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PROGRAMA DE PÓS-GRADUAÇÃO EM CIÊNCIAS E SAÚDE – MESTRADO

IGOR ALMEIDA SILVA

AVALIAÇÃO DO DESTREINAMENTO E RETREINAMENTO EM ATLETAS DE BADMINTON NAS RESPOSTAS PSICOLÓGICA E FISIOLÓGICA APÓS 1 ANO DE PANDEMIA DE COVID-19

TERESINA-PI

2022

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Projeto de pesquisa apresentado ao Mestrado em Ciências e Saúde da UFPI.

Área de Concentração: Métodos diagnósticos e análise das condições de saúde

Linha de Pesquisa: Investigação para diagnóstico em saúde

Orientador: Prof. Dr. Fabricio Eduardo Rossi

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PROGRAMA DE PÓS-GRADUAÇÃO EM CIÊNCIAS E SAÚDE

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ATA DE DEFESA DE DISSERTAÇÃO DO MESTRADO EM CIÊNCIAS E SAÚDE

Às 08:00 horas do dia 22/04/2022 teve início a Etapa de Defesa de Dissertação em formato de artigo intitulado ***"*Detraining and retraining in badminton athletes following 1-year COVID- 19 pandemic on psychological and physiological response"** do Programa de Mestrado em Ciências e Saúde - Área de Concentração: MÉTODOS DIAGNÓSTICOS E ANÁLISE DAS CONDIÇÕES DE SAÚDE, do

discente Igor Almeida Silva, regularmente matriculado no Programa de Mestrado em Ciências e Saúde, da Universidade Federal do Piauí, sob o número 20211001246**.** A banca examinadorafoi constituída pelos seguintes membros: Prof. Dr. Fabrício Eduardo Rossi (Presidente); Prof. Dr. LucasMelo Neves, (1º examinador); Prof. Dr. Marcos Antônio Pereira dos Santos (2º examinador); e Profª. Dra. Maria Zélia Madeira de Araújo (suplente). A defesa da Dissertação em formato de artigo ocorreu de acordo com o Regimento interno do Curso de Mestrado de Ciências e Saúde, no Capítulo XIII da Dissertação nos parágrafos primeiro e terceiro. Desse modo, a banca examinadora conferiu ao mestrandoa menção de: APROVADO.

Na forma regulamentar, está ata foi lavrada pela Comissão Examinadora, assinada pelos membros titulares e pela discente.

Prof. Dr. Fabrício Rossi
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Discente

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1 INTRODUÇÃO

O badminton é um esporte antigo, surgido na Índia por volta de 1800 com nome de Poona, consistia em rebater uma peteca, mantendo-a no ar o máximo possível, essa brincadeira era popular por todo país. Durante o período de 1858 a 1947 a Índia vivia o período de colonização inglesa, a brincadeira caiu no gosto dos oficiais, que levaram o esporte para a Inglaterra (CBBd, 2022).

Na Inglaterra era praticado pelo Duque de Beaufort's em sua residência denominada Badminton House, localizada na cidade de Gloucestershire, assim surgindo a denominação do esporte de Badminton. Em 1870 foi criado um conjunto de regras, tornando o esporte como conhecemos hoje. Em 1934 foi criado a Federação Internacional de Badminton (IBF posterior BWF), composto por nove países: Canadá, Dinamarca, Escócia, França, Holanda, Inglaterra, Nova Zelândia e País de Gales. Sua sede situada em Gloucestershire (CBBd, 2022).

Ganhou visibilidade mundial a partir de 1992, nas olimpíadas de Barcelona, e desde então vem sendo praticado pelo mundo, sendo considerado o segundo esporte mais praticado no mundo (FLORES ET AL, 2020; GOMES-DA-SILVA; SOUSA-CRUZ; ARRUDA, 2019). Porém, no Brasil o esporte é pouco popular, uma vez que a base cultural é estimulada para o futebol (FLORES ET AL, 2020).

O badminton é um esporte de raquete de alta intensidade, composto de movimentos rápidos e explosivos e habilidades mentais empregados para antecipar os movimentos do adversário e tomar decisões associadas à estratégia durante um jogo, necessitando de um bom condicionamento aeróbico, visto que durante sua prática atinge patamares de frequência cardíaca média superior a 90% da frequência cardíaca máxima, portanto, variáveis fisiológicas e psicológicas são consideradas características essenciais para o sucesso durante uma partida (LIU et al, 2021; JAN; PERT, 2020; PHOMSOUPHA; LAFFAYE, 2015).

Como muitos outros esportes, o badminton também sofreu impacto nos últimos anos, quando no final do ano de 2019 uma nova pneumonia viral surge na cidade de Wuhan, China, ganhando notoriedade por sua rápida capacidade de disseminação, sendo denominada COVID 19 (CORONAVIRUS DISEASE 2019), causada pelo vírus SARS-COV-2 (Severe Acute Respiratory Syndrome Coronavirus-2) (CHILAMAKURI; AGARWAL, 2021; WU ET AL, 2020). Apesar de ser conhecida por causar doenças pulmonares, foi observado diversas manifestações extrapulmonares, afetando os sistemas cardiovasculares, hematológicos, renais, gastrointestinais, entre outros (GUPTA, 2020).

A Sars-CoV-2 apresenta uma afinidade significativa ao receptor ECA2 (enzima conversor de angiotensina 2), sendo assim o mecanismo de entrada para a infecção. A ECA2 é uma molécula expressa em uma variedade de tecidos diferentes, desde as vias respiratórias, o miocárdio até a mucosa gastrointestinal (HAMMER ET AL, 2002). Por este motivo é possível compreender o aumento da transmissibilidade do vírus, além dos sintomas iniciais que incluíam anosmia, ageusia, desconforto respiratório entre outros (GUPTA; MADHAVAN; SEHGAL, 2020).

Em decorrência desta alta virulência e transmissibilidade, em 30 de janeiro de 2020, a Organização Mundial da Saúde (OMS) declara emergência de saúde pública de importância internacional, que segundo o Regulamento Sanitário "constitui um evento extraordinário que pode constituir um risco de saúde pública para outros países devido a disseminação internacional de doenças; e potencialmente requer uma resposta internacional coordenada e imediata". Em 11 de março de 2020, a OMS declara pandemia da COVID19 (OPAS, 2022; WACKERHAGE ET AL, 2020; WIERSINGA ET AL, 2019).

Por se tratar de um vírus novo, onde seu mecanismo de infecção e replicação, além do tratamento, eram desconhecidos, então medidas que visassem a diminuição da contaminação foram adotadas pelo mundo, o chamado LOCKDOWN. No Brasil, a restrição social atingiu todas as áreas da sociedade, não sendo diferente no setor esportivo, levando ao cancelamento de eventos esportivos, a fim de evitar aglomerações. Posteriormente, o treinamento esportivo foi banido (SACHS ET AL, 2020), e a restrição social reduziu drasticamente os níveis de atividade física e aumentou o tempo sedentário em atletas de badminton (DA SILVA; ROSSI, 2021). Além disso, o isolamento social aumentou o risco para ansiedade, depressão, vícios e outros problemas de saúde mental em atletas (HENRIKSEN ET AL, 2020), bem como, ocasionou mudanças nos hábitos alimentares (HUBER; STEFFEN, 2021).

Apesar da restrição social, os cientistas recomendaram que os atletas mantivessem seu desempenho por meio de treinamento individual em casa (SARTO ET AL, 2020). Nesse sentido, a restrição social causada pela pandemia do COVID-19 foi inédita no período atual. Estudos foram realizados para caracterizar as respostas dos atletas ao lockdown, porém, os achados não são concordantes. Especificamente, Fikenzer et al (2021) e Grazioli et al. (2020) demonstraram que curto período de lockdown (2 meses) não afetou a aptidão cardiorrespiratória em jogadores de alto rendimento em handebol e futebol. No entanto, no mesmo período, a massa gorda aumentou em jogadores de futebol (GRAZIOLI ET AL, 2020). Além disso, Spyrou et al (2021) relataram que 70 dias de bloqueio diminuíram o desempenho no sprint, salto contra movimento, na taxa de desenvolvimento de força, na potência de pico, na velocidade e força de pico de pouso em jogadores de futsal de elite. Finalmente, relatórios recentes mostram que o destreinamento na pandemia de COVID-19 não afetou o desempenho de nadadores (CSULAK, 2021), mas afetou o desempenho de atletas de vôlei e futebol (DAUTY; MENU; FOUASSON-CHAILLOUX, 2021).

Em relação aos atletas de badminton, até então, apenas o estudo de Valenzuela et al (2021) investigou os efeitos do bloqueio do COVID-19 no destreinamento e retreinamento, no entanto, este trabalho envolveu um período relativamente pequeno (7 a 10 semanas de lockdown e 6 a 8 semanas de retreinamento); os autores relataram uma redução significativa no salto de contramovimento (-6,5%) e desempenho máximo de 1 repetição (-11,5%) durante o lockdown, porém, após a fase de retreinamento, todas as medidas retornaram a valores semelhantes aos encontrados na linha de base.

Os efeitos negativos da restrição social para os atletas não se restringem apenas aos sistemas fisiológicos, mas também se refletem nos sintomas psicológicos. Chen et al. (CHEN ET AL, 2020) mostraram que a população de atletas sofre mais com problemas mentais como ansiedade, transtorno obsessivo-compulsivo e depressão durante a pandemia de COVID-19 em taxas equivalentes ou até mais altas do que não atletas. Além disso, o confinamento domiciliar pode resultar em mudanças na dieta, levando ao consumo excessivo de alimentos e consumo frequente de alimentos ultraprocessados, o que pode não apenas promover ganho de peso e perda de massa magra, mas também aumento do risco de lesões gastrointestinais (ANDREATO; COIMBRA; ANDRADE, 2020; MUSCOGIURI ET AL, 2020).

Apesar das diferentes declarações recomendando o retorno seguro aos treinos e competições após o lockdown causado pela pandemia de COVID-19 (BISCIOTTI ET AL, 2020; PELLICCIA, 2020; STOKES ET AL, 2020; WILSON; HULL, 2020), o efeito do período de retreinamento sobre essas variáveis ainda não está claro após uma longa temporada de destreinamento (≥8 meses) em jogadores de badminton altamente treinados. Portanto, monitorar as rotinas dos atletas durante o período de restrição e retreinamento de longo prazo pode ser útil para treinadores, fisiologistas esportivos e atletas na tomada de decisões sobre carga inicial e progressões durante o retorno aos treinos e jogos. Além disso, estratégias seguras e saudáveis podem ser desenvolvidas para mitigar as respostas fisiológicas e psicológicas para que os atletas retornem à prontidão em nível de competição (STOKES ET AL, 2020).

