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Research paper

Bodyweight Strength Training and Functional Capacity of Students During the COVID-19 Pandemic: A Randomized Control Trial Focusing on the Immune System

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Abstract

Background: The COVID-19 pandemic has created the largest disruption of students' physical activity and threatens immune system in the century. Although quarantine can be considered to fight against CORONA, its negative effects are certainly undeniable. **Methods:** The present study was a quasi-experimental study in a pretest and posttest design with a control group. The participants (16.1 ± 1.26 years old; n = 30) were randomly divided into the experimental group (CEP, n = 15) and the non-exercising control group (CG, n = 15). The pre/post assessment included: (1) salivary immunoglobulin-A (sIgA); (2) functional capacity (Muscular endurance, flexibility, and cardiovascular endurance). After proving the normality of data distribution using Kolmogorov-Smirnov test, analysis of covariance (ANCOVA) was used to evaluate the effectiveness of the exercises and Levene's test was used to prove the assumption of homogeneity of variance. **Results:** The results revealed a significant ($p = 0.045$) increase in s-IgA levels after CEP. In control group, s-IgA increased moderately and was not significant. Robust statistical differences was observed in muscular endurance, flexibility, and Vo2peak ($p < 0.05$) in experimental group. **Conclusion:** Body weight strength training is an effective program to improve functional capacity and immune system of students during COVID-19. It can be an available training program which can carried out at home. Although more research is needed to specify the relation of sport immunology and students kept in quarantine due to

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the possibility of closing schools in extraordinary circumstances such as the Corona pandemic or air pollution in densely populated cities such as Tehran.

Keywords: Bodyweight training, IgA, Covid-19, Fitness

Introduction

The COVID-19 pandemic has created the largest disruption of students' physical activity and threatens immune system in the century. Corona disease is a global pandemic, which has caused many deaths and illnesses (Chen et al., 2020; Peçanha, Goessler, Roschel, & Gualano, 2020). One of its long-term repercussions is on student's health. Although staying in quarantine can be considered as a solution to deal with COVID-19, its negative effects are definitely undeniable. One of them is the reduction of physical activities and therefore declining of students' functional capacities during COVID-19 pandemic (Moore et al., 2020; Nussbaumer-Streit et al., 2020).

Human performance is affected by various physiological and biochemical systems. The immune system is one of the vital systems of the body which will cause problems in life (Gorostiaga et al., 2004; Marques-Feixa et al., 2022). Specifically, at the present time when the corona disease affects the respiratory and immune system and has disrupted human life, the immunological aspects of sports and physical activity have attracted many researchers' attention. Studies have shown that there is a significant relationship between the nervous, hormonal, and immune systems which exercise as a factor can directly or indirectly affect the performance of these systems.

Immunoglobulin is the most important antibody in human saliva, which acts as the body's first protective barrier against pathogens and viral infections. In addition, it can inhibit the connection of viruses and bacteria with the mucosal epithelium and the proliferation of viruses and cause the removal of antigens throughout the mucosal surfaces and the neutralization of toxins and bacteria. Salivary Immunoglobulin A (s-IgA) levels are more closely related to upper respiratory tract infections than other antibodies in the body (Azzi et al., 2022; Nieman et al., 2002). sIgA has a number of essential functions in mucosal immunity. One of its tasks is to prevent disease-causing agents by competing for host cell transplants that cause virus entry (Chao, Rötzschke, & Tan, 2020). In the case of SARS-CoV-2, sIgA antibodies prevent adhesion to target epithelial cells by neutralizing the target protein of the coronavirus (and thereby inhibiting its interactions with the angiotensin-converting enzyme 2 (ACE2) protein receptor) or binding to SARS-CoV-2 nucleocapsid protein (Ahmadi Hekmatikar & Molanouri Shamsi, 2020). Salivary immunoglobulin A is the main class of

