TESIS DOCTORAL

PROGRAMA DE DOCTORADO EN MEDICINA

# VALORACIÓN CINEANTROPOMÉTRICA, NUTRICIONAL Y CONSUMO DE SUPLEMENTOS EN FUTBOLISTAS DE ÉLITE


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Universitat de València

Facultad de Medicina y Odontología

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# Valoración cineantropométrica, nutricional y consumo de suplementos en futbolistas de élite


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# RESUMEN


Introducción

El fútbol se originó en Inglaterra en 1863 tras la división del *rugby-football* y el *association football*, que dio lugar a la creación de la *Football Association*. Los partidos se estructuran en dos tiempos de 45 minutos, con un intermedio de 15 minutos y posibles pausas para hidratarse. El objetivo es marcar goles en la portería contraria, y el resultado puede ser una victoria, un empate o una derrota, con un sistema de puntuación que otorga tres puntos por victoria en las ligas nacionales. El fútbol es dinámico y sus exigencias físicas y técnicas han aumentado, lo que requiere intensos regímenes de entrenamiento para preparar a los jugadores. Por término medio, un jugador recorre entre 8 y 14 km por partido, con una variedad de movimientos que incluyen caminar, trotar, correr y esprintar. La energía para estas actividades procede de vías anaeróbicas y aeróbicas, con la degradación del adenosín trifosfato (ATP), la fosfocreatina, el glucógeno y los triglicéridos como fuentes clave. Sin embargo, las distancias totales varían según el tiempo jugado, el estilo de juego, la frecuencia de los partidos y la posición en el campo. Los porteros, por ejemplo, recorren aproximadamente la mitad de distancia que los demás jugadores.

El fútbol femenino, con su primer partido registrado en Escocia en 1892, tardó en alcanzar la popularidad del masculino, cuya primera Copa Mundial de la *Fédération Internationale de Football Association* (FIFA) fue en 1930, frente a 1991 para las mujeres. A pesar de ello, el fútbol femenino ha experimentado un aumento de popularidad y profesionalización, mejorando la calidad y la cobertura mediática. Tradicionalmente, se creía que las mujeres recorrían menos distancia en los partidos, pero estudios recientes demuestran que las diferencias de exigencia física entre hombres y mujeres se han reducido. Además,

las investigaciones sobre el impacto del ciclo menstrual (CM) en la recuperación y el bienestar de las futbolistas sugieren posibles efectos en el rendimiento, aunque los resultados no son concluyentes. En cuanto al fútbol base, las categorías varían en función de la edad y experimentan un aumento progresivo de las exigencias físicas a medida que los jugadores crecen y ascienden de categoría.

Las necesidades nutricionales de los futbolistas varían en función de múltiples factores, como las reglas del deporte, la fase de la temporada y la posición en el campo. El gasto energético diario de un futbolista oscila entre 2500-4400 kcal, siendo menor el de los porteros debido a las diferencias en las exigencias físicas de su posición. Durante los partidos, el gasto puede ser de 1100-1700 kcal, mayor que durante los entrenamientos. En el fútbol femenino de élite, el gasto energético es similar al de los hombres, con un rango de 2300-3200 kcal/día. En el fútbol base, las demandas energéticas varían más, influidas por la edad y la maduración biológica de los futbolistas.

Los hidratos de carbono (CH) son esenciales para los jugadores de fútbol, ya que aumentan el glucógeno muscular, mejorando la resistencia, la distancia recorrida y las habilidades específicas del fútbol. Las recomendaciones para la ingesta de CH varían según el volumen de entrenamiento, la intensidad y la duración del ejercicio. Pese a su importancia en el deporte, en las últimas décadas se ha observado una tendencia decreciente en la ingesta de CH entre los futbolistas.

Las proteínas son importantes para la recuperación y el mantenimiento de la masa muscular (MM), con recomendaciones de ingesta que oscilan entre 1,2 y 2,2 g/kg de peso corporal. La cantidad total, la calidad y el momento de la ingesta de proteínas son factores importantes para optimizar su efecto.

Las grasas también son un componente necesario de la dieta, ya que proporcionan energía y facilitan la absorción de las vitaminas liposolubles. Se recomienda que los deportistas consuman un 20-35% de su ingesta energética diaria en forma de grasas dietéticas, evitando una ingesta deficitaria o excesiva que pueda afectar negativamente a la composición corporal.

El agua es esencial para la salud humana y su gestión adecuada es fundamental para los deportistas. Durante el ejercicio, el calor generado por la contracción muscular debe disiparse, principalmente a través del sudor, para evitar el sobrecalentamiento corporal. Tanto la falta como el exceso de hidratación pueden afectar negativamente al rendimiento y a la salud, por lo que se recomienda mantener un estado de euhidratación. La pérdida de fluidos y electrolitos varía según las personas, por lo que es necesaria una estrategia de hidratación personalizada que incluya la reposición de fluidos y electrolitos durante la actividad física.

Las recomendaciones generales de ingesta de líquidos sugieren 6 ml/kg cada 2-3 h, ajustándose a la intensidad del ejercicio y a la temperatura ambiente. A su vez, las necesidades hídricas difieren entre hombres y mujeres, en parte debido a las diferencias en la MM, las cargas de trabajo físico y las variaciones en el equilibrio de líquidos a lo largo del CM, lo que puede influir en la regulación de la temperatura corporal y aumentar el riesgo de enfermedades relacionadas con el calor si se combina con la deshidratación. Los adolescentes pueden subestimar sus pérdidas de sudor, lo que pone de relieve la importancia de la educación alimentaria para optimizar la hidratación. Una variedad de fuentes dietéticas como las verduras, hortalizas o frutas pueden ayudar a garantizar una hidratación adecuada y evitar deficiencias que comprometan el rendimiento y la salud.

Las ayudas ergogénicas son métodos o maniobras que buscan aumentar la capacidad de realizar un trabajo físico y mejorar el rendimiento, pudiendo ser nutricionales, mecánicos, psicológicos o farmacológicos. Su uso es habitual en el deporte, tanto en atletas de élite como en aficionados, independientemente de su sexo. Sin embargo, existen riesgos asociados como la exposición a sustancias dopantes, fraudes en su composición y efectos secundarios debidos a interacciones con alimentos, otros suplementos o fármacos. La seguridad y la justificación de su uso deben evaluarse cuidadosamente, evitando su inclusión en programas deportivos sin el conocimiento adecuado.

Organizaciones como la *Australian Institute of Sport* (AIS) han clasificado los suplementos en función de las pruebas científicas disponibles, desde aquellos con pruebas sólidas (Grupo A) hasta los prohibidos o con alto riesgo de contaminación (Grupo D). A pesar de la popularidad de los suplementos y los avances en el fútbol femenino, la investigación en este campo es menor en comparación con el fútbol masculino. El uso de suplementos en atletas adolescentes es controvertido debido a los riesgos de efectos secundarios y a la presencia de sustancias prohibidas.

