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ORIGINAL ARTICLE

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Impact of the COVID-19 pandemic on perceived cardiorespiratory fitness in athlete patients

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Abstract

Introduction: Cardiorespiratory fitness (CRF), as one of the most potent prognostic factors in medicine, is followed longitudinally to guide clinical management. Coronavirus disease 2019 (COVID-19) pandemic-related changes in lifestyle stand to influence CRF.

Objective: To assess the influence of the pandemic on perceived CRF in athlete patients and evaluate how perceived CRF change was related to demographics, pre-pandemic measured CRF, and current physical activity (PA).

Design: Prospective cohort study, utilizing electronic survey.

Setting: Tertiary care sports cardiology clinical practice.

Participants: Adult athlete patients without COVID-19 with pre-pandemic measured CRF using cardiopulmonary exercise testing.

Interventions: Not applicable.

Main Outcome Measures: Perceived change in CRF since pandemic onset; association between perceived CRF change and demographics, PA, health status, and pre-pandemic measured CRF assessed via analysis of variance (ANOVA).

Results: Among 62 participants (male: 71%, 50.1 ± 12.1 years old), 40% (25/62) reported no change and 32% (20/62) reported an increase in perceived CRF since pandemic onset. Among the 27% (17/62) who reported a decrease in perceived CRF, in most (12/17), this was characterized as only mild. Demographics and pre-pandemic measured CRF did not differ across groups of perceived CRF change. Participants with a moderate or greater decrease in perceived CRF regarded their overall health (via Euro Quality of Life Visual Analogue Scale) as worse than other groups (ANOVA, $p = .001$). Although total PA was similar across groups, those who had improvement in perceived CRF reported higher levels of moderate intensity PA (ANOVA, $p = .008$).

Conclusions: The majority of participants perceived that they had maintained or improved CRF over the pandemic. Findings from this study suggest that a reduction in perceived CRF from pre-pandemic values in athletic patients in clinical practice may not result from population-wide pandemic changes in lifestyle. Worse health status and lower levels of moderate intensity PA were associated with perceived reduction in CRF over the pandemic in athlete patients.

INTRODUCTION

Coronavirus disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is a multisystem disease that was defined as a pandemic by the World Health Organization in March 2020. To mitigate the spread of disease, governments implemented stay-at-home orders, closure of nonessential businesses including gyms and other exercise facilities, and cancellation of mass events including sport competition.[1,2] All of these measures were fundamentally designed to reduce human contact, and as a consequence may have affected physical activity (PA) and cardiorespiratory fitness (CRF).[3] Existing data are conflicting regarding the influence of the pandemic on PA in the general population[4-10] and in athletes,[11-14] with several studies demonstrating a heterogenous response, where the most active pre-pandemic were paradoxically at the highest risk of decline in PA after pandemic onset.[4,6,9,14] Fewer studies have assessed a change in perceived or measured CRF over the pandemic, again demonstrating mixed results.[14-22]

CRF is among one of the most potent prognostic factors in medicine.[23] Peak oxygen consumption ($\dot{V}O_2$), as measured on cardiopulmonary exercise testing (CPET), is the gold standard measure of CRF and reflects the coordinated function of the cardiovascular system, lungs, and skeletal muscle.[24] In clinical practice, peak $\dot{V}O_2$ is assessed longitudinally to evaluate for deterioration in CRF that might prompt management changes or to assess the response to intervention such as procedures, medication, or structured exercise rehabilitation programs.[23,25,26] CPET is also used for individualized exercise prescription for individuals with existing cardiovascular or pulmonary disease,[27] but these recommendations are made on the basis of stable CRF. Changes in CRF due to pandemic-related alternations in PA stand to impact the longitudinal assessment of cardiovascular and pulmonary disease with CPET, to alter previously provided exercise recommendations, and to confound the assessment of COVID-19 effects on CRF in those who have been infected.

To evaluate the influence of the pandemic on CRF in a population of athlete patients referred for sports cardiology evaluation, we surveyed those patients without prior COVID-19 infection to determine the perceived effects of the pandemic on their CRF. In addition, we sought to evaluate how a perceived change in CRF was related to demographics, pre-pandemic measured CRF on CPET, current PA levels, and reported mental health.