antibodies present in the body's secretory fluids such as saliva, mucus and tears (Drummond et al., 2022). Due to its dominance in the immune system of mucus membranes, salivary immunoglobulin A (S-IgA) is typically considered as the first line of defense from environmental factors. Whilst the full relationship between s-IgA and training is still not fully comprehended, it is enough known to make assumptions regarding their interaction (Han & Ivanovski, 2020). For instance, it is understood and commonly agreed that short-term moderate-intensity exercise can improve immune defenses, whilst both high-intensity and a lack of exercise can suppress the immune system and increase upper respiratory tract infections. S-IgA has essential functions in mucosal immunity. One of the functions is to prevent host cell-dependent pathogens by competing for host cell ligands that cause virus entry (Isho et al., 2020). In the case of SARS-CoV-2, s-IgA antibodies may prevent adhesion to target epithelial cells by neutralizing the target protein of the coronavirus (and thereby inhibiting its interactions with the host ACE-2 receptor) or binding to SARS-CoV-2 nucleocapsid protein. Researchers believe that immunoglobulin A is the first resistance barrier against the corona virus, but this hypothesis has not been proven yet (Varadhachary et al., 2020; Zhou et al., 2020). Various studies investigated the effect of resistance or strength training on the mucosal immune system. Siavashi (2016) reported that 12-week resistance training can cause a significant increase in s-IgA in the training group (Siavoshy, 2016). This also has boosted the immune system in training group. In another study, strength training with moderate intensity, improves the mucosal immune system, especially s-IgA (Fornieles et al., 2014).
Due to the fact that the spread of the Covid-19 has caused changes in individuals' lifestyles (Xiang, Zhang, & Kuwahara, 2020), the reduction of the body's immune system has increased due to home quarantine. For this reason, this hypothesis is proposed that what factor can play a significant role in improving the stated factors. One of the most important strategies that has attracted a lot of attention in the world is home-physical activities (Zheng, Li, Gao, & Gallo, 2022). Physical activity is one of the main components of a healthy life. In addition to the functions related to preventing overweight students, a potential advantage of physical exercises in reducing infectious diseases, including viral injuries, has been suggested. Sports activity, whether it is low intensity like walking or high intensity like lifting weights, changes significantly the immune system (Nussbaumer-Streit et al., 2020; Ribeiro et al., 2022), The existence of a strong relationship between the mucosal immune system, corona and students has made planning physical activity inevitable during the pandemic, a program that can be done even at home and help to maintain and improve the health and performance of students. Due to the restriction of students being outside the house, it was not

possible for students to choose an aerobic protocol during quarantine. Moreover, in most of the past researches, resistance training with free weights and machines have been used to investigate the effectiveness of dependent variables in research (Borg, 1982; Fornieles et al., 2014; Hosseini, Rostami, Farzanegi, & Esteghamati, 2009; Siavoshy, 2016). As the world grapples with disease and definitive clinical treatments, attention has turned to training protocols that may help boost the immune system. According to the fact that the Covid-19 strongly affects the body's immune system, many researches have been conducted to improve the immune system.(Hoffmann et al., 2020; Kumar et al., 2021) During the quarantine, it is considered because it does not need special facilities and equipment, and it can be called the cheapest kind of resistance training. Body weight training is a type of resistance training that uses body weight as resistance to gravity (Contreras, 2013; Garber et al., 2011).

Studies on Covid-19 in students are limited and more research needs to be done to determine the mechanisms of the covid-19 virus in students (Windarwati et al., 2022). Due to the spread of COVID-19 all over the world and lack of definitive remedy, paying attention to the prevention of infection has increased. One of the ways to prevent infection is to increase the capacity of the first level of the immune system, which is the mucous barrier. Considering the impact of sports activity on the immune system and the limitation of people in using all kinds of physical activities in public, it highlights the importance of using resistance exercises with body weight in small environments such as homes. Therefore, in this study, the researchers decided to investigate the effect of eight weeks of body weight strength training on salivary immunoglobulin and the functional capacities of students during the pandemic.

