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Original Article

Internal training load and performance indices of cerebral palsy football players and effects of one week with and without training on heart rate variability

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Abstract:
The aim of this study was to describe Yo-Yo Intermittent Recovery level 1 (IR1) performance and internal training load (ITL) of cerebral palsy football (CP-Football) players from a national team during one week of training and analyze the effects of this week on athletes taking part or not in training with regards to HRV indices. The sample consisted of 10 CP-Football players who were submitted to a regular one week of training, and one injured CP-Football player who had to withdraw from training. ITL was monitored using the session rating of perceived exertion. The heart rate variability (HRV) of all players was verified on the first (pre) and sixth (post) days. The Yo-Yo IR1 was performed three weeks before the monitored week. The team covered 516.0m (± 201.7) in the Yo-Yo IR1, while the injured player covered 880m. An ITL of ~600 A.U. was performed in the training week. There was a likely decrease in SDNN, rMSSD, LF, and HF during the monitored training week, and the LF/HF presented unclear changes. The HRV variables increased in the injured player after the week without training. The National team CP-football players covered less distance in the Yo-Yo IR1 test than football players without physical disabilities. The ITL observed in one week of training was capable of disturbing HRV indices. This finding was reinforced by improved HRV indices presented by the injured player.
Key words*:* Physiology, Autonomic Nervous System, Exercise, CP- Football.

Introduction

Cerebral Palsy, also known as Chronic Encephalopathy, according to Vieira, Nogueira & Gorla (2020), its definition must be understood by four main components: 1) movement and posture disorder; 2) resulting from an abnormality in the brain; 3) acquired early in life; and 4) static condition at the time of recognition.

Football played by people with cerebral palsy, known as Football 7, Football for the cerebral palsy, Football PC or even Football PC, is a game that follows the rules of the sport for people without disabilities according to FIFA (Fédération Internationale de Football Association), with some modifications. Among them: 7 players on each side; 2 times of 30 minutes; field measuring 70m x 50m; 5m x 2m goal; penalty mark is located at 9.20m; there is no impediment and, finally, in addition to the conventional way, the side kick can also be performed with one hand, as long as the ball immediately touches the ground after its execution (IFCPF, 2018, ANDE, 2020).

To practice, the athlete must have a traumatic injury to the Central Nervous System (CNS), resulting in Cerebral Palsy (CP) or consequences that place them in conditions of eligibility for practice. To be eligible, the athlete must at least present one of the conditions of impairment: Hypertonia, Dyskinesia and or Ataxia (Nogueira, 2018; IFCPF, 2015).

In this sense, the Functional Classification is a fundamental process that is done through value judgment, based on individual perceptions, based on pre-established factors. Classification systems aim to promote participation in paralympic sport by individuals with disabilities by controlling for the impact of impairment on the outcome of competition (Tweedy & Vanlandewijck, 2011). The FC categorizes the athlete, taking into account the volume of action, that is, his ability to perform movements, taking into account and

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showing the potential of the muscle waste of sequels of some kind of deficiency, as well as the muscles that were not injured (Vieira, Nogueira & Gorla, 2020).

PC football in 2018 underwent transformations in terms of FC, from which athletes were divided into three new functional classes: FT1, FT2 and FT3. Briefly, if the athlete is very committed, he will be in the FT1 class, to belong to the FT3 class he has a slight commitment and FT2 will be a middle ground between the two others. Athletes who are currently class C8 will automatically be allocated to class FT3, and may even be considered ineligible for the sport. (ANDE, 2020)

In the current rule, it is mandatory that there should always be at least one FT1 class athlete on the field. In case it is not possible, the team must play with six players, as well as, each team can only count on a maximum of one athlete of the FT3 class on the field, during the entire match. (ANDE, 2020)

It should be noted that the sample of the present study, as they are athletes from the Brazilian team, who at the time of collection, recently participated in the Rio 2016 Paralympic Games are included in the old FC (FT5, FT6, FT7 and FT8). Monitoring responses to training is an essential part of the process (Aubry et al., 2014; Vanrenterghem et al., 2017). The intensification of the training load (TL) during the preseason, usually performed by team sports, can promote undesirable overreaching (Aubry et al., 2014). In this context, responses to heart rate variability at rest (HRV) have been used to monitor positive and negative adaptations to training (Flatt, Hornikel & Esco, 2017). Athletes conditions have a direct effect on the performance of metabolic, cardiorespiratory and neuromuscular fitness, when compared with people without CP (García et al., 2016). Therefore, the training parameters of soccer players with CP, such as physical fitness performance, TL magnitude and responses to training may be different for athletes without CP.