Portanto, o objetivo deste estudo foi comparar o impacto do longo período de destreinamento devido à restrição social da COVID-19 (8 meses e 1 ano) na aptidão cardiorrespiratória, composição corporal, comportamento nutricional e perfil de estados de humor em atletas de badminton altamente treinados e verificar se os atletas que retornaram aos treinos regulares quatro meses antes dos atletas que interromperam sua rotina diária de treinamento durante 1 ano melhorariam essas variáveis.

2 MATERIAIS E METODOS

2.1 DESENHO DE ESTUDO E PARTICIPANTES

O presente estudo acompanhou atletas de badminton jovens e altamente treinados pelo período de junho de 2020 à junho de 2021, totalizando um ano. De acordo com as leis estaduais durante a pandemia, cidadãos e atletas brasileiros tiveram que aderir às leis locais de isolamento social. De tal modo que em março de 2020, os atletas interromperam suas rotinas regulares de treinamento. Assim, em junho de 2020, três meses após o início da restrição social, foram realizadas as avaliações de linha de base, com um total de 32 atletas.

Então, em fevereiro de 2021, 28 atletas foram randomizados em dois grupos: Grupo Retreinado = 14 atletas, que permaneceram oito meses em restrição social pelo COVID-19 e retornaram a sua rotina diária de treinamento, por 4 meses, totalizando 1 ano para segunda avaliação; e Grupo Destreinado = 14 atletas, que interromperam sua rotina diária de treinamento por um ano devido à restrição social do COVID-19.

Após quatro meses (junho de 2021), os atletas foram avaliados novamente, neste momento, o Grupo Retreinado envolveu 7 mulheres e 7 homens; já o Grupo Destreinado, foram analisadas 6 mulheres e 3 homens (Figura 1). Os principais motivos de desistência no Grupo Destreinado consistiam em atletas que faltaram à segunda avaliação por motivos pessoais ou que ficaram desmotivados e abandonaram o esporte durante a pandemia. Assim, a amostra final analisada foi de 23 jovens atletas de badminton.

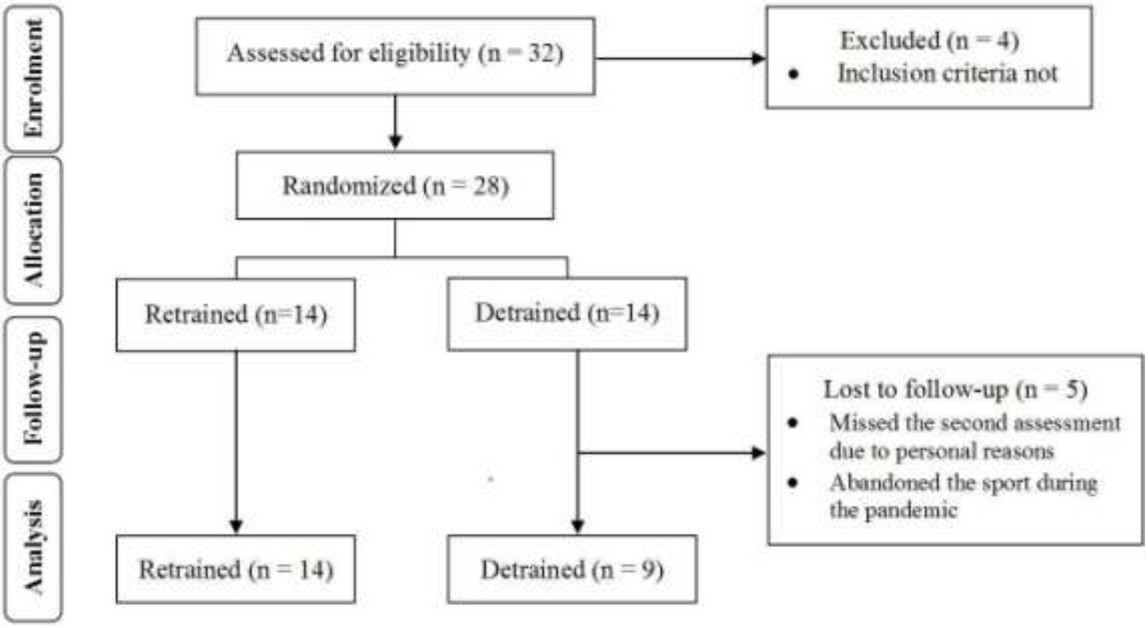

Figura 01. CONSORT chart.

Fonte: pesquisa própria.

Os atletas foram recrutados por conveniência por meio de contato com os técnicos da Confederação Brasileira de Badminton, sendo dez homens (idade = 18,7 ± 3,0 anos) e 13 mulheres (idade = 17,8 ± 2,1 anos). Os critérios de inclusão no estudo foram: ter idade superior a 15 anos na data da coleta; não apresentar lesões ou problemas cognitivos durante o período de avaliação; não ter contraindicações do sistema cardiovascular ou distúrbios musculoesqueléticos; não ter feito uso de nenhum medicamento. Todos os participantes assinaram o Termo de Consentimento Livre e Esclarecido. Além disso, os pais ou responsáveis assinaram o Termo de Consentimento Livre e Esclarecido (quando menor de 18 anos), ambos previamente aprovados pelo Comitê de Ética e Pesquisa da Universidade Federal do Piauí (Protocolo: 2.552.506). Além disso, desenvolvemos protocolos de acordo com a Declaração de Helsinque (GOODYEAR; KRLEZA-JERIC; LEMMENS, 2007).

Todos os atletas tinham pelo menos dois anos de experiência no badminton e participavam de competições nacionais e internacionais. Durante a pandemia, os treinadores utilizaram videoaulas via plataforma Google Meet, três vezes por semana, durante cerca de 60 minutos por dia, para orientar seus atletas em casa a se manterem em forma e saudáveis, focando apenas nas capacidades físicas, como flexibilidade, capacidade aeróbica, e agilidade, e não em treinamento técnico ou tático. A rotina foi conforme utilizada por Fikenzer et al (2020).

Os atletas que retornaram à rotina em fevereiro estavam treinando de forma consistente (5 a 6 vezes por semana, cerca de 4 a 5 horas por dia, mais de 30 horas por semana). A rotina incluiu treinamento geral de força e resistência, técnica básica e habilidades técnico-táticas. O Grupo Destreinado continuou treinando individualmente para manter-se em forma e saudável, focando apenas nas capacidades físicas: flexibilidade, capacidade aeróbica e agilidade utilizando as videoaulas via plataforma Google Meet, conforme descrito anteriormente e sugerido por Fikenzer et al (2020). Ninguém contraiu a infecção por COVID-19 durante este estudo atual.

2.2 PROCEDIMENTOS

Inicialmente, os atletas foram ao laboratório entre 8h00 e 9h00 da manhã de junho de 2020 e registraram o Teste de Perfil do Estado de Humor e o Questionário de Frequência Alimentar. Em seguida, foram avaliados os dados antropométricos e composição corporal. Por último, os atletas realizaram o teste de potência aeróbica. Após um ano (junho de 2021) os atletas repetiram todas as avaliações pessoalmente.

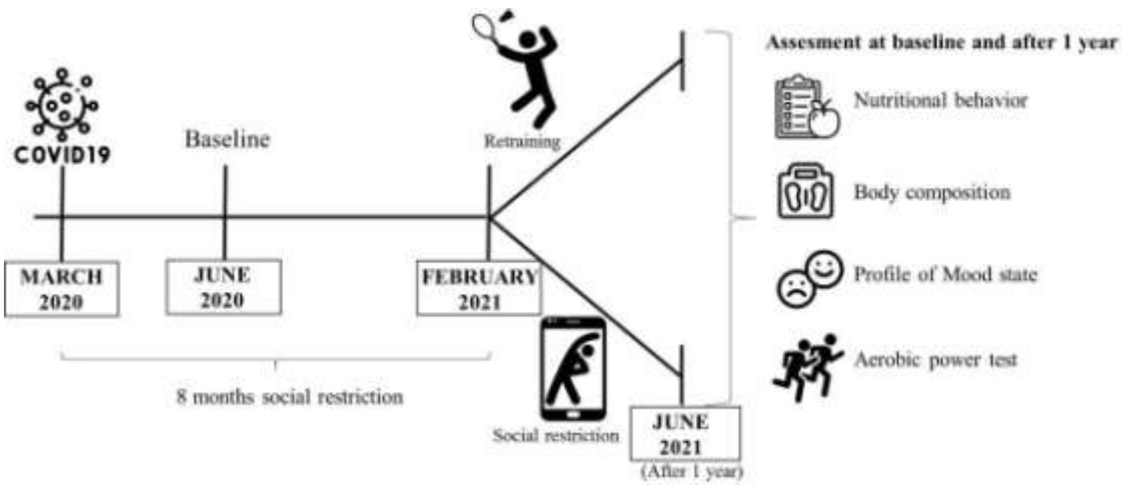

Figura 02. Desenho do estudo experimental.
Fonte: pesquisa própria.

2.3 ANTROPOMETRIA, COMPOSIÇÃO CORPORAL E COMPORTAMENTO NUTRICIONAL

A massa corporal foi medida com balança eletrônica (Filizola PL 50, Filizola Ltda, Brasil), com precisão de 0,1 kg e capacidade máxima de 150 kg, altura com estadiômetro fixo da marca Sanny (Sanny, São Paulo, Brasil) , com precisão de 0,1 cm e composição corporal usando uma análise de bioimpedância elétrica espectral (modelo BIA 310e, Biodynamics Body Composition, Seattle, WA, EUA) para medir a água corporal total (TBW), massa gorda (FM) e gordura livre massa (FFM) em quilogramas e percentual de gordura corporal (%GC). As avaliações foram realizadas no mesmo horário (8h às 9h) para garantir o controle cronobiológico. Com o sujeito em jejum, instruímos a não realizar atividade física no dia do teste e retirar todos os itens metálicos removíveis de seu corpo e evitar bebidas alcoólicas por pelo menos 12 horas antes do teste. Os participantes foram posicionados em decúbito dorsal com os membros afastados do tronco, os braços formando um ângulo de aproximadamente 30° e as pernas formando um ângulo de 45° e permaneceram parados durante todo o exame, usando roupas leves (MIALICH; SICCHIERI; JUNIOR, 2014). De acordo com as recomendações para BIA utilizando a técnica pé-mão em atletas, colocamos os eletrodos de superfície em quatro pontos anatômicos (CAMPA; TOSELLI, 2021). Com base nos resultados de um pequeno estudo piloto (n=8), os coeficientes de correlação intraclasse (ICC) teste-reteste de nosso laboratório foram TBW (0,99), FM (0,97), %GC (0,96) e FFM (0,99).

O Questionário de Frequência Alimentar (QFA) trata-se de uma análise sobre a frequência de consumo de cada item de uma lista de alimentos que varia de meses a um ano (WILLETT, 2012). O QFA utilizado é composto por 60 itens alimentares, com frequências de 0 a 10 vezes, unidade de tempo (dia, semana, mês e ano) e definição de porções (pequena, média, grande e extragrande), segundo Fisberg et al (2008) e validado por Selem et al (2014) para uma população específica. Além do comportamento nutricional, foi calculado o somatório da frequência alimentar de consumo de cada item de uma lista de alimentos.

