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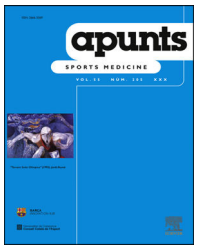

SPECIAL ARTICLE

Sports in time of COVID-19: Impact of the lockdown on team activity

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Abstract The COVID-19 pandemic has affected many sectors of our global society since its detection in Wuhan in December 2019, and team sports have been no stranger to this reality. This special article presents a review of the literature exposing the dangers for athletes of this virus, reporting the effects of the pandemic on competitive sport, and making evidence-based recommendations to avoid the consequences of detraining in confined athletes. Furthermore, we present the results of a survey with 361 answers computed from coaches and different staff members from 26 different countries, representing the activity of more than 4500 athletes from all over the world. The aim was to know more teams' activity during this cessation period. Finally, the article outlines recommendations based on the answers to help teams if a second outbreak of the virus forces massive confinements again, guiding a safe return to sport at any competitive level.

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Introduction

What is COVID-19?

Coronavirus disease (COVID-19), also known as the ''Wuhan coronavirus,'' is an illness caused by the enveloped RNA SARS-CoV-2 virus identified in Wuhan (China), a causative agent of a potentially fatal condition that has become a significant public health concern worldwide.[1] The SARS-CoV-2, a member of the betacoronavirus genus, is capable of infecting humans and animals. Coronaviruses are common viruses in nature, and several of them can infect humans, causing mild diseases in the form of colds.[2] However, genetic differences between this virus and others from the same family makes it more contagious and aggressive. As a consequence, on January 30, 2020, the World Health Organization (WHO) determined that the outbreak of COVID-19 became a Public Health Emergency at the international level.[3] WHO Member States were the advised to consider options to prevent the introduction of the disease to new areas or to reduce human-to-human transmission in zones where the virus COVID-19 was already circulating.

Following WHO recommendations, many countries imposed social distance measures to contain the spread of COVID-19 such as restricting travel from abroad, quarantining citizens returning to their home countries, limiting internal movement, massive testing, and in some cases of countries severely hit by the epidemic, a major lockdown, confining all the population and maintaining only essential services.[4]

Unfortunately, current measures seem insufficient to control the pandemic as herd immunity seems to be really low (prevalence of antibodies varies between 1 and 10% in countries such as Spain and Italy[5]), and warm weather does not affect the virus. Only the development of a future vaccine will stop this outbreak in the near future.[2] Future events regarding the presence of SARS-CoV-2 in humans it is something that the medical community cannot determine yet, so we should be prepared for any potential scenario.

Sporting events during the COVID-19 outbreak

The spread of COVID-19 and the measures taken by the governments have forced the relocation, interruption, partial or total cancellation of an endless list of sports competitions since January 2020.[6] Two Olympic qualifying tournaments were the first sporting events affected by the virus: the women's football qualifiers and the boxing qualifiers. Both were initially taking place in Wuhan (China), the original epicenter of the COVID-19 pandemic. Since then, virtually all sports leagues and competitions around the globe have suffered the impact of the SARS-CoV-2 in one way or another. National Basketball Association (NBA), National Hockey League (NHL), Union of European Football Association (UEFA) Champions League, the English Premier League, or Spains' ''La Liga,'' to put only some examples of internationally renowned team sport competitions, were suspended. Basketball EuroLeague and Australia's National Rugby League 2019–2020 seasons were canceled, the Major League Baseball (MLB) competition was delayed, and the International Olympic Committee announced on March 30, 2020, that the Tokyo Olympics were postponed for a year and will take place in July 2021. As a consequence of these alterations and restrictions imposed by the governments, almost all teams and athletes ceased their daily activity. Those constraints affected professional and amateur sports equally.

Dangers and health issues in the athletes derived from COVID-19

COVID-19 can be transmitted by close contact with respiratory droplets and touching inanimate objects or materials with relevant virus existence as the primary sources of infection. The virus can remain on surfaces such as metal, glass or plastic up to nine days if no prior disinfection procedure occurs.[7]

Once a person is infected, the incubation period for the illness can reach 14 days, but 95 percent of the cases occur in just five days. Main symptoms can be divided into two groups; systemic disorders (fever, cough, fatigue, sputum production, and headache as the typical cases) and respiratory disorders such as rhinorrhea, sneezing, a sore throat, and pneumonia.[1] Fever is the most common sign of this medical condition, and it is present in the vast majority of the cases, followed by fatigue (70%), dry cough (59%), and myalgias (35%) other common clinical presentations. However, some people will experience loss of smell (anosmia), altered taste (dysgeusia), labored breathing (dyspnea), or gastrointestinal manifestations.[7] Dyspnea seems to affect only severe COVID-19 cases,[1] and pneumonia with bilateral infiltrates is the most severe condition arising from the illness. Approximately 20 percent of the diagnosed cases will develop into severe or critical cases.[7]

The COVID-19 pandemic is associated with high morbidity rates in older people (>60 years). Many young individuals infected appear to develop a mild disease and recover over 5–7 days, but some will still have a risk of later deterioration (between days 7–9), with lower respiratory tract manifestations, requiring intensive medical care.[8] It is relevant to highlight that although many studies show that physical activity has a positive effect on improving the effects of the immune system against viral infections,[9] athletes per se are not protected from COVID-19.[2] In case of a high fever (over 37 °C) or severe shortness of breath, all physical activity must be suspended immediately to avoid further complications[10,11] and, it is more than recommended to seek expert medical health to find out the underlying causes.

To determine the level of physical activity that an individual can perform after upper respiratory tract infection, if the fever can be contained, the ''neck check rule'' is useful.[9] According to that rule, if symptoms are limited over the neck (coughing, sneezing, and sore throat), the individual is asked to jog for 10 min. Deteriorated conditions and signs after this time ''raise'' a red flag until full recovery. If the condition does not change, moderate physical activity under 80 percent of VO_2max is allowed. Nevertheless, if the symptoms are below the neck (myalgia, gastrointestinal symptoms, or persistent fever), physical activity should be prohibited until recovery.[12] In the case of pneumonia, return to physical activity should be slow and gradual in all cases, taking at least four weeks to resume it at a moderate level.[13]

Besides the above-mentioned medical problems derived from an eventual COVID-19 infection, many collateral physical and psychological problems arise due to the confinement situation. A relevant consequence of home isolation is reduced exposure to daylight, essential to induce vitamin D synthesis and the avoidance of physical activity and sleep patterns, as well as meal timing perturbations.[14] Confinement also decreases physical activity levels and increases sedentary behavior.[15] Individuals under lockdown spend more time sitting and doing activities with low rates of energy expenditure, such as office work, social networking, and watching television.[14] To avoid undesired increases in body mass due to reduced energy expenditure, nutritional advice can be necessary in some cases.

Numerous emotional problems, including stress, depression, irritability, insomnia, fear, confusion, anger, frustration, boredom, and stigma, are associated with quarantine. Some of these mental health issues persisted after the quarantine was over.[16] The duration of the confinement and medical problems are specific stressors to be considered. Athletes appear to be at a comparable risk of mental disorders relative to the general population. Athletes who are going through particular difficulties, such as injuries or recent poor game performances, may be at a higher risk of experiencing mental problems.[17] The anomalous situation resulting from the COVID-19 pandemic is undoubtedly an element to consider.