In this sense, the present study aimed to describe the performance of physical fitness through the Yo-Yo IR1 and ITL test of CP-Football players from a national team during a pre-season week before the Rio 2016 Paralympic Games, and analyze the effects (case study) of this week analyzed in athletes who participate or not (due to injury) in training with regard to HRV indexes.

Methods

Subjects

The sample consisted of 11 male athletes with cerebral palsy, from the Brazilian CP-Football team, that finished participation in the Rio 2016 Paralympic Games in third place. One player (28.7 years old; 169 cm of height; 62.7 kg of body weight; 8.1% of body fat) was injured and had to withdraw from training, without taking part in any training session during the investigated week.

During this period, the injured player performed sessions of rehabilitation in the medical department. Nevertheless, this athlete was monitored regarding HRV in order to verify the effects of no exposure to physical training during the observed training week. The remaining 10 players (age - 25.09 ± 5.89 years; height - 176.9 ± 7.58 cm; weight - 73.4 ± 6.3 kg; body fat - 11.22 ± 4.52%) were classified as healthy and free from injury, and were submitted to regular training. No player was taking any nutritional ergogenic substances or anti-inflammatory drugs during the study.

This study was approved by the Institutional Local Ethics Committee, Research Ethics Committee of the Medical School of UNICAMP, nº 709.135 / 2014, in accordance with the Declaration of Helsinki, and all participants provided written informed consent prior to participation in this study.

Experimental approach to the problem

This is a descriptive study involving top-level Paralympic Football Seven athletes. The sample was monitored for six days of training during the sixth week of preparation for the 2016 Rio Paralympic Games. The HRV of all players was verified on the first (pre) and sixth (post) days, in the first hours of the day (~9 a.m.) after breakfast. Prior to the first day, players did not train for 48 hours in order to obtain a reliable "baseline" measurement (Carvalho Leme et al., 2015). Furthermore, the Yo-YoIR1 was performed three weeks before the monitored week. Two training sessions per day were performed during the monitored days, comprising physical training in the morning and technical/tactical training in the afternoon. ITL was monitored using the session rating of perceived exertion (sRPE) approach (Foster et al., 2001).

Heart Rate Variability (HRV)

HRV measures were performed with R-R intervals monitored with players in the supine position for 10-minute using portable heart rate monitors (First Beat Sports Team 4.6®). Resting HRV was calculated from the final five minutes of observation (John, et al., 1996). All HRV recordings were completed under spontaneous breathing conditions. The software used has an algorithm that filters R-R intervals to exclude artifacts. R-R data were then transferred to a computer and further analyzed using specialized HRV analysis software (Kubios HRV Analysis, version 2.2 beta 1, Biomedical Signals Analysis Group, University of Kuopio, Finland). The time domain indices analysed included standard deviation of all normal R-R intervals (SDNN) and the root mean square difference of successive normal R-R intervals (rMSSD). In the frequency domain, using spectral analysis (Fast Fourier Transform), the low-frequency (LF: 0.04-0.15 Hz) and high-frequency (HF: 0.15-0.40 Hz) band

densities expressed in absolute and normalized units (nu) were analysed. The sympathovagal balance was obtained by the ratio of the LF to HF (LF/HF).

Yo-Yo Intermittent Recovery Test level 1

The Yo-Yo IR1 (Krustrup et al., 2003) was performed on a grass surface football pitch. This test consists of performing 40 m (2 x 20-m with 180º change of direction) shuttle runs at increasing speeds interspersed with 10 seconds of active recovery (recovery zone of 5m). The test started at the speed of 10 to 13 km/h (0–160 m) followed by seven shuttle runs at 13.5 to 14 km/h; subsequently, there were increases of 0.5 km/h after every eight shuttle runs. The test speed was adjusted according to a beep and ended when the players failed to reach the start or end lines in synchrony with the beep two times successively, or due to volitional exhaustion. The total distance covered was then reported as the performance criteria.

Statistical analysis

For pre-post comparisons, the chances of changes in HRV variables being different to the smallest worthwhile change (SWC- 0.2 multiplied by the standard deviation at pre moment) were calculated. In this analysis, a confidence level of 90% was considered. The quantitative chances of increased/trivial/decreased effects were interpreted as follows: <1% almost certainly not; >1–5% very unlikely; >5–25% unlikely; >25–75% possible; > 75–95% likely; > 95–99 very likely; >99% almost certain. If the chances were higher than 5% for positive and negative effects, the true difference was interpreted as unclear. The magnitude-based inferences were calculated with spreadsheets available at http://www.sportsci.org/. LF, HF, and LF/HF presented skewed distributions and were naturally log-transformed.

