applied sciences

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Effects of a Physical Training Program on Cognitive and Physical Performance and Health-Related Variables in Professional esports Players: A Pilot Study

Manuel Sanz-Matesanz [1], Luis Manuel Martínez-Aranda [2,3,*] and Gemma María Gea-García [4]

[1] Faculty of Sport, Catholic University of Murcia, 30107 Murcia, Spain; manuelsm94@gmail.com
[2] Physical and Sports Performance Research Centre, Faculty of Sports Sciences, Pablo de Olavide University, 41013 Seville, Spain
[3] SEJ-680: Science-Based Training (SBT) Research Group, Pablo de Olavide University, 41013 Seville, Spain
[4] Physical Education and Sport Department, Faculty of Education Sciences, University of Seville, 41004 Seville, Spain; ggea@us.es
* Correspondence: lmmarara@upo.es

Abstract: The present study focused on the effects of a physical training program on physical- and psychological-related variables in professional esports players. Five professional League of Legends (LOL) players belonging to the highest national category participated in this study. Data were obtained before and after a 5 h virtual training session (acute), as well as before and after an 8-week intervention period, focused on decreasing the impact of fatigue on players' health and performance. The results showed that a complete virtual training session influences their performance, decreasing jump height and joint mobility ($p < 0.01$), as well as increasing perceived physical and cognitive exertion by 76.9% ($p < 0.01$) and 166.67% on the "Rating of Fatigue" scale ($p = 0.002$). Moreover, the intervention was able to reduce the impact of fatigue (30.8% and 43.3% reduction in cognitive and overall fatigue, respectively, $p < 0.05$), improving, at the same time, the amount of muscle mass by 2%, jumping ability by 9.8% to 21%, and strength levels in various exercises by 63% to 173% ($p < 0.01$). The implementation of a physical training program is capable of reducing the players' fatigue perception, improving their physical conditioning and health status, and decreasing the injury risk.

Keywords: esports; pro-players; performance; health; physical training

Citation: Sanz-Matesanz, M.; Martínez-Aranda, L.M.; Gea-García, G.M. Effects of a Physical Training Program on Cognitive and Physical Performance and Health-Related Variables in Professional esports Players: A Pilot Study. *Appl. Sci.* **2024**, *14*, 2845. https://doi.org/10.3390/app14072845

Academic Editor: Mark King

Received: 24 February 2024
Revised: 23 March 2024
Accepted: 26 March 2024
Published: 28 March 2024

1. Introduction

Based on data from Activate Consulting in 2023 [1], the video games industry supports over 220,000 jobs in the United States alone. Moreover, the global investment and spending on video games increase by 8% every four years, with expenditures reaching USD 184 billion in 2022 [2]. These figures signify a growth of more than 40% within two years and forecast a consistent annual increase of 20% to 40% [2].

As the video games sector expands, certain games have evolved beyond mere entertainment to become competitive esports. These games are organized by institutions, operate within regulated leagues and competitions, and promote the formation of competitive teams akin to those in traditional sports [3].

The phenomenon of esports has burgeoned into a significant economic and social phenomenon, drawing audiences on par with traditional sports [4,5]. For instance, popular esports, such as League of Legends and Valorant, attract between 400,000 and 500,000 viewers on average in both Asian and European leagues [6]. Cranmer et al. [4] highlighted that esports garnered over 60 million new viewers in 2017, outpacing the NBA, which attracted 20.4 million new followers. This underscores the growing appeal of esports, capable of drawing larger audiences than traditional sports.

Particularly, League of Legends (LOL) stands out as a pivotal competitive E-sport [7], being the most watched game globally and highly esteemed in the competitive realm. It boasted an audience of 200 million viewers at its World Cup, surpassing the Super Bowl's viewership of 103 million [8].

The rise of LOL has paved the way for players' professionalization, enabling them to achieve economic standings comparable to those of traditional sports stars [5,8,9]. This professional commitment demands daily training sessions lasting 6 to 10 h [10]. Consequently, Difrancisco-Donoghue et al. [11] argue for the recognition of health and injury prevention in these athletes, advocating for a balanced lifestyle and incorporating specific physical conditioning into their regimen. Similarly, Pourmand et al. [12] identified injuries in esports, primarily related to fatigue and overtraining, affecting the shoulder, wrist, and back areas. Furthermore, the sedentary nature of esports poses risks of obesity, heart disease, and diabetes, threatening the health of both professional and amateur players [8].

Acknowledging the prevalent issues faced by esports players, incorporating physical exercise into their routines could offer a distinctive advantage. Physical training aids in managing muscular stress without reaching pain thresholds, enhancing effort perception and muscular fitness [13]. This approach could delay fatigue onset, potentially improving in-game performance [13,14].

Moreover, physical exercise's role extends to enhancing cognitive abilities [15]. With esports players facing psychological challenges and the necessity for high cognitive performance, it is crucial to implement intervention strategies that address both physical and psychological aspects [16,17]. These strategies could enhance decision-making and information processing [3], and reduce stress and anxiety [18,19]. Therefore, the inclusion of physical activity as part of the esports player's routine is key to enhance their health, as well as the competitive performance, both physically and psychologically [8].

Nonetheless, to effectively apply physical training programs targeting fatigue reduction, it is essential to measure this variable accurately [20]. Considering the specific conditions and regulations of competition venues, employing expensive laboratory tests is impractical [21]. Thus, assessments should rely on methods that are accessible and straightforward for team staff.

De las Heras et al. [8] conducted a study with occasional esports players, demonstrating significant performance improvements through physical exercise participation. However, research focusing on fatigue's impact on players during actual training sessions, particularly for professional teams, remains scarce [9,22]. Despite the growing professionalization of esports players and the increasing relevance of research tailored to this demographic, obtaining a representative sample to study is challenging. Most research has concentrated on the acute effects of neural and nutritional stimuli [18], with a lack of comprehensive studies examining long-term intervention program effects.

Actually, it is considered that the virtual training sessions undergone by professional esports players cause fatigue capable of affecting the players' performance and health. Such fatigue would be reduced following the implementation of an intervention program based on physical exercise, being capable of improving the players' health and influencing their competitive performance.

Based on this, there is a demand to know the effects of prevention and/or training programs in professional players, providing data of interest for coaches, clubs, as well as the players themselves, in order to implement such programs in their daily work routine.

Therefore, the aim of this study was based on analyzing the fatigue generated by a virtual training session in a sample of professional esports players and, subsequently, designing, implementing, and studying the effects of an 8-week physical training program on body composition, in-session heart rate, physical and cognitive perceived fatigue, as well as physical fitness- and psychological-related variables, affecting the players' health and performance.

2. Materials and Methods

2.1. Design and Participants

A descriptive, cross-sectional study design with non-probability sampling was used. The sample was selected by convenience or accidental sampling. A total of five professional E-sport players participated in the study (age = 19.6 ± 1.84; height = 176 ± 4.95 cm; league points = 752 ± 206; number of daily games = 7 ± 2; years of practice = 7 ± 2). These players belonged to a professional club of the first national esports division of the LOL modality (SuperLiga Orange, Professional Video Game League, Barcelona, Spain).

The inclusion and exclusion criteria for the sample were based on: (a) being actively part of a professional club, involved in the specific routine associated with competition; (b) reaching the top category in the game's internal ranking; (c) being in the competitive period during the implementation of the intervention program; (d) being free from physical or cognitive pathologies that would affect the relevant data collection during the research period, and (e) completing all measurement and training sessions during the intervention period.

Every player reached the highest category within the video game, which was identified as "Challenger". This category is usually associated with the most competitively skilled players, belonging to the best international teams, and who make up only 0.006% of all LOL players (Rank Distribution LOL). Similarly, it was noted that all players followed the same structure of virtual training throughout the process and successfully completed all the physical training sessions.

2.2. Sample Size

Sample size calculations were performed with the software G*Power 3.1.9.4. For this purpose, a protocol of the t-test family identified with the statistical test means: difference from constant (one sample case), was used [23]. The significance level was set at $\alpha = 0.05$. As a consequence, the sample size (power analysis) revealed that five participants were sufficient to obtain a power of 95%. This could be a representative sample from the entire population, given that there are only 10 professional teams in this Spanish "SuperLiga" category, with five players each.

2.3. Measurements and Material

Virtual Training Sessions

All pre- and post-intervention data collection sessions were conducted in the same time slot and room. In addition, esports players were monitored to ensure that they did not engage in any strenuous activity for 48 h prior to any measurement session.

The data collection sessions focused on the analysis of a common virtual training session of a professional esports team, in this case LOL. These training sessions were composed of 5 or 6 games or scrims (5 h length, approximately), where competitive simulations were carried out. These simulated contexts were conditioned by the strategies outlined by the coach and focused on training new skills or playing "champions vs. random opponents" or other pre-selected professional teams. These games always involved a level of competitiveness equal to or higher than the player's, implying a maximum standardized demand during all the games. The training demand and standardization were agreed with the team's staff members, managing to modify as little as possible the dynamics of a professional team, and bringing the data collected as close as possible to the reality of the demand experienced by professional players. The player's equipment was identical in both sessions, guaranteeing the setup used during competition and official club training sessions (Figure 1).

Figure 1. Gaming setup used by players during the virtual training sessions. The setup used was identical in both data collection sessions and is the official competition setup. It includes a desk, chair, monitor, camera with a direct connection to the competition, PC, keyboard, mouse, competitive mouse pad, and headphones. The selection of the components for training and competition was unique to each player and was not modified during the research period (self-created).

The test selection, focused on the measurement of each of the variables, was based on their reliability and validity for obtaining accurate data and their applicability in the esports club environment [21]. An explanatory diagram is provided below (Figure 2).

First Phase (First session)		
Pre Virtual training session	During Virtual training session	Post Virtual training session
60 45 30 15 0	Practice	0 15 30 45 60
1. PMCSQ-2, TEOSQ, SMS-II and PSS-14 questionnaires 2. Body composition 3. Pre Jump tests 4. Pre ROM tests	Heart rate monitoring RPE monitoring after each game	1. Post Jump tests 2. Post ROM tests
During 8 weeks intervention program Muscle strength tests after each session		
Second Phase (Second session)		
Pre Virtual training session	During Virtual training session	Post Virtual training session
60 45 30 15 0	Practice	0 15 30 45 60
1. PMCSQ-2, TEOSQ, SMS-II and PSS-14 questionnaires 2. Body composition 3. Pre Jump tests 4. Pre ROM tests	Heart rate monitoring RPE monitoring after each game	1. Post Jump tests 2. Post ROM tests

Figure 2. Design of data collection, selected tests, and timing of measurements carried out before and after the virtual training session and before and after the intervention period. Note: PMCSQ-2 = Perceived Motivational Climate in Sport Questionnaire; TEOSQ = Task and Ego Orientation in Sport Questionnaire; SMS-II = Sport Motivation Scale-II; PSS-14 = Perceived Stress Scale; ROM = Range of Movement.

