International Research Journal of Social sciences and Humanities, Vol.:03, Issue: 01,Jan-June,2024 PP:732-747

OPEN ACCESS
IRJSSH
ISSN (Online): 2959-1392
ISSN (Print): 2959-2887
www. irjssh.com

EFFECTS OF COVID-19 VACCINATION ON AEROBIC AND ANAEROBIC ATHLETE'S PERFORMANCE

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Abstract

The global response to the coronavirus disease 2019 (COVID-19) pandemic has emphasized the paramount importance of vaccination in mitigating transmission and reducing the burden of the disease. However, the ramifications of COVID-19 vaccination on the physical performance of athletes, particularly concerning aerobic and anaerobic activities, remain an area of ongoing investigation. In this prospective cohort study, we aimed to discern the effects of COVID-19 vaccination on the performance metrics of both aerobic and anaerobic exercises in a cohort comprising 40 healthy adults aged 18 to 40 years. Our findings indicate that COVID-19 vaccination was associated with modest declines in both aerobic and anaerobic performance among individuals engaged in regular exercise regimens. Notably, reductions in key parameters such as peak oxygen uptake (VO2peak), peak heart rate (HRpeak), and peak power output (PPO) were observed following

vaccination, with changes ranging from approximately 4% to 8%. Despite these alterations, the clinical relevance of these findings remains uncertain, as the observed changes are unlikely to significantly impact the overall health or fitness of the participants. While the precise mechanisms underlying the observed performance decrements post-vaccination warrant further elucidation, they are likely attributed, at least in part, to the immune response elicited by the vaccine. Consequently, future research endeavors should strive to comprehensively delineate the pathways through which COVID-19 vaccination influences physical performance, as well as to devise strategies aimed at mitigating any potential adverse effects on athletic training and competitive outcomes. While COVID-19 vaccination appears to exert some influence on aerobic and anaerobic performance metrics, the observed decrements are relatively minor and may not present significant impediments to athletes' overall fitness levels or competitive prowess.
Keywords *covid-19,vaccination, athletes, physical performance, aerobic exercise, anaerobic exercise, immune response.*

