EFFECT OF COVID-19 LOCKDOWN ON SPORTS PERFORMANCE PARAMETERS OF COMPETITIVE ATHLETES

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ABSTRACT

Background: Nationwide lockdown was enforced due to the spread of the new Coronavirus-19. This resulted in cessation of all sports training across the country, including elite athletes. This COVID-19 lockdown was hypothesized to result in detraining effects on elite athletes.

Aim: We aimed to study the impact of COVID-19 lockdown on athletes' physiological and anthropometric sports performance parameters.

Methodology: Seventy-five athletes (age: 23.25 ± 3.9 years, training experience 7.49 ± 3.5 years) from different sports participated voluntarily. International Physical Activity Questionnaire was used to grade home-based non-supervised physical activity undertaken during COVID-19 lockdown (137.81 ± 39.20 days). We compared the measured anthropometric, aerobic, and anaerobic performance parameters post-lockdown with pre-lockdown competitive phase recordings using Kruskal Wallis non-parametric test. Parameters were expressed as mean ± SD with level of significance fixed at $p < .05$.

Results: Statistically significant reduction of 33.28% was observed in aerobic capacity post- COVID-19 lockdown ($p = .01$). We did not find any statistically significant variation in the other anthropometric and physiological performance parameters, namely weight (↑17.50 %), body mass index (↑20.69 %), body fat mass (↑20.76 %), waist (↑21.07 %), hip (↑19.13 %), waist: hip ratio (↑10.71 %), peak power (↑11.32 %) and mean power (↑5.17 %).

Conclusions: We found that the athletes exhibited generalized detraining features despite maintaining home-based physical activity. Compared to other performance parameters, there was a significant decrease in the aerobic capacity post-lockdown. This shows the importance of incorporating an indoor-based supervised program including aerobic exercises to guide and monitor athletes.

Practical Implications: Off-season/home confinement requires a remotely supervised tailored exercise program with optimal stimuli to maintain training adaptations. Awareness and incorporation of these findings would aid coaches and trainers in designing training programs to promote athletes' injury-free gradual return to sports.

Keywords: *Athletic Performance, COVID-19, Endurance Training, Detraining, Training Program, Cardiorespiratory Fitness, Competitive Athletes*

INTRODUCTION

Systematic scientific sports training for years and guidance from multi-disciplinary coaching team yield high level of performance in Olympic sports (Bompa & Buzzichelli, 2019; Ericsson, 2020). Abrupt cessation of such a collaborative, competitive sports training program over months jeopardizes the physiological adaptations (Mujika & Padilla, 2000a, 2000b).

Post declaration of SARS COVID-19 as a 'Global Pandemic', a nationwide lockdown was enforced in India from 24 March until 08 June 2020, banning all sports activities, including training and competitions (Kalra et al., 2020). As a measure to halt the disease transmission chain, all elite athletes were performing self-training within the confinement of their homes. This unprecedented cessation of regular sports training for weeks resulted in a substantial decrement in the training load, thereby posing a risk of detraining (Kenney et al., 2015).

Irrespective of sports played, measurable decline in various motor physiological functions and performance capacity was reported with even 1 – 2 weeks of absence from training, especially as regards elite athletes (McArdle et al., 2010). It was shown that in elite athletes, aerobic capacity (VO_2max) appeared to decline more as compared to muscle strength and power decrements for the same duration of cessation of training activities (Mujika & Padilla, 2000a). In well-trained endurance runners, VO_2max was found to be decreased by 25% after only 15 days of inactivity due to reduced stroke volume (8). Reduction in muscle strength and power was also reported in well-trained athletes after 2 to 3 weeks of cessation of training, with initial decline attributed to neural alteration and later decline - to structural changes in the musculoskeletal system (Chen et al., 2021; Fleck, 1994; Nakisa & Rahbardar, 2021).