Lockdown is also distancing athletes from their daily training and competition routines and is increasing the uncertainties about the future. Reduced training and the loss of performance capacity reduces their future competitiveness, damaging their physical, technical and psychological capacities.[7]

Two main strategies are acknowledged as the most effective to avoid a SARS-CoV-2 infection.[2] To prevent this coronavirus from entering in our organisms, physical distancing and hand washing for at least 20 s with soap or using hand sanitizer (at least 60 percent alcohol),[18] and not touching our face or nose seems to be the most relevant measures. If we become infected, a healthy lifestyle can be an essential immune system booster.[2] Bodies such as the American CDC (Centers for Disease Control and Prevention) recommend wearing masks in public, especially if social distancing is challenging to maintain. They also encourage to be careful after touching door handles, shopping carts, or elevator buttons in public places. If we have to cough or sneeze, we should do it in the bend of the elbow.[11]

Effects of detraining induced by COVID-19

During the COVID-19 lockdown, regular training routines of athletes around the world have been discontinued. This unexpected breaks damage the quality and quantity of training, distancing the athlete from their daily routines in regular sports facilities.[7] Training reversibility, also known as detraining, is crucial to understand many of the changes that athletes undergo during training cessation, impairing their future performance.

Detraining can be defined as the partial or complete reversal of previously developed training adaptations.[19] The consequences of prolonged physical inactivity at a muscular level are well-known. Initial studies about long rest periods in healthy subjects found nitrogen, phosphorus, and calcium losses on skeletal muscle due to inactivity. Cardiac response with 28 percent average losses of VO_2max and 11 percent in heart volume also seems to be impaired by long resting periods.[20] The rate of loss is unequal in each physical capacity, being higher for endurance and strength endurance than in speed or maximal strength. An accepted convention is that each week of inactivity brings up to 10 percent overall loss in fitness.[10] Declines of approximately 90 percent daily activity levels in healthy young men, assessed in steps/day, entailed a 17 percent decline in muscle insulin sensitivity, a 7 percent reduction in cardiovascular fitness, and a 3 percent decrease in lean leg mass levels, with reduced myofibrillar protein synthesis rates.[14] Other expected adverse effects of lockdown include an increase in body mass, body fat percentage, loss of mental sharpness and toughness, insomnia and depression.[19,21]

A common approach to avoid the effects physical inactivity is to use the WHO guidelines for adults over 18 years of at least 75 min of weekly vigorous-intensity physical activity, including muscle-strengthening activities two or more days per week.[22] Another recommendation is to aim for 30 min of daily moderate-intensity activity and use body mass changes as a measure to determine if the amount and type of activity performed is adequate preventing training reversibility.[23] However, these general guidelines may not be enough to maintain the physical condition of trained or highly trained individuals during long confinements. Athletes show preferential atrophy of type II muscle fibers in just two weeks of detraining,[24] and concentric contractions are more affected by training cessation than eccentric contractions, maximal strength, or electromyographic activity in periods up to three months of inactivity.[25] Although, no significant alterations in the number of Satellite cells and myonuclei is observed in young men after 90 days of detraining,[26] the typical decline in one-repetition maximum (1RM) strength after one month of detraining is 8 ± 2 percent.[27] Recent evidence suggests that athletes can maintain, or suffer a limited decay, in muscular strength (bench press, squat, isometric and isokinetic concentric knee extension, and vertical jump) after fourteen days of training cessation.[28] Nevertheless, transition periods in sports usually have a maximum duration of 6 weeks,[29] and during this time, athletes have no limitations regarding the type, quality, and quantity of exercise that they can perform as if it has happened during COVID-19 confinement. For this reason and considering the exceptional nature of training conditions during this period, it is even more important to tailor the workouts to the athletes' needs.

Not only adults have had relevant movement restrictions during the COVID-19 pandemic. Young athletes have also been severely affected, making it necessary to understand if detraining follows the general behavior described in the literature in this population. Upper and lower explosive strength can be retained in teenagers during 16 weeks of reduced training if sports-specific loads (with jumps, frequents accelerations, decelerations, and change of direction) are maintained.[30] The problem is that it was not the case for the vast majority of athletes during the lockdown. By the consulted studies, it is also clear that metabolic parameters and specially aerobic-anaerobic

resistance training may worsen in 15 ± 1-year-old athletes for periods of complete rest over 15 days.[31] In younger athletes (7 years old), an 8-week detraining period maintained gains on the curl-up and single-leg hop exercises, while long jump levels and balance performance regressed toward baseline.[32] We need to consider that in youth, neural adaptations to resistance training play a significant role[33] with a different type of stimuli when compared to adults needed.

During the lockdown, not only the physical fitness of team sports athletes was affected. As we know, the array of abilities needed to practice sports from this family is varied, with technical and tactical components, game-understanding, and decision making[34] as paradigmatic aspects. Improve, or even maintaining the level of these skills has not been an easy task during confinement. Also, the recommendations regarding how to work in individualized conditions are much less specific for physical fitness. We are talking about a group of skills behaving not linearly, and therefore it is even hard to find some guidelines. When it comes to memory-retention, selective attention, and prediction measures, elite team-sport players seem to be better than control groups.[35] Three variables are relevant to improve athlete retention of audio and video feedback, tools that can be used at this time of limited access to team activities. Thus, athlete practice level, attention to coaches' feedback, and the number of ideas conveyed by coaches explained the amount of information retained (63% per-episode).[36] Regarding technical skills, high contextual interference tasks (repeating a sequence of skills, only twice before moving on to the next ability) leads to superior performance on retention and transfer tests than random, blocked, and serial practice in sports such as volleyball.[37] Variable and random practice, small-sided games (if possible in family units) and problem-solving drills also show effectiveness developing skill acquisition.[38]

Can home workouts minimize physical inactivity, lack of organized training, and boost the immune system?

During the COVID-19 lockdown, many teams have designed home workouts for their athletes to minimize the effects of detraining and physical inactivity and maintain the health and well-being of their athletes. Some staff had gone even further, proposing activities to preserve other skills such as game-understanding, or technical and tactical specific abilities. In other cases, psychological and nutritional advice has also been provided, taking special care of the players who were injured or undergoing sports rehabilitation. However, one of the pandemic's main problems is that containment measures could be extended for weeks or months,[39] increasing the inactivity time unusually compared to what happens in professional sports during the off-season, with shorter transition periods.[10]

Confinement training faces relevant issues such as the absence of organized training, lack of direct communication between athletes and coaches, movement restriction, and more critical, inappropriate training conditions.[19] However, a substantial effect on the immune system of moderate-intensity physical activity is reported, showing the importance of these practices. Thus, an increase in neutrophil and natural killer (NK) cell counts, salivary IgA, and stress hormones is reported, with changes in Th1/Th2 cell responses reducing upper respiratory tract infections (30%).[9] Acute exercise seems to stimulate the interchange of immune system cells between lymphoid tissues and blood.[40] Conversely, intense training can impair the immune system, increasing the risk of eventual COVID-19 infection.[10] After an acute bout of exercise, temporary suppression of circulating NK cells occurs, restoring average values within 24 h except for prolonged, intense, and stressful exercise.[41] For the reasons mentioned above, it is essential that coaches have not exceeded reasonable amounts of training in their home workouts, taking advantage of athletes with greater availability due to the confinement.

