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ORIGINAL

BONE MODIFICATION OF THE COLLEGE AMERICAN FOOTBALL PLAYER: LONGITUDINAL STUDY

MODIFICACIONES ÓSEAS DEL JUGADOR DE FUTBOL AMERICANO UNIVERSITARIO: ESTUDIO LONGITUDINAL

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ABSTRACT

The purpose of this study was to know the bone changes of college football (FA) players. A total of 39 male FA players participated, ranging in age from 18 to 25 years old. They were grouped according to each playing position they play in the team such as: Linemen (n = 15), players of great skills (n = 7), players of skill (n = 13) and quarterbacks (n = 4). For the assessment of BMD ($g/^{cm2}$) a Double X-ray Bone Densitometry (DXA) was used. The results of this study showed a significant

decrease (p<.05) of BMD in head and legs, in contrast, the CMO showed an increase in legs, however, in the pelvic region showed a significant decrease (p<.05). In conclusion, significant changes were found for BMD and CMO in the head, leg and pelvis regions in college AF players over a one-year span of competition.

KEY WORDS: Sport, Body Composition, College Football, DXA, Bone Mineral Density, Anthropometry, Bone Mineral Content.

RESUMEN

El propósito de este estudio fue conocer los cambios óseos de los jugadores de futbol americano (FA) universitario. Participaron un total de 39 jugadores de FA masculino, con rangos de edad de 18 a 25 años. Se agruparon acorde a cada posición de juego que desempeñan en el equipo como: Linieros (n=15), jugadores de grandes habilidades (n=7), jugadores de habilidad (n=13) y mariscales de campo (n=4). Para la valoración de DMO (g/cm^2) se utilizó un Densitometría Ósea Doble de Rayos X (DXA). Los resultados de este estudio mostraron una disminución significativa (p<.05) de DMO en cabeza y piernas, en cambio, el CMO mostró un aumento en piernas, sin embargo, en la región de pelvis mostro una disminución significativa (p<.05). En conclusión, se encontraron cambios significativos para la DMO y CMO en las regiones de cabeza, piernas y pelvis en los jugadores de FA universitario en un lapso de un año de competencia.

PALABRAS CLAVE: Deporte, Composición corporal, Fútbol americano universitario, DXA, Densidad mineral ósea, Antropometría, Contenido mineral óseo.

1. INTRODUCTION

Having an adequate body composition in sport gives an optimal level of competition; for example, fat mass and lean mass are some major components monitored in athletes, establishing that having a low fat mass and high lean mass is ideal for competing. (Elliott et al., 2016; Norton & Olds, 2001; Yamamoto et al., 2008). However, other components such as Bone Mineral Density (BMD) in the different sports areas have not had that role of monitoring for the characterization of sports physical performance (Turnagöl, 2016).

Because of this, some authors have investigated BMD in order to observe the importance of these components in athletes, for their control and monitoring.(Duncan et al., 2002; Helge & Kanstrup, 2002; Pettersson et al., 2000; Vlachopoulos et al., 2017; Walker et al., 2022). However, there are factors that can affect BMD such as genetics, absence of nutrients, tobacco and alcohol abuse. (Abukhadir et al., 2013; Chen et al., 2013; Fassio et al., 2018; Neglia et al., 2016; Valdmanis et al., 2008).

Por lo que, Friedman (2006), Hart et al. (2020), Porthouse et al. (2004) y Zwart et al. (2011) recommend having control and monitoring every 6 to 12 months on the components of bone mass in the general population and athletes, since this component is essential for the improvement of lean mass and this helps to improve

physical performance (Friedman, 2006; Hart et al., 2020; Porthouse et al., 2004; Zwart et al., 2011).

