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The BMX Training to Win Research Handbook

TRAINING TO WIN

BMX Training to Win: Ref. 622085-EPP-1-2020-1-ES-SPO-SCP

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1. INTRODUCTION

By Celia Marcén

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1. INTRODUCTION. THE BMX TRAINING TO WIN PROJECT.

BMX Training to Win is an Erasmus+ Sport co-founded Project (Ref. 622085-EPP-1-2020-1-ES-SPO-SCP) that pretends to promote education in and through sport with a special focus on skills development, with an emphasis on coach training to improve the quality of the sport's career development and safety of young athletes (most BMX coaches are former riders without specific training and BMX).

The project is coordinated jointly by the BMX School Zaragoza sports club and the higher education institution Fundación Universidad San Jorge, both from Spain. Its partners' partner countries are the Portuguese Cycling Federation (Portugal), Slovak Cycling Federation (Slovakia), the International Centre for the Promotion of Education and Development (Italy), Malta Street Sports Association (Malta), and the Association "Board of Directors of Latvian Sports Education Institutions from Latvia.

Local partners in Spain are the Spanish Cycling Federation, the Aragonese Cycling Federation, and Zaragoza Deporte Municipal.

The project-specific project objectives are:

- Objective 1.- To design a BMX integral training programme for coaches and trainers, adding scientific evidence and studies.
- Objective 2.- To promote BMX benefits for children and youth(physically, mentally, and socially).

- Objective 3.- To stimulate dual careers for BMX riders supporting their professional and educational development.

Achieving these ambitious objectives implies the scientific analysis of BMX from different perspectives, starting by analyzing the training needs that the BMX community (athletes, coaches, families, managers, and other stakeholders) know about BMX training and what are, in their opinion, themain aspects to improve not only regarding performance but for and integral development of the riders. This analysis would result in a complete training programme (an open-access free course).

BMX riders usually are self-coached or trained by other/former riders; actually, many countries do not have an official BMX specific coaching program or certificate. So, to establish a professional environment, education is needed for coaches and trainers. This would result in higherquality in the training of young riders, taking care of their safety inpractice, and enhancing the beneficial effects of their sport.

This Handbook displays the results of the second intellectual output of the BMX Training to Win project (BMX Training to Win: Ref. 622085-EPP- 1-2020-1-ES-SPO-SCP), the physical and psychosocial test battery to evaluate BMX performance.

It is structured into two big chapters with complementary material. First, an introduction about the European project is done and then the BMX Performance Evaluation chapter and the Psychosocial Factors in BMX Performance are extensively developed. Each of these parts contains an introduction, the applied test battery, the results, conclusions, recommendations for training, and, finally, the references. After these two main parts, the tables and figures index are displayed, as well as a specific section to describe the partnership (coordinators and partners).

1.1. Participants

The participants in this research were 28 BMX athletes, with a mean age of 17.82 years (Min. 14, Max. 48; SD= 6.7), participating in the European Cup in Anadia (Portugal) in September 2022 and belonging to teams from the countries participating in the project (Spain, Portugal, Latvia, and Slovakia). Their level ranges from regional (participation in national championships without having obtained outstanding positions) to high performance (having won medals in international championships), calculated based on the best athlete's results.

Only 25% of those who took part in this study are female; the average experience in the sport, in general, is 13.2 years, while the average experience in BMX is 9.7 years (Min. 2, Max. 34; SD= 6.7).

Table 1 describes the composition of the sample that participated in this study.

Table 1. Participants' description.

		F	%
Country	Latvia	3	10.7
	Slovakia	4	14.3
	Spain	15	53.5
	Portugal	6	21.5
Age	≤ 17	19	67.8
	17-29	7	25
	≥ 29	2	7.2
Gender	Male	21	75
	Female	7	25
Category	15-16	18	64.3
	Junior Challenge	3	10.7
	Junior Championship	4	14.3
	Elite	3	10.7
Experience in BMX	≤ 5 years	8	28.6
	6-9 years	11	39.3
	≥ 10 years	9	32.1
Sport level	Regional	3	10.7
	National	9	32.1
	International	5	17.8
	High Performance	11	39.4

When athletes were asked about their short and long-term goals, they found that most participants visualize themselves in the short term as being finalists in World or European Championships or Cups (Table 2).

Table 2. Participants' short- and long-term goals.

Objective/ Time frame	Short-term F (%)	Long-term F (%)
Being Olympic	0	3 (11.5)
World/ European Championship	8 (18.6)	2 (7.8)
World/ European Finalist	17 (39.7)	6 (23.0)
World /Europe Top 16	6 (13.9)	1 (3.9)
National Championship	6 (13.9)	3 (11.5)
To improve	6 (13.9)	8 (30.8)
To enjoy	0	3 (11.5)

One of the limiting factors for sports performance is the occurrence and severity of injuries. In a high-risk sport such as BMX, this is even more important due to the possibility of more serious injuries than in other sports (due to falls, crashes, etc.). 23 riders responded that they had suffered an injury in their sport, with only one rider answering in the negative (95.7% have suffered a BMX injury of varying severity). 13% of the participants had had minor injuries, 56.6% had moderate injuries, 21.8% had serious injuries and one case of severe injury was reported (4.3%), as well as the aforementioned rider who had never been injured (4.3%).

Image 1. Female riders in action.

2. THE BMX PERFORMANCE EVALUATION

By Noel Marcen & Juan Rabal

2. THE BMX PERFORMANCE EVALUATION

2.1. Introducción

2.1.1. BMX

The bicycle motocross (BMX race) is a cycling discipline that combines an individual race to qualify for the consecutive heats where 8 riders compete to reach the finish line in the first place. BMX race was included in the Beijing 2008 Olympic Games. BMX tracks range between 300 – 400 meters, races last 30 -50 seconds and the recovery period between heats is typically 15 -30 minutes. The track combines dirt and asphalt, including several obstacles: the start gate is elevated 5 – 8 meters high, variety of jumps, pumps and turns. A typical track can be categorized into three different phases: 1) Acceleration phase. Determined by the ramp height and slope; 2) Mixed central phase. Riders combine pedalling periods with non-pedalling actions while overcoming obstacles; and 3) Stamina phase. Riders try to maintain the cycling power and maximum speed. The technical and conditional requirements affect these phases (1).

2.1.2. Physical performance determinants.

BMX race is a very technical sport where interpretation of tactical situations is a key for performance. The technical ability to overcome obstacles is decisive in order to maintain speed during the track (2-4). It is also a highly demanding discipline. One of the main physical performance determinants in BMX is the ability to produce high mechanical power output during the pedal phase. The ability of athletes´ neuromuscular and musculoskeletal systems will determine this power output. Riders need to apply high levels of force to the pedal stroke at high contraction velocity.

Race efforts last around 30-50 seconds, being key the first 5-10 seconds as it is the time needed to get a good position in the first obstacle. Thus, the glycolytic and phosphagen systems are the most important physiological pathways involved in BMX race. Recovery capacity will ensure that riders face the subsequent heats/final at their best capabilities.

2.1.3. Power - Strength

Strength is the ability to exert force. A sport as BMX implies accelerations (i.e., change in velocity) of the ensemble rider-bike. The acceleration is closely related with force and mass. In the past years, sport performance has focussed on Power, as the ability to exert force at higher speeds. Several biomechanical factors may be involved in movement strength: 1) neural control, quantity and rate of motor units recruited will affect the contraction, 2) Muscle cross-sectional area, rather than to muscle volume, 3) arrangement of muscle fibers, fiber type and pennation angle, 4) muscle length, a muscle is more efficient at its resting length, 5) joint angle, the torque that can be exerted depends on the joint angle, 6) muscle contraction velocity, 7) strength-to-mass ratio and 8) body size (5).

2.1.4. Objectives

The main objective of this battery test was to continue studying this discipline. Authors aimed to characterize a sample of national level riders from different European countries and to stablish a relation of several conditional items to key aspects in the sport performance. Specifically, the goal was to evaluate the 1) Lower body Force-Velocity profile, 2) Jump ability, 3) Cycling power exerted in an ergometer, 4) Start time and 5) Lactate accumulation in an all-out effort.

2.2. Materials and methods

2.2.1. Subjects

On September 2021, following the BMX European Cup in Anadia, Portugal, a battery of performance test was conducted with riders from five countries and categories U16, Junior and Elite, both males and females. Every procedure was conducted in accordance with the principles of the Declaration of Helsinki. Each participant was informed of the nature of the study, the voluntariness of the participation and of any potential adverse effects and signed an informed consent form.

Table 3. Athletes' distribution. National Federation and category.

National federation	U16		Junior		Elite	
	Female	Male	Female	Male	Female	Male
Brazil	0	0	0	0	0	1
Latvia	0	0	0	3	0	0
Portugal	2	3	0	0	0	0
Slovakia	1	1	0	2	0	0
Spain	3	4	1	2	0	2

2.2.2. Battery test

Tests were chosen following recommendations of research literature (1,6,7):

- Anthropometric and performance data
- Force-velocity profile
- Jump battery
- Wingate test on WattBike

- Start test
- 1 All out lap - lactate test

TEST DESCRIPTION. Before every session, coaches proposed and leaded an appropriate general warming up for their athletes.

Day 1.

2.2.2.1. *Anthropometric and performance data*

Anthropometric data was collected to characterize the subjects and complete some performance test calculations. Height, weight, body mass index (BMI), and leg length (Two measures 1: trochanter – tiptoe, and 2: in squat position, knees in 90°, distance from trochanter to floor) were measured. The athlete gender, category, and level (ranking) were registered.

Material: anthropometric tape, stadiometer, scale.

Image 3. Jump battery 1 (Anadia Portugal).

2.2.2.2. Force-velocity profile

A test to study the Force-velocity profile of U16, junior and elite athletes was performed following recommendations of Morin et al (2016) (8). Gross et al. (2019) studied the force-velocity profile in national level BMX riders (7). To analyse the Force-Velocity profile it is needed to measure the rider´ body weight, lower limb length, starting height and jumping height. This test is based on the relation between the strength and the movement speed of athletes and permit to stablish a theoretical optimal relation Force-Velocity. This approach is used to characterise the neuromuscular system and its ability to generate force.

Thereafter the general warming up, athletes were asked to perform a submaximal counter movement jump (around 70% of their best) and then

3 maximal jumps were performed under 3 conditions: 1) a regular counter movement jump (CMJ), 2) a CMJ with 20% of body weight added and 3) a CMJ with 40% of body weight.

The best jump (highest) of each condition was registered. Force-Velocity profile and Force-Velocity imbalance were calculated and analysed.

Material: Rack with bar and bumper plates. Jumps were registered with the Optogait^{TM} System (Microgate, Bolzano, Italy) and Optogait software 1.12.1.0 (Microgate, Bolzano, Italy).

Image 4. Jump battery 2 (Anadia Portugal).

2.2.2.3. *Jump battery*

The Force-velocity test is not adequate for under 16 riders. Instead, a jump battery test was proposed. Athletes completed 3 CMJ and squat jump (SJ). Thereafter the general warming up athletes were asked to perform a submaximal squat jump and a submaximal counter movement jump (both around 70% of their best) and then 3 maximal SJ and CMJ were performed. The highest jumps of each kind were registered.

Material: Jumps were registered with the Optogait™ System (Microgate, Bolzano, Italy) and Optogait software 1.12.1.0 (Microgate, Bolzano, Italy).

Day 2.

2.2.2.4. *Wingate test on WattBike*

Following a general warmup, the protocol included: 10´ easy ride + 5” at 70% + 1´ easy ride + 5” at 100% level 1 (Sprint 1) + 1´ rest + 5” at 100% level suggested by the bike (depending on body weight) (Sprint 2) + 5´ rest + Wingate test. The Wingate test consists in a 30” maximal sprint. This is a widely used test in cycling (9) and it has been already applied in BMX (6). The main goal of this test is to measure the ability of the glycolytic and phosphagen systems, by measuring the power generated in an ergometer. Instruction to athletes is to perform an all-out test with a duration of 30”. The following variables were registered: 1) Powerpeak1 Sprint 1_5” (W); 2) Powerpeak2 Sprint 2_5” (W); 3) Powerpeak 30” (W); 4) average power 30” (W); 5) MaxCadence Sprint 1_5” (rpm); 6) MaxCadence Sprint 2_5” (rpm); 7) Averagecadence_30” (rpm).

Material: WattBike (WattBike Atom, WattBike LTD., UK)

Image 4. Wingate test on WattBike (Anadia, Portugal).

Day 3.

2.2.2.5. *Start test. 5-meter ramp. First 15m.*

A specific warming up was proposed and leaded by coaches. Athletes performed as many starts as they feel and, when ready, the test began. 3 starts were performed by each athlete, instructions were to start as it would be in a competition. A laser sensor was placed at 15 meters. The fastest trial was registered.

Material: ProStart gate and laser sensors (ProStart, Sainte Soulle, France).

Image 5. All-out- lactate test 1 (Anadia, Portugal)

2.2.2.6. *All out – lactate test.*

Finally, thereafter the start test, a one lap all-out test was carried out. Lactate was registered at three different times: 1) immediately after crossing the finish line, 2) 1´ recovering, and 3) 5´recovering.

Material: Lactate Scout (Lactate Scout 4, EKF Diagnostics, UK).

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Image 6. All-out- lactate test 2 (Anadia, Portugal).

2.3. Results and discussion

Table 4. Athletes' demographic data. Mean (Standard Deviation, SD).

	U16 Mean (SD)	JUNIOR Mean (SD)	ELITE Mean (SD)
Age (years old)	15,9 (0,5)	18,2 (2,2)	25,3 (3,8)
Height (cm)	171,7 (9,3)	180,9 (7,1)	172,0 (6,5)
Weight (kg)	67,5 (12,8)	72,2 (6,8)	73,0 (7,8)
BMI	22,8 (3)	22,2 (2,6)	24,6 (1,3)

BMI: Body Mass Index

Table 5. Men Athletes' demographic data. Mean (Standard Deviation, SD).

	U16 Mean (SD) N=8	JUNIOR Mean (SD) N=7	ELITE Mean (SD) N=3
Age (years old)	15,7 (0,5)	18,2 (2,2)	25,3 (3,8)
Height (cm)	176,8 (8,2)	182,4 (6,1)	172,0 (6,5)
Weight (kg)	70,7 (15,7)	73,1 (6,7)	73,0 (7,8)
BMI	22,4 (3,7)	22,0 (2,7)	24,6 (1,3)

BMI: Body Mass Index

Table 6. Women Athletes' demographic data. Mean (Standard Deviation, SD).

	U16 Mean (SD) N=6	JUNIOR Mean (SD) N=1	ELITE Mean (SD)
Age (years old)	16,0 (0,4)	18,5	
Height (cm)	164,8 (5,7)	170	
Weight (kg)	63,1 (6,1)	66	
BMI	23,2 (2)	22,8	

BMI: Body Mass Index

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Table 7. Athletes´ performance data. Mean (Standard Deviation, SD).

	U16. Mean (SD)	JUNIOR + ELITE. Mean (SD)
CMJ (cm)	32,2 (6,6)	47,6 (6,8) *
SJ (cm)	31,7 (5,2)	41,4 (6,1) *
Time15m (seconds)	2,3 (0,1)	2,2 (0,1)
FV-Imbalance 90º (%SFV_{opt})	47,9 (25,3)	30,8 (24,8)
Powerpeak Sprint 1_5" (W)	1432,0 (273,4)	1643,1 (217,8)
Powerpeak2 Sprint 2_5" (W)	1490,2 (216,1)	1662,4 (240,1)
Powerpeak 30" (W)	1320,3 (192,9)	1596,2 (234,6)
average power 30" (W)	883,3 (141,9)	959,2 (117,5)
W/kg 30"	14,95 (1,34)	21,96 (2,36) *
MaxCadence Sprint 1_5" (rpm)	161,7 (6,2)	175,4 (14,6) *
MaxCadence Sprint 2_5" (rpm)	162,7 (7,5)	169,5 (8,6) *
Averagecadence_30" (rpm)	137,7 (18,2)	148,7 (16,8)

* Shows significant differences between groups

CMJ: Counter movement jump; SJ: Squat jump; FV-Imbalance: Force-velocity imbalance

Table 8. Men Athletes´ performance data. Mean (Standard Deviation, SD).

