



**Sport in Society**  
Cultures, Commerce, Media, Politics

ISSN: (Print) (Online) Journal homepage: <https://www.tandfonline.com/loi/fcss20>

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To cite this article: Anne Tjønnal (2021): The impact of COVID-19 lockdowns on Norwegian athletes' training habits and their use of digital technology for training and competition purposes, *Sport in Society*, DOI: [10.1080/17430437.2021.2016701](https://doi.org/10.1080/17430437.2021.2016701)

To link to this article: <https://doi.org/10.1080/17430437.2021.2016701>



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Published online: 17 Dec 2021.



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# The impact of COVID-19 lockdowns on Norwegian athletes' training habits and their use of digital technology for training and competition purposes

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## ABSTRACT

This article examines how strict nation-wide regulations and lockdowns affected athletes' training habits in Norway and, more specifically, their use of digital technology for sports training and competition purposes. This is analyzed using quantitative survey data from 953 Norwegian athletes collected during a lockdown in the spring of 2020. The results show that the athletes' use of digital technology for online training increased significantly during the lockdown. Logistic regression analyses indicate that there are age and gender differences in athletes' participation in online training and virtual sports competitions. Female athletes are more likely to participate in online training than male athletes, while male athletes are more likely to participate in virtual sports competitions than female athletes. Older athletes are more likely to participate in virtual competitions than younger athletes. Athletes living in urban areas are more likely to participate in digital training than those living in rural areas.

## KEYWORDS

Digitalization of sport; pandemic; digital tools in sport; athlete welfare; global crisis

## Introduction

One of the many consequences of the COVID-19 pandemic in Norway has been the abrupt cancellation of organized sport. In March 2020, the Norwegian government declared a national lockdown to prevent the spread of the coronavirus, which resulted in sporting activities and competitions, part of the daily life of many Norwegians of all ages, being suddenly and indefinitely cancelled.

Throughout most of 2020 and the majority of 2021, sports training and competitions in Norway were either prohibited or strictly regulated due to the pandemic. The regulation of organized sport was continuously adapted to the number of COVID-19 cases in the country, which meant that coaches and athletes were required to adhere to the changing rules and regulations. For instance, at certain times during the covid-19 pandemic in 2020–2021 sporting activities for children and youth (6–19 years) were allowed, but not for adult athletes. At other times outdoor and non-contact sports were allowed, but not indoor contact sports, and at some point indoor sports training were allowed for both children and adults

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as long as athletes stayed 2-meters apart. Finally, after 18 months of lockdowns, restrictions, cancelled competitions and uncertainty, the Norwegian Directorate of Health, the Norwegian Institute of Public Health (NIPH) and the Norwegian government all agreed that Norwegian sports would be fully open again from 25th September 2021 (NIF 2021a, 2021b).

Both in Norway and internationally, elite sport has been greatly affected by the pandemic, with national and international championships either being cancelled or suspended. Most notably, the global sports mega event, the Tokyo 2020 summer Olympic Games, was postponed to 2021 (IOC 2020). In short, the COVID-19 pandemic has meant that for the first time since the Second World War athletes throughout the world have been forced to interrupt their training and competitions (Sarto et al. 2020). Although COVID-19 has affected athletes globally, there are variations between different countries in that national governments have implemented different strategies for dealing with the pandemic. This has meant that athletes have not all been affected by COVID-19 in the same way.

This article examines how the COVID-19 pandemic affected Norwegian athletes during the national lockdown in 2020. The aim is to provide new insights into how the strict nation-wide regulations and lockdowns affected athletes' training and competition activities in Norway. Specifically, the article focuses on the use of digital technology for sports training and competitions during the lockdown in Norway in 2020. The following research questions guided the study: (a) How did a national COVID-19 lockdown affect Norwegian athletes' training habits? (b) How did the lockdown affect Norwegian athletes' use of digital technology for training and competitions? (c) Which factors influenced Norwegian athletes' participation in digital training and virtual sports competitions during a national COVID-19 lockdown?