Currently, one of the most used methods for the evaluation of body composition in athletes is the Double X-ray Bone Densitometry (DXA), since it has a reliability, reliability and reproducibility to use between evaluations. (Nana et al., 2015; Patrocínio et al., 2015). For example, the National Football League (NFL) considers it the gold standard ("Gold Estándar") for your selection evaluations ("Draft") in FA players (Dengel et al., 2014; Goodell, 2020; NFL Enterprises LLC, 2020; Oliver et al., 2012).

The FA at a professional competitive level, players have different types of characteristics in terms of performance and body composition. Abbey et al. (2017) y Stuempfle et al. (2003) exp NCAA (National Collegiate Athletic Association) Division III FA players have weights above 90 kg, and do not detail aspects of BMD by region in different playing positions (Abbey et al., 2017; Stuempfle et al., 2003).

As for NCAA Division I players, Fullagar et al. (2017) State that the weight ranges are similar to NCAA Division III players, however, they do not mention the BMD for the different playing positions in the different regions of the body (Fullagar et al., 2017). On the other hand, Ammann y Rizzoli, (2003), Fonseca et al. (2014) state that body composition and BMD differ between the upper and lower extremities (Ammann & Rizzoli, 2003; Fonseca et al., 2014). However, there are also differences between playing and sport positions.(Ramos-Sánchez et al., 2018).

In this regard, the FA players of the study of Trexler et al. (2017) Mention that there are considerable significant changes in BMD over the course of a year in NCAA Division I players (Trexler et al., 2017), so it is of utmost importance to observe in which regions of the body undergo the most long-term changes. Therefore, the purpose of this study was to know the bone changes of the players of university FA major category from the period 2015 to 2016.

2. MATERIAL AND METHODS

2.1 Participants

A descriptive-comparative longitudinal retrospective study of repeated samples was conducted. The total duration of the study was two weeks, one week in June 2015 and another week in June 2016.

A total of 39 male FA players participated, with age ranges from 18 to 25 years (22.35±1.67 years), belonging to the Authentic Tigers team of the Autonomous University of Nuevo León (UANL). Participants are grouped according to each game position they play as: Linemen, 15 (OL = 7, offensive line and DL = 8, defensive line), players of great skills, 7 (LB = 7, linebacker), skill players, 13 (CB = 3, Cornerback, FS = 3, free safety, K = 1, kicker, RB = 5, running back, WR = 1, wide receiver) and quarterbacks, 4 (QB= 4, quarterback) (Galat, 2010; Goodell, 2020; Sierer et al., 2008; Vitale et al., 2016; Yamashita et al., 2017). Each participant was given an

informed consent, which they were asked to read and sign if they agreed to participate in this research.

2.2 Instruments

Weight (kg) and height (cm) were measured using a SECA ® model 711 scale and stadiometer. The BMD (g/^{cm2}) for the regions of upper limbs, lower limbs, trunk, head, spine, ribs and hip, was obtained using a Dual X-ray Densitometer Lunar Prodigy Advance brand General Electric ® (GE Medical Systems, Ultrasound and Primary Care Diagnostics, Madison, WI, USA) Model LU43616ES version 16.

2.3 Procedures

As a first step, the head coach together with his coaching staff was in charge of informing the FA players about the investigation to be carried out, in which informed consent was also administered. Subsequently, an appointment was added to the Human Performance Laboratory (LRH) of the Faculty of Sports Organization (FOD), for the measurement of DXA at the beginning of each pre-season. Participants had to meet the following requirements before the evaluation: 2 hours of minimum fasting, evacuated urine or feces, not carrying any metal objects (bracelets, earrings, piercings and clothes with metal), minimum clothing (short or lycra) and not having performed a previous physical activity.

For the evaluation of bone densitometry (Libber et al., 2012; Promma et al., 2018), were placed in a dorsal supine position, where, the palm of the hands next to the abductors of the thigh, fully extended arms without having a flexion in the elbow and wrist. And finally, participants were informed not to perform any body movement and not to speak during the measurement scan. The duration for each scan ranged from 8 to 12 minutes.

