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Director: Fernando Emilio Valladares Fuente

Email: fernando.valladares@upr.edu.cu

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Original article

Biomecánica del pase con borde interno entre futbolistas prejuveniles y juveniles de Formativas y Academia

Biomechanics of the pass with internal edge among prejuvenile and juvenile soccer players of Formative and Academy centers

Biomecânica do passe com bordo interior entre os jogadores de futebol pré-juvenil e juvenil de formação e academia

Daniel Alejandro Hualpa Loza[1*] https://orcid.org/0000-0002-5368-4472

Richard Alexander Sarabino Cuichan[1] https://orcid.org/0000-0001-6882-6894

Juan Carlos Cerón Ramírez[1] https://orcid.org/0000-0002-9893-3161

[1]University of the Armed Forces ESPE. Ecuador.

[*]Corresponding author**:** dahualpa@espe.edu.ec

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ABSTRACT

Recreational activities have numerous positive effects on human behavior, this can favor relevant psychological indicators such as perceived anxiety. In this sense, the purpose of the research was to determine how a recreational program influences the reduction of anxiety levels in high school students. The research is descriptive-explanatory, correlational; 30 high school students are intentionally diagnosed through the Beck *test,* before and after implementing a recreational proposal for eight weeks. The percentages of anxiety decreased as the intervention proposal was implemented, both in general and in the analysis by gender, as the decrease was significant (p=0.003). The present study shows that recreational activities can contribute to the reduction of anxiety in high school adolescents, both for the female gender and for the male gender. Three future actions are recommended: extend the implementation time of the intervention proposal, carry out studies by gender and direct future research at a quasi-experimental level.

Keywords: Recreational activities; Anxiety; High school student.

RESUMEN

Las actividades recreativas poseen numerosos efectos positivos en el comportamiento humano, esto puede favorecer a indicadores psicológicos de relevancia como la ansiedad percibida. En tal sentido, se planteó como propósito de la investigación determinar cómo influye un programa recreativo en la disminución de los niveles de ansiedad en estudiantes de bachillerato. La investigación es descriptiva-explicativa, de orden correlacional; se diagnostican intencionalmente a 30 estudiantes de bachillerato a través del *test* de Beck, antes y después de implementada una propuesta recreativa por ocho semanas. Los porcentajes de ansiedad disminuyeron a medida que se implementa la propuesta de intervención, tanto de forma general como en el análisis por género, al ser significativa la disminución (p=0.003). El presente estudio evidencia que las actividades recreativas pueden contribuir a la disminución de la ansiedad en adolescentes de bachiller, tanto para el género femenino como para el masculino. Se recomienda tres acciones a futuro: ampliar el tiempo de implementación de la propuesta de intervención, realizar estudios por género y direccionar la futura investigación a un nivel cuasiexperimental.

Palabras clave: Actividades recreativas; Ansiedad; Bachiller.

RESUMO

A biomecânica é uma ciência que ajuda o estudo dos movimentos aplicados em diferentes desportos, incluindo o futebol, o que permite a identificação e correção de erros técnicos. Esta é uma base fundamental para o controlo da preparação do atleta. Neste sentido, o objectivo da investigação era analisar biomecanicamente o passe com a extremidade interna do pé em jogadores de futebol pré-juvenil e juvenil em treino e academia. A investigação é de tipo descritivo-explicativo, de ordem correlativa; 40 jogadores de futebol são diagnosticados biomecanicamente em dois grupos independentes (Grupo 1: Formação; Grupo 2: Academia; entre 14-18 anos de idade). Foram analisados dez indicadores, incluindo a idade. Foram demonstradas diferenças significativas no indicador "DB" (p=0,000), o indicador "ÁFRA" (p=0,006), o indicador "DPAE" (p=0,000), e os indicadores "VF", "A" e "TE" (p=0,000) respectivamente, enquanto que as variáveis ou indicadores "ÁFRE" (p=1,000), "EX" (p=0,102) e "EY"

(p=0,056) não apresentavam diferenças significativas entre os grupos independentes. Na comparação feita com os jogadores de uma equipa profissional e com os jogadores de uma academia de treino, constatou-se que existem diferenças notáveis em relação à fase inicial do passe com a borda interior do pé, mostrando a distância do jogador em relação à bola, bem como na fase anterior em que os jogadores da academia de treino têm uma melhor execução do movimento técnico; isto reflete-se na fase de contato onde é evidente uma maior velocidade e aceleração no momento do impacto com a bola.

