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ORIGINAL

MONITORING OF A COMPETITIVE MICROCYCLE IN PROFESSIONAL WOMEN'S BASKETBALL THROUGH INERTIAL DEVICES

MONITORIZACIÓN DE UN MICROCICLO COMPETITIVO EN BALONCESTO FEMENINO PROFESIONAL MEDIANTE DISPOSITIVOS INERCIALES

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ABSTRACT

The implementation of effective load control strategies in training is essential to improve performance. The purpose of this study was to make a first approach to monitoring load with a professional women's basketball team. Ten players were equipped with an inertial device and a heart rate band during one microcycle. The load supported by the players during training and competition was analysed using External Load variables: (i) Distance performed, (ii) Distance performed at high intensity, (iii) PlayerLoad, (iv) Jumps, (v) Accelerations and Decelerations, (vi) Peak and average speed; and Internal Load variables: (i) Average and peak heart rate, (ii) Zones of % peak Heart Rate. Differences between training and competition were analysed using an ANOVA. The competition was the most demanding condition in all the variables studied except jumps per minute.

KEYWORDS: Basketball, monitoring, inertial devices, UWB, woman.

RESUMEN

La implementación de estrategias efectivas de control de carga en el entrenamiento es primordial para mejorar el rendimiento. El objetivo fue caracterizar las demandas soportadas durante un microciclo competitivo de un equipo profesional de baloncesto femenino y su interacción con la competición. Diez jugadoras se equiparon con un dispositivo inercial y una banda de frecuencia cardíaca. Se analizó la carga soportada por las jugadoras durante el entrenamiento y la competición mediante variables de Carga Externa: (i) Distancia recorrida, (ii) Distancia recorrida a alta intensidad, (iii) Playerload, (iv) Saltos, (v) Aceleraciones y Deceleraciones, y (vi) Velocidad máxima y media; y variables de Carga Interna: (i) Frecuencia cardíaca media y máxima, (ii) Zonas de % Frecuencia Cardíaca Máxima. Se analizaron diferencias entre el entrenamiento y la competición mediante un análisis *ANOVA,* observando que la competición fue la condición más exigente en todas las variables estudiadas a excepción de los saltos por minuto.

PALABRAS CLAVE: Baloncesto, monitorización, dispositivos inerciales, UWB, mujer.

INTRODUCTION

Load quantification is a widely used tool by physical trainers and coaches for monitoring and evaluating training and sports competition (Reina, Garcia-Rubio, Feu, & Ibañez, 2019). Load is quantified taking into account two main indicators. In the first place, the workload that the athletes support, considered as the set of psychological and biological demands (internal or real load) and, secondly, the load caused by training or competition activities (external or proposed load) (González-Badillo & Serna, 2002). These values will vary depending on the age and level of the player (Pion et al., 2015), the playing position or gender (Fort-Vanmeerhaeghe, Montalvo, Latinjak, & Unnithan, 2016), the moment in the season and the style of play (Miñano-Espín, Casais, Lago-Peñas, & Gómez-Ruano, 2017). Therefore, these types of results are essential for prescribing training individually, allowing it to be carried out with sufficient intensity to provide favourable adaptations while reducing the probability of injury (Gómez-Carmona, Bastida-Castillo, González-Custodio, Olcina, & Pino-Ortega, 2020).

At present, the use of inertial devices for monitoring and evaluating load is booming. Inertial devices, together with local positioning systems, are composed of microsensors that continuously calculate the position, direction and speed of the moving player, without the need for satellite references (Gómez-Carmona et al., 2019). In turn, they are used in combination with global positioning systems (GPS) to determine the direction in which the player is moving (Chambers, Gabbett, Cole, & Beard, 2015). However, GPS systems generally present limitations in indoor environments. Ultra-wide band radio frequency (UWB) technology has begun to be used to locate this type of device indoors. The UWB system uses a reference frame formed by different antennas and determines the positioning (coordinates) in relation to the time of emission and reception of the signal (Bastida-Castillo et al., 2019).

In basketball, the implementation of effective load monitoring strategies in training is essential to promote physiological adaptations that improve performance (Reina, Mancha-Triguero, García-Santos, García-Rubio, & Ibáñez, 2019). These strategies will depend on a wide variety of factors that influence external demands and internal responses (Stojanović et al., 2018). In the context of women's basketball, Boles and Ferguson (2010) present women as a unique challenge for sports medicine, since they run a greater risk than men athletes of suffering some injuries, which are related to morphological and physiological differences. To solve this, it is important to investigate training and competition in this type of population because it has been worked on from men's data (Delextrat et al., 2015). Therefore, to optimise performance in women's basketball, it is necessary to respect the principles of sports training, such as individuality and specificity (Bompa & Buzzichelli, 2018). This is complicated, mainly due to the scant number of existing studies on women's basketball, where the information about high-performance athletes is limited and the samples are small (Reina, García-Rubio, & Ibáñez, 2020).

For this reason and together with the booming state of the use of the latest technology through UWB systems in indoor sports, the main objectives of the present study were, on the one hand, to monitor external and internal load during a microcycle of an elite women's basketball team, and on the other hand, to analyse the differences and similarities between training and sports competition.

METHOD

DESIGN

This research was framed within observational and cross-sectional studies, since no type of intervention was carried out, giving an ecological treatment to the development of training and matches (Ato, López & Benavente, 2013).

PARTICIPANTS

Ten players belonging to a high-level professional basketball team (Swann, Moran, & Piggott, 2015) in the highest Spanish and European national competition (age: 24±3 years; height: 195±1 cm; mass body weight: 93±16 kg; professional game experience: 5±2 years), were monitored during a microcycle.

The team held 4 training sessions, the first one for physical preparation and the next three for training, as well as a match over the weekend. All the players and coaches were informed about the research protocol that was developed based on the ethical provisions of the Declaration of Helsinki (2013), approved by the Bioethics Committee of the University (234/2019).

VARIABLES

Six variables of External Load were analysed (Table 1), Kinematics: (i) Distance covered, (ii) Distance covered at high intensity, (iii) Average and maximum speed; Neuromuscular: (iv) PlayerLoadTM, (v) Jumps, (vi) Accelerations and Decelerations. And three variables of Internal Load (Table 2): (i) Average heart rate, (ii) Maximum heart rate, (iii) Work zones in % maximum heart rate.

Table 1. Variables of External Load (EL)

	Variable	Definition	Measure
Kinematics	Distance covered	Volume of meters covered by the player while on the court.	metres
	Distance covered at high intensity	Volume of meters covered by the player while on the court at explosively speed (>15 km/h).	metres
	Speed and Max Speed	Average and maximum speed reached by the player during training or game in kilometers per hour	Km/h
Neuromusculars	PlayerLoad™	Neuromuscular load that the player supports during the activity per minute. It is an objective and validated load measurement, calculated from the accelerometer signal in the 3 axes.	u.a
	Jump	Movement that consists of rising from the runway with a standard impulse that implies more than 400 ms of flight, to fall in the same place or in another. The total number of jumps during the activity and the number of jumps per minute are collected.	n
	Acelerations and Decelerations	Speed changes made during the match, total and per minute. These variables indicate both positive and negative changes in speed. Starts and Brakes.	n

Note: u.a (arbitrary units); n (number); km/h (kilometers per hour)

Table 1 shows the analyzed variables of External Load grouped according to the origin (Kinematic or Neuromuscular variables), it is accompanied by the definition and the measurement.