2.4 PERFIL DO TESTE DE ESTADO DE HUMOR

A Escala de Humor de Brunel foi adaptado do Perfil dos Estados de Humor (POMS) (MCNAIR; LORR; DROPPLEMAN, 1971) e validado para a população brasileira por Rohlfs et al (2008). Os seis fatores de humor ou estados afetivos medidos são tensão, depressão, raiva, vigor, fadiga e confusão [30]. A escala também fornece um escore total de distúrbio do humor (DTM), obtido pela seguinte fórmula: {[(Tensão + Depressão + Raiva + Fadiga + Confusão) – Vigor] +100} (ROHLFS ET AL, 2008). Todos os dados foram coletados pelos pesquisadores em laboratório.

2.5 TESTE DE POTÊNCIA AERÓBICA

A velocidade ($km.h^{-1}$) da última etapa completa alcançada no Yo-Yo Endurance Test foi utilizada para estimar o consumo máximo de oxigênio (VO2max ml.kg-^{1}.min^{-1}) com a seguinte equação: 24,4 + 6 * [velocidade final ($km.h^{-1}$)] para atletas com idade ≥ 18 anos ou 31,025 + (3,238 * velocidade final) - (3,248 * idade) + 0,1536 * (velocidade final * idade) para atletas com idade < 18 anos (LÉGER ET AL, 1998).

2.6 ANÁLISE ESTATÍSTICA

Os dados foram analisados por meio do Statistical Package for the Social Sciences 17.0 (SPSS Inc. Chicago. IL. USA). Utilizou-se o teste de Shapiro-Wilk para verificar a normalidade do conjunto de dados e a esfericidade foi verificada pelo teste W de Mauchly, sendo aplicada a correção de Greenhouse-Geisser quando necessário. Como os dados eram esféricos, mostramos como média e desvio padrão. Para comparar os resultados, uma análise de variância de duas vias (ANOVA) [2 grupos (destreinamento versus retreinamento) x 2 vezes (linha de base versus após um ano)] foi empregada. O eta quadrado parcial (η2) foi relatado para Anova e Intervalo de Confiança fixado em 95% (IC 95%) foi calculado. Calculamos os tamanhos de efeito (ES) como a mudança média pré-pós dividida pelo desvio padrão pré-teste agrupado, em que um valor > 0,20 foi considerado pequeno, > 0,50 médio e > 0,80 grande (MORRIS, 2008). A significância estatística foi fixada em p<0,05.

3 RESULTADOS

Detraining and retraining in badminton athletes following 1-year COVID-19 pandemic on psychological and physiological response.

Running title: Badminton athletes following 1-year COVID-19 pandemic

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Abstract

Purpose: Badminton is a racket sport, with fast and explosive movements and mental skills employed to anticipate the opponent's movements. The COVID-19 pandemic, led to social restriction in Brazil and sport event cancellations, subsequently, sports training was banned. Thus, the objective of this study was to compare the impact of long-period detraining due to COVID-19 social restriction (8-months and 1-year) on cardiorespiratory fitness, body composition, nutritional behavior, and profile of mood states in badminton athletes and to verify if the athletes who returned to their regular training four months earlier than athletes who stopped their daily training routine during 1-year would improve these variables. **Methods**: Twenty-three young badminton athletes were analyzed: Retrained Group (14 athletes who stopped their daily training routine for eight months due to the COVID-19 pandemic plus four months of retraining), and Detrained Group (9 athletes who stopped their daily training routine during one year of the COVID-19 pandemic but performed home-based training). We evaluated body composition, cardiorespiratory fitness, nutritional behavior, and mood states profiles. **Results**: Retrained athletes showed lower body fat (-24.1% vs. +20.8%, $p<0.001$) and higher fat-free mass (+6.0% vs. -0.2%, $p=0.007$) after 1 year compared with the Detrained group. For cardiorespiratory fitness (Retrained: baseline= 55.5 ± 5.3 (47.1,63.9) and after one year= 58.1 ± 2.4 (54.2,61.9), *ES* =0.65 vs. Detrained: baseline= 53.4 ± 6.7 (47.2,59.5) and after one year=53.1 ± 5.6 (48.0,58.3), *ES*= -0.03) and nutritional behavior, including sauces and spices (Retrained: baseline= 8.9±7.0(4.5,13.4), and after one year= 3.4±2.9(1.8,5.5), *ES*= -1.11 vs. Detrained: baseline= 6.8±6.7(1.6,11.9) and after one year= 6.3±5.5(2.1,10.6), *ES*=-0.08), the ESs were medium and large, respectively for Retrained but trivial for Detrained group. For depression, ES was trivial in the Retrained (baseline= 2.7±3.3(0.7,4.7) and after one year= 2.6±2.9(0.8,4.4), *ES*=0.03) and moderate for Detrained (baseline= 1.0±1.5(-0.1,2.1) and after one year= 1.8±2.7(-0.3,3.8), *ES*= 0.50). **Conclusions**: Young badminton athletes who returned to their regular daily training four months earlier than athletes who stopped their daily training routine during 1-year due to COVID-19 social restriction decreased fat mass and increased fat-free mass. There were no significant differences between groups for cardiorespiratory fitness, nutritional behavior, and profile of mood state response.

Keywords: Coronavirus; Athletes; Sports; Body composition; Depression; Dietary habits.

Introduction

Badminton is a racket sport with an average heart rate greater than 90% of the maximum heart rate during the match. Fast, explosive movements and mental skills are employed to anticipate the opponent’s movements and make decisions associated with the strategy during a game, therefore physiological and psychological variables are considered essential characteristics for success during a match[1].

In March 2020, the COVID-19 pandemic, caused by SARS-CoV-2 (Severe Acute Respiratory Syndrome Coronavirus-2)[2, 3] led to social restriction in Brazil and sport event cancellations. Subsequently, sports training was banned[4], and social restriction drastically reduced the physical activity levels and increased sedentary time in badminton athletes[5]. Furthermore, social isolation increased the risk of suffering anxiety, depression, addictions, and other mental health concerns in athletes[6]. Additionally, the changes in dietary habits are another negative impact generated by the COVID-19 pandemic[7].

Despite the lockdown, scientists recommended that the athletes must maintain their performance through individual training at home[8]. In this regard, social restriction caused by the COVID-19 pandemic was unprecedented in the current period. In this sense, scientific investigations were performed to characterize athletes' responses to the lockdown, however, the findings were not concordant. Specifically, Fikenzer et al.[9] and Grazioli et al.[10] demonstrated that a short period of lockdown (2 months) did not affect the cardiorespiratory fitness in highly trained handball and soccer players. However, over the same period, the fat mass increased in soccer players[10]. Additionally, Spyrou et al. [11] reported that 70 days of lockdown declined the performance in sprint, countermovement jump, rate of force development, peak power, velocity, and landing peak force in elite futsal players. Finally, recent reports show the COVID-19 pandemic detraining did not affect the performance of swimmers [12] but affected performance of volleyball and soccer athletes [13].

In regard to badminton athletes, to the best our knowledge, only the study of Valenzuela et al.[14] investigated the effects of COVID-19 lockdown in detraining and retraining, however, this work involved a relatively short period (7 to 10 weeks of lockdown, and 6 to 8 weeks of retraining). In their study, the authors reported a significant reduction in the countermovement jump (-6.5%) and 1-repetition maximum performance (-11.5%) during the lockdown, however, after the retraining phase, all measures returned to similar values to those found at baseline.

The negative effects of the social restriction for athletes are not restricted only to physiological systems, but are also reflected in psychological symptoms. Chen et al. [15] showed that the population of athletes suffers the most from mental issues such as anxiety, obsessive-compulsive disorder and depression during the COVID-19 pandemic at equivalent or even higher rates than non-athletes. Furthermore, home confinement can result in dietary changes, leading to excessive food intake and frequent consumption of ultra-processed foods, which may not only promote weight gain and fat-free mass loss but also increased risk of injury or gastrointestinal discomfort [16, 17].

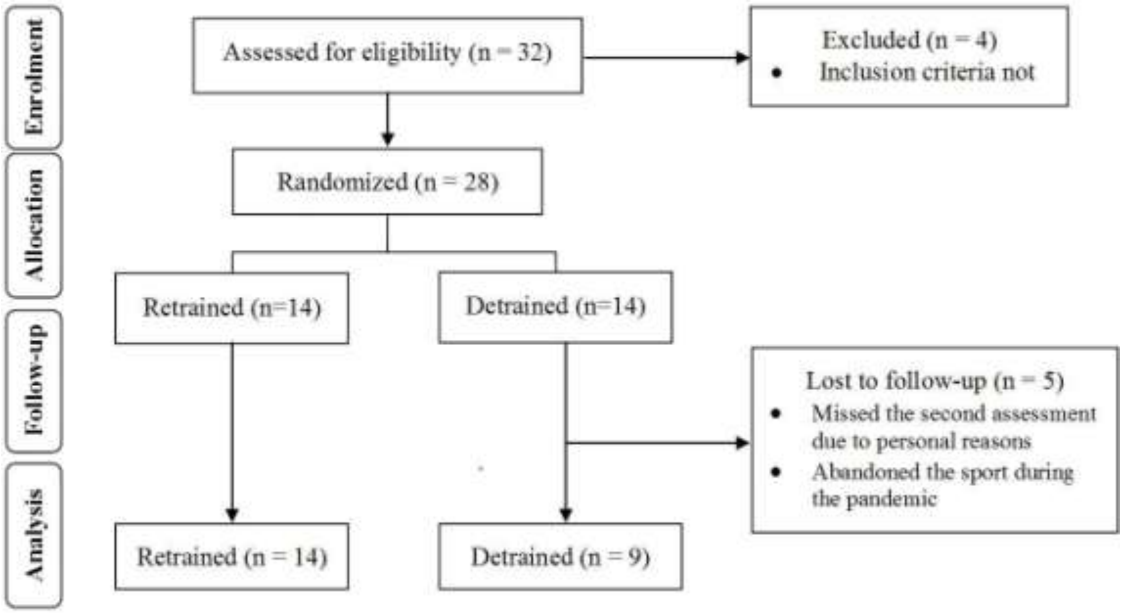
Despite the different statements recommending the safe return to training and competition after lockdown caused by the COVID-19 pandemic[18-21], the retraining period effect on these variables is not yet clear after a long detraining season (≥8 months) in highly trained badminton players. Therefore, monitoring athlete routines during the long-term training restriction and retraining period may be useful for coaches, sport physiologists, and athletes when making decisions concerning initial load and progressions during the return to training and matches. Also, safe and healthy strategies can be developed to mitigate physiological and psychological responses for athletes to return to competition-level readiness[19].

