Immunity benefits of yoga and physical exercises in the era of COVID-19 Pandemic

Karuppasamy Govindasamy 1ABCDE, Chandrababu Suresh 1BC, Mithin Anand 2BCD, Saran KS 3BCD, Mou Pramanik 4ABCD, Dilpreet Kaur 5ABCD, Imen Achouri 6BCD, Hiba Boughanmi 6BCD

1Department of Physical Education and Sports Science, College of Science and Humanities, SRM Institute of Science and Technology
2Govt. College of Physical Education, East Hill, Calicut, Kerala, India
3Department of Physical Education, C.K.G.Memorial Govt. College, India
4Department of Yoga, College of Science and Humanities, SRM Institute of Science and Technology, India
5Department of Physical Education, Chandigarh University, India
6Department of Physical Education & Sports Science, Higher Institute of Sport and Physical Education, Tunisia

Authors’ Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript preparation; E – Funds Collection

DOI: https://doi.org/10.34142/HSR.2022.08.03.08

How to Cite

Abstract

Purpose. The novel coronavirus is the recently emerged disease of the respiratory system for which various national and international research agencies are putting joint efforts towards finding a permanent cure. Recently, the vaccine against coronavirus has been designed by various pharmaceutical agencies that are currently undergoing clinical trials. Since vaccines prevent infection by strengthening the defense system of the body, we proposed that yoga and physical exercises could act as an integrative approach to synergize the immunogenic response of the coronavirus vaccine. Yoga and physical exercises are already known to boost immunity against several other infections.

Materials and Methods. In the present review article, we aimed towards exploring the role of yoga and physical exercise as an immunity booster against coronavirus infection. Being India is a low-income country, yoga and physical exercises could be an excellent cost-effective strategy that could be administrated along with vaccine trials to enhance immunity against virus infection.

Results. In the present review, we analyze the studies conducted to date focusing on finding the role of yoga and physical exercises to prevent coronavirus infection. We also described the potential exercises, which are already known to enhance the immunity of the body by particularly targeting respiratory disease.

Conclusion. The present review article will help in providing the health agencies potential targets, which could further be explored to established a standard exercise module to enhance the vaccine-mediated immunity against coronavirus infection.

Key Words: coronavirus, vaccine, physical exercises, COVID-19, yoga
Анотація

Каруппасамі Говіндасамі, Чандрабабу Суреш, Моу Праманік, Ділпріт Каур, Імен Ачурі, Хиба Боганмі.

Польза йоги і фізичних упражнень для іммунитету в епоху пандемії COVID-19

Цель.
Новий коронавірус — це недавно появився хвороба дихальної системи, від якої різні національні та міжнародні дослідницькі агенції докладають спільних зусиль, щоб знайти постійне лікування. Нещодавно різними фармацевтичними агенціями була розроблена вакцина проти коронавірусу, яка зараз проходить клінічні випробування. Оскільки вакцини запобігають інфекції шляхом зміцнення захисної системи організму, ми запропонували йогу та фізичні вправи діяти як інтегративний підхід до синергії імуногенної відповіді вакцин проти коронавірусу. Вже відомо, що йога та фізичні вправи зміцнюють імунітет проти кількох інших інфекцій.

Матеріали та методи.
У цій оглядовій статті ми мали на меті дослідити роль йоги та фізичних вправ як засобів підвищення імунітету проти коронавірусної інфекції. Нещодавно Індія є країною з низьким рівнем доходу, йога та фізичні вправи можуть бути чудовою економічно ефективною стратегією, яку можна застосовувати разом із випробуваннями вакцин для підвищення імунітету проти вірусної інфекції.

Результати.
У цьому огляді ми аналізуємо дослідження, проведених на сьогоднішній день, зосереджені на з'ясуванні ролі йоги та фізичних вправ у запобіганні зараження коронавірусом. Ми також описали потенційні упражнення, які вже відомі для підвищення імунітету організму, особливо спрямованого на респіраторні захворювання.

Висновок.
Ця оглядова стаття допоможе надати агентствам охорони здоров’я потенційні цілі, які можна було б додатково вивчити, щоб створити стандартний модуль вправ для посилення вакциноопосередкованого імунітету проти коронавірусної інфекції.