Table 2. Variables of Internal Load (IL)

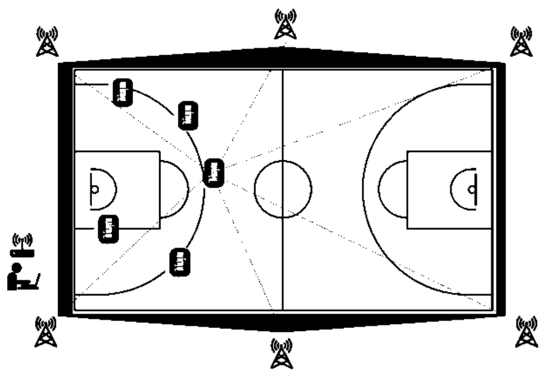
Variable	Definición	Medida
Heart Rate Average (HRAvg)	It is established with the arithmetic mean of the number of beats per minute in a specific period of time (a training task or the playing time in a match).	ppm
Heart Rate Maximum (HRMax)	it is established with the arithmetic mean of the maximum number of beats per minute.	ppm
Heart Rate Zones	are divided according to the percentage of maximum heart rate that each task or situation causes individually, being: Z1 (50-60%), Z2 (60-70%), Z3 (70-80%), Z4 (80-90%), Z5 (90-95%) y Z6 (>95%).	%

Table 2 shows the variables analyzed for Internal Load. It is also accompanied by the definition and measurement of each variable.

INSTRUMENTS

Each player was equipped with a GARMINTM heart rate strap for internal load analysis (Kansas, United States) and with a WIMUPROTM inertial device for external load analysis (RealTrack Systems, Almería, Spain) that was placed on the back of the upper torso in a specific vest made to measure and anatomically adjusted to the body (Figure 2 A and B). An antenna structure system was placed on the court through Ultra Wide-Band (UWB) technology (Serpiello et al., 2018) with the aim of creating a Local Positioning System (LPS) (Figure 2 C). In addition, the SVIVO™ software was used to automatically analyze all the data collected by the inertial device, sending it to a computer screen in real time. The WIMUPRO™ inertial device, the UWB antenna system and the SVIVO™ software come from the same company (RealTrack Systems, Almería, Spain).

A. Heart Rate Band **B.** Inertial Device



C. UWB system on the basketball court

Figure 2. Instruments used.

PROCEDURE

Three training sessions lasting 2 hours each were carried out. All sessions began with 15 standardised minutes based on dynamic stretching, activation and running exercises. The players were allowed to drink water during recovery periods. All sessions were designed, directed and supervised by the technical staff; therefore, data recording was completely ecological. The training tasks performed in this microcycle were tasks of (i) Activation, (ii) Continuous counterattack in 3 vs. 2, (iii) Free throws, (iv) Small sided format 3 vs. 3, (v) Tactical situations in 5 vs. 0, and (vi) 5 vs. 5. In the competition, a real-time analysis was carried out for the four periods of play, excluding the rest intervals between quarters (Torres-Ronda, Ric, Llabres-Torres, de las Heras, & Schelling i del Alcazar, 2016). Only the players on the court were analysed. At the end of each training session and match, the coaching staff received an immediate report of the session in order to help them design and plan the next session based on the results obtained.

STATISTIC ANALYSIS

For the statistical analysis of training and competition load, all the data were normalised to the practice time (repetitions per minute) with two different values, cumulative and relative. First, a descriptive analysis of the quantitative variables analysed (mean, standard deviation and percentiles) of the demands of training and sports competition was carried out. These descriptive results were shown on bar graphs with the cumulative values of each of the variables and, in turn, the relative variables (per minute) were represented by points. Subsequently, a one-way ANOVA was used to identify the differences between training and competition based on physical demands (Newell, Aitchison, & Grant, 2014). Differences were also identified in more detail with the Bonferroni post-hoc test as a function of relative variables. Power and effect size were calculated. The effect size was calculated from Cohen's d where an effect size is considered small 0.20-0.50, medium 0.50-0.80 and large 0.80-1 (Thalheimer & Cook, 2002). The software used was SPSS 24.0 (SPSS Inc., Chicago, IL, USA). Significance was established at <0.05 (Field, 2009; Newell et al., 2014).

RESULTS

First, descriptive results are presented based on training (Table 3) and competition (Table 4). In addition, to more accurately represent the results, the percentiles for each variable are shown in addition to the mean and standard deviation.

Table 3. Descriptive results during training

		Media ±DT	P.05	P.25	P.50	P.75	P.95
EL	Distance	**2531.95**±962.78	1402.99	1774.21	2192.04	3378.12	4171.38
	Distance/min	**38.52**±8.37	27.60	31.95	35.28	47.24	51.40
	Distance Explosive	**313.60**±118.26	156.88	219.10	294.15	410.42	522.67
	Distance Explosive/min	**5.08**±2.26	2.17	3.53	4.86	5.98	8.73
	Acelerations	**901.32**±260.63	580.00	690.50	851.00	1128.50	1265.00
	Decelerations	**264.96**±73.42	149.00	220.00	266.00	310.50	356.00
	Acelerations/min	**14.97**±3.23	11.54	13.26	15.03	16.94	19.50
	Decelerations/min	**4.68**±2.05	2.38	3.21	3.86	6.29	8.53
	Speed Max	**20.71**±1.54	18.39	19.27	20.69	21.84	23.05
	Speed Avg	**4.40**±0.20	4.11	4.22	4.44	4.56	4.81
	Jumps	**103.39**±45.97	50.00	74.50	94.00	115.00	180.00
	Jumps/min	**1.62**±0.60	0.82	1.13	1.51	2.06	2.74
	Player Load	**40.94**±14.64	24.07	31.89	35.07	51.62	68.31
	Player Load/min	**0.63**±0.15	0.38	0.52	0.67	0.74	0.84
IL	HR Max	**172.25**±8.54	160.00	164.50	172.50	178.00	189.00
	HR Avg	**125.00**±10.19	105.00	119.00	125.50	132.00	139.00
	% HR Max	**66.09**±7.47	52.50	60.50	67.25	71.45	76.50

EL: *External Load;* ***IL***: *Internal Load;* ***HR Max:*** *Heart Rate Maximum,* ***HR Avg***: *Heart Rate Average*

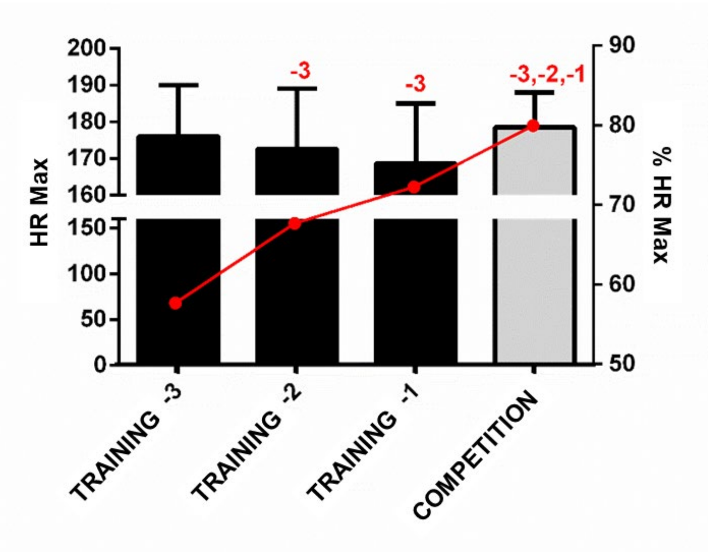
Table 4. Descriptive results during competition