Therefore, the objective of this study was to compare the impact of long-period of detraining due to COVID-19 social restriction (8-months and 1-year) on cardiorespiratory fitness, body composition, nutritional behavior, and profile of mood states in highly-trained badminton athletes and verify if the athletes who returned to their regular training four months earlier than athletes who stopped their daily training routine during 1 year would improve these variables.

Methods

Study design and participants

This 1-year follow-up study was conducted between June 2020 and June 2021 with young, highly trained badminton athletes. According to the state laws during the pandemic, Brazilian citizens and athletes must adhere to local laws and social isolation. Therefore, athletes were requested to stop their regular training routine in March 2020. Thus, we performed the baseline assessments on 32 athletes in June 2020, after three months of COVID-19 social restriction. Then, in February 2021, 28 athletes were randomized into two groups: Retrained Group = 14 athletes, who stopped their daily training routine for eight months due to COVID-19 social restriction plus four months of retraining; and Detrained Group = 14 athletes, who stopped their daily training routine for one year due to COVID-19 social restriction. After four months (June 2021), the athletes were evaluated again, and at this time, the Retrained Group was comprised of 7 women and 7 men; For the Detrained Group, 6 women and 3 men were analyzed (Figure 1). The main reasons for dropouts in the Detrained Group were athletes who missed the second assessment due to personal reasons or who remained detrained for one year and became demotivated and abandoned the sport during the pandemic. Thus, the final sample analyzed was 23 young badminton athletes.



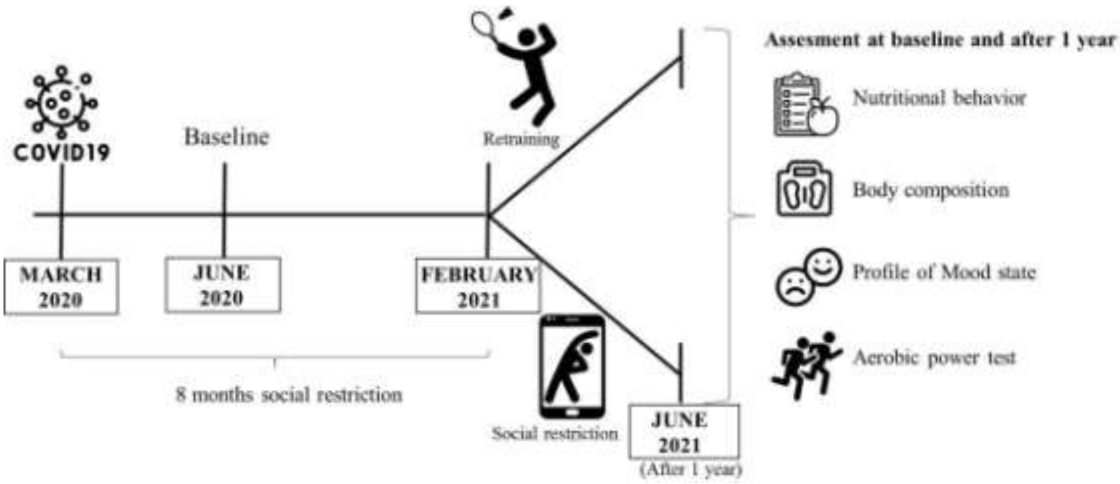
The athletes were recruited by convenience through contact with the Brazilian Badminton Confederation coaches, ten men (age = 18.7 ± 3.0 years), and 13 women (age = 17.8 ± 2.1 years). The inclusion criteria in the study were: being over 15 years old at the date of collection; not presenting injuries or cognitive problems during the evaluation period; having no cardiovascular system contraindications or musculoskeletal disorders; not having used any medication. Written informed consent was obtained from all subjects after the participants had been informed about the purpose and risks of the study. In addition, parents or guardians signed the written informed consent (when age <18 years), both previously approved by the Ethics and Research Committee of the Federal University of Piaui (Protocol: 2.552.506). Furthermore, we developed protocols according to the Declaration of Helsinki[22].

All athletes had at least two years of experience in badminton and participated in national and international competitions. During the pandemic, the coaches used video classes on the Google Meet platform, three times a week for about 60 minutes per day to guide their athletes at home to keep themselves fit and healthy, focusing only on physical capabilities, such as flexibility, aerobic capacity, and agility, and not on technical or tactical training. The routine was accordingly used by Fikenzer et al.[23].

Athletes who returned to their routine in February were training consistently (5 to 6 times a week, about 4 to 5 hours a day, over 30 hours per week). The routine included general strength and endurance training, basic techniques, and techno-tactical skills. The Detrained Group continued training individually to keep themselves fit and healthy, focusing only on physical capabilities: flexibility, aerobic capacity, and agility using the video classes on the Google Meet platform, according as previously described and suggested by Fikenzer et al.[23]. Nobody had the COVID-19 infection during this current study.

Procedures

Initially, the athletes went to the laboratory between 8:00 to 9:00 AM in June 2020 and they recorded Profile of Mood State test and Food Frequency Questionnaire. Next, they were assessed for anthropometrics and body composition. Last, the athletes performed the aerobic power test. After one year (June 2021) the athletes repeated all assessments personally.



Anthropometry, body composition, and nutritional behavior

We measured body mass using an electronic scale (Filizola PL 50, Filizola Ltda, Brazil), with an accuracy of 0.1 kg and a maximum capacity of 150 kg, height using a fixed stadiometer from the Sanny brand (Sanny, São Paulo, Brazil), with an accuracy of 0.1 cm and body composition using a spectral bioelectrical impedance analysis (model BIA 310e, Biodynamics

Body Composition, Seattle, WA, USA) to measure total body water (TBW), fat mass (FM), and fat-free mass (FFM) in kilograms and body fat percentage (%BF). The assessments were performed at the same time (8:00 AM to 9:00 AM) to ensure chronobiological control. With the fasted state subject, we instructed them to perform no physical activity on the test day and remove all removable metal items from their body and avoid alcoholic beverages for at least 12 hours before the test. The participants were positioned in a supine position with their limbs at a distance from the trunk, the arms forming an angle of approximately 30° and the legs forming an angle of 45° and remained still throughout the examination, and they were wearing light clothing[24].. According to the recommendations for BIA using the foot-to-hand technique in athletes, we placed the surface electrodes in four anatomic points[25]. Based on results of a small pilot study (n=8), the test-retest intraclass correlation coefficients (ICC) from our lab was TBW (0.99), FM (0.97), %BF (0.96) and FFM (0.99).

The Food Frequency Questionnaire (FFQ) on the frequency of consumption of each item from a list of foods ranging from months to a year[26]. The FFQ used consists of 60 food items, with frequencies from 0 to 10 times, time unit (day, week, month, and year), and definition of portions (small, medium, large, and extra-large), according Fisberg et al.[27] and validated by Selem et al.[28] for a specific population. In addition, to nutritional behavior, the sum of food frequency of consumption of each item from a list of foods was calculated.

Profile of mood state test

The Brunel Mood Scale test was adapted from the Profile of Mood States (POMS)[29] and validated for the Brazilian population by Rohlfs et al.[30]. The six mood factors or affective states measured are tension, depression, anger, vigor, fatigue, and confusion[30]. The scale also provides a total score of mood disturbance (TMD), obtained by the following formula: [(Tension + Depression + Anger + Fatigue + Confusion) - Vigor) +100] [30]. All data were collected by the researchers in the laboratory.

Aerobic power test

The speed ($km.h^{-1}$) of the last stage completed achieved in the Yo-Yo Endurance Test was used to estimate the maximal oxygen consumption (VO_{2max} $ml.kg^{-1}.min^{-1}$) with the following equation: 24.4 + 6 * [final velocity ($km.h^{-1}$)] for athletes aged ≥ 18 years or 31.025+ (3.238 * final velocity) - (3.248 * age) + 0.1536 * (final velocity * age) for athletes aged <18 years [31].

Statistical Analysis

The data were analyzed using the Statistical Package for Social Sciences 17.0 (SPSS Inc. Chicago. IL. USA). We used the Shapiro-Wilk test to verify the normality of the data set and the sphericity was verified according to Mauchly's W test, and the Greenhouse–Geisser correction was applied when necessary. Since the data were spherical, we showed it as mean and standard deviation. To compare outcomes, a two-way analysis of variance (ANOVA) [2 groups (detraining vs. retraining) x 2 times (baseline vs. after one year)] was employed. The partial eta squared (η^2) was reported for Anova and Confidence Interval set at 95%. (95% CI) was calculated. We calculated effect sizes (*ES*) as the mean pre-post change divided by the pooled pretest standard deviation, whereby a value of > 0.20 was considered small, > 0.50 medium, and > 0.80 large[32]. Statistical significance was set at $p<0.05$.

Results

Table 1 shows the characteristics of the participants. There was no significant difference between groups for all variables analyzed at baseline (p>0.05).

Table 1. Characteristics of the badminton athletes, according to group and sex.

Variables	Detrained athletes (n=9)	Retrained athletes (n=14)	*p*
Age (year)	18.6±2.2	18.0±2.8	0.618
Height (cm)	168.8±5.6	168.0±9.4	0.820
BMI (kg/m^2)	22.6±1.5	21.7±2.5	0.364
Badminton experience (y)	9.3±2.3	9.5±3.3±	0.897

Note: Data are shown as mean and standard deviation. BMI= body mass index (kg/m^2).

Table 2 compares body composition and cardiorespiratory fitness in Detrained and Retrained badminton athletes after one year of COVID-19 social restriction. The variables presented in table 2 showed normal distribution.

For fat mass, there was a significant group x time interaction (F= 41.782, p<0.001, η2= 0.67). Post hoc analysis showed a significant increment for Detrained Group (p<0.001) and a reduction in the Retrained athletes (p<0.001) with a significant difference between groups after one year (p<0.001). In concordance, there was a main interaction effect for BF %, (F= 71.764, p<0.001, η2= 0.77). Bonferroni's post hoc demonstrated significant increments for Detrained Group (p<0.001), in contrast, the BF % significantly reduced in the Retrained Group (p<0.001); and there were significant differences between groups after one year (p<0.001).

For FFM, there was a significant main interaction effect (F= 9.072, p=0.007, η2= 0.30). The post hoc analysis showed a significant increase in FFM only for the Retrained Group (p<0.001) but not in the Detrained Group (p= 0.912). Likewise, there was a significant main interaction effect (F= 11.343, p=0.003, η2= 0.35) for TBW. Specifically, we observed a significant increase in the Retrained Group for TBW (p<0.001) but there was no significant change in the Detrained Group (p= 0.570).