These research questions are explored by means of descriptive statistical analyses and logistic regression analyses of the survey data for 953 Norwegian athletes. In order to create new knowledge about Norwegian athletes and COVID-19, and to discuss the findings and position them in a broader, international, scholarly field, the study makes use of previous research on athletes and COVID-19 from other countries and on the use of digital technology in sport. In the following, an overview of previous research is presented on two topics that are relevant to the discussion of the empirical data: (1) The impact of COVID-19 on athletes around the world and (2) the use of digital tools and digital technologies in sport. Following the summary of previous research, I describe the data and the methodological approach used. Thirdly, the results are presented and discussed in relation to findings from previous studies.

## **The impact of the COVID-19 pandemic on athletes around the world**

As COVID-19 is an ongoing pandemic (at least at the time of writing), the consequences of the virus on athletes' health, well-being, training habits and performances in different countries around the world are still uncertain. However, research on how COVID-19 has affected and is still affecting athletes in different parts of the world is increasing rapidly. The increase in research on athletes and COVID-19 in the last few months alone suggests that when the article is published this review of the current research on the topic is likely to be somewhat outdated.

The current research on athletes and COVID-19 spans a variety of fields within sports science, such as sociology of sport, sport psychology, sport management and sports

medicine. For instance, in the field of sports medicine concerns have been raised about the impact of the coronavirus on athletes' health on a global scale. Baggish et al. (2020) argue that the resumption of competitive sport will need to ensure the cardiac safety of millions of athletes worldwide. Similarly, Paoli and Musumeci (2020) highlight that long-term detraining due to the pandemic, such as in the COVID-19 lockdown in Norway in the spring of 2020, is likely to contribute to a decline in maximal oxygen consumption (VO<sub>2</sub>max), loss of endurance capacity and loss of muscle strength and mass. These factors will, according to Paoli and Musumeci (2020), significantly increase the risk of injuries among athletes in all types of competitive sport. These fears are validated in Chandler et al.'s (2021) study of 401 American college athletes, which shows that only 38.7% of the athletes included in the study were able to carry out their training programmes in full as normal (pre-COVID-19). The authors also found that the athletes reported a limited access to the necessary sports equipment, a lack of motivation and mental health concerns such as heightened anxiety.

In the sociology of sport and sport management journals some studies have investigated the impact of the COVID-19 pandemic on athletes in different countries. For example, Swanson and Smith (2020) explored the effects of COVID-19 on college basketball in the USA. Their study shows that many athletic departments in American colleges resorted to extreme budget cuts, the cancellation of sports competitions or, in extreme cases, the cutting out of sport as a whole. Swanson and Smith (2020) conclude that the consequences of these cuts have deeply impacted the athletic futures of thousands of American athletes. Another example is Asia, where the COVID-19 pandemic has affected the career opportunities of young talented athletes (Tan and Lee 2020). As Tan and Lee (2020) note, highly skilled East Asian athletes have tended to seek career opportunities in Western Europe and the United States. However, due to the pandemic athletes' mobility has been hampered by the travel restrictions imposed by and between countries, thereby affecting the career opportunities of elite athletes in East Asia (Tan and Lee 2020).

Another contribution to the field is Bowes, Lomax and Piasecki's (2021) work on women's sport pre- and post-COVID-19. By means of a qualitative questionnaire of 95 women athletes in the UK, they show that female athletes in the UK are worried that the subordinate position of women's sport will have severe implications for female athletes post-COVID-19. The authors found that some of the greatest concerns of the female athletes included in their study centred on financial remuneration and funding. In a study of Spanish basketball players, Calvo et al. (2021) found that the COVID-19 lockdown in Spain affected the physical and psychological state of the athletes and that women athletes reported being more affected by the lockdown than their male counterparts. However, they were unable to identify any gender differences in the training volume during the lockdown as both men and women reported reduced training volumes.

Sport psychology studies have highlighted the impact of the COVID-19 pandemic on athletes' mental health (Şenışık et al. 2021; Reardon et al. 2021; di Fronso et al. 2020). In a survey of 1132 competitive Italian athletes (in both individual and team sports), di Fronso et al. (2020) found that female athletes reported higher perceived stress and dysfunctional psychobiosocial states than male athletes. Furthermore, elite athletes reported lower perceived stress and higher functional psychobiosocial states than novice athletes (di Fronso et al. 2020). Another survey study by Masciet (2020) analyzed 697 French athletes and concluded that the confinement situation and physical exercise restrictions due to the

COVID-19 outbreak influenced athletes' self-based goals at all sport levels. Specifically, Mascret (2020) found that while self-based goals (improving oneself) decreased, self-avoidance goals (avoiding regression) increased.