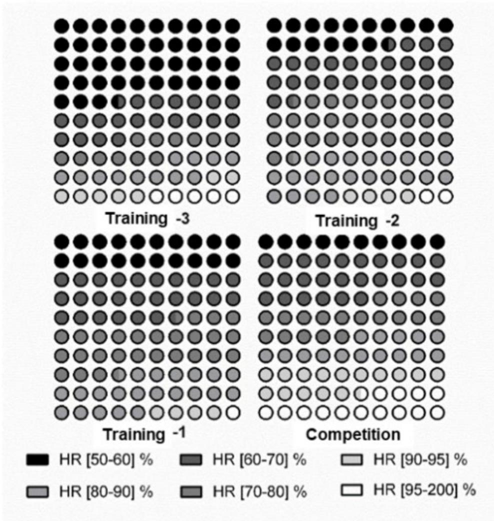
		Media ± DT	P.05	P.25	P.50	P.75	P.95
EL	Distance	**3531.56**±310.54	2938.08	3296.61	3551.18	3790.00	3931.38
	Distance/min	**69.15**±2.95	63.50	66.51	69.34	71.64	73.12
	Distance Explosive	**458.68**±69.92	327.10	430.94	464.87	498.57	568.16
	Distance Explosive/min	**8.95**±0.98	7.07	8.78	8.92	9.69	10.45
	Acelerations	**944.67**±81.40	791.00	916.00	942.84	964.00	1117.00
	Decelerations	**940.89**±80.13	786.00	915.00	941.45	965.00	1107.00
	Acelerations/min	**18.51**±1.07	16.61	18.06	18.47	18.69	20.55
	Decelerations/min	**18.44**±1.07	16.50	17.93	18.42	18.60	20.37
	Speed Max	**19.35**±1.60	17.12	18.44	18.83	20.16	22.49
	Speed Avg	**5.16**±0.16	4.85	5.16	5.18	5.25	5.38
	Jumps	**33.89**±16.00	18.00	20.00	33.95	41.00	70.00
	Jumps/min	**0.67**±0.33	0.34	0.39	0.66	0.79	1.44
	Player Load	**58.85**±9.54	37.88	57.06	59.09	64.75	70.97
	Player Load/min	**1.15**±0.15	0.82	1.10	1.17	1.26	1.33
IL	HR Max	**178.50**±6.08	169.00	175.00	178.50	183.00	188.00
	HR Avg	**141.50**±8.52	125.00	139.00	143.00	146.00	153.00
	% HR Max	**79.95**±3.95	74.40	75.70	79.95	83.90	85.30

EL: *External Load;* ***IL***: *Internal Load;* ***HR Max:*** *Heart Rate Maximum,* ***HR Avg***: *Heart Rate Average*

Tables 3 and 4 together show how, during training, the variation between the percentiles is greater than that of the competition, where the demands are equal. In average values, the results obtained in competition are greater than those of training, with the exception of the number of jumps. However, if the percentiles are observed (see supplementary material at the end of the text), specifically the maximum values (*p*.95), during training, higher accumulated values than those of the competition are obtained in terms of distance travelled, explosive distance travelled, accelerations and number of jumps, as well as higher speed executions. The same is not evident in the variables per minute, which imply greater intensity, where higher values were recorded in the competition.

Next is a visual depiction of how all the variables analysed evolved during the week according to the training session and match. Regarding the internal load variables, the players responded with a higher % of maximum heart rate during the competition (Figure 4, A) where the activity also demands work of greater intensity (Figure 4, B).





A) Heart rate evolution

B) Heart Rate Zones

Figure 4. Internal Load Demands during training and competition.

Figure 5 shows the results pertaining to the External Load variables during the competitive microcycle and the results of the competition.

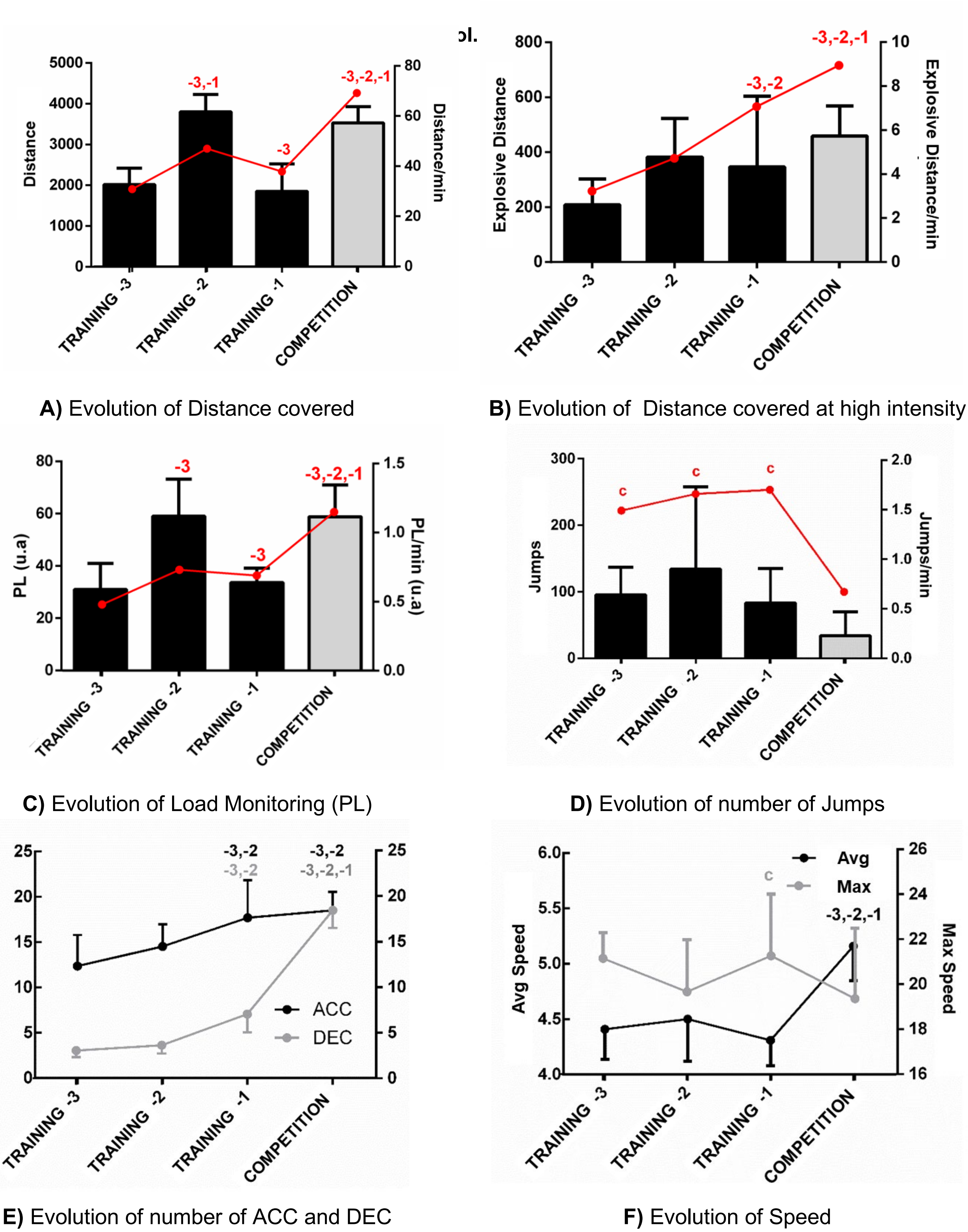


Figure 5. External Load Demands during training and competition.
Significant differences ($p < 0.05$) with Training -3 = (-3); with Training -2 = (-2); with Training -1 = (-1); with the Competition = (C)

Regarding external load variables, it was found that the highest number of metres travelled was recorded in session number two, however, the greatest distance and explosive distance travelled per minute corresponded to the competition (Figure 5, A and B). The loading volume (PL) was equal to the game in session two, but the intensity increased progressively, the game being more intense (Figure 5, C). In the case of the number of jumps, the opposite occurred, with the lowest number during competition compared to training (Figure 5, D). During training, more accelerations take place than decelerations, however, in competition they are equal (Figure 5, E). Regarding speed, average speed increased during the competition, although the maximum speed reached was lower (Figure 5, F).

DISCUSSION

The objectives of the present study were to monitor external and internal load during a competitive microcycle in a top-level team. After monitoring the load during training sessions and the study game, significant differences were observed between both conditions. A much higher intensity was found during the match, except for the number of jumps and the maximum speed reached. Competition has been shown to be the most demanding condition in women's basketball (Reina, Mancha, & Ibáñez, 2017). However, players should experience competition-like physical demands during training (Montgomery, Pyne, & Minahan, 2010). Work has been carried out during training oriented to the volume that covers competitive demands, however, the most intense actions carried out during the competition (variables per minute) are not reproduced during training. Therefore, coaches must be aware of them and be able to reproduce them (Conte et al., 2015; Matthew & Delextrat, 2009; Tee, Lambert, & Coopoo, 2016; Torres-Ronda, Ric, Llabres-Torres, de las Heras, & Schelling i del Alcazar, 2016), as well as knowing if the training load has been lower or higher than the reference loads of the actual game (Reina, Mancha-Triguero, & Ibáñez, 2017).