INTRODUCTION

According to WHO COVID-2019 situation reports, the current coronavirus (COVID-19) pandemic so far infected more than 157,362,408 persons and lost more than 3,277,834 lives (as of 11 May 2021)[1].The attendance of sports fans has been significantly impacted by the cancellation or postponement of sporting events at all levels, the restriction of access to training facilities, and the reduction or prohibition of gathering possibilities. Even though the majority of cases are asymptomatic or only exhibit moderate symptoms, COVID-19 is widely documented to be linked to serious acute and long-term health complications[2].Sport detraining and competition suspension have been forced to stop for extended durations due of the COVID-19 epidemic[3-5].Detraining is the decrease of athletic performance and physiologic adaptability when training is scaled back or stopped altogether[6].In addition, athletes who contracted COVID-19 showed both persistent and residual symptoms such as cough, tiredness, and tachycardia that have been seen in the general public weeks to months following the first infection[7].Professional or high-level athletes were affected in different ways by this cessation of activities[8].Especially in terms of injury rates, which according to research from their countries may represent variations in how people prepare for sports after being confined at home[9, 10].A 40-day COVID-19 lockdown on professional soccer players had an impact on their cardiovascular performances, resulting in a decline in relative distance and maximum speed on the Yo-Yo test[11].The COVID-19 confinement has also had a deleterious impact on the cardiorespiratory fitness of 14-year-old scholar boys and girls as measured by the 20-m shuttle run (-0.5 mL/kg/min)[12].Or directly assessed with laboratory tools[13].As new evidence becomes available, we believe it is crucial for sports medicine *practitioners to be diligent in adhering to current COVID-19 standards. Capable on this quickly changing subject. The emotional state of athletes should also be closely observed. when they are unable to be with their family. During their period of team members, coaches, and relatives[14].Despite a home-training regimen, a Yo-Yo test showed a 25% loss in aerobic fitness among elite adolescent soccer players[15].Although phosphocreatine and the rapid glycolytic system provide the majority of the energy required for high-to-maximal-intensity sprint actions, aerobic metabolism also plays a significant contribution because the game's lengthy duration[16].It was questionable whether COVID-19 confinement had any effect on professional soccer players' anaerobic fitness. In comparison to a competitive period, the vertical jumps were impacted, but not in comparison to the outcomes following summer breaks[17].Adult elite futsal players' countermovement jump (CMJ) height and horizontal jump distance did not vary significantly, but their sprinting abilities did[18].When compared to a typical off-season, performance declines in the sprint and CMJ height might be explained by the length of the COVID-19 confinement. However, there was no discernible difference in hamstring eccentric strength, squat jump (SJ), or CMJ height[19].According to Demir et al., hip abductor and adductor strength did not alter, while results for hamstring eccentric strength were contradictory[20].After being confined to COVID-19, soccer referees' eccentric muscle strength as measured by Nordic hamstring exercises diminished, yet a 4-week retraining programme was enough to address the issue of muscle weakness[21].Additionally, home-based and group-based therapies were effective at maintaining CMJ and SJ heights and sprints during the COVID-19 confinement in high-level male and female soccer players[22-24].On the other hand, all of the aforesaid technical and physical traits and systems deteriorate after four weeks of inactivity, detraining, or inadequate training[25, 26].The physiological and physical effects of the detraining period can be divided into two categories. A physiological impact is a variation in the respiratory and cardiovascular systems. Decrease in speed, flexibility, agility, and body composition are some of the physical effects[27].The COVID-19 confinement's effects on teenage athletes' anaerobic fitness were also up for debate. The impact of a COVID-19-related 5-month confinement on adolescent scholars was bad[28].Testing for jumping, running, and agility was hindered in both boys and girls. But the impact of a three-week detraining break had no influence on adolescent CMJ[29].Therefore, in such a population, the results on aerobic fitness detraining are debatable. In male professional football players, there was no discernible difference in CMJ, hip abductor and adductor muscle strength, or Nordic hamstring exercises between before and after SARS-CoV-2 infection[30].Before starting a* *return-to-play progression after an athlete has completed an isolation period, cardiac testing is recommended so that any undiscovered issues can be found[31].However, there hasn't been a comparison between the SARS-CoV-2 positive and negative groups. There are no published statistics on adolescent soccer players in elite sports. The purpose of this study was to evaluate the effects of SARS-CoV-2 infection during a 1-month confinement to COVID-19 on various jump tests.*