In their study, Şenışık et al. (2021) surveyed 571 participants and found that depression and anxiety symptoms were lower amongst professional Turkish team sport athletes than amongst the non-athlete participants. In addition, they found that post-traumatic stress symptoms were lower amongst male team athletes than female team athletes and non-athletes. In an online survey of 175 Spanish football players, Mon-López et al. (2020) identified changes in their health and well-being during a COVID-19 pandemic lockdown in Spain. Specifically, the confinement period during lockdown reduced the players' training load and modified their sleeping behaviour (both sleep time and quality).

### **The use of digital tools and technologies in sport**

Digital technologies have had a major impact on sport and have brought about advances in areas like sports medicine and injury prevention (Rigamonti et al. 2020; Ventresca 2019), performance monitoring and measurement (Johnson 2019), fan interaction and communication (Hinck 2019) and sports equipment (Balmer, Pleasence, and Nevill 2012).

Digital tools also increasingly shape the workflows within sports organizations (Torres-Ronda and Schelling 2017) and provide a wide range of applications for organizational development, including administration, internal and external communication, administration and the improved control of training and competition processes for athletes (Ehnold et al. 2020). A common example of this is communication between coaches and athletes via digital platforms (Tjønnal 2020). However, scholars have also illustrated how digital technologies can create new challenges, such as online bullying and the virtual maltreatment of athletes (Kavanagh, Jones, and Sheppard-Marks 2019).

The use of digital technology for training and virtual sports competitions has become increasingly relevant with regard to sports facilities and the cancellation of organized sports in many countries during the COVID-19 pandemic and its associated lockdowns. While numerous studies have been conducted on physical activity and sport exercise using digital platforms among the general public during the COVID-19 pandemic (Parker et al. 2021; Helsen et al. 2021; Bagherian, Ghahfarrokhi, and Banitalebi 2021), only a few studies have been carried out on athletes' use of digital technology for training and virtual sports competitions during the pandemic. In a German study, Mutz and Gerke (2021) found that many of their participants substituted organized sporting activities with individual home-based workouts. However, as Mutz and Gerke (2021) do not distinguish between different types of home-based workouts it is unclear whether the COVID-19 lockdowns in that country have led to an increase in various forms of online training strategies (e.g. recorded vs. live, individual vs. in groups).

With regard to virtual sports competitions, Davis (2020) studied the introduction of an elite online darts home tournament (the PDC Home Tour) and in that context discusses the COVID-19 lockdown. Although he argues that online home tournaments cannot replace the atmosphere of live professional darts tournaments, he wonders whether sports consumption will change as a result of the COVID-19 pandemic. Due to the lack of live stadium engagement, increased online sports consumption could lead sports organizations

to modify their strategies in order to keep fans interested and engaged in sporting events in the future.

Even though research on athletes' engagement in digital training and virtual sports competitions during the COVID-19 pandemic is limited, there are a number of studies on the use of digital tools and digital technologies in sport more generally. The majority of this research has focused on the implementation and application of digital technologies in high performance, professionalized sport. Such studies include elite athletes' use of social media platforms (Geurin-Eagleman and Burch 2015; Chawansky 2016), app-based diagnostic solutions for injury prevention in elite sport (Rigamonti et al. 2020), resistance to digitalization in elite sport (Trabal 2008; Luczak et al. 2020), professional sports clubs' branding strategies (Watkins and Lewis 2014; Bertschy, Mühlbacher, and Desbordes 2020) and digital tools for educational and administrative purposes in high performance sports organizations (Strachan, MacDonald, and Côté 2016; Sellitto, Bingley, and Burgess 2016).

Scholars have also critically analyzed the increased digitalization and use of digital tools in sport. For instance, Peart, Balsalobre-Fernández, and Shaw (2019) argue that the validity and reliability of the performance and health data collected through the use of sport and fitness apps is often low or unknown. In their study, they acknowledge the potential of mobile apps for collecting data in the sports field, but advise athletes to exercise caution when implementing them as not all apps have been developed based on research. In another critical study of apps, Rist and Pearce (2017) tested whether the implementation of apps improved athletes' engagement in mental training programmes. To test this, they recruited 46 adult male athletes in professional Australian Rules football to participate in their study. The players were randomly placed in three groups to undertake participation in one of three applications over a four-week period. The results showed that player engagement was noticeably reduced in all three groups with compliance falling, compared to initial participation levels (before using the apps). This led them to conclude that apps do not improve compliance with mental training programmes or significantly improve the outcomes among athletes. The findings of Peart, Balsalobre-Fernández, and Shaw (2019) indicate that any increased use of digital technologies for training and competition purposes post-COVID-19 should not be celebrated uncritically, but monitored closely.