2.4 Data processing

For the statistical analysis, the statistical package "Statistical Package for the Social Sciences" (SPSS) version 25 was used, making descriptive and inferential statistics. Subsequently, the normality of the variables was determined by the Shapiro-Wilks analysis of the variables of body composition (body weight, lean mass in kg, fat mass in kg and fat mass in %), the CMO in kg and the BMD in g / cm^2 for the regions of arms, legs, trunk, head, spine, ribs and hip, of the team for each grouping. Next, Student's t-tests, analysis of variance (ANOVA) of a factor of repeated measures with post hoc tests, were performed to observe the changes between the means of the same group in BMD and CMO, between the different groupings. Post hoc analyses were adjusted with Bonferroni and a p level < .05 was considered significant.

2.5 Ethical Considerations

The study is based on the provisions of the Regulations of the General Health Law on Health Research as stated in Chapter I of Title Two (Secretary of Health,

1987). This research has followed procedures according to the World Medical Association (WMA) following the Declaration of Helsinki.

3. RESULTS

In this study, 39 AF players were evaluated, showing considerable changes with respect to BMD. **Table 1** shows the body composition values divided by take 1 (2015) and take 2 (2016).

Table 1. Descriptive statistics of FA players by game groupings.

POSITIONS		
MEASUREMENT	**TEST 1**	**TEST 2**
Linemen (n=15)		
Height (cm)	182.6±4.1	182.5±4.2
Weight (kg)	114.7±18.5	115.6±16.38
Age	21.0±1.7	21.9±1.6
BMI (Kg/m^2)	34.3±5.8	34.5±5.5
Players of great abilities (n=7)		
Height (cm)	178.6±3.4	178.7±2.1
Weight (kg)	91.4±8.79	90.4±7.62
Age	22.1±1.6	23.1±1.5
BMI (Kg/m^2)	28.2±2.8	28.1±2.5
Skill players (n=13)		
Height (cm)	174.7±5.9	174.0±5.5
Weight (kg)	80.66±7.46	83.07±8.45
Age	21.6±1.5	22.5±1.5
BMI (Kg/m^2)	26.0±2.1	27.1±2.2
Quarterbacks (n=4)		
Height(cm)	180.5±6.6	181.2±5.5
Weight (kg)	85.7±7.94	88.0±8.72
Age	21.0±2.3	22.0±2.3
BMI (Kg/m^2)	25.6±1.5	26.47±1.2

Note: cm = centimeters; BMI = body mass index; kg = kilograms; kg/^{m2} = kilograms per square meter; n= sample number; % = percentage.

Table 2(a). Descriptive results of body composition of FA players by game groupings.

POSITIONS		
MEASUREMENT	**TEST 1**	**TEST 2**
Linemen (n=15)		
Fat mass (kg)	32.9±12.6	30.7±13.0
Lean mass (kg)	77.8±9.5	80.7±6.9
Body fat (%)	27.9±7.4	25.7±7.9
BMD (g/cm^2)	1.55±.095	1.56±.091
BMC (kg)	4.02±.334	4.06±.313
Players of great abilities (n=7)		
Fat mass (kg)	17.8±5.6	17.0±5.3
Lean mass (kg)	69.8±5.1	69.7±3.3

Table 2(b). Descriptive results of body composition of FA players by game groupings.

POSITIONS		
MEASUREMENT	**TEST 1**	**TEST 2**
Body fat (%)	19.2±4.7	18.5±4.7
BMD (g/cm²)	1.53±.053	1.52±.052
BMC (kg)	3.70±.300	3.69±.272
Skill players (n=13)		
Fat mass (kg)	15.0±4.2	16.4±5.0
Lean mass (kg)	62.2±5.1	63.1±5.3
Body fat (%)	18.4±4.2	19.5±4.8
BMD (g/cm²)	1.46±.067	1.48±.061
BMC (kg)	3.43±.246	3.42±.239
Quarterbacks (n=4)		
Fat mass (kg)	15.2±5.1	16.0±3.6
Lean mass (kg)	66.8±3.0	68.3±4.8
Body fat (%)	17.5±4.4	18.1±2.5
BMD (g/cm²)	1.46±.088	1.46±.098
BMC (kg)	3.63±.389	3.58±.436

Note: BMC= bone mineral content; BMD = bone mineral density; g/cm² = grams per cubic centimeter; kg = kilograms; n = sample number; % = percentage.