METHODS

Study setting

The Cardiovascular Performance Program (CPP) at the Massachusetts General Hospital (MGH, Boston, MA, USA) provides clinical care to athletes and highly active individuals with suspected or confirmed cardiovascular disease. Unless clinically contraindicated, patients referred to the program undergo a cardiopulmonary exercise test (CPET) in conjunction with their clinical intake visit. From the date of the program's current exercise laboratory opening (October 1, 2011) through the present, patient data including the results of CPET were prospectively collected and managed in a research database. Potential participants for this study were identified from this database and were mailed recruitment letters as part of a research study of athletes with COVID-19. Participants were eligible for potential inclusion in this sub-study if they were ≥18 years of age, referred to the sports cardiology program, and performed a maximal effort- CPET in our lab with normal peak VO_2 (≥80% predicted) after January 1, 2016. Patients who reported a history of COVID-19 on their survey were excluded from this specific analysis. All aspects of this study were approved by the Mass General Brigham Human Research Committee (Boston, MA).

Survey distribution and scoring

Surveys were self-administered electronically and were collected and managed using a secure, web-based software platform (Research Electronic Data Capture [RED-Cap] hosted at the MGH). Surveys were mailed on February 1, 2021. Participants were first asked if they had a previous confirmed or suspected diagnosis of COVID-19. Full survey details for participants who did not report a history of COVID-19 are shown in the Appendix S1. Participants were asked to provide a detailed history of their sports participation. Endurance athletes were defined as reporting participation only in endurance sports (eg, cycling, rowing, running, swimming, triathlon, or a combination of endurance sports).[28] Mixed-sport athletes were defined as those reporting participation in an endurance sport *and* either a power activity (eg, weight lifting) or a team sport (eg, soccer, basketball, lacrosse). Sport type for participants who did not meet either of these definitions was classified as "other." Participants were provided a 7-point Likert scale to rank their perceived change in CRF since the pandemic onset (significant, moderate, and mild worsening; no change; and mild, moderate, and significant improvement) with appropriate descriptors (Appendix S1). PA was reported using the International Physical Activity Questionnaire - Short Form (IPAQ-SF) and scored as reported previously.[29] Briefly, survey responses were used to calculate metabolic equivalent (MET)-minutes/week spent in walking moderate PA, vigorous PA, and in total. Based on the MET-minutes/week in each category and the total MET-minutes/week, responders' PA level was classified as high, moderate, or low. Those in the "high" category, either completed vigorous PA ≥3 days/week achieving ≥1500 MET-minutes/week of total PA or reported PA on 7 days/week with total PA ≥3000 MET-minutes/week. Those in the "moderate" category did not meet criteria for "high" and completed the equivalent the minimum recommended PA (150 min of moderate intensity PA per week), as defined by (1) ≥3 days/week of vigorous PA for ≥20 min/day; (2) ≥5 days/week of ≥30 min of moderate PA or walking; or (3) ≥5 days/week of walking, moderate PA; or vigorous

PA summing to a total PA of ≥600 MET-minutes/week. Those in the "low" category did not meet criteria for the "high" or "moderate" categories.

To determine participants' global assessment of their health, the Euro Quality of Life Visual Analogue Scale (Euro-QoL VAS) was utilized. Participants were instructed to move a cursor on a visual scale from 0 to 100 based on how they felt their health was on the day of completing the survey, with 100 being the "best imaginable health" and 0 being the "worst imaginable health." To evaluate for depression symptoms, the Patient Health Questionnaire-2 (PHQ-2) was utilized.[30] The PHQ-2 is a two-question screening tool to screen for depression that asks about the frequency of depressed mood ("feeling down, depressed or hopeless") and anhedonia ("little interest or pleasure in doing things") over the past 2 weeks using a 4-point Likert scale ranking system of "not at all" (0 points), "several days" (1 point), "more than half the days" (2 points), or "nearly every day" (3 points). Answers from the two questions are added together and scores range from 0 to 6. Participants who score ≥3 points are considered likely to have a major depressive disorder meriting further evaluation.[30]

Cardiopulmonary exercise testing

All CPETs were performed in a single CPET laboratory. Patients underwent an intensity graded, maximal effort–limited exercise test with continuous gas exchange (Ultima CardiaO2; Medgraphics Diagnostics, St. Paul, Minnesota) on a treadmill (Woodway Pro 27, Woodway USA, Waukesha, Wisconsin), upright cycle ergometer (Sport Excalibur Bicycle Ergometer, Lode, Holland), or rowing ergometer (Concept2, Concept2 Inc, Morrisville, VT). Full details of exercise protocols have been published previously. Peak $\dot{V}O_2$ was defined as the highest oxygen uptake, averaged over a period of 30 seconds, during the last minute of effort-limited exercise, and was assessed for normality using standard equations.[31,32]