Ключові слова: коронавірус, вакцина, фізичні вправи, COVID-19, йога

Аннотация

Каруппасам Говиндасам, Чандрабабу Суреш, Моу Праманик, Дилприт Каури, Имен Ачури, Хиба Боганми.

Польза йоги и физических упражнений для иммунитета в эпоху пандемии COVID-19

Цель.
Новый коронавирус — это недавно появившееся заболевание дыхательной системы, для которого различные национальные и международные исследовательские агентства прилагают совместные усилия для поиска постоянного лекарства. Недавно вакцина против коронавируса была разработана различными фармацевтическими агентствами, которые в настоящее время проходят клинические испытания. Поскольку вакцины предотвращают инфекцию, укрепляя защитную систему организма, мы предположили, что йога и физические упражнения могут выступать в качестве интегративного подхода для синергизма иммуногенного ответа вакцины против коронавируса. Уже известно, что йога и физические упражнения повышают иммунитет против некоторых других инфекций.

Материалы и методы.
В настоящей обзорной статье мы стремились изучить роль йоги и физических упражнений в качестве усилителя иммунитета против коронавирусной инфекции. Поскольку Индия является страной с низким уровнем дохода, йога и физические упражнения могут стать отличной рентабельной стратегией, которую можно применять вместе с испытаниями вакцин для повышения иммунитета против вирусной инфекции.

Результаты.
В настоящем обзоре мы анализируем проведенные на сегодняшний день исследования, посвященные выявлению роли йоги и физических упражнений в профилактике коронавирусной инфекции. Мы также описали потенциальные упражнения, которые, как уже известно, повышают иммунитет организма, в частности, нацелены на респираторные заболевания.

Вывод.
Настоящая обзорная статья поможет предоставить агентствам здравоохранения потенциальные цели, которые можно было бы дополнительно изучить для создания стандартного модуля упражнений для повышения опосредованного вакцинной иммунитета против коронавирусной инфекции.

Ключевые слова: коронавирус, вакцина, физические упражнения, COVID-19, йога
Introduction

The organized, coordinated, and repeated movement of body parts created by skeletal muscles that result in energy expenditure is known as physical exercises. Physical exercise can include sports activity, yoga, aerobics, running and other outdoor games [1]. Yoga is the traditional an ancient art of mind body balance which is practiced in India from centuries. Yoga and physical exercises are popular worldwide for achieving physical and mental fitness and are recommended as core elements of balanced living. Yoga and physical exercise, besides managing excess body weight, helps in fighting communicable diseases which may include viral infections, systemic inflammation and chronic non-communicable diseases. A large volume of studies has highlighted the applications of physical activities in maintaining homeostasis in non-communicable diseases also by lowering stress levels and boosting of immune power of the body [2]. Due to the lack of allopathic treatment of recently emerged novel coronavirus disease, various strategies such as social distancing and personal sanitization has been recommended by various health agencies to prevent COVID-19 infection. Health agencies have recommended that individuals should take necessary protective steps to increase their immunity, strengthen the respiratory system, and alleviate fear, fatigue, and depression. Currently, vaccines have been designed by various pharmaceutical companies to activate the body defense system to prevent coronavirus infection [3].

Since vaccines prevent viral infection by strengthening the immune system of the body, we proposed that if vaccine trials are integrated with yoga and physical exercises, it can help in boosting the immunogenic response of the coronavirus vaccine. In the present article, we performed an integrative analysis of literature on the role of physical activity in enhancing immunity against coronavirus infection. For this, the bibliographic analysis performed for the knowledge of respiratory diseases, effects of physical activity on the immune system and indicated an understanding of the latest research on coronavirus infection immunopathogenesis, including its interaction with the physical and health conditions of the host.

Materials and Methods

Search Strategy and Selection Criteria

References for this review were identified through searches of PubMed for articles published by the use of the terms “Coronavirus,” “COVID-19,” “SARS-CoV-2,” and “Yoga and physical exercise and immunity.” Relevant articles published were identified through searches in the authors’ files, in Google Scholar, Research Gate, and Springer Online Archives Collection. Materials resulting from these searches and relevant references cited in those articles were reviewed, and information from relevant articles was incorporated in the present review. Articles published in a language other than English were not included in the present review. 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).

