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Digital Workout Versus Team Training: The Impact of the COVID-19 Pandemic on Athletes

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ABSTRACT

The aim of the study was to assess the effects of the COVID-19 pandemic on sport practice and to identify measures adopted by individuals and sports organizations to allow a safe return to community sports. An electronic survey was launched worldwide in June 2020 in the German and English languages. The questionnaire collected anonymous data on sporting activity before, during, and after pandemic-induced confinement. Participants classified themselves as either recreational, competitive, or professional sports level athletes. A total of 1336 adults (30.5 ± 11.7 years; 54.0 % women) participated in the survey; 68.5 % were active athletes, 10.1 % coaches, 2.1 % officials and 4.3 % related medical staff, 3.6 % had another function, and 11.4 % indicated no regular sports activity. Most participants practiced their sport in Europe (93.8 %); the majority (61.0 %) was amateur athletes. During confinement, 15.7 % could perform their main sport unrestricted, 43.5 % stated a reduced amount of time spent on sporting activities, 46.4 % a reduced intensity level. Most participants (77.5 %) were neither aware of screening measures nor of guidelines for dealing with infected athletes (80.0 %) or for return to sports after a coronavirus infection (88.6 %). Preventive measures mentioned included basic hygiene, measures to reduce personal contacts or virus transmission, or to improve traceability of infections. During confinement, a higher age ($p = 0.004$) and training in a club setting ($p < 0.001$) were associated with reduced sporting activity, while the availability of online training ($p = 0.030$) was linked to both increased extent and intensity levels. A lower age ($p = 0.001$) and recreational sports level ($p = 0.005$) were associated with decreased activity after confinement. Although isolation can be necessary to protect public health, it alters the amount and intensity of physical activity.

Introduction

Sport in times of the COVID-19 pandemic

The COVID-19 pandemic has spread worldwide since the end of 2019 from the Chinese metropolis of Wuhan [1, 2]. Most countries implemented measures aimed at reducing the number of new infections, thereby protecting healthcare systems from patient overload and maintaining critical care capacity. These measures included social distancing and confinement as well as temporary closure of public or shared sports facilities. Athletes who rely on access to team-training facilities had to reshape their approach to their craft drastically. Athletes arguably remain least susceptible to viral exposure when training alone in their home environment. These solitary training sessions may provide opportunities to focus on individual fitness, however confined spaces and absence of training partners and instructors may limit the athlete's ability to maintain and/or improve their team sport-specific skills [3]. Furthermore, prior studies have shown that social interaction is an important motivating factor for physical activity [4, 5].

Preventive measures

Sports organizations have developed various risk-reducing strategies in an effort to protect their athletes' health without jeopardizing the athletic edge, e. g., systematic enquiry about COVID-19-specific symptoms and temperature monitoring prior to participation, surface disinfection of training equipment, reducing maximum capacity of training facilities, detailed recording of attendance, limitation of the numbers of training partners and reduced training group size, cancellation and rescheduling of competitions, relocating training session to outdoors, and donning of N95 face masks.

While certainly useful for detecting athletes in the symptomatic phase, systematic enquiry about specific COVID-19 symptoms and temperature monitoring before each training cannot rule out asymptomatic or incubating infections [6, 7]. Since infection through environmental contamination cannot be excluded [8], the implementation of strategies aimed at reducing spread through fomites, such as hand hygiene and disinfection, proper coughing etiquette, and surface disinfection in between uses can be considered a very important and quickly applicable measure. Kampf et al. [9] concluded that wipe disinfection of surfaces and training equipment with the appropriate substances can greatly reduce or eliminate the amount of active virus in a short time. Wang et al. [10] report that donning of surgical and non-surgical face masks protects from secondary infections, although only N95 masks without exhale valves may provide complete protection from both respiratory droplets and airborne infection. Wearing face masks during vigorous exercise had no detrimental effect on blood or muscle oxygenation in a cohort of young, healthy participants and did not affect exercise performance [11] but did increase airflow resistance [12, 13] and could therefore potentially limit maximum performance by depriving athletes of large air volumes required during peak exertion.