Methods

Approval Status

This study was reviewed in Research Ethics Committee of Sport Sciences Research Institute and approved according to compliance with Ethical Standards in Research of the Ministry of Science, Research and Technology, with the code IR.SSRI.REC.1401.1369.

Subjects

The current study wasquasi-experimental and practical in terms of purpose, which was carried out in two phases: pre-test and post-test with a control group. After reviewing the criteria for research inclusion, including not having regular sports activity in the past year, completion of the consent form by the student's guardian or legal guardian, compliance with measures to prevent the corona virus, including wearing a mask and maintaining proper physical distance, filling in the

health and wellness questionnaire (Werner & Sharon, 2011), the expert doctor's opinion on the health of the subjects, no history of cardiovascular diseases such as blood pressure, arrhythmia, fainting, and also no history of contracting the corona virus and presenting a negative test result sheet for the covid-19 virus, 30 individuals (26/ 16.10±1 years) were randomly selected and divided into two groups of 15 experimental (16.06±1.33 years, height 175.3±9.6 cm) and control (16.13±1.24 years, height 4.8±25.00 cm) /175). Training and familiarization sessions were conducted two weeks before the start of the training protocol. To evaluate the diet, the 24-hour food recall questionnaire was completed by the students 48 hours (about 2 days) before the start of the training protocol, and they were asked that during the 8 weeks of training, do not change dieting. 48 hours before the end of the exercises, the food recall questionnaire was completed again by the students.

Procedures

After completing the consent form, and the health and hygiene questionnaire and presenting the negative corona test sheet, the subjects were advised to refrain from taking medicine, food supplements, tea, coffee and cocoa 48 hours before the pre-tests and 24 hours after the test. 24 hours before the start of the training protocol, pre-tests including measuring the maximum oxygen consumption using Cooper's test (Cooper, 1968) and putting the result in the formula (11.3 - distance * 0.026), sit and reach test for measuring flexibility (Ayala, de Baranda, Croix, & Santonja, 2012). To measure muscle endurance, sumo squat, push-up and break dancer tests were used (*Bodyweight Strength Training: 12 Weeks to Build Muscle and Burn Fat*, 2017). The intensity of exercises was adjusted according to Borg's pressure perception scale (Borg, 1982).

Resistance Training Program

Resistance exercises were done in the sports hall of Shahid Iraqi in Tehran Pars with the presence of the trainer. The resistance training protocol with body weight (*Bodyweight Strength Training: 12 Weeks to Build Muscle and Burn Fat*, 2017) included four 8-week training sessions (once a week).. In this way, the volume of the exercise was 30 seconds and the rest time after the exercise was also 30 seconds. The students did the exercises 4 times a week with 3 days' rest. At the beginning of the session, the students warmed up in a dynamic way, including leg swings, squats with the touch of the big toes, and open leg jumps for 10 to 12 minutes (*Bodyweight Strength Training: 12 Weeks to Build Muscle and Burn Fat*, 2017). The training program is presented in Table No. 1.

Table 1- eight weeks resistance bodyweight training program

	First session	Second session	Third session	Forth session
Week 1	Sumo-Squat Cobra Squat Superman Bracer Hip tap Glenohumeral Rotation Bird dog Hands walking	Lunge Sumo-Squat Squat Burpee Glenohumeral Rotation Bird dog push up Scapular flying Cobra Hip tap	Sumo-Squat Cobra Squat Superman Bracer Hip tap Glenohumeral Rotation Bird dog Hands walking	Lunge Sumo-Squat Squat Burpee Glenohumeral Rotation Bird dog push up Scapular flying Cobra Hip tap
Week 2	Hip tap Sumo-Squat Cobra Squat Superman Bracer Glenohumeral Rotation Bird dog Hands walking	Burpee Lunge Sumo-Squat Squat Glenohumeral Rotation Bird dog push up Scapular flying Cobra Hip tap	Superman Sumo-Squat Cobra Squat Bracer Hip tap Glenohumeral Rotation Bird dog Hands walking	Bird dog Lunge Sumo-Squat Squat Burpee Glenohumeral Rotation push up Scapular flying Cobra Hip tap
Week 3	Sumo-Squat Cobra Squat Superman Bracer Hip tap Glenohumeral Rotation Bird dog Hands walking	Lunge Sumo-Squat Squat Burpee Glenohumeral Rotation Bird dog push up Scapular flying Cobra Hip tap	Bear crawl Sumo-Squat Cobra Squat Superman Bracer Kegel hip tap Glenohumeral Rotation Bird dog Hands walking	Single leg squat Lunge Sumo-Squat Jumping squat Burpee Glenohumeral Rotation Bird dog Push up Scapular flying Cobra Hip tap