There was a main effect of time for body weight (F= 4.792, p=0.040, η2= 0.19), but no main interaction effect was observed (F= 3.133, p=0.091, η2= 0.13). For VO2max (ml.kg-1.min-1) (F= 0.443, p=0.522, η2= 0.05) and maximum velocity speed (km.h-1) (F= 0.067, p=0.802, η2= 0.007) there were no significant interactions or main effects of time. However, the ES were medium (0.65; 0.62), for the Retrained Group and trivial in the Detrained Group (-0.03; 0.18), respectively.

Table 3 shows the comparison of nutritional behavior in the Detrained and Retrained Groups after one year of COVID-19 social restriction. There was a main effect of time for sauces and spices (F= 5.190, p=0.034, η2= 0.21), fruit (F= 9.506, p=0.006, η2= 0.33) and beverage (F= 10.182, p=0.005, η2= 0.35). However, the main interaction effects for all food groups analyzed were not observed. The ES was large for sauces and spices in the Retrained Group (-1.11) and trivial for the Detrained (-0.08), while for fruit and beverage, the ESs were large in the Detrained (-1.10; -1.45) and small for the Retrained Group (-0.30; -0.23), respectively.

Table 3. Comparison of nutritional behavior in detrained and retrained badminton athletes after one year of COVID-19 social restriction.

	Detrained athletes (n=9)			**Retrained athletes (n=14)**			
Variable	**Baseline**	**After 1 year**	***ES***	**Baseline**	**After 1 year**	***ES***	***p***
Soup and Pasta	20.8±15.0(9.3,32.3)	18.7±14.7(7.3,30.0)	-0.14	15.9±11.6(8.5,23.3)	12.4±10.0(6.1,18.8)	-0.32	0.800
Meat and Fish	23.3±10.0(15.7,31.0)	20.9±10.2(13.1,28.7)	-0.24	23.6±15.0(14.0,33.1)	19.8±17.7(8.6,31.1)	-0.23	0.831
Milk and dairy products	9.3±6.2(4.6,14.1)	8.0±5.3(3.9,12.1)	-0.23	10.8±5.5(7.3,14.3)	8.9±7.6(4.1,13.7)	-0.29	0.819
Vegetables and egg	11.3±3.7(8.5,14.2)	9.7±2.7(7.6,11.8)	-0.50	15.3±9.8(9.1,21.6)	13.0±8.5(7.6,18.4)	-0.25	0.837
Rice and seed products	16.3±7.8(10.3,22.4)	12.8±6.2(8.0,17.6)	-0.50	15.1±7.3(10.4,19.7)	15.3±13.6(6.7,24.0)	0.02	0.367
Leafy vegatables	10.3±4.4(7.0,13.7)	8.7±5.1(4.7,12.6)	-0.34	14.2±14.2(5.1,23.2)	12.6±14.2(3.4,21.6)	-0.11	0.970
Sauces and spices	6.8±6.7(1.6,11.9)	6.3±5.5(2.1,10.6) [a]	-0.08	8.9±7.0(4.5,13.4)	3.4±2.9(1.8,5.5) [a]	-1.11	0.070
Fruit	20.4±8.3(14.1,22.8)	13.0±5.1(9.0,17.0) [a]	-1.10	21.7±18.5(10.0,33.5)	16.5±15.8(6.5,26.5)[a]	-0.30	0.600
Beverage	16.0±4.5(12.6,19.4)	9.9±3.9(6.9,12.9) [a]	-1.45	11.5±6.2(7.6,15.4)	10.1±5.8(6.4,13.8) [a]	-0.23	0.061
Bread and biscuit	19.3±11.6(10.4,28.3)	15.8±8.4(9.3,22.3)	-0.35	17.0±8.1(11.8,22.1)	13.6±7.7(8.7,18.5)	-0.43	0.963
Candy and dessert	12.8±9.7(5.3,20,2)	8.8±5.8(4.3,13.3)	-0.52	8.9±6.8(4.6,13.2)	7.4±5.5(3.9,10.9)	-0.24	0.385

Note: Data are shown as mean and standard deviation. ES= effect size. a= Main effect of time. The 95%CI are shown in parentheses.

Table 4 compares the profile of mood state response in the detrained and retrained badminton athletes after one year of COVID-19 social restriction. The variables presented in Table 4 did not show normal distribution, and we showed data as median and interquartile range. We used for comparing groups across time, the Greenhouse–Geisser correction, and since data was spherical, the two-way ANOVA.

There was no significant difference between groups for all investigated profiles of mood state. However, the ES was medium for depression (0.50) and small (0.20) for confusion in the Detrained Group and trivial in the Retrained Group (0.03; -0.03), respectively. Concerning vigor, the Retrained Group showed small ES (-0.40) and trivial for detrained athletes (-0.14). Finally, the ES for the total score of mood disturbance was small in both groups (Retrained Group: 0.24, and Detrained Group: 0.31).

Table 4. Comparison of the profile of mood states in detrained and retrained badminton athletes after one year of COVID-19 social restriction.

	Detrained athletes (n=9)			**Retrained athletes (n=14)**			
Variable	**Baseline**	**After 1 year**	***ES***	**Baseline**	**After 1 year**	***ES***	***p***
Tension	3.2±3.6(0.5,6.0)	3.2±3.7(0.4,6.0)	0.00	4.5±4.3(1.9,7.2)	3.3±3.1(1.4,5.2)	-0.32	0.363
Depression	1.0±1.5(-0.1,2.1)	1.8±2.7(-0.3,3.8)	0.50	2.7±3.3(0.7,4.7)	2.6±2.9(0.8,4.4)	0.03	0.579
Anger	2.0±3.0(-0.3,4.3)	2.8±2.6(-0.8,5.5)	0.30	1.5±2.0(0.3,2.7)	2.8±3.1(1.0,4.7)	0.50	0.344
Vigor	8.7±3.6(5.9,11.4)	8.2±3.8(5.3,11.1)	-0.14	9.5±2.3(7.8,11.1)	8.5±3.1(6.7,10.4)	-0.40	0.771
Fatigue	2.7±2.2(0.9,4.4)	4.1±4.1(0.9,7.3)	0.44	3.7±3.5(1.6,5.8)	5.2±3.8(2.9,7.5)	0.41	0.959
Confusion	2.0±4.0(-1.0,5.0)	2.7±3.5(-0.02,5.4)	0.20	3.2±3.4(1.2,5.3)	3.1±3.3(1.0,5.1)	-0.03	0.580
TMD	2.0±10.8(-6.3,10.3)	5.9±14.5(-5.3,17.1)	0.31	5.8±15.9(-3.9,15.4)	9.4±14.7(0.5,18.3)	0.24	0.962

Note: Data are shown as mean and standard deviation. TMD= total score of mood disturb. ES= effect size. The 95%CI are shown in parentheses.

Table 2. Comparison of body composition and cardiorespiratory fitness in detrained and retrained badminton athletes after one year of COVID-19 social restriction.

	Detrained athletes (n=9)			Retrained athletes (n=14)			
Variables	**Baseline**	**After 1 year**	***ES***	**Baseline**	**After 1 year**	***ES***	***p***
Body composition							
Body weight (kg)	64.2 ± 7.1 (58.8,69.7)	67.0 ± 8.3[a] (60.6,73.4)	0.36	61.1 ± 11.3 (54.6,67.7)	61.4 ± 10.2 [a] (55.5,67.3)	0.03	0.091
Fat mass (kg)	13.8 ± 3.6 (11.0,16.5)	16.6 ± 2.6 * (14.6,18.6)	0.94	11.2 ± 2.9 (9.5,12.9)	8.5 ± 2.3 *,[£] (7.2,9.8)	-1.04	<0.001
Fat mass (%)	21.6 ± 5.6 (17.3,25.9)	24.9 ± 3.6 * (22.1,27.7)	0.72	18.7 ± 5.1 (15.7,21.6)	14.3 ± 4.9 *,[£] (11.5,17.1)	-0.88	<0.001
FFM (kg)	50.5 ± 7.8 (44.5,56.5)	50.4 ± 7.6 (44.5;56.2)	-0.01	49.9 ± 11.0 (43.5,56.3)	52.9 ± 11.1* (46.5,59.3)	0.27	0.007
TBW (liters)	34.4 ± 5.2 (30.4,38.4)	34.1 ± 5.2 (30.1,38.1)	-0.06	35.3 ± 7.9 (30.7,39.9)	37.3 ± 8.4 * (32.5,42.2)	0.25	0.003
Cardiorespiratory fitness							
VO_{2max} ($ml.kg^{-1}.min^{-1}$)	53.4 ± 6.7 (47.2,59.5)	53.1 ± 5.6 (48.0,58.3)	-0.03	55.5 ± 5.3 (47.1,63.9)	58.1 ± 2.4 (54.2,61.9)	0.65	0.522
Velocity ($km.h^{-1}$)	12.8 ± 1.2 (11.7,13.9)	13.0 ± 1.0 (12.1,14.0)	0.18	13.3 ± 0.9 (11.9,14.7)	13.7 ± 0.4 (13.1,14.4)	0.62	0.802

Note: Data are shown as mean and standard deviation. FFM= Fat-free mass; TBW= Total body water (Liters). *= Bonferroni's post hoc with significant difference between moments. £= Bonferroni's post hoc with significant difference between groups after one year; a= Main effect of time. ES= Effect size. The 95%CI are shown in parentheses.

Discussion

Recent studies and scientific opinions have provided guidelines for a safe return to training and competition after lockdown caused by the COVID-19 pandemic[18, 20]. However, to our best knowledge, this is the first study focused on assessing the physiological and psychological responses during the return to training after a long-period COVID-19 social restriction in highly-trained badminton athletes. The main finding of the present study was that young badminton athletes who returned to regular daily training 4-months earlier than athletes who stopped daily training routine during 1-year due to COVID-19 social restriction improved the body composition (we observed lower fat mass and higher fat-free mass). Notwithstanding, there was no significant difference between groups for cardiorespiratory fitness, nutritional behavior, and profile of mood states. However, the ES was medium for cardiorespiratory fitness, sauces, and spices in the Retrained and trivial in the Detrained Group. For depression, fruit and beverage intake Detrained showed medium to large effect and the Retrained Group, trivial effect.

Our data are concordant with previous works[14]. Valenzuela, et al[14] evaluated seven elite badminton players during 4 weeks of normal training (baseline), short period of lockdown (7 to 10 weeks), and 6 to 8 weeks of retraining and they found a significant reduction in heart rate variability (−2.0%), power (−6.5%) and 1-repetition maximum performance (−11.5%), after the lockdown; however, during the retraining phase, all measures returned to similar values found at baseline, demonstrating that although COVID-19 lockdown impaired performance on elite athletes, these detrimental effects might be avoided by short period of retraining both on performance, and as well as observed in our study on body composition.