COVID-19 lockdown resulted in a complete closure of sports training facilities, non-availability of expert suggestions from coaches, support personnel, and equipment. This also caused restrictions in both outdoor and group activities. This type of a training scenario was extremely new, challenging, and risky for competitors because they could lose their hard-earned training adaptations and skills (Fabre et al., 2020). It required continuation of the physical activity in a restricted home-based self-training exercise module. Because of the unavailability of facilities, expertise, and equipment, it was hypothesized that inadequate training stimuli during COVID-19 lockdown would lead to detraining effects (Nakisa & Rahbardar, 2021).

The detraining effects need to be quantified with respect to anthropometric, aerobic, and anaerobic factors to plan the exercise program for the conditioning phase when the competitive athletes resume their sports training to avoid training-related injuries (Fabre et al., 2020; Girardi et al., 2020; Myer et al., 2011; Nakisa & Rahbardar, 2021). Presently, there is a lack of studies quantifying the magnitude of the detraining effects of COVID-19 lockdown on various physiological parameters in athletes doing competitive sports.

Hence, we aimed at studying the impact of the COVID-19 lockdown on different anthropometric and physiological functional performance parameters, namely maximal aerobic capacity, peak power, average power, and body composition parameters in elite athletes playing various sports.

METHODOLOGY

Ethical statement

The study was approved by the Institutional Ethics Committee (IEC/2020/92). All participants provided written informed consent before participating in this study, and the study adhered to the ethical standards as per the Declaration of Helsinki (Harriss & Atkinson, 2015). This study was undertaken in a residential elite sports training institute after the first wave of COVID-19 lockdown restrictions had been lifted for resuming sports activity. Written informed consent was obtained from all participants in this study.

Approach to the problem

It was a pre-post cross-sectional study design wherein the participating athletes underwent anthropometric and physiological testing before resuming sports training after lockdown (post-lockdown). These measured post parameters were compared with the pre-lockdown parameters of the same athletes recorded during their competitive phases earlier. The functional anthropometric and physiological variables associated with cessation of training should be considered as they are significantly affected by detraining. These variables can be measured when adequate expertise is available.

Subjects

Adult male (>18 years) athletes (n =100) of the sports institute from different sports disciplines participated. All athletes who had been regularly undergoing sports training in the previous year and had undergone physiological testing in their respective competitive phase of sports training during pre-lockdown were included in the study. All participants who had any injury, illness, or had been hospitalized for at least 2 weeks during the three months prior to the research were excluded from the study. Volunteer athletes underwent sports training at the residential sports institute and dined at the same place.

Out of 100 volunteer athletes, 81 athletes met the criteria. Before we measured the anthropometric and physiological parameters, all the eligible athletes filled out the International Physical Activity Questionnaire (IPAQ) so that we could assess the home-based activity level during the lockdown period. Based on the activity level inferred from the questionnaire, these athletes were classified as low (n = 6), medium (n = 34), and high (n = 41) activity level categories (Hagströmer et al., 2006).

Both pre- and post-lockdown anthropometric parameters (weight, BMI, fat%, waist size, hip size, waist-hip ratio) and physiological parameters (VO_2max, peak power, average power) of the participants (n = 75), including descriptive data, were recorded. Figure 1 shows the flowchart of athletes' participation as per study criteria. The pre-lockdown measurements were made during the competitive phase training. After the lockdown, the athletes who arrived at the sports institute underwent successful quarantine and participated in the study after being deemed fit to resume sports training.

Procedures

The eligible participants were advised to avoid intense exercise or any vigorous physical activity for 48 h before the testing, to continue their usual diet, to maintain adequate hydration, and to report for physiological testing 2 hours post-consumption of light breakfast (American College of Sports Medicine et al., 2018). All the measurements were made during the morning hours.