Regarding internal load, work values were found at 79.95% of the maximum heart rate in competition, compared to 66.09% during training. Therefore, the competition caused higher values of internal load, showing a longer working time in zones 5 and 6 during the competition. Various authors have established work at around 82.4-92.5% of maximum heart rate during sports competition (Reina, Garcia-Rubio, et al., 2019; Reina, Mancha, et al., 2017; Sánchez-Sánchez 2007), which is higher than that found in this study. This may be because internal load values decrease as the competitive level increases (Abdelkrim et al., 2010) and, in this case, the analysed team competes at the highest competitive level. On the other hand, during training the general intensity is lower (Montgomery et al. (2010). The most similar loads to competition occur in the 5 vs. 5 training tasks; however, the highest values are always recorded in competition (Reina, Mancha-Triguero, et al., 2017). This may be due to the fact that, during training, the tasks do not keep the players at maximum intensity with the same workloads for the same length of time as in the real game. Therefore, other periods of high intensity training should be provoked (Svilar, Castellano, & Jukic, 2019).

Regarding external load, lower values were found in all the variables analysed in training compared to the competition, except jumps and maximum speed throughout the week and the values of absolute PL and distance travelled in training -2. Contrary to internal loading, higher-level players are able to perform more actions at higher intensity during competition compared to players of a lower competitive level (Ferioli et al., 2020). In the case of the number of jumps, however, the inclusion of tasks with specific objectives, such as shooting or bouncing exercises, can cause a greater use of them during training (Reina, García-Rubio, Antúnez, Courel-Ibáñez, & Ibáñez, 2019).

During competition, the players covered 28.31% greater distance compared to training. This was equal to competition in the number of metres covered in training -2; however, the metres covered per minute and the explosive distance were higher during the match. In PL values, the same occurred as with distance, a similar volume was reached in training -2 but the intensity in the match was much higher than the rest of the weekly training sessions. Both variables are, therefore, highly related. In the case of acceleration work, more accelerations than decelerations were found during training, however, in competition these values were equal. There is therefore a deficit in deceleration work during training. Something similar happened with running speed, where higher values of average speed were found in competition, but maximum speeds were reached during training. This higher intensity during training sessions may be due to non-stop training matches for fouls, free throws, etc. which causes variables related to intensity to increase (Svilar et al., 2019).

In accordance with previous studies, the design of tasks in a small-sided format, such as 3v3 on the whole court, increases the intensity of training as each player performs more actions related to the game by decreasing their number on the court (Castagna, Impellizzeri, Chaouachi, Ben Abdelkrim, & Manzi, 2011; O'Grady, Fox, Dalbo, & Scanlan, 2020; Torres-Ronda, Ric, Llabres-Torres, de las Heras, & i del Alcazar, 2016). Therefore, training tasks can elicit higher speed responses and acceleration / deceleration than competition. This may be due to the objective and design of tasks with a smaller number of players since the increase in the number of players practicing reduces these values, due to the increase in density (Gómez-Carmona, Gamonales, Pino-Ortega, & Ibáñez, 2018).

It has been found, in a general way, that the training sessions do not meet the demands of the match. The design of the tasks is key when it comes to explaining these differences. There are two different types of rest: intra-set and inter-set pauses. That is, the breaks that the exercise design allows within each repetition of the task (intra-set); and the breaks that the trainer allows between repetitions of the same exercise (Schelling & Torres, 2016). All these pauses determine the load and intensity of the exercises. Competition has a chaotic and unpredictable nature (García-Rubio, Gómez, Cañadas, & Ibáñez, 2015) and this causes physical and physiological responses of greater stress than a simulated context can do, such as during training (Taberner, Allen, & Cohen, 2019). Although it has been established that modified games increase these internal and external load demands while maintaining the specific technical and tactical characteristics of the competition (Halouani, Chtourou, Dellal, Chaouachi, & Chamari, 2017; Ibáñez, Pérez-Goye, García-Rubio, & Courel-Ibáñez, 2020), these are not enough to match competitive demands (Aguiar, Botelho, Lago, Maças, & Sampaio, 2012). However, the incorporation of tasks based on high intensity intermittent training (HIIT) can make players meet the specific needs of the competition when exposed to situations as intense as those of matches (Castagna et al., 2011). Therefore, taking into account the worst possible scenarios caused by real competition, these can be transferred to training through specifically designed tasks (Alonso et al., 2020), achieving a better adaptation by the players.

CONCLUSIONS

The results show that the systematic monitoring of external and internal load demands during training and competition generates information about the processes that are being carried out, in order to improve training strategies, specific tasks and, finally, performance in competition. It has been found that the internal demands were higher in competition, mainly due to the stress that it generates. Regarding external demands, it has been shown that during the training scenarios they are similar to the competition in the case of total variables (volume). The same did not occur with variables per minute (intensity), where the competition was more demanding. For all these reasons, it is necessary to make decisions and design different strategies of action with caution, respecting a series of principles, and the continuous evaluation of the load in training and competition allows this to be done in an objective and individualised way. Task design work is essential, with the aim of constructing tasks that demand more internal load, more deceleration work or cause higher PlayerLoad values in the players.

PRACTICAL APPLICATIONS

The research results suggest the need for new strategies to increase the intensity of training compared to matches. Some of these may be: i) Modification of the rules of the 5 vs. 5 matches in training (Svilar et al., 2019). For example, eliminating the use of free throws or time-outs modifies the physical load (Moreira, McGuigan, Arruda, Freitas, & Aoki, 2012), due to an increase in the work-rest ratio. Real game situations can also be used, e.g., 5 vs. 5 in which the time is not stopped, proposing that the ball be put into play quickly after the different infringements, thus causing an increase in the physiological response and fatigue (Vazquez-Guerrero, Reche, Cos, Casamichana, & Sampaio, 2018); ii) Use of modified games, maintaining the size of the playing field, but reducing the number of players. It has been shown that 2 vs. 2 in a full court is the situation that most closely resembles the demands of competition (Castagna et al., 2011); iii) Inclusion of specific tasks to achieve the intensity of competition. The incorporation of the HIIT methodology in the design of tasks that incorporate sport-specific movements and skills, such as bouncing and movement circuits, will allow increasing the intensity of the exercise (Stone & Kilding, 2009).

The main results of this study identified differences between training and sports competition. These differences must be corrected to achieve higher performance through optimal training processes. For this, a series of guidelines was established to apply in training:

- It is necessary that, throughout training, the players work in higher maximum heart rate zones; specifically, around 30% of the time at intensities greater than 90% of maximum heart rate.

- During the week in certain sessions there is an external load volume similar to that of the game, however, the same does not happen in intensity levels (actions per minute). The intensity of the training should be increased by proposing tasks that cause the players to travel more metres per minute continuously and not in isolation, since higher values of maximum speed were found in training.

- Regarding jumping, a very characteristic action in this sport, it is proposed to analyse and break down the tasks used during training so that they do not imply an extra demand for the players, since it was found that training required more jumps than the competition.

- Accelerations and decelerations are also very characteristic actions of the sport that must be trained in a specific way. More accelerations were found compared to decelerations, yet in competition the number of decelerations increased to equal the number of accelerations. Therefore, it is important to equalise both actions during training, focusing on decelerations since it is necessary mainly for the prevention of injuries.

Continuous monitoring and evaluation of the load borne by the players during their respective training sessions and matches can be of vital importance when it comes to physical conditioning programmes with the aim of optimising performance in women basketball players.

LIMITATIONS

The study sample was from a single high-competition team, so generalisation of the results, although in line with most of the studies published to date, is difficult and should be considered with caution. However, the purpose of this study was not to make generalisations about basketball training in women, much less in a sample as specific as the present one. The research sought to show the importance of monitoring and controlling training to individualise the needs and specificities of that particular team, knowing the process can be modified and adapted to the particular needs of that context.

