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REVIEW ARTICLE

Physical Activity, Yoga and Meditation in Improving Immunity and Fighting Against Viral Respiratory Infections - A Systematic Review . (An Aid to COVID-19 and such Pandemics).

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Abstract

Objectives: The primary objective of the present study was to systematically review the Randomized Controlled Trials (RCTs) pertaining to the effect of physical activity, yoga and meditation in improving immunity and fighting against viral respiratory infections. **Introduction:** The current ongoing pandemic has tormented the whole world for the last two years. There have been many pandemics to date due to viruses that infect the respiratory system specifically, but the current pandemic of COVID-19 has caused deleterious harm physically, mentally and financially. Immunity can be acquired by pharmacological and non-pharmacological means. This study was designed in the wake of the COVID-19 pandemic, in order to ascertain the beneficial effects of yoga, meditation and physical activity in fighting against such viral infections. **Method:** A systematic review protocol was prepared with an inclusion criterion of Randomized controlled trials in the area of physical activity, yoga and meditation in improving immunity and fighting against viral respiratory infections. Two hundred and thirteen articles were screened by using various search engines, out of which 25 articles met the inclusion criteria and were sent to four reviewers/experts for appraisal along with the Pedro scale. Fifteen articles which scored $\geq$ 5/11 score on the Pedro scale were included in the present systematic review. **Results:** Out of fifteen RCTs included in the systematic review, ten RCTs were related to the improvement/change in immune parameters with physical activity, yoga and meditation and five RCTs were related to the fight against viral respiratory infections, especially in context to the incidence of viral respiratory infections. Most of the studies have reported statistically significant improvement in the number of immunoglobulins, natural killer cells, B & T lymphocytes, Salivary flow rate, natural cell-mediated cytotoxicity (NCMC) and a decrease in the incidence of acute respiratory infections/COVID-19 after a regular practice/training of physical activity, yoga and meditation. **Novelty:** The

novelty of this systematic review is the inclusion of only RCTs focusing on the effect of physical activity, yoga and meditation in viral respiratory infections only. **Conclusion:** The included RCTs have shown that regular physical activity, yoga and/or meditation improve the immune parameters and help in fighting against viral respiratory infections. There is a need to have more RCTs having a large sample size and longer periods of training sessions in this area.

Keywords: Immunity AND Physical activity; Immunity AND Meditation; Physical activity AND Upper respiratory viral infections; Yoga AND Upper respiratory viral infections; Meditation AND Upper respiratory viral infections; Immunity AND Yoga

1 Introduction

The world has been battling the ongoing COVID-19 pandemic for the last two years, which is known to be caused due to Severe Acute Respiratory Syndrome Coronavirus - 2 (SARS-CoV-2). The COVID-19 pandemic resulted in considerably greater morbidities and mortality.[(1)] SARS-CoV-2 presents a wide range of clinical manifestations, ranging from asymptomatic infection to severe pneumonia accompanied by lengthy intensive care unit (ICU) stays and/or deaths due to multisystem failures. The main symptoms of the disease are shortness of breath, fever, cough, ageusia, anosmia, and fatigue.[(2)] To fight against such viral infection immunity can be acquired by pharmacological and non-pharmacological means. The immunity provided by vaccination is specific acquired immunity, and can only provide protection against specific viral infection, whereas immunity acquired by non-pharmacological means such as physical, activity, yoga and/or meditation may provide overall immunity and health benefits.

Studies have shown that yoga, physical activity and meditation can improve immunity and can help in fighting against viral respiratory infections.[(3)] Physical activity when practised at a moderate intensity for a longer duration will help in fighting against viral infections. A lower-intensity physical activity for a shorter duration would have no significant effect on an individual's efficacy in fighting against viral infections.[(4)] Different forms of yoga, pranayama and meditation practice can provide a beneficial effect on an individual's respiratory function. Yoga and meditation also help in improving the efficacy of an individual to fight against viral infections.[(5)]

Recent Observational studies on COVID-19 state that being physically active confers to improving protection, reducing ill-effects, duration of hospitalization & severity of disease in reference to Covid19.[(6)] Non-pharmacological interventions such as yoga, meditation and physical activity can be employed, for the overall well-being and can act as an adjunct not only against coronavirus but rather against all kinds of infections.[(7)]

The available literature on the effect of physical activity, yoga and meditation, varies in various parameters such as the study design, study population, and the duration of treatment. Hence, the present study was designed during the ongoing pandemic of COVID-19, to find out the role of physical activity, yoga and meditation in improving immunity and fighting against viral respiratory infections by systematically reviewing the RCTs pertaining to the same.