Results

Novel Coronavirus COVID-19 Pandemic

The novel coronavirus is a disease of the respiratory system, which is caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). In February 2020, the world health organization declared the name COVID-19 to coronavirus infection [4]. The outbreak of novel coronavirus occurred from the Wuhan city of China in December 2019 by the zoonotic transmission of viruses from animals to humans. COVID-19 is the fourth emerged novel coronavirus after HCoV-229E, SARS, and MERS-CoV [5]. Being contagious, the disease is spreading fiercely around the world within weeks taking the form of a pandemic. The infected person shows the symptoms of fever, fatigue, cough, chest congestion, difficulty in breathing, and inflammation in the lungs [6]. The appearance of symptoms may take a week after the infection, which makes it very difficult to diagnose the infection based on symptoms. Molecular testing methods that confirm the three viral genes- E, RdRp and N, in nasopharyngeal and oropharyngeal swabs using the
RT-PCR can diagnose disease before the appearance of symptoms [5], but due to the high cost and requirement of sophisticated laboratory facilities, mass testing is not feasible at the time of an outbreak. Due to unavailability of cheap detection method and specific pharmaceutical treatment or vaccine of the viral infection, alternative strategies which could limit the infection, is implemented all around the world. The worldwide outbreak of the pandemic of COVID-19 has contributed to a massive global health crisis. In contrast to seasonal influenza, SARS-CoV-2 mainly spreads through droplets, and is suggested to have greater transmissibility. Due to spread of COVID-19 via asymptomatic or minimally symptomatic individuals who do not pursue any clinical examination, pandemic emerges as a major health concern [7].

Fig. 1. Flowchart showing the search strategy and inclusion of studies from the peer reviewed data bases

<table>
<thead>
<tr>
<th>Immune Component</th>
<th>Function</th>
<th>Role of Yoga and Exercise</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cytokines</td>
<td>Inhibition of pro-inflammatory cytokines production including IL-1, IL-2, IL-12, IL-18, IFN-γ and TNF-α</td>
<td>Muscle contraction during exercise leads to upregulation of anti-inflammatory and pro-inflammatory cytokines by</td>
<td>[17]</td>
</tr>
<tr>
<td>Neutrophils</td>
<td>Recruit inflammatory mediators like TNF-α and IL-1β</td>
<td>Aerobic exercise led to significant reduction in neutrophil</td>
<td>[18]</td>
</tr>
<tr>
<td>Leukocytes</td>
<td>Fight infection and defend the body against other foreign material</td>
<td>Physical activity enhances concentration of circulating leukocyte</td>
<td>[19]</td>
</tr>
<tr>
<td>Natural killer cells (NKs)</td>
<td>Control several types of tumors and microbial infections</td>
<td>NK cells enhance due to cellular stress promoted by physical exercise</td>
<td>[20]</td>
</tr>
</tbody>
</table>

**Table 1**

**Immune Compromisation in COVID-19**

Immune response of the body act at two levels, innate immunity and adaptive immunity. The innate immune response involves the physical and chemical barriers which restrict the entry of pathogen in the body. Certain immune cells such as macrophages, dendritic cells, natural killer cells,
neutrophils are part of innate immunity. Apart from the cellular barriers, there are molecular barriers such as cytokines, interleukins, nitric oxide and anion superoxide which eliminate the invading pathogen. The more specific immune response is adaptive immunity which has cellular barriers made up of T lymphocytes and B lymphocytes and their products, such as antibodies and cytokines [2]. The host's immunity is an essential factor to promote infection eradication. Severely affected COVID-19 patients exhibit the compromised immune systems indicated by lymphopenia and elevated levels of C-reactive protein. Fever, exhaustion, and dry cough are predominant symptoms present in patients with COVID-19. Most patients have a better prognosis, but elderly patients and those with chronic underlying disorders may have worse outcomes [8]. In the early infection stages, patients are usually afebrile with only chills and respiratory symptoms [9]. The clinical symptoms may range from asymptomatic or moderate symptomatic to extreme forms of respiratory failure that may require ventilation support in the intensive care unit (ICU). Additional symptoms may involve sepsis, septic shock, and multiple organ dysfunction syndromes or multi-organ and systemic manifestations [10].