Palavras-chave: Biomecânica; Futebol; Passagem; Bordo interior; Técnica.

INTRODUCTION

The application of biomechanics to sport is an essential component in the analysis and improvement of the technical gesture in various sports, including soccer (Carrillo, Quintanilla, 2021). Biomechanics is related to the correction of motor gestures, which enhances performance and reduces injuries in athletes, while playing an important role in training within the teaching-learning process (Jordán *et al.,* 2018; González, Calero, 2017; Criollo *et al.,* 2018; Barreto *et al.,* 2017).

The technique in sport is fundamentally based on motor learning, in Formative soccer the coaches focus on the teaching-learning of the basic fundamentals such as: control, driving, passing, shooting (Gallardo *et al.,* 2019). A player must have the technical skills to control the ball in real game situations (Barreto *et al.,* 2017; Benítez *et al.,* 2018). That is why, within grassroots football, emphasis should be placed on correcting motor behavior so that they have solid foundations when moving from their training stage to the high-performance stage. The pass is the fundamental axis to open up the other technical gestures, (Quilachamin *et al.,* 2021) since the essence of soccer is to pass and look for an empty space. That is why this research is focused on the correct execution of the pass with an inside edge.

To talk about the pass, it must be first learn that it is a technical action that consists of sending the ball to a teammate. This action can be performed with any part of the body, as long as it does not penalize the sport's regulations (Crespo, 2020). Soccer is a discipline that clearly requires making specific and correctly executed passes. Although it is true that approximately 80 % of the game is based on making and receiving passes, it is applied both in attack and defense and even more so if teamwork is paramount (González, Calero, 2017).

The technical gesture of the pass includes several classifications, such as the short-distance pass at ground level, which is executed with the inner edge of the foot by hitting the ball in the mid-upper sector and always looking for a passing line. open to be able to progress with the game (Crespo, 2020).

According to (Sagnay *et al.,* 2020) the inner edge phases are:

1. Initial phase**:** In this phase, the soccer player's initial position with respect to the ball is observed, depending on which foot is dominant (right-handed or left-handed).

2. Previous phase: in this phase, the previous race is taken into account where the athlete must control his speed, depending on the distance at which he wants to

throw the ball. The position of the support foot is also important, which must be placed at the height of the ball and the knee slightly bent. The position of the arms plays a fundamental role in maintaining balance, they can be slightly separated and flexed from the center of gravity.

3. Contact phase: It is the moment in which the athlete hits the ball, the pass will have to be thrown with the precise strength so that it reaches the desired direction. In the contact phase, the executing leg should be rotated from the hip area. Both the ankle and knee joints should remain slightly flexed and have a slight degree of tension at the moment of impact with the ball.

4. Later phase**:** at the end of the technical gesture, the inertia of the blow itself must be continued, ending with a natural posture; In this phase, the arms are also important, as they help maintain balance.

Researches on the biomechanical analysis of the technique of hitting the ball in soccer has provided a preamble on the application of biomechanics in this sport (Milanca, Montiel, 2017; Criollo *et al.,* 2018; Jordán *et al.,* 2018; Camacaro *et al.,* 2021). The consulted literature has focused on the analysis of the phases of the technical gesture to correctly develop this skill from the sports initiation stage. The methodology used includes the bibliographic review of different authors and documents related to the subject, in order to find more updated information, reaching the conclusion that sports biomechanics is responsible for establishing correctly oriented joint and muscle parameters so that the technique is performed. successfully (León, *et al.,* 2016).