	U16. Mean (SD)	JUNIOR + ELITE. Mean (SD)
CMJ (cm)	37,0 (3,5)	49,4 (4,8) *
SJ (cm)	34,7 (3,5)	43,2 (4,4) *
Time15m (seconds)	2,24 (0,8)	2,2 (0,9)
FV-Imbalance 90º (%SFV_{opt})	46,1 (26,4)	31,4 (26,2)
Powerpeak Sprint 1_5" (W)	1558,0 (129,9)	1690, (169,2)
Powerpeak2 Sprint 2_5" (W)	1585,6 (124,2)	1713,6 (187,9)
Powerpeak 30" (W)	1431,5 (16,2)	1647,2 (188,9)*
average power 30" (W)	963,5 (41,7)	987,2 (87,7)
W/kg 30"	14,9 (1,9)	22,5 (1,8) *
MaxCadence Sprint 1_5" (rpm)	164 (5,1)	183,4 (12,4) *
MaxCadence Sprint 2_5" (rpm)	165,3 (6,6)	174,2 (5,7) *
Averagecadence_30" (rpm)	145(18,3)	154,8 (14,6)

* Shows significant differences between groups

CMJ: Counter movement jump; SJ: Squat jump: FV-Imbalance: Force-velocity imbalance

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Table 9. Women Athletes´ performance data. Mean (Standard Deviation, SD).

	U16+ Junior N=7
CMJ (cm)	28,1 (3,9)
SJ (cm)	27,8 (5,3)
Time15m (seconds)	2,37 (0,05)
FV-Imbalance 90º (%SFV_{opt})	46,4 (25,8)
Powerpeak Sprint 1_5" (W)	1137,5 (273,4)
Powerpeak2 Sprint 2_5" (W)	1202,5 (2,1)
Powerpeak 30" (W)	1141,5 (61,5)
average power 30" (W)	729(8,4)
W/kg 30"	16,4 (2)
MaxCadence Sprint 1_5" (rpm)	158,5 (4,9)
MaxCadence Sprint 2_5" (rpm)	156,5 (2,1)
Averagecadence_30" (rpm)	127,5 (6,3)

CMJ: Counter movement jump; SJ: Squat jump: FV-Imbalance: Force-velocity imbalance

Maximum lactate concentrations were around 14-17 mmol/l.

Table 10. Correlations between performance variables.

	SJ	CMJ	W/kg	Powerpeak1_5"	power peak2_5"	power peak 30"	average power 30"
SJ		✓✓	✓✓				
Powerpeak Sprint1_5"		✓	✓✓				
MaxCadencia1_5"		✓	✓✓				
Powerpeak2_5"		✓✓	✓✓	✓✓			
MaxCadencia Sprint 2_5"		✓✓	✓✓		✓✓		
Powerpeak_30"		✓✓	✓✓	✓✓	✓✓		
averagecadence_30"	✓✓				✓	✓	
AvgPower 30"		✓✓	✓✓	✓✓	✓✓	✓✓	
Time 15m			✓✓	✓✓*	✓✓*		✓✓*

✓ Shows correlation. (>0.7); ✓✓ Shows strong correlation (0.8); * means a negative correlation

Correlation express the relation between variables. Stronger the correlation, stronger the relation between those variables.

CMJ: Counter movement jump; SJ: Squat jump: FV-Imbalance: Force-velocity imbalance

Research in BMX is scarce, but most studies published (2,10-18) analysed the biomechanics of cycling, and more specific, the power output of riders. Power analysis in the present project was carried out in a laboratory bike, BMX non-specific, as it was done in other studies. Tests in a laboratory bike may analyse the physical condition, but it is not clear that results can be repeatable on the track. Mateo (2011) suggested that power in a BMX real race may be around 85% of the best power in a laboratory test (11).
Gross et al (2019) analysed the force-velocity profile in 12 national level BMX riders. These authors stablished a strong correlation between force and torque, and between maximal power in jumping and maximal power in pedal sprinting (7). Analysing the force-velocity profile, it is possible to identify if an athlete is deficient in strength or in speed of movement in a particular ballistic movement. In this present study we analysed the force-velocity profile in jumping, and as it has been mentioned, this can be related to the power in cycling for BMX riders. Depending on the force-velocity profile results, coaches can easily identify the needs of their athletes and adjust their training program. When athletes show a force-velocity profile higher than 100%, it means that they have a speed deficit. If they show a f-v profile lower than 100% it means that they lack strength. It is noticeable that almost every rider presented an imbalance in the F-V profile, showing an imbalance lower than 60%, and meaning a **high** deficit in strength.
Petruolo (2020) analysed the performance of junior and elite riders in a 5 second sprint, a Wingate test and CMJ. Overall, riders in present study performed better: Peak power 30” around 1350 W vs 1600 W; mean power 30” 850 W vs 960 W; peak power sprint 5” 1500 W vs 1660 W; but instead, performed slightly worse in CMJ 59 cm vs 48 cm (6).

Elite riders in Ryland et al (2017), reached slightly lower power peaks in a 10 seconds sprint (12).

Daneshfar (2020) conducted a field test with sub-elite riders. Participants showed lower peak power and lower cadences that those included in the present study: 1290 vs 1596 W; and 131 vs 148 rpm comparing one lap vs 30” test. Daneshfar (2020) also concluded that relative peak power correlated with race time and that mean cadence correlated with mean power (1). Similar results that present study. “Cadence has been highlighted as one of the key factors contributing to power production”. Herman (2009) included high level elite BMX riders in a cycling power study. These participants showed a peak power higher than 2000 W and cadences higher than 210 rpm (17).

Zabala in 2008 performed a Wingate test in laboratory with Spanish elite riders. Peak power in Wingate test was similar that findings in the present study, mean power in our study was slightly higher than findings in Zabala study (16).

2.4. Training recommendations

2.4.1 Introduction

Bicycle Motocross (BMX) is a cycling discipline that consists of racing across a track with jumps, banked turns and other obstacles over a distance between 300 and 400 metres lasting about 40-45 seconds; the aim of the riders is to reach the finish line in the best possible position (4,10). A competition starts with an individual time trial which decides the seeding used in the following races. This is followed by a series of heats) where 8 riders per heat race around the track. The best 8 riders of these heats compete in a final race to decide the general positions. This makes performance in multiple races important and not just setting the fastest time on one occasion.

An analysis of 175 World Cup races at 4 different venues during the 2012 season performed by Rylands and Roberts showed a moderately strong correlation between a rider's position 1 second after the start and their finishing position, and a strong correlation between a rider's position 8-9 seconds into the race and their finishing position (19). These results suggest that the first 8-9 seconds of a race have a significant impact in the final outcome, with the athletes who have the fastest starts having the greatest chance of finishing in the top 3 places. This information is a good starting point for understanding one of the determining performance factors in BMX racing. The importance of the start and being in a good position at the first bend has been reported by a number of authors because it is difficult to overtake opponents during the race (2,4,10,14,20). This starting point gives some keys to understanding the orientation of conditional training in BMX cyclists.

2.4.2 Physiological profile

The physical efforts required during BMX racing has been characterized as highly demanding despite the relatively short duration. Past scientific studies about the energy contribution in BMX riders highlighted both, aerobic and anaerobic metabolic stress during races (3,21).

Research to date on the physiological profile of bmx riders is limited. The results of the studies availables showed VO_2Max values close to 55 mL·kg-1·min-1 in BMX cyclists. Pretruolo et al. found VO_2Max values of 55.7±4.8

mL·kg-1·min-1 in BMX cyclists, these results are similar to those reported by Louis et al. and Novak and Dascombe (52.4±5.9 mL·kg-1·min-1) (6,18,21). However, these values are lower compared to those recorded in elite (69.6±11.5 mL·kg-1·min-1) and junior level (61.9-69.4 mL·kg-1·min-1) road cyclists, or Cross-country mountain bikers (65.3±7.0 mL·kg-1·min-1) (21,22). Despite the literature suggesting that BMX cyclists achieve an elevated V̇ O2peak (94.3±1.2%) during simulated BMX competitions , the comparisons with other cycling disciplines appear to indicate that the aerobic system is not a limiting factor for performance, potentially due to the “acyclic” nature of this discipline 6 and pedaling effort of less than 14 seconds (18).

Traditionally the study of blood parameters such as lactate, have been related to the anaerobic capacity of athletes. Petruolo et al. found an elevated blood lactate mean value following the 4 heats (12.9±1.6 mmol·L-1) (6). These findings are similar to those reported in a recent study on international BMX cyclists (14.5±4.5 mmol·L-1) (18). The performance of the different heats modified the bicarbonate concentration in blood sample ([HCO3-]) at the end of each simulated race. Hydrogen ion concentration (H+) in blood sample was higher at the start than at the finish in each “moto”. Petruolo et al. (2020) found an improvement in time performance between heats. As discussed, metabolites recovery was not completed between heats. The intermittent nature of the effort required during the different heats, and the technical skill requirements, may also explain the improvement in time performance between heats (6). To understand the intermittent nature of force production in pedalling in BMX, Figure 1 describes the analysis of power by time during an "all out" ride of a BMX track. The need to produce power peaks in the areas of the track where you can pedal seems to be decisive. Especially the peak power output and acceleration of the bike in the first 2-3 seconds of the race (1).

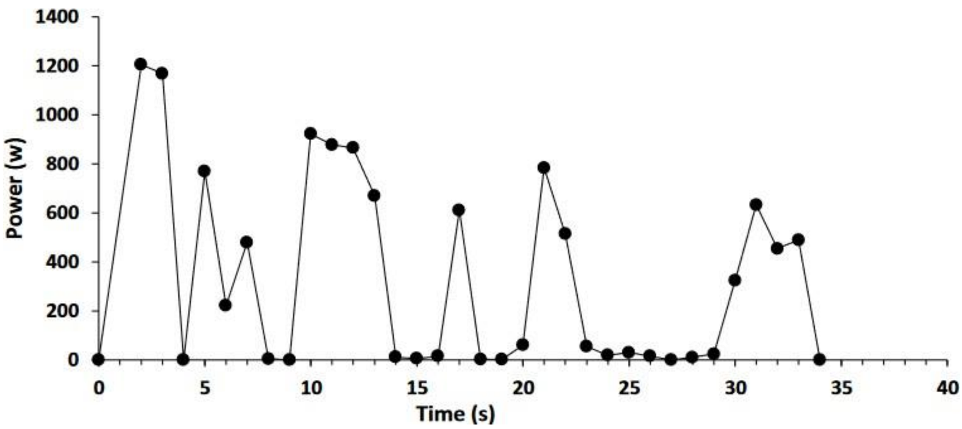

Figure 1. Mean power values recorded at 1-s intervals in the BMX race. Extracted from Daneshfar et al (2020) (1).

The physiological profile of elite level BMX cyclists described, highlights a greater emphasis on anaerobic characteristics, confirmed by elevated power values recorded during the Wingate and sprint tests. The elevated anaerobic and power characteristics recorded are comparable to sports requiring a great contribution of explosive force. The aerobic metabolism has less impact when compared with other cycling modalities, as confirmed by VO2max and lactate thresholds values. The attributes noted in BMX cyclists indicate the need for the integration of sport-specific training protocols relating to anaerobic capacity, as well as elements of force and power.

2.4.3 Training methodologies

2.4.3.1 High-Intensity Interval training

Due to the physiological demands of BMX racing, the use of high-intensity interval training (HIIT) methodologies could optimize athletes' performance. These intervals could be executed on the track itself to increase its specificity although it can also be applied on an ergometer. The use of this methodology can be used for the improvement of maximal oxygen uptake, increased sprint performance, development of neuromuscular properties, and the ability to repeat sprints or short high-intensity efforts (23,24).

HIIT is a training method that runners, swimmers, rowers, and cyclists can benefit from (25). The advantages it offers is the use of short periods of duration at a high intensity. In sports disciplines such as BMX where the competition is carried out "all out" to develop specific training methods on the track, similar intensities should be reached. Prescription for HIIT consists of the manipulation of up to nine variables, which include the work interval intensity and duration, relief interval intensity and duration, exercise modality, number of repetitions, number of series, as well as the between-series recovery duration and intensity. The manipulation of any of these variables can affect the acute physiological responses to HIIT (23,24).

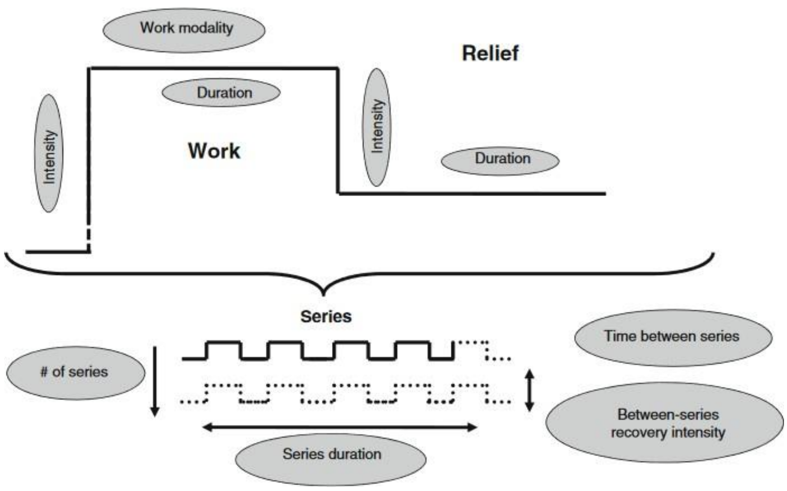

Figure 2. Variables to prescribe high-intensity interval training. Extracted of Bucheit et al (2013) (23,24).

The duration of a BMX race is approximately 30-45 seconds. Short-duration interval work (15-30 seconds) over several sets with 30-60 second rests at intensities above maximal aerobic speed may be a strategy for BMX cyclists to increase their maximal oxygen uptake. In some exercise modalities such as running, in trained athletes using recovery strategies between sets or repetitions could be beneficial to increase adaptations to oxygen consumption (23). Louis et al. found that during a race, the riders were achieving 94.3 ±1.2% of their VO2max. Interval training session consisting of 6x30-seconds all out cycling sprints interspersed with 2 min of passive recovery showed that training method elicits a greater muscle O2 extraction with successive sprint repetitions, despite the decrease in external power production (%Dec = 21%) (26).

The performance of the repetitions in the track (adapting the circuits to modify times) could get the BMX riders to reach intensities to achieve cardiopulmonary adaptations in their maximum oxygen consumption. The HIIT method can be planned to be carried out both on the track itself and with cycle ergometers that can also allow control of pedal power. Training of the straights on the track, as well as complete simulations of the circuit could be the most specific and efficient training to achieve the optimal physiological adaptations for BMX riders.

2.4.3.2. Sprint Interval Training.

Sprint interval training (SIT) is a training method that aims to improve the acceleration and power development of the BMX rider. The main objective would be to make efforts of less than 10 seconds at maximum speed. Although strength training is useful for improving sprinting in cyclists (27), sprint training seems to be more effective for improving sprinting and the power developed in it (28).