Fig. 2. Body immune response against coronavirus [11].

Table 2

<table>
<thead>
<tr>
<th>Study Type/Name</th>
<th>Study Population and Duration</th>
<th>Type of intervention</th>
<th>Outcomes assessed</th>
<th>Main Findings</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effect of integrated yoga practices on immune responses in examination stress-A preliminary study</td>
<td>60 first year MBBS students randomly assigned to control and yoga group</td>
<td>Integrated yoga practice for 35 minutes daily for 12 weeks</td>
<td>IL-4 and INF-γ level</td>
<td>Decrease in serum IL-4 and INF-γ level</td>
<td>[27]</td>
</tr>
<tr>
<td>Randomized trial of yoga as a complementary therapy for pulmonary tuberculosis</td>
<td>pulmonary tuberculosis patients</td>
<td>Yoga for 60 minutes per day, six time per week along with regular treatment for pulmonary tuberculosis</td>
<td>Symptom score</td>
<td>Reduced symptom score was found in yoga group</td>
<td>[28]</td>
</tr>
<tr>
<td>Effects of prenatal yoga on women's stress and immune function across pregnancy: A randomized controlled trial</td>
<td>94 healthy pregnant women</td>
<td>20-week yoga intervention</td>
<td>Salivary cortisol and IgA</td>
<td>Yoga group exhibit high cortisol and low IgA</td>
<td>[29]</td>
</tr>
<tr>
<td>Gene expression profiling in practitioners of Sudarshan Kriya</td>
<td>42 practitioners of Sudarshan Kriya</td>
<td>Gene expression in control vs. practitioners of Sudarshan Kriya</td>
<td>Antiapoptotic genes and antioxidant genes</td>
<td>Level of lymphocytes is upregulated due to high expression of</td>
<td>[30]</td>
</tr>
<tr>
<td>Study</td>
<td>Participants</td>
<td>Intervention</td>
<td>Outcomes</td>
<td>References</td>
<td></td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>--------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
<td>------------</td>
<td></td>
</tr>
<tr>
<td>Yoga stretching for improving salivary immune function and mental stress in middle-aged and older adults</td>
<td>23 adult women</td>
<td>Yoga practice for 90 minutes</td>
<td>Salivary cortisol and IgA increase in IgA level</td>
<td>[22]</td>
<td></td>
</tr>
<tr>
<td>Effects of meditation on the T-lymphocytes, B-lymphocytes and natural killer cells production</td>
<td>11 experienced meditators</td>
<td>1 hour meditation for 4 months</td>
<td>B Cells and T cells, NK Cells CD45, CD3, CD5 and Cd8 level increase</td>
<td>[31]</td>
<td></td>
</tr>
<tr>
<td>Regular yoga practice improves antioxidant status, immune function, and stress hormone releases in young healthy people:</td>
<td>25 Healthy university students</td>
<td>Yoga practice for 60 minutes for 12 weeks</td>
<td>Oxidative stress and antioxidant components Low oxidative stress and high antioxidant levels</td>
<td>[32]</td>
<td></td>
</tr>
<tr>
<td>Impact of yoga-based mind-body intervention on systemic inflammatory markers and co-morbid depression in active Rheumatoid arthritis patients</td>
<td>72 Rheumatoid arthritis patients</td>
<td>8-week yoga</td>
<td>Systemic inflammatory markers Decreased level of systemic inflammatory markers</td>
<td>[33]</td>
<td></td>
</tr>
<tr>
<td>Comparative efficacy of a 12-week yoga-based lifestyle intervention and dietary intervention on adipokines, inflammation, and oxidative stress in adults with metabolic syndrome</td>
<td>260 young adults</td>
<td>12-week yoga based lifestyle intervention IL-6, TNF-alpha</td>
<td>Decreased level of inflammatory markers</td>
<td>[34]</td>
<td></td>
</tr>
<tr>
<td>Effect of Hatha yoga training on rhinitis symptoms and cytokines in allergic rhinitis patients</td>
<td>30 allergic rhinitis patients</td>
<td>Hatha yoga for 60 minutes/ 3 times per week/ for 8 weeks</td>
<td>Cytokine level Yoga group have high nasal secretion of IL-12</td>
<td>[35]</td>
<td></td>
</tr>
</tbody>
</table>
Coronavirus Vaccine Trials in India