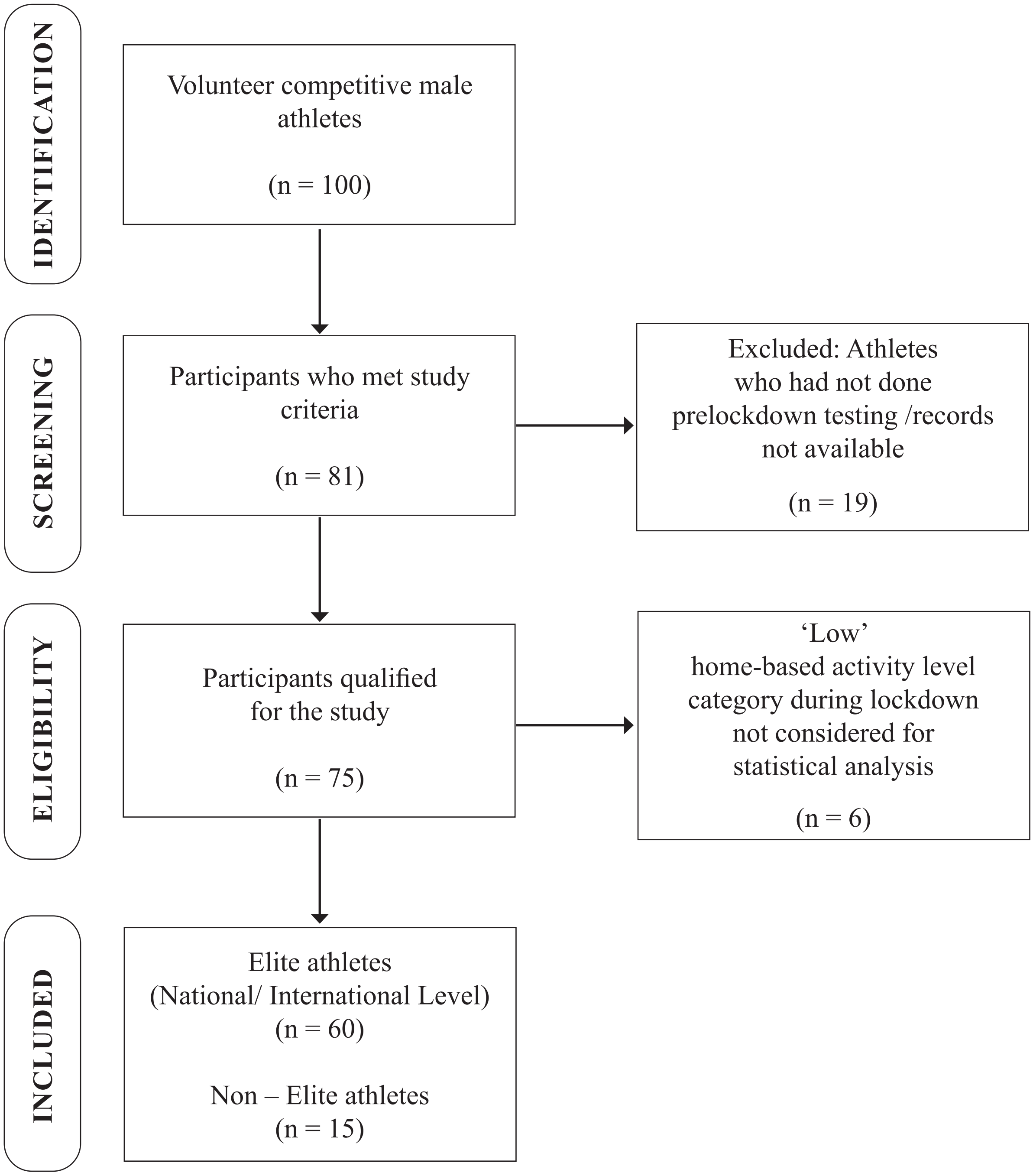

Figure 1. *Athletes' participation as per study criteria*

Anthropometric measurements

After recording the descriptive details, the athletes underwent measurement of anthropometric parameters height was measured with Stadiometer (Cardinal Detecto, USA) and bodyweight with digital weighing scale (Omron digital weight scale, Kyoto, Japan). Waist and hip measurements were recorded according to the guidelines proposed by the International Society for the Advancement of Kinanthropometry (Esparza-Ros et al., 2019). Body Fat and Lean Body Mass were determined by bioelectrical impedance (Quadscan 4000, Bodystat, British Isles) on an empty stomach during the morning in a well-hydrated state. Body Mass Index and Waist Hip ratio were calculated based on these recorded measures.