The reason for CPET and relevant cardiovascular diagnoses were ascertained from chart review and the CPET order requisition. Reasons for testing included: (1) known cardiovascular diagnosis: testing performed for risk stratification or serial evaluation of exercise capacity in setting of a significant diagnosis such as obstructive coronary artery disease (CAD), myocardial infarction (MI), cardiomyopathy, valvular heart disease (≥ moderate regurgitation or stenosis), atrial fibrillation, other sustained arrhythmias; (2) exertional symptoms: defined as symptoms suggestive of cardiovascular or pulmonary origin occurring during exercise (ie, chest pain, shortness of breath, palpitations, reduced exercise tolerance, syncope); (3) nonexertional symptoms: defined as symptoms suggestive of cardiovascular or pulmonary origin (detailed above) that do not ever occur during exertion; (4) known cardiovascular risk factors: test performed for risk stratification in setting of risk factor(s) such as hypertension, hyperlipidemia, or family history of cardiovascular disease; or (5) other: not fitting the above definitions. If the reason for testing met one or more of the definitions above, the patient's test was assigned to the first listed category above of the five (eg, if patient had both exertional symptoms and a known cardiovascular diagnosis, the reason for testing was assigned as known cardiovascular diagnosis). For sub-group analysis purposes, participants were defined as having significant cardiovascular disease if they had any of the diagnoses listed above (i.e., obstructive CAD, MI, cardiomyopathy, valvular heart disease [≥ moderate regurgitation or stenosis], atrial fibrillation, other sustained arrhythmias) either known at the time of the baseline CPET or made as a result of the CPET.

Statistical analysis

Continuous variables were described using means and standard deviations (SD) and compared between groups (ie, responders vs. nonresponders) using Student's *t*-test and across groups (ie, all participants divided by reported perceived change in CRF) by one-way analysis of variance (ANOVA), as specified. Categorical variables are presented as n (%) and compared across groups by chi-square testing or Fisher's exact test when $n < 5$ per category. Statistical analyses and graphical displays were generated using GraphPad (Prism 7.0d). A significant p value was set at <.05 for all analyses.

RESULTS

Study population

The overall response rate of the survey was 12% (71/579). Nine participants were excluded for a history of COVID-19. A total of 62 participants without COVID-19 were included in this analysis. All surveys were completed between February and May 2021, which followed the wintertime increase in COVID-19 cases.[33] Baseline characteristics of survey participants are presented in Table 1. The average age of this predominantly male (71%), largely Caucasian cohort (98%) was 50.1 ± 12.1 years (range, 19-64). CPET was performed for evaluation of exertional symptoms in 40%, for evaluation of known cardiovascular diagnoses in 32%, and for other reasons (known cardiovascular risk factors, nonexertional symptoms, other) in 28%. Detailed comparison of survey responders included in this analysis versus the nonresponders is shown in the Table S1. Responders and nonresponders had similar height, weight, sex, and pre-pandemic measured CRF (peak

TABLE 1 Survey participant characteristics

	Participants (*n* = 62)
Age (years)	50.1 ± 12.1
Female Sex	17 (27%)
Race/Ethnicity	
White/not-Hispanic/Latino	61 (98%)
White/Hispanic/Latino	0 (0%)
Asian	1 (2%)
Height (cm)	175.9 ± 8.5
Weight (kg)	76.1 ± 12.0
BMI (kg/m^2)	24.4 ± 2.5
Sport Type	
Endurance	46 (74%)
Mixed	14 (23%)
Other/not specified	2 (3%)
Sport exposure	
High School	43 (69%)
College	31 (50%)
Post-collegiate endurance competition	29 (47%)
Cardiovascular diagnoses	
Hyperlipidemia	25 (40%)
Hypertension	15 (24%)
Coronary artery disease	18 (29%)
Atrial fibrillation	9 (15%)
Other arrhythmia	18 (29%)
Congenital/valvular disease	4 (6%)
Cardiomyopathy	3 (5%)
Other cardiovascular diagnosis[a]	4 (6%)
Symptom(s), without cardiovascular diagnosis	5 (8%)
Basic cardiopulmonary exercise test parameters	
Reason for testing	
Exertional symptoms	25 (40%)
Known cardiovascular diagnosis	20 (32%)
Known cardiovascular risk factor(s)	9 (15%)
Nonexertional symptoms	6 (10%)
Other	2 (3%)
Testing modality	
Cycle ergometer	31 (50%)
Treadmill	31 (50%)
Gas exchange	
Peak VO_2 (L/min)	3.38 ± 0.80
Peak VO_2 (mL/kg/min)	44.8 ± 9.9
Percent predicted (%)	137 ± 25