2 Methodology

A systematic review protocol was prepared with the aim of finding the effects of physical activity, yoga and meditation on immunity/immune parameters in fighting against viral respiratory infections. The inclusion criteria was to include only randomized controlled trials (RCTs) focusing on the aim on the normal healthy adult population. Articles published in English language, irrespective of the year of publication were taken into

consideration. RCTs on specific population such as athletes, children with congenital disorders, people with HIV, cancer, bacterial infections, asthma, tuberculosis etc. were excluded from the study. The viral infections other than that of respiratory, were also excluded.

Electronic search strategy was employed to search the literature using different search engines/databases: The databases used were PUBMED, EBSCO, Cochrane Library, NCBI, CINAHL, Lancet, Elsevier, PsycInfo, SciELO, Bireme, SportDiscus and Google Scholar. The websites of various organizations were also visited namely The World Health Organization (WHO), Ministry of Health and Family Welfare (MoHFW), Centre for Disease Control (CDC), Indian Council of Medical Research (ICMR), United Nations Children's Fund (UNICEF) and National Health Service (NHS).

Various keywords used were Physical activity AND Immunity; Yoga and Meditation AND Immunity; Yoga AND Immunity; Physical activity AND COVID-19; Physical activity AND viral respiratory infections; Yoga, Meditation AND viral respiratory infections; Yoga, Meditation AND Immune system; Yoga, Meditation IN improving Immunity; Yoga, Meditation AND COVID-19; Yoga AND COVID-19; Meditation AND COVID-19; Meditation IN fighting against viral respiratory infections; Yoga IN fighting against viral respiratory infections; Physical activity IN fighting against viral respiratory infections; Yoga AND viral respiratory infections; Meditation AND viral respiratory infections etc.

Using Boolean operators and keywords, 62,729 articles were reflected, out of which 435 articles were accessed and twenty-five RCTs met the inclusion criteria and were sent to four reviewers for appraisal along with PeDRo scale.[8] Articles which scored >5/11 score on the Pedro scale by at least 3 reviewers were included in the systematic review. After appraisals, fifteen articles were included in the study.

3 Results

Out of fifteen RCTs included in the systematic review, ten RCTs were related to the improvement/change in immune parameters with physical activity, yoga and meditation and five RCTs were related to the fight against viral respiratory infections, especially in context to the incidence of viral respiratory infections. The characteristics of the fifteen articles included in the study are as presented in Table 1 & Table 2.

Table 1. Characteristics of Included RCT's based on immunity (N=10)

Author/ / Title/ Journal/ Year	Study Population / No. of Participants / Age Group / Gender	Methodology				Immune Parameters								
		Experiment		Control										
		Type of Training	Freq and Duration	Type of Training	Freq. and Duration	CD3+ CD20+ CD2+ CD8+ (T-cell)	CD19+ &CD4+ (B cell and Memory cells	CD3-, CD56+ CD16+ (NK Cell)	Lymphocyte proliferation / count	NCMC / SFR	Immunoglobulin	Secretion Rate S-IgA	INF-C	IL-2
• Effect of physical activity, yoga and meditation in improving immunity														

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Table 1 continued

Nehlsen-Cannarella SL et al.[9]	Premenopausal, obese, sedentary women 36 participants. 32±1.4 to 36±1.6 Years	Walking till 60% HRR.	5X / wk 45 min / session for 15 wk.	Sedentary	↓(E)	⊠ (C)	-	↓(E)	-	IgA,IgG ↑ (E) & IgM: ↑ (E)	-	-	-	
Woods JA, et. al.[10]	Elderly 29 participants. 65±0.8 Years	Brisk walking at 52% HRR.	3X / wk for 6 months. 10-15 min to 40 min / session	Large muscle stretching and light resistance exercises against a rubber tubing at 21% HRR.	3X / wk for 6 months. 40 min / Session.	-	↓ (C): Memory Cells	-	-	-	-	-	-	-
Peter T. Campbell, et. al.[11]	Post-menopausal, obese, sedentary women. 115 participants, 50-75 Years	Aerobic exercise leg extension, leg curls, leg press, chest press, and seated dumbbell row Home Exercise-walking, aerobics, and bicycling.	≥45 min / day, 5X / wk for 12 month. Aerobic Exc: 10 reps.	Stretching Classes and relaxation Exercise.	60 min session – 1X / wk.	-	-	-	-	-	IgA: ↑ (C)	-	-	-
Lim SA, et. al.[12]	Healthy University students 25 Participants	Yoga class (Awareness, Pranayama and Meditation)	1 Day / wk for 90 mins + At home: 3X / week for 12 weeks.	Sedentary		-	-	-	-	-	-	-	↑(E)	↑(E)