Alternatively, strategies to reduce the risk of airborne infection, namely periodic ventilation of sports facilities and training outdoors, have the potential to remove and/or dilute infectious suspended aerosol droplets in the air [14].

In the instance of combat or contact team sports, where spacing and prevention of contact with bodily fluids cannot be effectively enforced, outdoor training, limitation of the numbers of training partners, reduction of training groups as well as documentation of contacts, and when feasible, usage of face masks are of utmost importance in reducing the risk of exposure to SARS-CoV-2.

Furthermore, measures facilitating the tracing of athletes exposed to an infected individual, such as allotted training times and detailed records of attendance, allow for quicker isolation and quarantine, therefore limiting further disease spread [15].

Research question and hypothesis

Owing to the above-mentioned methods and strategies athletes and physically active individuals have been experiencing a spectrum of limitations and hindrances. Few studies [16, 17] have focused on changes in physical activity during the pandemic. However, they were mostly performed at a regional level. We hypothesized that the impact of confinement depended on the level of sports activity and the protective measures taken against SARS-CoV-2 infection.

Therefore, the aim of this study was to assess the effects of the COVID-19 pandemic on the amount and intensity of sport practice and to identify preventive measures adopted by individuals and sports clubs in order to allow a safe return to community sports.

Materials and Methods

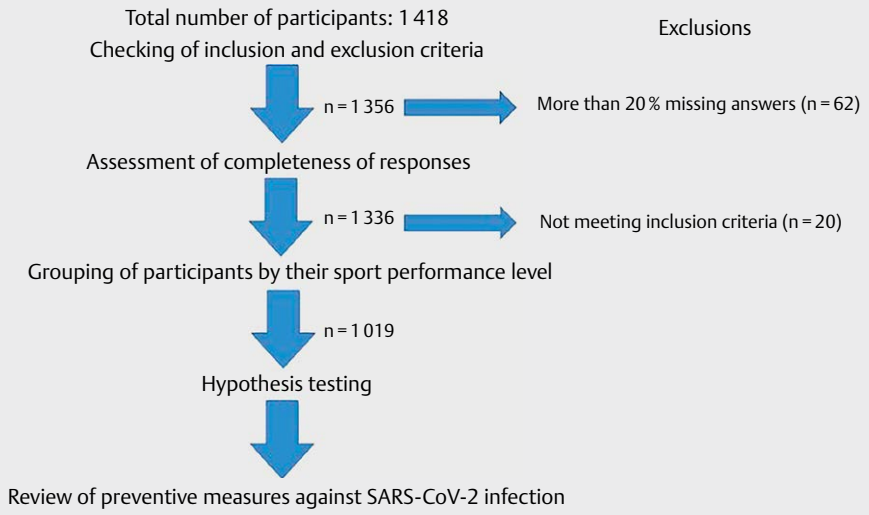
Participants

The present research was designed as a retrospective study based on a self-administered questionnaire. An electronic survey was launched online in June 2020 until August 2020 in the German and English languages. The study was conducted according to the guidelines of the Declaration of Helsinki and in accordance with the Certificate of Good Standing concerning "Ethical guidelines for surveys conducted at the Department of Sport Science" of the Institutional Review Board for Ethical Issues of the University of Innsbruck. The study was registered on ClinicalTrials.gov (Identifier: NCT04649333). The survey was shared and promoted by the participating universities, some sport organizations and officials, and by multiple colleagues and athletes throughout the world, even if the main contacts were in Europe. Participants were included after answering the introductory key questions (informed consent, language version) as indicated in the flow chart in ▶ **Fig. 1**. Exclusion criteria were minor age and an insufficiently answered questionnaire with a proportion of more than 20 % missing answers.