2.4. Project Variables Measured during the Program Implementation

2.4.1. Body Composition

Changes in body composition (BC) are a good indicator of the player's health status. BC is even related to resilience and stress tolerance, which is very common in esports players [24]. Therefore, it could provide relevant information concerning the usefulness of the intervention program.

Body weight (kg), body mass index, as well as the other parameters that determine the body composition of the esports players were measured using a bioelectrical bio-impedance analysis device (Tanita BC 545-N, Tanita Europe B.V., Amsterdam, The Netherlands) with an accuracy of 0.1 kg. On the other hand, height (cm) was measured using a stadiometer (Tanita HR001 Leicester portable height rod, Tanita Europe B.V., Amsterdam, The Netherlands) with an accuracy of 0.1 cm. All these measurements were collected at the beginning and at the end of the intervention period. Anthropometric measurements followed the standards established by the International Society for the Advancement of Kinanthropometry (ISAK) [25]. Data collection was performed in the same time slot and not allowing the intake of liquids and diuretics in the previous two hours in order to avoid possible interferences. Likewise, prior to the measurements, the clothing requirements were established, and all this information was recorded in the information dossier provided to athletes, coaches, and/or parents. More specifically, it was established that esports players should wear comfortable sports clothing (T-shirt and short trousers), and height and weight were collected barefoot.

2.4.2. Heart Rate

In addition to the changes in body composition, data were collected regarding the players' heart rate (HR) during the virtual training. This variable provides data on the external load borne by the players, which is closely related to their perceived fatigue and their ability to withstand physical and cognitive effort [26].

Player's HR was recorded during the entire training session. For this purpose, a chest band with the Polar H10 device was used [27]. In this regard, the consumption of stimulant or relaxing substances was avoided at any time during the 48 h prior to the training session.

2.4.3. Muscle Fatigue

Concerning the analysis of muscle fatigue, several non-invasive tests were used, oriented to the possibility of being carried out by different professional clubs in their own facilities [28].

2.4.4. Jump Height Loss

The jump height loss test has a high correlation with lactate and cortisol indexes, so it is recommended for workload testing [29,30]. The jumping modality selected was the countermovement jump without arm assistance (CMJ). This jump is performed starting from an upright vertical position, placing the hands on the hips. From this position, a knee flexion–extension must be performed until a 90° angle is reached, and then, without any pause in the movement, a maximum vertical jump must be performed [31]. An iPad Mini 4 with a high-speed camera (120 fps) and the My Jump 2 app were used for the measurement [32,33]. The CMJ jump test was performed on four occasions: before and after the training session carried out prior to the intervention protocol and, subsequently, 8 weeks after the intervention, the jump tests were repeated both before and after the second training session analyzed.

2.4.5. Muscle Stiffness

In order to detect localized fatigue in regions exposed to higher demand in esports players, muscle stiffness detection tests were selected to detect the loss of joint range of motion at the shoulder and wrist [12]. This methodology has been used to diagnose fatigue after long-duration precision exercises, such as surgery, showing a high degree of validity as a detector of localized fatigue, as well as a predictor of imbalance [34–36].

The stiffness tests were applied at two different time points. More specifically, the first time was before starting the first training session and after its completion. The second time was after the 8-week training period (before and after the training session). Data collection was carried out using a smartphone with the Goniometer Pro application [37].

To perform these tests, the protocol established by Norking and White in [38] was conducted. More specifically, to detect a joint range loss in the shoulder, the esports player was placed lying supine, with the dominant arm extended along the body. The research team took the initial 0° position as the moment when the arm and trunk were parallel, fixing the measuring device to the lateral side of the arm from the humerus major tuberosity. Then, the player performed a maximum flexion to the overhead point of pain or limitation, accompanying the movement with the measuring device and ending the gesture at the maximum range of motion. Likewise, for the measurement and detection of the loss of articular range in the wrist, the subject was seated, with 0° of shoulder flexion and 90° of elbow flexion, completely supporting the entire forearm and hand on a table. From this position, considered to be 0°, an extension of the wrist was performed, ensuring that the forearm remained in contact with the table, taking the limitation or pain point as the end of the movement.

2.4.6. Perceived Exertion

Perceived exertion is a valid and reliable tool for load control at any age and applied to any fatiguing activity [39–41]. In the present study, data were collected on the player's perceived exertion after each of the 6 games, both before and after the intervention protocol. To measure and evaluate this variable, the 6–20 scale designed by Borg [42] was used twice. The first use referred to the player's cognitive fatigue after each training game. Secondly, and in parallel, the scale was applied in the same way to the player's perception of physical fatigue throughout the training [12,43]. Finally, at the end of the whole training session, the player was asked to assess the general perceived fatigue. In order to improve the quality of these results, the players carried out a familiarization period using the scale during the two weeks prior to data collection.

In addition to the numerical perceived exertion, the Rating of Fatigue (ROF) scale was selected to obtain data on the player's general perceived fatigue after each game, complementing the previous data [44].

Finally, data on the player's performance perception were obtained by recording their subjective rating at the end of the training session (0–10 scale).

2.4.7. Motivational Scale

Using standardized questionnaires, the motivational climate of the team, as well as the player's ego or task orientation, were analyzed. The selected tests were the Perceived Motivational Climate in Sport Questionnaire (PMCSQ-2), the Task and Ego Orientation in Sport Questionnaire (TEOSQ), and the Sport Motivation Scale-II (SMS-II).

Firstly, the PMCSQ-2 questionnaire is composed by 33 items rated on a Likert scale, where each item is valued between 1 (total disagreement) and 5 (total agreement). This questionnaire is oriented toward the player's assessment of the perceived motivation while playing and the affinity with the rest of the teammates. The internal consistency level was considered acceptable (Cronbach's alpha coefficient value: 0.86—task; 0.85—ego) [45].

Secondly, the TEOSQ questionnaire analyzes the player's ego or task orientation by showing their level of agreement on a 13-item Likert scale from 1 (completely disagree) to 5 (completely agree). This instrument starts with the initial sentence: "I feel most successful in a sport when ...", then showing the different items to be assessed, divided into ego-oriented items (1, 3, 4, 6, 9, and 11) and task-oriented items (2, 5, 7, 8, 10, 12, and 13), with a Cronbach's alpha coefficient of 0.89 and 0.82, respectively [46].

Finally, the SMS-II questionnaire, referring to players' motivation to play, was applied, obtained by answering 18 items with a score between 1 (completely false) and 7 (completely true) on a Likert scale. This questionnaire yields specific data on the players' motivational orientation toward different areas, such as: intrinsic (items 2, 7, and 13), integrated (items 4, 5, and 15), identified (items 9, 11, and 17), introjected (items 3, 13, and 14), external (items 1, 6, and 16), and a-motivated (items 8, 10, and 18). It also offers a global value called the "Relative Autonomy Index" (RAI), showing the player's self-determination feeling. This value is calculated by adding the results of each category, taking into consideration that the values of introjected, external, and a-motivated will yield a negative value, so they will be subtracted. The internal consistency values for all categories varied between 0.74 and 0.80 [47].

2.4.8. Perception of Stress

The stress perceived by players is of great interest to coaches and clubs, being capable of influencing the player's performance during the competition [48]. Therefore, the 14-item Perceived Stress Scale (PSS-14) was selected as a validated method for the analysis of perceived stress (frequency during the last month) before and after the intervention protocol, revealing a Cronbach's alpha value above 0.70 [49,50]. This questionnaire is rated on a Likert scale from 0 (never) to 4 (very often). To obtain the final value, the value for each item must be added, considering the necessary inversion (0 = 4, 1 = 3, and 2 = 2) of items 4, 5, 6, 7, 9, 10, and 13.

2.4.9. Muscular Strength

Finally, in order to check the players' evolution during the training period, the loads performed in every exercise during the 8-week intervention program were recorded, guaranteeing in all cases to leave 4 repetitions in reserve (RIR 4) in a set of 10 repetitions [51]. To ensure measurement accuracy, players performed a two-week familiarization period with the RIR-based load quantification methodology, as well as a standardized warm-up before each session. The RIR is a methodology for quantifying the intensity of each set, based on the individual's perception of the number of reps that could be performed to exhaustion with a given load [52]. This methodology has proven its validity as a monitoring and individualization method for strength training, increasing efficiency and motivation in a young population [53].

2.5. Procedure

Before starting the study, all players and managers were informed of the characteristics of this research, as well as its potential benefits and risks. Subsequently, all participants proceeded to complete and sign the informed consent form. The study was conducted in accordance with the ethical principles of the Helsinki declaration for research involving human subjects (World Medical Association) and was approved by the institutional review board of the Catholic University of Murcia (code: CE052209).

This study was conducted over 8 weeks from January to March 2021. All esports players completed a total of three training sessions per week throughout the intervention period. Prior to the start of the intervention and data collection, the players were invited to avoid any physical activity outside the established plan and to maintain their daily routines of eating, resting, and virtual training.

All sessions were held in the morning, lasting less than 70 min. Each session included a specific initial warm-up aimed at the mobility of the joint regions most demanded by the players. The warm-up included specific flexion–extension movements of the shoulder, wrist, back, and neck, together with the exercises performed during the subsequent session, focusing on postural correction and gains in full joint range in each gesture. In addition, resisted gestures were included with elastic bands for shoulder external rotation and anti-rotational abdominal activation.

Among the total number of weekly sessions, two of them were oriented to strength training. This work focused on the development of upper and lower body strength, following the indications of the American College of Sports Medicine [54,55]. On the other hand, the third weekly session focused on cardiovascular work, aiming to produce adaptations that would improve the subject's ability to tolerate prolonged efforts associated with training and competitions lasting more than 5 h [17].

This intervention protocol, in addition to specifically targeting the player's muscular and cardiovascular capacities, also aims to have a positive impact on psychological elements, such as anxiety, stress, and group cohesion. These psychological variables affect the performance and well-being of the team, and may also be conditioned by physical training [56].

2.5.1. Strength Training Sessions

More specifically, the aim of this strength training program was to increase the players' muscle tolerance to effort, as well as their functionality. These types of strength training protocols are very common in studies aimed at the prevention of certain occupational risks in office workers but have not been applied to esports players. Considering the similar physical performance of both in front of a computer, this type of training could be more than adequate for this population [13,57,58]. These trainings focus on improving the tolerance of the structures most demanded by workers, which can be extrapolated to esports players, aiming to generate adaptations that allow for an optimal performance state to be prolonged over time.

The volume of each session was then standardized (3 sets $\times$ 10 repetitions, 4 exercises per session, assuming a total of 8 strength exercises per week) (American College of Sports Medicine). The load was determined individually for each player on the basis of the repetitions in reserve (RIR) by using 4–6 repetitions as the optimal range in the fatigue-adaptation comparison [59]. This methodology ensured an optimal intensity to provoke strength adaptations in the players' muscles.

Finally, 4 basic exercises were performed during each training session (2 dedicated to upper limb and 2 to lower limb strength work). These exercises were interspersed with each other in order to prevent fatigue influencing the players' performance [55].