La cineantropometría es una disciplina científica que mide la composición corporal humana, fundamental en el deporte para lograr un rendimiento óptimo. En el fútbol, aspectos como la MM, la carga de impacto y la masa grasa (MG) son fundamentales para mejorar el rendimiento, ya que afectan a movimientos como las aceleraciones y los saltos. Existen varios métodos para evaluar la composición corporal, clasificados como directos, indirectos y doblemente indirectos. En el fútbol, se utilizan principalmente la antropometría, la bioimpedancia (BIA) y la absorciometría dual de rayos X (DXA) para la evaluación de la composición corporal, contando cada método con sus ventajas y desventajas, y la elección depende de factores como la precisión requerida, el costo y el tiempo disponible.

La antropometría, que mide el tamaño y las proporciones corporales, está promovida por la Sociedad Internacional para el Avance de la Cineantropometría (ISAK) para unificar las normas de evaluación.

Cuando se utiliza la antropometría, la composición corporal puede abordarse con un modelo bicompartimental (MG y masa libre de grasa (MLG)), un modelo tetracompartimental (MG, MM, masa ósea y masa residual) y un modelo pentacompartimental (adiposo (grasa subcutánea), muscular (músculo), residual (vísceras, órganos y pulmones), óseo (huesos) y cutáneo (piel)). La BIA, un método no invasivo, mide la conductividad eléctrica de los tejidos para estimar la composición corporal, pero puede verse afectada por factores como tratamientos médicos o situaciones clínicas. La DXA, por su parte, es un método indirecto que mide la MM, la MG y la densidad mineral ósea (DMO) mediante la atenuación de fotones, pero tiene limitaciones como el coste económico y la exposición a la radiación. El somatotipo es otra herramienta importante, que cuantifica la forma y la composición corporal en tres componentes: endomorfia (adiposidad), mesomorfia (robustez musculoesquelética) y ectomorfia (delgadez). La representación gráfica del somatotipo se denomina la somatocarta, útil para la comparación con referencias deportivas.

Objetivos

El objetivo principal de la presente Tesis Doctoral es analizar y evaluar la composición corporal en el fútbol profesional masculino, así como los hábitos dietéticos, hídricos, de consumo de suplementos y el estado de hidratación en futbolistas de la Academia Valencia CF y su variabilidad entre posiciones de juego, nivel competitivo y sexo.

Resultados

**Composición corporal de futbolistas profesionales masculinos mediante diferentes métodos de medición: Una revisión sistemática y un metaanálisis**

Los resultados del estudio se basan en una revisión sistemática y un metaanálisis de 74 estudios, que incluyeron un total de 5197 futbolistas. Los métodos de medición analizados fueron la antropometría, la BIA y la DXA, de los cuales 32 se basaban en el uso de antropometría, 21 en BIA, 13 en DXA, 3 combinaban antropometría y BIA, 3 combinaban antropometría y DXA, y 2 combinaban BIA y DXA. En relación con el instrumento de medición antropométrica, el principal utilizado fue el plicómetro Harpenden (n = 25) seguido del Holtain (n = 8) y del Slimguide (n = 5). En cuanto a la BIA, los modelos más utilizados fueron el Tanita BC 418 MA (n = 5), Akern BIA 101 (n = 4), y Tanita TBF 543 (n = 2). Por último, los modelos de DXA más frecuentes fueron GE Lunar Prodigy (n = 4), Hologic QDR Series Delphi A (n = 2), Hologic QDR Series Discovery A (n = 2) y Hologic Discovery W (n = 2). De los 38 artículos incluidos en los que se utilizó la antropometría como método de evaluación, 15 utilizaron el protocolo de la ISAK, dos utilizaron el protocolo del *Anthropometric Standardization Reference Manual* (ASRM), uno utilizó el protocolo del *International Biological Program* (IBP), uno utilizó el protocolo del *American College of Sports Medicine* (ACSM), y los 19 artículos restantes no especificaron el protocolo aplicado. En cuanto a la suma de pliegues cutáneos, las fórmulas más utilizadas fueron la suma de seis pliegues cutáneos (tríceps, subescapular, supraespinal, abdominal, medio muslo y pantorrilla) (n = 4), seguida de la suma de ocho pliegues (bíceps, tríceps, subescapular, cresta ilíaca, supraespinal, abdominal, medio muslo y pantorrilla) (n = 3).

En cuanto al porcentaje de MG, la fórmula más utilizada fue la de Durnin y Womersley, 1974 (n = 10), seguida de los siete pliegues de Jackson y Pollock, 1978 (n = 6), y Faulkner, 1968 (n = 4). En el caso del porcentaje de MM, la fórmula más utilizada fue la de Matiegka, 1921 (n = 3), seguida de la de Kerr, 1988 (n = 1). Por último, para el porcentaje de masa ósea, las dos fórmulas igualmente utilizadas fueron las de Matiegka, 1921 y Kerr, 1988 (n = 1).

La muestra tenía una edad media de 24,50 años, y se encontraron los siguientes valores medios: 179,76 cm de altura, 76,29 kg de peso, 12,48 kg de MG, 11,85% de MG, 66,10 kg de MLG, 81,36% de MLG, 39,28 kg de MM y 52,03% de MM. La comparación de los grupos según el método de evaluación no mostró diferencias significativas en edad (p = 0,45), peso (p = 0,11), porcentaje de MLG (p = 0,59), kilogramos de MM (p = 0,37) o porcentaje de MM (p = 0,38). Sin embargo, hubo diferencias significativas en la altura, con el uso de la BIA mostrando la mayor altura (p = 0,001); en los kilogramos de MG, con el método de la antropometría mostrando el valor más alto (p < 0,0001); en el porcentaje de MG, con el uso de la DXA mostrando el porcentaje más alto (p < 0,0001), y en los kilogramos de MLG, con el método de la antropometría mostrando el resultado más elevado (p = 0,0004).

Teniendo en cuenta la ecuación utilizada para el cálculo del porcentaje de MG a través de la antropometría, se obtuvo una media de 10,19%, con diferencias significativas entre las distintas ecuaciones. Las ecuaciones Durnin y Womersley, 1974 y Faulkner, 1968 mostraron los valores más altos, y las ecuaciones Carter, 1982 y Yuhasz, 1974 los valores más bajos. Según la ecuación utilizada para calcular la suma de los pliegues cutáneos, la suma de seis pliegues cutáneos mostró una media de 52,18 mm, mientras que la suma de ocho pliegues cutáneos mostró un valor de 59,93 mm.

Los estudios indican una media de 2,32 puntos para la endomorfia, 2,32 puntos para la ectomorfia y 5,15 puntos para la mesomorfia. Por último, se notificaron valores medios de 3,17 kg para el contenido mineral óseo (CMO), 1,33 g/cm$^3$ para la DMO, y 47,52 l para el agua corporal total.

**Diferencias en la composición corporal entre las posiciones de juego en el fútbol profesional masculino: Una revisión sistemática con metaanálisis**

En esta revisión sistemática con metaanálisis se incluyeron un total de 26 estudios con una muestra de 3117 futbolistas, siendo 1025 defensas (combinando defensas centrales y laterales), 1093 centrocampistas (combinando centrocampistas defensivos, centrales, centrocampistas ofensivos y laterales), 691 delanteros y 308 porteros.