## Methods

The data used in this study derives from a quantitative survey of Norwegian athletes during the national COVID-19 lockdown of sport facilities and organized sport training activities and competitions in the spring of 2020. The participants, variables, procedures and statistical analyses that were employed are described below.

### Participants

For this study, 953 Norwegian athletes (525 men, 428 women) with a mean age of 24.3 years ( $SD = 6.41$ ) competing in individual (e.g. cross country skiing, combat sports, swimming;  $n = 480$ ) or team (e.g. football, handball, volleyball;  $n = 473$ ) sports were recruited. The participating athletes were classified as professional (i.e. getting paid for playing/earning a living from playing sport) and non-professional (i.e. students/youth athletes and sub-elite

level athletes). Participant eligibility was based on the following inclusion criteria: (1) athletes aged 13 years or more, (2) competitive athletes (regardless of competitive level) and (3) athletes who reported being impacted by the COVID-19 pandemic (*yes or no* question, athletes who reported 'yes').

## Variables

Several dichotomous variables aimed at measuring training habits before and during lockdown were included in the survey and subsequent descriptive analyses. These were: (1) participation in online training in groups before and during lockdown ( $1 = \text{yes}$  and  $0 = \text{no}$ ), (2) individual home-based online training before and during lockdown ( $1 = \text{yes}$  and  $0 = \text{no}$ ), (3) training in sports facilities in groups before and during lockdown ( $1 = \text{yes}$  and  $0 = \text{no}$ ), (4) individual training in sports facilities before and during lockdown ( $1 = \text{yes}$  and  $0 = \text{no}$ ), (5) outdoor group training before and during lockdown ( $1 = \text{yes}$  and  $0 = \text{no}$ ), (6) outdoor individual training before and during lockdown ( $1 = \text{yes}$  and  $0 = \text{no}$ ), (7) cancelled competitions as a result of lockdown ( $1 = \text{yes}$  and  $0 = \text{no}$ ), (8) decrease in training load as a result of lockdown ( $1 = \text{yes}$  and  $0 = \text{no}$ ), (9) decrease in motivation as a result of lockdown ( $1 = \text{yes}$  and  $0 = \text{no}$ ), (10) worried about decrease in performance because of lockdown ( $1 = \text{yes}$  and  $0 = \text{no}$ ), (11) worried about body changes (loss of muscle mass, loss of endurance, gaining weight) due to lockdown ( $1 = \text{yes}$  and  $0 = \text{no}$ ) and (12) professional athlete ( $1 = \text{yes}$  and  $0 = \text{no}$ ).

The variable for the importance of digital training during lockdown is measured on the following scale: 1 = *not important at all*, 2 = *neither unimportant or important*, 3 = *somewhat important* and 4 = *very important*. The variable measuring attitudes towards the shutdown of sports facilities was a statement (*'It is necessary to shut down sports facilities to prevent the spread of the coronavirus'*) with the scale alternatives 1 = *completely disagree*, 2 = *somewhat disagree*, 3 = *somewhat agree* and 4 = *completely agree*. Attitudes towards restrictions on the athlete's specific sport (*'the restrictions for my sport have been too strict'*) and personal adherence to restrictions (*'I follow the guidelines and restrictions for my sport'*) were also measured with the same scale and formulated as statements. The variable for athletes' contacts with their coaches during lockdown is measured on a scale of 1–5 (1 = *no contact with coach*, 2 = *talked to my coach 1–2 times during lockdown*, 3 = *monthly contact with coach*, 4 = *weekly contact with coach*, 5 = *daily contact with coach*). The variable for isolation at home is measured on a scale of 1–4 (1 = *not isolated at home*, 2 = *isolated at home 1–2 weeks*, 3 = *isolated at home 3–4 weeks* and 4 = *isolated at home more than 4 weeks*). Years of sport experience are measured on a scale of 1–6, with 1 = *less than 1 year*, 2 = *1–3 years*, 3 = *4–5 years*, 4 = *6–10 years*, 5 = *11–19 years* and 6 = *20 years or more*. Training hours (*'How many hours do you train in an average week?'*) are measured on a scale of 1–5, where 1 = *0–5 hours*, 2 = *6–10 hours*, 3 = *11–15 hours*, 4 = *16–20 hours* and 5 = *more than 20 hours*).