Several biotech organizations, such as the Serum Institute of India, Bharat Biotech, PremaS Biotech, and Zydus Cadila, have been actively involved in vaccine trials. The Serum Institute of India has a rich history of developing tetanus, flu, rabies, measles, and mumps vaccines. With Codagenix, the Serum Institute of India is exploring the potential of a live-attenuated vaccine against COVID-19. Apart from deCodagenix, the Serum Institute of India has also collaborated with the New York-based firm to develop the COVID-19 vaccine. India also has a collaboration with Oxford University to develop the Oxford COVID-19 or ChAdOx1 nCoV-19 vaccine. Bharat Biotech in partnership with the University of Wisconsin and FluGen Inc., and Thomas Jefferson University, has is developing a one-drop nasal vaccine called "CoroFlu" against COVID-19. Besides, PremaS Biotech uses recombinant proteins to create the new COVID-19 vaccine with Aker's Biosciences jointly. Likewise, Zydus Cadila has developed a COVID-19 vaccine called ZyCoV-D [3].

Discussion

Yoga and physical exercises Can Boost Immunity against coronavirus

The host’s immunity is an essential condition to promote infection eradication and, therefore, to combat the COVID-19 infection, the host must possess and robust immune system. Patients infected with the coronavirus known to have a disturbed immune system [12]. An important clinical feature of COVID-19 is impaired immunity characterized by lymphopenia and elevated CRP levels [9]. The frequent representation of elderly people in cases infected with COVID-19 indicates the possible role of immunosenescence that underlies their vulnerability to the infection. The magnitude and outcome of the viral infection may be either the result of a successful cellular/innate immune response that fights SARS-CoV-2, as seen in patients with mild clinical signs of infection, or a state of immunosuppression weakens the host’s defense and often overwhelms it. Several studies have highlighted the positive effect of yoga and physical exercises in the management of communicable diseases like influenza, tuberculosis (TB), and acquire immune deficiency syndrome in which the state of the immune system is an essential factor in the development of the disease [10]. Yoga and physical exercises have been found to prevent acute respiratory illness [12]. Breathing exercises have been reported in previous studies to enhance immunity, which helps combat viral infections subsequently [13].

Despite the lack of reliable evidence on how physical activity strengthens the immune response to the coronavirus, multiple studies show that daily yoga and physical exercise is explicitly connected to reduced mortality from respiratory diseases, better vaccination response, and general metabolic homeostasis [14]. Daily yoga and physical exercise helps to strengthen the immune system while helping to reduce respiratory disorders and thereby defend against infections such as COVID-19 [15]. Yoga and physical exercise is much more critical for the elderly population, as these people typically have larger comorbidities and are more prone to developing the disease in comparison to the current coronavirus [16]. Proposed that people who have been healthy during their lives have less prominent features of immunosenescence, which could be a likely preventive factor against the occurrence of COVID-19 complications.

Innate and adaptive immunity function in a synchronized manner to fight against viral infections which otherwise can cause immunopathology. Physical activity of moderate strength is responsible for enhancing the anti-pathogenic activity of macrophages thus increasing the circulation of immune cells, immunoglobulins and anti-inflammatory cytokines, thereby reducing the pathogenic load on organs such as the lung and decreasing the risk of lung damage due to inflammatory cell infiltration [21]. Inflammatory responses and stress factors are reduced during daily yoga and physical exercise while lymphocytes, NK cells, immature B cells and monocytes are elevated. 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 the levels of INF-γ, thus exhibiting a buffering action to restore the imbalance marked by either suboptimal or excessive expression of immune responses. Yoga and physical exercises could improve innate immune responses during incubation periods of viral infection by regulating the IFN-γ levels [22]. The level of various immune cells including CD4, CD8, B-lymphocytes and Natural Killer cells, knows to shift towards homeostasis level via yoga and physical exercises [23]. NK cells are innate lymphocytes that act as the first line of protection against the spread and eventual tissue damage of invading viruses. The available evidence confirms that pro-inflammatory markers, including interleukin-1 (IL-1) beta, IL-6...
and tumor necrosis factor (TNF)-alpha, maybe downregulated by yoga and physical exercises [2].