Previous studies from our group have shown that although highly trained athletes accomplish the moderate-to-vigorous physical activity recommendations during the regular season, they increased sedentary time and decreased total physical activity, time in moderate to vigorous physical activity, and time in vigorous activities during the COVID-19 pandemic compared with the pre-COVID-19 period[5]. Furthermore, home confinement can result in dietary changes, such as excessive food intake and frequent consumption of ultra-processed foods, leading to the consumption of high caloric foods due to impulse or anxiety [16], which contribute to weight and fat mass gain. Roberts [33] demonstrated that rugby's athletes increased or maintained their food intake during the lockdown. In addition, the athletes reduced daily energy expenditure, contributing to decrease lean mass and strength, although these effects seem to be recovered after the retraining period[13, 14].

Longer periods of detraining (>12 weeks) decreased mean muscle fiber areas of both fiber types, cross-sectional area and decreased voluntary capacity to generate forces, as well as prolonged exposure to mechanical unloading may also cause impairments in tendon structures and properties [34], in the same sense, short period of detraining decreased half-life of mitochondrial proteins (~1 week), which may reduce the mitochondrial´s function and capacity [35], and only 2-wk period of detraining decreased lipoprotein lipase (LPL) regulation in muscle of athletes and increased LPL activity in adipose tissue, which contributed to the adipose tissue storage [36]. These morphological and physiological remodeling adaptations underlines the importance of movement and exercise to preserve not only the integrity of the muscles, but also reduced-training stimuli and mechanical unloading, such as the COVID-19 home confinement [37].

On the other hand, trained high-nuclei muscles have a biological predisposition to hypertrophy in response to subsequent retraining after a long-intervening period [38]. The authors verified that the protein expression of various mitochondrial regulatory proteins, such as PGC-1α and mitochondrial fusion/fission proteins (i.e. Mfn2, Fis1 and Drp1), was upregulated to a greater extent in retrained muscles compared to naive muscles. In addition, there was a tendency to express more oxidative fibre-like properties in the retrained muscles, which could explain the benefits on cardiorrespiratoy fitness observed in both groups.

In the current study, the athletes decreased sauces and spices, beverages, and fruit throughout the study without significant differences between groups. However, the ES was large for sauces and spices in the Retrained Group and trivial for the Detrained, while for fruit and beverage, the ESs were large in the Detrained and small for the Retrained. Highly trained athletes' diets should include fruit as its high sugar content provides great energy and performance. In addition, it includes a lot of minerals and vitamins for proper cell and tissue development [39], since antioxidant, vitamin C, vitamin E and alpha-lipoic acid have proven effective in reducing plasma free radicals, restoring microvascular function after eccentric exercise [40], and it seems to be effective in improving athletic performance by increasing oxygen, glucose and other nutrients for better muscle fue [41].

Although the badminton players evaluated did not have the resources or a dietician to provide one-on-one nutritional education or nutrition recommendations for each athlete, everyone lived with their families and did not have time for grocery shopping and food preparation. Furthermore, it is essential to indicate that at the baseline assessment, both athletes' groups were already living a short period of COVID-19 social restriction (3 months) , on the other hand, one year later, despite the second wave of COVID-19 in Brazil in January 2021, the restrictions decreased, and athletes could have returned to their social routine following the WHO health guidelines [42]. Therefore, highly trained athletes seem to improve their nutritional behavior after one year; therefore, sports activity could be a preventative approach to avoid the harmful effects of inactivity due to the pandemic.

The negative effects of the COVID-19 social restriction in athletes are not restricted to physiological systems, but are also reflected in psychological symptoms [43]. Recent studies show that the population of athletes suffer the most from mental issues (anxiety, obsessive-compulsive disorders and depression) during the COVID-19 pandemic, at equivalent or even higher rates than non-athletes [15]. Some factors that worsen the psychological symptoms in athletes include isolation from society, cancellation of training and competitions, loss of income and fear of becoming infected and/or infecting other people [44, 45]. In this regard, a study conducted by Di Fronso et al.[46] revealed that the pandemic had a detrimental impact on perceived stress and psychobiosocial states of Italian athletes and related such effects as likely caused by the characteristics and emergency period restrictions.

The potential mechanism of social restriction to disturbing psychobiosocial symptoms in athletes can be explained by the physical effects of exercise and via neurobiological mechanisms. Additionally, exercise is a vehicle for cultivating behavioral mechanisms of change (e.g., self-regulatory skills and self-efficacy) [47]. It is well-known the potential effects of exercise to reduce depression and anxiety symptoms, mainly by activating adult neurogenesis in the dentate gyrus of the hippocampus[48]. Besides the molecular aspect, social restriction for the athlete is more than the need to stay at home but an obligation of social isolation, career interruption, the uncertainty of the qualification process, and unconventional and limited access to adequate training environments and training partners for example. The postponement of the Olympic Games (or the main competition of athletes in general) represents a significant career break involving loss of identity, motivation, and meaning [49]. However, it is essential to highlight that even knowing that the competition was postponed, lack of training can impact their subjective perception of mental health[50]. To understand the complexity of the pandemic experience for the athlete, comparing it to an injury or severe illness is perhaps a way of giving meaning to the fact. An injury or severe illness presents itself unexpectedly and forces sports practitioners to considerably change their engagement in sport [51], considering career interruption and training partners, for example.

Furthermore, according to coach information, some athletes who stopped their training routine during their one-year COVID-19 social restriction became demotivated and abandoned the sport. On the other hand, sports have long been viewed as an opportunity in terms of physical performance and can make socially vulnerable youth less vulnerable[52]. Therefore, providing such sporting opportunities for youth during the pandemic can be a necessary strategy to prevent mental health and minimize the chance of social exclusion outcomes during adulthood[53]. Furthermore, the same study demonstrated that a more structured leisure time spending (including sports) correlates with less social exclusionary outcomes on later periods of human life[53].

It is worth noting that the current study has some limitations. Firstly, the small total sample size and disproportionate subject distribution among groups, mainly only three men athletes in the Detrained Group, impaired the comparison between sexes. Second, this study includes both adults and adolescents (>15 years of age). Third, we not realized that sport performance analyses and subjective measurement of food intake and mood state response profile presented some limitations based on recall bias and the detraining period was not equivalent in the two groups (8 months in the retraining group versus 12 months in the detraining group) and the baseline assessment was taken after 3 months of detraining, since there are good chances of detraining to happen. However, it is necessary to highlight the long-term follow-up (1 year) and athletes were evaluated personally at the same period at baseline during COVID-19 pandemic, as well as after one year, since most studies in the literature evaluated high trained athletes only during the short time (< 4 months) and used an online survey.

Conclusions

In conclusion, young badminton athletes who stopped daily training routine during 8-months due to COVID-19 social restriction but returned to regular daily training 4-months earlier than athletes who stopped daily training routine during 1-year due to COVID-19 social restriction decreased fat mass and increased fat-free mass. There were no significant differences between groups for cardiorespiratory fitness, nutritional behavior, and profile of mood state response. However, the ES was medium for cardiorespiratory fitness, sauces, and spices in the Retrained and trivial for the Detrained Group. For depression, fruit, and beverage intake, Detrained athletes showed a medium to large effect, and the Retrained athletes trivial effect. Thus, long-term COVID-19 social restriction seems to impact mainly body composition in young badminton athletes.

Therefore, the results of this study may be applied by coaches, trainers and sport nutritionist looking to improve body composition after long-term training restriction and retraining period in highly trained badminton players when making decisions concerning initial load and progressions during the return to training and matches. Also, safe and healthy strategies can be developed to mitigate physiological and psychological responses for athletes to return to competition-level readiness.

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Ethics approval: All procedures performed were developed according to the Declaration of Helsinki and approved by the Research Ethics Committee at the Federal University of Piauí (protocol: 2.552.506).

Informed consent: Informed consent was obtained from all individual participants included in the study.

References

1. Phomsoupha M, Laffaye G: **The science of badminton: game characteristics, anthropometry, physiology, visual fitness and biomechanics**. *Sports medicine (Auckland, NZ)* 2015, **45**(4):473-495.
2. Wackerhage H, Everett R, Krüger K, Murgia M, Simon P, Gehlert S, Neuberger E, Baumert P, Schönfelder M: **Sport, exercise and COVID-19, the disease caused by the SARS-CoV-2 coronavirus**. *Dtsch Z Sportmed* 2020, **71**(5):E1-E12.
3. Wiersinga WJ, Rhodes A, Cheng AC, Peacock SJ, Prescott HC: **Pathophysiology, Transmission, Diagnosis, and Treatment of Coronavirus Disease 2019 (COVID-19): A Review**. *Jama* 2020, **324**(8):782-793.
4. Sachs JD, Karim SA, Aknin L, Allen J, Brosbøl K, Barron GC, Daszak P, Espinosa MF, Gaspar V, Gaviria A: **Lancet COVID-19 Commission Statement on the occasion of the 75th session of the UN General Assembly**. *The Lancet* 2020, **396**(10257):1102-1124.
5. da Silva Santos AM, Rossi FE: **COVID-19 pandemic impacts physical activity levels and sedentary time but not sleep quality in young badminton athletes**. 2021:1-9.
6. Henriksen K, Schinke R, Moesch K, McCann S, Parham WD, Larsen CH, Terry P: **Consensus statement on improving the mental health of high performance athletes**. *International Journal of Sport and Exercise Psychology* 2020, **18**(5):553-560.
7. Huber BC, Steffen J: **Altered nutrition behavior during COVID-19 pandemic lockdown in young adults**. 2021, **60**(5):2593-2602.
8. Sarto F, Impellizzeri FM, Spörri J, Porcelli S, Olmo J, Requena B, Suarez-Arrones L, Arundale A, Bilsborough J, Buchheit M *et al*: **Impact of Potential Physiological Changes due to COVID-19 Home Confinement on Athlete Health Protection in Elite Sports: a Call for Awareness in Sports Programming**. *European journal of nutrition* 2020, **50**(8):1417-1419.
9. Fikenzer S, Fikenzer K, Laufs U, Falz R, Pietrek H, Hepp P: **Impact of COVID-19 lockdown on endurance capacity of elite handball players**. *Sports medicine (Auckland, NZ)* 2021, **61**(7):977-982.
10. Grazioli R, Loturco I, Baroni BM, Oliveira GS, Saciura V, Vanoni E, Dias R, Veeck F, Pinto RS, Cadore EL: **Coronavirus Disease-19 Quarantine Is More Detrimental Than Traditional Off-Season on Physical Conditioning of Professional Soccer Players**. *Journal of strength and conditioning research* 2020, **34**(12):3316-3320.
11. Spyrou K, Alcaraz PE, Marín-Cascales E, Herrero-Carrasco R, Cohen DD, Calleja-Gonzalez J, Pereira LA, Loturco I, Freitas TT: **Effects of the COVID-19 Lockdown on Neuromuscular Performance and Body Composition in Elite Futsal Players**. *Journal of strength and conditioning research / National Strength & Conditioning Association* 2021, **35**(8):2309-2315.
12. Csulak E: **The Impact of COVID-19 on the Preparation for the Tokyo Olympics: A Comprehensive Performance Assessment of Top Swimmers**. *International journal of environmental research and public health* 2021, **18**(18).
13. Dauty M, Menu P, Fouasson-Chailloux A: **Effects of the COVID-19 confinement period on physical conditions in young elite soccer players**. *J Sports Med Phys Fitness* 2021, **61**(9):1252-1257.
14. Valenzuela PL, Rivas F, Sánchez-Martínez G: **Effects of COVID-19 Lockdown and a Subsequent Retraining Period on Elite Athletes' Workload,**