REFERENCES

Abdelkrim, N. B., Castagna, C., Jabri, I., Battikh, T., El Fazaa, S., & El Ati, J. (2010). Activity profile and physiological requirements of junior elite basketball players in relation to aerobic-anaerobic fitness. *The Journal of Strength and Conditioning Research 24*(9), 2330-2342. doi: 10.1519/JSC.0b013e3181e381c1

Aguiar, M., Botelho, G., Lago, C., Maças, V., & Sampaio, J. (2012). A review on the effects of soccer small-sided games. *Journal of Human Kinetics, 33*, 103-113. doi: 10.2478/v10078-012-0049-x

Alonso, E., Miranda, N., Zhang, S., Sosa, C., Trapero, J., Lorenzo, J., & Lorenzo, A. (2020). Peak Match Demands in Young Basketball Players: Approach and Applications. *International Journal of Environmental Research Public Health, 17*(7), 2256. doi: 10.3390/ijerph17072256

Ato, M., López-García, J. J., & Benavente, A. (2013). Un sistema de clasificación de los diseños de investigación en psicología. *Anales de Psicología 29*(3), 1038-1059. doi: 10.6018/analesps.29.3.178511

Bastida-Castillo, A., Gómez-Carmona, C. D., la Cruz-Sánchez, D., Reche-Royo, X., Ibáñez, S. J., & Pino Ortega, J.(2019). Accuracy and inter-unit reliability of ultra-wide-band tracking system in indoor exercise. Applied Sciences, *9*(5), 939. doi: 10.3390/app9050939

Boles, C. A., & Ferguson, C. (2010). The female athlete. *Radiologic Clinics, 48*(6), 1249-1266.

Bompa, T. O., & Buzzichelli, C. (2018). *Periodization: Theory and methodology of training*. Barcelona, España: Human Kinetics.

Castagna, C., Impellizzeri, F. M., Chaouachi, A., Ben Abdelkrim, N., & Manzi, V. (2011). Physiological responses to ball-drills in regional level male basketball players. *Journal of Sports Sciences, 29*(12), 1329-1336. doi: 10.1080/02640414.2011.597418

Chambers, R., Gabbett, T. J., Cole, M. H., & Beard, A. (2015). The use of wearable microsensors to quantify sport-specific movements. *Sports Medicine, 45*(7), 1065-1081. doi: 10.1007/s40279-015-0332-9

Conte, D., Favero, T. G., Lupo, C., Francioni, F. M., Capranica, L., & Tessitore, A. (2015). Time-motion analysis of Italian elite women's basketball games: individual and team analyses. *The Journal of Strength Conditioning Research 29*(1), 144-150. doi: 10.1519/JSC.0000000000000633

Delextrat, A., Badiella, A., Saavedra, V., Matthew, D., Schelling, X., & Torres-Ronda, L. (2015). Match activity demands of elite Spanish female basketball players by playing position. *International Journal of Performance Analysis in Sport 15*(2), 687-703. doi: 10.1080/24748668.2015.11868824

Ferioli, D., Schelling, X., Bosio, A., La Torre, A., Rucco, D., & Rampinini, E. (2020). Match activities in basketball games: comparison between different competitive levels. *The Journal of Strength Conditioning Research, 34*(1), 172-182. doi:10.1519/JSC.0000000000003039

Field, A. (2009). *Discovering statistics using SPSS*. Londres, Reino Unido: Sage publications.

Fort-Vanmeerhaeghe, A., Montalvo, A., Latinjak, A., & Unnithan, V. (2016). Physical characteristics of elite adolescent female basketball players and their relationship to match performance. *Journal of Human Kinetics, 53*(1), 167-178. doi: 10.1515/hukin-2016-0020

García-Rubio, J., Gómez, M. Á., Cañadas, M., & Ibáñez, S. J. (2015). Offensive Rating-Time coordination dynamics in basketball. Complex systems theory applied to Basketball. *International Journal of Performance Analysis in Sport 15*(2), 513-526. doi: 10.1080/24748668.2015.11868810

Gómez-Carmona, C. D., Bastida-Castillo, A., García-Rubio, J., Ibáñez, S. J., Pino-Ortega, J. (2019). Static and dynamic reliability of WIMU PRO™ accelerometers according to anatomical placement. *Journal of Sports Engineering & Technology*, *233*(2), 238-248. doi: 10.1177/1754337118816922

Gómez-Carmona, C. D., Bastida-Castillo, A., González-Custodio, A., Olcina, G., & Pino-Ortega, J. (2020). Using an Inertial Device (WIMU PRO) to Quantify Neuromuscular Load in Running: Reliability, Convergent Validity, and Influence of Type of Surface and Device Location. *The Journal of Strength and Conditioning Research 34*(2), 365-373. doi: 10.1519/JSC.0000000000003106

Gómez-Carmona, C. D., Gamonales, J. M., Pino-Ortega, J., & Ibáñez, S. J. (2018). Comparative analysis of load profile between small-sided games and official matches in youth soccer players. *Sports, 6*(4), 173. doi: 10.3390/sports6040173

González-Badillo, J. J., & Serna, J. (2002). *Bases de la programación del entrenamiento de fuerza* (Vol. 308). Barcelona, España: Inde.

Halouani, J., Chtourou, H., Dellal, A., Chaouachi, A., & Chamari, K. (2017). Soccer small-sided games in young players: rule modification to induce higher physiological responses. *Biology of Sport, 34*(2), 163. doi: 10.5114/biolsport.2017.64590

Ibáñez, S. J., Pérez-Goye, E., García-Rubio, J., & Courel-Ibáñez, J. (2020). Effects of task constraints on training workload in elite women's soccer. *International Journal of Sports Science Coaching 15*(1), 99-107. doi: 10.1177/1747954119891158

Matthew, D., & Delextrat, A. (2009). Heart rate, blood lactate concentration, and time-motion analysis of female basketball players during competition. *Journal of Sports Sciences, 27*(8), 813-821. doi:10.1080/02640410902926420

Miñano-Espin, J., Casáis, L., Lago-Peñas, C., & Gómez-Ruano, M. Á. (2017). High speed running and sprinting profiles of elite soccer players. *Journal of Human Kinetics, 58*(1), 169-176. doi:10.1515/hukin-2017-0086

Montgomery, P. G., Pyne, D. B., & Minahan, C. L. (2010). The physical and physiological demands of basketball training and competition. *International Journal of Sports Physiology Performance 5*(1), 75-86. doi: 10.1123/ijspp.5.1.75

Moreira, A., McGuigan, M. R., Arruda, A. F., Freitas, C. G., & Aoki, M. S. (2012). Monitoring internal load parameters during simulated and official basketball matches. *The Journal of Strength Conditioning Research, 26*(3), 861-866. doi: 10.1519/JSC.0b013e31822645e9

Newell, J., Aitchison, T., & Grant, S. (2014). *Statistics for sports and exercise science: a practical approach*. Nueva York, Estados Unidos de América: Routledge.

O'Grady, C. J., Fox, J. L., Dalbo, V. J., & Scanlan, A. T. (2020). A Systematic Review of the External and Internal Workloads Experienced During Games-Based Drills in Basketball Players. *International Journal of Sports Physiology Performance 1*(aop), 1-14. doi: 10.1123/ijspp.2019-0785

Pion, J., Segers, V., Fransen, J., Debuyck, G., Deprez, D., Haerens, L., Vaeyens, R., Philippaerts, R., & Lenoir, M. (2015). Generic anthropometric and performance characteristics among elite adolescent boys in nine different sports. *European Journal of Sport Science, 15*(5), 357-366. doi: 10.1080/17461391.2014.944875

Reina, M., García-Rubio, J., Antúnez, A., Courel-Ibáñez, J., & Ibáñez, S. J. (2019). Load Variability of Training Sessions and Competition in Female Basketball. *Revista de Psicología del Deporte, 28*(3), 0093-0099.

