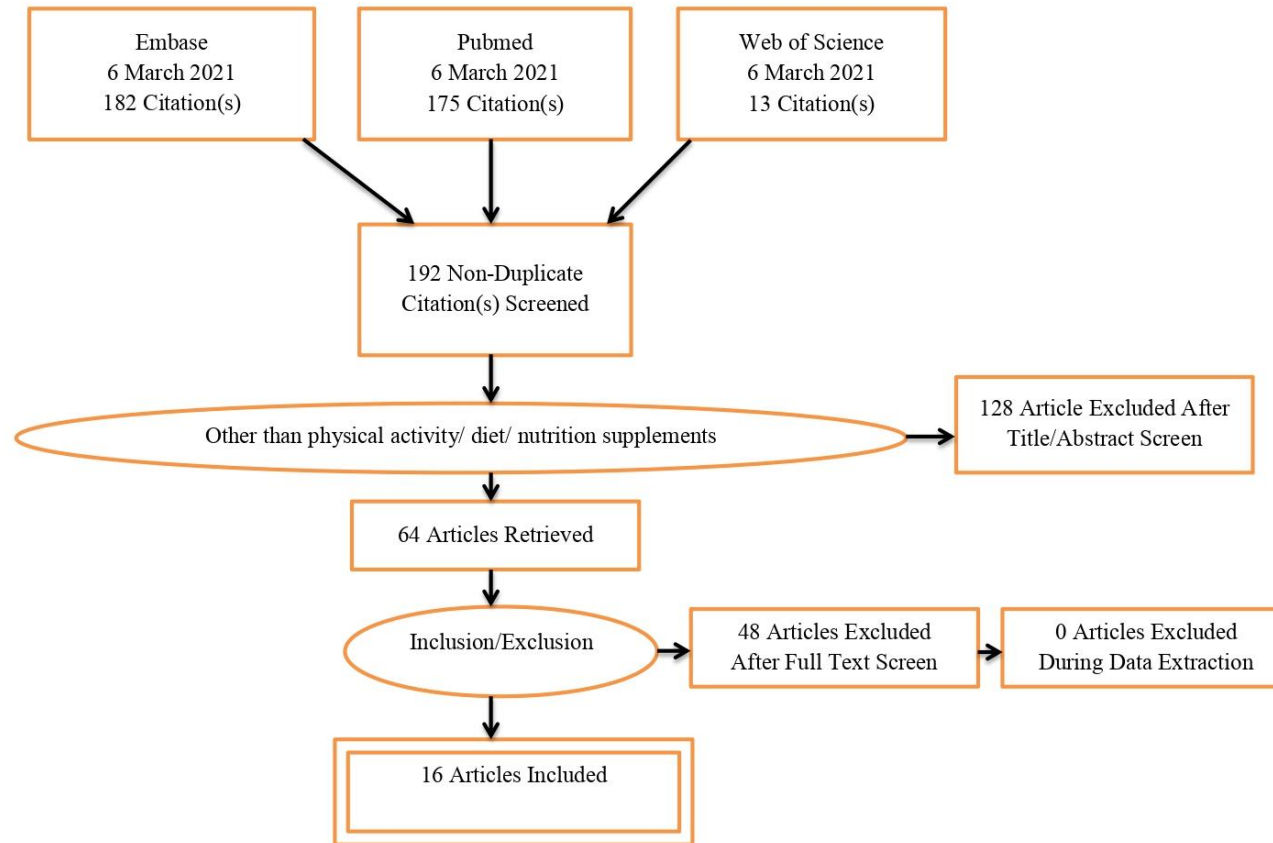


Figure 1. We found 16 articles relevant and included for the final analysis and narrative synthesis

3. Results

3.1. COVID-19, Immunity and Vaccines

Covid-19 is more likely to occur in older adults who have concurrent comorbidities and weaker immune functions [4]. Severe COVID-19 patients exhibit lymphopenia, reduced leukocytes and elevated neutrophils and inflammatory cytokines [4]. Virus linked pyroptosis, programmed cell death is often associated with COVID-19 virus infections [5]. Increased primary inflammation, coupled with reduced CD4 and T cells exhaustion after a week of COVID-19 symptoms, is responsible for perpetuating the viral replication [5]. The elevated inflammatory biomarkers are found to be associated with pulmonary inflammation and extensive lung damage. The vaccines are speculated to improve the lymphocytes count, especially cell-mediated immunity, to counter the future infection attack. However, the unopposed elevated neutrophils and proinflammatory cytokines such as interleukins continue to damage the body tissues, causing muscle atrophy, fatigue and neuropathic pain [6]. Thus, the immunogenic responses offered by the virus and the reduced lymphopenia may be combated by the lifestyle measures such as physical activity or Yoga.