Questionnaire

The anonymous questionnaire was subdivided into three sections, relating epidemiological data, sport activity before confinement and at the moment of filling in the questionnaire, and applied preventive measures for a safe return to community sport. The full version of the questionnaire used has been added as a supplemental file to the appendix.

Athletes were asked to classify themselves as practicing sporting activity at either the recreational, competitive or professional sports level. Accordingly, coaches, officials and related (medical)



▶ **Fig. 1** Flowchart of participant inclusion and exclusion.

staff were categorized relating to the group of athletes they were predominantly in charge of. Recreational sport was defined as no participation in competitions or participation in regional competitions with focus on amusement, health-related, or social aspects of sport. Competitive sports level was defined as participation in national championships or other supra-regional competitions and focus on performance. Professional sportspeople and participants in the Olympic Games or other international championships with a focus on top performance were categorized as at the professional sports level.

A single combined question ("Do you have any known risk factor for a potentially serious course of the COVID-19 disease?") was used to roughly assess participants for generally known risk factors. Examples mentioned were an "age above 60, chronic diseases (especially chronic respiratory or lung diseases, diabetes, cardiovascular diseases, cancer, high blood pressure, diseases and therapies that weaken the immune system)" [18, 19].

Participants gave information on the development of their sporting activity before confinement and at the moment of filling in the questionnaire, which was most likely after confinement in most cases.

In July and August 2020, the questionnaire was slightly adapted to address differing national time courses of the outbreak by changing the wording of the related questions from the mere time period to the concrete formulation "confinement".

Statistical evaluation

Data were analyzed using IBM SPSS Statistics Version 26 (IBM Corp., Armonk, NY, USA) and Graphpad v9.0 (GraphPad Software, Inc., San Diego, CA, USA). Descriptive statistics and logistic regression analysis were used to analyze the data. Results are presented as means with the corresponding standard deviation (SD) as well as absolute and relative frequencies. Multiple logistic regression analysis was used to compare expected and actual values. The odds ratio (OR) was computed for possibly influencing factors with 95 % confidence intervals (CIs). The given CIs relate to the odds ratio values. P-values of less than .05 were considered significant.

Results

Characteristics of the cohort

A total of 1418 participants took part in the survey. Minors (under 18 y) and questionnaires with insufficiently answered key questions were excluded. Finally, data from 1336 participants (30.5 ± 11.7 years; 54.0 % women) were available for analysis. Demographics of the study participants as well as their performance levels are shown in ▶ **Table 1**. The cohort consisted of participants from Europe (93.8 %), America (5.1 %), Asia (0.5 %), Africa (0.2 %), Australia (0.2 %) and other (0.2 %). A total of 844 athletes (68.5 %), 124 coaches (10.1 %), 26 officials (2.1 %), 53 related (medical) staff (4.3 %) and other (n = 46; 3.6 %) participated in the study; 140 subjects (11.4 %) indicated no regular participation in sports. The majority (n = 622; 46.6 %) stated to be mainly practicing recreational sports; competitive sports was indicated 351 times (26.3 %) and professional sports level 46 times (3.4 %).

Sport in times of the COVID-19 pandemic

During confinement, 15.7 % of all participants could perform their main sport without restrictions, 43.5 % reported a reduced amount of time spent on sporting activities and 46.4 % reduced intensity levels. Conversely, 21.3 % declared an increased extent, 17.8 % increased intensity levels during confinement conditions. A high percentage of the respondents (40.1 %, n = 385) stated that they switched to other sports during the lockdown period. Most commonly, outdoor and home-based activities were mentioned as newly discovered sports. Results of the regression model showed higher age (p = 0.004; OR = 0.963; 95 % CI = 0.937 to 0.986) and usually training in a club setting (p < 0.001; OR = 0.283; 95 % CI = 0.143 to 0.543) to be statistically associated with reduced physical activity (both reduced extent and intensity levels) during the

▶ **Table 1** Participant characteristics*.