Although lockdown limits the opportunity to do sport outdoors, home workouts, when adequately designed, seem to provide sufficient stimuli to stay fit and healthy. These home-based activities can include bodyweight training, aerobic exercise, and aerobic high-intensity exercise using stationary bikes or rowing ergometers.[39] The implementation of online sessions using the internet, media broadcasts, or phone calls to add a social element that can improve adherence is highly recommendable.[2] Physically active people can use without problem routines with exercises demanding up to 90 percent of their maximum heart rate (HRmax), with ratings of perceived exertion (RPE) between five and 10.[39] When the workouts are based on high-intensity training (HIT), increases in health markers (cardiovascular fitness, skeletal muscle mitochondrial density, and insulin sensitivity) just after six HIT sessions in 15 days[14] are observed in healthy individuals. Improvements in fitness and exercise capacity, prevention of sedentary behavior, and reduced risk of cardiovascular mortality have also been attributed to home-based physical activity.[15] Aerobic physical activity prevents mitochondrial dysfunction and oxidative damage to motoneuron and neuromuscular junction, maintaining neurotrophin release. The advice to protect the neuromuscular system is to use a combination of both high-intensity resistive exercises and aerobic exercise.[20] Under confinement, exercises involving large muscle groups (rope-skipping, jogging, burpees, or mountain climbers), alternated with some sort of resistance training in the form of circuits seem to be a suitable formula.

As many athletes are going to train at home under equipment constraints, bodyweight training can be a suitable way to induce strength adaptations. Bodyweight training produced improvement in muscle strength, endurance, agility, cardiovascular endurance, and flexibility in young, healthy males that trained five days a week for 10 weeks.[42] Although without nutrition control, bodyweight training seemed to have a small impact on 21–23-year-old women's body composition, it was effective in improving general physical fitness, muscle strength, and endurance. This form of training also increased the participants' flexibility.[43] When used with high frequency and intensity, bodyweight training is recommended for young, healthy people with high motivation for training.[42] As muscle power is particularly susceptible to detraining, even in athletes with experience, plyometric training[44] and a maintenance program of resistance training are necessary to avoid excessive declines in neuromuscular function in breaks longer than two or three weeks.[45] The use of inexpensive equipment such as elastic bands or small weights is also an outstanding alternative to the unavailability of bulky traditional strength equipment during the confinement. Bands are affordable, can be used almost everywhere; many exercises can increase their resistance with them and show a similar effect in prime

movers, antagonists, synergists, and stabilizing muscles to isoinertial resistance training.[46] Kettlebells, for instance, show viability increasing strength and power, and may also show postural control enhancement.[47] Suspension training can also be used without any problems in small places. The invention of some branded devices is attributed to American soldiers looking to do exercise in boats and submarines, where significant space constraints exist. Research with a high-level of scientific evidence shows that muscle activation using suspended exercises is higher to comparable traditional resistance exercises.[48]

Some work oriented to maintain the range of motion can be included in the workouts of home-confined team sport athletes. To be effective, the training plans should include major muscle groups (prime mover of relevant kinetic chains) and at least two or three specific sessions per week, with static and dynamic exercises.[10] The use of recovery strategies is also a practice that can be implemented in home activities during the COVID-19 lockdown. Several methods, such as cold-water immersion (CWI), contrast water therapy (CWT), compression garments, stretching,[49] psychological techniques, or proper management of sleeping times,[50] can enhance subsequent physical performance while diminishing the impact of HIT on the immune system.

Exercise can help to avoid some of the issues of home isolation, such as depression, stress and anxiety. Evidence shows that regular activity improves mood and sleep quality. Active people are more likely to show mental well-being[51] with several studies suggesting that mindfulness and yoga can be good practices to decrease depressive and anxious symptoms, being effective strategies to improve mood.[52,53]

Home-workouts can then be extremely beneficial for athletes from many points of view. However, careful supervision of the exercises is needed as athletes are going to be exercising in narrow spaces that are not explicitly designed to do physical activity, practicing in different surfaces[54] than those used to, and in many cases, not employing their regular sports shoes. Thus, we do not want to reduce their safety by any means, avoiding severe injuries like some reported in professional athletes working out at home during COVID-19 lockdowns.[55]

Objectives

This article seeks to know the extent of the practices carried by team sports internationally during the COVID-19 lockdown. Although general recommendations in this period may have provided evidence-based insight to practitioners looking for information to tailor the practices to their athlete's needs, generic advice may not be beneficial as, generally speaking, coaches and staff already apply these principles.[56]

Methodology

A cross-sectional study was conducted using non-probability sampling techniques. Data was gathered via a tailored ad hoc online questionnaire to understand the rationale behind every team practice and providing insight from every context. Understanding this information is relevant to prepare better the return to sport (RTS), as well as to recognize the deficits that COVID-19 lockdowns may have caused in the preparation of teams and athletes.

Participants

Three-hundred and eighty answers coming from national and international contacts, personal networks, clubs, professional franchises, associations, and sports governing bodies were received. The respondents provided anonymous information about their teams, leagues, and practices, with no personal or nominal information gathered by the questionnaire. After carefully studying all the registered data, 19 answers were excluded from the final dataset, due to missing information, they were not referred to team sports with an opposition-cooperation setting, or refusal to answer the questionnaire ($n = 3$) after reading the information section. Three hundred and sixty-one answers coming from 27 different countries (Fig. 1), representing the activity of more than 4500 worldwide athletes (Median 4723.5; range 3728−5719), were finally included.

Procedure

An ad hoc online questionnaire about the practices and activities carried out by sports teams and athletes during the COVID-19 lockdown, and their hypothetical return to sport was modeled using Google Forms (Initial release February 6, 2008, Google LLC, USA). The questionnaire was based on a list of categories and variables identified as relevant, to understand better how staff had adapted their practices during the confinement. The online instrument articulated different questions depending on the respondent's professional profile (coach, assistant coach, strength and conditioning coach, and physiotherapist). If any staff member fulfilled different roles (i.e., assistant coach and strength and conditioning coach) with the same team, they were kindly asked to answer as often as it was pertinent. The questionnaire was divided into ten major sections with different questions depending on the section:

a) General data: Sport, competitive level, context, gender, league, country, and role in the staff
b) Technical preparation: Activities performed during the confinement, aims, schedule, number of sessions, conduction of activities, equipment, periodization, and level of compliance
c) Tactical preparation: Activities performed during the confinement, aims, schedule, number of sessions, conduction of activities, use of equipment, periodization, and level of compliance
d) Strength and conditioning: Activities performed during the confinement, aims, schedule, number of sessions, conduction of activities, use of equipment, periodization, and level of compliance
e) Injury prevention (IP): Staff members in charge of the IP programs, program contents, injured players follow-up, and level of general physical activity during confinement
f) Testing − Tests performed, if that was the case
g) Load monitoring − Wellness, internal and external load measurements, if that was the case