Cyclical power in bike sprint is interactively constrained by force-velocity properties, activation-relaxation kinetics and muscle coordination across the continuum of cycle frequencies, with the relative influence of each factor being frequency dependent. Muscle cross-sectional area and fibre composition appear to be the most prominent properties influencing maximal muscular power and the power-frequency relationship. Due to the role of muscle fibre composition in determining maximum shortening velocity and activation-relaxation kinetics, it remains unclear how improvable these properties are with training (29). Approximately 80-85% of the power produced over a pedal cycle is generated during leg extension (i.e., the downstroke), whilst 15-20% is produced during leg flexion (i.e., the upstroke). This power is a product of joint-specific actions of the ankle, knee, and hip, and by upper body actions which transfer power across the hip. The apex of the power-pedalling rate relationship typically occurs at an ‘optimal cadence’ (i.e., ‘optimal frequency’) of 120-130 rpm. For BMX riders it is not only important to build power quickly but gaining position over opponents gives you a tactical advantage during the event.

Whilst a foundation of traditional strength training will benefit maximal cycling power, there is a clear biomechanical discrepancy between the acyclic bilateral movements (e.g., squats and Olympic lifts) often implemented in practice and the cyclic unilateral demands of sprint cycling. Cycling-based force and power training likely remain critical to maximising the transfer of general neuromuscular strength and power to specific sprint cycling power production. Isokinetic cycling may be an especially effective mean to maximise the transfer of general strength to cycling-specific force and power production at a given pedalling rate (29). Resistance training combined with cycling-based strength and power training remains the foundation for long term power-development within sprint cycling. Short sprint training has been shown to be an equally effective method as strength training for gaining strength and power in the lower limbs in cyclist (30).

The ability to produce the best possible average sprint performance over a series of sprints (≤10 seconds), separated by short (≤60 seconds) recovery periods has been termed repeated-sprint ability (RSA) (31). This aspect is relevant in BMX because it is necessary to carry out more than one race within the same competition. Based on knowledge from the race itself, BMX riders should train acceleration from the start as well as reacceleration of the pedals during the race itself. That is, the ability to sprint at the start and re-sprint during the race within its duration. Two key recommendations in RSA training method: it is important to include some training to improve single-sprint performance (e.g. 'traditional' sprint training and strength/power training); and some high-intensity (80-90% maximal oxygen consumption) interval training to improve the ability to recover between sprints (31). Just like the HIIT training method, RSA and SIT methods can be done on the bike itself on the track or on cycle ergometers.

The objective of the Sprint training is to improve the starting phase, as well as the different straights of the track. Using simulated race starts with other riders, it would be beneficial to include technical-tactical elements. The ability to sprint on the flat (without the starting ramp) could be a variant to consider.

2.4.3.3. Strength Training

Peak power development, power development during the Wingate test (30 seconds) and the ability to sprint for 8-9 seconds are important performance factors for optimal BMX cycling performance (6,19,32). Previous studies showed that strength training (off-track training in the gym) can improve cyclists' ability to achieve peak power and improve their sprinting ability achieving their power peak and cadence (33-35). Also in road cyclist, strength training could achieve the cycling economy and pedalling characteristics (34,36). On the other hand, the height reached in CMJ has been studied in BMX riders (6) and in some cases it shows that riders with higher jump height are faster on the track (37). The values found for elite BMX riders are values around 55 cm of jump CMJ (Pretruolo et al. 58.6 ±7.7 cm and Rober et al; 50.9 ± 9.7 cm). Strength training (traditional and velocity-based training), plyometrics (traditional, assisted and resisted plyometric) and Olympic lifts have been shown to be good training methods to improve the vertical jump parameter in athletes (38-40). Resistance training is an effective method to enhance muscle strength and jump performance in young athletes (41).

Currently, limited scientific studies are available with strength training protocols to optimize performance for BMX riders. The truth is that the available studies indicate that athletes in this discipline can benefit from strength training, because the maximal strength is a muscular determinant of the performance during short all-out cycling sprint (20).

BMX racing has unique characteristics when compared with other cycling disciplines. Because of the short duration and technical demands of the sport, speed-strength, strength-speed, explosive power, and strength are important (42). Start race in BMX needs a high amount of force in a short time and a great maximal strength is not necessarily associated with a great rate of force development (RFD). The athlete has to attempt to maximise the execution velocity against the load (20). The priority objective of strength training should be to be able to apply the maximum possible force in the shortest possible time (improving RFD). This means that weightlifting must be done with the maximum intentionality possible and moving the loads as fast as possible. Velocity-based training could be a positive proposal for intensity control in this type of athletes (38,43,44). Velocity-based resistance training might be more effective than percentage-based training in maximal strength improvement, in which velocity-based resistance training is more suitable for athletes in season, while percentage-based training is more suitable for the general sports population (45).

Despite the perception that leg strength is important in cycling the upper body plays a large role in force production both during cycling and pumping around the track, therefore the upper body should not be neglected in the weights room. A high degree of movement literacy, dynamic stability and efficient use of the kinetic chains are required to manipulate the bike and for aerial skills and so Olympic and other free-weight exercises such as the squat and bench-press are to be prioritised over machine weights.

2.4.3.4. Resistance training - Exercise selection

Considering the different skills associated with BMX racing, there are several exercises that are thought to influence performance in these areas. The selection of exercises described below are thought somewhat specific to the strength, power, and technical demands of the sport. Specific attention should be paid to flexion/extension of the hip and knee and to horizontal shoulder adduction/abduction (42). Generation of force while pedalling is predominantly a product of hip and knee extension (46). From a gym strength training perspective, strength and condition coaches should focus on:

- Improve lower extremity strength for more pedalling power or jumping ability.
- Increase the strength of the upper extremity to control the bike (pumping techniques, turns...).
- Increase the stability and strength of the core muscles (transmission of forces, stability on the bike, disturbances...).
- Use free weights instead of machines.
- Develop power exercises that involve multi-joints.

The exercise proposal that is developed below starts from the perspective of the development of basic movement patterns. The objective is to improve the strength of pushes and pulls with the upper limbs (in horizontal and vertical vectors), as well as knee dominant exercises (eg: squats or lunges) and hip hinges (eg: dead lift, hip thrust…). In addition, the development of trunk stability as a basis for the transfer of force between limbs will be encouraged.

To build strength in the lower extremities, we should select exercises that involve extension of the ankle, knee, and hip. The basic movements will be the squat and the deadlift (Image 7). The deadlift exercise involves hip and knee extension, as well as the need to hold the barbell with your hands, making it an ideal choice for the BMX athlete (Image 8) (42).

Image 7. Squat with barbell.

Image 8. Deadlift from floor or hanging.

Starting from bilateral exercises, we can develop strength with unilateral exercises such as lunges, single leg dead lift or box step ups (Image 9 and 10). These exercises can be used with the full spectrum of loads for strength development. This type of training could help develop the strength of each of the lower extremities (right and left side) as well as reduce possible imbalances and asymmetries between the sides (47,48).

Image 9. Single leg dead lift.

Image 10. Box step up.

For the acceleration phase of the bike, Olympic weightlifting could be an effective proposition. They require great intermuscular coordination and in turn high rates of force development (RFD) and tremendous technique, as in the start (42). To achieve more appropriate angles during the movement and have a biomechanical similarity to the pedalling phase, both the clean and the snatch could be performed from hanging positions above and below the knees (Image 11). We must develop these types of exercises with the maximum lifting speed possible to enhance power. Other adaptations for non-weightlifters' athletes like BMX riders could be high pulls and jump shrugs.

Image 11. Hang power clean with different start positions.

As we have discussed in previous sections, the development of plyometric exercises, especially the concentric phase, could be an effective option within the strength training programs of BMX riders (Image 12).

Image 12. Counter movement jump and box jump.

Upper extremity training in BMX riders should not be a less important part of training schedules. The ability to control the bike makes them able to generate and resist the forces that occur in technical elements such as jumps or pumping. Upper extremities exercises can be developed with the body itself, dumbbells, barbells, or other training devices like kettlebells. The purpose is to move away (push) or approach (pull) a weight to the body. It could be interesting to use grip widths like those used in handling the bike handlebars.

Bench press is one of the exercises most used by athletes to improve pushing strength. This exercise and its derivatives with other types of material, unilateral and in other vectors, is an effective option for developing the basic pushing pattern (Image 13).

Image 13. Bench press.

The pull-up and rowing exercises are proposed as exercises for improving specific pulling strength in the BMX athlete (Image 14). Although some may consider a lat pull-down a viable alternative to the pull-up, our suggestion is that this would decrease the specificity of the exercise. In BMX, the ability to control one's body is a foundational skill for optimal technique. The pull-up is an excellent demonstration of relative strength (strength in relation to body mass) (42).

Image 14. Pull up and barbell row.

Strong core muscles function as hubs in the biological motor chain, which create a fulcrum for the four limbs' strength and establish a channel for the cohesion, transmission, and integration of the upper and lower limbs (49). In other words, core training optimizes the transfer and overall control of motion and force to the terminal segment within athletic actions. Meanwhile, core training could increase stability and stiffness in the spine to reduce unrequired "energy leaks" and torso movement during the exertion of external loads. This mechanism could help athletes achieve better skill performance (49,50).

Trunk muscle training improves core stability (51). Core stability provides the foundation from which power is generated in cycling. Improved core stability and endurance could promote greater alignment of the lower extremity when riding for extended durations as the core is more resistant to fatigue (52). Core stabilization exercises are just as effective in activating the trunk muscles as traditional exercises (crunch, sit-up), managing to involve the muscles of the front and back of the trunk working at the same time to stabilize. Swiss ball (fitball) is a good element to promote trunk stability with different exercises (image 15).

Image 15. Core stability exercise (plank) in Swiss ball and a variation.

2.4.4 Periodization

Considering the dates of the competitions according to the Union Cycliste Internationale World Cup season of BMX. It is appropriate to highlight the programming proposed by Cowell and collaborators (42), in the case of senior BMX rider. The main idea is to obtain high maximum strength levels without forgetting to emphasize explosive strength which is the main performance factor in BMX. For this reason, the selection of exercises (resistance exercises, plyometric exercises...) should be aimed at improving RFD.

Table
Annual training plan for Supercross BMX season

Date	Emphasis	Repetition Range	Set Range
November-December	GPP	12–15	2–4
December-January	Hypertrophy	8–12	3–5
January-February	Strength	3–5	6–8
February-May	Strength/power	1–5	8–12
Late May-mid June	Hypertrophy	8–12	3–5
Mid June-July	Strength	3–5	6–8
Mid-July- August	Power	1–5	8–12
Early August	Strength	3–5	6–8
Mid-August	Power	1–5	8–12
Mid-August-September	Strength	3–5	6–8
September-October	Power	1-5	8-12
October-November	Transition	Off	Off

Figure 3. Annual training plan for Supercross BMX season. Extracted of Cowell et al. (2012) (42).

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BMX is currently the sport selected by many children, as the sport they practice during their childhood and youth. For this reason, it seems appropriate to write down a series of very useful recommendations for BMX school coaches who want to train strength with their athletes and prepare them for future phases.

Long-term athlete development (LTAD) models may aid in structuring a young athlete's training (53). Irrespective of chronologic age (biological age is more important in youth sport athletes to detect sensible phases of musculoskeletal growth), following an initial focus on fundamental movement techniques, such as the squat and hip-hinge, strength development can then be periodised within a LTAD program (53). As strength fundamentally underpins power, it is important to first develop this, while concurrently refining the technical skill required for weightlifting. Physically mature athletes should undertake high-intensity resistance training to maximise neuromuscular adaptations to resistance training, leading to changes in physical performance.

Resistance training is an effective method to enhance muscle strength and jump performance in youth athletes, moderated by sex and resistance training type. Dose-response relationships for key training parameters indicate that youth coaches should primarily implement resistance training programmes with fewer repetitions and higher intensities to improve physical performance measures of youth athletes (41).

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		10	11	12	13	14	15	16	17	18	19	20	21	>21
Chronological age (years) Biological age		Pre-PHV				PHV				Post-PHV				
Training focus	Functional movements	FOUNDATIONAL MOVEMENTS												
	Weightlifting		TECHNICAL DEVELOPMENT				INTRODUCTION TO LOAD					HIGH-INTENSITY LOADING		
	Traditional resistance training					INCREASE IN TRAINING INTENSITY								
Recommendations		General strength Emphasis on functional movements 1-3 sets x 8-10 reps			Strength development increases in training intensity 2-3 sets x 6-8 reps 70-80% 1RM					High intensity resistance training Traditional and weightlifting movements 3-4 sets x 1-6 reps 70-100% 1RM				

Figure 4. Free-Weight Resistance Training recomendations in Youth Athletes. Extracted of McQuilliam et al. (53). Grey areas refers a lower focus, green areas refers to a greater training focus. *PHV* Peak-height velocity, *reps* repetitions, *RM* repetition maximum.

2.4.5 Injury Risk

Injuries in BMX are more present than in other cycling sports (54-57). The incidence observed in Rio de Janeiro Olympic Games (2016) was six times higher than reported in 1989 in the study by Brøgger-Jensen et al. (54,57). Concussions and abrasions are the most common type of injury. Crashes, often involving several participants, occurred frequently. Injuries were sustained through impact on the track and/or collision with the rider's own or other riders bicycles (54). There are currently no data available to compare the incidence of injuries in periods of training and in competition. It is remarkable that the fact of competing with 7 other riders makes it necessary to train the initial starts and curves with other cyclists to improve tactical skills in the race. The risk of injury can be reduced through skill development to ensure riders are competent over the obstacles found on a track and through hypertrophy training to protect the body in the event of a crash (42).

2.5. Education Recommendations

BMX coaches need to understand the fundamentals of physical determinants in athletic performance, and specifically in this sport. Classic strength training methodology is the basis, focussing on the importance of power and strength. During the last years new approaches in strength training have emerged. Coaches would benefit of Velocity-based training (VBT); High-Intensity Interval training (HIIT); Sprint interval training (SIT); and repeated-sprint ability (RSA) methods. In addition, coaches should be trained to properly use the different biomechanical assessment tools: 2D video analysis, 3D sensor analysis, power meter, velocity-based sensors, etc.

2.6. Conclusions

BMX riders in the present study presented a good level of general performance attending the power analysis. Data registered is similar or better than other scientific studies results with national level BMX riders. As far as the authors knowledge, there is only one study with high level international riders. In this study riders presented significant higher peak power and higher cadences, showing that these variables are key for performance in BMX. A strong correlation was found between the counter movement jump (CMJ) performance and the power peak in 5 seconds and 30 seconds sprint and with the average power in 30 seconds' sprint. The peak power in 5 and the average power in 30 seconds sprints also correlated with the time performance in the first 15-meter start simulation. It is necessary to highlight the need to improve the power in jumping and the overall strength level.

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Image 16. Anadia BMX track

3. THE PSYCHOSOCIAL FACTORS OF BMX PERFORMANCE

By Ana Aguilera & Celia Marcen

Co-funded by the Erasmus+ Programme of the European Union

3. THE PSYCHOSOCIAL FACTORS OF BMX PERFORMANCE

3.1. Sport Psychology introduction

Sport psychology brings together knowledge about the human being in the sports context. Therefore, it works on the specific skills and competencies of each of the agents that make up this context. Numerous studies over the last few years have demonstrated the improvement of sports performance through the use of various psychological techniques, as reflected in the conclusions of a recently published systematic review (Lochbaum, et al., 2022).

Among the broad areas of intervention in sports psychology, some authors state that in the specific case of sports training: athletes need comprehensive skills training to handle the existential challenges of their age, and these interventions should include their environment (coaches and teammates, among others) and that these interventions should maintain a long-term focus (Henriksen, et al., 2014).

While it is true that systematic reviews of research studying the psychological demands of cycling have been appearing, these reviews reflect those studies conducted so far in the field of sport psychology applied to cycling lack strong scientific evidence. Specifically, they have only highlighted that professional cyclists have higher than normative mood profiles, that pre-competitive anxiety levels affect performance and those high levels of confidence facilitate performance. Furthermore, they have highlighted how certain leadership qualities are associated with better performance (Spindler, et al., 2018).