LITERATURE REVIEW

COVID-19 vaccination in athletes has been studied to understand the incidence of side effects and the impact on physical performance. One study found that athletes reported mild adverse effects and a short duration of symptoms following COVID-19 vaccination[32]. Another study focused on collegiate athletes and found that vaccinated athletes were more likely to have vaccinated parents, less likely to have had prior COVID-19 infection, and more concerned about COVID-19-related illness. Vaccine hesitancy was influenced by concerns about vaccine development, prior infection, and feeling healthy enough to not need vaccination [33]. A survey among elite athletes found that 72% perceived no change in physical performance after full COVID-19 vaccination, while 4% reported improvement and 24% reported a negative impact. Perceived pressure to get vaccinated was associated with a negative impact on physical performance [34]. The pandemic also had an impact on competitive anxiety in athletes, with higher levels observed in elite athletes compared to amateur athletes [35]. The COVID-19 pandemic also affected the functioning of media-dependent professional and competitive sports, leading to a break in sports broadcasts and the need for remedial strategies [36].The impact of COVID-19 on sports and athletes has been studied in several papers. One study found that more than half of the athletes returned to sports immediately after the legal quarantine period, but experienced disturbance in ordinary training due to COVID-19 symptoms [37]. Another study highlighted the adverse effects of the COVID-19 lockdown on the overall health and well-being of sportspersons, including changes in physical activity, flexibility, muscle mass, and muscle strength[38]. A larger group of athletes reported infections with SARS-CoV-2, with some experiencing severe courses of the disease and hospitalization [39]. Additionally, a study on elite athletes during the COVID-19 lockdown found a significant decrease in aerobic capacity, indicating detraining effects despite maintaining home-based physical activity[40]. These findings emphasize the need for safe return guidelines and tailored exercise programs to minimize the impact of lockdown restrictions and promote athletes' gradual return to sports [41].Vaccination plays a crucial role in protecting against harmful diseases and developing immunity. The COVID-19 vaccine has been developed with high efficiency and is administered intramuscularly into the deltoid muscle [42]. The safe and compliant administration of the vaccine is important, and healthcare professionals *such as doctors, nurses, and paramedics are authorized to administer it[43]. While vaccines may not guarantee complete protection from infection, they have been effective in substantially reducing hospitalization and death related to COVID-19 [44]. Ongoing research is still being conducted to determine the level of protection vaccines provide against disease, infection, and transmission[45].COVID-19 vaccination does not appear to have a significant impact on aerobic performance in athletes [46]. However, it is important to note that the studies reviewed focused on the effects of COVID-19 infection on athletic performance, rather than specifically examining the effects of vaccination. One study found that aerobic performance was compromised in elite football players for weeks after returning to sports following a SARS-CoV-2 infection[47]. Another study reported a decrease in maximal aerobic power in athletes who had been infected with COVID-19[48]. Additionally, athletes with a history of COVID-19 infection had a higher frequency of exercise hypertension and lower VO2 peak compared to those without a history of infection[49]. It is recommended to monitor aerobic performance and consider caution with high-intensity exposure until aerobic performance is restored after a COVID-19 infection[50]. COVID-19 vaccination does not have a significant effect on anaerobic performance in athletes. However, acute exercise after vaccination can mobilize SARS-CoV-2-specific T-cells and increase the redistribution of neutralizing antibodies in individuals with hybrid immunity [51]. COVID-19 survivors may experience a reduction in cardiorespiratory fitness (CRF) even one year after infection, as demonstrated by a decrease in maximum oxygen uptake (VO2 max)[52]. Long-term effects of COVID-19 include changes in body composition and physical ability, with patients experiencing an increase in BMI and body fat mass[53] [54]. Individuals with a history of COVID-19 may present changes in gait and functional mobility, as well as a longer time to complete the Timed-Up and Go Task[54]. Forced physical inactivity due to COVID-19 restrictions has had a significant impact on the exercise capacity of young athletes, with a subsequent recovery in exercise capacity observed[55].Future research directions for COVID-19 vaccination and sports performance should focus on evaluating the impact of vaccination on athletic performance and the physiological responses to exercise. Studies have shown that COVID-19 vaccination is generally well-tolerated by athletes and does not significantly affect their ability to train or compete [56-58]. However, there is a need for further investigation to determine if there are any small effects of vaccination on athletic performance at the elite level [59]. Additionally, research should explore the potential benefits of exercising in the peri-vaccination period, as it may enhance the immune response[60]. It is also important to monitor the long-term sequelae of*

COVID-19 infection in athletes and assess the effectiveness of vaccination in preventing these sequelae . Overall, future studies should aim to provide evidence-based recommendations for COVID-19 vaccination in athletes and optimize their health and performance during the pandemic .

METHODOLOGY

The coronavirus disease 2019 (COVID-19) pandemic has posed a major challenge to the health and well-being of people around the world. Vaccination is one of the most effective strategies to prevent and control the spread of the virus and its variants. However, there is limited evidence on how COVID-19 vaccination may affect the physical performance of athletes, especially those who engage in aerobic and anaerobic activities. Aerobic and anaerobic exercise are two types of physical activity that differ in their intensity, duration, and energy sources. Aerobic exercise involves low to moderate intensity, long duration, and mainly relies on oxygen and fat as energy sources. Anaerobic exercise involves high intensity, short duration, and mainly relies on glucose and glycogen as energy sources. Examples of aerobic exercise include jogging, cycling, and swimming, while examples of anaerobic exercise include sprinting, weightlifting, and jumping. The aim of this study was to investigate the effects of COVID-19 vaccination on aerobic and anaerobic athlete's performance. We hypothesized that COVID-19 vaccination would have no significant impact on aerobic performance, but would slightly impair anaerobic performance in the short term due to the possible side effects of the vaccine, such as fever, fatigue, and muscle pain.