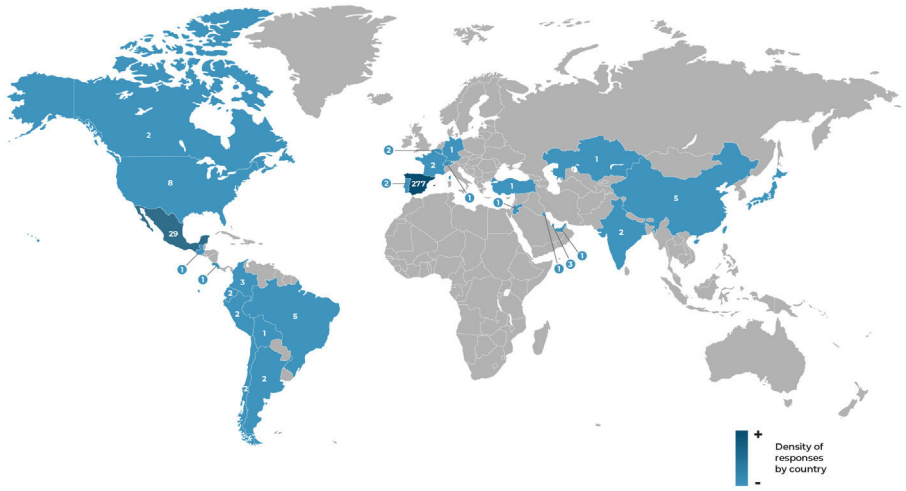

Figure 1 Countries of origin and number of respondents to the survey.

h) Recovery strategies – Type of recovery strategies employed, if that was the case
i) Nutrition – Nutritional strategies and diet used during the confinement
j) Psychological preparation – Type of psychological strategies and player follow-up, if that was the case
k) Return to sport (RTS) – Players preparation before RTS and preventative measures adopted in the sports environment

Approximately 90 percent of the questionnaire contained closed-response formats (yes/no, frequency responses, checklists, and Likert scale ratings), with the remaining 10 percent using opened-ended formats.[57] The questionnaire was able to adapt the answers provided to the different restriction levels imposed by worldwide governments due to the COVID-19 pandemic. After a revision of the questionnaire, a pilot study was conducted among trusted coaches to identify errors, problems derived from the interpretation of the questions, and make the instrument less time-consuming.

Ethics approval and consent to participate

The study was approved by the Investigation Ethics Committee (CER) of the University of Vic-Central University of Catalonia (internal code 118/2020) at its meeting of May 11th, 2020. Participants had access to all the relevant information about the project in the first section of the questionnaire and provided informed consent. Participants were informed about how their rights and the information provided were preserved according to current EU regulations (2016/679 GDPR), were asked for voluntary participation, and could withdraw from the study at any point.

Data collection

The online survey was active for 14 days (May 12th to May 26th, 2020), collecting information from coaches and teams contacted through professional networks and personal contacts. This snowball sampling had the objective of gathering expert opinion, and to represent in the final sample a similar percentage of teams playing internationally, nationally, regionally, and locally. The research team declined to use social media and mailing lists to access higher-quality responses and avoid missing data.

Statistical analyses

A descriptive study was performed. Absolute and relative frequencies for categorical variables and measures of central tendency (mean and median) and dispersion (standard deviation (SD), Range) for continuous variables were calculated.

All analyses were performed using Microsoft Excel for Mac version 16.37 (Redmond, WA).

Results

Context

Two-hundred and thirty coaches (coach or assistant coach) from 20 countries and different competitive levels responded to the survey. Seventy-eight percent of the answers were from Spain ($n = 179$) and 22 percent from other countries ($n = 51$). Thirteen of them belonged to teams competing internationally. The remaining coaches ($n = 217$) competed at a national, regional or local level.

Regarding trainers (physical fitness or strength & conditioning coach, physical therapist, physiotherapist, or athletic trainer), 131 answers from 15 different countries were computed. Seventy-five percent of the answers were received from Spain ($n = 98$) and 25% ($n = 33$) from other countries. Thirty-three trainers were staff members of teams competing internationally, and the remaining 98 competed at a national, regional or local level.

Answers from nine different team sports, different competitive levels, settings, and both genders were included in the final sample (Tables 1–3).

Table 1 Number of answers received by discipline and survey respondent profile.

	Coaches (64%)		Trainers (36%)		Total	
Sports	*n*	%	*n*	%	*n*	%
Basketball	35	15%	36	27%	71	20%
Handball	14	6%	3	2%	17	5%
Football	124	54%	65	50%	189	52%
Futsal	4	2%	3	2%	7	2%
Field hockey	6	3%	2	2%	8	2%
Rink Hockey	14	6%	18	14%	32	9%
Rugby	2	1%	0	0%	2	1%
Volleyball	26	11%	4	3%	30	8%
Waterpolo	5	2%	0	0%	5	1%
Total	230	100%	131	100%	361	100%

Table 2 Percentage of answers coming from every competitive level.

	International	National	Regional	Local	Total
Coaches	4%	18%	21%	21%	64%
Trainers	9%	17%	7%	3%	36%
Total	13%	35%	28%	24%	100%

Table 3 Competitive setting and gender of the teams when the respondents were coaches and trainers.

	Coaches		Trainers	
	Female teams	Male teams	Female teams	Male teams
High-performance training centers	3%	2%	4%	4%
Youth sports	62%	58%	26%	26%
Senior-level competitions	35%	40%	70%	70%
Percentage	100%	100%	100%	100%
Total answers	61	169	27	104
Accumulated percentage	27%	73%	21%	79%
Total	100%		100%	

Fifty-six percent of the surveyed coaches ($n = 129$) declared not having finished the season at the moment when they provided their answers. However, 68% of those coaches ($n = 88$) reported that the competition was over at that point. From the other forty-one coaches, 20% ($n = 26$) did not know if their official competition had concluded, while 12% ($n = 15$) admitted that their competition was still running. This fact leads us to think that even most of them knew they would not compete anymore until the next season, they continued with their practices to avoid a severe effect of technical and tactical detraining over their athletes.

Similar results were reported by the trainers, with eighty-eight (67%) with an ongoing season at the moment to receive the survey. Fifty-one percent of those trainers reported that their competition had finished at that point ($n = 45$). From the other 49%,19% ($n = 17$) did not know if their competition was over, while 30% ($n = 26$) admitted that their competition was still running. Again, it seems that a high percentage of the teams had plans to maintain their physical routines as long as possible, promoting some activities during the first phases of deconfinement in many Asian and European countries.

Sixty-seven percent of coaches and trainers working with international level athletes ($n = 31$) reported that their season was still ongoing, while this percentage rose to 60% ($n = 129$) for the teams belonging to other competitive levels. From those teams competing internationally, 39% of the trainers ($n = 12$) declared that their competition was over, 29% ($n = 9$) were not sure, and 32% ($n = 10$) admitted that their season was still running. Instead, 64% ($n = 119$) of the trainers, belonging to teams competing at other levels declared that their competitive season was over, 18% ($n = 33$) did not know if it was the case, and 18% ($n = 34$) admitted that their competition was still running.