Assessment of aerobic capacity (VO_2max)

VO_2max was estimated with Astrand–Rhyming submaximal cycle ergometer test (Monark 839E, Sweden) with the use of documented protocol (Cink & Thomas, 1981). The initial workload was 150 Watts, and the participants were instructed to maintain a cadence of 60 revolutions per minute (rpm) throughout the test. Workload, heart rate, and perceived exertion were recorded at the end of each minute. The test was terminated if the participants reached a steady-state, which means the heart rate at the end of 5th min and 6th min differed by less than 06 bpm. VO_2max was estimated from the steady-state average heart rate and the workload with the use of Astrand-Rhyming nomogram corrected for age.

Assessment of lower body peak power (pp) and mean power (mp)

Wingate anaerobic test (WAnT) was used to measure the lower body peak power and mean power (Monark 894E, Sweden; (Bar-Or, 1987). Each participant completed a standard warm-up protocol (cycling for 5 min on a cycle ergometer) and a cool down after completion. The resistance used during the testing was 7.5% of their own body weight. The test was terminated after 30 seconds of all-out effort. All subjects were verbally encouraged throughout the test. Peak power was measured during the first five seconds segment, and average power measured over the entire 30s duration was recorded as mean power in Watts.

STATISTICAL ANALYSIS

The statistical analysis was performed with SPSS Version 20 for Windows (SPSS Inc., Chicago, IL). Descriptive statistics were observed using mean and standard deviation. Standard statistical procedures were used for the calculations. The normality of data was tested using Kolmogorov Smirnov test and Shapiro-wilk test. The data violated the assumption of normality. Hence, a nonparametric Kruskal Wallis test was performed to test the difference in variables between both activity level categories and pre-post comparison of the parameters. Epsilon-squared estimate of effect size was reported with p-values. The level of significance was $p < .05$.

Data Availability: The data associated with the paper are not publicly available but are available on a reasonable request.

RESULTS

The mean period of COVID-19 lockdown resulting in cessation of regular sports training was found to be 137.81 ± 39.20 days. It was calculated from the date of cessation of training to the date of reporting to the sports institute post lockdown. Out of 100 athletes who volunteered, 81 athletes were eligible to participate. Out of these eligible athletes, six athletes responded with a low level of home-based physical activity during the lockdown and hence were excluded to ensure statistically comparable groups and to avoid bias. Descriptive statistics of study participants is depicted in Table 1.

Table 1. *Descriptive Statistics of Study Population*

Description of the Study population	Value
Total number of participants included	75
Number of Elite athletes	60 (80%)
Number of Non-Elite athletes	15 (20%)
Age	23.25 ± 3.99 years
Training Age	7.49 ± 3.49 years
Average period of lockdown	137.81 ± 39.20 days

Figure 2 denotes the sports disciplines of study population. We found no statistical difference between the high and medium activity level groups except for waist circumference and hip circumference (Table 2). Hence, both groups were clubbed and analyzed. A pre-post comparison of the anthropometric and physiological parameters is depicted in Figure 3. The pre-post percentage change of all the parameters and their effect sizes are tabulated in Table 3. VO_2max was significantly reduced by 33.28 % (p = .01).