En relación con el método de medición, en 12 ocasiones se basaron en el uso de antropometría, seis en BIA, siete en DXA, y una combinó antropometría y BIA. En relación con el instrumento de medición antropométrica, el principal utilizado fue el picómetro Harpenden (n = 7). En cuanto al BIA, el modelo más utilizado fue el Tanita BC 418 MA (n = 3), mientras que el modelo de DXA más utilizado fue el Hologic QDR Series Discovery A (n = 2).

De los 13 artículos incluidos en los que se utilizó la antropometría como método de evaluación, siete utilizaron el protocolo de la ISAK, uno utilizó el protocolo del ASRM, uno utilizó el protocolo del IBP, otro utilizó el protocolo del Sistema de Acreditación en Técnicas Antropométricas (SATA), y los tres artículos restantes no especificaron el protocolo aplicado. En cuanto a la suma de pliegues cutáneos, las fórmulas más utilizadas fueron la suma de seis pliegues cutáneos (tríceps, subescapular, supraespinal, abdominal, medio muslo y pantorrilla) (n = 3), mientras que en el porcentaje de MG no predominó ninguna de las siete ecuaciones incluidas en el estudio, estando presentes sólo en un artículo cada una.

La muestra tenía una edad media de 24,4 años, 180 cm de estatura, 76,8 kg de peso, 54,56 mm de suma de pliegues cutáneos, 11,89% de MG, 11,14 kg de MG, 47,01% de MM, 38,59 kg de MM, 64,7 kg de

MLG, 2,31 de endomorfia, 2,30 de ectomorfia, 5,06 de mesomorfia, 1,35 g/cm³ de DMO y 3,33 kg de CMO.

Al comparar los resultados por posición de juego, se encontró una diferencia significativa en la edad (0 = 0,002), siendo los porteros y los defensas mayores y los delanteros más jóvenes; la estatura ($p < 0,001$), siendo los centrocampistas los más bajos de estatura y los porteros los más altos; el peso ($p < 0,001$), siendo los porteros los más pesados y los centrocampistas los más ligeros; la suma de pliegues cutáneos ($p = 0.038$), con el portero presentando la mayor suma, seguido de los defensas, centrocampistas y delanteros; kilogramos de MM ($p = 0,001$), con los porteros y defensas mostrando mayor MM y los centrocampistas y delanteros mostrando menor MM; y kilogramos de MLG ($p = 0,009$), con los porteros teniendo más kilogramos de MLG. No se encontraron diferencias significativas para el CMO, la DMO, el somatotipo, peso y porcentaje de MG.

**Hábitos alimentarios de los futbolistas de élite: Variaciones según el nivel competitivo, la posición de juego y el sexo**

El estudio incluyó 110 jugadores de fútbol, siendo 13 jugadores del Valencia Mestalla, 17 jugadores del Juvenil A, 16 jugadores del Juvenil B, 17 jugadores del Cadete A, 18 jugadores del Cadete Fundacions, 15 jugadoras del Valencia CF Femenino y 13 del Valencia CF Femenino B. Todos los jugadores tenían al menos 4 años de experiencia en el entrenamiento de fútbol y realizaban de 4 a 7 sesiones regulares de entrenamiento por semana, jugando un partido oficial de fútbol por semana.

Se encontraron diferencias significativas en el consumo de pasta ($p = 0,000$), pan ($p = 0,004$), carnes magras ($p = 0,042$), huevos y ovoproductos ($p = 0,040$), carne roja ($p = 0,035$), dulces ($p = 0,046$) y alimentos preparados o congelados ($p = 0,002$). Se observó que los cadetes tenían un mayor consumo de pasta, pan, dulces y alimentos preparados o congelados, pero un menor consumo de pollo y pavo, mientras que los juveniles eran la categoría con un mayor consumo de huevos y sus derivados y carne roja. En relación con las distintas posiciones de juego, sólo se encontraron diferencias significativas en el consumo de carne roja (p = 0,012), con un mayor consumo por parte de los delanteros.

Con relación al sexo, se encontraron diferencias significativas para el consumo de frutas (p = 0,022), legumbres (p = 0,001), pasta (p = 0,000), arroz (p = 0,014), carnes magras (p = 0,012), carne roja (p = 0,012), alimentos fermentados (p = 0,014) y alimentos preparados o congelados (p = 0,049). En todos estos grupos de alimentos, y a excepción del consumo de carnes magras, se observó que los hombres tenían un mayor consumo que las mujeres.

En relación con el consumo de alcohol, la frecuencia aumenta a medida que aumenta la categoría, siendo la categoría absoluta la que más consume. También se observaron diferencias significativas en cuanto al tipo de alcohol consumido (p = 0,000), ya que los juveniles consumían más bebidas mezcladas y los adultos más cerveza y vino. En relación con el sexo, sólo se encontraron diferencias significativas en el tipo de alcohol consumido (p = 0,024), ya que las mujeres consumían más cerveza y vino y los hombres más bebidas mezcladas.

**Consumo de suplementos por futbolistas de élite: Diferencias por nivel competitivo, posición de juego y sexo**

El estudio incluyó 70 jugadores de fútbol, siendo 12 jugadores del Valencia Mestalla, 15 jugadores del Juvenil A, 15 jugadores del Juvenil B, 15 jugadoras del Valencia CF Femenino y 13 del Valencia CF Femenino B. Todos los jugadores tenían al menos 9 años de experiencia en el entrenamiento de fútbol y realizaban de 4 a 7 sesiones regulares de entrenamiento por semana, jugando un partido oficial de fútbol por semana. Las bebidas deportivas (55,7%), las barritas deportivas (50,0%), la proteína de suero (48,6%), la cafeína (47,1%) y la creatina (60,0%) fueron los suplementos más consumidos por el total de la muestra.

En cuanto a los niveles competitivos de los equipos, se encontraron diferencias significativas tanto en el total como en todos los suplementos del grupo A (F = 4,531-8,781; p = 0,037-0,004) y en los suplementos del grupo C (F = 9,693; p = 0,003), observándose en todos los casos valores más elevados en la categoría adulta. En las categorías absolutas, destacaron la proteína de suero (p = 0,016), CH *gainers* (p = 0,011), β-alanina (p = 0,001), leucina (p = 0,004), y melatonina (p = 0,001) comparado con los juveniles.

Con relación a la posición de juego, se observó que, en todas las posiciones, los alimentos deportivos pertenecientes a los suplementos del grupo A fueron los más consumidos. También se observó que en todas las posiciones los suplementos pertenecientes al grupo C fueron más consumidos que los pertenecientes al grupo B. Sólo se encontraron diferencias significativas para el consumo de cafeína (p = 0,013), donde los centrocampistas y los delanteros presentaron frecuencias más elevadas.

Respecto al sexo, se encontraron diferencias significativas en el consumo de confitería deportiva (p = 0,036), proteína de suero (p = 0,002), β-alanina (p = 0,013), y melatonina (p = 0,016), observándose un mayor consumo en las mujeres, a excepción de la confitería deportiva que fue más habitual en los hombres.