Note: Categorical variables are presented as n (%); continuous variables are presented as mean (SD).
Abbreviations: BMI, body mass index; Peak VO_2, peak oxygen consumption.
[a]Other cardiovascular diagnoses: swimming-induced pulmonary edema, thoracic aortic disease, neurocardiogenic syncope.

TABLE 2 Survey responses

Perceived change in CRF during pandemic	
Significant decrease	2 (3%)
Moderate decrease	3 (5%)
Mild decrease	12 (19%)
No change	25 (40%)
Mild increase	10 (16%)
Moderate increase	10 (16%)
Significant increase	0 (0%)
Reported physical activity	
Total physical activity (MET-minutes/week)	2791 ± 1825
Vigorous physical activity	1718 ± 1531
Moderate physical activity	572 ± 873
Walking physical activity	499 ± 437
Time spent sitting (h/day)	8.0 ± 6.7
Physical activity level	
High	38 (61%)
Moderate	19 (31%)
Low	5 (8%)
PHQ-2 depression score	
0	42 (67%)
1–2	18 (29%)
≥3	3 (5%)
Euro Quality of Life Visual Analogue Scale	79 ± 13

Note: $n = 62$.
Abbreviation: MET, Metabolic Equivalents; CRF, Cardiorespiratory Fitness; PHQ-2, Patient Health Questionnaire-2.

VO_2: responders: 44.8 ± 9.9 vs. non-responders: 43.1 ± 10.7 mL/kg/min, $p > .05$). Responders and nonresponders had similar indications for undergoing CPET ($p > .05$). Responders were older than nonresponders (50.1 ± 12.1 vs. 44.3 ± 15.8, $p = .002$), and as a result, peak $\dot{V}O_2$ when expressed as a percentage of predicted was slightly lower in nonresponders (126 ± 29 vs. 137 ± 25% predicted, $p = .003$), but supra-normal in both groups. CPETs were performed on average 2.5 ± 1.5 years before the survey in responders and 2.4 ± 1.3 years in nonresponders ($p > .05$).

Among survey participants, most (74%) were endurance athletes, with the remaining participating in mixed (23%) or other (3%) sporting disciplines. The majority (69%) of participants competed in at least one high school sport, 50% completed in at least one collegiate sport, and 47% continued with competitive racing in an endurance sport post-collegiately.

Survey responses

Survey responses are shown in Table 2. Most of participants responded that they did not perceive any change

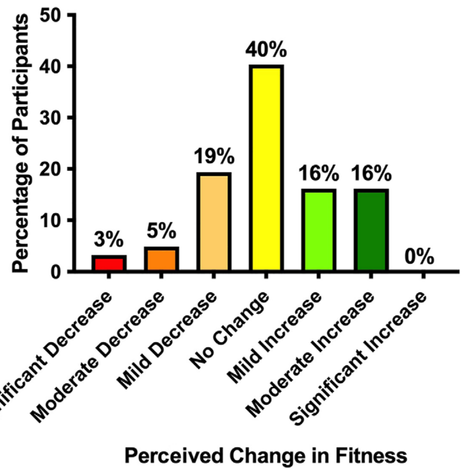

FIGURE 1 Perceived change in cardiorespiratory fitness (CRF) since the COVID-19 pandemic onset in survey participants

in their CRF (25/62, 40%) or that their CRF had improved (20/62, 32%) since the onset of the pandemic (Figure 1). Of the remaining 17 participants (27%) who reported that they perceived a decrease in their CRF, most (12/17) reported only mild decrease, and a few (5/17) reported a moderate or greater decrease in CRF since the onset of the pandemic. Due to the small numbers of participants reporting a significant increase ($n = 0$) or decrease ($n = 2$, 3%) in CRF, all subsequent analyses were performed combining these participants with those reporting a moderate increase or decrease in CRF, respectively, for a total of five categories of *perceived CRF change* (≥ moderate decrease, mild decrease, no change, mild increase, ≥ moderate increase).