Characteristic	Frequency n (%)
Sex	
Female	705 (54.0)
Male	600 (46.0)
Risk factor **	
Yes	240 (19.7)
No	980 (80.3)
Function	
No regular participation in sports	140 (11.4)
Athlete	844 (68.5)
Coach	124 (10.1)
Official	26 (2.1)
Medical staff	53 (4.3)
Other	46 (3.6)
Club setting	
Yes	618 (59.3)
No	425 (40.7)
Performance level	
Recreational sports	622 (61.0)
Competitive sports	351 (34.5)
Professional sports	46 (4.5)

*The respective (sub-)categories do not add up to the total number of 1336 participants, depending on the proportion of missing answers; ** A single combined question ("Do you have any known risk factor for a potentially serious course of the COVID-19 disease?") was used to roughly assess participants for generally known risk factors.

confinement period. After confinement, lower age (p = 0.001; OR = 1.061; 95 % CI = 1.026 to 1.102) and recreational level (p = 0.005; OR = 0.296; 95 % CI = 0.1246 to 0.6786) were associated with both reduced extent and intensity levels. A total of 114 participants (12.0 %) stated that no training for children was currently carried out in their main sport; 243 (25.6 %) of the participants reported that no training programs were offered for high-risk groups at the time of filling in the questionnaire. A minority of 46 participants (4.9 %) mentioned the availability of some kind of online training for this second group of athletes. The availability of online training (p = 0.030; OR = 3.280; 95 % CI = 1.089 to 9.519) was a factor linked to both increased extent and intensity levels during confinement.

▶ **Figure 2** shows the indicated extent of sporting activity during (**a**) and after (**b**) confinement and the indicated intensity during (**c**) and after (**d**) confinement for the three aforementioned performance levels. Although a decrease of extent and intensity of physical activity can be observed for the majority of participants during the confinement period, at all three performance levels, but especially in the group of recreational athletes, a subset of athletes was able to increase their sporting activity during and directly after the confinement period.

Preventive measures

Of the participants, 694 (77.5 %) stated that in their usual training environment, club, or association, no standardized SARS-CoV-2 screening measures were applied before exercising. The participants reported various preventive measures, including basic hygiene standards, measures to reduce individual contacts or risk of transmission, and measures for better traceability of infections that had already occurred. ▶ **Table 2** presents the most frequently mentioned preventive and screening measures.

A total of 690 participants (80.2 %) declared that there were either no clear guidelines or at least none known to them on how to deal with infected training participants in their usual training environment/club/association.

A total of 764 participants (88.6 %) reported that they were not aware of guidelines for a return to sports (RTS) or that none existed in their usual training environment, their club, or association after an athlete had a coronavirus infection.