Periodization

Coaches and trainers were surveyed about their strategies to organize practices during the lockdown and the implementation of technical, tactical, and physical activities in their

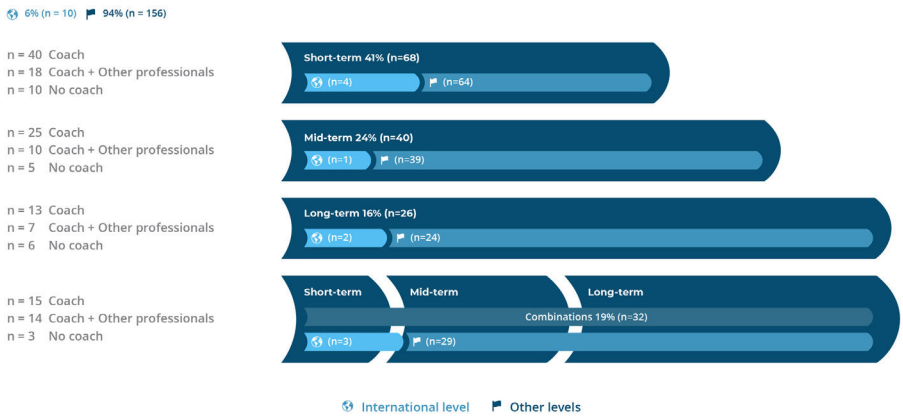

Figure 2 Timeline for the technical periodization.

players' schedules. Twenty-eight percent of the coaches ($n = 64$) did not implement any technical activity (3 belonging to the international level (23%) vs. 61 from other levels (28%)). Short-term (1–2 weeks) periodization was the most common approach (41%), with several cases of coaches reporting not being the professional or the only professional responsible for preparing these activities (Fig. 2).

Fifty-eight percent of the coaches ($n = 134$) declared not having prepared any tactical content for their players during this COVID-19 time (5 international level (38%) vs. 129 other levels (59%)). Short-term periodization was also the most common approach for tactical content (47%). Tactical activities were less frequent for teams during lockdowns than technical contents, even though international level coaches implemented more tactical content than coaches from lower competition levels (Fig. 3).

All the trainers in the sample ($n = 131$) had scheduled some type of activity for their players during the lockdowns. The short-term periodization of these contents was also the most common approach (14 international level (42%) vs. 33 other levels (34%)), but it was not as prevalent as in previous content (38%). It is in this content where we observe the highest percentage of combinations (25%) of short, mid (3–4 weeks) and long-term (more than 4 weeks) approaches (Fig. 4).

Sessions

Coaches and trainers reported sessions with their players in four different formats: individual, small-group, full squad, and combinations. Several differences can be observed when comparing international level teams from teams belonging to the other levels. International level teams used more combinations for their technical (30%) and physical fitness (46%) practices, while the full squad format was the most preferred among teams belonging to national, regional, and local levels (42%) for their physical fitness sessions (Fig. 5).

Communication between staff members and players during the confinement was carried out using different online channels, as it has happened in almost every aspect of life. To better understand how sessions were conducted during the lockdown, we asked in our survey if they were imparted synchronously, asynchronously, or using both modalities. The latter was the preferred modality for technical (28%; $n = 65$) and physical fitness (40%; $n = 52$) content, while tactical content was delivered on a higher but not significant number of occasions live (19%; $n = 44$).

Drill and exercise goal establishment considered two categories in the survey: one goal and more than one goal. It seems clear that the primary content designed for team sport athletes during the confinement has been physical fitness. Trainers answered that they had tailored conditioning and injury prevention programs with more than one goal predominantly at every competitive level (Fig. 6). The percentage of international level teams proposing technical and tactical activities with one or more aim to their players was very similar to that of teams belonging to other competitive levels.

The technical contents most periodized by the teams during the lockdowns were drills aimed at honing ball and no-ball skills, with similar percentages for teams of every competitive level (Fig. 7a). Regarding the tactical contents, working with concepts affecting full squad were the ones preferred by the coaches (Fig. 7b), with a higher percentage of teams competing at a national, regional, or local level working on individual and position-specific concepts. In the case of physical fitness, two contents were priorities: physical condition maintenance and injury prevention (Fig. 7c). Teams using specific injury prevention protocols during this time ($n = 32$ international and $n = 96$ ''other levels''), used sport-specific and individualized approaches preferentially (Fig. 7d). In almost 60% of the cases, fitness coaches were the professionals designing and periodizing these prevention programs. In the remaining 40%, this duty was fulfilled in collaboration with more professionals, and only in 3% of the cases of teams belonging to ''other levels,'' another professional (physiotherapist, physical therapist, or athletic trainer) is the main and only responsible. Only 5 teams ($n = 1$ international and $n = 4$ ''other levels'') reported not performing any injury prevention protocol.

A variety of pieces of equipment were used to work on physical fitness during COVID-19 lockdowns (Fig. 8). However, elastic bands, household items and furniture, foam rollers, suspension devices, and free weights stand out above the rest. The international level teams used cardio machines and small weights (dumbbells and kettlebells)

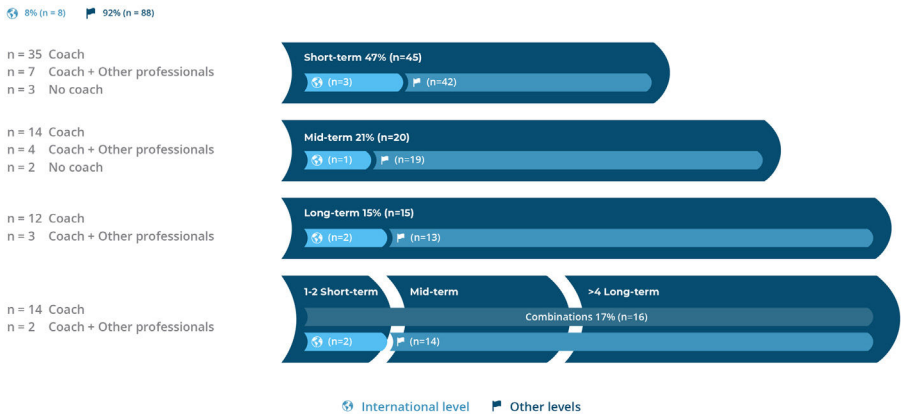

Figure 3 Timeline for the tactical periodization.

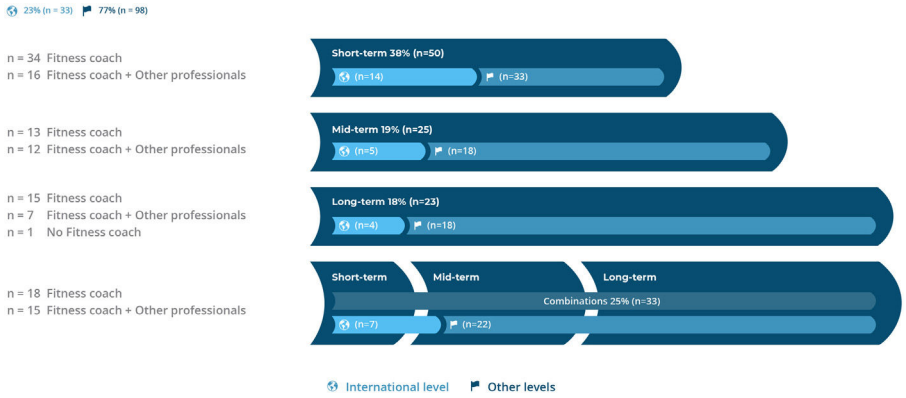

Figure 4 Timeline for the physical fitness periodization.