Across categories of perceived CRF change, there were no significant differences in age, sex, body size, current sport type, previous sport exposure, or pre-pandemic CRF (ANOVA, all $p > .05$, pre-pandemic peak VO_2 shown in Figure 2B). PHQ-2 scores for depression were low (<3) in 95% of participants and did not vary across categories of perceived CRF change (ANOVA, $p > .05$). The Euro-QoL VAS, a global assessment of health, varied across categories of perceived CRF change (ANOVA, $p = .001$), with those reporting a ≥ moderate decrease in CRF having a lower average score (57 ± 17) than those in other categories (mild decrease in CRF: 78 ± 12, no change 81 ± 12, mild increase in CRF: 79 ± 12, ≥ moderate increase in CRF: 86 ± 7, Figure 2A). When the cohort was grouped into those with a significant cardiovascular diagnosis ($n = 25$) versus those without any significant cardiovascular diagnosis ($n = 37$), the differences across categories of perceived CRF change in EuroQol remained significant (ANOVA $p = .01$ and $p = .004$, respectively) with lower EuroQol scores in those who perceived a decrease in CRF.

Almost all (57/62, 92%) of the participants reported recent PA levels that met or exceeded guideline-recommended minimum levels of PA[34] (moderate or high PA level, Table 2), and most participants (38/62, 61%) were classified as highly active. Recent total PA (in MET-minutes/week) did not vary significantly across categories of perceived CRF change (ANOVA, $p > .05$, Figure 2C). Recent moderate intensity PA did vary significantly (ANOVA, $p = .008$), with those reporting an increase in perceived CRF during the pandemic recording a higher amount of moderate intensity PA (mild increase in CRF: 660 ± 502, ≥ moderate increase in CRF: 1330 ± 1680 MET-minutes/week) as compared to those reporting a ≥ moderate decrease (24 ± 54 MET-minutes/week) or no change in CRF (272 ± 305 MET-minutes/week, Figure 2D). Although self-reported PA was not evaluated synchronously with measured CRF on the baseline CPET, the amount of recent vigorous PA (MET-minutes/week) reported on the survey was correlated with baseline peak VO_2 (mL/kg/min, $r^2 = 0.09$, $p = .018$); correlation between total PA and baseline peak VO_2 did not meet statistical significance ($r^2 = 0.05$, $p = .07$).

DISCUSSION

This study was conducted to assess the influence of the COVID-19 pandemic on perceived CRF in an active population of athlete patients in a sports-oriented clinical practice. Key findings are summarized as follows. First, despite the potential for pandemic-related reductions in PA due to changes such as working from home, closure of exercise facilities, and cancellation of sporting events, most participants reported no change or an improvement in perceived CRF since the onset of the pandemic. Second, those that did report a perceived decrease in CRF differed from those that maintained or improved CRF in several important ways. Specifically, the few patients who reported moderate or greater decrease in perceived CRF rated their overall health as worse than other groups. Finally, although baseline pre-pandemic measured CRF and recent total PA levels were not significantly different across groups, those that perceived that their CRF had improved reported higher levels of moderate intensity PA. These findings suggest that in a population of active, fit patients, decreases in CRF when compared to pre-pandemic levels, in most instances, should not be dismissed as a secular trend related to the pandemic itself. Our results suggest that failure to maintain CRF in this specific population may be related to overall poor health status and low levels of moderate intensity PA, among other factors that may not have been fully evaluated in this study.

Existing data vary regarding the influence of the pandemic on PA and CRF in adults. Initial data reported PA reductions in both the general population and athletes, possibly as a result of stricter mandates