The selected exercises were the bench press, squat, shoulder press, leg press, lat pulldown, deadlift, Pendlay row, and hip thrust. The selection of exercises was based on the guidelines of the American College of Sports Medicine, choosing movements that involved all the muscle groups of the body in their overall actions of both pulling and pushing. In order to ensure the correct execution of the exercises, as well as the understanding of the RIR-based training methodology, a two-week familiarization period was conducted with all players.

2.5.2. Cardiovascular Capacity Training Session

For the development of cardiovascular capacity, the 10–20–30 method was selected, implemented by Gunnarsson and Bangsbo [60], which is specifically designed for early-stage athletes. This methodology has proven to be valid both for the improvement of maximum oxygen consumption (VO2Max), as well as the decrease of heart rate at rest, involving a total training volume of less than 20 min, thus increasing the work efficiency and motivation toward it.

The application of training methods aimed at improving the VO2Max of players is based on the relationship between the players' cardiovascular capacity and their endurance for long-duration activities, such as their virtual training sessions [9,60]. An improvement in their cardiovascular endurance can reduce the perceived fatigue, thereby enhancing their performance and reducing their injury incidence [5,8].

2.6. Data Analysis

Data analysis was performed using SPSS statistics ver. 25 (IBM Corp., Armonk, NY, USA). Descriptive data for the different variables under study are presented by mean (M) and standard deviation (SD) values. The Shapiro–Wilks test was used to check the data normality. Therefore, a *t*-test for related samples was applied to analyze the possible differences between the variables before and after the 8-week intervention period. Finally, to study the load progression of each exercise proposed during the intervention, as well as to verify the changes in perceived fatigue after every match within the virtual training session, the Friedman post hoc statistical test was applied using the Wilcoxon test. Effect size was calculated via Rosenthal's r or Cohen's d statistics, as appropriate [61] (0.1 to 0.3 (small), 0.3 to 0.5 (medium), and >0.5 (large) effect). A significance level of $p < 0.05$ was accepted for statistical comparisons.

3. Results

3.1. Acute Effects of Virtual Training Sessions

Firstly, the data showed a reduction in the players' acute muscle capacity associated with fatigue in both virtual training sessions. The height of the third jump performed before and after virtual training ($M\_Session\_1_{\_pre}$ = 32.85 ± 3.8 vs. $M\_Session\_1_{\_post}$ = 28.85 ± 3.73; $p < 0.01$; $M\_Session\_2_{\_pre}$ = 37.00 ± 5.98 vs. $M\_Session\_2_{\_post}$ = 34.90 ± 5.65; $p < 0.01$) and the average total jump (M_Session_1_pre = 31.98 ± 3.13 vs. M_Session_1_post = 29.29 ± 4.24; $p < 0.05$; $M\_Session\_2_{\_pre}$ = 35.99 ± 5.56 vs. $M\_Session\_2_{\_post}$ = 34.16 ± 5.53; $p < 0.01$) showed significant differences in both training sessions, before and after the intervention program. Similarly, significant differences were found in the players' muscle stiffness, decreasing the range of motion of the shoulder in virtual training session 1 (M_{pre} = 170 ± 12.51 vs. M_{post} = 161.26 ± 10.47; $p < 0.05$), as well as concerning the wrist and shoulder in virtual training session 2 (shoulder: M_{pre} = 182.00 ± 7.87 vs. M_{post} = 177.60 ± 7.27; $p < 0.01$; wrist: M_{pre} = 54.60 ± 13.05 vs. M_{post} = 50.00 ± 13.58; $p < 0.01$) (Table 1).

Table 1. Countermovement jump height and joint range loss pre- and post-in-game training session.

Characteristics	Pre		Post		t	*p*	ES
	M	SD	M	SD			
CMJ_S1_1	30.91	1.95	29.21	4.54	1.356	0.246	--
CMJ_S1_2	32.18	3.87	29.82	4.66	2.499	0.067	--
CMJ_S1_3	32.85	3.81	28.85	3.73	12.727	0.000 **	--
CMJ_S1_M	31.98	3.13	29.29	4.24	3.937	0.017 *	1.761
CMJ_S2_1	35.63	5.61	34.09	6.50	2.403	0.074	--
CMJ_S2_2	35.34	5.19	33.48	4.51	3.277	0.031 *	--
CMJ_S2_3	37.00	5.98	34.90	5.65	9.288	0.001 **	--
CMJ_S2_M	35.99	5.56	34.16	5.53	5.438	0.006 **	2.432
JR_S1_Shoulder	170.00	12.51	161.26	10.47	3.270	0.031 *	1.463
JR_S1_Wrist	46.40	13.67	44.60	16.24	0.745	0.498	0.333
JR_S2_Shoulder	182.00	7.87	177.60	7.27	6.487	0.003 **	2.901
JR_S2_Wrist	54.60	13.05	50.00	13.58	6.782	0.002 **	3.033

Note: CMJ = counter movement jump test; JR = joint range; S1 = pre-intervention program; S2 = post-intervention program; M = mean; SD = standard deviation. ** = p-value < 0.01; * = p-value < 0.05.

Secondly, when analyzing the variations in players' perceived fatigue between the first and the last game within each virtual or in-game training day, significant differences ($p < 0.03$) were observed, except in the physical fatigue perception in the second virtual training session. More specifically, an increase in the effort perception tests was observed, revealing a progressively increased fatigue as the training session progressed, with significant changes in both sessions, but showing lower values in the second one (Table 2). According to the data on the perceived exertion during in-game training session 1, an increase of 76.9% was observed in the physical perception ($p = 0.026$; ES = 0.568), an increase of 76.92% in the cognitive one ($p = 0.002$; ES = 0.693), and an increase of 166.67% on the ROF scale ($p = 0.002$; ES = 0.829). In the same line, changes could be observed in the data referring to the second in-game training session, with increases of 47.22% ($p = 0.004$; ES = 0.641) and 36.96% ($p = 0.004$; ES = 0.800) for physical and cognitive perception, as well as an increase of 166.67% on the ROF scale ($p = 0.004$; ES = 0.824).

Table 2. Changes in RPE values after each game.

Exercise	Game 1		Game 4		Game 6		X2	*p*	ES
	M	SD	M	SD	M	SD		Games 1 and 6	
RPE Phy. S1	9.60	2.07	13.00	5.29	14.00	4.30	19.266	0.026 *	0.568
RPE Cog. S1	10.40	2.51	15.80	3.27	18.40	2.07	21.948	0.002 **	0.693
ROF scale S1	3.00	0.71	6.40	2.51	8.00	1.58	23.179	0.002 **	0.829
RPE Phy. S2	7.20	1.79	8.80	2.28	10.60	2.88	17.360	0.004	0.641
RPE Cog. S2	9.20	3.03	11.20	2.59	12.60	3.36	22.233	0.004 **	0.800
ROF scale S2	1.80	1.48	3.80	1.64	4.80	2.17	21.899	0.004 **	0.824

Note: RPE = rating of perceived exertion; Phy. = physical; Cog. = cognitive; ROF = rating of fatigue; S1 = pre-intervention program; S2 = post-intervention program; M = mean; SD = standard deviation. ** = p-value < 0.01; * = p-value < 0.05.

3.2. Effects of the Intervention Program on Players' Health and Physical Fitness

Table 3 shows the mean values obtained for the assessment of body composition in the esports players. Significant differences were reported when comparing the mean values for muscle mass ($M_{pre} = 51.56 \pm 7.27$ vs. $M_{post} = 52.54 \pm 7.78$; $p < 0.05$), basal metabolism ($M_{pre} = 1628.20 \pm 220.00$ vs. $M_{post} = 1652.40 \pm 231.00$; $p < 0.05$), and body water percentage ($M_{pre} = 64.50 \pm 4.70$ vs. $M_{post} = 63.06 \pm 4.70$; $p < 0.05$) before and after the intervention program. In addition, a reduction in the players' mean heart rate was reported during in-game training sessions, although with no significant differences.

Table 3. Players' body composition changes and average heart rate pre- and post-intervention program.

Characteristics	Pre		Post		t	*p*	ES
	M	SD	M	SD			
Weight (kg)	63.22	10.82	63.46	10.65	−0.806	0.465	0.361
Body fat percentage	13.78	4.99	12.42	5.44	1.726	0.159	0.772
Muscle mass (kg)	51.56	7.27	52.54	7.78	−2.897	0.044 *	1.296
Bone mass (kg)	2.76	0.38	2.80	0.34	−1.633	0.178	0.730
Body mass index	20.40	2.62	20.44	2.54	−0.459	0.670	0.205
Basal metabolic rate (Kcal/day)	1628.20	220.00	1652.40	231.00	−3.570	0.023 *	1.597
Metabolic age (Y)	16.20	6.02	15.60	5.13	1.500	0.208	0.671
Body water percentage	62.50	4.70	63.06	4.70	−3.311	0.030 *	1.481
Visceral fat index	1.70	1.09	1.60	0.89	1.000	0.374	0.447
Average heart rate during training	90.00	2.34	84.40	4.72	2.514	0.066	1.125

Note: kg = kilograms; Kcal/day = kilocalories per day; Y = years; M = mean; SD = standard deviation. * = p-value < 0.05.

On the contrary, no significant differences were revealed before and after the application of the intervention program concerning the variables of motivation and stress perception ($p > 0.05$) (Table 4).

Regarding the muscular capacity of esports players, the results showed significant differences when comparing the data before and after the application of the intervention program ($p < 0.05$). More specifically, pre- and post-eight-week training program variations were observed between the jump height achieved by the players in all jumps before and after the in-game training sessions (before in-game: M = +12.54% after intervention program, $p < 0.05$; after in-game: +16.63% after intervention program, $p < 0.01$). The same results were found for data of the pre- and post-eight-week training period concerning players' mobility in the shoulder (before in-game = +7.06%, $p < 0.05$; after in-game = +10.17%, $p < 0.01$) and wrist (before in-game = +17.67%, $p < 0.05$; after in-game = +12.11, $p > 0.05$) (see Table 5).

Table 4. Comparison of players' perception of motivation and stress pre- and post-intervention program.

Characteristics	Pre		Post		t	p	ES
	M	SD	M	SD			
SMS Intrinsic Scale	46.20	13.01	48.00	16.43	−0.739	0.501	0.330
SMS Integrated Scale	27.00	10.90	25.60	11.08	1.581	0.189	0.707
SMS Identified Scale	14.60	2.61	14.40	3.05	0.250	0.815	0.112
SMS Introjected Scale	15.80	3.70	15.60	3.97	0.408	0.704	0.183
SMS External Scale	16.00	8.60	12.40	6.69	1.857	0.137	0.830
SMS A-motivated Scale	18.60	4.93	17.40	3.91	0.590	0.587	0.264
SMS RAI	38.00	35.23	42.60	34.73	−1.197	0.297	0.536
PMCSQ 2 T	2.02	0.34	2.43	0.58	−2.362	0.077	1.056
PMCSQ 2 E	4.37	0.23	3.70	0.93	1.621	0.180	0.725
TEOSQ T	4.37	0.43	4.32	0.57	0.423	0.694	0.189
TEOSQ E	3.23	0.54	3.27	0.64	−0.145	0.892	0.065
Perceived Stress Scale	21.20	4.97	28.60	4.98	−2.607	0.060	1.166

Note: SMS = Sport Motivation Scale-II; RAI = Relative Autonomy Index; PMCSQ 2 = Perceived Motivational Climate in Sport Questionnaire; TEOSQ = Task and Ego Orientation in Sport Questionnaire; T = task-oriented; E = ego-oriented; M = mean; SD = standard deviation.