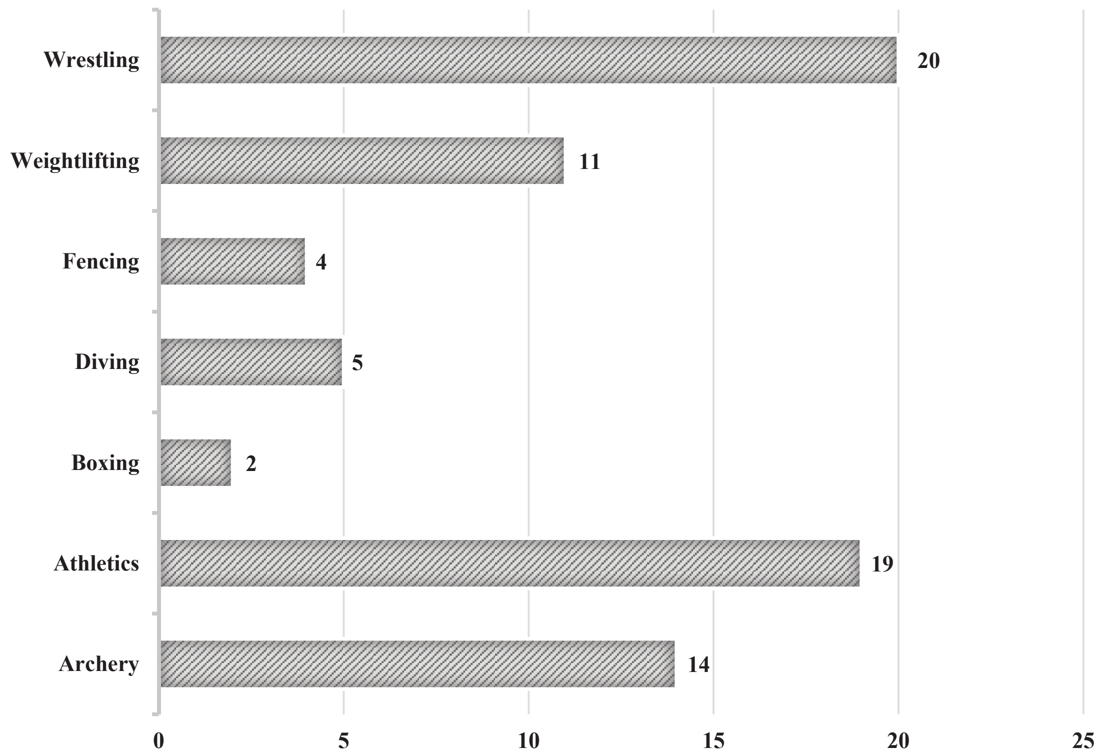

Figure 2. *Sports Disciplines of Study Population*

Table 2. *Lockdown - Activity level-based comparison of anthropometric and physiological parameters*

Parameter (SI unit)	Lockdown - Activity category	No of athletes (n =75)	Mean rank	Kruskal Wallis Non-parametric test		
				Chi-Square	Degree of freedom	P-value
Age (years)	High	41	38.80	.189	1	.67
	Medium	34	37.03			
Anthropometric parameters						
Weight (kg)	High	41	40.98	1.701	1	.19
	Medium	34	34.41			
Body Mass Index (kg m^{-2})	High	41	40.45	1.231	1	.27
	Medium	34	35.04			
Body fat (%)	High	41	40.48	1.230	1	.27
	Medium	34	35.01			

Waist circumference (cm)	High	41	45.24	10.089	1	.001*
	Medium	34	29.26			
Hip circumference (cm)	High	41	44.71	8.612	1	.003*
	Medium	34	29.21			
Waist: Hip	High	41	38.85	.139	1	.710
	Medium	34	36.97			
Physiological parameters						
Aerobic Capacity – VO_2max (ml min^{-1} kg^{-1})	High	41	38.12	.003	1	.96
	Medium	34	37.85			
Peak Power (watts)	High	41	38.39	.030	1	.86
	Medium	34	37.53			
Mean Power (watts)	High	41	36.05	.818	1	.37
	Medium	34	40.35			