Reina, M., Garcia-Rubio, J., Feu, S., & Ibañez, S. J. (2019). Training and Competition Load Monitoring and Analysis of Women's Amateur Basketball by Playing Position: Approach Study. *Frontiers in Psychology, 9*. doi:10.3389/fpsyg.2018.02689

Reina, M., García-Rubio, J., & Ibáñez, S. J. (2020). Training and Competition Load in Female Basketball: A Systematic Review. *International Journal of Environmental Research Public Health 17*(8), 2639. doi: 10.3390/ijerph17082639

Reina, M., Mancha-Triguero, D., García-Santos, D., García-Rubio, J., & Ibáñez, S. J. (2019). Comparación de tres métodos de cuantificación de la carga de entrenamiento en baloncesto.[Comparison of three methods of quantifying the training load in basketball]. *Revista Internacional de Ciencias del Deporte, 15*(58), 368-382. doi: 10.5232/ricyde2019.05805

Reina, M., Mancha-Triguero, D., & Ibáñez, S. J. (2017). ¿ Se entrena como se compite? Análisis de la carga en baloncesto femenino. *Revista de Psicología del Deporte, 26*(1), 9-13.

Sánchez-Sánchez, M. (2007). El acondicionamiento físico en baloncesto. *Apunts. Medicina de l'Espor, 42*(154), 99-107.

Schelling, X., & Torres, L. (2016). Accelerometer load profiles for basketball-specific drills in elite players. *Journal of Sports Science Medicine, 15*(4), 585.

Serpiello, F., Hopkins, W., Barnes, S., Tavrou, J., Duthie, G., Aughey, R., & Ball, K. (2018). Validity of an ultra-wideband local positioning system to measure locomotion in indoor sports. *Journal of Sports Sciences, 36*(15), 1727-1733. doi: 10.1080/02640414.2017.1411867

Stojanović, E., Stojiljković, N., Scanlan, A. T., Dalbo, V. J., Berkelmans, D. M., & Milanović, Z. (2018). The activity demands and physiological responses encountered during basketball match-play: a systematic review. *Journal Sports Medicine, 48*(1), 111-135. doi: 10.1007/s40279-017-0794-z

Stone, N. M., & Kilding, A. E. (2009). Aerobic conditioning for team sport athletes. *Journal Sports Medicine, 39*(8), 615-642. doi: 10.2165/00007256-200939080-00002

Svilar, L., Castellano, J., & Jukic, I. (2019). Comparison of 5vs5 training games and match-play using microsensor technology in elite basketball. *The Journal of Strength Conditioning Research, 33*(7), 1897-1903. doi:10.1519/JSC.0000000000002826

Swann, C., Moran, A., & Piggott, D. (2015). Defining elite athletes: Issues in the study of expert performance in sport psychology. *Psychology of Sport Exercise, 16*, 3-14. doi: 10.1016/j.psychsport.2014.07.004

Taberner, M., Allen, T., & Cohen, D. D. (2019). Progressing rehabilitation after injury: consider the 'control-chaos continuum'. *British Journal of Sports Medicine, 53*(18). doi:10.1136/bjsports-2018-100157

Tee, J. C., Lambert, M. I., & Coopoo, Y. (2016). GPS comparison of training activities and game demands of professional rugby union. *International Journal of Sports Science Coaching, 11*(2), 200-211. doi: 0.1177/1747954116637153

Thalheimer, W., & Cook, S. (2002). *How to calculate effect sizes from published research: A simplified methodology*. Retrieved November 31, 2002 from http://work-learning.com/effect_sizes.htm.

Torres-Ronda, L., Ric, A., Llabres-Torres, I., de las Heras, B., & i del Alcazar, X. S. (2016). Position-dependent cardiovascular response and time-motion analysis during training drills and friendly matches in elite male basketball players. *The Journal of Strength Conditioning Research, 30*(1), 60-70. doi:10.1519/jsc.0000000000001043

Vazquez-Guerrero, J., Reche, X., Cos, F., Casamichana, D., & Sampaio, J. (2018). Changes in External Load When Modifying Rules of 5-on-5 Scrimmage Situations in Elite Basketball. *Journal of Strength Conditioning Research,* 34(11), 3217-3224. doi: 10.1519/JSC.0000000000002761

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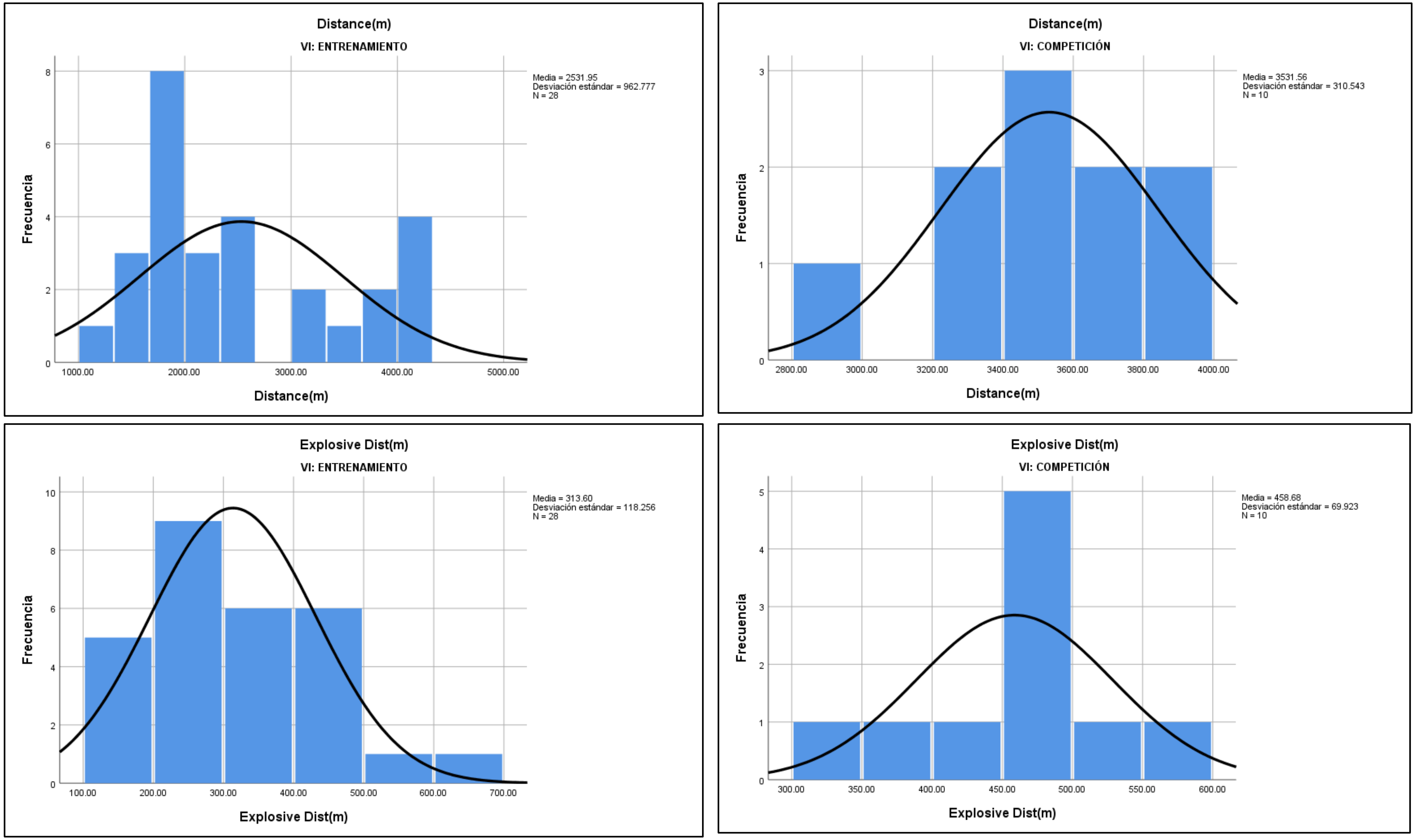
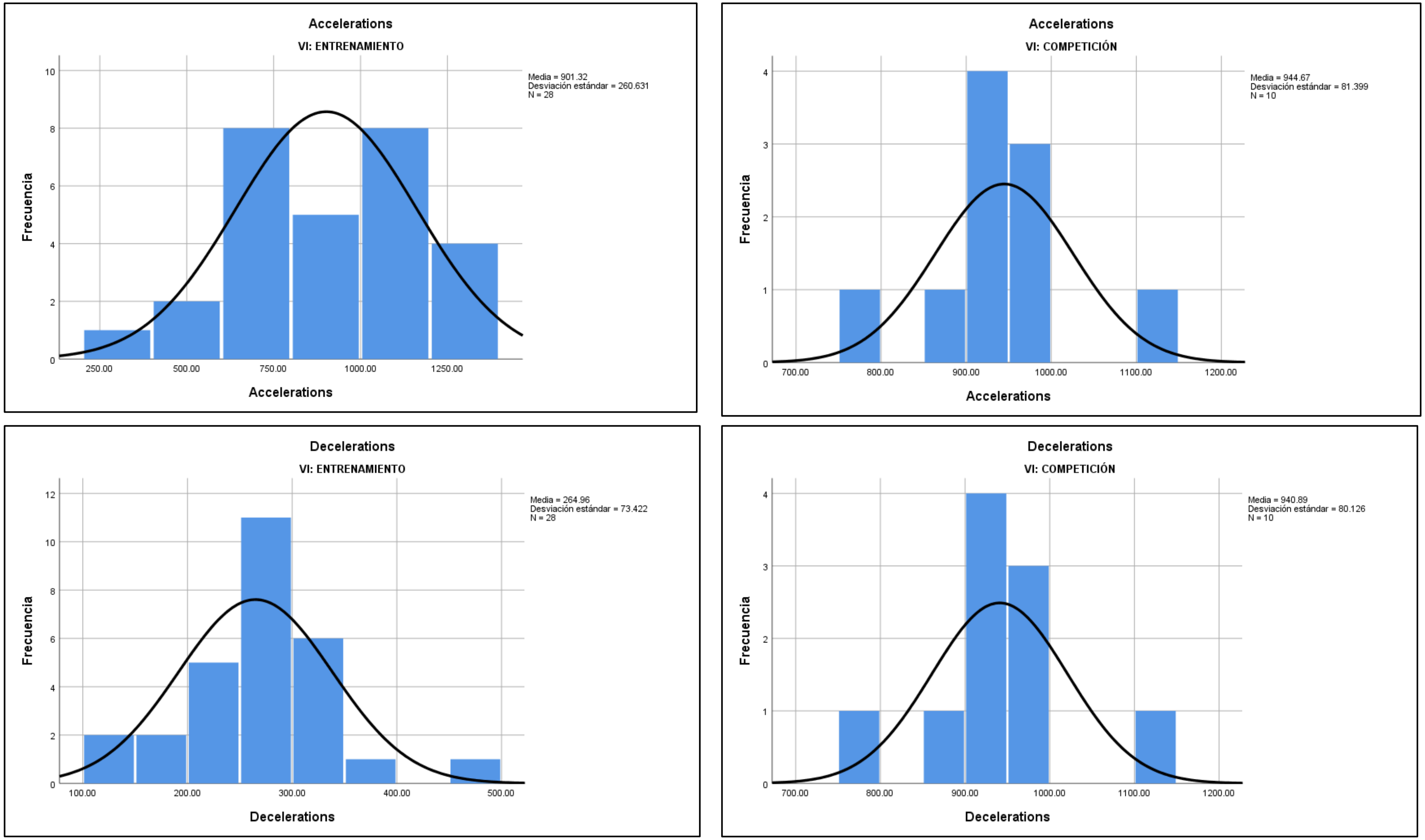
Material complementario. Representación gráfica de percentiles durante el entrenamiento y la competición deportiva