On the other hand, the development of the passing technique in the training of soccer players' intention to play from sports initiation includes the importance of correctly teaching the technique, prioritizing the training stage for the development of the intention to play of players. young soccer players (Crespo, 2020). Therefore, it has been proposed as the objective of the research to biomechanically analyze the pass with the inner edge of the foot in pre-juvenile and youth soccer players of formation and Academy schools.

MATERIALS AND METHODS

Under a non-probabilistic intentional sampling, a population of athletes between 14 and 18 years old who belong to professional and amateur soccer clubs (40 subjects) was studied, all the subjects were selected, based on a non-probabilistic intentional sampling, using as criteria of inclusion the mentioned age range, the non-presence of lesions that hinder the biomechanical analysis and the signing of informed consent.

The soccer players studied were classified into two independent groups with 20 soccer players each, according to their moment of practice, they were delimited as follows:

1. Group 1: athletes from the professional training team: members of the training teams of Club América de Quito belonging to Series B in Professional Soccer in Ecuador. (20 athletes).

2. Group 2: athletes from the Amateur Formative Academy: Members of the Barcelona-Guayllabamba Formative Academy (20 athletes).

For data collection, a video is made of each athlete who executes the technical gesture of the pass with an inside edge. For the analysis of biomechanical data, the Kinovea program is used in its version 0.8.24 and for data tabulation the Microsoft Excel program in its version 2021. The analysis can be applied thanks to the variety of tools provided by the program. Kinovea, the athlete is parameterized with height so that all measurements are calibrated.

The movements specified below are analyzed in each phase of execution of the pass:

1. Initial phase:

- Player's distance from the ball.

2. Previous Phase:

- Support foot knee flexion angle.
- Center of gravity position.
- Opening distance of the executing foot with respect to the support foot.
- Flexion angle of the knee of the executing foot.

3. Contact Phase:

- Final execution speed.
- Acceleration.

4. Post Phase:

- Technical gesture execution time.

The evaluations will be carried out through a passing exercise, which consists of executing the pass to a teammate with a set distance (ten meters). On the other hand, the variables analyzed biomechanically in the passing technique are described below:

1. Distance of the player with respect to the ball (DB): distance that the player must travel until reaching contact with the ball.
2. Angle of flexion at the knee of the executing foot (AFRE): angle that the knee must form in the back of the body before impacting the ball.
3. Angle of flexion of the knee of the support foot (ÁFRA): angle that the knee that is on the side of the ball must form.
4. Distance of the support foot and executing foot (DPAE): separation between both legs at the moment of executing the technical gesture.
5. X axis (EX): center of gravity; Horizontal axis.
6. Y axis (EY): center of gravity; Vertical axis.
7. Final Speed (VF): maximum speed reached by the player when making the pass.

8. Acceleration (A): variation of the player's speed during the execution of the technical gesture.

9. Gesture execution time (TE): time it takes to execute the action; It is taken from the beginning of the race until the moment of contact with the ball.

10. Taking into account the characteristics of the research, it will be descriptive-explanatory, correlational in nature. As there was no normal distribution of the data, it was decided to compare the results in both independent groups with the non-parametric Mann-Whitney U test ($p \leq 0.05$); the differences between each analyzed variable are established.

RESULTS AND DISCUSSION

Table 1 describes the numerical values achieved in the nine variables or biomechanical indicators analyzed as part of the players of the BSC Academy of Guayllabamba (Group 2), the average or arithmetic mean is expressed as part of the last row (Table 1).

Table 1. - BSC Academy Players Data Guayllabamba (Group 2)