Results

The team covered an average distance in theYo-YoIR1 of 516.0 m (± 201.7; Table 1), while the injured player covered 880 m. Values of sRPE during the training week of the investigated team are shown in Figure 1.

Table 1: Performance in Yo-YoIR1 of CP-Players.

Players	Position	Distance covered (m)
1	Defender	920
2	Side field	720
3	Defender	560
4	Goalkeeper	200
5	Midfield	480
6	Side field	560
7	Side field	360
8	Midfield	560
9	Striker	360
10	Midfield	440
Injured	Midfield	880m

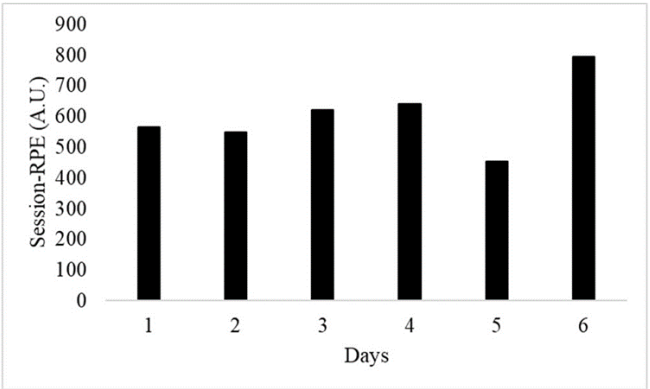

Figure 1: Session-RPE (sRPE) of CP-football players during the training week.

There was a likely decrease in SDNN, rMSSD, LF, and HF during the monitored training week (Table 1). The LF/HF presented unclear changes. It is interesting to note that the HRV variables increased in the injured player after remaining "inactive" during the week without training (Figure 2 and Table 2).

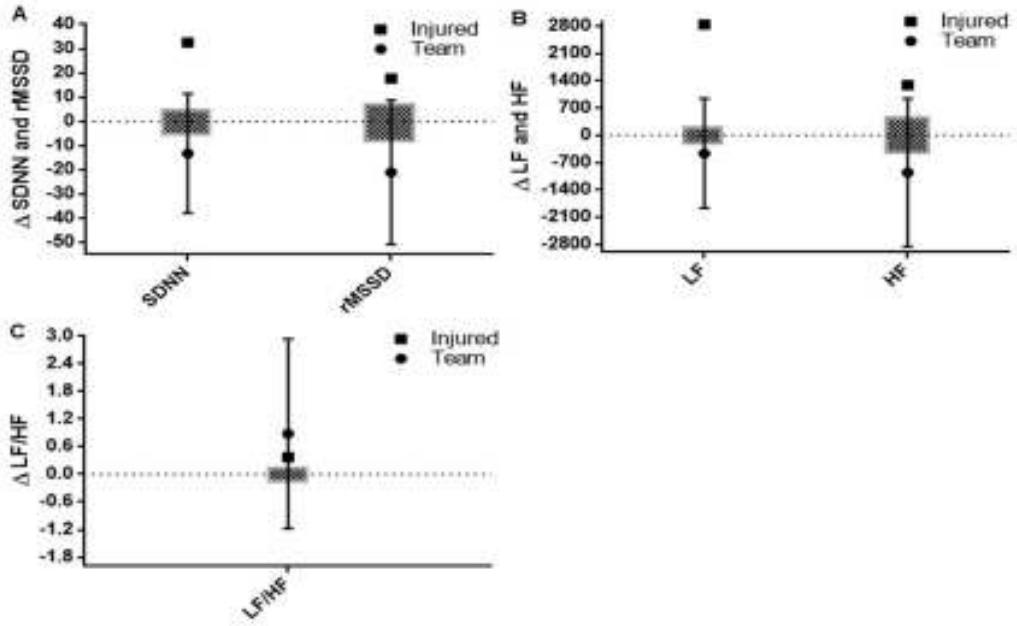

Figure 2: Changes in HRV indices during the monitored week. Data are presented as mean and SD. Hatched boxes correspond to the threshold for important or harmful (raw) values: A - SDNN = -5.7/5.7; rMSSD = -7.4/7.4 (raw values); B - LF = -254.7/254.7; HF = - 417.0/417.0; C - LF/HF = -0.2/0.2.

Table 2: Mean and SD of HRV variables pre and post training week in the team players and injured player.

