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Impact of eSports semiprofessional practice on the trunk stabilizer muscle complex. A cross-sectional study

Introduction

In the last few years, a new sporting discipline has emerged, changing the paradigm of the world of sports. ESports are described as a form of activity consisting in playing videogames in organized competitions with an audience (Kocak, 2022). Currently, eSport teams have large numbers of enthusiasts. Audience numbers of some of the eSport finals have reached, or even exceeded, the levels of traditional sports (Kane & Spradley, 2017). This leads to great interest in sponsoring and therefore, huge investments that promote the professionalization of the sector (Emara et al., 2020).

The International Olympic Committee stated in 2017 that eSports were declared a sport activity, as their players were trained and prepared at an equal intensity as the one reached by traditional athletes (Cristòfol, Martínez-Ruiz, Román-Navas, & Cristófol-Rodríguez, 2020; Yamagata, Yamagata, & Abela, 2022). In order to achieve maximum performance, eSports teams maintain precompetition training schedules ranging from 5.5 to 10 h/day, performing an average number of 600 movements per minute on the mouse–keyboard complex while maintaining a sitting position (DiFrancisco-Donoghue, Balentine, Schmidt, & Zwibel, 2019).

Due to this challenging training schedule, specific sport-related conditions are beginning to make their appearance. Some authors focus on the impact of sedentarism on the cardiovascular system of this young population (Yamagata et al., 2022; Zwibel, DiFrancisco-Donoghue, DeFeo, & Yao, 2019). Psychological conditions have also been addressed in the scientific literature, reporting stress, anxiety and sleep disorders (Bányai, Griffiths, Demetrovics, & Király, 2019; Bányai, Griffiths, Király, & Demetrovics, 2019; Moen, Vatn, Olsen, Haugan, & Skalicka, 2021; Schmidt, Gnam, Kopf, Rathgeber, & Woll, 2020; Smith, Sharpe, Arumuham, & Birch, 2022; ValladÃo, Middleton, & Andre, 2020). Regarding musculoskeletal injuries, scientific literature in the field is still scarce, mainly due to the novelty of the activity. However, there are some studies reporting a pattern of injuries similar to that of office workers, where long hours in a sitting position, repetitive movements and sedentarism are common (Pereira, Brito, Figueiredo, & Verhagen, 2019). Several authors reported in their findings that low back pain (LBP) was a prevalent condition in this population (DiFrancisco-Donoghue & Balentine, 2018; Lindberg et al., 2020; Takakura et al., 2020).

LBP is associated, amongst many other factors, with sedentarism and a sitting position (Bontrup et al., 2019). Morphologic alterations of the trunk muscles in subjects affected with chronic LBP have been described by many authors (Kiesel, Underwood, Mattacola, Nitz, & Malone, 2007; Pulkovski et al., 2012; Sutherlin et al., 2018). Specifically, changes in function and cross sectional area (CSA) of the Lumbar Multifidus (LMult) (Wallwork, Stanton, Freke, & Hides, 2009), Transversus abdominis (TrAb) (Miura et al., 2014) and Internal Oblique (IO) (Hides et al., 2009) muscle morphology has been reported in several studies using ultrasound imaging (USI).

LMult and abdominal wall muscles—external oblique (EO), IO, and TrAb, and rectus abdominis (RA)—act together as a synergic unit to provide stability and allow functional movement (Romero-Morales et al., 2020). Ultrasound exploration of the trunk stabilizer complex is considered a reliable, rapid, and non-expensive tool for muscle morphology assessment (Abuín-Porras et al., 2019, 2020; Romero-Morales et al., 2020) and has been performed in different sport-practitioner populations, showing

Availability of data
Data are available upon reasonable request from the authors.