Performance, and Autonomic Responses: A Case Series. *International journal of sports physiology and performance* 2021:1-5.
15. Chen P, Mao L, Nassis GP, Harmer P, Ainsworth BE, Li F: **Coronavirus disease (COVID-19): The need to maintain regular physical activity while taking precautions**. *J Sport Health Sci* 2020, **9**(2):103-104.
16. Andreato LV, Coimbra DR, Andrade A: **Challenges to athletes during the home confinement caused by the COVID-19 pandemic**. *Strength and Conditioning Journal* 2020.
17. Muscogiuri G, Barrea L, Savastano S, Colao A: **Nutritional recommendations for CoVID-19 quarantine**. *European Journal of Clinical Nutrition* 2020, **74**(6):850-851.
18. Bisciotti GN, Eirale C, Corsini A, Baudot C, Saillant G, Chalabi H: **Return to football training and competition after lockdown caused by the COVID-19 pandemic: medical recommendations**. *British journal of sports medicine* 2020, **37**(3):313-319.
19. Stokes KA, Jones B, Bennett M, Close GL, Gill N, Hull JH, Kasper AM, Kemp SPT, Mellalieu SD, Peirce N *et al*: **Returning to Play after Prolonged Training Restrictions in Professional Collision Sports**. *International journal of sports medicine* 2020, **41**(13):895-911.
20. Wilson MG, Hull JH: **Cardiorespiratory considerations for return-to-play in elite athletes after COVID-19 infection: a practical guide for sport and exercise medicine physicians**. 2020, **54**(19):1157-1161.
21. Pelliccia A: **Return to play after the COVID-19 pandemic: a commentary by the Editor in Chief**. *J Sports Med Phys Fitness* 2020, **60**(5):675-676.
22. Goodyear MD, Krleza-Jeric K, Lemmens T: **The declaration of Helsinki**. In.: British Medical Journal Publishing Group; 2007.
23. Fikenzer S, Fikenzer K, Laufs U, Falz R, Pietrek H, Hepp P: **Impact of COVID-19 lockdown on endurance capacity of elite handball players**. *The Journal of Sports Medicine and Physical Fitness* 2020.
24. Mialich MS, Sicchieri JF, Junior AJ: **Analysis of body composition: a critical review of the use of bioelectrical impedance analysis**. *Int J Clin Nutr* 2014, **2**(1):1-10.
25. Campa F, Toselli S: **Assessment of Body Composition in Athletes: A Narrative Review of Available Methods with Special Reference to Quantitative and Qualitative Bioimpedance Analysis**. 2021, **13**(5).
26. Willett W: **Nutritional epidemiology**, vol. 40: Oxford university press; 2012.
27. Fisberg RM, Colucci ACA, Morimoto JM, Marchioni DML: **Questionário de freqüência alimentar para adultos com base em estudo populacional**. *Revista de saúde pública* 2008, **42**:550-554.
28. Selem SSAdC, Carvalho AMd, Verly-Junior E, Carlos JV, Teixeira JA, Marchioni DML, Fisberg RM: **Validade e reprodutibilidade de um questionário de frequência alimentar para adultos de São Paulo, Brasil**. *Revista Brasileira de Epidemiologia* 2014, **17**:852-859.
29. McNair DM, Lorr M, Droppleman LF: **Manual profile of mood states**. 1971.
30. Rohlfs ICPdM, Rotta TM, Luft CDB, Andrade A, Krebs RJ, Carvalho Td: **Brunel Mood Scale (BRUMS): an instrument for early detection of overtraining syndrome**. *Revista Brasileira de Medicina do Esporte* 2008, **14**(3):176-181.
31. Léger LA, Mercier D, Gadoury C, Lambert J: **The multistage 20 metre shuttle run test for aerobic fitness**. *Journal of sports sciences* 1988, **6**(2):93-101.

32. Morris SB: **Estimating effect sizes from pretest-posttest-control group designs**. *Organizational research methods* 2008, **11**(2):364-386.
33. Roberts C, Gill N, Sims S: **The influence of COVID-19 lockdown restrictions on perceived nutrition habits in rugby union players**. *Frontiers in nutrition* 2020, **7**:216.
34. Frizziero A, Salamanna F, Della Bella E, Vittadini F, Gasparre G, Nicoli Aldini N, Masiero S, Fini M: **The role of detraining in tendon mechanobiology**. *Frontiers in aging neuroscience* 2016, **8**:43.
35. Hood DA: **Invited Review: contractile activity-induced mitochondrial biogenesis in skeletal muscle**. *Journal of applied physiology* 2001, **90**(3):1137-1157.
36. Simsolo RB, Ong JM, Kern PA: **The regulation of adipose tissue and muscle lipoprotein lipase in runners by detraining**. *The Journal of clinical investigation* 1993, **92**(5):2124-2130.
37. Girardi M, Casolo A, Nuccio S, Gattoni C, Capelli C: **Detraining effects prevention: A new rising challenge for athletes**. *Frontiers in physiology* 2020, **11**.
38. Lee H, Kim K, Kim B, Shin J, Rajan S, Wu J, Chen X, Brown MD, Lee S, Park JY: **A cellular mechanism of muscle memory facilitates mitochondrial remodelling following resistance training**. *The Journal of physiology* 2018, **596**(18):4413-4426.
39. Ibrahim SA, Ayad AA, Williams LL, Ayivi RD, Gyawali R, Krastanov A, Aljaloud SO: **Date fruit: A review of the chemical and nutritional compounds, functional effects and food application in nutrition bars for athletes**. *International Journal of Food Science & Technology* 2021, **56**(4):1503-1513.
40. Richardson RS, Donato AJ, Uberoi A, Wray DW, Lawrenson L, Nishiyama S, Bailey DM: **Exercise-induced brachial artery vasodilation: role of free radicals**. *American Journal of Physiology-Heart and Circulatory Physiology* 2007, **292**(3):H1516-H1522.
41. Ormsbee MJ, Lox J, Arciero PJ: **Beetroot juice and exercise performance**. *Nutrition and Dietary Supplements* 2013, **5**:27-35.
42. WHO: **Lancet COVID-19 Commission Statement on the occasion of the 75th session of the UN General Assembly**. *Lancet (London, England)* 2020, **396**(10257):1102-1124.
43. Chen P, Mao L, Nassis GP, Harmer P, Ainsworth BE, Li F: **Coronavirus disease (COVID-19): The need to maintain regular physical activity while taking precautions**. *Journal of sport and health science* 2020, **9**(2):103.
44. Reardon CL, Bindra A, Blauwet C, Budgett R, Campriani N, Currie A, Gouttebarge V, McDuff D, Mountjoy M, Purcell R: **Mental health management of elite athletes during COVID-19: a narrative review and recommendations**. *British journal of sports medicine* 2021, **55**(11):608-615.
45. Clemente-Suárez VJ, Fuentes-García JP, de la Vega Marcos R, Martínez Patiño MJ: **Modulators of the personal and professional threat perception of olympic athletes in the actual COVID-19 crisis**. *Frontiers in psychology* 2020, **11**:1985.
46. Di Fronso S, Costa S, Montesano C, Di Gruttola F, Ciofi EG, Morgilli L, Robazza C, Bertollo M: **The effects of COVID-19 pandemic on perceived stress and psychobiosocial states in Italian athletes**. *International Journal of Sport and Exercise Psychology* 2020:1-13.
47. Smith PJ, Merwin RM: **The Role of Exercise in Management of Mental Health Disorders: An Integrative Review**. *Annu Rev Med* 2021, **72**:45-62.

48. Micheli L, Ceccarelli M, D'Andrea G, Tirone F: **Depression and adult neurogenesis: Positive effects of the antidepressant fluoxetine and of physical exercise**. *Brain research bulletin* 2018, **143**:181-193.
49. Henriksen K, Schinke RJ, Noce F, Poczwardowski A, Si G: **Working with athletes during a pandemic and social distancing: International Society of Sport Psychology Corona Challenges and Recommendations**. 2020.
50. Gupta S, McCarthy PJ: **Sporting Resilience During COVID-19: What Is the Nature of This Adversity and How Are Competitive Elite Athletes Adapting?** *Frontiers in psychology* 2021, **12**:374.
51. Samuel RD, Tenenbaum G, Galily Y: **The 2020 Coronavirus Pandemic as a Change-Event in Sport Performers' Careers: Conceptual and Applied Practice Considerations**. *Frontiers in psychology* 2020, **11**(2522).
52. Haudenhuyse RP, Theeboom M, Coalter F: **The potential of sports-based social interventions for vulnerable youth: Implications for sport coaches and youth workers**. *Journal of youth studies* 2012, **15**(4):437-454.
53. Feinstein L, Bynner J, Duckworth K: **Young people's leisure contexts and their relation to adult outcomes**. *Journal of youth studies* 2006, **9**(3):305-327.

Titles of figures

Figure 1. CONSORT chart.

Figure 2. Experimental design.

REFERÊNCIAS

ANDREATO, L. V.; COIMBRA, D. R.; ANDRADE, A. Challenges to athletes during the home confinement caused by the COVID-19 pandemic. **Strength and Conditioning Journal** 2020.

BISCIOTTI, G. N.; EIRALE, C.; CORSINI, A.; BAUDOT, C.; SAILLANT, G.; CHALABI, H. Return to football training and competition after lockdown caused by the COVID-19 pandemic: medical recommendations. **British journal of sports medicine**, v. 37, n. 3, p. 313-19, 2020.

CAMPA, F.; TOSELLI, S. Assessment of Body Composition in Athletes: A Narrative Review of Available Methods with Special Reference to Quantitative and Qualitative Bioimpedance Analysis, **Nutrients** v. 13, n. 5, 2021.

CBBD. Confederação Brasileira de Badminton. Jogos Olímpicos. Disponível em: <http://www.badminton.org.br/>. Acessado 18 de abril de 2022.

CHEN, P.; MAO, L.; NASSIS, G. P.; HARMER, P.; AINSWORTH, B. E.; LI, F. Coronavirus disease (COVID-19): The need to maintain regular physical activity while taking precautions. **J Sport Health Sci**, v. 9, n. 2, p. 103-104, 2020.