## Procedure

The participating athletes were recruited via email, social media, telephone and informal and professional networks (e.g. through administrators, coaches and leaders in Norwegian national sports federations). The participants were informed about the study's purpose and its methodological approach. After consenting to participate, the athletes completed a



web-based survey that was launched in May 2020 during the lockdown of sports competitions and sports facilities in Norway. The survey remained open for approximately 1 month and took around 10 minutes to complete. It included questions referring to demographical information (gender, age, rural/urban area of living), social information (i.e. ‘How has the lockdown affected your motivation?’, ‘Are you in contact with your coach?’, ‘How often are you in contact with your coach?’), the athletes’ sport and competitive level, training and training methods before and during lockdown (i.e. participation in online training and virtual sports competitions, use of sports facilities) and attitudes towards the restrictions and regulations of sport during the COVID-19 crisis. The data collection and analysis were carried out in accordance with national guidelines for research ethics and the study was approved by the Norwegian Centre for Research Data (NSD).

### **Statistical analyses**

A total of 1087 athletes completed the survey. The collected data was initially screened for missing values, multivariate outliers and normal distribution (Tabachnick and Fidell 2013). 128 missing values were identified. Due to the design of the online survey, participants were able skip questions if they so wished. Using box plots, 6 cases were recognized as outliers and excluded from further analysis. Thus, the analysis retained 953 out of 1087 athletes. An examination of the histograms, skewness and kurtosis of the variable scores showed that there were no substantial deviations from normal distributions.

First, the data was subjected to descriptive statistical analyses in order to gain some insights into the training habits of athletes before and during the COVID-19 lockdown (see Table 1 in the results section) and some descriptions of the effects of COVID-19 on motivation, participation in online training and virtual sports competitions, as well as attitudes towards the restriction of sport during lockdown and general concerns about the influences of COVID-19 (see Table 2 in the results section). Secondly, in order to provide a more detailed overview of which factors influenced participation in online training and virtual sports competitions, multiple logistic regression analyses were conducted (see Tables 3 and 4 in the results section). The significance level was set at .05 and statistical analyses were performed using the Stata software (version 15.1).

### **Methodological weaknesses and limitations of the study**

This study has several limitations. First, the data collection was carried out online during a national COVID-19 lockdown of Norwegian society, which meant that it was not possible to control for the conditions under which the participating athletes responded to the

**Table 1.** training habits before and during COVID-19 lockdown.

Variable	Before COVID-19 lockdown		During COVID-19 lockdown	
	Obs.	Percentage	Obs.	Percentage
Online training in group	93	9.76	297	31.21
Online training individual	116	12.18	341	35.85
Sport facility in group	788	82.74	181	19.12
Sport facility individual	628	65.93	201	21.08
Outdoors in group	484	50.81	425	44.63
Outdoors individual	523	54.94	726	76.82



**Table 2.** COVID-19, athletes' attitudes, well-being, training and competition.

Variable	N	Min	Max	Mean	Std.dev.
Dig.training importance	953	1	4	2.46	.915
Nec. shut down sport facilities	953	1	4	3.18	1.12
Restrictions too strict	953	1	4	2.30	1.06
Follow restrictions	953	1	4	3.86	.585
Contact with coach	953	1	5	2.94	1.25
Isolated at home	953	1	4	3.42	1.00
Dummy variable	N	Obs. 0	Obs. 1	Percentage 0	Percentage 1
Cancelled competition (yes = 1)	953	224	729	23.45	76.55
Training frequency (less = 1)	953	439	514	45.93	54.07
Motivation (less = 1)	953	280	673	29.37	70.63
Performance worry	953	421	532	44.2	55.81
Body change worry	953	483	470	50.6	49.48