Table 1- eight weeks resistance bodyweight training program

	First session	Second session	Third session	Forth session
Week 4	Cobra Squat Superman Bracer hip tap Glenohumeral Rotation bird dog hands walking	Lunge Sumo-Squat Jumping-squat Burpee Single leg squat Glenohumeral Rotation bird dog Push up Scapular flying cobra Hip tap	Cobra Squat Superman Bracer hip tap Glenohumeral Rotation bird dog hands walking	Lunge Sumo-Squat Jumping-squat Burpee Single leg squat Glenohumeral Rotation bird dog Push up Scapular flying cobra Hip tap
Week 5	Sumo-Squat jumping-squat Kegel Hands walking Break dancer Pushup Plank Bracer Hip tap Bird dog	Glenohumeral Rotation Sphynx Kegel Pushup Plank Knee scratcher Hip tap Cobra Bracer Bird dog	Sumo-Squat jumping-squat Kegel Hands walking Break dancer Pushup Plank Bracer Hip tap Bird dog	Glenohumeral Rotation Sphynx Kegel Pushup Plank Knee scratcher Hip tap Cobra Bracer Bird dog
Week 6	Sumo-Squat jumping-squat Kegel Hands walking Break dancer Pushup Plank Bracer Hip tap Bird dog	Glenohumeral Rotation Sphynx Kegel Pushup Plank Knee scratcher Hip tap Cobra Bracer Bird dog	Sumo-Squat jumping-squat Kegel Hands walking Break dancer Pushup Plank Bracer Hip tap Bird dog	Glenohumeral Rotation Sphynx Kegel Pushup Plank Knee scratcher Hip tap Cobra Bracer Bird dog

Table 1- eight weeks resistance bodyweight training program

	First session	Second session	Third session	Forth session
Week 7	Sumo-Squat jumping-squat Kegel Hands walking Break dancer Pushup Plank Bracer Hip tap Bird dog	Glenohumeral Rotation Sphynx Kegel Pushup Plank Knee scratcher Hip tap Cobra Bracer Bird dog	Sumo-Squat jumping-squat Kegel Hands walking Break dancer Pushup Plank Bracer Hip tap Bird dog	Glenohumeral Rotation Sphynx Kegel Pushup Plank Knee scratcher Hip tap Cobra Bracer Bird dog
Week 8	Sumo-Squat jumping-squat Kegel Hands walking Break dancer Push-up Plank Bracer Hip tap Bird dog	Glenohumeral Rotation Sphynx Kegel Push-up Plank Knee scratcher Hip tap Cobra Bracer Bird dog	Sumo-Squat jumping-squat Kegel Hands walking Break dancer Pushup Plank Bracer Hip tap Bird dog	Glenohumeral Rotation Sphynx Kegel Pushup Plank Knee scratcher Hip tap Cobra Bracer Bird dog

Saliva Collection

In this study, the measurement of anthropometric indices including height with an accuracy of 0.1 cm, weight with an accuracy of 0.1 kg, and body mass index was calculated by dividing the weight in kilograms by the square of the height in meters. Saliva samples were taken in 2 phases including: the day before starting the experimental group training (phase 1) and the day after the end of the eighth week of training, it was collected during rest time at 8 am. The special plastic tubes were poured (Hosseini et al., 2009) and the saliva samples were frozen immediately after collection at -20 degrees Celsius and sent to Soren laboratory in Tehran for measurement. For IgA test, immunoturbidometric laboratory method by creating a complex between anti-IgA antibody and IgA present in the saliva sample, which this reaction was measured by turbidity method (Lima et al., 2012). To measure s-IgA, the laboratory kit DEXK276 made in Germany with a sensitivity of 1 mg/dl was used.