Table 5. Changes in players' jumping ability and joint range before and after in-game training pre- and post-intervention programs.

Characteristics	Pre-intervention		Post-intervention		t	p	ES
	M	SD	M	SD			
CMJ_PreIGT_1	30.90	1.95	35.63	5.61	−2.662	0.056	- -
CMJ_PreIGT_2	32.18	3.87	35.34	5.19	−4.708	0.009 **	- -
CMJ_PreIGT_3	32.85	3.81	37.00	5.98	−2.962	0.041 *	- -
CMJ_PreIGT_M	31.98	3.13	35.99	5.56	−3.257	0.031 *	1.457
CMJ_PostIGT_1	29.21	4.54	34.09	6.50	−4.701	0.009 **	- -
CMJ_PostIGT_2	29.82	4.66	33.48	4.51	−7.482	0.002 **	- -
CMJ_PostIGT_3	28.85	3.73	34.90	5.65	−5.865	0.004 **	- -
CMJ_PostIGT_M	29.29	4.24	34.16	5.53	−7.292	0.002 **	3.261
JR_PreIGT_Shoulder	170.00	12.51	182.00	7.87	−4.000	0.016 *	1.789
JR_PreIGT_Wrist	46.40	13.67	54.60	13.05	−4.487	0.011 *	2.001
JR_PostIGT_Shoulder	161.20	10.47	177.60	7.27	−5.304	0.006 **	2.372
JR_PostIGT_Wrist	44.60	16.24	50.00	13.58	−2.502	0.067	1.119

Note: CMJ = counter movement jump test; JR = joint range; PreIGT = pre-in-game training session; PostIGT = post-in-game training session; M = mean; SD = standard deviation. ** = p-value < 0.01; * = p-value < 0.05.

Finally, Table 6 shows the results concerning the players' muscle strength, where a clear increase in the player's strength capacity was observed ($p < 0.05$). The lifted load experienced an increase of 83.56% ($p = 0.000$; ES = 0.949) for the bench press exercise, 105.61% ($p = 000$; ES = 0.940) for deadlift, 133.34% ($p = 0.002$; ES = 0.846) for hip thrust, 82.61% ($p = 0.001$; ES = 0.930) for lat pull down, 97.3% ($p = 0.001$; ES = 0.909) for leg press, 91.67% ($p = 0.001$; ES = 0.906) for overhead press, 173.44% ($p = 0.000$; ES = 0.924) for Pendlay row, and finally, 62.96% ($p = 0.000$; ES = 0.914) for squat.

Table 6. Progression of players' loads during the intervention program.

Exercise	Load Week 1		Load Week 4		Load Week 8		X2	p	ES
	M	SD	M	SD	M	SD		Weeks 1 and 8	
Bench press	22.50	7.16	31.60	7.64	41.30	7.43	34.266	0.000 **	0.949
Deadlift	21.40	6.07	28.00	7.58	44.00	7.42	34.035	0.000 **	0.940
Hip thrust	12.00	2.74	19.00	2.24	28.00	2.74	33.101	0.002 **	0.846
Lat pull down	23.00	4.47	32.00	6.71	42.00	6.71	33.764	0.001 **	0.930
Leg press	37.00	13.96	54.00	19.49	73.00	21.09	33.781	0.001 **	0.909
Overhead press	4.80	1.10	6.50	1.22	9.20	1.10	33.515	0.001 **	0.906
Pendlay row	12.80	6.57	24.00	5.48	35.00	6.12	33.891	0.000 **	0.924
Squat	27.00	2.74	36.00	6.52	44.00	6.75	34.064	0.000 **	0.914

Note: M = mean; SD = standard deviation. ** = p-value < 0.01.

3.3. Effects of the Intervention Program on Performance and Perceived Fatigue during Training

To conclude, the results showed a significant difference between the perception of physical fatigue after the third game before and after the training program (M_{pre} 11.40 ± 3.29 vs. M_{post} 7.60 ± 1.14; $p < 0.05$). On the other hand, no more significant differences were found concerning the perception of physical fatigue pre- and post-training program, despite an evident decrease in the data recorded (Table 7). At the cognitive level, the results showed significant differences after game 2 (M_{pre} 13.60 ± 1.67 vs. M_{post} 9.80 ± 3.11; $p < 0.05$), game 3 (M_{pre} 14.00 ± 2.55 vs. M_{post} 10.40 ± 3.05; $p < 0.05$), and game 6 (M_{pre} 18.40 ± 2.07 vs. M_{post} 12.60 ± 3.36; $p < 0.05$). These data coincide with the comparison on the ROF scale, also showing significant differences after games 2, 3, and 6 (see Table 7).

Table 7. Comparison of players' perceived exertion, fatigue, and performance (physical, cognitive, and overall) after each game pre- and post-intervention program.

Characteristics	Pre		Post		t	*p*	ES
	M	SD	M	SD			
RPE Phy. G1	9.60	2.07	7.20	1.79	2.138	0.099	0.956
RPE Phy. G2	10.60	2.79	7.60	2.07	2.739	0.052	1.225
RPE Phy. G3	11.40	3.29	7.60	1.14	3.283	0.030 *	1.468
RPE Phy. G4	13.00	5.29	8.80	2.28	2.040	0.111	0.912
RPE Phy. G5	13.80	3.90	9.60	2.07	2.064	0.108	0.923
RPE Phy. G6	14.00	4.30	10.60	2.88	1.731	0.159	0.774
RPE Cog. G1	10.40	2.51	9.20	3.03	1.238	0.284	0.554
RPE Cog. G2	13.60	1.67	9.80	3.11	3.919	0.017 *	1.753
RPE Cog. G3	14.00	2.55	10.40	3.05	3.882	0.018 *	1.736
RPE Cog. G4	15.80	3.27	11.20	2.59	2.438	0.071	1.090
RPE Cog. G5	16.40	2.30	12.00	3.08	2.240	0.089	1.002
RPE Cog. G6	18.40	2.07	12.60	3.36	3.127	0.035 *	1.399
ROF Scale G1	3.00	0.71	1.80	1.48	1.809	0.145	0.809
ROF Scale G2	4.60	1.34	2.60	1.82	3.162	0.034 *	1.414
ROF Scale G3	4.40	1.52	2.80	1.64	4.000	0.016 *	1.789
ROF Scale G4	6.40	2.51	3.80	1.64	2.229	0.090	0.997
ROF Scale G5	7.00	1.87	4.40	1.95	2.152	0.098	0.962
ROF Scale G6	8.00	1.58	4.80	2.17	3.301	0.030 *	1.476
RPE general Phy.	12.60	3.85	8.40	2.07	2.298	0.083	1.028
RPE general Cog.	15.60	2.41	10.80	2.77	3.446	0.026 *	1.541
ROF Scale general	6.00	1.41	3.40	1.67	2.804	0.049 *	1.254
Per. Performance Scale	6.20	2.68	7.80	1.09	−1.725	0.160	0.772

Note: RPE = rating of perceived exertion; Phy. = physical; Cog. = cognitive; ROF = rating of fatigue; G = game; M = mean; SD = standard deviation. * = *p*-value < 0.05.

When referring to the overall assessment of the training session, no significant differences were found in the performance perception before and after the intervention program. Similarly, there were also no differences in the players' general physical perceived exertion, despite the improvement reported by the players. However, there were significant differences in players' general cognitive perceived exertion (M_{pre} 15.60 ± 2.41 vs. M_{post} 10.80 ± 2.77; $p < 0.05$) and rate of fatigue, combining physical and cognitive (M_{pre} 6.00 ± 1.41 vs. M_{post} 3.40 ± 1.67; $p < 0.05$) (see Table 7).

4. Discussion

After the analysis of the results, the existence of both physical and mental fatigue in esports players was demonstrated. This demand resulted in a decrease in their muscular capacity, having an impact on their fatigue perception in general terms, as has been previously demonstrated in other studies with other populations [29,62]. On the other hand, when studying the loss of muscle function applied to joint range and jumping ability, it was possible to observe, in both sessions, a decrease in the players' neuromuscular capacity. These losses align with those observed in previous studies applied to samples with similar ergonomic circumstances, such as office workers and surgeons [63,64]. In both cases, these occupations require a large number of hours sitting down to perform physically and mentally demanding tasks in front of a computer, leading to problems associated with muscle decompensation or pathologies located in regions similar to those of esports players.

These localized imbalances in regions most demanded by players, such as the shoulder and wrist areas [12], can eventually lead to more significant pathologies, which could hamper the players' careers, even leading to their retirement [11,14]. Based on this, the present study highlights the importance of healthcare professionals intervening in prevention protocols and the enhancement of pathologies, generally focused on players and, specifically, on the most demanded regions [3]. Additionally, these pathologies and imbalances can result in possible chronic muscular and joint pain, a finding demonstrated when applied to other samples, such as athletes or workers [34,36]. The progression from overuse-related ailments to chronic pathologies is common in populations that do not perform specific prevention protocols and spend long hours in front of the computer [13,14,35]. Based on this, not only is the attention to localized fatigue in esports players shown to be relevant, but also its potential danger of generating chronic pathologies in a young population is very high, considering its parallels with other sectors, such as office workers, requiring specialists to address this issue before it leads to lifelong alterations.

Based on this loss of muscle function after the virtual training session, and apart from the observed improvements in the players' muscle capacity across the eight-week intervention, the results demonstrated that the demands of a professional club training day are capable of having an obvious impact on the players' musculature. However, the data extracted in this research concerning players' fatigue contradict those observed in the study by Thomas et al. [65]. These authors found that after playing three consecutive games of LOL, no changes in fatigue tests were shown in professional players. The possible explanation for these discrepancies could be based on the type of intervention, sessions, and sample selected for the development of this study. Thomas et al. [65] developed their intervention with real players, but in simulated competitive situations. This fact may lead to a lack of change in the players, since within real training sessions, such as those studied in the present study, professional players are affected by different elements, such as competitive stress with high-level opponents, pressure from staff members, and a real and professional club environment that forces the player to perform at the highest level. These factors clearly contribute to an increase in physical and cognitive fatigue [9,17].