In the results of **table 3** of the BMD, divided by grouping, the linemen show a higher BMD than the rest of the groupings of the FA players. However, there are no significant differences for BMD (p= .283). On the other hand, significant differences were found in the head region F (1.00, 35.0) = 55.9, p<.05, η_{2p}=0.941; obtaining a decrease in head BMD in FA players, showing mean differences of 1.266±DE 0.054. In linemen (p=.00), players of great abilities (p=.00), skill players (p=.00) and quarterbacks (p=.00).

In the same way, in the leg region significant changes are shown F (1.00, 35.0) =10.77, p<.05, η_{2p}= 0.235, obtaining an increase in the BMD in legs in the FA players, showing a mean difference of .023±.007 in the groupings of linemen (p = .00) and skill players (p = .003). On the other hand, in the regions of arms, trunk, ribs, pelvis, spine, and total in BMD no significant changes (p>.05) were found in any of the groupings.

Table3 (a). ANOVA of DMO by groups for the PLAYERS of FA of the UANL.

BONE MINERAL DENSITY (G/CM²)				
MEASUREMENT	**TEST 1**	**TEST 2**	***P***	**DIF.**
Linemen (n=15)				
Head	4.02±.33	2.45±.23	.00*	1.56±.07
Arms	1.29±.11	1.29±.11	.92	.00±.02
Legs	1.63±.10	1.67±.09	.00*	.04±.01
Trunk	1.36±.11	1.36±.11	.95	.00±.01
Ribs	1.16±.11	1.14±.10	.11	.01±.01
Pelvis	1.46±.12	1.50±.14	.06	.03±.01
Spine	1.54±.17	1.52±.13	.28	.02±.01
Total	1.55±.09	1.56±.09	.16	.01±.00

Table3 (b). ANOVA of DMO by groups for the PLAYERS of FA of the UANL

BONE MINERAL DENSITY (G/CM^2)				
MEASUREMENT	**TEST 1**	**TEST 2**	***P***	**DIF.**
Players of great abilities (n=7)				
Head	3.70±.30	2.43±.16	.00*	1.26±.11
Arms	1.28±.08	1.29±.05	.99	.00±.03
Legs	1.58±.05	1.59±.07	.68	.00±.01
Trunk	1.33±.07	1.32±.05	.69	.00±.01
Ribs	1.09±.09	1.08±.09	.40	.01±.01
Pelvis	1.48±.07	1.49±.06	.74	.00±.02
Spine	1.47±.09	1.44±.10	.24	.03±.02
Total	1.53±.05	1.52±.05	.93	.00±.01
Skill players (n=13)				
Head	3.43±.24	2.38±.23	.00*	1.04±.08
Arms	1.18±.08	1.20±.10	.44	.02±.02
Legs	1.53±.06	1.57±.07	.00*	.03±.01
Trunk	1.27±.07	1.27±.05	.90	.00±.01
Ribs	1.05±.06	1.04±.06	.54	.00±.01
Pelvis	1.44±.09	1.45±.09	.74	.00±.01
Spine	1.34±.10	1.34±.09	.82	.00±.02
Total	1.46±.06	1.48±.06	.16	.01±.01
Quarterbacks (n=4)				
Head	3.63±.38	2.44±.24	.00*	1.18±.14
Arms	1.22±.07	1.22±.06	.88	.00±.46
Legs	1.50±.10	1.50±.10	.75	.00±.01
Trunk	1.24±.11	1.25±.14	.75	.00±.02
Ribs	1.03±.07	1.03±.08	.98	.00±.02
Pelvis	1.40±.15	1.42±.16	.505	.02±.03
Spine	1.31±.14	1.32±.21	.85	.00±.03
Total	1.46±.08	1.46±.09	.88	.00±.01