Statistical Methods

After proving the normality of data distribution using the Kolmogorov-Smirnov test, covariance analysis was used to evaluate the effectiveness of the training and Levene's test was used to prove the assumption of homogeneity of variances. Besides, the resulting data were analyzed by SPSS 16 software. A significance level of $P < 0.05$ was considered.

Results

The mean and standard deviation of the students' anthropometric characteristics (N=30) are reported in Table 2. The results of the analysis of covariance showed that eight weeks of resistance training with body weight increased the amount of s-IgA in both the control and training groups, and the amount of this increase in the training group was reported to be significant compared to the control.

Table 2-Descreptive statistics of students (Mean ± Standard Deviation)

Variables	Control group		Training group		Total	
	Before	After	Before	After	Before	After
Weight (kg)	76/82±9/46	78/73±9/84	78/66±10/57	75/00±10/35	77/74±9/90	76/86±10/10
BMI	24/72±7/72	25/12±7/66	25/34±3/01	24/45±2/99	24/78±5/72	24/78±5/72

Table 3- Investigating the effects of the intervention on the changes using inferential statistics (mean ± standard deviation)

Variables	Control group		Training group		P value	F
	Before	After	Before	After		
s-IgA (mg/dl)	14/11±4/69	15/62±5/47	15/22±3/46	25/55±6/58	0/045	4/40*
Plank(sec)	81/80±25/61	71/80±27/34	74/80±26/23	93/66±29/50	0/001	12/53*
Vo2max (ml/kg/min)	37/64±9/17	33/34±9/17	36/54±8/23	38/46±10/57	0/001	12/79*
Flexibility(cm)	31/46±4/05	30/26±4/87	28/80±5/23	33/33±7/92	0/001	16/52*
Squat (rep)	43/20±9/78	36/40±11/48	42/46±9/04	46/73±9/35	0/001	16/66*
Push up(rep)	17/06±9/56	14/26±7/98	18/33±10/50	23/40±10/09	0/001	32/79*
Break dancer (rep)	17/06±9/56	14/26±7/98	18/33±10/50	15/62±10/09	0/001	17/38*

Discussion

The purpose of this study was to investigate the effect of eight-week bodyweight strength training on salivary immunoglobulin A as one of the indicators of the