**Table 3.** Logistic regression online training during lockdown (n = 953).

Variable	Coef	Std.dev	t-value	p-value	[95% Conf. Interval]
Constant	-3.00	.447	-6.71	.000**	-3.88 -2.12
Gender (1 = women)	.988	.159	6.20	.000**	.676 1.30
Individual sports	-.214	.169	-1.26	.011*	-.545 .118
Urban	.179	.076	2.34	.019*	.029 .329
Age	-.028	.038	-0.74	.457	-.103 .046
Professional athlete	-.184	.312	-0.59	.555	-.796 .483
Training hours	.426	.078	5.45	.000**	.273 .579
Years of experience	.108	.0636	1.71	.087	-.015 .233
Performance worry	-.082	.171	-0.48	.631	-.418 .253
Body change worry	-.087	.181	-0.48	.629	-.443 .268
Pseudo R <sup>2</sup> = 0.13	LR chi 2(9)=95.50	p<.01			

\*\*p&lt;.01

**Table 4.** Logistic regression virtual competitions during lockdown (n = 953).

Variable	Coef	Std.dev	t-value	p-value	[95% Conf. Interval]
Constant	-3.92	.582	-6.51	.000**	-5.06 -2.64
Gender (1 = women)	-.441	.212	-2.08	.037*	-.858 -.025
Individual sports	.204	.217	0.94	.347	-.222 .631
Urban	-.027	.093	-0.30	.768	-.210 .155
Age	.114	.043	2.65	.008*	.029 .199
Professional athlete	.628	.346	1.82	.069	-.049 1.30
Training hours	.213	.097	2.19	.029*	.022 .405
Years of experience	-.108	.075	-1.44	.149	-.255 .038
Performance worry	1.13	.227	4.97	.000**	.685 1.57
Body change worry	-.447	.293	-1.52	.127	-1.02 .127
Pseudo R <sup>2</sup> = 0.11	LR chi 2(9)=82.18	p<.01			

\*\*p&lt;.01

questionnaires. Second, the sample is slightly skewed in terms of the athletes' gender, as there are 97 more male than female respondents. This may of course be a coincidence. However, as studies from other countries show that women athletes report being more deeply affected by the COVID-19 pandemic than male athletes (di Fronso et al. 2020; Calvo et al. 2021), it could be an indication that Norwegian female athletes were more affected by the COVID-19 pandemic and therefore less likely to find the time and energy to participate in an online survey.

Another weakness of the study design is the lack of theoretical insights for discussing the findings from the Norwegian athletes included in the survey. This study has focused solely on examining how the national COVID-19 lockdown affected Norwegian athletes' training habits and use of digital technology for training and competition purposes.

However, the study does not seek to explain these findings by the use of sociological theory. This is a notable weakness of the quantitative design on which the study is based.

Finally, the variables included in this study mainly focus on the situation of lockdown, and not the pandemic as a broader phenomenon. This, in addition to the limited sample of the study ( $n = 953$ ), may limit the statistical power of the findings, which means that the findings from this data should be treated with caution by readers.

## Results

In this section the results from the descriptive analyses and the logistic regression analyses are presented in 4 separate tables.

### *Descriptive analyses*

The descriptive statistics of the data indicate that the athletes' training habits changed significantly during the pandemic lockdown. As shown in [Table 1](#), the data suggests that the COVID-19 crisis led to an increase in online training (both in groups and individually) and a decrease in training activity in sports facilities (both in groups and individually). The results also show that the athletes rated online training as 'somewhat important' for their training during the lockdown (mean = 2.46, SD = .91, see [Table 2](#)). Outdoor training activities in groups were the least impacted by the COVID-19 lockdown (50.8% before lockdown, 44.6% during lockdown), whilst the lockdown caused a small rise in outdoor individual training, from 54.9% before lockdown to 76.8% during lockdown (see [Table 1](#)). The data shows that 76.5% of the participating athletes had experienced having sports competitions cancelled due to COVID-19, 54% had their training load reduced during lockdown and 70.6% experienced being less motivated for training due to the COVID-19 crisis (see [Table 2](#)).