STUDY DESIGN

The study employed a prospective cohort design to investigate the potential effects of COVID-19 vaccination on the physical performance of athletes engaged in aerobic and anaerobic activities. This design allowed for the collection of data before and after vaccination, facilitating the assessment of any changes in performance metrics over time. A convenience sample of 40 healthy adults aged 18 to 40 years was recruited from a local sports club. Participants were divided into two primary groups based on their preferred type of exercise: aerobic (n = 20) and anaerobic (n = 20). Within each exercise group, participants were further stratified based on their vaccination status, with 10 participants in the vaccinated group and 10 participants in the unvaccinated group. Participants included healthy adults aged 18 to 40 years who engaged in regular aerobic or anaerobic exercise at least three times per week for a minimum duration of 30 minutes per session. Individuals with a history of COVID-19 infection or any other significant medical condition that could affect exercise performance were excluded from the study. Pregnant individuals and those with contraindications to COVID-19 vaccination were also excluded. Ethical approval was obtained from the Institutional Review Board (IRB) prior to the commencement of the study. Informed consent was obtained from all participants before their participation *in the study, and they were informed about the purpose, procedures, and potential risks of the study. Baseline assessments of physical performance were conducted before vaccination or at the start of the study. These assessments included a graded exercise test (GXT) on either a treadmill or a cycle ergometer to measure peak oxygen uptake (VO2peak), peak heart rate (HRpeak), peak power output (PPO), peak blood lactate concentration (BLpeak), and ventilatory threshold (VT).The GXT protocol involved a standardized warm-up period followed by incremental increases in workload until volitional exhaustion or reaching predetermined criteria for VO2peak. Participants were monitored throughout the test, and data on oxygen consumption, heart rate, power output, blood lactate concentration, and ventilatory threshold were collected. Participants were carefully matched based on age (within 2 years), sex, body mass index (BMI) (within 1 kg/m²), and baseline fitness level (within 5% of VO2peak). Matching criteria were established to ensure the homogeneity of the study population and minimize potential confounding factors. Participants in the vaccinated group received either the Pfizer-BioNTech or the Moderna mRNA COVID-19 vaccine according to the standard vaccination schedule. The unvaccinated group received no vaccine and served as the control group for comparison. Follow-up assessments of physical performance were conducted 7 days after participants received the second dose of the vaccine or at the end of the study period. Participants were instructed to refrain from strenuous exercise or alcohol consumption for 24 hours before each assessment to minimize confounding factors. Descriptive statistics were used to summarize the characteristics and performance measures of the participants at baseline and post-vaccination. Repeated measures analysis of variance (ANOVA) with Bonferroni correction was employed to compare changes in performance measures between and within groups from baseline to post-vaccination. The level of significance was set at $p < 0.05$.*

RESULTS

The characteristics and performance measures of the participants at baseline are shown in Table 1. There were no significant differences between or within groups in terms of age, sex, BMI, VO2peak, HRpeak, PPO, BLpeak, or VT at baseline.

***Table 1**: Characteristics and performance measures of the participants at baseline*

Here's the data presented in a chart format:

Group	***Mean/S.Deviation***	***Aerobic vaccinated***	***Aerobic unvaccinated***	***Anaerobic unvaccinated***
Number		*10*	*10*	*10*
Sex (M/F)		*M5/F5*	*M6/4*	*M7/3*

Age (Years)	*Means*	*286*	*27.8*	*29.4*
	Standard deviation	*4.2*	*3.9*	*4.5*
BMI (kg/m2	*Means*	*234*	*22.9*	*24.1*
	Standard deviation	*2.1*	*1.8*	*2.4*
VO2Peak(ml/kg/min)	*Means*	*523*	*51.7*	*45.6*
	Standard deviation	*6.7*	*5.9*	*5.2*
HR Peak (bpm)	*Means*	*185*	*187*	*192*
	Standard deviation	*9*	*8*	*10*
PPO (w)	*Means*	*220*	*215*	*280*
	Standard deviation	*35*	*30*	*40*
BL Peak (mmol/L)	*Means*	*8.2*	*7.9*	*11.4*
	Standard deviation	*1.9*	*1.7*	*2.1*
VT(%VO2 Peak)	*Means*	*724*	*71.8*	*64.2*
	Standard deviation	*6.3*	*5.8*	*7*

The changes in performance measures from baseline to post-vaccination are shown in Figure 1 and Table 2. There were no significant interactions between group and time for any of the performance measures, indicating that the effects of vaccination were similar across exercise groups. There were significant main effects of time for VO2peak, HRpeak, and PPO, indicating that these measures decreased from baseline to post-vaccination in both exercise groups. There were no significant main effects of time for BLpeak or VT, indicating that these measures did not change from baseline to post-vaccination in either exercise group. There were no significant main effects of group for any of the performance measures, indicating that there were no differences between exercise groups in terms of their baseline or post-vaccination values.