mucosal immune system and students' functional capacities, including cardiorespiratory endurance, muscular endurance, and flexibility. Planning the physical activity of students during the corona epidemic is considered essential to be implemented by all students. After eight weeks of training with body weight, the level of s-IgA increased in the training group, which was reported to be significant (P=0.045). Further, the training program caused a significant increase (P<0.05) in the maximum oxygen consumption, flexibility and muscular endurance of the students. In many studies, it has been shown that the concentration of s-IgA depends on the intensity and load of the exercise, level of stress and mental pressure (Kiess et al., 1995; Koch, Wherry, Petersen, & Johnson, 2007). Belnin (1998) reported a significant increase in s-IgA by studying the effect of exercises with different intensities up to the point of disability (Blannin et al., 1998). Dimitro (2002) reported that s-IgA levels increase in mild to moderate activities (Dimitriou, Sharp, & Doherty, 2002). Siavashi (2016) in a study in line with the current research, used a 12-week resistance training(3 training sessions per week) , in which the exercises were sectioned and the intensity of the exercises was measured based on the performance of the maximum 8 repetitions test for each exercise. The results reported that s-IgA has increased after 12 weeks of resistance training (Siavoshy, 2016). Fernels (2014) reported in a study that weight resistance training for 12 weeks for Down syndrome patients caused a significant increase in s-IgA levels (Fornieles et al., 2014). Hosseini (2009) in a study consistent with this study, 29 non-athlete female students were divided in three groups of control, endurance training, and strength training which the endurance group in the first week included running with an intensity of 65% of the maximum heart rate for 16 minutes, In the last week, the intensity reached 80% and the volume was 30 minutes. The strength training program included performing leg press, chest press, lat pulldown and seated leg extension, which was done in the first week with 50% of 1RM in 10 repetitions, and in the eighth week reached 80% of 1RM in 6 repetitions. It is reported an increase in s-IgA levels in the strength training group compared to the control group and the endurance training group. Moreover, the reason for the increase in the mucosal immune system in the strength training group compared to the control group and endurance training is the increase in the anabolic state stated (Hosseini et al., 2009). Aktimoto (2003) in a study inconsistent with the findings of the present research, reported the effect of 12 weeks of resistance training in non-athlete men and women, reducing salivary immunoglobulin A (Akimoto et al., 2003). Ahan (2016) also reported in another study that four-month resistance training with elastic bands, which were performed three days a week (60 minutes in each session), caused a decrease in the amount of salivary immunoglobulin A in

women, although this decrease was not reported to be significant (Ahn & Kim, 2018). In the contrast studies, In contrast, some studies revealed that the opposite relation between cortisol and sIgA (Talebi et al., 2013). One of the possible reasons is that they measured sIgA in competition protocols and the increase of cortisol caused by the stress imposed on students. The short duration of protocols is the other possible reason for this contrast; most of the studies carried out from one session to one week (Engels, Kendall, Fahlman, Gothe, & Bourbeau, 2017; Gaeini, Pari, Mohammad, & Azar, 2013). Among the other possible reasons for these differences, it can be mentioned the amount of secretion of hormones such as cortisol, beta-endorphin, enkephalin, physical stress, psychological stress, decrease in salivary flow and insufficient intensity of exercises. After all, in this study by controlling all confounding variables, s-IgA increased after eight weeks of resistance training. Thus, it seems that immune system would be boosted by bodyweight strength training program.

Due to the complete quarantine during the Corona pandemic, the inactivity of students has increased and this issue is considered a serious threat to their health (Varadhachary et al., 2020). One of the reasons for improving Vo2max is the structure of the training protocol, in which the rest time between sets is less than normal training (30 seconds). This study concluded that the exercise protocol is an effective way to improve Vo2max. Some researchers have shown that intermittent exercises with body weight have more physiological effects compared to continuous exercises. In explaining what is the mechanism of increasing the maximum oxygen consumption following exercises in teenagers (Javadinezhad, Nasiri, & Samadi, 2022; McManus, Cheng, Leung, Yung, & Macfarlane, 2005), it is not possible to definitively explain the mechanism. According to the definition of the maximum oxygen consumption as well as the organs and devices involved, it can be said that the compatibility of these devices increases the maximum oxygen consumption (Javadinezhad et al., 2022).

Increasing comprehension of how physical activity and competition affect the immune system of adolescents is particularly important, because it helps us to adopt appropriate strategies to boost the immune system in order to prevent the reduction of immune function. Currently, several studies are investigating the relationship between s-IgA and corona disease. SARS-CoV-2 appears to spread mainly through respiratory droplets that begin as mucous secretions in infected individuals. These droplets are released by coughing, sneezing or talking and can spread through the air or through contaminated surfaces. Respiratory droplets are especially infected when infected people are in confined areas or in close contact with others (Meselson, 2020). Beside efforts to limit physical exposure, including wearing a mask and limiting contact with others, the first line of defense against