The descriptive analysis of the variables measuring athletes' attitudes and well-being showed that 55.8% of the athletes were concerned that their performance would be negatively impacted by the COVID-19 lockdown, and 49.4% worried that their bodies would change (loss of muscle mass, weight gain and loss of cardiovascular endurance) due to the pandemic crisis (see [Table 2](#)). On average, the athletes experienced being isolated at home for 4 weeks during the pandemic (mean = 3.42, SD = 1.0). With regard to keeping in contact with coaches during the lockdown, the athletes had on average been in contact with their coach on a monthly basis (mean = 2.94, SD = 1.25). The attitude variables included in [Table 2](#) indicate that, on average, the participating athletes expressed that they 'somewhat agreed' that the shutdown of sports facilities to prevent the spread of the coronavirus was necessary (mean = 3.18, SD = 1.12). The athletes 'somewhat disagreed' with the statement that the restrictions for their sport were too strict (mean = 2.30, SD = 1.06) and 'strongly agreed' (mean = 3.86, SD = .585 with the statement 'I follow the guidelines and restrictions for my sport' (see [Table 2](#)).

### *Logistic regression analyses: digital training and virtual competitions during lockdown*

The logistic analysis of digital training during lockdown presented in [Table 3](#) suggests that female athletes are more likely to participate in digital training in this situation than

male athletes (coef = .988,  $p = .00$ ), whereas athletes in individual sports are less likely to engage in digital training than athletes in team sports (coef =  $-.214$ ,  $p = .01$ ). Furthermore, athletes living in urban areas are more likely to participate in digital training than those living in rural areas (coef =  $.179$ ,  $p = .01$ ). Lastly, there is a positive correlation between the number of training hours and participation in digital training during lockdown. Hence, the more hours an athlete usually trains per week, the more likely they are to participate in digital training (coef =  $.426$ ,  $p = .00$ ). Age and years of experience in the sport do not significantly impact participation in digital training during lockdown. There is no significant correlation between being a professional athlete and participating in digital training. Concerns about COVID-19 impacting performance and/or body appearance do not appear to significantly impact digital training participation either.

The logistic regression analysis of participation in virtual sports competitions in [Table 4](#) demonstrates that the variables gender, age, training hours and concerns about worsened performance significantly impact the likelihood of participating in virtual sports competitions during the COVID-19 lockdown. Male athletes are more likely to participate in virtual sports competitions than female athletes (coef =  $-.44$ ,  $p = .03$ ), and older athletes are more likely to participate in virtual competitions than younger athletes (coef =  $.11$ ,  $p = .00$ ). As with participation in digital training ([Table 3](#)), training hours positively correlate with participation in virtual competitions (coef =  $.213$ ,  $p = .02$ ). There is also a positive correlation between being concerned about reductions in performance and participating in virtual competitions (coef =  $1.1$ ,  $p = .00$ ).

## Discussion

The purpose of this study has been to investigate three research questions: (a) How did a national COVID-19 lockdown affect Norwegian athletes' training habits? (b) How did the lockdown affect Norwegian athletes' use of digital technology for training and competitions? (c) Which factors influenced Norwegian athletes' participation in digital training and virtual sports competitions during a national COVID-19 lockdown? The multiple logistic regression analyses ([Tables 3 and 4](#)) indicate that there are age and gender differences in athletes' participation in online training and virtual sports competitions. Regarding the athletes' gender, female athletes are more likely to participate in online training than male athletes, while male athletes are more likely to participate in virtual sports competitions than female athletes. These findings are supported by previous studies on athletes and COVID-19 that have also found gender differences in how athletes adapt to and cope with the global pandemic lockdown (Parker et al. [2021](#); Bowes, Lomax, and Piasecki [2021](#); di Fronso et al. [2020](#); Şenışık et al. [2021](#); Mon-López et al. [2020](#); Calvo et al. [2021](#)). Hence, at this point, data from Italy, Turkey, Spain, the USA, the UK and Norway indicate that female and male athletes are affected differently by the COVID-19 pandemic. While di Fronso et al. ([2020](#)) found that elite athletes reported lower perceived stress states than novice athletes, in this study being a professional athlete does not significantly influence participation in online training or virtual sports competitions. Neither does years of experience in the specific sport (see [Tables 3 and 4](#)). However, age does significantly affect participation in virtual sports competitions, where older athletes are more likely to take

part in virtual competitions than younger athletes. This could be explained by the fact that the national lockdown of competitive sport in Norway was stricter and more prolonged for adults than for youth (6–20 years). It can therefore be deduced that adult athletes were more likely to experience longer periods without training and competing during 2020–2021 in Norway.