		VARIABLES								
N	**AGE**	**DB (m)**	**AFRE (°)**	**AFRA (°)**	**DPAE (m)**	**X AXIS (°)**	**AXIS Y (°)**	**FV (m/s)**	**A (m/s²)**	**TEA (s)**
1	13	0.6	117	160	0.53	1.66	0.79	2.4	4.8	0.5
2	13	0.51	98	132	0.59	2.25	0.6	3.09	9.37	0.33
3	17	0.48	126	179	0.69	1.58	0.66	1.92	3.84	0.5
4	18	0.3	138	168	0.48	2.25	0.69	1.2	2.4	0.5
5	16	0.19	147	158	0.38	1.82	0.57	0.88	2.06	0.43
6	13	1.19	107	163	0.49	1.46	0.53	2.45	2.53	0.97
7	17	0.67	95	141	0.53	1.68	0.6	1.61	1.95	0.83
8	17	0.71	99	160	0.76	1.52	0.85	1.46	1.51	0.97
9	17	0.41	110	153	0.5	1.75	0.65	1.55	2.92	0.53
10	18	1.01	102	142	0.52	1.73	0.71	2.1	2.19	0.96
11	16	0.52	67	119	0.82	2.61	1.06	2.6	6.5	0.4
12	17	0.29	122	139	0.46	1.91	0.61	1.57	4.24	0.37
13	18	0.69	101	140	one	1.38	0.99		3.83	0.6
14	17	0.5	97	134	0.33	1.68	0.34	0.97	0.94	1.03
15	18	0.33	151	161	0.82	1.62	0.84	1.65	4.13	0.4
16	16	0.78	112	136	1.04	1.41	1.2	2.23	3.18	0.7

17	13	1.07	97	161	0.57	1.25	0.85	2.93	4.02	0.73
18	18	0.55	97	139	0.9	1.35	0.94	1.57	2.24	0.7
19	18	0.8	100	140	0.5	1.69	0.7	1.67	1.74	0.96
20	13	1.04	101	146	0.74	1.89	1.03	2.97	4.24	0.7
□	**16.15**	**0.632**	**109.2**	**148.55**	**0.6325**	**1.7245**	**0.7605**	**1,956**	**3.4315**	**0.6555**

The soccer players of the BSC Academy of Guayllabamba have a mean age of H"16 years, while in the biomechanical variables studied a characteristic mean or average is described, where the "DB" indicator determined a mean of 0.632m in the player's distance with regarding the ball. On the other hand, in the variable or indicator "ÁFRE" an average of 109.2° was reached, and in the variable "ÁFRA" an average of 148.55°, describing the average values of the Angle of flexion in the knee of the executing foot and the angle knee flexion of the supporting foot, respectively.

In the case of the "DPAE" indicator, the mean reached 0.6325m in the distance between the supporting foot and the executing foot, while in the "X Axis" indicator an average of 1.7245° was established and in the " X Axis ". Y" an average of 0.7605°. The mean final velocity (VF) in the movement of the pass was determined to be 1.956m/s, with an average acceleration (A) of 3.4315m/s^2 and an average execution time of the technical gesture (TE) of 0. .6555s.

Table 2 has the respective data concerning the Formative players of Club América de Quito (Group 1) (Table 2).

Table 2.- Formative America de Quito players data (Group 1)

		VARIABLES								
N	**AGE**	**DB (m)**	**AFRE (°)**	**AFRA (°)**	**DPAE (m)**	**AXIS X (°)**	**AXIS Y (°)**	**FV (m/s)**	**A (m/ s²)**	**TEA (s)**
1	13	0.16	139	132	0.99	2.54	0.93	0.86	2.32	0.37
2	14	0.13	130	137	0.99	1.78	0.98	1.52	8.94	0.17
3	14	0.15	102	160	0.82	1.6	0.92	3	30	0.1
4	14	0.15	90	160	0.97	1.46	1.04		17.69	0.13
5	14	0.18	130	131	one	1.69	0.79	2.76	21.23	0.13
6	14	0.17	90	135	1.04	1.57	0.93	3.4	3. 4	0.1
7	13	0.18	132	132	0.75	2.01	0.76	2.76	21.23	0.13
8	13	0.14	133	138	0.46	1.14	0.44	2.8	28	0.1
9	13	0.15	110	136	0.91	1.6	0.76		17.69	0.13
10	13	0.16	132	137	0.99	1.55	0.83	3.2	32	0.1