Continued on next page

Table 1 continued

Sloan et al.[13]	Post-menopausal sedentary women 32 Participants 50+ Years	Home-based Moderate Intensity Walking.	5 days / week 30 min / day for 16 weeks	Sedentary	-	-	-	-	↓ (E): Acute EXC ↑ (E): Chronic EXC	-	↓ (E): Acute EXC ↑ (E): Chronic EXC	-	-			
Fahlman M. et. al.[14]	Elderly Women 29 Participants 70-87 Years	Walking at 70% HRR.	3dys / week On day 1_20 min increased by 5min / day until it reached 50min / day. For 10 weeks	Sedentary	-	-	-	-	↓(E) ↑ (C)	-	-	-	-			
La Perriere A. et. al.[15]	Healthy but sedentary Males. 14 Participants 18-40 Years.	Cycle ergometry exercise at 70-80% HRR.	45min / day; 5 days / week for 10 wk.	Sedentary	↑(E) CD8+, CD20+ and CD2	↑(E)	-	-	-		-	-	-			
Bermon S et al.[16]	Elderly sedentary individuals 30 participants 50+ Years	Strength training: 3 sets of leg press, knee extension and seated chest press exercises.	3times / week on non-consecutive days for 8 weeks	Sedentary	-	-	-	-	-	-	-	-	-			
Nieman D. C. et. al.[17]	Mildly obese sedentary women 36 participants 25-45 Years	Walking at 60% HRR	5X/wk 45 min/session each for 15 wks.	Sedentary.	-	-	-	↑(E)	-	-	-	-	-			

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Table 1 continued

M. Moyna[18]	Healthy but sedentary Individual 64 participants 23 – 25 Years.	Incremental protocol of cycling up to 55%, 70% and 85% peak oxygen uptake (VO2peak).	Three periods of 6 min, 12min and 18 min.	Sedentary	↓ (E)	↓(E)	↑ (E)	-	-	-	-	-	-

Notes: HRR-Heart Rate Reserve, NCMC-Natural Cell-Mediated Toxicity, SFR-Salivary Flow Rate, IL-2-Interleukin-2, S-IgA-Salivary Immunoglobulin-A, INF-C-Interferon-C, IgA-Immunoglobulin-A, IgG-Immunoglobulin-G, IgM-Immunoglobulin-M, FT-CON – Flexibility/training Control group, X-Refers to times.

Table 2. Characteristics of included RCT's based on Viral Respiratory Infections (N=05)

Author / Title / Journal / Year	Study Population	Age Group / Gender	No. of Participants	Intervention				Outcome measures				
				Experiment		Control		No. of ARI episode	Total days of illness / URI	No. of missed workdays	No. of health care visits	Mean global severity
				Type of training	Freq. & duration	Type of training	Freq. and duration					
Nieman et. al.[17]	Pre-menopausal women	25-45 years Female	36	Walking at 60% HRR for 15 weeks.	45 min session / 5 days / week.	Control group was instructed not to participate in any exercise.	-	-	E: 5.1±1.2 C: 10.8±2.3	-	-	-
Chubak J. et al.[20]	Post-menopausal women	50-75 years Female	115	Moderate intensity exercise (treadmill walking and stationary bicycling. Strength training, brisk-walking) for 12 months.	45 min session /5 days/ week	Stretching sessions for 12 months.	45 min session/ 1 day/ week	Risk of cold in C was 3x ↑ than E group. Atleast 1 episode of cold: 48.4% C & 30.2% in E group. P = 0.03	-	-	-	-
Barrett B, et al.[19]	Adults	59.3±6.60 years		a. MBSR b. Moderate intensity exercise (Stationary bicycles, treadmill, brisk-walking or jogging)	2.5 hours/ week + at home 45 mis/day for 8 weeks.	Observational Control		E: 26 M: 27 C: 40	E: 241 (P=0.47) M: 257 (P=0.033) C: 453	E: 32 M: 16 C: 67	E: 15 M: 10 C: 16	E: 248 (P=0.31) M: 144 (P=0.010) C: 358