En cuanto a la opinión del consumo de suplementos, 62 futbolistas se mostraron a favor de su uso (88,5%), mientras que 6 no contestaron (8,6%) y 2 no se mostraron a favor (2,9%). Sin embargo, la mayoría de los futbolistas han consumido suplementos en algún momento de su carrera (91,5%). Los futbolistas los utilizan principalmente tanto en los entrenamientos como en los días de partido (78,5%), especialmente después de la práctica deportiva (60,0%).

Por último, las principales razones para consumir estos productos fueron mejorar el rendimiento deportivo (80,0%), cuidar la salud (27,1%) y mejorar el aspecto físico (20,0%). Los futbolistas obtuvieron los suplementos principalmente a través del propio club (94,2%), pero también a través de Internet (14,2%), farmacias (7,1%), y herbolarios (7,1%); siendo motivados a tomarlos especialmente por el nutricionista interno del club (65,7%), el preparador físico (18,6%), el dietista/nutricionista externo del club (11,4%), y el médico (4,3%).

**Análisis del balance de líquidos y valores de orina en futbolistas de élite: impacto de diferentes ambientes, posiciones de Juego, sexos y niveles competitivos**

19 futbolistas del Valencia Mestalla, 21 del Juvenil A y 22 del Valencia CF Femenino completaron el entrenamiento en ambiente cálido, mientras que 12 jugadores del Valencia Mestalla, 6 del Juvenil A y 7 del Valencia CF Femenino completaron el entrenamiento en ambiente frío. Así pues, la muestra se analizó dividiéndola en dos subgrupos: la muestra con mediciones repetidas (RM), y la muestra con mediciones no repetidas (n-RM). Todos los jugadores tenían al menos 9 años de experiencia en el entrenamiento de fútbol y realizaban de 5 sesiones regulares de entrenamiento por semana junto con dos sesiones adicionales a la semana, jugando un partido oficial de fútbol por semana.

Durante el entrenamiento de verano, los jugadores del Valencia Mestalla experimentaron una mayor pérdida de peso (RM: 0,87 ± 0,59 kg; 1,17 ± 0,82% / n-RM: 0,96 ± 0,63 kg; 1,27 ± 0,8%), ingesta de líquidos (RM: 1,97 ± 0,88 l / n-RM: 2,12 ± 0,73 l), tasa de sudoración (RM: 1,34 ± 0,46 l/h / n-RM: 1,46 ± 0,40 l/h) y densidad específica de la orina en RM (1,03 ± 0,01) en comparación con el entrenamiento de invierno. Sin embargo, no hubo diferencias estadísticamente significativas en la diuresis.

Las jugadoras del Valencia CF Femenino presentaron una tasa de sudoración significativamente mayor durante el entrenamiento de verano (RM: 0,72 ± 0,17 l/h / n-RM: 0,68 ± 0,16 l/h) en comparación con el entrenamiento de invierno (RM: 0,63 ± 0,14 l/h / n-RM: 0,55 ± 0,10 l/h).

Los futbolistas del Juvenil A tuvieron una mayor tasa de sudoración (RM: 1,18 ± 0,31 l/h / n-RM: 1,09 ± 0,25 l/h), ingesta de líquidos (RM: 1,72 ± 0,28 l / n-RM: 1,76 ± 0,37 l) y pérdida de peso en RM (0,82 ± 0,62 kg / 1,15 ± 0,86%) durante el entrenamiento en verano, mientras que la densidad específica de la orina en n-RM fue mayor durante el entrenamiento en invierno (1,03 ± 0,00). No se encontraron diferencias estadísticamente significativas en la diuresis.

Cuando se compararon por sexos, los futbolistas del Valencia Mestalla tuvieron una mayor pérdida de peso (RM: 0,87 ± 0,59 kg; 1,17 ± 0,82% / n-RM: 0,96 ± 0,63 kg; 1,27 ± 0,8%), ingesta de líquidos (RM: 1,97 ± 0,88 l / n-RM: 2,12 ± 0,73 l), tasa de sudoración (RM: 1,34 ± 0,46 l/h / n-RM:1,46 ± 0,40 l/h) y densidad específica de la orina (RM: 1,03 ± 0,01 / n-RM: 1,02 ± 0,01) durante el entrenamiento de verano, así como en la media total.

Al comparar los niveles competitivos entre futbolistas masculinos, los jugadores del Valencia Mestalla mostraron una mayor pérdida de peso (Mestalla: 0,96 ± 0,63 kg / Juvenil A: 0,58 ± 0,53 kg), ingesta de líquidos (Mestalla: 2,12 ± 0,73 l / Juvenil A: 1,76 ± 0,37 l), y tasa de sudoración (U23-21: 1,46 ± 0,40 l/h / Juvenil A: 1,09 ± 0,25 l/h) durante el entrenamiento de verano en n-RM.

Por último, no se observaron diferencias estadísticamente significativas entre las posiciones de juego durante los entrenamientos de verano e invierno en n-RM. Sin embargo, los centrocampistas mostraron una mayor pérdida de peso (1,07 ± 0,68 kg / 1,56 ± 0,90%), ingesta de líquidos (1,96 ± 0,82 l) y tasa de sudoración (1,39 ± 0,55 l/h) en la sesión de entrenamiento de verano y una menor densidad específica de la orina (1,02 ± 0,01) que las otras posiciones de juego en RM.

Conclusiones

La composición corporal de los futbolistas profesionales tiende a presentar un somatotipo mesomorfo balanceado, con una suma media de seis y ocho pliegues cutáneos de 52,18 y 59,93 mm respectivamente, un volumen de agua corporal total de 47,52 litros, una DMO de 1,33 g/cm³ y un CMO de 3,17 kg. Aunque se han identificado diferencias significativas en la medición de la talla, el porcentaje y peso de la MG, y el peso de la MLG dependiendo del método o fórmula utilizada, no se encontraron diferencias significativas en el cálculo del peso, porcentaje de MLG, y el porcentaje y peso de la MM entre las distintas posiciones de juego en futbolistas masculinos.

En cuanto a las posiciones específicas, los porteros suelen tener mayor estatura, edad, peso corporal, sumatorio de pliegues cutáneos y MM, mientras que los defensas comparten una edad y MM elevadas. Los centrocampistas presentan menor estatura, peso total y MM, y los delanteros son generalmente más jóvenes y tienen menores sumas de pliegues cutáneos y MM. No obstante, no se observaron diferencias significativas en CMO, DMO, somatotipo, peso y porcentaje de MG entre las distintas posiciones.

Respecto a los hábitos alimenticios, los hombres tienden a consumir más CH, alimentos fermentados, congelados y carnes rojas, mientras que las mujeres prefieren carnes magras. Los futbolistas más jóvenes optan por una dieta más rica en CH y alimentos menos saludables, como dulces y congelados, en comparación con los jugadores de mayor nivel competitivo, aunque no se detectaron diferencias significativas en los patrones alimentarios entre las distintas posiciones de juego.

El consumo de suplementos es común entre los futbolistas de la Academia Valencia C.F., destacando las bebidas deportivas, barritas energéticas, cafeína, creatina y proteína de suero, siendo más frecuente en los de mayor nivel competitivo. Se observaron diferencias en el consumo de suplementos entre sexos, con los hombres prefiriendo confitería deportiva y las mujeres proteína de suero, β-alanina y melatonina. Además, el consumo de cafeína varía según la posición de juego, siendo más común entre centrocampistas y delanteros.