11	13	0.17	90	136	0.97	1.45	0.8	3.4	3. 4	0.1
12	15	0.17	120	135	0.93	1.95	0.97	2.61	20.15	0.13
13	15	0.18	133	139	0.92	2.25	0.93	2.76	21.23	0.13
14	15	0.17	110	132	0.69	2.08	0.84	2.61	20	0.13
15	15	0.34	120	169	0.98	2.34	0.88	6.8	68	0.1
16	15	0.59	90	135	0.98	2.57	0.94	11.8	118	0.1
17	15	0.45	90	135	1.21	2.26	1.06	6.92	53.23	0.13
18	15	0.4	100	138	0.98	2.13	1.01	8	80	0.1
19	15	0.46	90	135	0.94	2.63	0.83	7.07	54.38	0.13
20	15	0.42	93	136	0.93	2.31	0.8	6.46	49.69	0.13
□	**14.15**	**0.246**	**111.2**	**139.4**	**0.9225**	**1.9455**	**0.872**	**4.1665**	**36,589**	**0.132**

As established in Table 2, the data obtained by the soccer players of Club América de Quito in the 9 biomechanical variables analyzed established a mean in the "DB" indicator of 0.246m in the player's distance from the ball, being less than that established in group 2 (Table 1); therefore, the soccer players of the BSC - Guayllabamba Academy have less effective pass control on average.

On the other hand, the average in the "ÁFRE" indicator of the soccer players of Club América de Quito was established at 111.2° and in the "ÁFRA" indicator of 139.4°, being the flexion angles in the knee of the foot executor and the angle of flexion of the knee of the supporting foot less than those established in group 2. For the variable or indicator "DPAE", the mean was established at 0.9225m, being the distance between the supporting foot and the supporting foot executor greater than that established in Group 2.

In the case of the indicator "Axis X" (1.9455°) and Axis Y (0.872°), the means were higher than those established in group 2, while the final speed (VF) reached an average of 4, 1665m/s, much higher than group 2. In the case of the acceleration indicator (A), the mean was established for group 1 at 36.589m/s^2 and the mean of the "TE" indicator at 0.132s; therefore, both the acceleration and execution time of the technical gesture were higher in group 1 (Table 2).

The international literature specifies for the soccer player the importance of speed and acceleration of movements, where authors such as González *et al.,* (2013); Sánchez *et al.,* (2018) determine the importance of the analysis of both indicators to characterize two independent groups, basing their implications on the control of preparation; another similar study that supports this hypothesis is represented in Jordán *et al.,* (2018).

It should be noted that the average age range of the soccer players of Club América de Quito was established at ≈14 years (Table 2), being two years younger than that established for the soccer players of the BSC Academy Guayllabamba (Table 1), indicative of a minor sports longevity and, therefore, a lower sports experience, deducing a lower sports performance from various points of view, including the component of sports technique. On this aspect, Úbeda *et al.,* (2020) denotes the so-called relative age

effect, where they specify that the date of birth could be a variable that influences the soccer player's performance (Table 3).

A more detailed comparison of the mean magnitudes can be seen as part of table 3.

Table 3.- Comparison of the average of magnitudes

Magnitude	Formative	Academy
Age	14 years	16 years
Player distance from the ball (DB)	0.246	0.632
Angle of flexion at the knee of the executing foot (AFRE):	111.2	109.2
Support foot knee flexion angle (ÁFRA):	139.4	148.55
Distance of the supporting foot and executing foot (DPAE):	0.9225	0.6325
Center of Gravity; X-Axis (EX) and Y-Axis (EY)	1.9455; 0.872	1.7245; 0.7605
End Velocity (VF)	4.1665	1,956
Acceleration (A)	36,589	3.4315
Gesture Execution Time (TE)	0.132	0.6555

Table 3 shows the average values of each magnitude ready for comparison. Formative players apply a shorter distance (m) with respect to the ball, which is why the execution time is shorter. Likewise, the Academy players show a shorter distance from the support foot with respect to the executing foot within the previous phase, which influences the force that the player prints on the ball at the moment of contact, being the Formative players (Group 1) those who perform the gesture with greater force, because their separation distance is greater.