Figure 5 Organization of the practices by number of players and content.

more than teams belonging to other competitive levels. In any case, and without a doubt, the use of bodyweight training was the most prevalent among teams, with 97% of them acknowledging its use.

A majority of athletes (>90%) used their equipment, but depending on the competitive level, clubs provided it (64% international and 18% ''other levels''), or it had to be obtained by the athlete after club recommendation (46% international and 24% ''other''). In really few cases (9% international and 5% ''other levels''), sponsors provided the equipment.

Teams promoted less congested schedules (37%; $n = 85$) or programs with the usual number of sessions (28%; $n = 65$) for the technical contents. Just a small percentage of teams increased the number of training sessions (7%; $n = 16$) during the confinement. Teams considered tactical aspects with the same number of sessions in 14% of the cases and with fewer practices in 26% of them. When it comes to physical

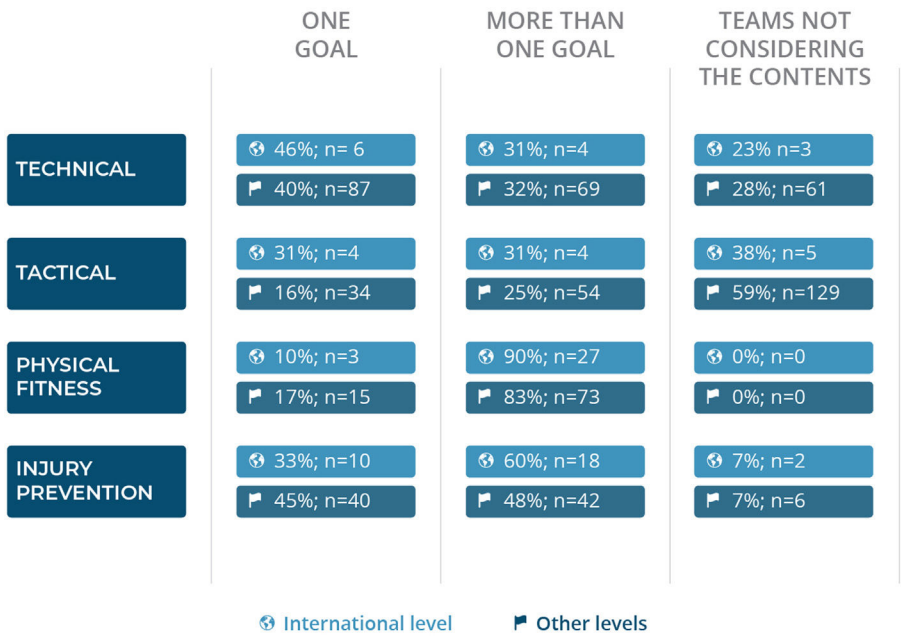

Figure 6 Goal setting during confined sessions.

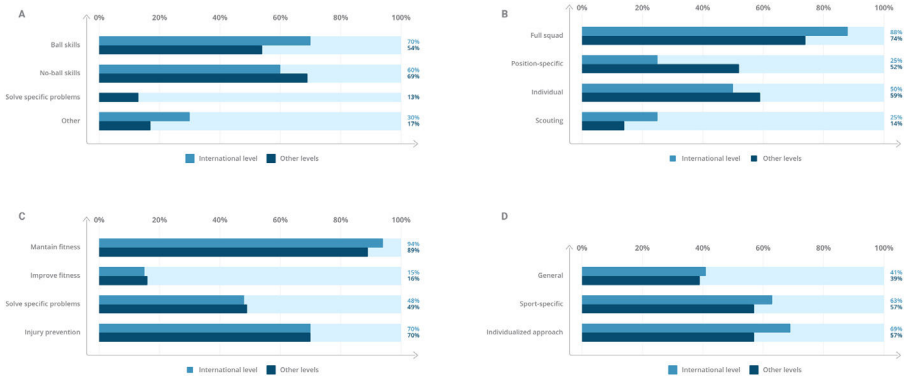

Figure 7 (a–d) Contents periodized in the technical, tactical, physical fitness, and injury prevention sessions.

fitness, trainers established programs with the regular number of practices in 54% of the cases ($n = 71$) and increased the number of practices taking advantage of player availability, in 41 cases (31%).

Physical fitness tests

A small percentage of teams performed physical tests before the lockdowns (12% international and 10% ''other levels''), more than likely, intending to compare the level of physical fitness of the players before the RTS in a reliable way. When no test was carried out, expecting a shorter period of confinement was the reason given by the majority of the teams (Table 4).

Anthropometric tests (50% international and 30% ''other levels''), followed by strength tests (33% international and 39% ''other levels''), were the ones that the teams carrying out any form of assessment employed the most before and after COVID-19 lockdowns (Table 5).

When the comparison is drawn between the responses received from Spain and those that came from the rest of the world, not expecting such a long period of confinement is again the reason chosen on the highest number of occasions to explain the fact that really few teams performed pre-lockdowns physical tests (71% Spain and 90% rest of the world).

Athlete motivation and degree of goal accomplishment

Using a 5-point Likert scale, coaches and trainers were asked about the perceived motivation that their athletes had experienced carrying out technical and physical fitness activities, as well as the perceived degree of goal accomplishment in the tactical aspects. International level coaches observed higher levels of motivation in the technical sessions (4.10 ± 0.74) and tactical goal accomplishment (3.18 ± 0.85) among their players than coaches belonging to ''other levels'' (3.49 ± 0.92 and 3.88 ± 0.84 respectively). The same trend is observed in motivation towards physical fitness (Fig. 9).

Table 4 Number and percentage of teams carrying out physical tests before the confinement according to their competitive level and reasons not to do it, if it was the case.

	International level	%	Other levels	%
No, we were not expecting such a long confinement	26	79%	74	76%
No, we did not consider it necessary	3	9%	14	14%
Yes	4	12%	10	10%
Total	33	100%	98	100%

Table 5 Type of tests performed by the teams according to their competitive level.

	International level	Other levels
Strength	33%	39%
Anthropometrical	50%	30%
Endurance	17%	9%
Speed	0%	17%
Flexibility – ROM	0%	4%
Total	100%	100%

Load monitoring

Many teams of all competitive levels monitored players' loads and wellness levels during worldwide confinements (61% international and 46% ''other levels''). Sixty-five percent of international level teams and 84% of ''other levels'' teams used Ratings of Perceived Exertion (RPE) as the preferred tool to monitor internal loads. Few teams used heart rate (HR) alone, with 35% of international and 13% of ''other levels'' teams using a combination of RPE and HR. Fifty-five percent of international teams and 41% of teams belonging to other competitive levels monitored external loads. Set and repetition count, as an expression of volume, were the most used factors to control loads (89% international and 90% ''other levels''), with total session time and total effective time as less employed alternative metrics. Twenty-eight percent of international level teams and 13% of teams of ''other levels'' used Global Positioning Systems (GPS) to control their players' performance. Sixty-two percent of teams belonging to every level used wellness questionnaires to do the follow-up of their athletes.