On the other hand, when studying the results found for the jumping and joint mobility tests, before and after the application of our intervention program, there was evidence of a reduction in the muscle fatigue affection in the most stressed regions, but without being able to eliminate it completely. Perhaps after this evidence, it would be advisable to increase the duration of the intervention program, or to introduce the addition of muscle unloading programs, as in both cases it would be possible to provoke and/or contribute to the reduction of localized muscle fatigue in repetitive actions in front of the computer [38,66].

As stated by Pourmand et al. [12], the targeting of the gamer's muscle demands on specific regions inevitably leads to an overloading, as well as to an increase in physical and psychological fatigue associated with sitting at the computer for many hours [67]. In this regard, physical exercise might be able to increase the tolerance of the musculature [68], but it seems not to be capable of completely eliminating a loss of muscular capacity when facing such high-incidence fatiguing situations, only achieving a reduction of their impact and a possible modification of the players' perceived exertion that would benefit them during their training sessions [69,70]. These same results have been previously verified in office workers, who have certain parallel professional demands of their work performance as professional video game players, and where the practice of physical exercise causes an increase and improvement in their performance and well-being at work [57,69].

As indicated in these studies, strength exercise protocols, similar to those shown in this research, are effective for improving workers' well-being, which has a direct influence on their job performance, enhancing not only their health but also their productivity [57,69].

Therefore, despite the non-disappearance of the impact of fatigue, the reduction found in this study can similarly cause modifications in the players' perception of well-being that have a specific impact on their perceived health status and their specific performance.

Along the same lines, recent studies have corroborated how physical fatigue directly affects the cognitive level, greatly worsening the subjects' problem-solving capacity [71,72]. In relation to this, when referring to the increase in cognitive fatigue, an associated increase in physical tiredness in office workers can also be observed [73,74]. This evidence of a psycho–physical relationship increases the importance of observing the perception of cognitive fatigue in esports players. An increase in cognitive fatigue could have an effect on the physical state, and vice versa, giving rise to fatigue at a general level that would affect the players' decision-making capacity and well-being perception.

Based on this, the results found in this research allowed us to demonstrate that our intervention program was effective as a method to reduce the players' perception of fatigue, as the data showed a decrease in these values on a cognitive and general level. As a consequence, it could be affirmed that through this type of intervention, it is possible to significantly modify the subjective esports players' perception of general and cognitive fatigue, influencing their physical and psychological state, well-being, and performance. As previous research has shown, the execution of repetitive actions during long working days requires a high level of attention, which causes cognitive fatigue that decreases performance in the activity [71,72,75]. Concerning the esports players, their professional performance requires a high level of concentration in repetitive situations, so the appearance of fatigue at a cognitive level is justified, and the loss of performance associated with this cognitive fatigue is evident.

Furthermore, continuing with the analysis of the players' perceived fatigue, cognitive and general fatigue perception tests decreased significantly after the eight-week intervention program, while those specific to the players' physical perceived fatigue experienced a clear decrease, although not achieving significance. In addition, it should be noted that the differentiation of perceived fatigue into two different scales (physical and psychological) is of great interest, allowing coaches to better understand the workload. In fact, this may allow physical or psychological modifications to be made on an individual basis, leading to more specific and accurate adaptations [76–78]. This specific differentiation of fatigue perception at general, cognitive, and physical levels can be a highly useful tool for the esports environment and its application in professional competitive structures. Through this differentiation, and after the demonstrated connection between the influence of physical and cognitive fatigue [73,74], the accuracy of data collection regarding the daily load on players can be increased.

In this sense, observing high levels of cognitive fatigue and low levels of physical fatigue can lead to modifications that refer to the mental demands of the players, such as their screen time or the complexity of the trainings, without altering the physical aspects. On the other hand, if the highest levels are of physical fatigue and not cognitive, it could imply a modification of the physical training sessions or the posture and furniture used by the player, which can condition their overall performance despite not having a specific cognitive influence.

This information is of great interest for clubs and players, demonstrating that physical exercise is capable of improving the player's perception of well-being, prolonging their physical and cognitive capacity over time and, in this way, preventing possible physical and performance problems. These data are consistent with studies applied to workers, where the ability to maintain their physical and mental well-being determines their work performance and health status [64,69,79]. These studies revealed that physical exercise is a reliable and useful tool for maintaining and developing cognitive capacity, mental health, and muscular function [80]. These assertions have been demonstrated in similar samples to esports players, with high cognitive demands during long periods [15,81]. Furthermore, at the same time, it has been shown to have an indirect effect on the players' feeling of well-being, making them feel better and reporting a lower level of demand [69].

These modifications, found in samples such as office workers, lead to reductions in their risk of pathology and an increase in their well-being that is not limited to a mere temporary improvement. These studies show how the application of training programs based on cardiovascular and strength training, very similar to the one carried out in the present study, have chronic effects on workers, increasing the importance of physical exercise as a fundamental part of the routine of people who work in front of a computer [70,79]. Considering that the benefits found in office workers show a clear parallelism with those discovered in this study applied to esports players, and the intervention protocols are based on the same principles, the possible long-term improvements of physical exercise applied to esports players can imply chronic modifications in the well-being of the players and their most frequent pathologies.

As indicated in various studies from highly relevant publications [11,22], esports players should have specialized medical attention. Similarly, it is noted that interventions should focus on modifying the well-being of the player not only during training or competitions, but also in the long term, extending their professional careers and reducing an injury incidence that, with various pathologies, affects nearly half of the esports players [11,12].

Along the same lines, and pointing to these psychological benefits, it is worth noting that players' perceived fatigue influences their performance and health status in an equivalent or superior way to physical complaints, considering the key importance of cognitive elements in esports performance [3,9]. This statement is consistent with the findings of the present study, where it was shown that the highest values of fatigue were experienced at the cognitive level, compared to the physical, concluding that professional esports is an activity involving high demands on the psycho-cognitive level for players. Therefore, a tool allowing the control of these variables will be a step forward toward achieving sustained performance over time during training sessions, where, as stated in different studies, it can reach between 6 and 10 h a day [10].

The present physical exercise program proved to be effective in reducing the players' perceived fatigue, showing a higher level of well-being during the virtual training sessions (significant differences in game 6 and overall) and maintaining their cognitive level over time. This implies a greater chance of achieving high performance under prolonged situations of high general or cognitive fatigue. An improvement of the subject's performance capacity in the final moments, especially in games 5 and 6, could mean victory in most championships, since the decisive matches in the selected esports modality (LOL) are played to the best of 5 games, being necessary to maintain a high performance during all of them in order to achieve victory [21]. These data are consistent with the study by de Las Heras et al. [8], where the effectiveness of physical exercise as a performance and accuracy enhancer was demonstrated. The relationship between cognitive fatigue and mental performance and problem-solving ability in demanding computer-based activities has been proven as well [74], so its application to esports is justified.

On the other hand, aside from the benefits of improving player well-being at key moments in competition, modifications focused on reducing the impact of fatigue on esports players during training hold specific high relevance in the players' careers. Physical training is capable of modifying performance and precision in the long term not only in office workers, but also in jobs that require a high level of precision, such as surgeons [81]. In this group, improvements from physical exercise result in greater abilities of specialists in long-duration surgical interventions, thereby increasing their capacity to perform and, consequently, to successfully meet the operation's objective.

These improvements are based on preventing fatigue, both physical and mental, from diminishing surgeons' abilities and prolonging a better general state that influences their performance. These adaptations are very similar to those achieved by esports players. The decrease in the impact of fatigue at the final moments of training sessions, as found in this study, not only has an impact on best-of-five competitions but also prolongs an optimal performance state, giving the player the ability to perform at the highest level for longer. These modifications could dramatically increase the quality of the training sessions, providing the player with improvements they would not achieve if, affected by fatigue, their physical and mental capacities diminish as the session progresses.

However, despite experiencing changes in physical and cognitive well-being, our study showed no significant differences in the players' perception of performance, even though there was an increase in their scale of perception. This element is directly conditioned by the demands of the games performed in both training sessions. The present study ensured maximum demand in both data collection sessions, ensuring matches with opponents on similar levels, being facilitated by the LOL algorithms. These algorithms consistently match the player with opponents and teammates of the same level as the player, implying a linearity in the demands of each game [82].

By constantly maintaining a maximum level of demand on the opponents, the players' overall perception of performance is not conditioned by external agents, so the improvement of well-being will probably not influence this performance and competitive demand. The advantage of maintaining an optimal physical and psychological well-being throughout the training is the ability to extend the possibility of performing optimally for more games. This may ensure that the opponents faced can also maintain an equivalent high level for a longer period, increasing the potential improvements of programed training by delaying the presence of higher-ranked opponents over time, without losing the match quality due to the fatigue influence.

This may be the direct reason for the absence of significant changes in motivation and perceived stress data. Therefore, collecting data during a long competitive period and always guaranteeing maximum-intensity opponents may contribute to the maintenance of a constant motivational and stress state in the players. Thus, it may not be modified by the implementation of training programs, such as in this study. In addition, the study by Lopes Angelo et al. [83] stated that the main determinants of the motivational climate in LOL players are the coaches and the competitive level. On this basis, the inclusion of a physical training program, despite its positive and beneficial influence on the health and performance of professional players, may not sufficiently modify parameters such as motivation and stress.

Furthermore, in addition to all the improvements discussed previously the current study also focused on the subjects' physical condition improvement. Thus, it has been demonstrated that an increase in the players' physical capacities contributes to improving their health status and preventing possible pathologies [84].

Therefore, the intervention program proved to have an impact on the players' muscle mass, increasing their lean mass values, basal metabolism, and body water percentage. Additionally, improvements were shown in the players' jumping ability, linked to lower limb strength [85], and a considerable increase in strength capacity in all the exercises used during the intervention. Similarly, improvements were achieved in the joint mobility development. These data demonstrate the efficacy of the intervention protocol as a health-enhancing element for the players, considering that an increase in their muscle mass and strength contributes to their tolerance to daily physical exertion and increases their sense of well-being [52]. It also increases the metabolic rate, being of great interest in contributing to the reduction of obesity associated with video game players [86,87].

Along with the physical benefits, the improved movement ability is associated with an obvious decrease in the risk of injury [34,88], something that is exponentially increasing in association with extended keyboard and mouse use [89]. This reduction is associated with an improvement in the player's immediate state of well-being, but also with a change in their potential risk of pathology, reducing the incidence of injuries among players and potentially extending their sporting careers, as highlighted in previous paragraphs.

In parallel to the players' physical improvements, changes in the body composition also influence the psychological well-being, increasing their self-esteem and decreasing their propensity to suffer psychological pathologies [90], being very common in esports players [91]. In fact, related to self-esteem, we found another factor: the perception of support. Various studies indicate that society views playing video games as a harmful activity for people, generating unhealthy life habits [86]. Based on this, esports players perceive a low level of general societal support, finding support only among their teammates and other players [92]. These perceived support issues are compounded by insecurities associated with the high public exposure they face during competitions, which have audiences in the millions and expose players in live competitions [93]. The combination of perceived lack of social support and media exposure makes pathologies associated with insecurities very common in the esports environment [91].