*Note: BMD = bone mineral density; g/^{cm2} = grams per cubic centimeter; n = sample number; * = significant difference p< 0.05.*

In the results of **table 4** of BMC, divided by grouping, in the linemen a higher BMC is observed than the rest of the groupings of the FA players. However, no significant differences were found for BMC *p*>.05 (*p*= .718). On the other hand, the grouping of linemen in the pelvic region showed a significant change (*p*=.033). On the other hand, for the rest of the groupings no significant changes are shown.

Table 4 (a). ANOVA of the BMC by groupings of the FA players of the UANL.

BONE MINERAL CONTENT (KG)				
MEDICIONES	**TEST 1**	**TEST 2**	***P***	**DIF.**
Linemen (n=15)				
Head	.59±.06	.60±.06	.18	.00±.00
Arms	.56±.01	.58±.01	.11	.01±.01
Legs	1.54±.03	1.53±.03	.29	.01± .00
Trunk	1.30±.03	1.32±.03	.21	.02±.01
Ribs	.45±.01	.45±.018	.80	.00±.00
Pelvis	.56±.01	.59±.018	.03*	.02± .01
Spine	.28±.01	.28±.00	.42	.00±.00
Total	4.02±.07	4.06±.07	.15	.03±.02

Table 4 (b). ANOVA of the BMC by groupings of the FA players of the UANL.

BONE MINERAL CONTENT (KG)				
MEDICIONES	**TEST 1**	**TEST 2**	***P***	**DIF.**
Players of great abilities (n=7)				
Head	.59± .56	.59±.05	.69	.00±.01
Arms	.53± .02	.54±.02	.48	.01±.01
Legs	1.40±.04	1.40±.04	.60	.00±.01
Trunk	1.17±.05	1.14±.05	.33	.02±.02
Ribs	.37±.025	.36±.02	.25	.01±.01
Pelvis	.53±.022	.52±.02	.61	.00±.01
Spine	.26±.016	.26±.01	.88	.00±.01
Total	3.70±.11	3.69±.11	.69	.01±.03
Skill players (n=13)				
Head	.55±.07	.54±.06	.16	.01±.00
Arms	.46±.01	.48±.01	.48	.01±.01
Legs	1.33±.03	1.33±.03	.91	.00±.01
Trunk	1.06±.03	1.06±.04	.78	.00±.01
Ribs	.34±.01	.33±.01	.68	.00±.00
Pelvis	.50±.01	.50±.01	.91	.00±.01
Spine	.22±.01	.22±.01	.74	.00±.00
Total	3.43±.08	3.42±.08	.86	.04±.05
Quarterbacks (n=4)				
Head	.55±.07	.54±.06	.43	.01±.01
Arms	.52±.03	.51±.02	.72	.00±.02
Legs	1.40±.06	1.33±.05	.049*	.03±.01
Trunk	1.09±.06	1.09±.07	.78	.00±.03
Ribs	.34±.03	.35±.03	.57	.00±.01
Pelvis	.49±.03	.50±.01	.93	.00±.02
Spine	.25±.02	.25±.01	.90	.00±.01
Total	3.63±.15	3.58±.14	.37	.04±.05

*Note: BMC= bone mineral content; kg = kilograms; n = sample number; * = significant difference p ≤ 0.05.*

On the other hand, significant changes were found in the leg region F (1.00, 35.0) = 4.3, p<.05, η_{2p}=0.110, showing a decrease in BMC in legs. However, this change was only observed in the quarterback grouping (*p* = .049) having a decrease in BMC. For the rest of the groups, no significant changes were found.