Discussion

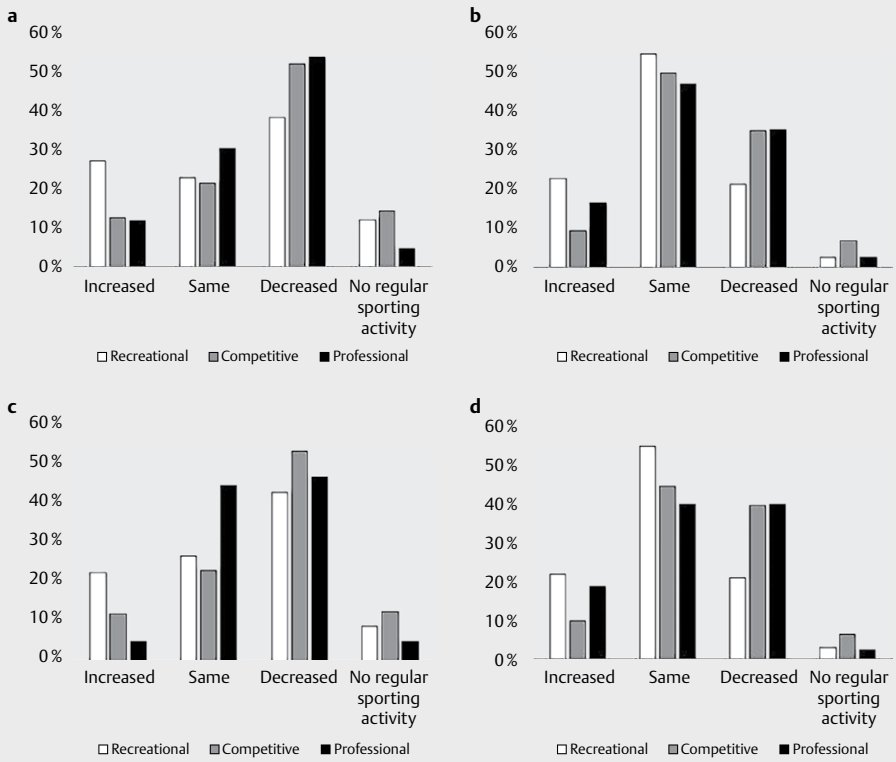
The most important finding of this study was that several groups of athletes had to accept major cuts in their sports and exercise habits, and some disproportionately suffered from the pandemic, especially older athletes and people who usually train in a club setting.

The evidence on general sporting activity during the lockdown period has been discussed controversially so far. Ding et al. [20] extracted Google Relative Search Rates for the topic "exercise" and found a sharp increase in exercise interest immediately following the lockdown.

The present study resulted in the dichotomous finding of a partial increase in average sporting activity during the lockdown with a high proportion of participants at the same time stating reduced physical activity.

Similarly, Washif et al. [21] surveyed 12,526 athletes and reported substantial reductions in key training variables for all performance levels during the confinement period. Concordantly, both studies demonstrate a frequent switch to home-based training activities, In contrast to this study, Washif et al. reported that "higher classification athletes retained training specificity to a greater degree than others" [21].

Despite lower frequency and severity of COVID-19, the impact of the pandemic-associated school closures and confinement conditions on the daily life of children is tremendous. In the present study, it was stated in 114 cases (12.0 %) that no training for children was currently offered in the sport concerned. Xiang et al. [22], who analyzed physical activity data from 2426 Chinese children and adolescents before and during the pandemic, reported a drastic decline of the median time spent in physical activity (540 min/week to 105 min/week). This stands in striking contrast to the general physical activity recommendations for children and the well-known health benefits of regular physical activity [23]. During the pandemic, the full potential of online training programs has not yet been exploited, neither for risk groups nor for the (digitally raised) minors. The participants indicated the pnossibility of online training with a frequency of around 5 % for both minors and athletes with risk factors. Furthermore, the results of the current study suggest that online training programs might be an effective public health measure to increase or maintain physical activity during confinement conditions. Similarly, Washif et al. stated that "remote-



▶ **Fig. 2** Indicated extent and intensity of sporting activity during and after confinement.

based practices using digitally mediated technology for coaching/training emerged, appeared effective, and were best received by higher classification athletes" [21].

It seems important that coaches and athletes learn to assess the individual risk of developing serious disease and correspondingly offer or attend lower-risk exercise programs [3].

In the current study, 40.1 % (n = 385) of the respondents stated that they switched to other sports during the lockdown time. Membership numbers and further studies will have to show how many athletes will return to their original sports.

Furthermore, professional sports had to accept major cuts. Various national leagues as well as the 2020 Tokyo Olympic Games were postponed or canceled. Lower media presence, declining sponsorship funding, and reduced audience numbers further increase the financial and psychological pressure on individual athletes, sports teams, and leagues [24–26]. During and after the implementation of the present study, antigen-detecting rapid diagnostic tests for SARS-CoV-2 became increasingly popular. In a recent prospective point of care study, two widely available antigen tests showed good sensitivity and specificity values [27]. Furthermore, in late 2020 COVID vaccines were found to be safe and efficacious in clinical trials. Consequently the Food and Drug Administration (FDA) approved emergency use [28].