En relación con la hidratación, los futbolistas no alcanzaron la ingesta de líquidos recomendada, aunque no excedieron una pérdida de peso corporal del 1,5%. Además, durante el entrenamiento de verano los futbolistas experimentan un incremento en la pérdida de peso, la ingesta de líquidos y la tasa de sudoración en comparación con la sesión de invierno, especialmente los futbolistas del Valencia Mestalla. Sin embargo, no se encontraron diferencias significativas en los niveles de hidratación entre las diferentes posiciones de juego.

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## ABREVIATURAS, SIGLAS Y ACRÓNIMOS

AA: Aminoácidos

AC: Agua corporal

ACSM: *American College of Sport Medicine*

AGL: Ácidos grasos libres

AIS: *Australian Institute of Sport*

AMA: Agencia Mundial de Antidopaje

ATP: Adenosín trifosfato

BIA: Bioimpedancia

CC: Composición corporal

CH: Hidratos de carbono

CMO: Contenido mineral óseo

COI: Comité Olímpico Internacional

CK: Creatina quinasa

CM: Ciclo menstrual

DMO: Densidad mineral ósea

DXA: Absorciometría dual de rayos X

GREC: Grupo Español de Cineantropometría

ISAK: Sociedad Internacional para el Avance de la Cineantropometría

ISSN: *International Society of Sports Nutrition*

FIFA: *Fédération Internationale de Football Association*

LDH: Lactato deshidrogenasa

MG: Masa grasa

MLG: Masa libre de grasa

MM: Masa muscular

PCr: Fosfocreatina

RMN: Resonancia magnética nuclear

SEMED: Sociedad Española de Medicina del Deporte

SENC: Sociedad Española de Nutrición Comunitaria

TAC: Tomografía axial computarizada

UEFA: *Union of European Football Associations*

$VO_2$ máx.: Volumen máximo de oxígeno

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# PRIMER CAPÍTULO: INTRODUCCIÓN

**«***No puedo cambiar el viento, pero puedo ajustar mis velas para alcanzar mi destino***»**

Jimmy Dean

## 1.1. FÚTBOL

### 1.1.1. Normativa y demandas físicas

La historia del fútbol abarca un periodo de más de 100 años. Comenzó en Inglaterra en el año 1863, cuando el *rugby-football* y el *association football* se separaron y se fundó en consecuencia la *Football Association*, el primer organismo rector de este deporte (1). Con la posterior fundación de la *Fédération Internationale de Football Association* (FIFA) en 1904, este deporte se ha expandido siendo de los más populares a nivel mundial en cuanto a audiencia, asistencia y participación (2,3).

Los partidos oficiales constan de 2 tiempos de 45 minutos cada uno, intercalados por un descanso de 15 minutos. Pueden establecerse pausas de hidratación de hasta 3 minutos si las condiciones lo aconsejan en torno a los minutos 30 y 75 del partido. Dos equipos contrarios compiten por la posesión de un solo balón, siendo el objetivo disparar el balón hacia la portería contraria para marcar un gol, impidiendo al mismo tiempo que el equipo contrario llegue a la portería propia. Un equipo de fútbol está compuesto por 11 jugadores, de los cuales 1 es el portero y los otros 10 son jugadores de campo. Tras la pandemia por coronavirus SARS-CoV-2, se modificaron las reglas del juego en cuanto a las sustituciones de jugadores durante el partido, pasando de tres a cinco jugadores (4) (Figura 1).


**Figura 1.** Elementos esenciales de un partido competitivo de fútbol. Elaboración propia.

El resultado del partido es el producto de los goles marcados y recibidos por ambos equipos, y puede resolverse como una victoria para un equipo cuando ha marcado más goles que el adversario; un empate, cuando ambos equipos han marcado los mismos goles o ninguno durante el partido; o una derrota, cuando el equipo contrario marca más goles. En las competiciones de liga nacional, se conceden 3 puntos al equipo por una victoria, 1 punto por un empate y 0 puntos por una derrota (4).

El fútbol es un deporte global que evoluciona constantemente con un aumento sustancial de las exigencias físicas y técnicas en los partidos. Los regímenes de entrenamiento se han vuelto más exigentes a nivel físico con el fin de preparar a los jugadores para estos cambios, atendiendo a si mismo a las necesidades individuales de cada jugador (5). En la actualidad, los jugadores de fútbol recorren una distancia media total durante un partido completo de unos 8-14 km (3,5–10), comprendiendo un patrón muy variable de acciones como caminar, trotar, correr a velocidades altas y bajas, esprintar, desplazarse hacia atrás, dar patadas, saltar o realizar placajes. Sin embargo, las distancias recorridas dependen principalmente de: (i) el tiempo jugado (ligado a sustituciones durante el encuentro), (ii) el estilo de juego del equipo, (iii) el número de partidos en una misma semana o (iv) las diferentes posiciones de juego (3). Además, en caso de prórroga (un periodo de tiempo extra tras el final de los 90 minutos en las competiciones que incluyen eliminatorias como la Copa del Rey en España), las exigencias físicas aumentan aún más y, con ello, el riesgo de lesiones (11). Una revisión sistemática reciente (11) estimó un aumento total de la distancia de 3.213 ± 286 m, de los cuales 153 ± 105 m correspondían a niveles de intensidad alta.

Si se observa el patrón de movimientos durante un partido de competición, las acciones de baja intensidad (caminar, trotar o correr despacio) predominan frente a otras más exigentes (esprintar o correr a gran velocidad) (7). De hecho, se estima que alrededor del 70% o más de las acciones realizadas por los jugadores durante un partido son de baja intensidad (12), mientras que cubren el 22-24% de la distancia total del partido a velocidades superiores a 15 km/h, el 8-9% a velocidades superiores a 20 km/h y el 2-3% a velocidades superiores a 25 km/h (3,5). A modo de ejemplo, la Figura 2 muestra las distancias totales recorridas por los futbolistas profesionales brasileños según diferentes rangos de velocidad, siendo V1 <11 km/h (de pie, caminando y trotando); V2: 11 ≤ V2 <14 km/h (carrera a baja velocidad); V3: 14 ≤ V3 <19 km/h (carrera a velocidad moderada); V4: 19 ≤ V4 <23 km/h (carrera a alta velocidad); V5: ≥ 23 km/h (esprintando).

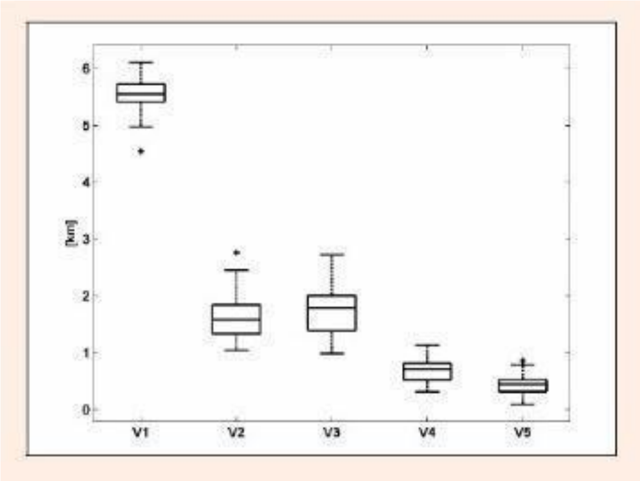


**Figura 2.** Distancias recorridas por los jugadores según los rangos de velocidad tras jugar un partido completo. Fuente: Barros y col., 2007 (7).