**Statistically significant value*

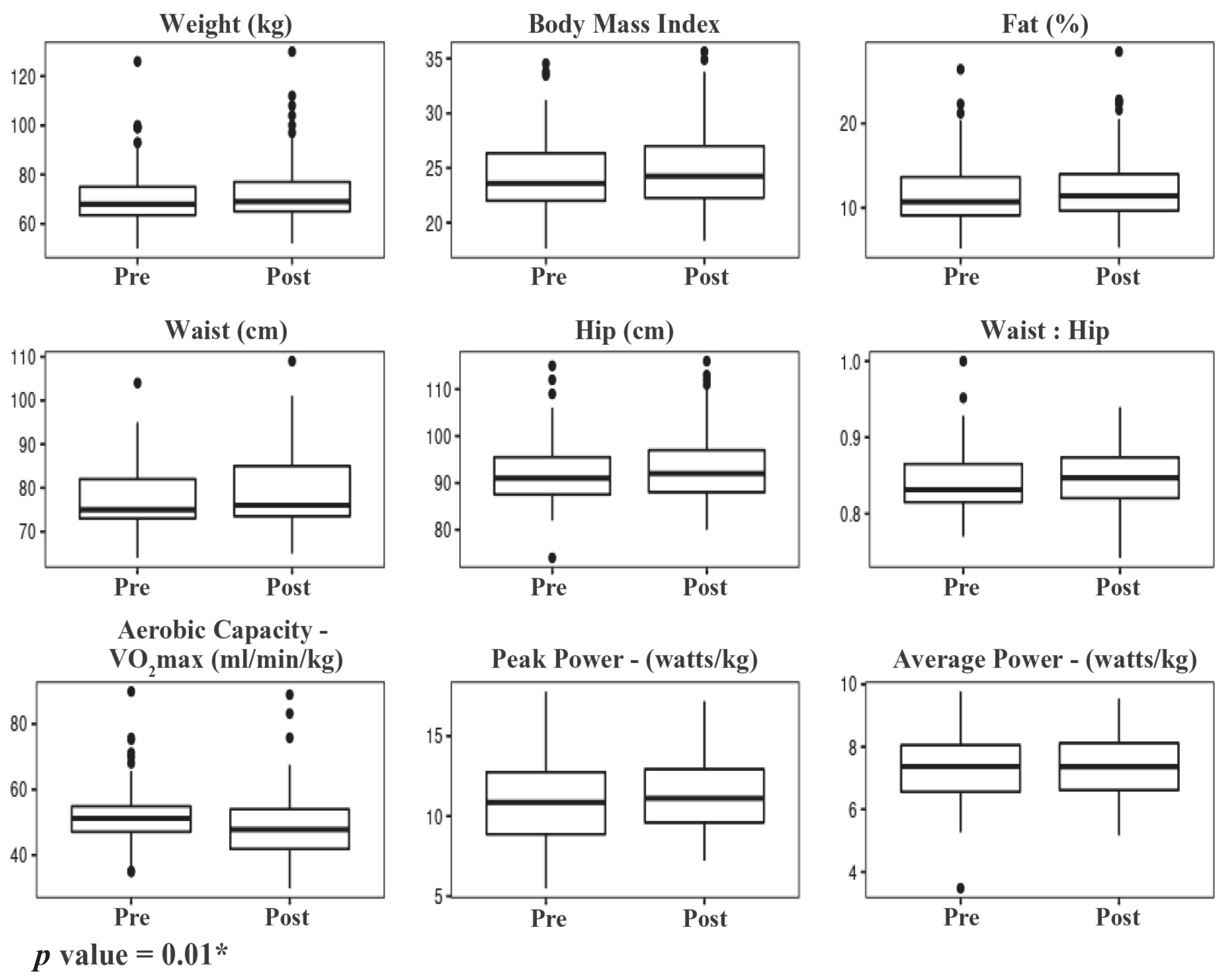

Figure 3. *Pre-post COVID-19 lockdown comparison of athletes' anthropometric and physiological parameters*

Table 3. *Pre-Post COVID19 lockdown percentage change of athletes' physiological parameters*