However, when it comes to the study and intervention of sports psychology in BMX, few studies reflect all the psychological demands and needs of this sport. There is only some research that has focused on very specific aspects such as the perception of anxiety through heart rate variability and its relationship with the starting position, the benefit of visualization practice (psychological technique), as well as the study of motivational processes and burnout syndrome (Mateo, et al., 2012; Di Rienzo, et al., 2018; Daneshfar, et al., 2021; Gautheur and Descas, 2014). Paquet, Bertucci, and Hourder (2006) focused on the relationship between one of the most commonly used tests, the Wingate test, and certain psychological variables such as attributional style, self-esteem, and motivation, finding that only the former could explain more than 9% of the variance in terms of the athlete's performance in the test.

Therefore, we do not know specifically those psychological skills and techniques that influence BMX performance and racing. Therefore, this exploration of the psychosocial profile of the BMX athlete will contribute to the improvement of sports coaching and training.

For this purpose, we have assessed those factors that previous literature highlights, among others, as key elements for sports performance, such as psychological characteristics like stress control, motivation, the impact that the evaluation of others has on the athlete, mental ability, or group cohesion. For this purpose, the Questionnaire of Psychological Characteristics involved in Sports Performance (CPRD) by Gimeno, Buceta, and Llantada (2001) was applied.

To carry out effective psychological interventions in the context of sport, it is necessary to integrate general principles of psychology, identifying the characteristics and possible differentiating variables not only of sport, to meet its requirements, but also those of each of the different modalities

(Arias, Cardoso, Aguirre, Arenas, 2016:26). This specificity would be such in terms of assessment instruments and terms of the sports modality. The CPRD questionnaire has been applied to tennis, paddle tennis, kayaking, swimming, rhythmic gymnastics, judo, football, and even sport referring. There are no studies about these variables in BMX Race or similar sports (competitive risk sports).

Another key factor has to do with the leadership style that the coach exercises, in this case questioning the participants about their model of the "ideal coach". For this purpose, Chelladurai and Saleh's (1980) Sports Leadership Scale was used, in their version of athletes' preferences about their coach's leadership model (LSS-1).

Previous literature highlights parental support, or more broadly, that of the family and close environment, not only for sporting performance but also for the integral and healthy development of young athletes. Ding (2019) concluded parents acceptation is a key factor in BMX and other lifestyle sports in China. In this research, a brief scale that measures family support and that was developed specifically with technical and high-performance athletes was also applied to identify the perception of athletes in terms of this variable (Marcén, Gimeno, and Gómez, 2012).

Finally, in a high-risk sport, it seemed necessary to assess the inclination towards risk-taking and preventive behaviors of BMX athletes. For this purpose, the Risk-Taking Inventory for High-Risk Sports was applied (Woodman et. al, 2013).

The following sections describe the test battery used, the results, the conclusions, and recommendations for improving the performance and training of sports coaches and conclude with the bibliographical references used and the recommendations for the improvement of performance and the training of sports coaches and conclude with the bibliographical references used and the recommendations for the improvement of performance and the training of sports coaches.

Image 17. Coach demonstration.

3.2. Psychosocial Battery: Questionnaire description

To gain insight into this psycho-social environment, assessment instruments developed and validated specifically in a sports context have been chosen.

3.2.1. Questionnaire of Psychological Characteristics for Sport Performance

Psychological skills in sports performance have been considered a mediating factor between the physical, technical, and tactical abilities of athletes (Mahamud et al., 2007) and, therefore, in the development of sports talent (Ramírez and Andreu, 2021).

A widely used assessment tool to explore these aptitudes, characteristics, and sporting skills is the questionnaire Psychological Characteristics Related to Sporting Performance, hereafter "CPRD" (Gimeno, et al 2001). This was developed taking as a starting point the "Psychological Skill Inventory for Sport" (PSI) (Mahoney, et al., 1987). This instrument was translated and adapted into Spanish and subsequently completed with 26 new items that covered issues that had not been covered in the original version (Mahamud, Tuero, & Márquez, 2017). The CPRD questionnaire has been used in various research and applications in the study of the psychological profiles of various sports and is composed of 55 items that analyze 5 psychological skills in sport: stress control, influence, performance evaluation, motivation, mental ability, and team cohesion.

As an example of the application of this questionnaire, we could find the research carried out in the Gipuzkoa Sports Talent Development programme, which aimed to analyze these psychological skills in promising and talented sportsmen and women from Gipuzkoa. In this study, they found statistically significant differences according to gender in the total of the scales analyzed, as well as differences between the promising and talented categories (showing lower scores for promising athletes) in the mental ability scale (Ramírez and Andreu, 2021).

These five scales and the relationship established in their scores are described below.

Stress management: describes the characteristics of the athlete's response to the demands of training and competition, as well as in potentially stressful situations. A high score on this scale indicates that the athlete has psychological resources.

Influence of performance evaluation: describes the characteristics of the athlete's response to situations in which the athlete evaluates his or her performance or considers being evaluated by significant others, as well as to antecedents that may lead to an appraisal. A high score indicates a perception of high control of the impact of a possible negative evaluation (self or others).

Motivation: includes the degree of motivation to train and improve oneself, goal setting and goal achievement, the importance of sport concerning other activities, and the cost/benefit ratio of this sports activity. A high score indicates the presence of high levels of motivation.

Mental ability: all those psychological skills that can support sports performance (goal setting, performance analysis, behavioral rehearsal in imagination, and cognitive functioning). A high score indicates the presence of these skills.

Team cohesion: explores the integration of the athlete in his or her team or sports group taking into account the interpersonal relationship with the members of the group, the level of satisfaction in group work, the individualistic attitude, and the importance he or she attaches to "team spirit". A high score indicates a high level of integration in the group.

Previous literature carried out with the same instrument (CPRD) shows gender differences, not only in general but also concerning the modality practiced, which is why it will be one of the variables to pay special attention to (Arias et al., 2026). Fradejas & Espada-Mateos found higher scores in men in stress control and influence of performance evaluation. Furthermore, mental ability and team cohesion relation in men with the sport modality, but not in women. No significant differences were found concerning age, but there were significant differences in self-confidence in men according to the modality practiced (in school sports).

In addition, among women who are professionally involved in sport, they could score higher in motivation, while those who are amateurs do so in stress control and the evaluation of the influence of performance (Ruiz-Esteban, Olmedilla, Mendez, Tobal, 2020).

In the study conducted at a National High-Performance Center (Marcen, 2014), a statistically significant association was observed between age and the "influence of performance evaluation" scale. Similarly, the relationship between the questionnaire scales and sports level showed a statistically significant positive correlation between the "influence of performance evaluation" scale and sports level. Analyses of the possible relationship between the questionnaire scales and gender showed significant differences in the "team cohesion" scale, where male athletes scored significantly higher than female athletes. About the modalities practiced, athletes playing individual sports (or individual events within a sport) scored significantly higher on this same "team cohesion" scale.

Di Rienzo et al. (2018) on the Influence of starting fence position on physical performance and anxiety perception in expert BMX athletes, found that anxiety scores (somatic and cognitive) were higher before riding from the inside lane compared to the outside lane. Something they did not expect to find since the inside lane was assumed to be more favorable. State anxiety (somatic, worry, and concentration disorders) negatively predicted initial performance. They recommended individualized interventions aimed at limiting such somatic anxiety and worry during BMX initiation.

Gautheur and Descas (2014) on burnout syndrome and motivational dynamics in BMX athletes found that physical and psychological demands (concentration, reflexes, and commitment) are repeated in all training and competitions among elite athletes, which leads to feeling burned out in season. The environment must perceive possible signs and symptoms of athlete burnout as well as the motivational tendency associated with it to carry out interventions aimed at reducing this syndrome at the onset of its appearance among athletes. There is a negative relationship between burnout and intrinsic motivation, so the athlete's self-determination and competence should be strengthened.

Daneshfar, Petersen & Gahreman (2021), evaluated the effect of a 4-week mental imagery training programme on BMX performance. They used MI training (mental imagery, a form of simulation) where the entire physical experience of an action (e.g. feeling, hearing, and seeing) occurs in the mind and has been shown to influence actual performance. There was no significant improvement in the finish time of the cyclists after MI training, but it showed a slight trend of improvement. Despite this, muscle power improved significantly after MI practice. They recommend the application of MI as a complimentary training method in addition to physical training to improve sports performance.

These studies, despite not having used the CPRD questionnaire as a tool, demonstrate the relevance of the variables it measures for BMX performance and psychological work.

3.2.2. Leadership in Sports Scale

Taking a multidimensional approach, leadership effectiveness is a function of three interacting aspects of leader behavior: actual preferred and required behavior (Moen, et al. 2014). These three behaviors make up the three versions of the Leadership Scale for Sport LSS: preferred leadership behaviors (LSS-1), required leadership behaviors (LSS-2), and actual leadership behaviors (LSS-3).

These three versions, in turn, can result in five dimensions (coaching and instruction, democratic behavior, autocratic behavior, social support, and positive feedback) reflected in 40 items, which are answered using a 5-point Likert-type scale. Empirical research shows that these five dimensions are significantly related to athlete satisfaction, intrinsic motivation, perceived competence, and performance (Chelladurai, 1993). These dimensions can be grouped into three factors (Loughead and Hardy, 2005): direct-to-task factor (training and instruction), decision style factor (autocratic vs. democratic behavior), and motivational factors (positive feedback and social support).

Pitts, Nyambane & Butler (2018) on preferred leadership in student-athletes found that the leadership dimension of democratic behavior was preferred more by student-athletes participating in individual sports than student-athletes in team sports; corroborating findings from other studies. Calvo & Topa (2019) on leadership and motivational climate with football players found that coaching and instructional leadership style and a task-oriented motivational climate significantly predict player satisfaction and sport commitment.

In a study conducted specifically with BMX athletes, it was found that those athletes who were more satisfied with their sports performance rated the coach's leadership behavior with higher scores on the dimensions of coaching and instruction, democratic behavior, social support, and positive feedback (Moen, et al., 2014).

The version used in this project explores those preferred leadership behaviors (LSS-1) and will reflect the scores for each dimension directly with the scores obtained. The description of these five dimensions is presented below.

Training and instruction perceive ideal coach behavior as behavior that is directed towards athlete performance by emphasizing instructions and structuring and coordinating athlete activities. It consists of 13 items such as "my ideal coach instructs each athlete individually about the skills needed in his or her sport".

Democratic behavior conceives the ideal coach's behavior as one that allows for greater participation of the athletes in decisions regarding group goals, practice methods, tactics, and game strategies. It consists of 9 items such as "my ideal coach lets the athletes be part of the decision making".

Autocratic behavior perceives the ideal coach's behavior from independence in decision making and emphasizing personal authority. It consists of 5 items such as "my ideal coach does not explain his actions".

Social support conceives the ideal coach behavior as focusing on the well-being of individual athletes, a positive group atmosphere, and interpersonal relationships with members. It consists of 8 items such as "my ideal coach is attentive to the well-being of the athletes".

Positive feedback perceives that the coach's behavior reinforces the athlete by recognizing and rewarding good performance. Use consists of 5 items such as "my ideal coach tells the athlete when he/she does a good job".

Coach leadership is relevant both in training and in competition, affecting both the intensity and the direction, positive or negative, of the athlete's effect (González-García, Martinet, and Nicolas, 2020).

3.2.3. Parental (Family) Support in Sport Scale

The family environment plays a decisive role not only in initiation (choice of sport and type of practice), but also in the relationship (positive, negative, or indifferent) that children will have with physical activity in general and sport in particular, with its continuity and dedication, and in their attitude towards it. This influence is determined by the imitation of practice models, by the perceived support or obstacles, as well as by the contribution of economic and human resources so that the sports activity can be developed (Marcen, et al., 2012).

In the study carried out in a national high-performance Centre with more than 200 athletes (Marcen, 2014), statistically significant associations with CPRD were found for the following items: "I tend to trust myself even in the most difficult moments of a competition"; item "in most competitions I trust that I will do well"; and with the item "at this moment, doing well in my sport is the most important thing in my life". We then proceeded to study the possible relationship between parental support and age and gender. For the first variable, the correlation is not statistically significant, while for the gender variable, the female group has a higher perception of parental support compared to the male group.

To assess the support of the athletes' family environment, we will use the Parental Support in Sport Scale. It is aimed at athletes with a performance objective to a greater or lesser extent. It was designed and validated for athletes from a National High-Performance Centre (Marcen, 2014), in which 347 athletes from 19 sports participated. This scale was developed with a mixed qualitative-quantitative methodology. In its first qualitative evaluation phase, using a survey of open-ended questions, athletes from a high-performance center were asked about the support they perceive from their parents. The content analysis carried out identified the units of meaning that served as the basis for the wording of the items of a new closed-ended survey. This 7-item scale measuring the construct of family support about sports performance was then developed. The 7 items are answered using a Likert scale of 1 to 5 in which the athlete reports the degree of agreement-disagreement (Marcen, et al., 2012) with items such as "my parents support me emotionally". In this project, the items will be presented under the name "my family" instead of "my parents" to cover the maximum number of family and age casuistries that may make up our sample of athletes.

3.2.4. Risk in High-risk Sports Inventory

There has been much debate about the personality of those people, especially young people, who are attracted to high-risk sports, by awarding them the preliminary research significant effect sizes in favor of the high-risk participants for sensation seeking, extraversion, and impulsivity (McEwan, Boudreau, Curran, Rhodes, 2019).

Although some individuals appear to deliberately increase exposure to danger by deliberately engaging in additional risk-taking behaviors while participating in high-risk sports (Llewellyn and Sanchez, 2008), many high-risk sports participants appear to engage in an expressed desire to minimize and control the dangers inherent in the high-risk activity by exhibiting precautionary behaviors (Celsi, et al. 1993; Pain and Pain, 2005 as cited in Woodman, et al. 2013).

Thus, risk-taking in high-risk sports does not appear to be a unitary phenomenon but comprises two well-contrasted behaviors: deliberate risk-taking and precautionary behavior. For example, a climber might deliberately climb a steep rock face without a rope (deliberate risk) and yet take several precautionary measures (e.g. recognize the type of rock very carefully and check the weather).

Based on this conceptualization of risk and its associated behaviors, a scale was developed to more accurately analyze participation in high-risk sports. The authors propose this scale as a measure that will allow researchers and practitioners to investigate risk-taking as a conceptually distinct variable from participation in high-risk sports. In the process of developing this scale, different verifications of this scale were carried out through four research studies: relating it to other psychological constructs (sensation seeking, impulsivity, behavioral activation, etc.) and to the number of accidents suffered in high-risk sports (Woodman, et al., 2013).

Therefore, this scale has been included in the psychosocial test battery, since it allows for measuring the tendency of athletes to perform risky behaviors and precautionary behaviors. It is easy to apply and has been adapted and validated in different contexts (i.e. Frühauf, Hardy, Roberts, et al., 2018 in Germany). High-risk sports could have, in the age of adolescence, the potential to satisfy reward needs, prestige or social recognition, and risk-taking in a socially accepted way (Frühauf and Kopp, 2020).

seem to have the possibility to satisfy the need for rewards, prestige, and risk-taking in a socially accepted way.

It is composed of 7 items in which the athlete marks the frequency of this behavior or thought. The results are presented on two different scales: deliberate risk with items such as "I proactively look for dangerous situations" and precautionary behaviors with items such as "I take time to check conditions (e.g. weather conditions"). In addition, the data will be analyzed together with the athletes' information on the variables "injuries" and "falls" collected in the dossier of evaluation session 2.

Finally, defining the psychological profile of BMX riders is fundamental, this profile being those psychosocial variables that affect sporting performance (Ruiz-Esteban, et.al., 2020), as there is no single athlete profile, but rather it depends on variables such as the type of sport, gender, or competitive level. Galilea (in Gonzalez et al., 2015:352) stated that ‘a good specialization in sports requires to determine which variables should be considered to succeed in that field’, being specific to the modality.