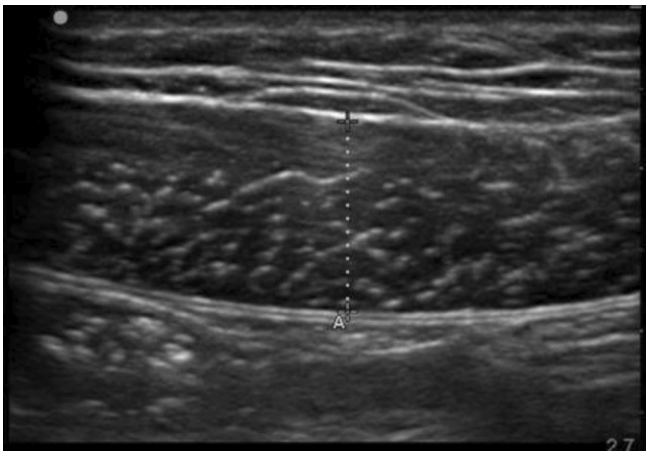

Fig. 1 ▲ RA Ultrasound image. *RA* Rectus Abdominis

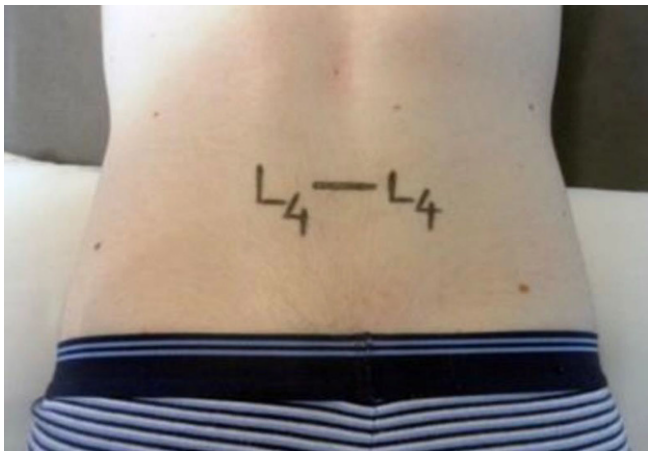

Fig. 2 ▲ Reference marks for probe location during ultrasound evaluation of the LMul muscles

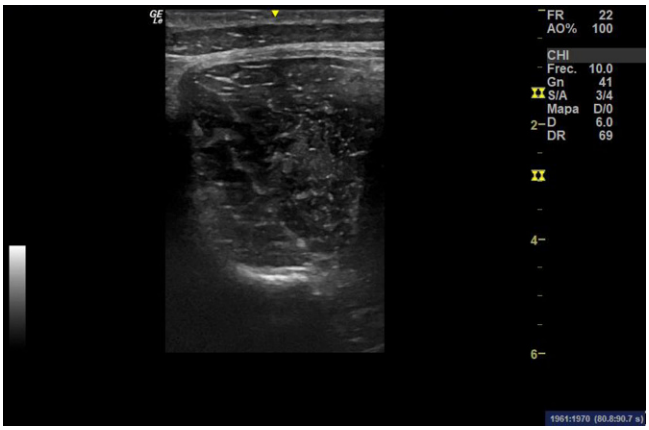

Fig. 3 ◄ LMult ultrasound image. *LMult* Lumbar Multifidus

discipline-specific changes in CSA of the main muscles of the trunk stabilizer complex (Aginsky, Gray, Vaughan, Derman, & Hodges, 2015; Almazán-Polo et al., 2018; Gala-Alarcón et al., 2018; Pedret et al., 2011; Sanchis-Moysi, Idoate, Dorado, Alayón, & Calbet, 2010; Wachi et al., 2017; Whittaker & Emery, 2015).

The aim of this study was to assess the thickness of the trunk stabilizing muscles in semiprofessional eSports players using ultrasonography, in comparison with a control group of healthy young adults.

Materials and methods

Design

This study followed an observational, cross-sectional design. The protocol was developed from January to August 2022, adhering to the Strengthening the Reporting of Observational Studies in Epidemiology Statement (STROBE) (von Elm et al., 2008).