Aunque la mayoría de los estudios aplican una subdivisión horizontal para las posiciones de juego (portero, defensa, centrocampista y delantero), se recomienda utilizar también una subdivisión vertical (Figura 3) para especificar mejor las características antropométricas, los perfiles de actividad y/o las exigencias fisiológicas de cada jugador (13).

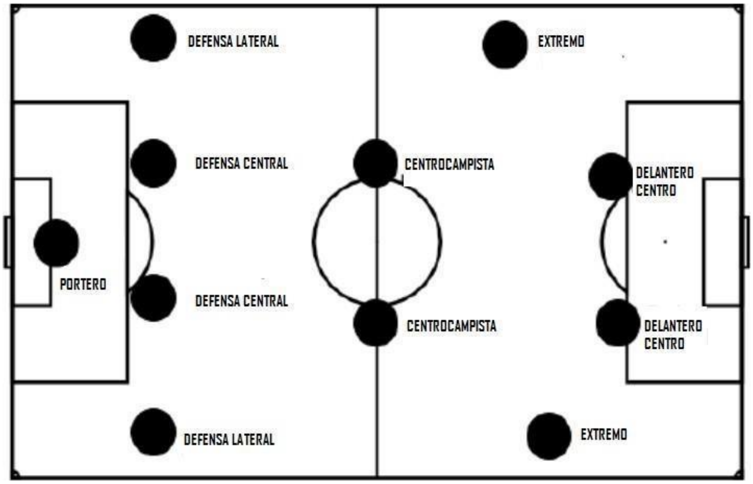


**Figura 3.** Asignación táctica de las posiciones de juego en el fútbol. Fuente: Adaptado de Rivilla-García y col., 2019 (10).

En relación con las exigencias físicas según la posición de juego, Barros y col. (7) observaron una mayor distancia recorrida por los defensas laterales, los centrocampistas y los extremos en comparación con los delanteros y los defensas centrales. Estos resultados son similares a los de otro estudio (8) en el que los centrocampistas y los laterales recorrieron distancias totales mayores que los extremos, los delanteros y los defensas centrales tras analizar 20 partidos de la Liga Española y 10 de la Liga de Campeones. En cambio, durante los entrenamientos y los partidos, los porteros suelen recorrer una distancia total que es alrededor de un 50% inferior a la de las otras posiciones (14,15).

El patrón semanal o microciclo durante la temporada competitiva de un club de fútbol profesional suele consistir en 6 sesiones de entrenamiento a lo largo de 5 días (es decir, 1 día con doble sesión) y 1 día de descanso después del partido (Tabla 1). En los casos en los que se juegan dos o más partidos en la misma semana, lo habitual es entrenar sólo una vez al día, aunque esto dependerá del nivel competitivo del club y de las variaciones que estipule el entrenador (12). Cabe señalar que, en ocasiones, los jugadores pueden realizar entrenamientos adicionales, ya sea por decisión del personal técnico-médico del club o por su cuenta, llevándose a cabo en las instalaciones del club o en otros lugares. A su vez, un equipo de fútbol profesional suele jugar unos 60 partidos al año, con una media de 5,5 partidos al mes (16), aunque esto puede variar en función del número total de competiciones nacionales e internacionales disputadas.

**Tabla 1.** Ejemplo de un programa de entrenamiento semanal durante la temporada, para un equipo de fútbol profesional, cuando juega uno o dos partidos en una semana. Fuente: Bangsbo y col., 2006 (12).

| Day | One match a week | Two matches a week |
|---|---|---|
| Sunday | Match | Match |
| Monday | Free | Low-/moderate-intensity aerobic training, 30 min<br>Strength training, 30 min |
| Tuesday | Warm-up, 15 min<br>Technical/tactical, 30 min<br>High-intensity aerobic training, 23 min<br>Play, 15 min | Warm-up, 15 min<br>Technical/tactical, 30 min<br>High-intensity aerobic training, 10 min<br>Play, 15 min |
| Wednesday | *Morning*<br>Strength training, 60 min<br>*Afternoon*<br>Warm-up, 15 min<br>Technical/tactical, 30 min<br>Speed endurance training, 20 min | Match |
| Thursday | Warm-up, 15 min<br>Technical/tactical, 30 min<br>Play, 30 min | Low-/moderate-intensity aerobic training, 40 min<br>Strength training, 30 min |
| Friday | Warm-up/technical, 25 min<br>Speed training (long), 20 min<br>High-intensity aerobic training, 18 min | Warm-up/technical, 25 min<br>Speed training (long), 10 min<br>High-intensity aerobic training, 20 min |
| Saturday | Warm-up/technical, 25 min<br>Speed training (short), 20 min<br>Play, 30 min | Warm-up/technical, 25 min<br>Speed training (short), 20 min<br>Play, 30 min |
| Sunday | Match | Match |

Debido a la naturaleza intermitente de este deporte y a la duración de los partidos, la vía conocida como anaeróbica (vía del fosfágeno y la glucólisis) y la aeróbica (fosforilación oxidativa) se producen simultáneamente (Figura 4) para satisfacer las necesidades energéticas del futbolista. Por esta razón, se requiere un alto desarrollo de ambas vías para optimizar el rendimiento durante el esfuerzo físico (3,6).


**Figura 4.** Resumen de la utilización de los sustratos energéticos implicados en las exigencias físicas del fútbol. Elaboración propia.

El proceso de contracción muscular depende de la energía liberada a través de la degradación de las moléculas de adenosín trifosfato (ATP), por lo que su resíntesis es esencial para el mantenimiento del rendimiento. Sin embargo, como la fosfocreatina (PCr), el glucógeno y los triglicéridos tienen una estructura y unas vías metabólicas diferentes, sus tasas de degradación varían, lo que influye directamente en las tasas de resíntesis de ATP, tal como se muestra en la Figura 5.