The total number of participants in this study was 28 athletes (21 men and 7 women) with a mean age of 17.89 years (SD= 6.70) and mean BMX experience of 9.68 years (SD= 6.67). The competitive level was defined as: high performance (n=11), international level (n=5), national level (n=9) and regional level (n=3). All data in this paper were entered and processed using the SPSS statistical package version 28.

3.3. Results

3.3.1. Questionnaire of Psychological Characteristics for Sport Performance Results (CPRD)

Descriptive data for the different scales of the Psychological Characteristics for Sports Performance Questionnaire are shown in Table

Table 11. Means and standard deviation of CPRD.

	N	Minimum	Maximum	Mean	SD
Stress Control	28	22.00	72.00	52.11	12.33
Performance Evaluation Influence	28	16.00	49.00	32.93	7.91
Motivation	28	14.00	30.00	23.43	3.79
Mental Ability	28	17.00	30.00	22.86	3.59
Team Cohesion	28	4.00	22.00	15.07	4.21

Compared to the original study (Gimeno, Buceta, and Pérez-Llantada, 2001), all measured scores obtained except for team cohesion are higher in the BMX study than with athletes in general (Figure 5), but similar. The biggest difference is the influence of performance evaluation.

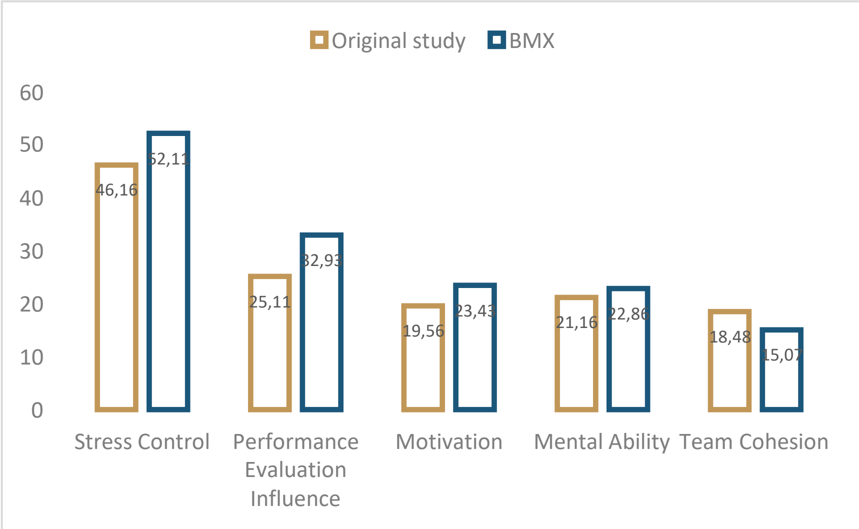


Figure 5. Comparison between the original CPR study (Gimeno, Buceta, and Perez-Llantada, 2001) and the BMX Training to Win study.

Figure 6 shows the mean scores by gender for each of the scales, showing differences in the stress control scale, with lower scores obtained by females.

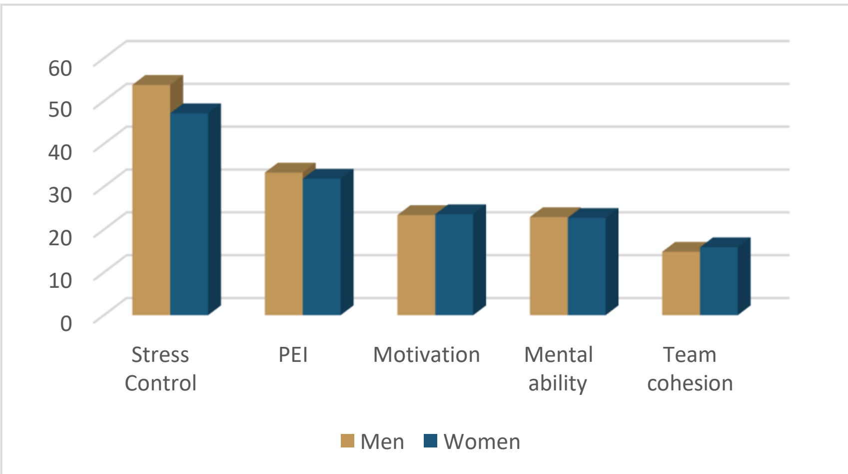


Figure 6. Psychological characteristics influencing sports performance by sex.

Similarly, it is the stress management scale in which there is the greatest difference in mean scores between children under and over 16 years of age, being somewhat higher among the latter (Figure 7). In addition, older children scored higher on performance evaluation influence (PEI) and, to a lesser extent, on motivation and group cohesion. Younger children only score slightly higher on mental ability.

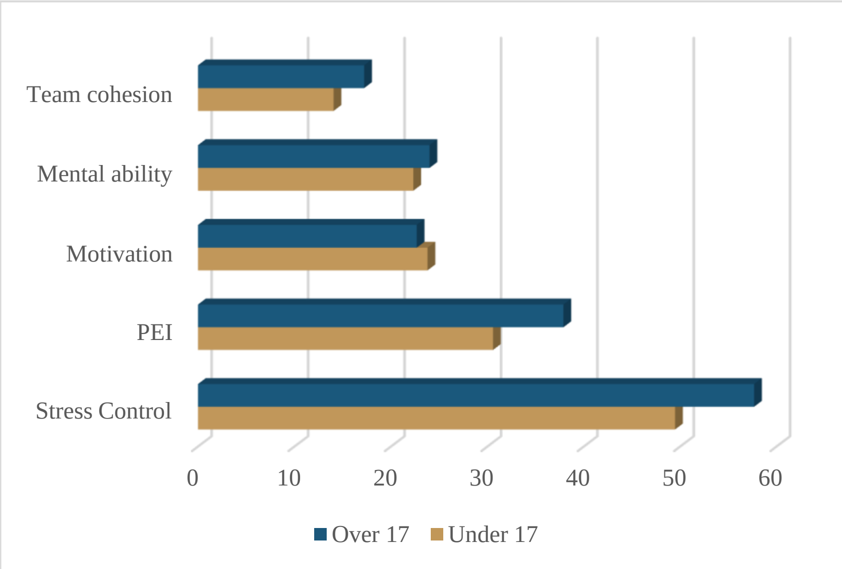


Figure 7. Psychological characteristics influencing sports performance by age range.

Based on experience (years of BMX riding) we found that more experienced riders seem to have better stress control, better influence on performance evaluation, mental ability, and team cohesion. Only in terms of motivation, a slightly higher score is observed for those with a medium level of experience in the sport (Figure 8).

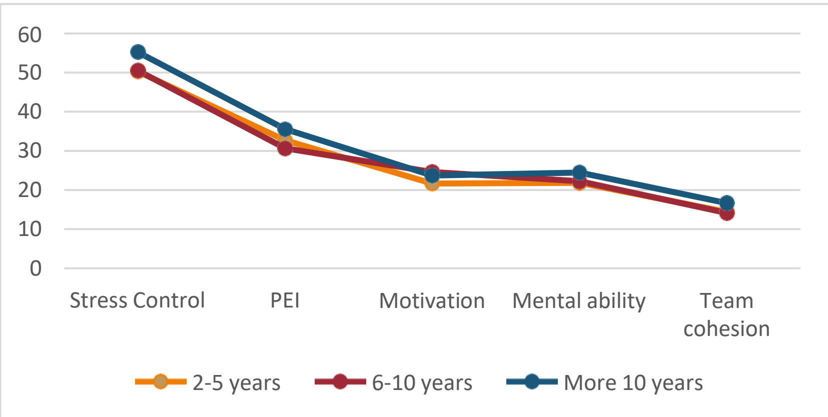


Figure 8. Psychological characteristics influencing sports performance by BMX experience (in years).

Regardless of their experience and classified into four levels according to the sporting performance demonstrated (best result), the higher and lower levels manage stress better, the lower levels are less affected by the evaluation of their performance in the eyes of others, and the higher levels show higher levels of motivation, mental ability and team cohesion (Figura 9).

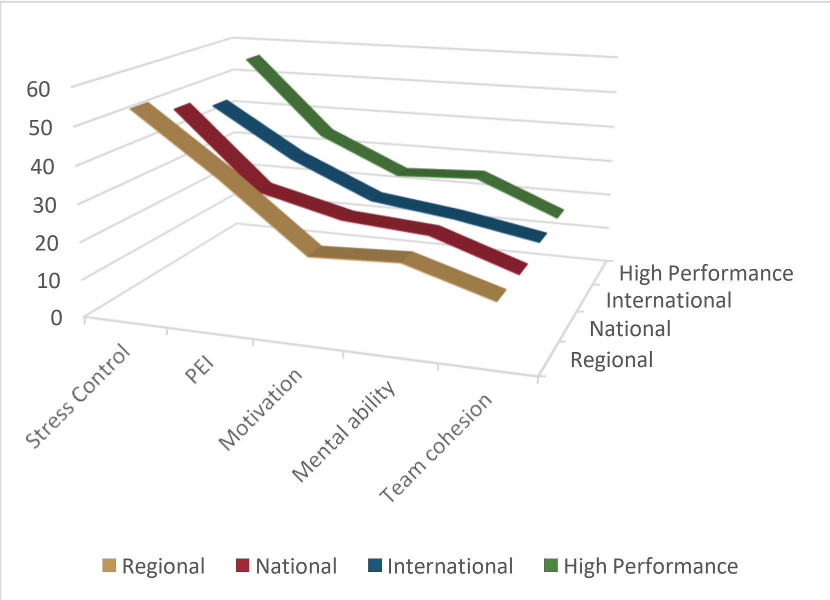


Figure 9. Psychological characteristics influencing sports performance by BMX level.

3.3.2. Leadership in Sports Scale Results (LSS)

Descriptive data for the different scales of the Leadership in Sports Scale (LSS) are shown in Table 12.

Table 12. Means and standard deviation LSS-1.

	N	Minimum	Maximum	Mean	SD
Training and instruction	28	3.54	5.00	4.55	.360
Democratic Behavior	28	3.11	5.00	4.10	.469
Autocratic Behavior	28	1.00	4.00	2.40	.774
Social Support	28	3.38	5.00	4.08	.530
Positive Feedback	28	3.80	5.00	4.61	.396

Compared to the reference study (Moen, Høigaard & Peters, 2014), all measured scores obtained are higher in the BMX study than with athletes in general (Figure 10), but similar. The biggest difference is found in Social Support.

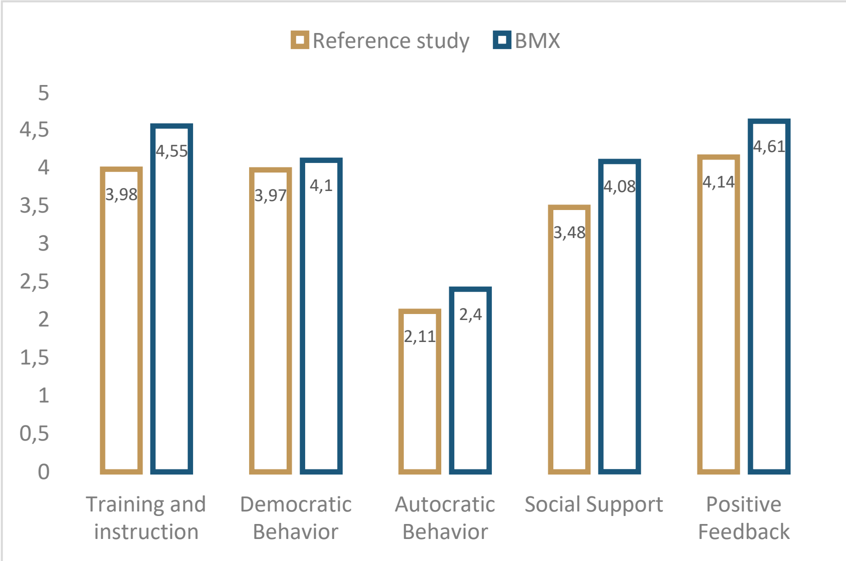


Figure 10. Comparison between the reference LSS-1 study (Moen, Høigaard & Peters, 2014) and the BMX Training to Win study.

Figure 11 shows the mean scores by gender for each of the scales, showing differences in the Training and Instruction and Autocratic Behavior scales, scoring higher for women in the first and men in the second one.

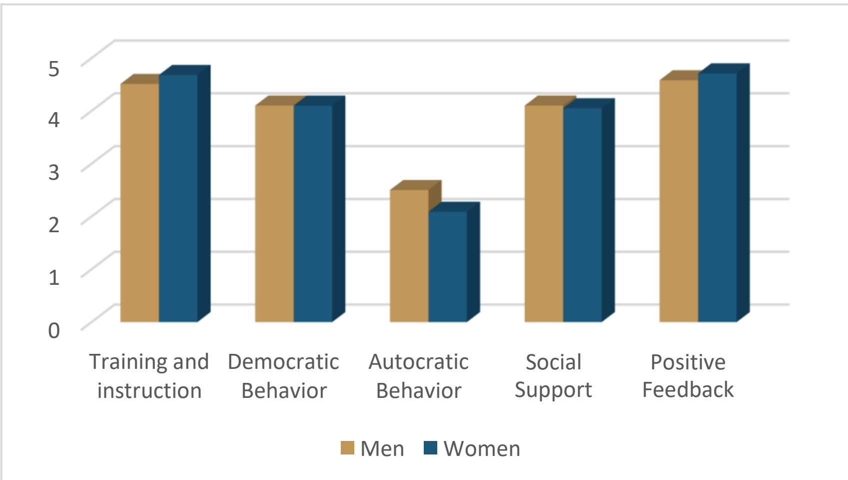


Figure 11. Preferred Leadership behavior (LSS-1) by sex.

Similarly, it is the Democratic Behavior scale in which there is the greatest difference in mean scores between children under and over 16 years of age, being somewhat higher among the youngest (Figure 12).

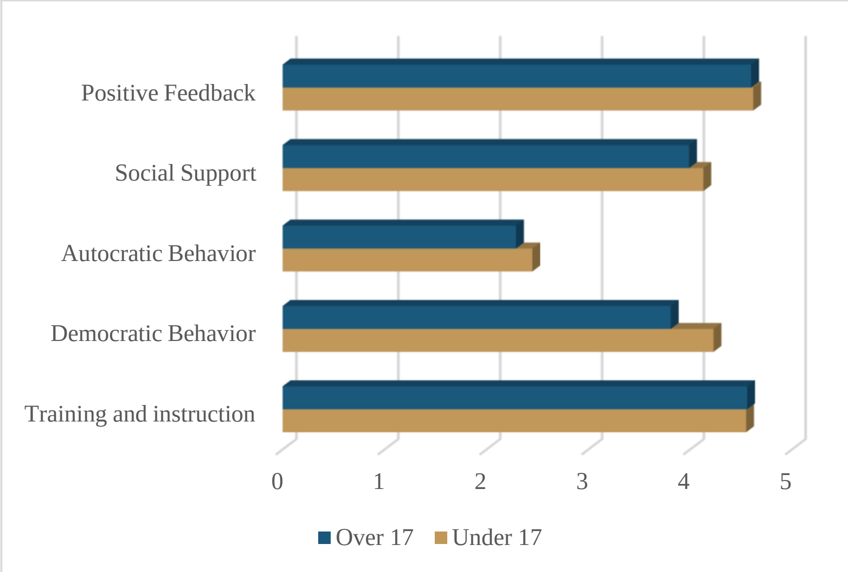


Figure 12. Preferred Leadership behavior (LSS-1) by age range.

Based on experience (years of BMX riding) we found that more experienced riders seem to prefer Training and Instruction and Autocratic behavior to a greater extent than the less experienced ones. Less experienced scored higher in the Positive Feedback style (Figure 13).