Physiological Parameters (SI units)	Pre- COVID19 lockdown (mean ± SD)	Post – COVID19 lockdown (mean ± SD)	Change in percent (%)	Effect Size
Anthropometric Parameters				
Weight (Kg)	71.24 ± 13.26	73.56 ± 14.23	↑ 17.50	.0232
BMI (kg m^{-2})	24.13 ± 3.63	24.88 ± 3.85	↑ 20.69	.0178
Fat (%)	11.59 ± 4.05	12.43 ± 4.49	↑ 20.76	.0211
Waist (cm)	77.59 ± 7.69	79.21 ± 8.86	↑ 21.07	.0139
Hip (cm)	92.05 ± 7.05	93.40 ± 7.96	↑ 19.13	.0182
Waist: Hip	.84 ± .04	.85 ± .04	↑ 10.71	.0184
Physiological parameters				
Aerobic capacity (VO_2max) (ml min^{-1} kg^{-1})	52.06 ± 9.69	48.64 ± 11.52	↓ 33.28*	.0878#
Peak Power (watts kg^{-1})	11.07 ± 2.47	11.35 ± 2.30	↑.390	.0084
Average Power (watts kg^{-1})	7.29 ± 1.16	7.35 ± 1.06	↑.751	.0009

**Statistically significant (p-value = .01 by Kruskal Wallis nonparametric test)*

#Moderate effect size (Epsilon squared estimate of effect size .06 – .14)

DISCUSSION

This study aimed at determining the effects of athletes' detraining due to the impact of the almost 4-month long COVID-19 lockdown (137.81 ± 39.20 days), which is a highly unprecedented phenomenon globally. In this study, we assessed the effect of detraining on 75 athletes, practicing different Olympic sports. The lack of any surveys in the literature assessing the detraining effects on such a large sample of athletes playing different sports signifies the uniqueness of our study.

The study included almost 80% of elite athletes who were on active international or national competitive level. All athletes with an average training experience of 7.49 ± 3.49 years would further interest sports coaches and trainers. The anthropometric and physiological parameters included in this study are basic and functional in nature. The results can be generalizable to competitive athletes playing any type of sport. We did not research the impact of lockdown on each sport because this was not our primary objective and due to the unequal distribution of athletes from different sports who took part (Figure 2).

During such a unique pandemic, it was essential to follow a home-based exercise regimen given the restrictions and constraints of infrastructure, peer group training, and high-performance multidisciplinary coaching sessions (Bowes et al., 2020; Jagim et al., 2020). Hence, athletes who maintained a high or medium level of physical activity during lockdown were included for analysis. The objective was to assess the level of detraining on athletes so that necessary strategies could be planned in the future for such lockdowns.

The assessment of common anthropometric and functional physiological parameters showed variation in all of these parameters. Statistically, a significant decrease was observed in aerobic capacity (VO_2max) of the athletes by 33.28% with 137.81 ± 39.20 days of lockdown period (p = .01). This finding of decreased VO_2max after a period of lack or reduced training has also been documented in various studies. Mujika et al., in their review, found that multiple studies had documented a reduction of 4 to 14% of decrement in VO_2max with even

4 weeks of training stoppage, and this decline was found to be steep in case of elite athletes (Mujika & Padilla, 2000a). Dauty et al. found that despite a multimodal training program conducted at home during COVID-19 home confinement, there was a significant reduction in aerobic abilities, namely run distance (25%), calculated oxygen consumption (9%), and run speed (5%) during endurance yo-yo test among young soccer players (Dauty et al., 2021). The probable mechanism for this decline in aerobic capacity due to detraining was attributed to loss of blood volume and plasma volume, which led to a reduction in the stroke volume and cardiac output, reduction in left ventricular dimensions, and thickness as well as decrease in peripheral adaptations (Dauty et al., 2021; Fleck, 1994; Mujika & Padilla, 2000a, 2000b; Nakisa & Rahbardar, 2021).