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Table 2 continued

Barrett B. et. al.[21]	Adults	30-69 years	413	a. MBSR b. Moderate intensity exercise (Stationary bicycles, treadmill, brisk-walking or jogging)	2.5 hours/week + at home 20-25 mins/day for 8 weeks.	Observational Control	E: 120 M: 112 C: 134	E: 1010 M: 1045 C: 1210	E: 81 M: 73 C: 105	E: 21 M: 22 C: 24	E: 224 M: 256 C: 326
Sarwal R. et. al.[22]	Health care professional	19-65 years	250	Pranayama practice (including preparatory yoga practice and meditation also), twice a day (30 mins in morning and 15 mins in evening)	Twice a day for 28 days.	Walking, jogging, running	-	M: 01 (developed COVID) C: 09 (developed COVID)	-	-	-	-

Note: E=Exercise group, C=Control group, M=Meditation group, MBSR=Mindfulness based stress-reduction exercise; HRR=Heart Rate Reserve, URI=Upper respiratory infection, ARI=Acute respiratory infection. Only significant results are mentioned in the above table. Types of infections included in the above RCTs are cold, COVID-19, sore throat and runny nose. The observed P-value for total days of illness is 0.039[7], 0.47 for the Exercise group and 0.0033 in the meditation group,[19] for global mean severity in the exercise group 0.31 and meditation group 0.010[19] and for the number of ARI episodes is 0.03.[20]

4 Discussion

This study was undertaken due to the COVID-19 pandemic to find out the role of physical activity, yoga and meditation in improving immunity and fighting against viral infections. There is enough literature available in this area on healthy individuals as well as on specific populations with certain diseases/disorders and it has been mentioned that the regular practice of yoga, meditation, and physical activity have shown changes in their immune parameters and improving their ability to fight against the viral infections. Yoga practices can increase the oxidative components and immune-related cytokines and can also lower the oxidative stress-related biomarkers.[12] But there are fewer randomized controlled trials (RCTs) in this area.

Fifteen RCTs met the inclusion criteria in the present study. Included RCTs have shown an increase in T-cells (CD8+, CD20+, CD2+), B-cells and Memory cells (CD19, CD4+), Natural Killer cells (NK cells), lymphocyte proliferation/count, Immunoglobulins - IgA, IgG, IgM, Salivary Immunoglobulin-A (S-IgA), Natural cell-mediated cytotoxicity (NCMC), Salivary Flow Rate (SFR), Interferon-C (INF-C), and Interleukin-12 (IL-2) levels with the regular/longer duration training of physical activity, yoga and meditation.[6,23]

The included studies where the duration of the training was shorter or did not have a true sedentary group showed a decrease in the immune parameters such as T-cells, B-cells in the experimental group or decrease in memory cells, and an increase of IgA in the control group. Seasonal variations have also been documented as having a significant effect on immune parameters/function.

The high levels of B and T-lymphocytes, Immunoglobulins and S-IgA are required for better immunity.[24] Lymphocytes are involved in antibody production, creating memory cells, and cell-mediated killing. NK Cells are large granular lymphocytes, accounting for 10-15% of mononuclear blood cells.[18] They provide the first line of defence against infections as they can differentiate infected from non-infected host cells. They can act as a barrier until the time the antibody and T-cells are produced to eliminate the infection. NK cells and T-cell function is found better in highly conditioned elderly women when compared to their sedentary counterparts.[14] Researchers have also suggested that maximal graded exercise and submaximal graded exercise or acute and moderate level exercises can significantly increase NK cell number, enhancing the capability of NK cells to kill foreign cells.[17] Exercise intensity and duration play an important role in the mobilization of NK cells.[18] Immunoglobulins have specified functions in allergic reactions, hypersensitivity, fighting against infections, developing adaptive immunity and creating memory cells. A higher level of IL-2, a pro-inflammatory cytokine that regulates NK and T-cells responses, leads to a quicker response and link between innate and adaptive immunity.[25] An increase in CD20+ cells suggest a potential increase in humoral immunity for neutralizing foreign bodies.[15]