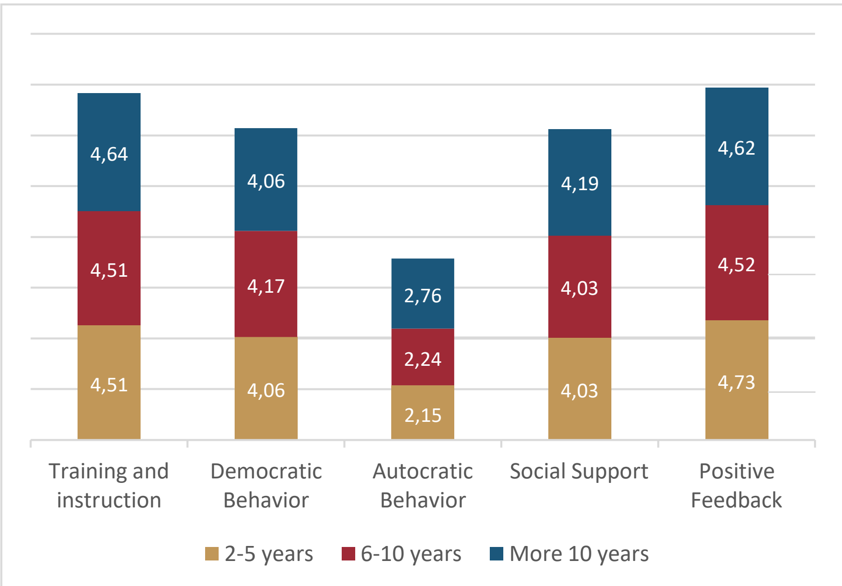


Figure 13. Leadership preference per BMX experience (in years).

Regardless of their experience and classified into four levels according to the sporting performance demonstrated (best result), (Figura 14). Those that were classified as High Performance scored higher in Autocratic Behavior; those on an International level showed their preferences for Training and Instruction, Social Support, and Positive Feedback.

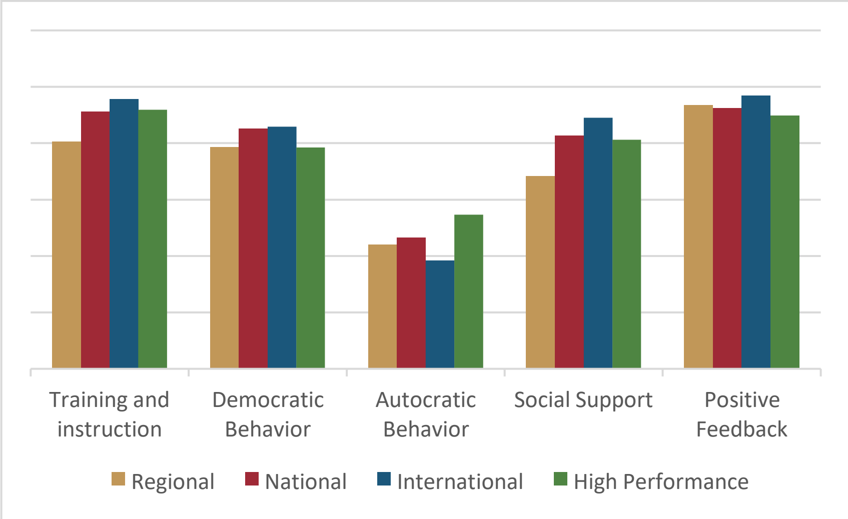


Figure 14. Leadership behavior preferences by BMX level.

There are small differences by gender, with women preferring Positive Feedback (+0.13) and Training and Instruction (+0.17) styles. Autocratic Behavior (-0.41) is the one they reject more than men, which should be taken into account.

More experienced athletes prefer to a greater extent Coaching and Instructing styles, (as found in previous studies with LSS), as well as Autocratic Behavior. Less experienced athletes prefer Positive Feedback, while those with 6 to 10 years of experience perform better with the Democratic Behavior style.

Regarding sport level, those who have reached higher levels perceive ideal coach behavior as behavior that is directed towards athlete performance by emphasizing instructions and structuring and coordinating athlete activities. Those who have reached finals in international competitions perceive that the coach's behavior reinforces the athlete by recognizing and rewarding good performance (Positive Feedback), in the same way as those at the national level.

3.3.3. Parental (Family) Support in Sport Scale Results

Descriptive data for the different scales of the Parental (family) Support in Sport Scale (PSS) are shown in Table 13. Compared to the reference study (Marcen, 2014), the BMX rides scored

Table 13. Means and standard deviation Parental Support in Sport.

	N	Minimum	Maximum	Mean	SD
Parental Support	27	25.00	35.00	33.0	2.41
Reference study (Marcen,2014)	209	0.00	25.00	11.66	3.96

Figure 15 shows the mean score by gender, being scores very similar both for men and women.

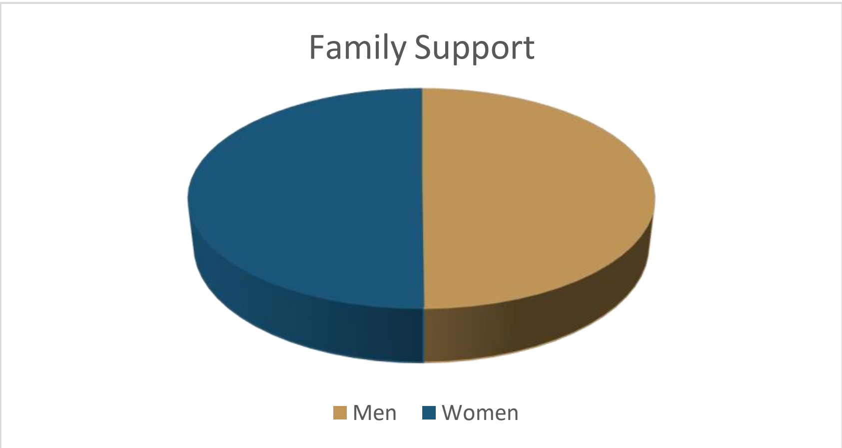


Figure 15. Perceived Family Support by sex.

By age, the differences are also small (2,5 points), considering the high scores obtained in general (Figure 16)

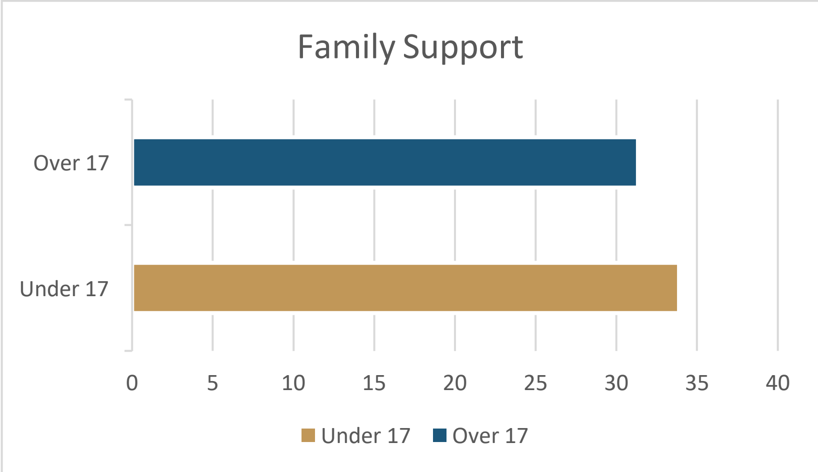
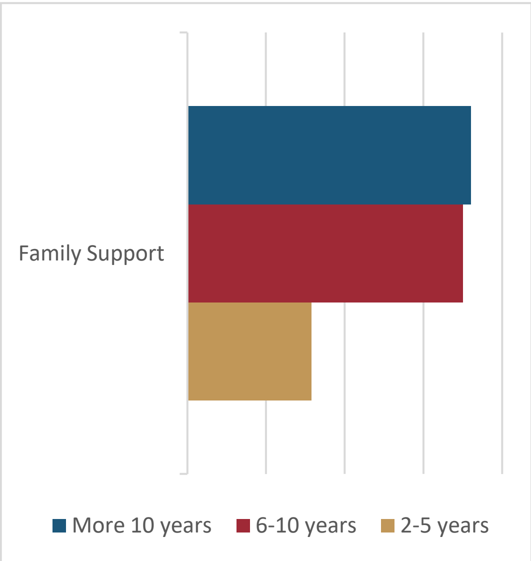


Figure 16. Perceived Family Support by age range.

Based on experience (years of BMX riding) we found that less experienced riders perceive less support than most experienced. However, high-performance athletes score lower than the other level categories (Figures 17 and 18).



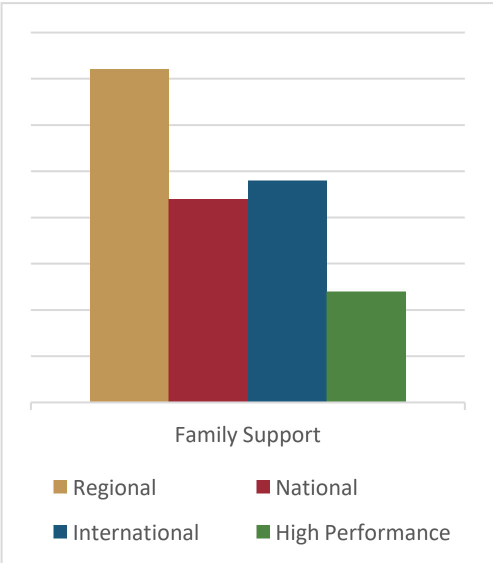


Figure 17. Perceived support by BMX experience. Figure 18. Perceived support by BMX level.

3.3.4. Risk in High-risk Sports Inventory Results (RTI)

Descriptive data for the different scales of the Risk in High-risk Sports Inventory Results (RTI) are shown in Table 14. Compared to the original research (Woodman et al. 2103), in their studies (with a sample of 518 individuals who participated in a range of high-risk sports), BMX participants' scores are slightly higher on Deliberated Risk-taking and considerably lower on Precautionary Behaviors (Figure 19).

Table 14.. Means and standard deviation RTI.

	N	Minimum	Maximum	Mean	SD
Deliberate Risk-Taking (DRT)	23	3.00	13.00	7.74	2.30
Precautionary Behaviours (PB)	23	6.00	17.00	13.13	2.90

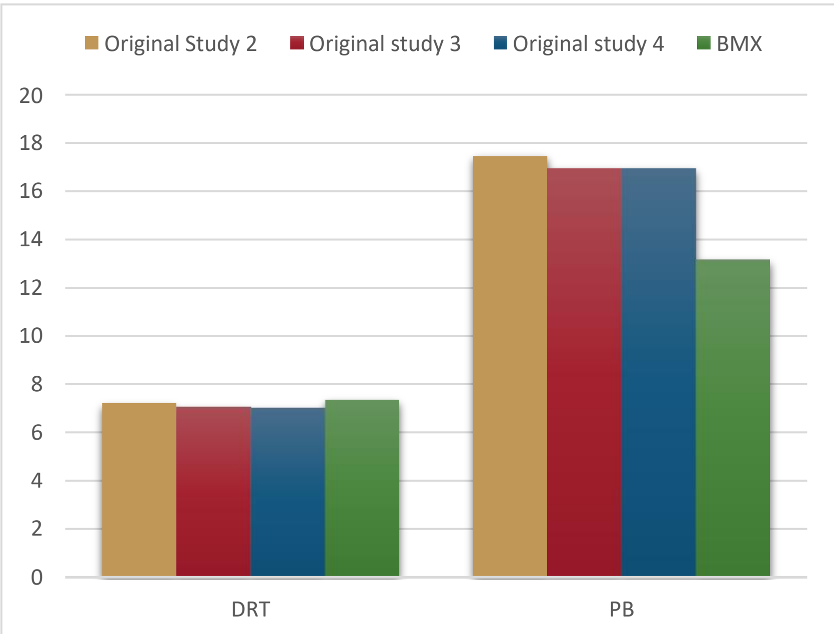


Figure 19. Comparison between the original studies (Woodman et. al., 2013) and BMX Training to Win Study.

Figure 20 shows the mean scores by gender for each of the scales, with significant differences in scores by gender, with men being more likely to engage in risky behavior, but also more likely to engage in precautionary behavior than women.

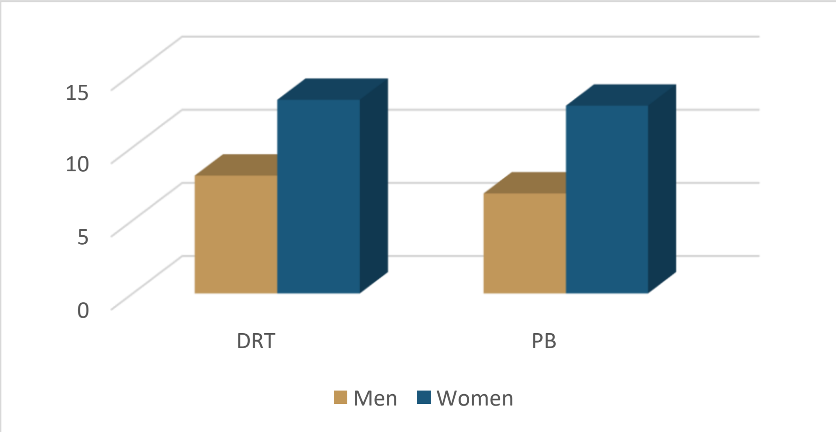


Figure 20. Risk and precautionary behavior by sex.

As far as the age of the participants is concerned, while the scores for deliberate risk-taking are similar between those under and over 16 years of age, there are differences in the adoption of precautionary behaviors in favor of the older ones (Figure 21).

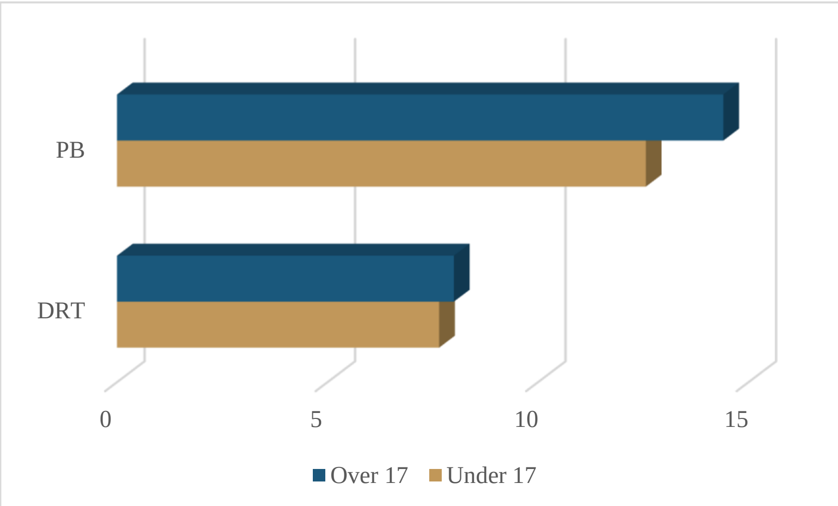


Figure 21. Risk and precautionary behavior by age range.

Based on experience (years of BMX riding) it was found that more and less experienced riders scored slightly higher than the intermediate experienced both in DRT and PB (Figure 22).

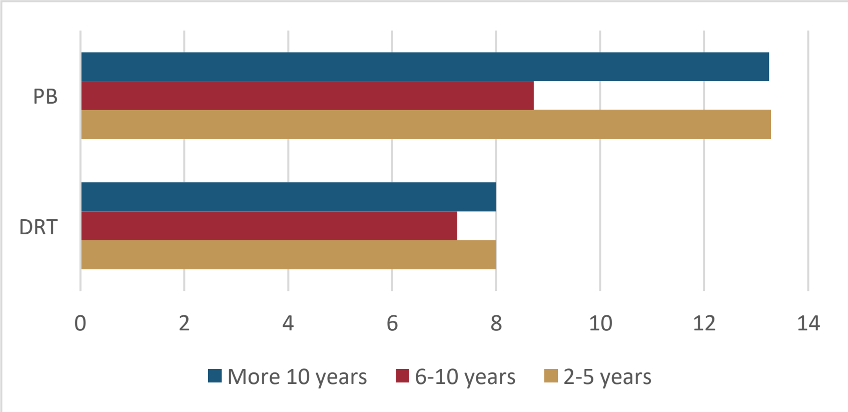


Figure 22. Risk and precautionary behavior by BMX experience (in years).