4. DISCUSSION

Our results on bone modifications of major category FA players by game groupings (linemen, skill players, high-skilled players, and quarterbacks) for this study showed significant changes in BMD in the head region in linemen, high-skill players, skill players, and quarterbacks. In the same way, in the leg region only for linemen and skill players. Similarly, significant changes were shown for the BMC in legs, however, it only occurred in the quarterbacks. On the other hand, in the pelvic region significant changes were obtained for the linemen. These results combine

with what is reported by Bosch et al., (2019) showing a mean total BMD ($g/^{cm2}$) in the LO was 1.63 and LD 1.65, resulting in a significant difference ($p<.05$) lower for this study in the grouping of linemen (Bosch et al., 2019), in the same way there were results with higher BMD for the LB, RB, DB, WR and ST playing positions ($p<.05$), on the other hand, for the quarterbacks no significant changes ($p>.05$) in DMO were found in the different shots, resulting in similarities with the quarterbacks of the UANL.

Supporting the above, the studies carried out by Trexler et al., (2017) y Turnagöl (2016) made in university FA players(Trexler et al., 2017), they pointed out the changes in the DMO and BMC over the course of a season to the next. Trexler et al., (2017) mentions in the pre-season a DMO 1.537 and BMC 4.74, by the end of the season it showed a DMO 1.552 and BMC 4.80, obtaining significant differences ($p<.05$) (Trexler et al., 2017). On the other hand, for Turnagöl (2016) in university FA players by game positions the BMC is similar to this study, on the other hand, the BMD is lower (Turnagöl, 2016).

This may be rooted in the frequency/volume of training, or in nationality. In the AF, positive effects have been presented to the increase in BMD and BMC at the same time as physical activity and feeding by specialists in the area (Vlachopoulos et al., 2017).

In accordance with the above, Lambert et al., (2020) mentions that there are positive effects when performing impact and resistance training for the improvement of BMD (Lambert et al., 2020), however, there are different bone responses for the different training modalities and sports disciplines, such is the case, in youth *soccer* players they present an improvement of BMD and BMC over a season, however, the DMO and BMC of these *soccer* players is lower than that of fa players (López-García et al., 2019).

In the same way, Tervo et al., (2009) mentions that when performing a physical activity increases BMD and helps to have improvements in the trabecular and cortical bone, however (Tervo et al., 2009), when stopping physical activity there is greater loss in the trabecular bone in the hip and spine areas. On the other hand Al-Ani et al., (2015) mentions that young people who have a femoral neck fracture due to trauma is associated with BMD and a low fat-free mass index (Al-Ani et al., 2015). Additionally, Heydenreich et al., (2020) reports that age, physical activity, fat-free mass and sex are highly related to bone components in young people and children for their development, recommending regular physical activity (Heydenreich et al., 2020).

In this sense, it is of the utmost importance to assess bone status and develop strategies to take care of bone in athletes, since there are high training loads, which can imply risks by not having control and monitoring (Elliot-Sale, 2019). Melvin et al., (2014) report that having a low BMD in the spine can cause an injury, adding that this risk can increase more in players who perform a collision sport, also recommends that when suffering from a low BMD in the spine should perform

exercises that help strengthen the spine at the same time as adequate supplementation (Melvin et al., 2014).

On the other hand, body weight and lean mass are some components that are key to having a maximum bone mineral density in healthy people, however to have these results you must consider a good level of physical activity in daily life, this in order to maximize bone mass during the stage of adulthood, in addition, it helps reduce the risk of osteoporosis or osteopenia at an older age (Nguyen et al., 2020).

In most sports it is of the utmost importance to have a boy composition according to the physical demands for the competition, as in the case of the FA, currently in some playing positions it is essential to have a high body weight to be able to meet the demands of the competition, result with problems of obesity or overweight, adding a surplus of body fat, causing a possible prevalence of chronic degenerative diseases (Sparvero & Warner, 2019), in addition to presenting cardiovascular problems (Feairheller et al., 2016).