3.2. Yoga/Physical Activity and T-cell Immunity

Physical activity is associated with neutrophilia and lymphocytosis though a window period of reduction of lymphocytes noted post-exercise for two hours [7]. Trained individuals showed a reduction in leucocytes during exercises, while the reduction is not severe during the window period, especially after exercises [7]. Moderate to vigorous physical activity, a primary pillar for healthy living increases macrophages, T lymphocytes and anti-inflammatory cytokines [8]. The lymphocyte responsiveness to mitogen was found better in trained individuals than untrained or sedentary individuals [7]. Besides, natural killer cells are found to be elevated in long-term exercising individuals. Hence, any form of exercise (Yoga or calisthenics) may promote immunogenic effects against primary infections. However, the contemporary evidence demonstrating dose-response effects on immunogenic responses are inconsistent.

3.3. Yoga/Physical Activity, Immunogenic Responses and Covid-19 Vaccines

The robust host's immunity is a critical mechanism that may aid to combat the COVID-19 infection. A significant clinical feature of COVID-19 has weakened immunity characterized by lymphopenia and raised C-Reactive Protein levels [9]. Frequent representation of older adults in cases infected with COVID-19 shows the possible role of immunopositivity that underlies their susceptibility to contagion. The magnitude and the outcome of the virus's

infection may be either the result of a successful inherent immune response that fights the COVID-19 virus, as shown in patients with mild clinical evidence of disease, or immunodeficiency be weakened often overwhelms the host's defense. Contemporary evidence has highlighted the positive effect of Yoga and physical exercises in controlling contagious illnesses such as influenza, tuberculosis, and immune deficiency syndrome, where the state of the immune system is a crucial factor in developing the disease [10]. Yoga and physical exercises have been found to prevent acute respiratory illness [11]. Previous studies have reported that breathing exercises have enhanced immunity, helping combat viral infections subsequently [12].

Despite the absence of empirical evidence of immunoprotection offered by physical activity to the Coronavirus, anecdotal evidence claims Yoga and physical exercise are explicitly connected to reduced mortality from respiratory diseases, better vaccination response, and general metabolic homeostasis [8]. Yoga and physical exercise are vital for the elderly as these vulnerable populations typically have significant comorbidities and are more prone to develop the disease than their younger peers [13]. Damiot et al [14] proposed that physically healthy people during their lifetime had favourable effects on immunosensitivity. The immunopositivity with complementary therapies such as physical activity or Yoga is crucial information for informing stakeholders to recommend Yoga or physical activity to prevent COVID-19.

Physical activity of moderate intensity is responsible for enhancing immune cells activity, immunoglobulin's, and anti-inflammatory cytokines, thus reducing the pathogenic load on organs such as the lung and reducing the risk of lung damage infiltration of inflammatory cells [15]. Inflammatory responses and stress factors are reduced during daily Yoga and physical exercise while lymphocytes, natural killer cells, and monocytes are elevated [3]. Therefore, there is an increase in immune vigilance and a decline in the systemic inflammatory response. Molecular mechanisms based on Yoga and physical exercise are known to increase or decrease interferons' levels, thus exhibiting a buffering action to restore an imbalance marked by either a suboptimal or an excessive expression of the immune response. Yoga and physical exercises could improve innate immune responses during incubation periods of viral infection by regulating the interferons [16]. The level of various immune cells and lymphocytes, and natural killer cells, know how to shift to homeostasis levels through Yoga and physical exercises [17]. Natural killer cells are innate lymphocytes that act as the first line's production against the spread and possible tissue damage to invasive viruses. Substantial evidence claims that proinflammatory markers, including interleukins (IL-2, IL-8, IL-10) and tumor necrosis factor-alpha, maybe down-regulated Yoga and physical exercises [3].