Subjects

Participants for the eSports group were recruited amongst eSport team members (interuniversity Esports Amazon League). Participants for the control group were recruited through advertising at several university campuses and via social media. Twenty-four subjects were assessed for eligibility, and inclusion and exclusion criteria were applied. Finally, 20 subjects were recruited: 10 eSports semiprofessional players (21.90 ± 1.19 years) and 10 healthy young adults, matched by age, for the control group (CG; 22.30 ± 1.25 years). The inclusion criteria for eSports group were the following: subjects from 18–30 years (Sutherlin et al., 2018) practicing eSports for 30 or more hours per week. The control group was recruited matching the eSports group age rank. Inclusion criteria for the control group stated self-reported normal physical activity (around 150 min/week) (Edwards & Loprinzi, 2016). Exclusion criteria were the following: reported lumbar pain higher than 8 on the pain visual analogue scale (indicating an acute lumbar pain process), a body mass index (BMI) of more than 31 kg/m^2 (Almazán-Polo et al., 2018), previous abdominal surgery or abdominal hernia (Beer et al., 2009), current rheumatological disorders or conditions affecting connective tissue (Chiarello & McAuley, 2013), systemic diseases (Rankin, Stokes, & Newham, 2006), severe neurological impairment, neuromuscular and/or respiratory illness (Rankin et al., 2006; Whittaker, 2008), surgical procedures in the lumbar area 6 months prior to the study, skin alterations in the trunk area (Rankin et al., 2006) and known ultrasound gel allergies (Gillard, Ryan, Stokes, Warner, & Dixon, 2018). From the 24 initially recruited subjects, 3 did not meet the clinical history criteria and 1 had a BMI higher than 31 kg/m^2. The sex of all screened eSports group subjects was male, however, that was unintentional. Accordingly, subjects in the CG were also matched by gender in order to seek homogeneity.

Outcome measurements

All measurements were taken by the same therapist (ASG) with USI experience, and were recorded with a LOGIC S7 (XD-clear, GE Healthcare, IL, US) ultrasound model. A linear transducer in B mode with a 10–13 MHz range (with a 55 mm footprint) was used.

Participants were asked to lie supine for the measurements of RA, IRD, EO, IO, and TrAb (Whittaker, 2008). For TrAb, EO and IO, the probe was located 25 mm anteromedial to the middle point of the imaginary line connecting the last rib and iliac crest on the mid-axillary line (Noormohammadpour et al., 2016). RA thickness (**Fig. 1**) was recorded by placing the probe aligned with the umbilicus and right below it. IRD was measured over the umbilicus, transversally to the linea alba (Whittaker, 2008) during exhalation.

For LMult measurements, subjects were asked to lie prone, with a pillow under their abdomen. The spinous process of L4 was located by palpation and confirmed with USI by identifying every spinous process from S1 to L4 (**Figs. 2 and 3**). The probe was positioned parallelly to the segment (Wang-Price, Zafereo, Brizzolara, Sokolowski, & Turner, 2017).

The mean of 3 repeated values was recorded for each measurement.

Statistics analysis

Statistical analysis was performed with the Statistical Package for Social Sciences (SPSS) for IOS (version22, IBM, Armonk, NY, USA). Normality of the sample was assessed with the Shapiro–Wilk test, followed by a descriptive analysis. Finally, a comparative analysis was performed. For parametric data, mean, standard deviation (SD) and Student's *t*-test for independent samples were used. In addition, nonparametric data analysis was performed with the Mann–Whitney *U* test, and the results expressed in terms of median and interquartile range (IR). Levene's test was applied for equality of variances assessment. An α error of 0.05 (95% confidence interval [CI]) and a desired power of 80% (β error of 0.2) were used for all statistical tests.

Results

Age, weight and BMI of the sample were homogeneous. Only height showed statistically significant differences between groups (**Table 1**).

As shown in **Table 2**, statistically significant differences were found with decreased thickness in the ES group bilaterally in TrAb ($p < 0.01$) and IO ($p < 0.05$), right EO ($p < 0.05$) and right RA ($p < 0.01$). Regarding IRD, results showed a statistically significant decrease in the eSports group ($p < 0.01$).

Discussion

The aim of this pilot study was to evaluate the thickness of the muscle groups responsible for the stabilization of the trunk, TrAb, IO, EO, RA, and LMult and, furthermore, assess IRD, in a sample of eSport players using ultrasonography, in comparison with a control group of healthy young adults. The initial hypothesis was confirmed since there were signs indicating decreased muscle activity—lower thickness values—in the eSports group.