Regarding the approach to these issues, these pathologies can be treated from a psychological perspective, but sports sciences have also proven to be an effective agent in improving players' perceptions [90]. Physical exercise has the capacity to directly mediate the psychological elements very common in esports, such as stress and anxiety [94]. This improvement could also influence their subjective perception and improve their mental well-being [90].

Finally, despite the validity demonstrated in this study of physical training for improving players' health and reducing perceived fatigue, the findings should be extrapolated with caution. The possibility of applying intervention programs longitudinally in professional teams is very limited, even more difficult considering the existing number of professional teams. However, precisely for this reason, studies applied to this special sample are crucial [22], since to achieve any result, even by using a very small sample, implies a major breakthrough.

The emergence of studies demonstrating that the application of physical exercise programs can modify the health and performance of esports players represents a significant advancement for the sector, which is undergoing rapid professionalization [5,9]. The esports environment aims to evolve by learning from other competitive methodologies, such as traditional sports, attempting to adopt their positive aspects, such as their structure and exploitation resources, without falling into the issues associated with overexposure and exploitation of players to unhealthy extents [3].

Accordingly, studies showing that the application of physical exercise should be a fundamental part of the routine of a professional esports club represent a significant step forward for the sector. It is beginning to be understood that the keys to players' performance are not solely in the hours spent gaming, but also in other factors, such as rest, physical exercise, and psychological therapy [9]. Similarly, demonstrating with data that physical exercise is a determinant of the health and performance of professional players allows health professionals to have a justification for the application of programs in professional teams. Clubs can often be reluctant to understand the importance of physical activity in esports players and may need objective data to be persuaded and flexible in their implementation. Thus, this study provides a basis for justifying the need to implement these programs in professional structures, which must increase in number and quality to generate knowledge so extensive that it leaves no doubt among esports clubs.

Lastly, it should be noted that this study was applied to a sample of professional LOL players, and not to a sample of players from different disciplines. However, considering the similarities in the characteristics of training in the professional esports environment, the data regarding fatigue indices recorded in virtual training sessions could be extrapolated to other major references in the competitive esports scene, such as Counter-Strike and Valorant [2].

These video games, despite having evident differences in the specific requirements of the players, are played with the same equipment (a computer and peripherals identical to those used in LOL) and have typical structures in their virtual training sessions very similar to those studied in this investigation [4]. Therefore, considering the existing similarities, the application of the intervention program proposed in this study could be transferred to these video games with a potential positive effect on players. However, it is noted that the application of intervention programs in professional esports samples must evolve, covering not only LOL players, as in the study by de las Heras et al. [8] or this study, but also encompassing other modalities that provide greater breadth to the conclusions drawn.

Video games, such as those mentioned previously, have variations in competitive rhythms and different demands, such as higher requirements for attention and precision compared to other skills unique to LOL, such as specific mechanics [95]. These characteristics cause modifications in their particularities that can affect the application of the strategies and require specific studies for these samples.

5. Conclusions

To our knowledge, this is the first study to develop an intervention program focused on fatigue management, performance improvement, and health-related variables' maintenance in professional esports players.

The findings of this ground-breaking study provide new and relevant information on the role of fatigue in professional esports players' performance and well-being. The evident loss of muscle function and the increased perception of fatigue caused by virtual training pointed out the demands placed on esports players. These demands require the application of intervention programs capable of reducing the fatigue impact, mainly to increase the players' optimal performance state and the injury/pathologies prevention.

Through the inclusion of an intervention program, such as the one described in this study, it has been demonstrated that physical exercise is capable of reducing the general and cognitive fatigue perceived during a virtual training session in professional esports players, increasing their ability to perform at the highest level until the last game, thus increasing their potential competitive performance. Similarly, it has been shown that a program of these characteristics is capable of influencing the players' health status, increasing their muscular capacity, and thus reducing their risk of suffering from various physical and psychological pathologies.

This contribution could be highly relevant, pointing positively to the implementation of physical training intervention programs in professional esports players, adapted to the needs and particularities of this activity. Based on the conclusions reached in this study, clubs will be empowered to implement physical exercise as part of the training routine of a professional esports team, obtaining the improvements described in the results and contributing to both the players' performance and life quality.

6. Limitations

This study presents limitations that must be taken into consideration by the authors. Firstly, the small sample size of players participating in the research is noted. However, despite being a sample of only 5 players, only 10 professional teams are enrolled in the national first division of LOL, which implies a total of 50 players at this level of demand. Based on this, a sample of five players from such a limited pool of players can be considered representative of the population. Similarly, the difficulty in accessing professional samples for conducting intervention methodologies is very high, being almost non-existent in current publications. Therefore, any study applied to professional samples represents a significant advance in the science applied to the esports sector.

It is also noted that the intervention methodology was based on a LOL team, finding specific benefits in this type of sample, which may not be successfully extrapolated to any professional competitive video game.

Consequently, it would be very interesting to continue the study of professional esports players, applying methodologies oriented toward their health and performance. Future research is essential to build upon the findings of this study, enhancing our understanding of this field. This entails not only prolonging the duration of the intervention programs to better assess their long-term effects, but also applying these programs across various teams and players in different competitive video games.

Author Contributions: Conceptualization, M.S.-M., L.M.M.-A. and G.M.G.-G.; methodology, M.S.-M., L.M.M.-A. and G.M.G.-G.; validation, M.S.-M., L.M.M.-A. and G.M.G.-G.; formal analysis, G.M.G.-G.; investigation, M.S.-M., L.M.M.-A. and G.M.G.-G.; resources, M.S.-M., L.M.M.-A. and G.M.G.-G.; data curation, G.M.G.-G.; writing—original draft preparation, M.S.-M., L.M.M.-A. and G.M.G.-G.; writing—review and editing, M.S.-M., L.M.M.-A. and G.M.G.-G.; visualization, M.S.-M., L.M.M.-A. and G.M.G.-G.; supervision, L.M.M.-A. and G.M.G.-G.; project administration, L.M.M.-A. and G.M.G.-G. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The study was conducted in accordance with the ethical principles of the Helsinki declaration for research involving human subjects (World Medical Association) and was approved by the institutional review board of the Catholic University of Murcia (code: CE052209; approval date 27 May 2022).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The raw data supporting the conclusions of this article will be made available by the corresponding or last authors of the manuscript on request.

Acknowledgments: The authors would like to thank the staff and all the players who took part in this study.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Activate Consulting. Activate Technology & Media Outlook. 2023. Available online: https://www.activate.com/insights (accessed on 18 December 2023).
2. Newzoo Global Games Market Report. 2023. Available online: https://newzoo.com/games-market-reports-forecasts (accessed on 18 December 2023).
3. Jenny, S.E.; Manning, R.D.; Keiper, M.C.; Olrich, T.W. Virtual(ly) Athletes: Where eSports Fit Within the Definition of "Sport". *Quest* **2017**, *69*, 1–18. [CrossRef]
4. Cranmer, E.E.; Han, D.I.D.; van Gisbergen, M.; Jung, T. Esports matrix: Structuring the esports research agenda. *Comput. Hum. Behav.* **2021**, *117*, 106671. [CrossRef]
5. Giakoni-Ramírez, F.; Merellano-Navarro, E.; Duclos-Bastías, D. Professional Esports Players: Motivation and Physical Activity Levels. *Int. J. Environ. Res. Public Health* **2022**, *19*, 2256. [CrossRef]
6. Popov, T. The Most Popular Teams of League of Legends Summer Splits in 2021. Esports Charts. 2021. Available online: https://escharts.com/blog/most-popular-teams-summer-split-2021 (accessed on 8 January 2024).
7. Poulus, D.R.; Coulter, T.J.; Trotter, M.G.; Polman, R. A qualitative analysis of the perceived determinants of success in elite esports athletes. *J. Sports Sci.* **2022**, *40*, 742–753. [CrossRef]
8. de Las Heras, B.; Li, O.; Rodrigues, L.; Nepveu, J.-F.; Roig, M. Exercise Improves Video Game Performance. *Med. Sci. Sports Exerc.* **2020**, *52*, 1595–1602. [CrossRef]
9. Sanz-Matesanz, M.; Gea-García, G.M.; Martínez-Aranda, L.M. Physical and psychological factors related to player's health and performance in esports: A scoping review. *Comput. Hum. Behav.* **2023**, *143*, 107698. [CrossRef]
10. Lee, S.; Bonnar, D.; Roane, B.; Gradisar, M.; Dunican, I.C.; Lastella, M.; Maisey, G.; Suh, S. Sleep characteristics and mood of professional esports athletes: A multi-national study. *Int. J. Environ. Res. Public Health* **2021**, *18*, 664. [CrossRef] [PubMed]
11. Difrancisco-Donoghue, J.; Balentine, J.; Schmidt, G.; Zwibel, H. Managing the health of the eSport athlete: An integrated health management model. *BMJ Open Sport. Exerc. Med.* **2019**, *5*, e000467. [CrossRef] [PubMed]
12. Pourmand, A.; Lombardi, K.; Kuhl, E.; O'Connell, F. Videogame-Related Illness and Injury: A Review of the Literature and Predictions for Pokémon GO! *Games Health J.* **2017**, *6*, 9–18. [CrossRef] [PubMed]
13. Gram, B.; Andersen, C.; Zebis, M.K.; Bredahl, T.; Pedersen, M.; Mortensen, O.; Jensen, R.H.; Andersen, L.L.; Sjogaard, G. Effect of training supervision on effectiveness of strength training for reducing neck/shoulder pain and headache in office workers: Cluster randomized controlled trial. *Biomed. Res. Int.* **2014**, *2014*, 693013. [CrossRef]
14. Andersen, L.L.; Saervoll, C.A.; Mortensen, O.S.; Poulsen, O.M.; Hannerz, H.; Zebis, M.K. Effectiveness of small daily amounts of progressive resistance training for frequent neck/shoulder pain: Randomised controlled trial. *Pain* **2011**, *152*, 440–446. [PubMed]
15. Wilke, J.; Giesche, F.; Klier, K.; Vogt, L.; Herrmann, E.; Banzer, W. Acute Effects of Resistance Exercise on Cognitive Function in Healthy Adults: A Systematic Review with Multilevel Meta-Analysis. *Sport. Med.* **2019**, *49*, 905–916. [CrossRef]
16. Bányai, F.; Griffiths, M.D.; Király, O.; Demetrovics, Z. The Psychology of Esports: A Systematic Literature Review. *J. Gambl. Stud.* **2019**, *35*, 351–365. [CrossRef] [PubMed]
17. Leis, O.; Lautenbach, F. Psychological and physiological stress in non-competitive and competitive esports settings: A systematic review. *Psychol. Sport. Exerc.* **2020**, *51*, 101738. [CrossRef]