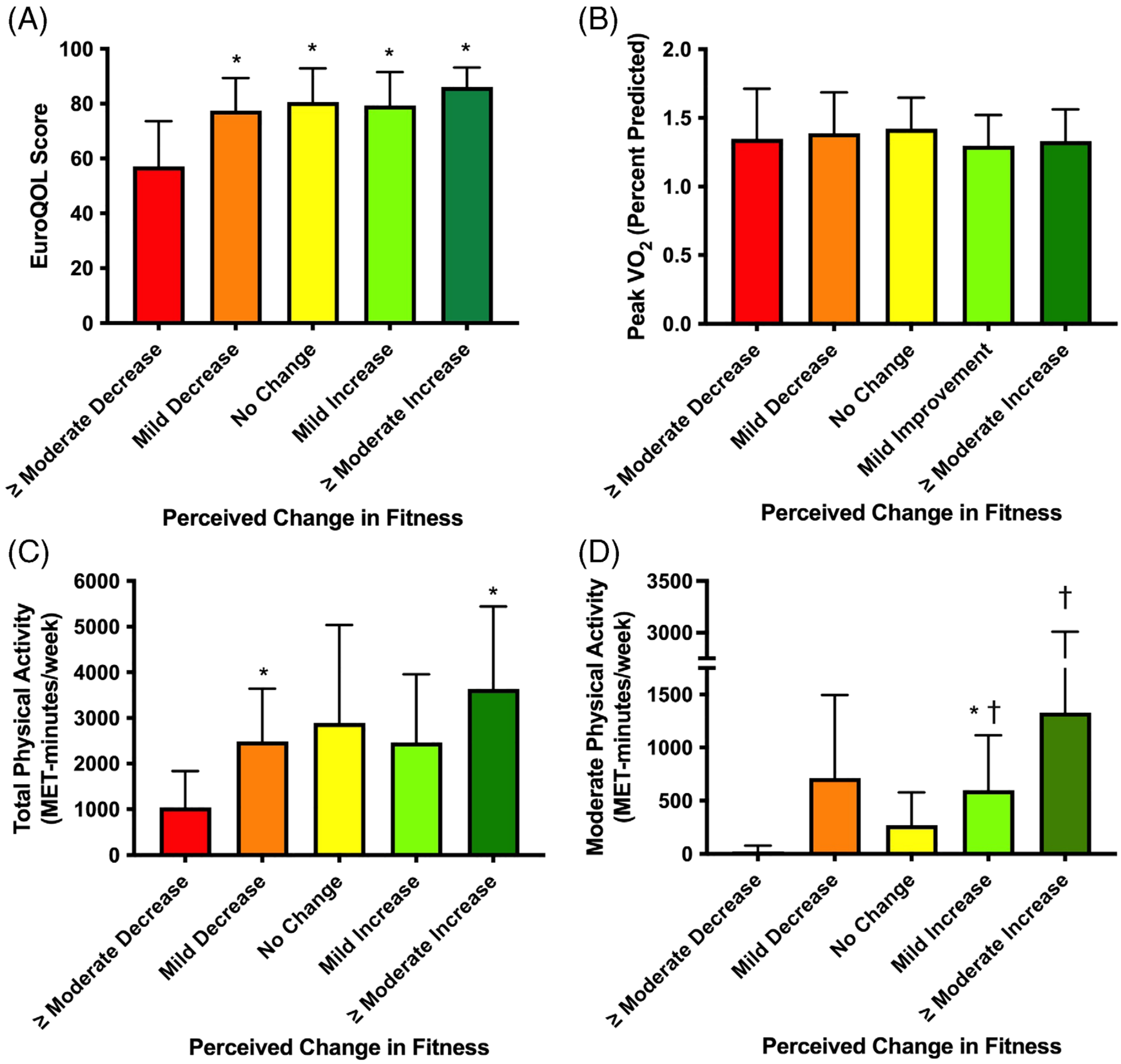

FIGURE 2 Survey responses and measured pre-pandemic cardiorespiratory fitness (CRF). (A) Euro Quality of Life Visual Analogue Scale (EuroQOL) scores significantly varied across groups (ANOVA, $p = .001$). Individuals with a significant/moderate decrease in perceived CRF had lower EuroQOL scores, a global assessment of health, as compared to all other groups (*t*-test, vs. mild CRF decrease, $p = .01$; vs. no change, $p < .001$; vs. mild CRF increase, $p = .008$; vs. moderate/significant CRF increase, $p < .001$). (B) Across groups, pre-pandemic measured CRF, shown here as percent predicted of achieved peak VO_2, did not vary significantly (ANOVA, $p > .05$). (C) Across groups, recent total physical activity (PA) did not vary significantly (ANOVA, $p > .05$). Those with a moderate or significant decrease in perceived CRF reported the lowest total PA, which in pairwise comparisons was significantly less than that in those perceiving only a mild decrease or a moderate increase in CRF (*t*-test, $p = .02$ and $p = .01$, respectively). (D) The amount of recent moderate intensity PA significantly varied across groups (ANOVA, $p = .008$), with those perceiving an increase in CRF reporting higher amounts than those perceiving a decrease or no change in CRF (moderate/significant increase vs. no change in CRF, $p = .004$; mild increase vs. no change in CRF, $p = .02$; mild increase vs. moderate/significant decrease in CRF, $p = .03$). **p* < .05 vs. significant/moderate decrease in perceived physical activity. † *p* < .05 vs. no change in perceived physical activity