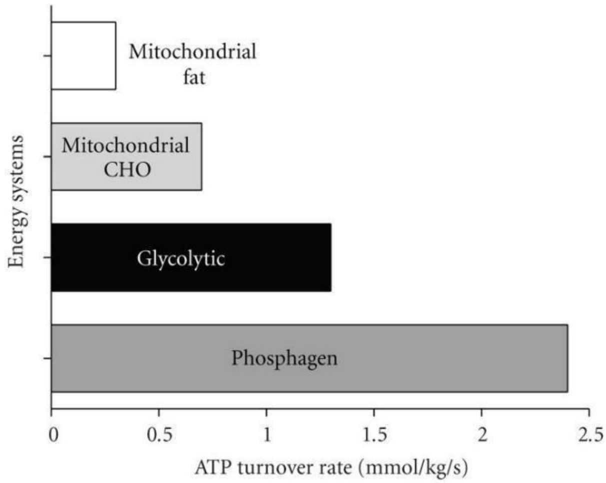


**Figura 5.** Tasas de renovación de ATP de las diferentes vías energéticas. Fuente: Baker y col., 2010 (17).

El glucógeno hepático y, especialmente, el glucógeno muscular son sustratos energéticos importantes para el futbolista, con una mayor contribución energética absoluta y relativa durante el ejercicio a intensidades superiores al 60% del Volumen Máximo de Oxígeno ($VO_2$ máx.) (9,18,19). Sin embargo, varias publicaciones mencionan que existe una prevalencia de futbolistas que ingieren hidratos de carbono (CH) por debajo de la ingesta recomendada en las competiciones (13,20–23). El ejercicio intenso durante el partido también conduce a una alta tasa de degradación de la PCr muscular a través de la vía del fosfágeno, aunque ésta se restablece parcialmente durante los periodos de baja intensidad (24).

Por otro lado, el uso de triglicéridos como fuente de energía es esencial para las actividades de baja intensidad (≤ 10 km/h). Un estudio reciente (25) estimó que la tasa media absoluta de oxidación de grasas en 16 jugadores del primer equipo del FC Barcelona era de 0,69 ± 0,15 g/min, superior a la determinada por el mismo equipo de científicos en jugadores no profesionales (0,58 ± 0,7 g/min) (26). Sin embargo, debe tenerse en cuenta que ambos estudios se realizaron en condiciones de ayuno (>5 h), que no son representativas o, al menos, poco aconsejables antes de un partido. La localización de la grasa (y no tanto el porcentaje de grasa corporal) junto con la capacidad oxidativa del tejido muscular funcional son factores condicionantes que explican las diferentes tasas de oxidación de la grasa que pueden presentar los futbolistas (26). Mientras que la oxidación de las grasas aumenta a medida que avanza el partido, como demuestran las mayores concentraciones de ácidos grasos libres (AGL) en sangre (especialmente durante los últimos 45 minutos del partido) (12), parece tener una relación inversa si se ingieren CH durante el esfuerzo físico (27). En una simulación de partido, se observó que los AGL plasmáticos aumentaron (en comparación con los valores previos al partido) 1,5 veces en la primera mitad del partido y 3 veces al final de este, lo que apoya el papel de la lipólisis y la oxidación de grasas en la obtención de energía durante las exigencias físicas. También se estableció una correlación entre la disminución de los esprints realizados al final del partido y los niveles de glucógeno de las fibras musculares (24).

En cuanto a la fatiga fisiológica, podría definirse como una disminución del rendimiento deportivo, determinada por diferentes factores que se clasifican principalmente en dos contextos: durante y después del esfuerzo físico (28). Durante el partido destacan las siguientes situaciones:

- **Fatiga temporal durante el partido**: se manifiesta en un periodo de 5 minutos tras las acciones más intensas del partido. Aunque se han postulado como posibles causas la acidosis muscular (por acumulación de iones de hidrógeno), una disminución de la PCr muscular o incluso una reducción del ATP muscular, parece que la acumulación de potasio en el intersticio muscular es capaz de producir perturbaciones eléctricas asociadas en la célula, despolarizando el potencial de membrana y reduciendo significativamente el desarrollo de la fuerza (12,29,30).

- **Fatiga al inicio del 2º periodo de partido**: El menor rendimiento durante los primeros 5 minutos del segundo tiempo se ha relacionado con un descenso de la temperatura muscular (se han observado descensos de hasta 2°C). Sin embargo, no ocurre lo mismo en los primeros 5 minutos del primer tiempo cuando se realiza un calentamiento adecuado (30). La Figura 6 muestra las diferencias encontradas en las distancias recorridas por los futbolistas de élite en carreras de alta intensidad durante los primeros 5 minutos de la primera y la segunda parte del partido.

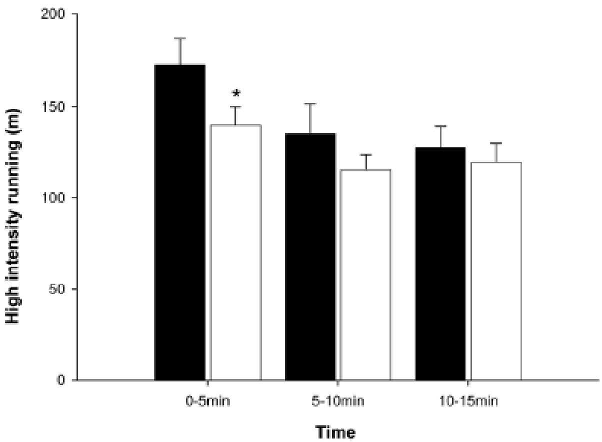


**Figura 6.** Distancias recorridas por futbolistas de élite mediante carreras de alta intensidad durante la fase inicial de la primera (barra negra) y segunda (barra blanca) parte del partido. Fuente: Mohr y col., 2005 (30).

- **Fatiga al final del partido**: En los últimos 15 minutos del partido parece producirse una disminución del rendimiento debido al agotamiento del glucógeno muscular, la hipohidratación y la hipertermia del jugador (30). La Figura 7 muestra este fenómeno en los partidos de fútbol recogidos en el estudio.

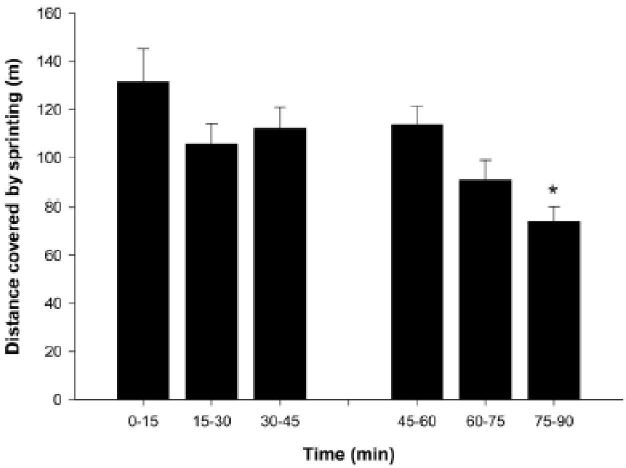


**Figura 7.** Distancias recorridas esprintando durante periodos de 15 minutos en diferentes partidos de competición a nivel internacional. Fuente: Mohr y col., 2005 (30).

Es lógico pensar que, durante el transcurso del partido, los niveles de glucógeno se reducen significativamente, lo que provoca una disminución tanto de la distancia total recorrida (3,7,8,10,30,31) como de la velocidad durante el partido (3,6,30), contribuyendo así a la fatiga observada en los últimos minutos del partido (9). La Figura 8 muestra cómo las distancias recorridas por futbolistas profesionales brasileños fueron inferiores en la segunda mitad del partido.