Generally, acute moderate exercise is characterized by mild leukocytosis and a strong lymphocytosis (usually 60-130%).[26] There is also an increase in the number of B and T-cells (more of B-cells) and a decrease in the ratio of T-helper/suppressor cells. A significant lymphopenia is observed 30 minutes to 3 hours post-endurance exercise of 60 minutes or longer in duration, which comes back to normal level after 6 hours of recovery. Catecholamines rise during acute endurance training leads to mild leukocytosis but strong and rapid lymphocytosis, while cortisol rises in response to either high intensity or long-term

submaximal exercise, inducing leukocytosis but inhibiting the entry of lymphocytes into the circulation and facilitating them towards the peripheral tissues.[9] It has also been stated that exercise training has minimal effect on immunoglobulin production as they do not tend to increase with high-intensity exercise training.[26] There is a decline in the proliferative response of T-cells.[10,14] and exercise can suppress the activity of lymphocyte proliferation, during or immediately after post-exercise with ageing.[14]

The increase in most of the immune parameters was seen in the studies which had a longer duration of training sessions i.e. 8-15 weeks, which is in agreement with the available literature that a longer duration and higher intensity exercise training would be required to show significant positive effects on the immune functions.[23,27] The difference in increase or decrease in immune parameters was also observed with acute vs chronic training session effects, where the acute effect was of decrease and the chronic effect was of increase in the immune parameters such as S-IgA and SFR. Salivary immunoglobulins act as the first line of defence, secreted externally by the oral mucosal lining in salivary secretions. They are involved in the homeostatic regulation of oral microbiota and respiratory mucosal epithelia. Hoffmann and Pederson had proposed a theory of "open window" or "vulnerable period", which states that S-IgA can reduce post-exercise which reduces resistance to viral infections and makes one prone to catch an infection. On the other side, chronic moderate exercise increases S-IgA levels. Salivary immunoglobulin-A[13] and salivary flow rate tend to decrease with age and in post-menopausal women. Moderate walking exercise has been found to be beneficial in improving oral dryness, and in turn, increasing the SFR levels.[14]

The included RCTs have shown a reduction in the number of acute respiratory infections/colds and total days of illness/upper respiratory infections in a group who were involved in yoga/meditation and/or physical activity on a regular basis. The decrease in URI could also be related to the elevation in NK cell activity.[17,23] One of the studies by Sarwal et al has also shown a reduction in acquiring COVID-19 infection in a group which was involved in pranayama practice. It has been documented in the literature that yoga asanas, pranayama, meditation and exercise play a pivotal role in improving lung health and reducing the duration, severity and incidences of viral respiratory infections.[27] Studies have shown that pranayama, anulom-vilom, bhastrika, vaata-neeti, kapalbhati, udgeeth and dhyana improves lung capacity, supply of oxygen generally and also in patients with respiratory infections and enhances quality and longevity of life.[28] Ujjayi increases O_2 saturation, brahmari improves nasal nitric oxide levels by improving blood flow to the ciliary epithelium and nadi-shodhana reduces sympathetic activity whereby increases parasympathetic activity via vagus nerve.[28]

It has been suggested in the literature that a physically fit and active individual has better prevention against pathogens and reduced risk of developing chronic diseases, because of improvised cardiovascular and metabolic health.[29] The relationship between incidences of upper respiratory tract infection (URTI) and exercise training is also explained by a "J-shaped curve" or "U-shaped curve", which indicates a lower risk of URTI in individuals involved in regular moderate exercise whereas, a higher intensity exercise or sedentary lifestyle may increase the risk of URTI. Thus, the duration and intensity of exercise have effects on the immune system.[13]

There are fewer RCTs aligning with the aim of the study and the included studies also vary in context to the study population, sample size, type and duration of the intervention. Thus, more RCTs with a larger sample size including different age groups, and gender, a longer period of training and several seasons are required.

5 Conclusion

The included RCTs have shown that physical activity, yoga and/or meditation improve the immune parameters such as B-lymphocytes, T-lymphocytes, number of NK cells, Immunoglobulins, Salivary IgA, cytokines, NCMC as well as causes a significant decrease in the number of acute respiratory infections including COVID-19. But there is a need to have more RCTs in this area.

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