regarding activities outside the home.[4-7,9-11] During later stages of the pandemic, studies focused on athletic populations suggest a preservation of PA.[12-14] Changes in CRF have been less well studied, but small studies in specific groups of athletes (ie, elite soccer players, masters cyclists, para-athletes) have demonstrated no change in measured CRF over the pandemic.[16-18] Although peak VO_2 was not measured directly, our study also suggests a reassuring picture of CRF preservation in most athletes despite challenges posed by the pandemic. To our knowledge, our study is the first to address this issue in the specific population of athletes who are also patients, in whom change in CRF is relevant both to performance but also to longitudinal medical care.

Our results can most directly be compared to one prior study by Matsumura et al. that also assessed perceived change in CRF via survey, but focused on adult high-level non-elite runners ($n = 189$).[14] They found a similar distribution of perceived change in CRF, with 45% reporting no change, 29% reporting increase, and 26% reporting decrease in CRF. They demonstrated that increases in reported PA over the pandemic were related to improvement in CRF. Similarly, we observed that higher levels of moderate intensity PA were associated with a perceived increase in CRF. Of interest, Matsumura et al. also reported that those with a decrease in perceived CRF had higher PA levels pre-pandemic. The concept that those who were the most fit or active pre-pandemic may have the “most to lose” was also demonstrated in other studies in the general population.[4,6,9] Although we do not have data on pre-pandemic PA levels in our cohort, we did not observe that higher pre-pandemic measured CRF was related to a higher risk of deterioration in perceived CRF during the pandemic. This may be related to the unique nature of our clinical athlete cohort or other factors that were not fully evaluated in our study.

We observed that among individuals who reported a moderate or greater decrease in perceived CRF, their assessment of their overall health was worse regardless of whether they had significant cardiovascular diagnoses. It is possible that interval medical events, other than COVID-19 illness, resulted in the perceived decrement in CRF in these participants. Conversely, given that this patient population is athletic and may highly value maintenance of their CRF, it is possible that feeling less fit directly led to worse assessment of their overall health even in the absence of any change in medical status. Although the data we collected do not allow us to distinguish between these two possibilities, our results suggest that those with lower EuroQoL scores may be an important subset of patients at risk for loss of CRF over the pandemic.

We acknowledge several very important limitations of this study. First, the response rate was low, which may introduce bias into the results. However, although this does not resolve the potential for bias, reassuringly survey responders were similar to nonresponders regarding the reason that CPET was performed and most demographic parameters, apart from a small difference in age. Second, the population studied included active, athletic, largely white individuals referred for cardiovascular evaluation, largely for exertional symptoms or established cardiovascular disease. The specific population studied limits the generalizability of our results to other patient or athlete populations. However, we believe these results are useful to the specific but important group of clinicians who use CRF assessment in the clinical care of athletic patients. Finally, we focused this project on assessing perceived changes rather than measured changes in CRF over the pandemic. Our results, which show a variable influence of the pandemic on perceived CRF that is not well predicted by demographic or sport-specific factors, indicate that assessing longitudinal change in measured CRF over the pandemic is an important area of future research.

CONCLUSION

In conclusion, we found that most athlete patients perceived that they had maintained or improved their CRF over the pandemic. This result is helpful in sports-oriented clinical practices that utilize longitudinal assessment of CRF to guide management and it suggests that perceived or measured declines in CRF may not reflect a predictable reduction in PA due to the pandemic. Demographic factors and baseline CRF did not easily identify the few athletes with a perceived decreased in CRF over the pandemic. However, athletes with a perceived decrease in CRF reported a worse perception of their overall health and lower levels of moderate intensity PA, which may help distinguish those at risk of pandemic-related deterioration of CRF. Future work is needed to identify the longer-term impact of the COVID-19 pandemic on athlete-specific and population-wide CRF.

DISCLOSURES

None.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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