Healthy habits

From the 131 trainers who took part in the survey, 126 responded positively about promoting healthy habits during

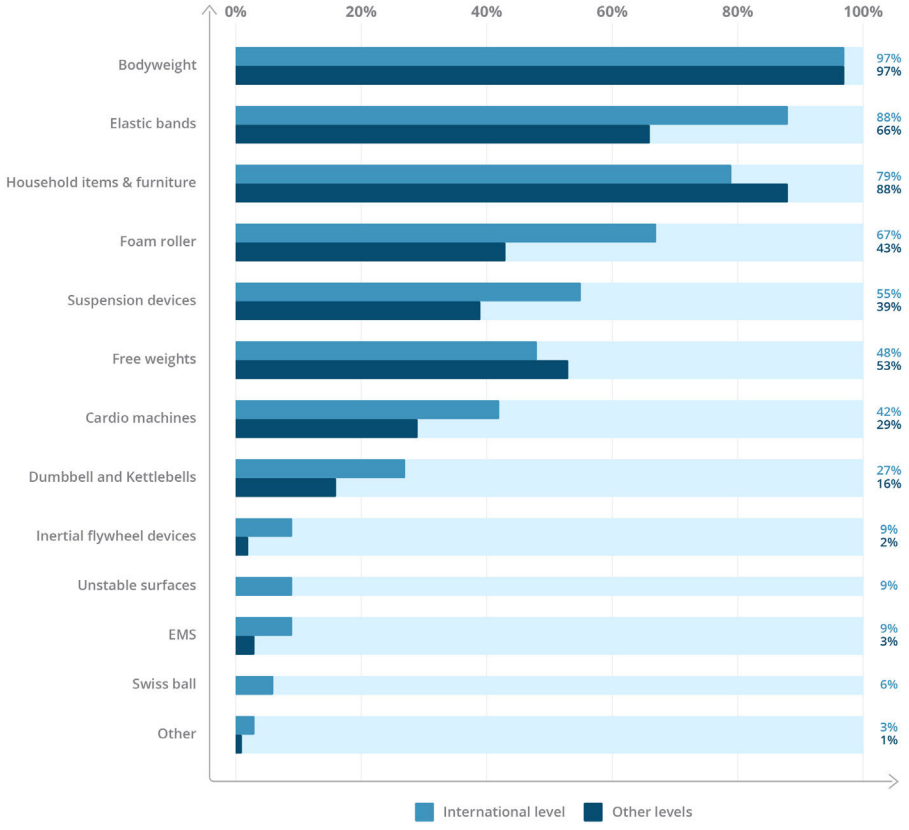

Figure 8 Equipment used for the physical fitness sessions during the lockdowns.

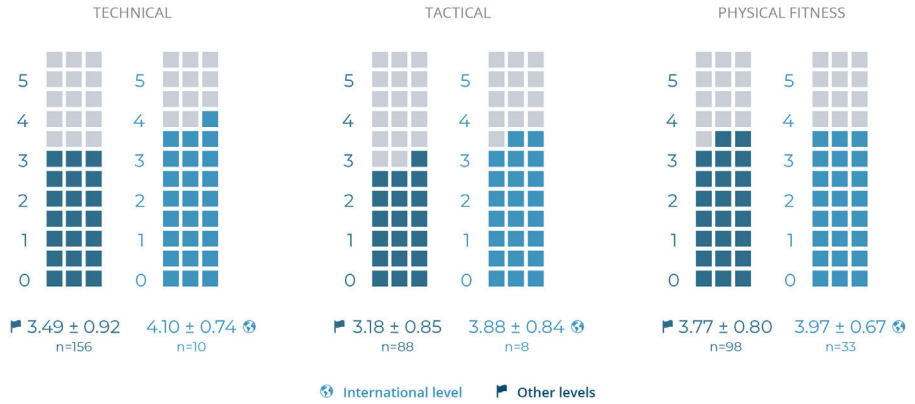

Figure 9 Perceived degree of motivation and goal accomplishment in the sessions carried out during the confinements.

the confinement. Fifty-eight percent of them (15 international and 58 ''other levels'') provided education on the matter, while 17 international (53%) and 36 ''other levels'' did not.

Summing up, ''other levels'' trainers seemed to be more conscious about healthy habits than staff members from international level teams.

What if we have to resume the confinement in the future?

The world has been unable to find a vaccine or a treatment effective in COVID-19 cases yet. Many epidemiologists are warning about new outbreaks of the virus, probably during the next autumn, although many things about the future behavior of the SARS-CoV-2 virus remains still undoubtedly unknown. If that is the case, some countries with a high incidence of infections may experience a second wave of mandatory lockdowns. The sports sector initially caught ''offside'' by the virus, should be more prepared to handle these eventualities. From this article, we want to offer some recommendations based on international consensus and the literature available, but also considering the attitudes and behaviors reported by clubs, associations, and bodies in our questionnaire. We have summarized our findings and recommendations in Figs. 10 and 11. These guidelines can also be used as general recommendations for regular postseason periods to tailor content for athletes far from their usual facilities.

RTS after COVID-19

Asymptomatic and negative COVID-19 athletes can RTS without additional testing. That is not the case for positive athletes independently of if they show or no symptoms. When a positive is detected, athletes should refrain from training at least for two weeks and follow strict isolation guidelines. RTS should be guided after that period by their medical staff.[58] Athletes with previous infections are recommended to undergo cardiac testing (clinical cardiovascular evaluation in combination with cardiac biomarkers and imaging) before engaging any physical activity.[59]

A general guideline when resuming training after the COVID-19 confinement will be to approach practices with reduced volume. Fifty percent of the exercise that the athlete was doing before the lockdown is a well-accepted starting point to avoid injuries.[60] Weekly increases of around 20 percent can also be a reasonable progression. In any case, in most COVID-19 detraining situations, as a ''rule of thumb,'' the time needed by the athletes to resume their average level of training (100%), will be at least half of the total confinement time (50%). However, some studies have tried to provide more exact information on the matter. To decrease the likelihood of injury when reaching the standard 100 percent load values, a very reduced training the weeks before ($\leq$60% of the regular volume) increases the odds of suffering health problems significantly.[61] Thus, proper load monitoring during the confinement can lead to more accurate risk-free load progressions. The use of tests to objectively assess the impact of lockdowns on the athletes it is also more than advisable if we want to establish a realistic starting point to our training levels during the RTS. The choice of which ones to use depends on the discipline, but reliability, measurement, and construct validity, as well as to pre-confinement data availability, seem to be crucial elements to make a decision. Results in tests such as 1RM, isometric, isokinetic, vertical jump,[28] and markers such as VO_2max, increased respiratory exchange ratio, insulin sensitivity, or lactate concentrations[62] been used in the past with success as markers of training reversibility. An adequate balance between acute and chronic workload in the first team activities after RTS is essential since low chronic loads have shown low protective power against injuries,[63] and spikes in workload are also associated with increased injury risks.[63] Training load is a critical stress inducer.[64] A variety of mechanisms explain why loads generate stress at a tissue level (microdamage, loading beyond loadbearing capacity, fatigue, or insufficient recovery) and an athlete level (impaired decision-making, coordination, and neuromuscular control).[65] The period after the COVID-19 lockdown will be similar to preseason, with the limitation of an uncommon previous ''off-season.''