As a result of these developments among other things, the postponed Olympic Games in Tokyo could be carried out in 2021 with more than 80 % of athletes and staff vaccinated [29].

Numerous studies have pointed out the possible consequential damages resulting from an infection, which might be particularly important for an RTS and other high intensity activities. Besides the early known respiratory illness possibly resulting from SARS-CoV-2 infection, further studies indicated cardiac involvement [30–32], as well as possible psychological, physical and cognitive issues [33]. Pillay et al. [17] showed significant changes in dietary habits as well as in sleeping patterns in a cohort of elite and semi-elite athletes. Financial and mental health aspects should also be considered. Pillay et al. reported that 52 % of the athletes felt depressed and 55 % required extra motivation to keep active [17]. The majority of respondents (n = 764; 88.6 %) in the present study indicated that they did not have any structured rules for a return to sports (RTS) after infection with SARS-CoV-2.

The number and impact of possible complications demand a structured approach to RTS. Löllgen et al. [34] recommend a basic check-up with resting ECG for all asymptomatic and symptomatic athletes with confirmed SARS-CoV-2 infection. Further examinations are advised if clinically indicated and depending on the severity of the course of the disease [34, 35].

Elliott et al. [35] have suggested a graduated RTS starting with low-level activities such as walking or usual activities of daily living after a period of ten days rest from onset and being symptom-free for at least seven days.

Several limitations apply. Firstly, owing to the completely new situation at the beginning of the pandemic, one aim of the study was primarily the broad collection of possible measures without further evaluation of specific effectiveness and applicability. However, according to the authors' knowledge, this study provides the

▶ **Table 2** Specified screening and preventative measures (multiple choice).

Measures	Frequency (n)	Percentage (%)
Screening measures		
Risk questionnaire	110	12.3
Temperature measurement	62	6.9
SARS-CoV-2 test (nasopharynx swab or antibody test)	15	1.7
Other	38	4.2
None	694	77.5
Total	**919**	
Preventative measures		
Increased implementation of outdoor activities	339	37.9
Requirements for individual arrival and departure	189	21.1
Mouth and nose protection on arrival and departure	264	29.5
Mouth and nose protection during physical activity	34	3.8
Construction of disinfectant dispensers	435	48.6
Surface disinfection of training equipment and facilities	350	39.1
Reduction in the number of training participants	408	45.6
Establishing constant training pairs/groups	180	20.1
Mandatory minimum distance	298	33.3
Restriction of infrastructure (e. g., cloakrooms, showers)	391	43.7
Other measures	70	7.8
None	161	18.0
Total	**3119**	

most extensive collection of preventive measures applied worldwide.

Secondly, the results of this study relate to the first COVID-19 confinement period (March to June 2020) and predominantly include the German-speaking area (Austria, Germany, Switzerland, Italian South Tyrol) and also some preferred sports (e. g., judo). The results of the study apply to other regions and sports as well as to the situation in the following lockdowns only to a limited extent.

Thirdly, it should be noted that this study relies on self-reported data with the associated potential biases and partly incomplete answers, which presumably are of little importance owing to the timely and anonymous query and the overall high number of participants.

The results of our survey indicate the serious impact of the COVID-19 pandemic on the amount and intensity of sporting activity. Online training sessions could be used to maintain physical activity even in times of necessary isolation. This study gives an overview of health measures adopted by individuals and sports clubs in order to enable continuing or resuming healthy sports practice. Future research should examine the effectiveness and applicability of the aforementioned measures and address how long the discussed consequences of the pandemic will last. This knowledge could be of help in the context of following waves of viral infections.

Conflict of Interest

The authors declare that they have no conflict of interest.

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