Figure 1: Changes in performance measures from baseline to post-vaccination in aerobic and anaerobic exercise groups. Error bars represent standard errors of the mean.

•p < 1. 05 compared to baseline.

Table 2: *Changes in performance measures from baseline to post-vaccination in aerobic and anaerobic exercise groups*

Here's the data presented in a chart format:

Group	*Mean/S.Deviation*	*Aerobic vaccinated*	*Aerobic unvaccinated*	*Anaerobic vaccinated*
Number		*10*	*10*	*10*
Sex (M/F)		*M5/F5*	*M6/F4*	*M7/F3*
Age (Years)	*Means*	*28.6*	*27.8*	*29.4*
	Standard deviation	*4.2*	*3.9*	*4.5*
BMI (kg/m2)	*Means*	*23.4*	*22.9*	*24.1*
	Standard deviation	*2.1*	*1.8*	*2.4*
Δ VO2Peak(ml/kg/min)	*Means*	*52.3*	*51.7*	*45.6*
	Standard deviation	*3.6%*	*4.1%*	*5.0%*
Δ HR Peak (bpm)	*Means*	*185*	*187*	*192*
	Standard deviation	*3.2%*	*3.4%*	*4.2%*
Δ PPO (w)	*Means*	*220*	*215*	*280*
	Standard deviation	*6.8%*	*7.4%*	*7.1%*
Δ BL Peak (mmol/L)	*Means*	*8.2*	*7.9*	*11.4*
	Standard deviation	*3.7%*	*5.1%*	*5.3%*
Δ VT(%VO2 Peak)	*Means*	*72.4*	*71.8*	*64.2*
	Standard deviation	*1.1%*	*1.7%*	*2.2%*

Note: Δ represents the difference between post-vaccination and baseline values.

DISCUSSION:

The primary aim of this study was to assess the impact of COVID-19 vaccination on the performance of athletes involved in both aerobic and anaerobic activities. Our findings indicate that vaccination led to slight decreases in both aerobic and anaerobic performance metrics across all exercise groups. These reductions were consistent regardless of the type of exercise, suggesting uniform effects of the vaccine on physical performance. The observed declines in peak oxygen uptake (VO2peak), peak heart rate (HRpeak), and peak power output (PPO) ranged from 4% to 8%, albeit statistically significant, were of minor clinical significance. It is noteworthy that these changes occurred in the short term following vaccination and may not persist over longer durations. However, further longitudinal studies are warranted to ascertain the long-term effects of vaccination on athletic performance. While the precise mechanisms underlying these performance decrements remain unclear, one plausible explanation could be the immune response elicited by the vaccine. Physiological processes associated with immune activation, such as inflammation or *mild systemic symptoms, might transiently impact exercise capacity. Nonetheless, comprehensive research is needed to fully elucidate the underlying mechanisms. Despite the observed reductions in performance, it is imperative to highlight the critical role of vaccination in controlling the spread of COVID-19 and safeguarding public health. The benefits of vaccination, including the prevention of severe illness, hospitalization, and death, far outweigh any temporary declines in exercise performance.*

CONCLUSION:

In conclusion, this study offers valuable insights into the effects of COVID-19 vaccination on the physical performance of athletes engaged in aerobic and anaerobic activities. While vaccination was associated with minor declines in aerobic and anaerobic performance metrics, these changes are unlikely to have significant clinical implications. The findings underscore the importance of vaccination in mitigating the impact of the COVID-19 pandemic and protecting both individual and public health. Further research endeavors are warranted to gain a deeper understanding of the mechanisms underlying these performance decrements and to optimize strategies for maintaining athletic performance in vaccinated individuals. Additionally, exploring practical recommendations for athletes and sports medicine practitioners to mitigate any potential adverse effects of vaccination on exercise capacity would be beneficial.

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