CHILAMAKURI R, AGARWAL S. COVID-19: Characteristics and Therapeutics. **Cells**, v. 10, n. 2, p. 206, 2021. https://doi.org/10.3390/cells10020206

CSULAK, E. The Impact of COVID-19 on the Preparation for the Tokyo Olympics: A Comprehensive Performance Assessment of Top Swimmers. **International journal of environmental research and public health**, v. 18, n. 18, 2021.

DA SILVA SANTOS, A. M.; ROSSI, F. E. COVID-19 pandemic impacts physical activity levels and sedentary time but not sleep quality in young badminton athletes, **Sport Sci Health**, p. 1-9, 2021.

DAUTY, M.; MENU, P.; FOUASSON-CHAILLOUX, A. Effects of the COVID-19 confinement period on physical conditions in young elite soccer players. **J Sports Med Phys Fitness**, v. 61, n. 9, p. 1252-7, 2021.

FIKENZER, S.; FIKENZER, K.; LAUFS, U.; FALZ, R.; PIETREK, H.; HEPP, P. Impact of COVID-19 lockdown on endurance capacity of elite handball players. **Sports medicine**, Auckland - NZ, v. 61, n. 7, p. 977-82, 2021.

FIKENZER, S.; FIKENZER, K.; LAUFS, U.; FALZ, R.; PIETREK, H.; HEPP, P. Impact of COVID-19 lockdown on endurance capacity of elite handball players. **The Journal of Sports Medicine and Physical Fitness** 2020.

FISBERG, R. M.; COLUCCI, A. C. A.; MORIMOTO, J. M.; MARCHIONI, D. M. L. Questionário de freqüência alimentar para adultos com base em estudo populacional. **Revista de saúde pública**, n. 42, p. 550-54, 2008.

FLORES, P. P.; ANVERSA, A. L. B.; QUEIROZ, L. C.; SILVA, F. L. O.; COUTINHO, A. A. C. S.; SOUZA, V. F. M. Análise da produção científica brasileira sobre badminton: uma revisão integrativa. **Caderno de Educação Física e Esporte**, Marechal Cândido Rondon, v. 18, n. 2, p. 63-70, mai./ago. 2020

GOMES-DA-SILVA, P. N.; SOUSA-CRUZ, R. W.; ARRUDA, E. P. S. Entre o lance e a chance: lógica interna numa final de badminton. **Motrivivência**, Florianópolis, v. 31, n. 58, p. 1-19, 2019.

GOODYEAR, M. D.; KRLEZA-JERIC, K.; LEMMENS, T. The declaration of Helsinki. In.: **British Medical Journal Publishing Group**; 2007

GRAZIOLI, R.; LOTURCO, I.; BARONI, B. M.; OLIVEIRA, G. S.; SACIURA, V.; VANONI, E.; DIAS, R.; VEECK, F.; PINTO, R. S.; CADORE, E. L. Coronavirus Disease-19 Quarantine Is More Detrimental Than Traditional Off-Season on Physical Conditioning of Professional Soccer Players. **Journal of strength and conditioning research**, v. 34, n. 12, p. 3316-20, 2020.

GUPTA, A., MADHAVAN, M.V., SEHGAL, K. ET AL. Extrapulmonary manifestations of COVID-19. **Nat Med**, n. 26, p. 1017–1032, 2020. https://doi.org/10.1038/s41591-020-0968-3

HARMER, D.; GILBERT, M.; BORMAN, R.; CLARK, K. L. Quantitative mRNA expression profiling of ACE 2, a novel homologue of angiotensin converting enzyme. **FEBS Lett**, v. 532, n. 1-2, p. 107-10, 2002.

HENRIKSEN, K.; SCHINKE, R.; MOESCH, K.; MCCANN, S.; PARHAM, W. D.; LARSEN, C. H.; TERRY, P. Consensus statement on improving the mental health of high performance athletes. **International Journal of Sport and Exercise Psychology**, v. 18, n. 5, p. 553-60, 2020.

HUBER, B. C.; STEFFEN, J.; SCHLICHTIGER, J.; BRUNNER, S. Altered nutrition behavior during COVID-19 pandemic lockdown in young adults. **Eur. J. Nutr,** v. 60, n. 5, p. 2593-602, 2021.

JAN, C.; PETR, S. Serve e Return in Badminton: Gender Differences of Elite Badminton Players. **Int. J. Phys. Educ. Fit. Esportes**, n. 9, p. 44-48, 2020.

LÉGER, L. A.; MERCIER, D.; GADOURY, C.; LAMBERT, J. The multistage 20 metre shuttle run test for aerobic fitness. **Journal of sports sciences**, v. 6, n. 2, p. 93-101, 1988.

LIU, H.; LENG, B.; LI, Q.; LIU, Y.; BAO, D.; CUI, Y. O Efeito do Treinamento de Intervalo sprint de oito semanas sobre o desempenho aeróbico dos jogadores de badminton de elite. **Revista Internacional de Pesquisa Ambiental e Saúde Pública**; v. 18, n. 2, p. 638, 2021. https://doi.org/10.3390/ijerph18020638

MCNAIR, D. M.; LORR, M.; DROPPLEMAN, L. F. **Manual profile of mood states**. 1971.

MIALICH, M. S.; SICCHIERI, J. F.; JUNIOR, A. J. Analysis of body composition: a critical review of the use of bioelectrical impedance analysis. **Int J Clin Nutr**, v. 2, n. 1, p. 1-10, 2014.

MORRIS, S. B. Estimating effect sizes from pretest-posttest-control group designs. **Organizational research methods**, v. 11, n. 2, p. 364-86, 2008.

MUSCOGIURI, G.; BARREA, L.; SAVASTANO, S.; COLAO, A. Nutritional recommendations for CoVID-19 quarantine. **European Journal of Clinical Nutrition**, v. 74, n. 6, p. 850-1, 2020.

OPAS/OMS. Histórico da pandemia de COVID-19. **OPAS/OMS**, 2020. Disponível em https://www.paho.org/pt/covid19/historico-da-pandemia-covid-19. Acesso em: 08 de abril de 2022.

PELLICCIA, A. Return to play after the COVID-19 pandemic: a commentary by the Editor in Chief. **J Sports Med Phys Fitness**, v. 60, n. 5, p. 675-6, 2020.

PHOMSOUPHA, M.; LAFFAYE, G. The science of badminton: game characteristics, anthropometry, physiology, visual fitness and biomechanics. **Sports Medicine,** Auckland - NZ, v. 45, n. 4, p. 473-95, 2015.

ROHLFS, I. C. P. D. M.; ROTTA, T. M.; LUFT, C. D. B.; ANDRADE, A.; KREBS, R. J.; CARVALHO, T. D. Brunel Mood Scale (BRUMS): an instrument for early detection of overtraining syndrome. **Revista Brasileira de Medicina do Esporte** v. 14, n. 3, p. 176-81, 2008.

SACHS, J. D.; KARIM, S. A.; AKNIN, L.; ALLEN, J.; BROSBØL, K.; BARRON, G. C.; DASZAK, P.; ESPINOSA, M. F.; GASPAR, V.; GAVIRIA, A. Lancet COVID-19 Commission Statement on the occasion of the 75th session of the UN General Assembly. **The Lancet** 2020, v. 396, n. 10257, p. 1102-24, 2020.

SARTO, F.; IMPELLIZZERI, F. M.; SPÖRRI, J.; PORCELLI, S.; OLMO, J.; REQUENA, B.; SUAREZ-ARRONES, L.; ARUNDALE, A.; BILSBOROUGH, J.; BUCHHEIT, M.; ET AL. Impact of Potential Physiological Changes due to COVID-19 Home Confinement on Athlete Health Protection in Elite Sports: a Call for Awareness in Sports Programming. **European journal of nutrition**, v. 50, n. 8, p. 1417-19, 2020.

SELEM, S. S. A. D. C.; CARVALHO, A. M. D.; VERLY-JUNIOR, E.; CARLOS, J. V.; TEIXEIRA, J. A.; MARCHIONI, D. M. L.; FISBERG, R. M. Validade e reprodutibilidade de um questionário de frequência alimentar para adultos de São Paulo, Brasil. **Revista Brasileira de Epidemiologia,** n. 17, p. 852-59, 2014.

SPYROU, K.; ALCARAZ, P. E.; MARÍN-CASCALES, E.; HERRERO-CARRASCO, R.; COHEN, D. D.; CALLEJA-GONZALEZ, J.; PEREIRA, L. A.; LOTURCO, I.; FREITAS, T. T. Effects of the COVID-19 Lockdown on Neuromuscular Performance and Body Composition in Elite Futsal Players. **Journal of strength and conditioning research / National Strength & Conditioning Association,** v. 35, n. 8, p. 2309-15, 2021.

STOKES, K. A.; JONES, B.; BENNETT, M.; CLOSE, G. L.; GILL, N.; HULL, J. H.; KASPER, A. M.; KEMP, S. P. T.; MELLALIEU, S. D.; PEIRCE, N.; ET AL. Returning to Play after Prolonged Training Restrictions in Professional Collision Sports. **International journal of sports medicine**, v. 41, n. 13, p. 895-911, 2020.

VALENZUELA, P. L.; RIVAS, F.; SÁNCHEZ-MARTÍNEZ, G. Effects of COVID-19 Lockdown and a Subsequent Retraining Period on Elite Athletes' Workload, Performance, and Autonomic Responses: A Case Series. **International journal of sports physiology and performance**, p.1-5, 2021

WACKERHAGE, H.; EVERETT, R.; KRÜGER, K.; MURGIA, M.; SIMON, P.; GEHLERT, S.; NEUBERGER, E.; BAUMERT, P.; SCHÖNFELDER, M. Sport, exercise and COVID-19, the disease caused by the SARS-CoV-2 coronavirus. **Dtsch Z Sportmed**, v. 71, n. 5, p. E1-E12, 2020.

WIERSINGA, W.J.; RHODES, A.; CHENG, A. C.; PEACOCK, S. J.; PRESCOTT, H. C. Pathophysiology, Transmission, Diagnosis, and Treatment of Coronavirus Disease 2019 (COVID-19): A Review. **JAMA**, v. 324, n. 8, p. 782-93, 2020.

WILLETT, W. **Nutritional epidemiology**, vol. 40: Oxford university press; 2012.

WILSON, M. G.; HULL, J. H. Cardiorespiratory considerations for return-to-play in elite athletes after COVID-19 infection: a practical guide for sport and exercise. **Medicine Physicians**, v. 54, n. 19, p. 1157-61, 2020.

WU, J.; LI, J.; ZHU, G.; ZHANG, Y.; BI, Z.; YU, Y.; HUANG, B.; FU, S.; TAN, Y.; SUN, J.; ET AL. Clinical Features of Maintenance Hemodialysis Patients with 2019

Novel Coronavirus-Infected Pneumonia in Wuhan, China. **Clin. J. Am. Soc. Nephrol**. v. 15, p. 1139–45, 2020.