a viral respiratory infection is the mucosal immune system in the respiratory tract. The mucosal immune system plays an important role in innate and adaptive immunity. As part of the innate response, the mucosal immune system covers the lumen of the airways with a fluid lining containing surfactants, mucus, and peripheral fluid. A rapid response to respiratory tract pathogen challenge is initiated by "sensor" cells, which include epithelial cells, macrophages, dendritic cells, and mast cells. Upon recognition of a pathogen, these cells develop innate responses, which include the production of reactive oxygen species and antimicrobial peptides. Part of this adaptive response is the production of antibodies against the pathogen, among them IgA, which plays an important role in mucosal immunity. S-IgA is the antibody that is produced in the largest amount by the body (Pilette, Ouadrhiri, Godding, Vaerman, & Sibille, 2001). S-IgA has a number of essential functions in mucosal immunity. One of the functions is to prevent host cell-dependent pathogens by competing for host cell ligands that cause virus entry (Stokes, Soothill, & Turner, 1975). In the case of SARS-CoV-2, s-IgA antibodies may prevent adhesion to target epithelial cells by neutralizing the target protein of the coronavirus (and thereby inhibiting its interactions with the host ACE-2 receptor) and or binding to SARS-CoV-2 nucleocapsid protein.

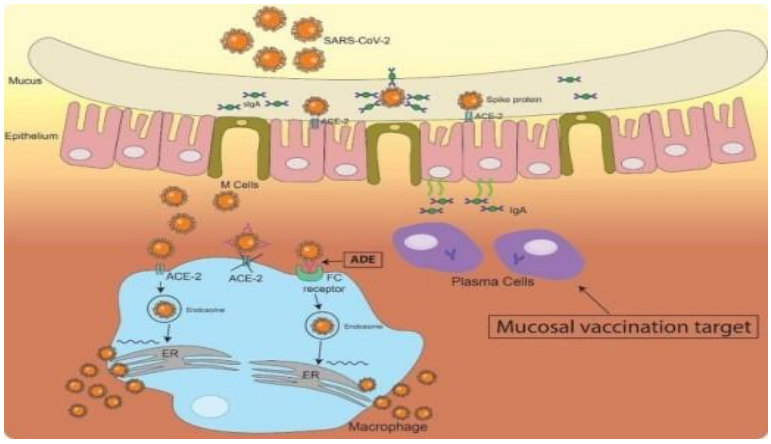

figure1. Mucosal immunity after SARS-CoV-2 infection.

After analyzing the data and the results of the statistical tests, it was observed that the program of resistance exercises with body weight can be used as an accessible and simple method to increase the functional capacities of students. The study's findings are in agreement with Shakri (2012), Gharakhanlou et al. (2008), reporting the positive effect of eight weeks of strength training with certain rest

sets between, on the development of muscle endurance and maximum strength (Gharakhanlou, Agha, & Gharakhanlou, 2008; Shakeri N, 2012). Brosh also emphasized the positive effects of resistance training on improving the strength of young subjects (Buresh, Berg, & French, 2009). The maximum oxygen consumption is one of the important parameters in measuring the capacity of the cardiorespiratory system. Reduction in aerobic capacity of the body means an increase in the risk of infectious respiratory diseases, including Corona. Due to the complete quarantine during the Corona period, the inactivity of students has increased and this issue is considered a serious threat to their health (Levine, 2008). Due to the possibility of closing schools in special circumstances such as the corona epidemic or air pollution in densely populated cities and the impossibility of attending gyms or exercise in outdoor fields, this program is suggested as a possible method which even can be done at home (Hammami, Harrabi, Mohr, & Krustrup, 2022) to improve performance and physical fitness factors related to students' health. It should be included in their weekly schedule. It is suggested to investigate the effect of body weight training on serum immunoglobulin A in future studies to determine the correlation between these two factors with resistance training. Besides, investigating combined resistance and endurance exercises and its effect on the mucosal immune system can bring us closer to a comprehensive exercise program for students' physical activities at school or even at home during school holidays.

Conflict of Interest

There is no conflict of interest concerning this article.

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