Regardless of their experience and classified into four levels according to the sporting performance demonstrated (best sporting result), the lowest performers score highest on deliberate risk-taking, while for precautionary behavior-taking, both high performers and regional level score higher than the other performance levels. (Figura 23).

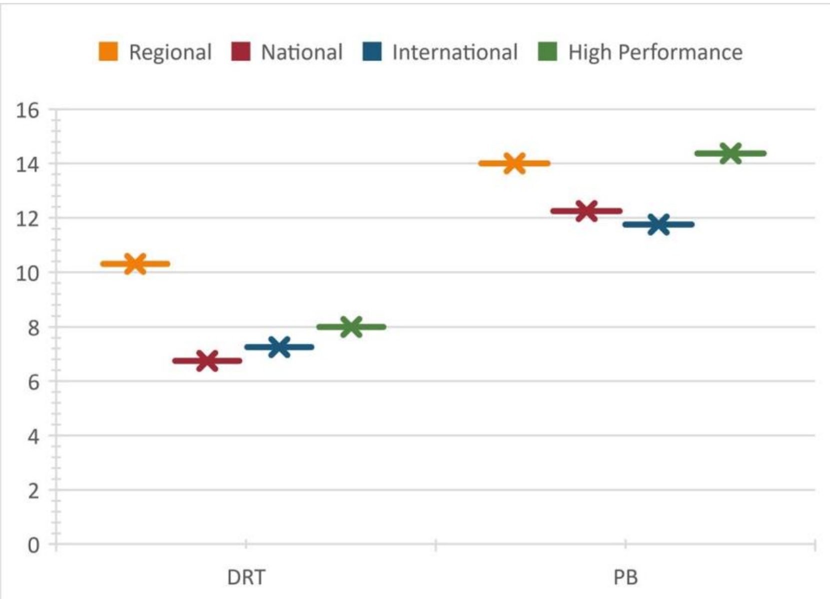


Figure 23. Risk and precautionary behavior by BMX level.

3.3.5. Association between variables

After the descriptive analysis, normality tests were carried out on the scales of all the questionnaires used.

According to the data reflected in the Shapiro-Wilk test (due to the size of the sample), it was found that the scales: training and instruction, social support, positive feedback (all of them from the LSS-1 questionnaire), parental support and precautionary behaviors (from the RTI questionnaire) were not parametric. Thus, Spearman's Rho test was applied to these scales in the study of bivariate correlations.

In the study of bivariate correlations for the rest of the scales, Pearson's correlation test was applied.

To analyze the correlation between the variables sex and age with the scales of the questionnaires, the following order was carried out. First, the analysis of bivariate correlations was applied to the non-parametric scales together with the variables age and sex. Subsequently, the analysis of bivariate correlations was performed on the parametric scales together with the variables age and sex.

Table 15. Spearman correlations.

	Age	Training and Instruction	Social Support	Positive Feedback	Parental Support	PB
Age	-	.011	-.039	-.214	-.484*	.308
Training and Instruction		-	.573**	.211	.495**	-.042
Social Support			-	.417*	.504**	-.211
Positive Feedback				-	-.044	-.473*
Parental Support					-	-.177
PB						-

*Correlation is significant at the 0.05 level (bilateral).

**Correlation is significant at the 0.01 level (bilateral).

Regarding the analysis of correlations in the non-parametric scales, no significant bilateral correlation was found for any scale with the sex variable. However, as shown in Table 16, a significant negative bilateral correlation was found between the parental support scale and the variable age (r=-.484; p= .011).

Table 16. Pearson correlations.

	Age	Stress Control	Performance Evaluation Influence	Motivation	Mental Ability	Team Cohesion	Democratic Behavior
Age	-	.207	.444*	-.220	.407*	.170	-.509**
Stress Control		-	.745**	.451*	.513**	.182	-.162
Performance Evaluation Influence			-	.250	.382*	.277	-.281
Motivation				-	.163	.338	.199
Mental Ability					-	.094	-.111
Team Cohesion						-	-.108
Democratic Behavior							-
Autocratic Behavior							
DRT							

*La correlación es significativa en el nivel 0.05 (bilateral)

**La correlación es significativa en el nivel 0.01 (bilateral)

Regarding the correlation analysis of the parametric scales, no significant bilateral correlation was found with the gender variable. In the analysis of correlations of the parametric scales with the variable age (see Table 6), three significant correlations were found: weak positive correlation of the performance evaluation influence scale (r= .444; p= .018), weak positive correlation of the mental ability scale (r= .407; p= .031) and medium negative correlation of the democratic behaviour scale (r= .509; p= .006).

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3.4. Conclusions and Recommendations

This study aimed to explore the psycho-social profile of the BMX athlete to be able to make improvements in the advice and sports training of this discipline. For this reason, different questionnaires were applied that explored the psychological skills related to their sporting performance, the athlete's preference for the leadership style of their coaches, the presence of a family environment in their sporting career, and, given that this sport is seen as a risk sport, the behaviors that may be associated with its practice.

From the results of this study, it could be highlighted that, concerning the psychological skills of sporting performance, there could be a certain relationship between the influence of performance evaluation and age, so that the older the athlete, the greater the perception of control and, therefore, the lower the probability of suffering while competing. In addition, there also seems to be a certain relationship between age and the mental ability of the athlete. Thus, as the athlete advances in years, he/she would know how to apply more efficiently certain psychological resources related to performance, such as setting goals or carrying out a correct analysis of his/her performance.

Concerning the athlete's social environment, it could be pointed out that the preference for actions typical of democratic behavior (such as the athlete's participation in decision-making) decreases as age increases. We could study whether this negative relationship between age and preference for democratic behavior is exclusively due to age or whether the number of years of BMX practice also plays a role.

Finally, and also concerning the athlete's environment, it seems that the presence of family support decreases as the athlete's age increases.

A Decalogue of Recommendations is presented below:

1. Psychological skills

- It is important to train and work on **psychological skills applied to sport**, as it has been demonstrated that these are mediating factors between the physical, technical and tactical abilities of sportsmen and sportswomen.
- The variables affecting sport performance analysed are affected by the gender, age, sport level and specific BMX experience of the riders analysed.
- In general, the evaluated athletes present values similar to those of other previous studies in terms of the characteristics involved in sports performance and, in particular, to the original study by Gimeno et a., (2001).

2. Psychological Characteristics Involved in Sports Performance

- Sporting careers can be long and challenging, leading to high levels of burnout during the season. **Enhancing optimal levels of intrinsic motivation** of the athlete through the development of self-determination and perceived competence helps in the prevention of negative consequences (burnout).
- **Psychological work should be strengthened in terms of stress management among female and younger athletes**. Stress management as well as performance evaluation score on average lower among younger and less experienced BMX athletes, which is related to the fact that the older they are, the more likely they are to have acquired that experience, but also due to greater maturity. Higher level athletes show greater psychological skills, scoring higher on all scales.

3. Objectives

- The **ability to correctly establish and analyse sports performance objectives** increases with the age of the athlete. Therefore, it would be advisable to work on and strengthen this ability in younger athletes.

4. Activation

- It is necessary to enhance all those psychological skills related to the **regulation of the level of activation and pre-competitive anxiety**, particularly in younger athletes.

5. Gender differences

- **There are no major differences in the psycho-social profile between men and women**. However, there is a slight difference in the stress management ability of female athletes. Therefore, it may be necessary to train this particular mental ability.

6. Mental imaginery

- The **practice of visualisation or mental imagery** as a form of simulation can improve some components related to sports performance and is often applied in learning to regulate pre-competitive arousal in various sports.

7. Preferred leadership

- **The preferred leadership typology varies** according to the age/category of the athlete. Younger athletes express a greater preference for democratic leadership, which allows them to participate in decision-making.
- Los estilos de liderazgo preferidos por los deportistas de BMX participantes en el estudio fueron Feddback Positivo y Entrenamiento e Instrucción, aunque obtienen aceptación también Comportamiento Democrático y Apoyo Social. El Comportamiento Autocrático es el menos deseado.

8. Parental Support

- **Family or parental support** seems to be more present in the first years of a sporting career. It is a fundamental part of the athlete's support network that can strengthen their sporting commitment.
- **The family support perceived by young people is very high**, which could be partly due to the fact that BMX is a risky sport, which has a medium-high economic cost and requires more logistics than other sports.

9. Risk-taking

- While Deliberate Risk Taking behaviours are similar to those in previous studies, the athletes analysed scored much lower on precautionary behaviours. **There are considerable differences between men's and women's attitudes to risk**, with women scoring higher on both scales, which contradicts many previous studies that have assumed that men are more risk-taking.
- In terms of sporting level**, beginners take more deliberate risk-taking behaviour**, so training in risk management is essential for new riders. The model should be the higher level athletes, who have a medium level of deliberate risk-taking and a high level of preventive behaviours.
-

10. Injuries and falls

- Among those who had minor or serious injuries (i.e. on the outer two of the injury classification), they scored lowest on deliberate risk-taking. **Those who said they had serious injuries scored highest on preventive behaviours.**
- For those who reported **never falling, the scores between DRT and PB are balanced** (13 and 14, respectively), and this relationship becomes unbalanced as the frequency of falls increases, with a difference of 5.50 points between those who fall the most.

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Limitations

One of the biggest difficulties has been the lack of specific scientific studies on BMX psychology. Instruments have been applied and contrasted and applied in multiple sportsmen and contexts so that a profile of the BMX rider can be drawn. In this sense, the battery applied has proved adequate to measure a wide range of psychological variables in a modality that has hardly been studied.

Another major difficulty for data collection was the COVID-19 pandemic, which prevented a higher-level sample of around 30 athletes with at least national level in their respective countries (being a finalist or regular medallist in national championships), and of Elite categories, as planned.

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INDEX

INDEX

Table index

Images index

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Figures index

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THE PARTNERSHIP

THE BMX TRAINING TO WIN PROJECT CONSORTIUM

PROJECT COORDINATORS

BMX School Zaragoza (Spain)

BMX School Zaragoza it is a grassroot sport club from Zaragoza (Spain). Its mission is to approach BMX to all riders, looking for performance or not, and especially for all-age children. Their vision is shown in an Albert Einstein quote: "Life is like riding a bicycle. To keep your balance, you must keep moving."

Their values as a sports club are effort, fellowship, sportsmanship, and fun. It has a high-performance section, a children's school section, and a sport-for-all section.

Created in 2017, its president, Rafael Izquierdo Tello is a rider, BMX National Champion, and still active as an athlete.

The club collaborates with other three nearby clubs in different municipalities of Aragon- Spain (Ricla- BMX Valdejalón, Utebo- Adrenalina Bikes, and Calamocha- Club BMX Calamocha), creating a BMX school where children, youth and adults can practice in four different circuits with different mates, increasing the BMX-community feeling between riders of all ages. A total of 150 riders are involved.

They promote additional activities: Additional activities they do are:

- BMX classes to a specific population.
- Educational talks at primary and secondary schools about biking, road safety, and youth leadership.
- Bike technique for adults.
- BMX event's organization.
- Holiday camps for children.

They collaborate with the town councils on programming BMX in different cultural and sports events.

Best results:

- Jorge Gil: European Champion (Orleans 2012 in Cruiser 40+) and 5th World Championship (Baku, 2018, in Cruiser 45+ Men).
- Rafael Izquierdo: 5th World Championship (Zolder 2019, Cruiser 25-29 Men) and Champion in European Cup (Anadia 2021, in 25+ Men).
- Adriana Domínguez: 5 times Spanish National Champion, 9th World Championship (Baku 2018, 15 years Women), 15º World Championship (Papendal 2021, Junior Women), finalist in several European Cups.
- Lara Palacio: 4 times Spanish Champion.
- Fabiola Contamina: 6th European Cup (Anadia 2021, 15-16 years Women), Spanish National Champion.

Fundación Universidad San Jorge (Spain)

San Jorge University Foundation (Spain) (hereinafter FUSJ) is a non-profit organization dedicated to training and research. Its mission is to serve society by creating and transmitting knowledge and contributing to the formation of integrity and good professionals.

The teaching and learning model of San Jorge University is based on six distinct elements:

- The integral education of the person is present in the curriculum of each program (personal project and professional project).
- A culture of service to those around us through the integration of Service Learning in the curriculum and the promotion of voluntary work with the University community.
- The personalized attention of the student through the commitment of the teaching staff to attain positive results in the application of the tutorial action plan.
- Teaching innovation and the integration of new technologies to constantly

improve the learning experiences of our students.

- The internationalization of the study programmes to prepare the student for an increasingly international and global employment market.
- Links to the industrial and business community, encouraging the participation of visiting professionals in teaching activities and the development of real undergraduate and postgraduate projects in collaboration with companies and institutions.
- The University is composed of different knowledge areas (degrees, master and doctorate):
    - Faculty of Health Sciences (Bioinformatics, Biomedicine, Nursing, Pharmacy, Physiotherapy, Psychology, and Sport Sciences).
    - Faculty of Communication and Social Sciences (Journalism, Advertising and Public Relations, Translation & Intercultural Communication, Film, TV and Digital Communication, Marketing, Infant and Primary Education, Law and School of Governance and Leadership: Administration and Business Management).
    - School of Architecture and Technology (Computer Sciences, Computer Engineering & Design and Development of Video Games, Design and Creative Technologies, Environmental and Energy Engineering and Architecture School).

Moreover, there are two integrated research institutes: the Institute of Modern Language and the Institute of Humanism & Society.

The University has more than 2500 students, and the human resources are around 150 people in technical and administrative positions, more than 350 lecturers and researchers conducting degrees, master's, doctorate, and summer courses, etc.

ValorA Research Group

This research group aims to develop, validate and/or apply instruments and working methodologies leading to product development to improve physical, psychological, and social health, and performance in specific movements, such as those related to work or sports activities.

Researching lines:

1. Movement assessment.

   Within the group, there are experts in biomechanical analysis both from a performance and clinical point of view. Movement kinematic studies are carried out both in our laboratory and in real situations through portable technology. Different physiological variables related to musculoskeletal disorders are also analyzed. Global intervention programs are also being implemented that prevent these disorders and can even improve the quality of life of the people analyzed. The studies that are being carried out are developed in the clinical area and the work environment and sports. These include the analysis of walking and running using spatial-temporal parameter recording systems, high-speed imaging, and the study of plantar pressures. From the field of ergonomics, movements are analyzed in real work situations, using accelerometers and portable electromyography, detecting harmful postures, and proposing exercises that compensate for the discomfort found due to poor execution and/or repetition of these gestures.

2. Social research applied to health and sport.

   Within this line, the relationship between the individual and their environment is evaluated, to propose improvement strategies and contribute to decision-making. Among the research topics of this line is the study diagnosis of specific populations in the field of health or sports, surveys of life habits related to physical activity, the study of the perception of quality of life in specific populations, research in the field of health education, assessment of social intervention programs, or study-diagnosis of inequality around sports and health: structure, reproduction, and social change.

ValorA Research Group (Universidad San Jorge) has participated in the following European Projects:

- GEO-LUDENS: Creating a tech tool to promote European Traditional Sport and Games from an intergenerational and inclusive perspective (Ref. Project: 579689- EPP-1-2016-1-ES-SPO-SSCP). Role: Coordinator.
- FAN-OUT: Outdoor Sports as a Universal Language for Learning (Ref. Project: 590411-EPP-1-2017-1-ES-SPO-SSCP). Role: Coordinator.
- A-TWIN: Active Twinning for Enhancing Physical Activity in Rural Areas. (Ref. Project: 613158-EPP-1-2019-1-ES-SPO-SSCP). Role: Coordinator.
- KIDS IN ACTION (Ref. Project: 622130-EPP-1-2020-PT-SPO-SSCP). Role: Partner.
- BMX Training to Win (Ref. Project: 622085-EPP-1-2020-1-ES-SPO-SCP). Role: Co-coordinator (with BMX School Zaragoza).