	Pre Team	Post Team	Chances of increase/trivial/decrease	Pre injured player	Post injured player
SDNN	52.51 ± 28.65	39.31 ± 22.19	2/16/82 Likely	40.2	72.80
rMSSD	61.98 ± 37.09	40.89 ± 24.46	1/8/91 Likely	55.1	72.70
LF	1316.40 ± 1273.53	851.60 ± 941.09	4/17/78 Likely	727.00	3560.00
HF	1732.60 ± 2085.08	773.40 ± 987.01	1/11/87 Likely	426.00	1714.00
LF/HF	1.35 ± 0.88	2.23 ± 2.47	72/23/5 Unclear	1.71	2.08

The principal results found in this study were that one week of training with a mean sRPE of ~600 A.U. promoted decreases in SDNN, rMSSD, LF, and HF of CP-football players, in contrast to the injured player who presented increases in all HRV variables.

Discussion

To date, this is the first study that describes the ITL of CP-football players monitored by sRPE. In accordance with the sRPE reported in the present sample, daily sRPEs between 500 and 1000 A.U. are commonly found during pre-seasons of different team sports (De Freitas et al., 2017; Miloski, De Freitas & Bara Filho, 2012, Soares-Caldeira et al., 2014). In rugby, for example, ITLs of similar magnitude (~300-700 A.U.) were reported during a period of intensification of training load related to symptoms of overreaching (Coutss et 3020----------

al., 2007a, Coutss et al., 2007b). As a consequence of typical team sports annual plans, which in general comprise short preseasons aiming at concurrently developing several technical and physical qualities, high training load is concentred into a few weeks (Moreira, 2010). Apparently, the found results showed that the training load distribution in CP-football is not different from other team sports with players without physical disability. It is likely that moderating these training loads could result in preservation of neuromuscular abilities (e.g., jump and sprint performances) and reduce the risk of overreaching (Ferioli et al., 2018; Nakamura et al., 2016). However, this hypothesis needs to be tested in this specific population of athletes.

Due to overreaching, players may present several negative psycophysiological symptoms (Macedo &Martins, 2018), such as disturbance in the cardiac autonomic system (Dong, 2016; Tian et al., 2013). In fact, this idea is in accordance with results reported in the present study, in which high sRPE accumulated by CP-football players decreased HRV indices (SDNN, rMSSD, LF, and HF) during a typical training week, suggesting a decrease in parasympathetic modulation (John, et al., 1996). In collegiate sprint-swimmers, for example, an overload period decreased vagal activity (lnRMSSD), while tapering allowed rebound of lnRMSSD (Flatt, Hornikel &Esco, 2017). Accordingly, in the present study, the injured player demonstrated an increase in all HRV indices, suggesting recovery of the autonomic system over the week in which he rested. Similar autonomic system recovery was reported in non-athletes submitted to one month of overload TL followed by two weeks of recovery, who showed increases in parasympathetic indices (HF, pNN50, rMSSD) (Pichott et al., 2002). Therefore, these results suggest that high TL during a training week in the preseason can disturb the parasympathetic modulation of CP-football players. It appears that in just one week of reduced training, athletes can recover. However, since this finding was only a “case study” within our observational cohort study, it needs to be confirmed in a group of CP-football players who deliberately reduce TL after observing a reduction in HRV indices.

Another important finding described in the present study is performance in the Yo-YoIR1 of CP-football players. Unfortunately, it was not possible to perform this test pre and post the investigated week of training, since this was a period corresponding to preparation for the 2016 Rio Paralympic Games. Performance assessment could have helped determine whether the high TL undertaken by the team was sufficient to cause fatigue and impair Yo-Yo IR 1 distance. Nevertheless, it is interesting to note that the results found by our players (516.0 – 880 m) were lower than the results found in the Irish CP-football team (993 m) (Kloyiam et al., 2011). It is possible that these two teams presented players with different classifications (class FT 5 to FT 8) in accordance with the International Federation of Cerebral Palsy Football (IFCPF). Hence, future comparative studies between National teams are needed, taking into account the classification of the players composing each team. Nevertheless, our study confirms that CP-football players present lower performance than football players without physical disabilities (Kloyiam et al., 2011).

Conclusions

In summary, the players of the Brazilian PC football team performed TL during a week of preparation for the 2016 Paralympic Games in Rio, similar to other high level non-Paralympic team sports. The amount of LT observed here was able to disturb cardiac autonomic modulation, as suggested by changes in HRV indices.

This finding was reinforced by the fact that the injured player included in the analyzes showed an improvement in HRV indices after that week of training. Finally, high-level CP football players perform less well on the Yo-Yo IR1 test than football players without physical disabilities.

It is believed that the information generated by this study will help coaches and physical trainers of PC football to better prescribe training and interpret their physiological responses, since they are of fundamental importance for the performance, as well as for the athletes' quality of life. This study elucidates the need for further research with the population, in order to get to know the profile of the athletes, the demand demanded by the modality, in addition to contributing to the development of the modality and providing practitioners with a practice directed according to the requirements.

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