The literature review showed a few surveys conducted among football/ soccer players and handball players on detraining effects due to COVID-19 lockdown (Fikenzer et al., 2020; Grazioli et al., 2020; Korkmaz et al., 2020). All these studies comparing the retrospective pre-lockdown data of athletes were done with smaller samples, namely 10 male elite handball players, 23 male professional soccer players, and 14 football players with a maximum sports cessation period of 8 weeks, 63 days, and 86 days, respectively.

Fikenzer et al. found that in handball players, VO_2max did not vary after 8 weeks of detraining, but the aerobic performance measured by a shuttle run decreased post lockdown (Fikenzer et al., 2020). Similarly, in their study, Grazioli et al. found no significant cardiorespiratory fitness changes (Grazioli et al., 2020). The lack of decrease in the VO_2max in both of these studies was probably due to the retrospective pre-lockdown data used for comparison. In our study, we used the retrospective data of peak level adaptation achieved in competitive phase during regular sports training, and the comparison with the data obtained after the lockdown explained the effect of detraining due to abrupt COVID-19 lockdown. Korkmaz et al., in their study with football players, did not include aerobic capacity or performance as a parameter for comparison (Korkmaz et al., 2020). The drastic decline in VO_2max found in our study might be attributed to restriction of outdoor activities during lockdown period, lack of indoor endurance training equipment, and reduced endurance training sessions in terms of frequency and volume.

We also found that all basic body composition parameters, namely weight, body fat percentage, BMI, waist circumference, hip circumference, and WHR increased post lockdown, though the increment was not statistically significant for any of these parameters (Figure 3). Two of the studies conducted post COVID-19 quarantine/lockdown found that body composition parameters varied significantly, implying that the athletes were not able to maintain their body composition owing to reduced sports training and lack of monitoring (Grazioli et al., 2020; Korkmaz et al., 2020). Venezuela et al. in their study on body composition of combat athletes during COVID-19 lockdown found that the body mass significantly increased even with 20 ± 5 days of COVID-19 quarantine (Esparza-Ros et al., 2019). Even though there was an increase in all these body composition parameters in our study, they were not significant. One reason for this may be the inclusion of athletes who had been maintaining a high/medium level of physical activity during the home confinement, which is in agreement with the study on handball players by Fikenzer et al. where the athletes followed home-based exercise training protocols during lockdown (Fikenzer et al., 2020). Other factors such as motivation, fear of uncertainty, fear of falling behind peers, preparing for future competitions, doing unsupervised bodyweight activities at home to maintain fitness can also be considered. It is important to realize that these tasks were not comparable with the rigorous training and mental state of mind when training at the institute (Ruffault et al., 2020).

We found that both lower body anaerobic peak power and mean power did not vary significantly post lockdown. Most of the studies on detraining have documented that there is a decline in power and muscle endurance within the third week of inactivity as a function of time (Bosquet et al., 2002; Fleck, 1994; Mujika & Padilla, 2000a). Korkmaz et al. found a significant reduction in peak power and average power among football players post 89 days of COVID-19 lockdown (Korkmaz et al., 2020). However, Fikenzer et al., after 8 weeks of lockdown, found no significant reduction in pre-season power output of the handball players as they were involved in regular home-based bodyweight exercise training, which is akin to our study findings on power output parameters (Fikenzer et al., 2020). In our study, the participants included were athletes who had been performing moderate to high-intensity home-based exercises. This statistically non-significant increase in peak and mean power may be due to a lack of sports-specific optimal stimuli during the COVID-19 lockdown despite a home-based program (Sarto et al., 2020).

CONCLUSION

The COVID-19 lockdown was found to significantly affect aerobic performance, i.e., a decrease in cardiorespiratory fitness by almost 33.28% in competitive athletes. This needs to be considered by coaches and trainers while designing a sports training program, especially for athletes who do aerobic sports. There is a variation of body composition parameters as well as muscle power and endurance parameters, although not statistically significant. Our findings showcase the need to plan remotely supervised training programs for such prolonged confinement periods to prevent detraining effects. Coaches should take these findings into consideration when designing their training programs before resuming the training sessions to promote injury-free gradual return of their athletes.

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