PARTNERS

Biedrība "Latvijas Sporta izglītības iestāžu "Direktoru padome" LSIIDP (Latvia)

LSIIDP is a non-profit association that merges all sports schools in Latvia that are financed by municipalities and the government, that merges 75 sports schools, more than 1200 coaches, and more than 33000 athletes between the ages 5 – 25. The board of LSIIDP consists of 15 board members, which are: 1 chairperson, 2 deputy chairpersons, and 12 members, as well as 1 auditor.

The objective, tasks, and rights of the Association are:

- To coordinate and manage the implementation of professional sports education programs in the country.
- To address issues that are related to the actions of sports schools, and sports clubs of Latvia, to represent their interests in public authorities and other organizations.
- To advance the development of youth sports and improve the sports

system in Latvia.

- To promote youth sports in the country.
- To advance the development of sports in Latvia, the implementation of sports programs, the continuity of the learning process, and methodological work in sports institutions.
- To public benefit activities aimed at supporting sports.

The Association has got the right to represent sports schools, including sports clubs, in public and international bodies to carry out any legally allowed activities to implement tasks of the Association.

The Association:

a) Determines and controls issues within its competence that are related to the development of youth sports, and cooperation with other organizations in Latvia and other countries.

b) Constantly determines directions of actions, carries out its planning and organization, income distribution, opens accounts in banks, and arranges accounting and record-keeping following the procedures described by law.

They coordinated the project "Involvement of Children and Youth in Sports Schools with Particular Emphasis on Socially Disadvantaged, Low-income and Minority Families from Rural Districts, Simultaneously Educating Their Families-ICY" (Erasmus + Sport Call 2017, Ref. Project – 2017-2869 / 001 – 001 of 16.11.2017.). LSIIDP is a social partner of the Ministry of Education and Science – Sports Department. LSIIDP regularly takes part in work groups of ministries in the development of laws (like Sports Law, as well as the Cabinet's rules, etc.) and operates since 1995. LSIIDP represents all sports schools' and sports clubs' needs at the governmental level – like OCL (Olympic Committee of Latvia), OUL (Olympic Unity of Latvia), National Sports Council of Latvia (NSCL), Subcommittee of the Saeima of the Republic of Latvia, Local Union of Municipalities.

CEIPES – International Centre for the Promotion of Education and Development (Italy)

CEIPES is an International non-profit association founded in Palermo in 2007 and with antennas in other 8 European countries.

They believe that education and development are fundamental values to achieve peace and dignity for all human beings. Each individual and community has the potential to fulfill its rights. CEIPES acts as a facilitator for activating the community, through an educational approach to create and transform energy and resources. This process is necessary for both individual and social development.

The mission of CEIPES is to foster and support the sustainable development of local communities and individuals' empowerment through education and training, human rights, sports activities, and international cooperation.

The CEIPES Network is a net of organizations working together with the belief that Education and Development are fundamental values to achieve peace and dignity for all human beings. It is operating with antennas in more than 8 European countries. CEIPES' work is inspired by and based on the principles of human rights and democracy, equal opportunities, the respect for the environment and it is promoting the values of diversity and social inclusion, peace, and nonviolence, active participation, cooperation, interculturality, and solidarity.

CEIPES is cooperating on a European and international level with more than 150 partner organizations. On a local level, it is operating in Sicily, in strong cooperation with more than 40 organizations in the region, such as public and private bodies, educational institutions and research centers, local governmental bodies, and organizations from the social, environmental, and sport sector.

CEIPES' main activities are educational, intercultural, and sports activities at the local level and in partnership with organizations on the European and international level, awareness-raising activities, seminars and conferences, capacity building and skill development activities (learning and training courses, workshops) for young people and adults, research and innovation, and exchange of good practices.

Departments of CEIPES:

- Education and Training Department (ET).
- Cooperation, Innovation and Research Department (CIR).
- Inclusion through Health-enhancing Physical Activity Department (I-HEPA). The I-HEPA Department of the CEIPES works in a fruitful and solid partnership with the Sport and Exercise Sciences Research Unit of the University of Palermo and with the University Sports Center of Palermo.

Sport and Exercise Sciences Research Unit, SPPF - University of Palermo

Its degree program provides the students a multidisciplinary learning path - theoretical and practical with the aim of training professionals with a solid background in the field of sport and physical activity in different areas:

- Technical sports: theory and methodology of training and teaching of different sports.
- Prevention and adapted physical education: theory, technique, and teaching of physical activities addressed to people of all ages and on preventive and compensatory physical activities, aimed at maintaining a better physical efficiency and a more suitable lifestyle.
- Management: the organization and management of facilities for sports activities, as well as organizing events in the field of sports and physical activities.
- Education: psychological and pedagogical skills aimed at motor learning and development of physical skills in developmental, that is aimed at the training of educators for physical and sports activities.

CUS - The University Sports Center of Palermo: one of the biggest sports complexes of the Mediterranean region based in Palermo (Sicily), Italy.

CUS Palermo, founded in 1947, has a long and meaningful story full of sports activities, records, successes, and events that took place during the years. A solid and reliable organizational structure, which over the years has grown, has always played a leading role in the spread and practice of sports both for the University and for the city of Palermo.

The main sports activities promoted are athletics (start-up center), volleyball, basketball, water polo, swimming, handball, football, futsal, offshore sailing, and tennis.

A common place for shared goals:

The I-HEPA Department of CEIPES is implementing its activities together with its prestigious local partners to reach its objectives in the field of sport on a European level:

- To maintain and develop the bio-psychosocial health of individuals.
- To identify and promote sport as an educational and developmental tool for all people at any age to foster individual and collective growth.
- To promote, through sports participation, fundamental principles and values such as gender equality, nonviolence, and social inclusion, and use sport as a tool to prevent and reduce all forms of discrimination, as well as a tool for community development promoting social inclusion and equal opportunities.
- To promote sport as a tool for overcoming socio-economic and cultural barriers, encouraging intercultural dialogue, fostering mutual understanding and respect between individuals and groups from different cultures, and increasing intercultural through the sharing of values, traditions, and different modus vivendi.
- To promote the sport in non-formal educational contexts as a vital tool in the education of youth and adults and as complementary to formal education.

- To strengthen cooperation among actors and stakeholders from the fields of education, culture, human rights, and sport to realize innovative international collaborations based on interculturality, solidarity, peace and nonviolence, active citizenship, and sustainability.
- To improve methodologies and develop innovative strategies and tools for the promotion of sport and physical activity through international cooperation, studies, and research.
- To support the athletes' double career, through their inclusion in high-quality education path, allowing the acquisition of fundamental skills for their job placement, at the end of the sports career.
- To promote fair play, support the fight against doping, and prevent match-fixing.
- Promoting peace, nonviolence, and human rights is the only way to reach a world of equity and solidarity in which all human beings enjoy their fundamental rights.

Slovenský Zväz Cyklistiky (Slovakia)

The Slovak Cycling Federation or SZC (in Slovak: Slovenský Zväz Cyklistiky) is the national governing body of cycle racing in Slovakia. Slovak Cycling Association provides physical activities in forms of sport for all and amateur and professional cycling. In 2017, we had 174 registered clubs and 2204 memberships. Their coaches help them to develop cycling and help young talents to become the best riders.

Cycling clubs cooperate with municipalities and the association of towns and municipalities for effective assistance at the regional level to ensure action or event. They are members of the Slovak Olympic Committee. They are partly financed by the state budget, and partly by sponsors.

Slovak Cycling Federation organizes races for the young called Young Tour of Peter Sagan and races on the UCI and UEC levels. Slovak Cycling Federation organized the Congress of the UEC in May 2015 where delegates from 43 European countries were present, among them cycling federations from European Union.

During 2016-2017 we cooperated with 4 partners within the Erasmus+ project - Collaborative Partnerships - Not-for-profit European sports events. The main objective of the project was to stimulate the active life and health of the youngest EU citizens, boost volunteering and bring added value to cultural heritage.

União Velocipédica Portuguesa- Federação Portuguesa de Ciclismo

The Portuguese Cycling Federation or UVP-FPC (in Portuguese: União Velocipédica Portuguesa- Federação Portuguesa de Ciclismo) is the national governing body of cycle racing in Portugal.

It is the oldest sports federation in Portugal, created on December 14, 1899. In 2019 the federation celebrated 120 years of continuity and excellence. Currently, the UVP-FPC has about 16,488 athletes and 1,759 sports agents.

The UVP-FPC is a member of the UCI - Union Cycliste Internationale and the UEC - Union Européenne de Cyclisme.

The UVP-FPC develops cycling in Portugal in all its forms and for all people, as a competitive sport, a healthy leisure activity, and a sustainable means of transport, but also as a way to have fun.

The UVP-FPC manages and promotes cycling's seven disciplines: road, track, mountain bike, BMX Racing, BMX Freestyle, cyclo-cross, and trials. Five of these are featured on the Olympic Games program (road, track, mountain bike, BMX racing, and BMX freestyle), and two in the Paralympic Games (road and track).

The UVP-FPC manages the promotion of its events, most notably the National Championships for all disciplines. These competitions crown the Portuguese National Champions, who wear - for one year - the National Champions jersey. The National Championships constitute the high point of the season in each discipline.

The UVP-FPC also organizes the Portuguese Cups, each of these season-long series for the discipline concerned. The race for the leaders' jersey is a major challenge, and to be crowned the winner of a Portuguese Cup ranking is a significant sporting achievement.

In addition, the UVP-FPC organizes several international events with the participation of the UCI and UEC, such as the “Volta ao Algarve 2020" (UCI Pro series), the 2020 UEC Track Juniors & Under 23 European Championships (Anadia), and the 2020 UEC MTB Marathon European Championships (Serra da Estrela), as well as many other important races registered in the UCI international Calendar (Road, Track, MTB, BMX).

Cycling is also more than just a competitive sport; bicycles have many uses outside the high-level sport, as a means of transport and leisure activity. This is why the UVP-FPC is developing its “cycling for all” program, which aims to improve conditions for bike riding and its accessibility.

The High-Performance Centre in Anadia, Portugal, which provides major and very important support for the UVP-FPC Cycling development program, becomes a World Cycling Centre Training and Education Satellite (WCC-TES), in 2019.

The Anadia WCC-TES offers the best training conditions to athletes and national teams who develop their activity in the four Olympic disciplines (road, track, MTB, and BMX).

The Center has excellent conditions for academic research on cycling, alongside coaching for coaches, commissaries, and mechanics.

The Anadia WCC-TES can offer the following first-class sports and non-sporting facilities:

250 meters wooden indoor track Sangalhos velodrome, a newly renovated BMX Olympic track with two start ramps (5-meters and 8-meters), and a cross-country Olympic Mountain bike trail in nearby Curia. There is also a gym, mechanics

workshop, classroom, medical offices, accommodation, and catering facilities.

Malta Street Sport Association-MSSA (Malta)

The Malta Street Sports Association is a group of individuals passionate about street sport and thriving to progress the sport and educate the general public about the benefits of participating in street sport.

The Malta Street Sports Association shall aim to use street sport as a tool to help youth stay away from all sorts of addictions, namely drugs, alcohol, corruption, etc. The organization will also promote and educate people on how to use Street sports to participate in physical activity which will help them in living a healthy lifestyle. We will also be using our knowledge to promote and push the sports that fall under street sport, so such sports become more popular and available to youth.

The following are the sports we are currently working with: BMX, Skateboarding, Inline Skate, Scooter, Street Football, 3v3 Basketball

In 2020 we shall be organizing a Youth and Street Sports Festival over a weekend showcasing street sports through various activities and competitions. A skatepark shall be built for the event and after disassembling be donated to localities that are in partnership with us to make this event happen. These miniature skateparks will be used to organize sessions to teach the street sport to the youth who gained interest in the sport through the festival. They have participated in the Medicines for Worlds Ghettos project (https://www.ghettogames.com/en), the Maltese Delegate at the Democracy, youth and sport seminar, and Volunteer Project Manager for Malta's first Indoor Skatepark.

Authors

Celia Marcen

Celia Marcen holds a Ph.D. in Psychology and Sociology (Universidad de Zaragoza, 2014), and an MBA in Sport Management. Her dissertation dealt with the psychosocial variables involved in sports performance in the National High-Performance Centre of Mexico. She graduated in Political Sciences and Sociology as well as Physical Education in Primary School Teaching and she has been professionally linked to sports for more than30 years.

From 2003 to 2010, she worked for different Mexican governments in sports talents' development, and she wasCoordinator of the Multidisciplinary Team of Nuevo Leon State (Mexico), having under her responsibility the Methodology, Sports Medicine and Rehabilitation, Nutrition, and Psychology areas. For the last 12 years she hasbeen a lecturer, first at UNIR university and since 2012 at San Jorge University, where she teaches in the SportSciences and the Infant and Primary Education Degrees.

Within ValorA Research group, she coordinated 2015 the Zaragoza city Sports Participation Survey, she hasled as project manager four European projects: GEO-LUDENS, Fan-Out, A-TWIN, and BMX Training to Win (jointlywith Rafa Izquierdo from BMX School Zaragoza), all of them within the frame of Erasmus + Sport Programme.She is also the main researcher in KIDS IN ACTION and MoPYL Mobile Programme for Youth Learners in Erasmus

+ KA2.

Her research focuses on the fields of sociology of sport and health, gender, and public policies in sport.

Noel Marcén

Noel Marcén holds a Ph.D. in Health Sciences (Universidad San Jorge, 2020) a Sports Performance Master (Universidad Barcelona, 2013), and a Sports Sciences Degree (Universidad Zaragoza, 2006). His thesis aimed to study perceptual performance in sports climbing. He is a lecturer at Universidad San Jorge since 2013 where he teaches subjects such as Cycling, Outdoor Sports, and Sports Performance. Before 2013 he worked as a cross-country ski coach in the Spanish National Team and the Augustana University ski team, Canada. Being part of ValorA research group his main research lines are sports performance, sports biomechanics, and occupational health.

Juan Rabal

Juan Rabal holds a Ph.D. in Health Sciences (Universidad San Jorge, 2021). His thesis was focused on occupational health in manufacturing company workers and the objective of it was to reduce musculoskeletal disorders. Juan is a sports science graduate (Universidad de Zaragoza, 2014) and has worked as a fitness coach in different sports since 2014.

He has been working as a lecturer at Universidad San Jorge in sports sciences degree since 2020 and belongsto the ValorA research group. The research in which he participates focuses on occupational health or sports performance. He has participated with the ValorA research group in the Aragonese Government-funded "WorkFIT" project and in the "BMX Traning to Win" European project.

Ana Aguilera

Ana Aguilera holds a degree in Psychology from the Autonomous University of Barcelona (2013). She completed a Master's Degree in Psychology of Physical Activity and Sport at the Autonomous University of Madrid (2015) and a Master's Degree in General Health Psychology at the National

University of Distance Education (2018). Her research work focused on the therapeutic effects of physical activity and sport in the population with functional diversity and patients with obsessive-compulsive disorder.

She is currently teaching for the Bachelor's Degree in Physical Activity and Sport Sciences since 2020 and for the Bachelor's Degree in Psychology since 2021.

In addition, she has been working since 2016 in psychological assistance in a private center as head of the sport and physical activity psychology area and as a psychologist in juvenile health psychological assistance. She has collaborated with different sports teams carrying out individual and collective monitoring and intervention for several seasons.

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TRAINING TO WIN

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