Whittaker et al. (Whittaker, Warner, & Stokes, 2013) examined the characteristics of TrAb, IO and RA in a sample of subjects with chronic LBP and healthy controls, concluding that there were statistically significant differences between the two groups regarding RA thickness. Although the present study focused on muscle morphology and not on LBP, it is important to consider the prevalence of this lumbar pain condition among eSport professional players. In addition, the mean age in the present study was 21.90 (± 1.19) years old, whereas in the study by Whittaker et al. it was 46.6 (± 8.0). This early presence of decreased thickness in RA has to be pointed out, as it could lead to LBP without appropriate prevention. In several more recent publications, the trunk stabilizer

Abstract

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Impact of eSports semiprofessional practice on the trunk stabilizer muscle complex. A cross-sectional study

Abstract

Introduction. ESports have emerged in the sporting paradigm achieving a great deal of importance both in terms of audience and economics. Professional players have to improve their performance through training, which leads to an increase in the risk of injuries derived from long periods of time spent a sitting position, sedentarism and repetitive movements. The most prevalent injury is low back pain (LBP), probably due to the professionals' lifestyles, similar to the day-to-day activity of office workers but acquired at a younger age.

Objective. The aim of this study was to assess the morphology of the trunk stabilizing muscles in semiprofessional eSport players in comparison with healthy subjects, using ultrasonography.

Methods. A total of 20 participants were recruited (10 players from a semiprofessional eSports team and 10 age-matched healthy controls). Ultrasound measurements of the thickness of the transversus abdomini (TrAb), internal oblique (IO), external oblique (EO), rectus abdomini (RA) and lumbar multifidus (LMult) muscles, and interrecti distance (IRD) were recorded.

Results. Statistically significant differences were found with decreased thickness in the eSports group bilaterally in TrAb ($p < 0.01$) and IO ($p < 0.05$), right EO ($p < 0.05$) and right RA ($p < 0.01$); and decreased IRD ($p < 0.01$).

Conclusions. Statistically significant differences were found between young semiprofessional eSports players and healthy adults in this study, with morphologic characteristics similar to those found in older adults with chronic LBP.

Keywords

Electronic Sports · Abdominal muscles · Ultrasound · Transverse abdominal muscles · Low back pain

Table 1 Sociodemographic data

Data	ESports ($n = 10$)	Controls ($n = 10$)	*P*-value cases vs. controls
Age, years	21.90 (1.19) [a]	22.30 (1.25) [a]	0.47[b]
Weight, kg	74.42 (11.39) [a]	78.46 (7.17) [a]	0.35[b]
Height, m	1.72 (0.06) [a]	1.79 (0.06) [a]	0.04[b]
BMI, kg/m^2	24.82(3.16) [a]	24.48 (1.7) [a]	0.73[b]

BMI Body mass index
[a] Mean (standard deviation) was applied
[b] Student's *t*-test for independent samples was performed

Table 2 Results of ultrasound imaging of the abdominal wall muscles

Measurement	Esport ($n = 16$)	Controls ($n = 16$)	*P*-value (Cohen's *d* effect size)
	Mean ± SD	Mean ± SD	
Distance (cm)			
IRD	0.94 ± 0.34	1.59 ± 0.48	0.001[b] (0.84)
Thickness (cm)			
Right TrAb	0.27 ± 0.06	0.37 ± 0.07	0.001[a](1.53)
Right IO	0.93 ± 0.16	1.05 ± 0.24	0.02[a](0.58)
Right EO	0.63 ± 0.11	0.73 ± 0.22	0.03[a](0.57)
Right RA	1.21 ± 0.14	1.32 ± 0.16	0.01[a](0.73)
Right LMult	2.37 ± 0.39	2.06 ± 0.71	0.11[a](0.54)
Left TrAb	0.27 ± 0.09	0.37 ± 0.07	0.001[b](1.24)
Leftt IO	0.68 ± 0.02	0.72 ± 0.24	0.01[a](0.23)
Left EO	1.19 ± 0.12	1.03 ± 0.11	0.15[b](1.38)
Left RA	1.19 ± 0.15	1.26 ± 0.14	0.07[a](0.48)
Left LMult	2.31 ± 0.4	2.62 ± 0.74	0.055[a](0.52)