COVID-19 inflammation is correlated with

proinflammatory cytokines expressed by increased levels of cytokines, lymphopenia (T lymphocytes and natural killer cells) and decreased interferons expression in CD4 cells [18]. The contraction of the muscle during Yoga and physical exercise enhances the production of anti-inflammatory and proinflammatory cytokines (interleukins, interferons and tumor necrosis factor) in a duration and strength dependent manner [19]. Yoga or physical activity increases muscle contraction which in turn is known to trigger the calcium release followed by selectin secretion from the proinflammatory cytokines. This further improves the adapted immunity by increasing lymphocyte and neutrophils for immunosurveillance [20]. Physical activity was also responsible for increasing circulating leukocyte concentrations due to cutting immune cells, particularly

subsidiary lymphoid tissues, such as the spleen, liver and lungs in the blood vessels. After continuous Yoga and physical exercise, the leukocyte concentration remains high for 30-120 minutes, lasting up to 24 hours [21]. Hence, the available evidence favors Yoga or physical activity in the general population to augment underlying immunological mechanisms and may offer protection against COVID-19. Though limited evidence is available, we propose that Yoga or physical exercise may offer a synergistic effect for the inflammatory and immuno-protective effects due to COVID-19 vaccination. Figure 2 represents postulated mechanisms by which physical activity or Yoga may mediate the immunogenic responses of the Covid-19 virus and vaccines.

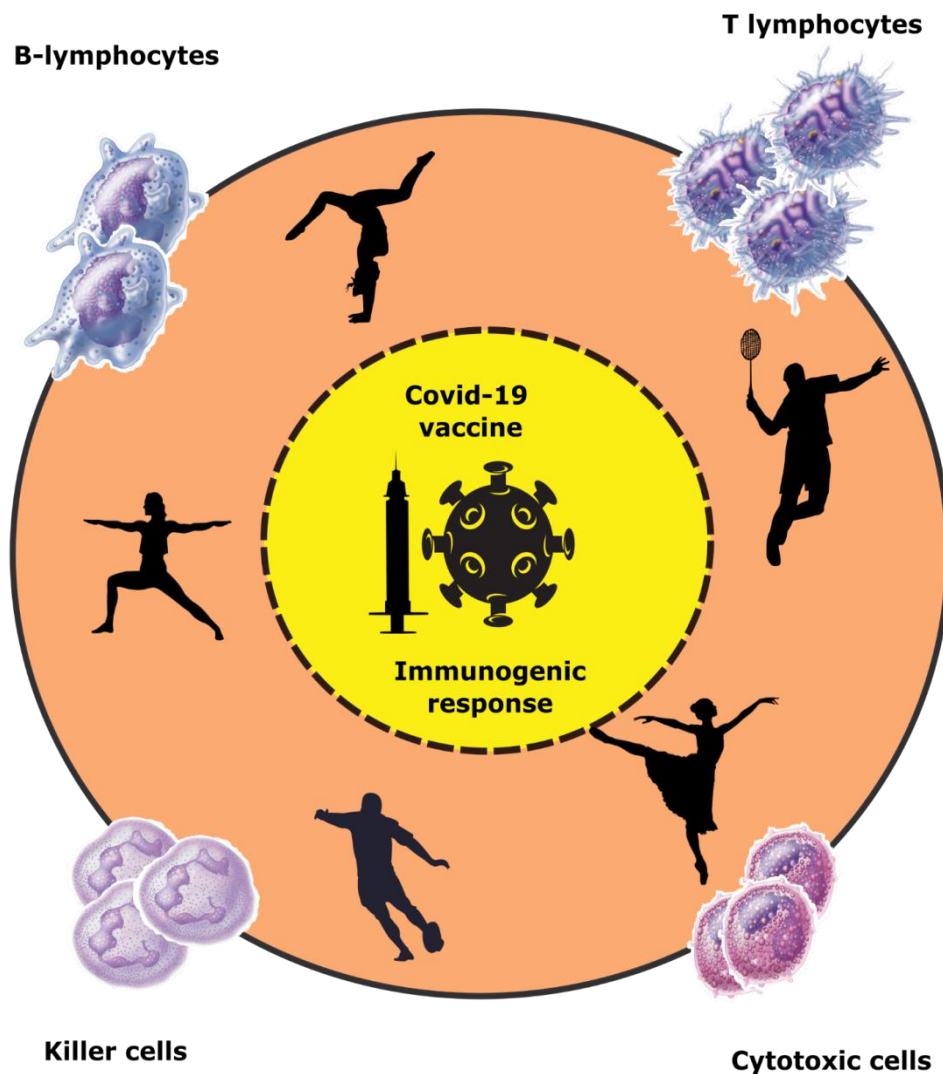


Figure 2. Represents postulated mechanisms by which physical activity or Yoga may mediate the immunogenic responses of the Covid-19 virus and vaccines

4. Conclusions

Yoga and physical exercise, which are known to enhance immunity, may augment the immune responses associated with vaccine trials. Thus, Yoga or physical activity can be integrated with the COVID-19 vaccine trials to enhance its immunogenic potential. We recommend pragmatic trials to advocate Yoga and physical exercises' role in enhancing immunogenic response to coronavirus vaccines.

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