Preseasons are always periods imposing significant risk of training load-related injuries.[66] Nevertheless, players that maximize their participation during this period may suffer

Figure 10 Summary of recommendations to design technical-tactical sessions if new outbreaks of COVID-19 force a second wave of lockdowns.

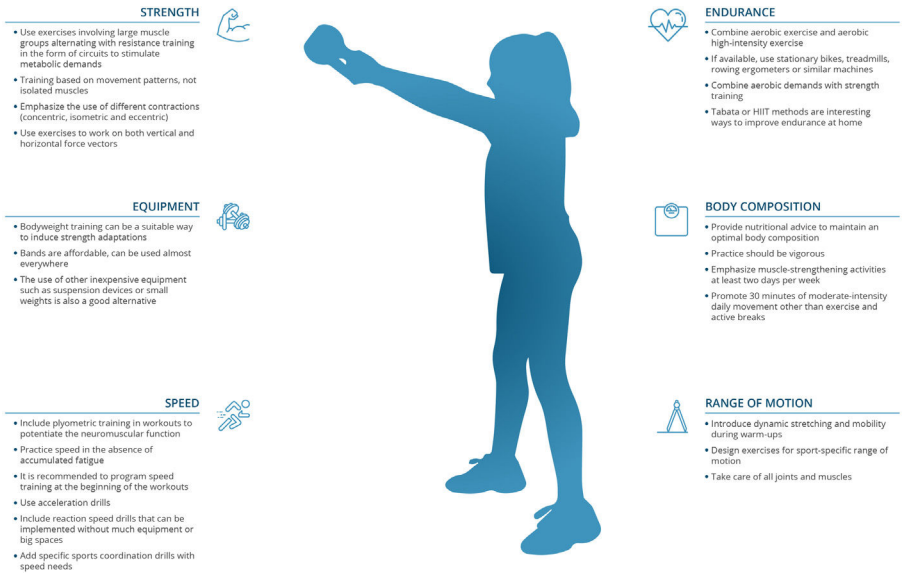

Figure 11 Recommendations to design physical fitness practices if new outbreaks of COVID-19 force a second wave of lockdowns.

less in-season injuries,[67] fact that highlights the relevance of the work conducted during preparatory periods in team sports.

Few situations can compare to the COVID-19 consequences over organized sports. Lockouts, temporary closing, in professional leagues are among the only ones in terms of exceptionally extended periods out of competitive activity. After the 2011 NFL lockout, a study[68] reported significant increases in the number of Achilles tendon injuries during the training camps and the preseason games. Several reports have also informed of relevant rises in the injury rates in the only European professional league that has RTS so far after the COVID-19 lockdown, the German Bundesliga. In four weeks of the competition, 0.88 injuries per game were tracked, more than twice the pre-confinement values.[69] Moreover, recent data from the Australian Football League shows a weekly increase of contact and non-contact injuries throughout the games following the COVID-19 lockdown. Importantly, from the observed hamstring injuries (11 in 18 games), many injured players (81%) presented a previous hamstring injury, supporting the evidence of players at a higher risk.[70] Not only injuries affect players' health negatively, but also team performance.[71] These values cast doubt that a general home-based physical preparation, with short pre-competition periods after, can be enough countermeasures to avoid sports injuries.

Apart from the dangers derived from inactivity, the risk of a new COVID-19 outbreak is also a concern in competitive sport. Professional leagues such as the NBA, the NFL, the Bundesliga, as mentioned above, or the Spanish ''La Liga'' have sought creative formats to continue their activity. All these championships will use measures to prevent

infections. International consensus on the matter[72] advice the implementation of:

a) Daily health check of the athletes, including regular temperature checks
b) Handwashing, alcohol-based hand gel and hygiene facilities in the event facility and accommodation
c) Provide medical masks to athletes, technical staffs, medical staff, organizers, media staff, and sick individuals
d) Ensure proper hygiene signage across all venues, changing rooms, and training facilities
e) Physical (at least 1 meter) distancing of competitors, officials, audience and support staff
f) Thorough disinfection and cleaning after and between practices and competitions of all the facilities
g) Prohibition of sharing equipment, in particular towels, water bottles, and cups
h) Safe utilization of containers for disposable and reusable hygiene materials
i) Ensure capacity to isolate suspected cases
j) Provide first aid and medical services which can triage and refer suspected cases for COVID-19 testing

As mass gatherings may increase the risk of transmission of COVID-19, many future sports events will take place behind closed doors. The TV companies holding the broadcasting contracts will air these events, that many people understand as a symbol of post-COVID-19 normality. Some sports can respect social distancing without many issues, but team sports have more difficulties doing so because of obvious reasons (contact, ball handling, communication between teammates). Additionally, travel (use of airports and hotels) can also increase the risk of infection.[73] Professional sports coming back to activity should accept that risk assessment and safety measures are going to be part of the so-called ''new normality'' for a while.

Limitations

The present piece of research gathered answers from 361 voluntary coaches and trainers with their teams under the effects of COVID-19 worldwide lockdowns during the season 2019-2020 showing possible behavior patterns that would only be generalized with a larger sample. The instrument used for data collection, an online survey, has several limitations. Respondents may not be 100% honest in their answers to preserve their privacy. We tried to tackle this issue by guaranteeing the anonymity of the data, not collecting any personal information nor nominal information referred to the clubs. We reinforced this matter in the participant information section of the questionnaire.

Questions administered online can also be interpreted in different ways. Although several simulations with the questionnaire with volunteers were performed, some concepts may be misunderstood. To minimize the impact of wrong assumptions, we provided the contact of the lead researcher to every team just in case they had any questions. Our questionnaire was very detailed, especially for the trainers. Respondents may have experienced survey taking fatigue, although, in the previous tests, nobody needed more than eight minutes to answer all the questions. The last limitation that we acknowledge is related to the calculation of the volume of activity represented by all the computed responses. By not collecting any nominal information related to teams, clubs, or franchises, an approximation to this value had to be made. For this reason, it is expressed in the text with the median and range values.

Conclusions

The COVID-19 pandemic has hit all substrates of society hard, and team sports have been no exception. However, most teams have been active during government-imposed lockdowns, working with their players to maintain a certain degree of normality, avoiding detraining. This study provides relevant data on that level of activity, contrasting it with general health recommendations, scientific studies aimed at providing evidence on how to mitigate the effects of detraining, and research setting guidelines for a safe RTS after a long period of inactivity. During the COVID-19 pandemic, many studies with recommendations have been published. However, to the best of our knowledge, those providing verified information are scarce. We also aimed at proposing in this article advice on the activities to implement in team sports settings if a new wave of confinements were to occur in the future.

Conflict of interest

The authors declare that they do not have any conflict of interest.

Acknowledgments

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