Severe COVID-19 infection is correlated with cytokine storms represented by increased cytokine levels (IL-6, IL-10, and TNF-α), lymphopenia (in CD4+ and CD8+ T cells), and decreased IFN-γ expression in CD4+ T cells [24]. The contraction of the muscle during the yoga and physical exercise enhances the production of anti-inflammatory (IL-10 and TGF-β) and pro-inflammatory cytokines (IL-1, IL-2, IL-12, IL-18, IFN-γ and TNF-α) in a duration and strength dependent manner [25]. The stimulation of the muscle fiber during yoga and physical exercise is responsible for increasing the release of calcium (Ca2+) and thereby facilitating the synthesis of pro-inflammatory cytokines, namely TNF-alpha and IL-1β, which function in the production of selectins, which in turn draw neutrophils to the site [26]. Physical activity is also responsible for increasing circulating leukocyte concentrations due to the shearing of immune cells, especially secondary lymphoid tissues such as the liver, spleen and lungs, in the blood vessels. After continuous yoga and physical exercise, the leukocyte concentration stays high with a peak of 30-120 minutes, which can last for up to 24 hours [19]. For populations at risk or already suffering from COVID-19, yoga and physical exercises could be a complementary intervention.

**Conclusion**

Coronavirus vaccines are a promising measure to end to COVID-19 pandemic. The yoga and physical exercise, which is already known to enhance the immune response in many vaccine trials, could be integrated with the COVID-19 vaccine trials to enhance the immunogenic potential of the vaccine. Other advantages offered by yoga and physical exercise may include improved immune vigilance, enhanced immune competence, avoidance or elimination of overweight, improved physical and cardiopulmonary conditioning, attenuation of systemic pro-inflammatory and pro-thrombotic disorders, reduction of oxidative stress, improvement of glycemic, insulinic and lipid metabolisms, as well as improvement of the reaction to vaccination. Therefore, the studies which could highlight the role of yoga and physical exercises in enhancing immunogenic response to coronavirus vaccine should be conducted to establish a direct correlation.

**Acknowledgements**

Authors wish to thank Dr. R. Mohanakrishnan, Director of Sports, Department of Physical Education and Sports Sciences, College of Science and Humanities, SRM Institutes of Science and Technology, Kattankulathur, Tamilnadu, India for his support towards research.

**Funding**

No funding sources

**Conflicts of interest**

None of the authors have any competing interests concerning the review.

**Ethics approval and consent to participate**

Not Applicable

**References**


Information about authors

Karuppasamy Govindasamy
gowthamadnivog@gmail.com
https://orcid.org/0000-0002-3019-5545
Department of Physical Education and Sports Science, College of Science and Humanities, SRM Institute of Science and Technology, Kattankulathur-603203, Tamilnadu, India

Chandrababu Suresh
sureshc@srmist.edu.in
https://orcid.org/0000-0002-2385-1831
Department of Physical Education and Sports Science, College of Science and Humanities, SRM Institute of Science and Technology, Kattankulathur-603203, Tamilnadu, India

Mithin Anand
mithin.anand@gmail.com
https://orcid.org/0000-0002-8126-4299
Govt. College of Physical Education, East Hill, Calicut, Kerala, India

Saran KS
saran32@gmail.com
https://orcid.org/0000-0002-0145-4405
Department of Physical Education, C.K.G.Memorial Govt. College, Perambra, Calicut, Kerala, India

Mou Pramanik
moupramanik1991@gmail.com
https://orcid.org/0000-0002-7560-9019
Department of Yoga, College of Science and Humanities, SRM Institute of Science and Technology, Kattankulathur-603203, Tamilnadu, India

Dilpreet Kaur
dilpreet.kaur2818@gmail.com
https://orcid.org/0000-0003-0517-1688
Department of Physical Education, Chandigarh University, Gharuan, 140413, Mohali, Punjab, India