18. Mendoza, G.; Clemente-Suárez, V.J.; Alvero-Cruz, J.R.; Rivilla, I.; García-Romero, J.; Fernández-Navas, M.; Carrillo de Albornoz-Gil, M.; Jiménez, M. The role of experience, perceived match importance, and anxiety on cortisol response in an official esports competition. *Int. J. Environ. Res. Public. Health* **2021**, *18*, 2893. [CrossRef] [PubMed]
19. Wattanapisit, A.; Wattanapisit, S.; Wongsiri, S. Public Health Perspectives on eSports. *Public. Health Rep.* **2020**, *135*, 295–298. [PubMed]
20. Taylor, K.; Chapman, D.; Cronin, J.; Newton, M.; Gill, N. Fatigue Monitoring in High Performance Sport. *J. Aust. Strength. Cond.* **2012**, *20*, 12–23.
21. George, J.; Sherrick, B. Competition Formats in Esports. In *Understanding Esports: An Introduction to the Global Phenomenon*; Rowman & Littlefield: Lanham, MD, USA, 2019; pp. 45–56.
22. Pluss, M.A.; Bennett, K.J.M.; Novak, A.R.; Panchuk, D.; Coutts, A.J.; Fransen, J. Esports: The chess of the 21st century. *Front. Psychol.* **2019**, *10*, 431830. [CrossRef] [PubMed]
23. Faul, F.; Erdfelder, E.; Lang, A.G.; Buchner, A. G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behav. Res. Methods* **2007**, *39*, 175–191. [CrossRef]
24. Teisala, T.; Mutikainen, S.; Tolvanen, A.; Rottensteiner, M.; Leskinen, T.; Kaprio, J.; Kolehmainen, M.; Rusko, H.; Kujala, U.M. Associations of physical activity, fitness, and body composition with heart rate variability-based indicators of stress and recovery on workdays: A cross-sectional study. *J. Occup. Med. Toxicol.* **2014**, *9*, 16. [CrossRef]
25. Esparza-Ros, F.; Vaquero-Cristóbal, R.; Marfell-Jones, M. *International Standards for Anthropometric Assessment*; International Society for the Advancement of Kinanthropometry (ISAK): Glasgow, UK, 2019.
26. Elsworthy, N.R.; Blair, M.; Lastella, M. On-field movements, heart rate responses and perceived exertion of lead referees in Rugby World Cup matches, 2019. *J. Sci. Med. Sport* **2021**, *24*, 386–390. [CrossRef]
27. Gilgen-Ammann, R.; Schweizer, T.; Wyss, T. RR interval signal quality of a heart rate monitor and an ECG Holter at rest and during exercise. *Eur. J. Appl. Physiol.* **2019**, *119*, 1525–1532. [CrossRef]
28. Hughes, S.; Chapman, D.W.; Haff, G.G.; Nimphius, S. The use of a functional test battery as a noninvasive method of fatigue assessment. *PLoS ONE* **2019**, *14*, e0212870. [CrossRef] [PubMed]
29. Jiménez-Reyes, P.; Pareja-Blanco, F.; Cuadrado-Peñafiel, V.; Ortega-Becerra, M.; Párraga, J.; González-Badillo, J.J. Jump height loss as an indicator of fatigue during sprint training. *J. Sports Sci.* **2019**, *37*, 1029–1037. [CrossRef]
30. Balsalobre-Fernańdez, C.; Tejero-Gonzaĺez, C.M.; Del Campo-Vecino, J. Relationships between training load, salivary cortisol responses and performance during season training in middle and long distance runners. *PLoS ONE* **2014**, *9*, e106066. [CrossRef]
31. Samozino, P.; Rejc, E.; Di Prampero, P.E.; Belli, A.; Morin, J.B. Optimal force-velocity profile in ballistic movements-Altius: Citius or Fortius? *Med. Sci. Sports Exerc.* **2012**, *44*, 313–322. [CrossRef]
32. Brooks, E.R.; Benson, A.C.; Bruce, L.M. Novel technologies found to be valid and reliable for the measurement of vertical jump height with jump-and-reach testing. *J. Strength. Cond. Res.* **2018**, *32*, 2838–2845. [CrossRef]
33. Gallardo-Fuentes, F.; Gallardo-Fuentes, J.; Ramírez-Campillo, R.; Balsalobre-Fernández, C.; Martínez, C.; Caniuqueo, A.; Cañas, R.; Banzer, W.; Loturco, I.; Nakamura, F.Y.; et al. Intersession and intrasession reliability and validity of the my jump app for measuring different jump actions in trained male and female athletes. *J. Strength. Cond. Res.* **2016**, *30*, 2049–2056. [CrossRef] [PubMed]
34. Matthews, M.J.; Green, D.; Matthews, H.; Swanwick, E. The effects of swimming fatigue on shoulder strength, range of motion, joint control, and performance in swimmers. *Phys. Ther. Sport.* **2017**, *23*, 118–122. [CrossRef] [PubMed]
35. Bullock, M.P.; Foster, N.E.; Wright, C.C. Shoulder impingement: The effect of sitting posture on shoulder pain and range of motion. *Man. Ther.* **2005**, *10*, 28–37. [CrossRef]
36. Nizamis, K.; Rijken, N.H.M.; Mendes, A.; Janssen, M.M.H.P.; Bergsma, A.; Koopman, B.F.J.M. A novel setup and protocol to measure the range of motion of the wrist and the hand. *Sensors* **2018**, *18*, 3230. [CrossRef]
37. Wellmon, R.H.; Gulick, D.T.; Paterson, M.L.; Gulick, C.N. Validity and reliability of 2 goniometric mobile apps: Device, application, and examiner factors. *J. Sport. Rehabil.* **2016**, *25*, 371–379. [CrossRef] [PubMed]
38. Monteiro, E.R.; Costa, P.B.; Correa-Neto, V.G.; Hoogenboom, B.J.; Steele, J.; Da Silva-Novaes, J. Posterios thigh foam rolling increases knee extension fatigue and passive shoulder range-of-motion. *J. Strength. Cond. Res.* **2019**, *33*, 987–994. [CrossRef]
39. Tibana, R.; de Sousa, N.; Cunha, G.; Prestes, J.; Fett, C.; Gabbett, T.; Azevedo-Voltarelli, F. Validity of Session Rating Perceived Exertion Method for Quantifying Internal Training Load during High-Intensity Functional Training. *Sports* **2018**, *6*, 68. [CrossRef]
40. Foster, C.; Florhaug, J.A.; Franklin, J.; Gottschall, L.; Hrovatin, L.A.; Parker, S.; Doleshal, P.; Dodge, C. A New Approach to Monitoring Exercise Training. *J. Strength. Cond. Res.* **2001**, *15*, 109–115.
41. Haddad, M.; Stylianides, G.; Djaoui, L.; Dellal, A.; Chamari, K. Session-RPE method for training load monitoring: Validity, ecological usefulness, and influencing factors. *Front. Neurosci.* **2017**, *11*, 612. [CrossRef]
42. Borg, G. *Borg's Perceived Exertion and Pain Scales*; Human Kinetics: Champaign, IL, USA, 1998.
43. Christodoulou, C. *The Assessment and Measurement of Fatigue. Fatigue as a Window to the Brain*; The MIT Press: Cambridge, MA, USA, 2005; pp. 19–35.
44. Micklewright, D.; St Clair-Gibson, A.; Gladwell, V.; Al Salman, A. Development and Validity of the Rating-of-Fatigue Scale. *Sport. Med.* **2017**, *47*, 2375–2393. [CrossRef] [PubMed]