EO external oblique; *IO* internal oblique; *IRD* interrecti distance; *RA* rectus anterior; *TrAb* transversus abdominis; *LMult* lumbar multifidous, *SD* standard deviation
[a] Student's *t*-test for independent samples was performed
[b] Mann–Whitney *U* test was utilized

complex has been explored by USI in many sport fields, such as baseball batters (Wachi et al., 2017), handball (Pedret et al., 2011), cricket (Aginsky et al., 2015), women's football (Whittaker & Emery, 2015), basketball (Almazán-Polo et al., 2018), tennis (Sanchis-Moysi et al., 2010), rugby (Abuín-Porras et al., 2019) and Pilates (Gala-Alarcón et al., 2018). The results of these studies, generally report higher thickness values in some of the abdominal/trunk muscles in their samples, contrary to the control groups. However, the results of the present study showed lower thickness values for the eSports group compared to healthy adults with normal physical activity. In 2020 Nagorsky & Wiemeyer (Nagorsky & Wiemeyer, 2020) performed an online survey amongst eSport players. In their study, 95% of the 1835 participants were men. In the present study, all participants were men, but, as previously stated, this was unintentional. Due to this, extrapolations of the observed thickness of the abdominal muscles in eSport players in this study to the general population has to be taken with caution.

The need for exhaustive health examinations, the same as for traditional professional sport players, has been pointed out by several authors (DiFrancisco-Donoghue et al., 2019; Yamagata et al., 2022), although most of the publications are not experimental studies. Literature addressing concrete clinical interventions for musculoskeletal injuries is limited. A study in Japan by Takakura et al. (Takakura et al., 2020) with a sample of 12 eSport athletes showed positive results for an acupuncture intervention (21% reported low back pain). Due the small sample size, these results have to be considered with caution. Another study, from Lindberg et al. (Lindberg et al., 2020) reported that up to 11% of a sample of 188 eSport athletes had sought physical therapy assistance in the previous 3 months. Nevertheless, the type of treatment applied was not reported in this publication. Joanne DiFrancisco-Donoghue (DiFrancisco-Donoghue et al., 2019) concluded in an invited commentary that eSport collegiate practitioners should receive the same medical care as their traditional sport peers, including physical therapy attention in order to prevent sport-related injuries. Other studies focus on the necessity of specific physical conditions, such as endurance, strength or flexibility that will not only lead to better performance (Kari & Karhulahti, 2016), but—from a clinical approach—would also have a positive impact on injury prevention. Montero et al. (Pereira et al., 2019), in a viewpoint publication, highlight the necessity of quality care and health protection. USI assessment could be included in this model of protection and injury prevention, to determine whether eSport athletes are at risk of developing musculoskeletal conditions due to changes in their muscle morphology.

Some limitations must be reported in this study. Firstly, LBP was not recorded as an outcome measure, although reported LBP higher than 8 in a VAS scale was an exclusion criterion to avoid acute processes that could interfere with the muscle morphology at the moment of the evaluation. Intra- and interreliability study of the measurements were not carried out. The USI operator was not blinded; thus, this point should be taken into account for the results interpretation. Further studies should be carried out with larger samples focusing on pain symptoms. Moreover, the group was not homogeneous in height at the baseline analysis, which may have a potential confounder effect in the USI assessment.

Conclusions

Statistically significant differences in the morphology of the trunk stabilizer muscles were found between young semiprofessional eSport players and healthy young adults in this study, with

morphologic characteristics (decreased thickness compared to healthy controls) similar to those found in the scientific literature in older adults with chronic LBP. Esport athletes could benefit from prevention programs in order to reduce the risk of sport-related injuries.

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Declarations

Conflict of interest. M. de la Cueva-Reguera, A.S. García, V. Abuín-Porras, J. Velázquez Saornil, D. López-López, H. Pareja-Galeano, M. Bravo-Aguilar and C. Romero-Morales declare that they have no competing interests.

All procedures performed in studies involving human participants or on human tissue were in accordance with the ethical standards of the institutional and/or national research committee (Universidad Europea de Madrid Ethics Committee) and with the 1975 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

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