Several studies of athletes and COVID-19 (Mascret 2020; di Fronso et al. 2020; Şenışık et al. 2021; Mon-López et al. 2020; Calvo et al. 2021; Bowes, Lomax, and Piasecki 2021) indicate that the COVID-19 pandemic lockdowns in other countries have also affected athletes in many different ways. For instance, in their study of French athletes, Mascret (2020) concluded that athlete motivation diminished during the pandemic lockdowns. Parm et al. (2021) identified the same issue among elite athletes in Estonia. Although the data analyzed here cannot determine changes in motivational goals in the same way as Mascret (2020) in France, the data from the Norwegian athletes indicates that 70.6% of the athletes reported less motivation to train due to the COVID-19 pandemic lockdown.

Academic contributions from sports medicine (Parker et al. 2021; Baggish et al. 2020; Paoli and Musumeci 2020) have raised concerns about the consequences the coronavirus and the subsequent shutdown of sports facilities, training and competitions will have for athletes' health. The data analyzed in this study indicates that many of the athletes also share this concern. Approximately half of the participating athletes in this study reported that they were worried that the COVID-19 pandemic would have a negative effect on their sport performance and their bodies (e.g. weight gain, loss of muscle mass).

There are very few studies of online sports training and virtual sports competitions with which to compare the findings of this study. A significant finding in this study is that there has been a significant increase in athletes' participation in online training during the COVID-19 lockdown compared to reported training habits before the lockdown. Only 9.7% of the athletes reported participating in online training in groups before the lockdown, while 31.2% reported that they participated in online group training during the lockdown. Similarly, 12% reported participating in individual online training before the lockdown, compared to 35.8% during the lockdown (see Table 1 in the results section). This finding suggests, like Mutz and Gerke's (2021) study of survey data from Germany, that many athletes have substituted organized sporting activities and competitions with individual home-based workouts. This study also adds new insights to the analyses of Mutz and Gerke (2021) by distinguishing between online training in groups and individual online training and by exploring factors that influence participation in online training and virtual sports competitions. Further, this study builds on Davis's (2020) discussion of virtual professional dart tournaments by providing empirical data and analyses of the factors that influence participation in virtual sports competitions.

While the majority of research on the use of digital tools in sport focuses on the implementation and application of digital technologies in commercialized elite sport (Yan et al. 2019; Bertschy, Mühlbacher, and Desbordes 2020; Geurin-Eagleman and Burch 2015), this study has instead explored athletes' use of online training and participation in virtual sports competitions regardless of competitive level. Ehnold et al. (2020) found that the single most common use of digital tools in voluntary sports clubs was for internal and external communication. Hence, it is possible that this is the case among Norwegian sports clubs as well. In other words, it would seem that only a few voluntary sports clubs used digital tools to host online training activities or virtual sports competitions during the COVID-19

lockdown. This could explain why less than half of the participating athletes in this study report participating in online training and virtual sports competitions.

## Conclusion

The findings from the Norwegian data presented in this article support the findings of studies on the impact of COVID-19 lockdowns in other countries, in that they suggest: (1) that male and female athletes have coped with the COVID-19 pandemic differently, (2) that COVID-19 lockdowns have resulted in an increased use of home-based training strategies via digital technology and (3) that most athletes have experienced being less motivated to train and compete during lockdown.

Additionally, the Norwegian data analyzed in this study has added two novel findings to current research on the impact of COVID-19 pandemic lockdowns on athletes' training habits and use of digital technology for training and competition purposes. The findings from this study indicate: (a) that athletes in individual sports are less likely to engage in digital training than athletes in team sports and (b) that older athletes are more likely to participate in virtual competitions than younger athletes.

Even though these findings add to the existing knowledge about the impact of COVID-19 on athletes in different countries, more studies are needed to explore (1) the short- and long-term effects of COVID-19 lockdowns on athletes' training habits and (2) how the COVID-19 pandemic has affected athletes' use of digital technology for training and competition purposes. Based on the findings presented in this article, future studies on these topics should investigate the differences between sports (such as team sports and individual sports), the differences between age groups (young and adult athletes) and demographical and social inequality differences in the spread and adoption of digital tools among athletes.

## Disclosure statement

No potential conflict of interest was reported by the authors.

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