Imen Achouri
imenachouri2021@gmail.com
https://orcid.org/0000-0003-1051-6978
Department of Physical Education & Sports Science, Higher Institute of Sport and Physical Education, University of Sfax, Sfax, 3000, Tunisia

Hiba Boughanmi
hiba.boughanmi1@yahoo.com
https://orcid.org/0000-0002-6512-478X
Department of Physical Education & Sports Science, Higher Institute of Sport and Physical Education, University of Sfax, Sfax, 3000, Tunisia

Інформація про авторів

Каруппасами Говіндасами
gowthamadnivog@gmail.com
https://orcid.org/0000-0002-3019-5545
Кафедра фізичного виховання та спортивних наук, Науково-гуманітарний коледж, Інститут науки та технологій SRM, Каттанкулатур-603203, Тамілнаду, Індія

Чандрабабу Суреш
sureshc@srmist.edu.in
Кафедра фізичного виховання та спортивних наук, Науково-гуманітарний коледж, Інститут науки та технологій SRM, Каттанкулатур, Тамілнаду, Індія
Mithin Anand
mithin.anand@gmail.com
https://orcid.org/0000-0002-8126-4299
Урядовий Коледж фізичного виховання, Іст-Хілл, Калікут, Керала, Індія

Saran CS
saran32@gmail.com
https://orcid.org/0000-0002-0145-4405
Департамент фізичного виховання, С.К.Г.Меморіал Говт. Коледж, Перамбра, Калікут, Керала, Індія

Mou Pramanik
moupramanik1991@gmail.com
Департамент йоги, Науково-гуманітарний коледж, Інститут науки та технологій SRM, Каттанкулатур, Тамілнаду, Індія

Dilpreet Kaur
dilpreet.kaur2818@gmail.com
Факультет фізичного виховання, Університет Чандігарха, Гаруан, 140413, Мохалі, Пенджаб, Індія

Imen Achouri
imenachouri2021@gmail.com
Кафедра фізичного виховання та спортивних наук, Вищий інститут спорту та фізичного виховання, Сфакський університет, Сфакс, 3000, Туніс

hiba.boughanmi1@yahoo.com
Кафедра фізичного виховання та спортивних наук, Вищий інститут спорту та фізичного виховання, Сфакський університет, Сфакс, 3000, Туніс

Информация об авторах

Каруппасами Говиндасами
gowthamadnivog@gmail.com
https://orcid.org/0000-0002-3019-5545
Департамент фізичного виховання и спорта, Колледж естественных и гуманитарных наук, Институт науки и технологий SRM, Каттанкулатур-603203, Тамилнаду, Индия

Чандрабабу Суреш
sureshc@srmist.edu.in
Департамент физического воспитания и спорта, Колледж естественных и гуманитарных наук, Институт науки и технологий SRM, Каттанкулатур-603203, Тамилнаду, Индия

Митин Ананд
mithin.anand@gmail.com
https://orcid.org/0000-0002-8126-4299
Правительственный Коледж физического воспитания, Ист-Хилл, Каликут, Керала, Индия

Saran CS
saran32@gmail.com
https://orcid.org/0000-0002-0145-4405
Департамент физического воспитания, СКГ Мемориал Говт. Коледж, Перамбра, Каликут, Керала, Индия

Mou Pramanik
moupramanik1991@gmail.com
Кафедра йоги, Колледж естественных и гуманитарных наук, Институт науки и технологий SRM, Каттанкулатур, Тамилнаду, Индия

Дилприт Каур
dilpreet.kaur2818@gmail.com
https://orcid.org/0000-0003-0517-1688
Кафедра физического воспитания, Чандигархский университет, Гаруан, 140413, Мохалі, Пенджаб, Индия
Имен Ачури
imenachouri2021@gmail.com
Департамент физического воспитания и спортивной науки,
Высший институт спорта и физического воспитания, Университет Сфакса, Сфакс, 3000, Тунис

Хиба Богани
hiba.boughanmi1@yahoo.com
Кафедра физического воспитания и спортивной науки, Высший институт спорта и физической культуры,
Университет Сфакса, Сфакс, 3000, Тунис

This work is licensed under a Creative Commons Attribution 4.0 International License (CC BY 4.0)

Received: 2022-08-22   Accepted: 2022-08-27   Published: 2022-09-25