45. Zurita-Ortega, F.; Castro-Sánchez, M.; Chacón-Cuberos, R.; Cachón-Zagalaz, J.; Cofré-Bolados, C.; Knox, E.; Muros, J.J. Analysis of the psychometric properties of Perceived Motivational Climate in Sport Questionnaire and its relationship to physical activity and gender using structural equation modelling. *Sustainability* **2018**, *10*, 632. [CrossRef]
46. Duda, J.L. Relationship between Task and Ego Orientation and the Perceived Purpose of Sport among High School Athletes. *J. Sport. Exerc. Psychol.* **1989**, *11*, 318–335. [CrossRef]
47. Clancy, R.B.; Herring, M.P.; Campbell, M.J. Motivation measures in sport: A critical review and bibliometric analysis. *Front. Psychol.* **2017**, *8*, 1–12. [CrossRef]
48. Gathmann, B.; Schulte, F.P.; Maderwald, S.; Pawlikowski, M.; Starcke, K.; Schäfer, L.C.; Schöler, T.; Wolf, O.T.; Brand, M. Stress and decision making: Neural correlates of the interaction between stress, executive functions, and decision making under risk. *Exp. Brain Res.* **2014**, *232*, 957–973. [CrossRef] [PubMed]
49. Cohen, S.; Kamarck, T.; Mermelstein, R. A global measure of perceived stress. *J. Health Soc. Behav.* **1983**, *24*, 385–396. [CrossRef] [PubMed]
50. Lee, E.H. Review of the psychometric evidence of the perceived stress scale. *Asian Nurs. Res.* **2012**, *6*, 121–127. [CrossRef]
51. Zourdos, M.C.; Klemp, A.; Dolan, C.; Quiles, J.M.; Schau, K.A.; Jo, E.; Helms, E.; Esgro, B.; Duncan, S.; García-Merino, S.; et al. Novel Resistance Training-Specific Rating of Perceived Exertion Scale Measuring Repetitions in Reserve. *J. Strength. Cond. Res.* **2016**, *30*, 267–275. [CrossRef] [PubMed]
52. Graham, T.; Cleather, D.J. Autoregulation by "Repetitions in Reserve" Leads to Greater Improvements in Strength Over a 12-Week Training Program Than Fixed Loading. *J. Strength. Cond. Res.* **2021**, *35*, 2451–2456. [CrossRef]
53. Ormsbee, M.J.; Carzoli, J.P.; Klemp, A.; Allman, B.R.; Zourdos, M.C.; Kim, J.S.; Panton, L.B. Efficacy of the repetitions in reserve-based rating of perceived exertion for the bench press in experienced and novice benchers. *J. Strength. Cond. Res.* **2019**, *33*, 337–345. [CrossRef]
54. Ratamess, N.A.; Alvar, B.A.; Evetoch, T.K.; Housh, T.J.; Ben Kibler, W.; Kraemer, W.J. Progression models in resistance training for healthy adults. *Med. Sci. Sports Exerc.* **2009**, *41*, 687–708.
55. Garber, C.E.; Blissmer, B.; Deschenes, M.R.; Franklin, B.A.; Lamonte, M.J.; Lee, I.M.; Nieman, D.C.; Swain, D.P. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: Guidance for prescribing exercise. *Med. Sci. Sports Exerc.* **2011**, *43*, 1334–1359. [CrossRef]
56. Stubbs, B.; Vancampfort, D.; Rosenbaum, S.; Firth, J.; Cosco, T.; Veronese, N.; Salum, G.A.; Schuch, F.B. An examination of the anxiolytic effects of exercise for people with anxiety and stress-related disorders: A meta-analysis. *Psychiatry Res.* **2017**, *249*, 102–108. [CrossRef]
57. Santos, H.G.; Chiavegato, L.D.; Valentim, D.P.; da Silva, P.R.; Padula, R.S. Resistance training program for fatigue management in the workplace: Exercise protocol in a cluster randomized controlled trial. *BMC Public Health* **2016**, *16*, 1218. [CrossRef]
58. Sundstrup, E.; Jakobsen, M.D.; Andersen, C.H.; Jay, K.; Persson, R.; Aagaard, P.; Andersen, L.L. Effect of Two Contrasting Interventions on Upper Limb Chronic Pain and Disability: A Randomized Controlled Trial. *Pain. Physician* **2014**, *17*, 145–154. [CrossRef] [PubMed]
59. Helms, E.R.; Cronin, J.; Storey, A.; Zourdos, M.C. Application of the Repetitions in ReserveBased Rating of Perceived Exertion Scale for Resistance Training. *Strength. Cond. J.* **2016**, *38*, 42–49. [CrossRef]
60. Gunnarsson, T.P.; Bangsbo, J. The 10-20-30 training concept improves performance and health profile in moderately trained runners. *J. Appl. Physiol.* **2012**, *113*, 16–24. [CrossRef] [PubMed]
61. Tomczak, M.; Tomczak, E. The need to report effect size estimates revisited. An overview of some recommended measures of effect size. *Trends Sport Sci.* **2014**, *1*, 19–25.
62. Constantin-Teodosiu, D.; Constantin, D. Molecular mechanisms of muscle fatigue. *Int. J. Mol. Sci.* **2021**, *22*, 11587. [CrossRef] [PubMed]
63. Thompson, B.J.; Stock, M.S.; Banuelas, V.K. Effects of Accumulating Work Shifts on Performance-Based Fatigue Using Multiple Strength Measurements in Day and Night Shift Nurses and Aides. *Hum. Factors* **2017**, *59*, 346–356. [CrossRef]
64. Gerodimos, V.; Karatrantou, K.; Papazeti, K.; Batatolis, C.; Krommidas, C. Workplace exercise program in a hospital environment: An effective strategy for the promotion of employees physical and mental health. A randomized controlled study. *Int. Arch. Occup. Environ. Health* **2022**, *95*, 1491–1500. [CrossRef] [PubMed]
65. Thomas, C.J.; Rothschild, J.; Earnest, C.P.; Blaisdell, A. The Effects of Energy Drink Consumption on Cognitive and Physical Performance in Elite League of Legends Players. *Sports* **2019**, *7*, 196. [CrossRef]
66. Galeoto, G.; Sansoni, J.; Valenti, D.; Mollica, R.; Valente, D.; Parente, M.; Servadio, A. The effect of physiotherapy on fatigue and physical functioning in chronic fatigue syndrome patients: A systematic review. *Clin. Ter.* **2018**, *169*, 184–188.
67. Kar, G.; Hedge, A. Effects of a sit-stand-walk intervention on musculoskeletal discomfort, productivity, and perceived physical and mental fatigue, for computer-based work. *Int. J. Ind. Ergon.* **2020**, *78*, 102983. [CrossRef]
68. Ament, W.; Verkerke, G.J. Exercise and Fatigue. *Sport. Med.* **2009**, *39*, 389–422. [CrossRef] [PubMed]
69. Bretland, R.J.; Thorsteinsson, E.B. Reducing workplace burnout: The relative benefits of cardiovascular and resistance exercise. *PeerJ* **2015**, *3*, e891. [CrossRef] [PubMed]
70. Sundstrup, E.; Jakobsen, M.D.; Brandt, M.; Jay, K.; Persson, R.; Aagaard, P.; Andersen, L.L. Workplace strength training prevents deterioration of work ability among workers with chronic pain and work disability: A randomized controlled trial. *Scand. J. Work. Environ. Health* **2014**, *40*, 244–251. [CrossRef] [PubMed]

71. Stephenson, M.L.; Ostrander, A.G.; Norasi, H.; Dorneich, M.C. Shoulder Muscular Fatigue From Static Posture Concurrently Reduces Cognitive Attentional Resources. *Hum. Factors* **2020**, *62*, 589–602. [CrossRef] [PubMed]
72. Smith, M.; Sharpe, B.; Arumuham, A.; Birch, P. Examining the Predictors of Mental Ill Health in Esport Competitors. *Healthcare* **2022**, *10*, 626. [CrossRef] [PubMed]
73. Baker, R.; Coenen, P.; Howie, E.; Lee, J.; Williamson, A.; Straker, L. A detailed description of the short-term musculoskeletal and cognitive effects of prolonged standing for office computer work. *Ergonomics* **2018**, *61*, 877–890. [CrossRef] [PubMed]
74. Baker, R.; Coenen, P.; Howie, E.; Lee, J.; Williamson, A.; Straker, L. The Short Term Musculoskeletal and Cognitive Effects of Prolonged Sitting During Office Computer Work. *Int. J. Environ. Res. Public. Health* **2018**, *15*, 1678. [CrossRef] [PubMed]
75. Ma, J.; Gu, J.; Jia, H.; Yao, Z.; Chang, R. The relationship between drivers' cognitive fatigue and speed variability during monotonous daytime driving. *Front. Psychol.* **2018**, *9*, 459. [CrossRef]
76. Vanrenterghem, J.; Nedergaard, N.J.; Robinson, M.A.; Drust, B. Training Load Monitoring in Team Sports: A Novel Framework Separating Physiological and Biomechanical Load-Adaptation Pathways. *Sports Med.* **2017**, *47*, 2135–2142. [CrossRef]
77. Weston, M.; Siegler, J.; Bahnert, A.; McBrien, J.; Lovell, R. The application of differential ratings of perceived exertion to Australian Football League matches. *J. Sci. Med. Sport.* **2015**, *18*, 704–708. [CrossRef]
78. McLaren, S.J.; Taylor, J.M.; Macpherson, T.W.; Spears, I.R.; Weston, M. Systematic reductions in differential ratings of perceived exertion across a 2-week repeated-sprint-training intervention that improved soccer players' high-speed-running abilities. *Int. J. Sports Physiol. Perform.* **2020**, *15*, 1414–1421. [CrossRef]
79. McDonald, A.C.; Mulla, D.M.; Keir, P.J. Muscular and kinematic adaptations to fatiguing repetitive upper extremity work. *Appl. Ergon.* **2019**, *75*, 250–256. [CrossRef] [PubMed]
80. Taieb-Maimon, M.; Cwikel, J.; Shapira, B.; Orenstein, I. The effectiveness of a training method using self-modeling webcam photos for reducing musculoskeletal risk among office workers using computers. *Appl. Ergon.* **2012**, *43*, 376–385. [CrossRef] [PubMed]
81. Parry, D.A.; Oeppen, R.S.; Amin, M.S.A.; Brennan, P.A. Could exercise improve mental health and cognitive skills for surgeons and other healthcare professionals? *Br. J. Oral. Maxillofac. Surg.* **2018**, *56*, 367–370. [CrossRef] [PubMed]
82. Hulaj, R.; Nyström, M.B.T.; Sörman, D.E.; Backlund, C.; Röhlcke, S.; Jonsson, B. A Motivational Model Explaining Performance in Video Games. *Front. Psychol.* **2020**, *11*, 1510. [CrossRef] [PubMed]
83. Lopes-Angelo, D.; Junior, M.V.B.; de Freitas-Corrêa, M.; Souza, V.H.; de Paula-Moura, L.; de Oliveira, R.; Reyes-Bossio, M.; Ferreira-Brandao, M.R. Basic Psychological Need Satisfaction and Thwarting: A Study with Brazilian Professional Players of League of Legends. *Sustainability* **2022**, *14*, 1701. [CrossRef]
84. Baiamonte, B.A.; Kraemer, R.R.; Chabreck, C.N.; Reynolds, M.L.; McCaleb, K.M.; Shaheen, G.L.; Hollander, D.B. Exercise-induced hypoalgesia: Pain tolerance, preference and tolerance for exercise intensity, and physiological correlates following dynamic circuit resistance exercise. *J. Sports Sci.* **2017**, *35*, 1831–1837. [CrossRef] [PubMed]
85. Nuzzo, J.L.; Mcbride, J.M.; Cormie, P.; Mccaulley, G.O. Relationship between countermovement jump performance and multijoint isometric and dynamic tests of strength. *J. Strength. Cond. Res.* **2008**, *22*, 699–707. [CrossRef]
86. Kohorst, M.A.; Warad, D.M.; Nageswara-Rao, A.A.; Rodriguez, V. Obesity, sedentary lifestyle, and video games: The new thrombophilia cocktail in adolescents. *Pediatr. Blood Cancer* **2018**, *65*, e27041. [CrossRef]
87. Kracht, C.L.; Joseph, E.D.; Staiano, A.E. Video Games, Obesity, and Children. *Curr. Obes. Rep.* **2020**, *9*, 1–14. [CrossRef]
88. Chopp-Hurley, J.N.; O'Neill, J.M.; McDonald, A.C.; Maciukiewicz, J.M.; Dickerson, C.R. Fatigue-induced glenohumeral and scapulothoracic kinematic variability: Implications for subacromial space reduction. *J. Electromyogr. Kinesiol.* **2016**, *29*, 55–63. [CrossRef] [PubMed]
89. Baker, N.A.; Cidboy, E.L. The effect of three alternative keyboard designs on forearm pronation, wrist extension, and ulnar deviation: A meta-analysis. *Am. J. Occup. Ther.* **2006**, *60*, 40–49. [CrossRef] [PubMed]
90. Mahoney, J.W.; Gucciardi, D.F.; Ntoumanis, N.; Mallet, C.J. Mental toughness in sport: Motivational antecedents and associations with performance and psychological health. *J. Sport. Exerc. Psychol.* **2014**, *36*, 281–292. [CrossRef] [PubMed]
91. Andre, T.L.; Walsh, S.M.; Valladao, S.; Cox, D. Physiological and Perceptual Response to a Live Collegiate Esports Tournament. *Int. J. Exerc. Sci.* **2020**, *13*, 1418–1429. [PubMed]
92. Freeman, G.; Wohn, D.Y. Social support in eSports: Building emotional and esteem support from instrumental support interactions in a highly competitive environment. In Proceedings of the Annual Symposium on Computer-Human Interaction in Play, Amsterdam, The Netherlands, 15–18 October 2017; pp. 435–447.
93. Reitman, J.G.; Anderson-Coto, M.J.; Wu, M.; Lee, J.S.; Steinkuehler, C. Esports research: A literature review. *Games Cult.* **2020**, *15*, 32–50. [CrossRef]
94. Landrigan, J.F.; Bell, T.; Crowe, M.; Clay, O.J.; Mirman, D. Lifting cognition: A meta-analysis of effects of resistance exercise on cognition. *Psychol. Res.* **2020**, *84*, 1167–1183. [CrossRef]
95. Nagorsky, E.; Wiemeyer, J. The structure of performance and training in esports. *PLoS ONE* **2020**, *15*, e0237584. [CrossRef]