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Decelerations
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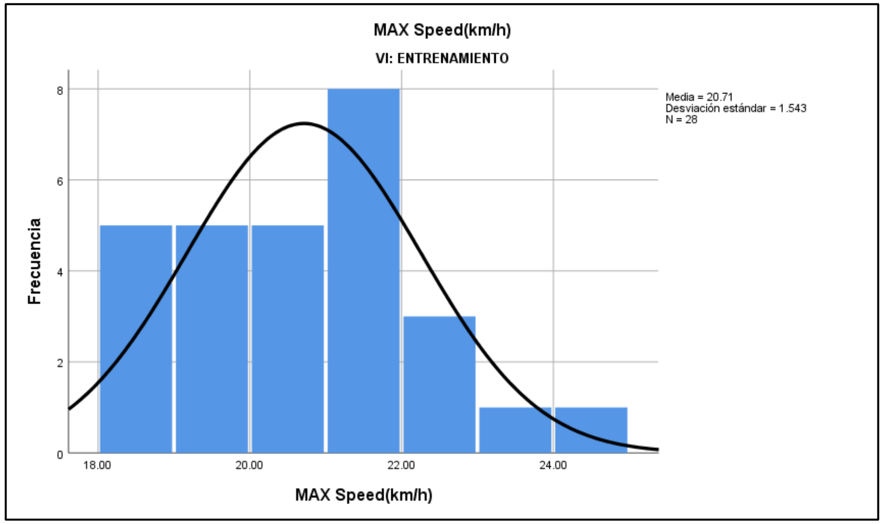
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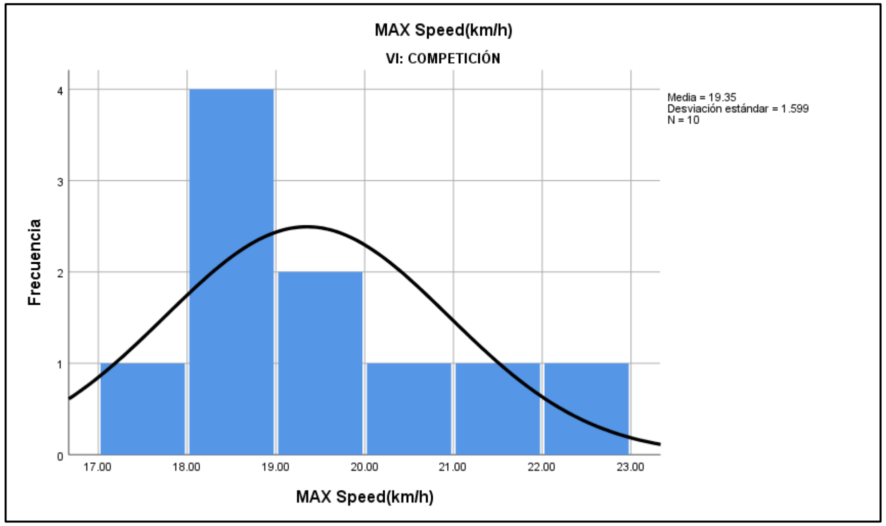
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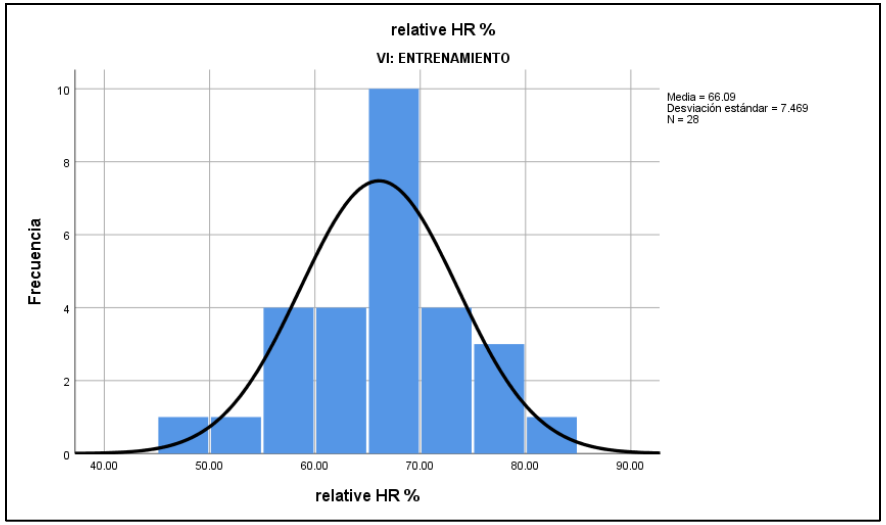
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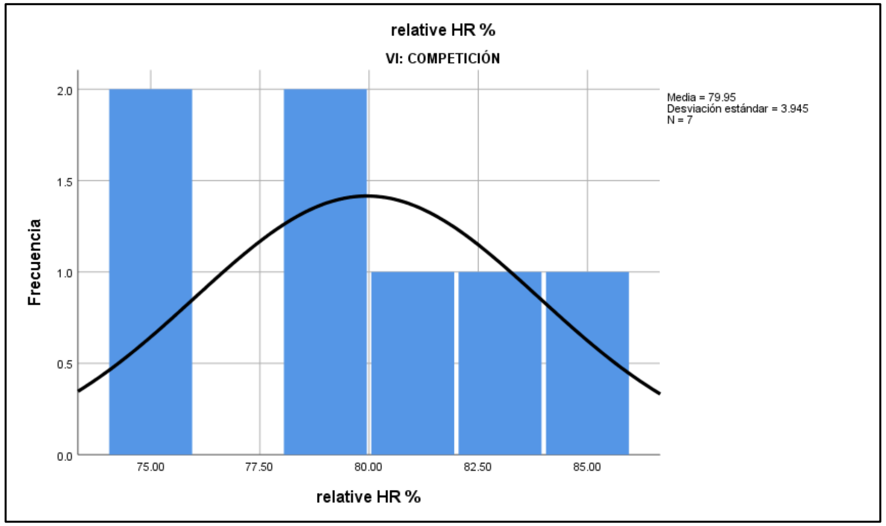