Regarding the knee flexion angles of the executing foot, the values show that there is no greater degree of difference, but in the knee flexion angle of the supporting foot, a difference of approximately 9 degrees was found in favor of Formative players, this is an indicator that they have greater stability when making the pass.

The center of gravity is similar in both groups, the differences found lie in the posture at the time of performing the gesture, the Academy players tend to slouch because they are in a learning process, where error correction is prioritized along with the excellence of execution, while the players of the professional team have a better posture, since they have a previously established technical gesture or skill, even more so with a training process throughout their young age.

The intensity and demand in which the Formative players work are evident in the speed of execution, which is why there is a difference of 2.21 m/s with respect to the Academy players, who make the pass in a greater weather. Likewise, the acceleration is directly proportional to the previously mentioned magnitude; the faster the movement, the

greater its acceleration (Sagñay *et al.*, 2020) which is observed in table 3, with a difference of 33.16m/s² in favor of the professional team players.

In the comparisons, the significant differences can be seen as part of table 4, where the Mann-Whitney U Test specifies the average ranges and the existence or not of notable differences in each variable or indicator analyzed (Table 4) and (Table 5).

Table 4.- Mann-Whitney U test

	ranks			
	groups	N	average range	sum of ranks
DB	Academy	20	28.85	577.00
	Formative	20	12.15	243.00
	Total	40		
AFRE	Academy	20	20.50	410.00
	Formative	20	20.50	410.00
	Total	40		
AFRA	Academy	20	25.55	511.00
	Formative	20	15.45	309.00
	Total	40		
DPAE	Academy	20	13.65	273.00
	Formative	20	27.35	547.00
	Total	40		
EX	Academy	20	17.45	349.00
	Formative	20	23.55	471.00
	Total	40		
EY	Academy	20	16.95	339.00
	Formative	20	24.05	481.00
	Total	40		
FV	Academy	20	13.90	278.00
	Formative	20	27.10	542.00
	Total	40		
A	Academy	20	11.20	224.00
	Formative	20	29.80	596.00
	Total	40		
TE	Academy	20	30.43	608.50
	Formative	20	10.58	211.50
	Total	40		

Table 5.- Test statistics[a]

	DB	AFRE	AFRA	DPAE	EX	EY	VF	A	TE
Mann–Whitney U	33,000	200,000	99,000	63,000	139,000	129,000	68,000	14,000	1,500
W for Wilcoxon	243,000	410,000	309,000	273,000	349,000	339,000	278,000	224,000	211,500
Z	-4,521	,000	-2,740	-3,709	-1,651	-1,922	-3,572	-5,033	-5,436
sig. (bilateral)	,000	1,000	.006	,000	.099	.055	,000	,000	,000
Exact significance [2*(one-sided sig.)]	,000[b]	1,000b –	.006b –	,000[b]	.102b –	.056b –	,000[b]	,000[b]	,000[b]

a. Grouping Variable: Groups.
b. Not corrected for ties.

As defined in table 4, in 6 variables the existence of significant differences is demonstrated, such as the indicator "DB" (p=0.000), the indicator "ÁFRA" (p=0.006), the indicator "DPAE" (p=0.000) and the indicators "VF", "A" and "TE" (p=0.000) respectively, while the variables or indicators "ÁFRE" (p=1.000), "EX" (p=0.102) and "EY" (p=0.056) did not present significant differences.

For the present research, it is recommended to establish greater analysis indicators in the future, allowing the explanatory method to be applied in a better way, with a view to forming analysis methodologies of the passing technique with the inner edge of the foot, in initiation and development soccer players.

CONCLUSIONS

In the comparison made with the players of a professional team and the players of a Formative Academy, the existence of notable differences was evidenced from the initial phase of the pass with the inner edge of the foot, showing the distance of the player with respect to the ball, in the previous phase where the Formative players have a better execution of the motor movement, which is reflected in the contact phase where there is evidence of greater speed and acceleration at the moment of impact with the ball. In this sense and in accordance with the general objective of the research, the biomechanical analysis will allow perfecting the technical gestures of the initiation soccer player, helping to identify what aspect can be improved, as well as in the process of correcting errors.

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