On the other hand, the lean mass in FA players must always be high for sports practice and competition (Bosch et al., 2014). In addition, having a high lean mass has been found to have positive effects for BMD in certain regions of the body (López García et al., 2020). In addition, having a physical activity significantly affects an increase in bone properties, by which performing a functional model of the development of strength brings positive effects for bone metabolism, lean mass and increased strength (Ludwa et al., 2021). Likewise, having strength as well as adequate muscle power is a good predictor for healthy bone mass (Janz et al., 2015).

On the other hand, for fat mass, some authors mention that it is more likely to suffer a fracture due to low BMI than due to a high fat mass (Holecki & Wiecek, 2010), even so there is little evidence to support this data, on the contrary, some authors find linked a high fat mass with overweight and obesity, by which, many times this excess is associated with a decrease in bone mass, causing metabolic, mechanical and hormonal interference (López-Gómez et al., 2016).

In the same way, Fassio et al., (2018) in their study associates that people who have obesity have a higher risk of fracture in some sites (Fassio et al., 2018), mainly in the lower limbs (ankle) excluding the hip despite having an elevated BMD. Another important factor to consider is visceral fat, because if it is very high the quality of bone properties will be worse and this can also cause an increase in falls and a lower bioavailability of vitamin D contained in fat, therefore fat mass and its distribution should be taken into account even more than a high or low BMD, as this will not determine whether you are at adequate levels of health for patients who are overweight or obese as it is with AF players (Biver, 2017).

On the other hand, the FA is one of the sports that entails more collisions in its competition and sports practice, leading players to constantly receive collisions, collisions, blows in different parts of the body, such is the case, that Le Flao et al.

(2021) mention that performing a high number of collisions per session in college players has an acute neurological effect affecting the performance of players (Le Flao et al., 2021). The contribution of this study could have a relationship with what was reported in this research with a decrease in BMD in the head region, this may be due to constant exposure to head collisions causing a loss of bone mineral density in college AF players.

On the other hand Maureira et al. (2019), mention that performing regular physical activity helps to promote bone mass, in addition to having a memory and sustained high attention, however, this study shows that BMD in the head region decreased over a season, this can affect the neurological processing of memory and sustained attention for college AF players (Maureira Cid et al., 2019).

In the present research, the changes of BMD and BMC over a season (2015-2016) in players of higher university FA were analyzed, using a reliable and reliable measurement using the DXA. On the other hand, although the present research provides in a general way an area of the Mexican Republic (Monterrey, Nuevo León) and considering that the players belong to different areas of the republic, in addition, that the results obtained are from a single university team (UANL), this can open to new investigations considering these variables mentioned and contributing if this reduction in BMD is caused by the number of collisions per training session, by the total number of collisions per game and whether these collisions have an acute or chronic neurological effect on college AF players.

5. CONCLUSION

Based on the above, we can conclude that FA players exhibit a significant decrease in BMD in the head region in the groupings of linemen, skill players, high-skilled players, and quarterbacks; on the other hand, the BMD in the lower limbs in the groupings of linemen and skill players had a significant increase, this can help to favor their physical performance as well as the improvement of physical abilities; in the same way in the pelvic region there was a significant increase in BMD in the grouping of linemen. For the BMC a significant increase was found in the pelvic region in the grouping of linemen, while for the grouping of quarterbacks in the leg region presented a decrease in the leg region, these differences may be due to the fact that each playing position has its physical, psychological and technical demands during the playing field. Finally, this decrease in BMD in the head region could have a risk to health and physical performance in the long term, on the other hand, there are different factors that could cause these decreases in BMD, for example, training volume, total collisions per season and eating habits, it would be important to investigate these variables for future research to answer these doubts.

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