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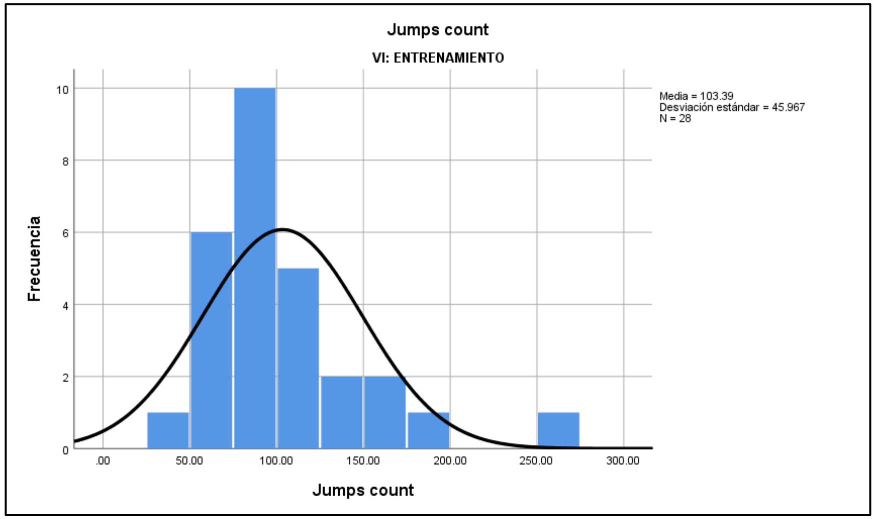
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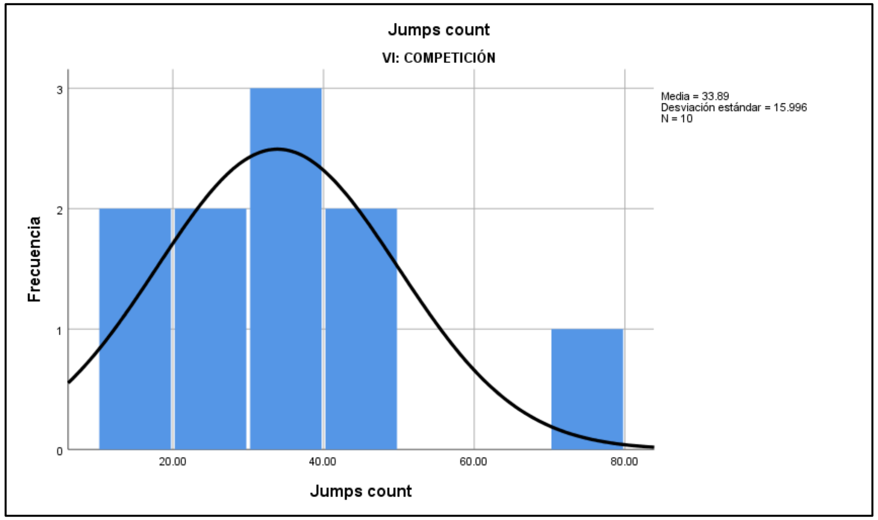
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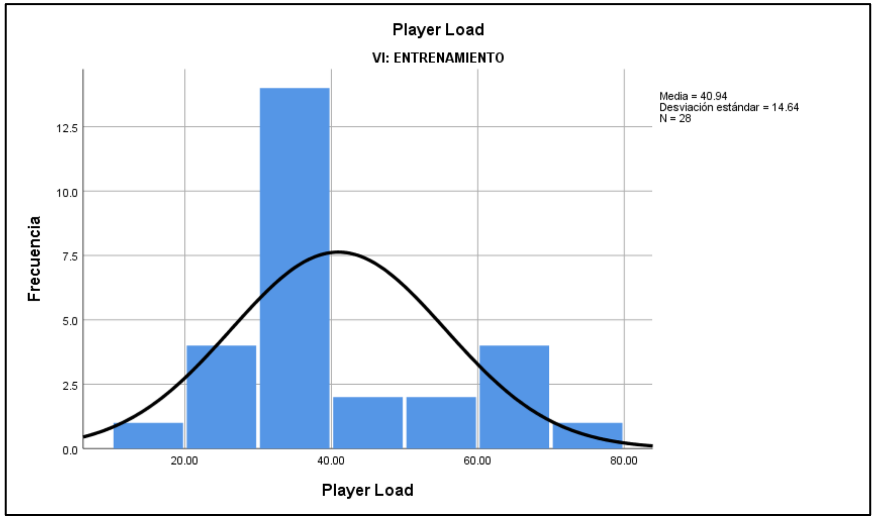
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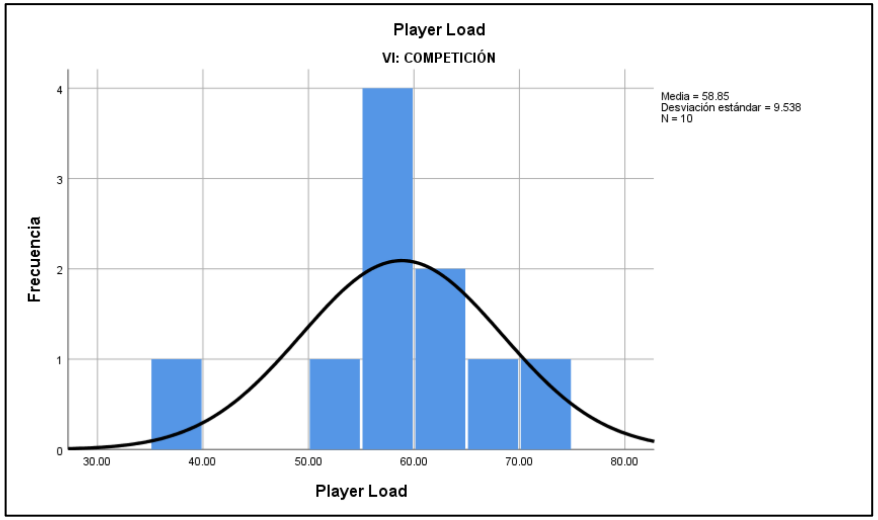
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