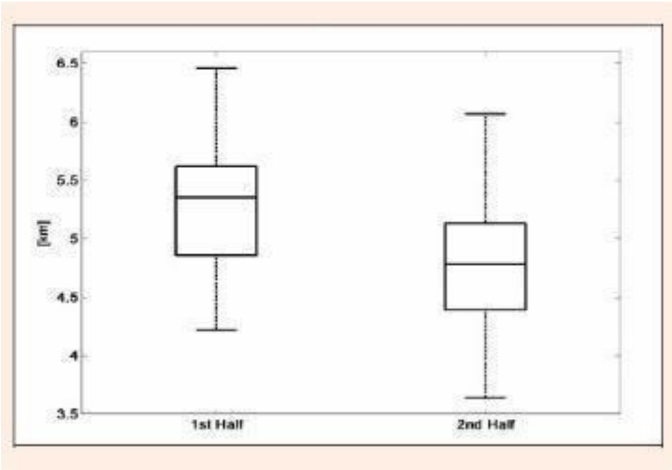


**Figura 8.** Distancias cubiertas según los períodos del partido. Fuente: Barros y col., 2007 (7).

- **Fatiga posterior al partido**: Tras el final de la competición, la deshidratación (en principio, a partir del 2% o más del peso perdido), el agotamiento del glucógeno (especialmente del glucógeno muscular), el daño muscular (atribuido a la rotura mecánica de las fibras y al daño de la membrana, las roturas miofibrilares caracterizadas por la desorganización del miofilamento y la pérdida de la integridad del disco Z) y el estrés mental son los factores que contribuyen a la fatiga del futbolista (28).

### 1.1.2. Fútbol femenino

El primer partido oficial de fútbol femenino del que se tiene constancia tuvo lugar en Escocia en 1892 (32). Sin embargo, mientras que el fútbol masculino evolucionó constantemente a lo largo del siglo XX, el fútbol femenino no alcanzó una popularidad similar. Por ejemplo, la Copa Mundial Masculina de la FIFA inaugural tuvo lugar en 1930, mientras que la primera Copa Mundial Femenina de la FIFA se celebró en 1991.

Afortunadamente, el fútbol femenino de élite ha experimentado un reciente aumento de popularidad (33). Como resultado de esta profesionalización el juego ha evolucionado en calidad, atención mediática y apoyo por parte de la afición. (34,35). Tradicionalmente, se ha sugerido que las mujeres recorren menos distancia en los partidos. Bradley y col. (36) examinaron las diferencias de género en las características del rendimiento de los jugadores de fútbol de élite, observando una mayor disminución del rendimiento en la segunda parte, con una mayor fatiga en las jugadoras en comparación con los jugadores. También se comprobó que los centrocampistas y los laterales cubrían más distancia en comparación con sus homólogos femeninos. Sin embargo, las exigencias físicas y las cargas de trabajo durante las competiciones han ido evolucionado en el fútbol femenino. Durante las Copas Mundiales de la FIFA masculina (Rusia 2018) y femenina (Francia 2019), las distancias totales recorridas fueron similares, si bien la distancia media a mayor velocidad siguió siendo inferior en las jugadoras. Por lo tanto, las diferencias significativas en las exigencias físicas de un partido entre hombres y mujeres parecen haber disminuido en la última década (37,38). De hecho, se estima que las distancias totales recorridas durante los partidos son de entre 9 y 11 km (39–41).

La investigación centrada en el ciclo menstrual (CM) y su impacto en la atleta femenina también es relevante, ya que la literatura reciente sugiere que pueden existir efectos potenciales de la fase del CM en la recuperación (42) y el bienestar (calidad del sueño, fatiga percibida, estrés...) de la futbolista (43,44). Por el contrario su relación con los parámetros relacionados con el rendimiento sigue sin ser concluyente (45–47). Comprender el CM de las deportistas es muy importante dado que las fluctuaciones hormonales pueden causar síntomas físicos como sensibilidad en los senos, dolor abdominal y calambres (48), además determinados trastornos menstruales (49,50) pueden afectar negativamente a la participación y el rendimiento de la deportista (51,52). También, algunos parámetros psicológicos como los cambios de humor o la ansiedad (44,50) pueden verse influidos por las hormonas del CM y constituir un factor de riesgo de lesión en las futbolistas (53).

En relación con la recuperación fisiológica tras las competiciones, recientemente se publicó un metaanálisis que recogía datos de 465 futbolistas, donde se observó, a través de indicadores de rendimiento físico como el salto con contramovimiento o las pruebas de resistencia intermitente Yo-Yo de nivel 1 y nivel 2, que las jugadoras se recuperaban al cabo de 72 h, mientras que ciertos biomarcadores de daño muscular como las enzimas creatina quinasa (CK) o la lactato deshidrogenasa (LDH) seguían elevados en ese periodo de tiempo. Estos resultados son relevantes de cara a la planificación de los entrenamientos, la programación de los partidos y el papel del área de nutrición del club, con el fin de aplicar protocolos para la recuperación de las deportistas (54).

En conclusión, a pesar de la creciente popularidad y los avances científicos en el fútbol femenino, la investigación sobre las jugadoras de este deporte sigue siendo significativamente inferior en comparación con el fútbol masculino (5).

### 1.1.3. Fútbol base

Muchos clubes de fútbol de todo el mundo han formalizado programas de desarrollo de talentos (llamados academias) con el objetivo de adquirir jugadores que puedan progresar hasta representar a su primer equipo o que puedan ser traspasados a otros clubes para obtener beneficios (55).

Se denomina fútbol base al practicado por los jóvenes jugadores antes de alcanzar la categoría absoluta. En las diferentes categorías (dependientes de su edad) en las que se divide el fútbol base, se formarán como futbolistas, recibiendo las lecciones técnicas y tácticas necesarias para lograrlo. Las categorías establecidas tanto para el fútbol masculino como para el femenino son: querubín (5-6 años), prebenjamín (7-8 años), benjamín (9-10 años), alevín (11-12 años), infantil (13-14 años), cadete (15-16 años) y juvenil (17-19 años) (56). Durante la adolescencia, se producen importantes cambios fisiológicos y hormonales que condicionarán el desarrollo madurativo y el crecimiento físico (muscular y esquelético). Por este motivo, las exigencias físicas aumentan progresivamente a medida que los jugadores pasan por las diferentes categorías de la academia, lo que probablemente refleja el crecimiento y la maduración de parámetros físicos clave, así como una mayor carga física (5). Como muestra la Tabla 2, de manera general, a medida que aumenta la categoría competitiva, no sólo las sesiones de entrenamiento son más exigentes físicamente, sino que también se reduce el número de días de descanso, incrementándose la posibilidad de aumentar el número de competiciones por temporada (57).

**Tabla 2.** Resumen de una semana competitiva en equipos de categoría infantil (sub12/13), cadete (sub15) y juvenil (sub18) de una academia de fútbol. Fuente: Hannon y col., 2021 (57).

| | **Week 1** | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Day 1** | **Day 2** | **Day 3** | **Day 4** | **Day 5** | **Day 6** | **Day 7** |
| U12/13 | Saturday<br>Rest (8) | Sunday<br>Match (8)<br>~1100–1220 h | Monday<br>Rest (8) | Tuesday<br>Training<br>(8) ~1530–1730 h | Wednesday<br>Rest (8) | Thursday<br>Rest (1)<br>Training (7)<br>~1530–1730 h | Friday<br>Rest (8) |
| U15 | Sunday<br>Rest (8) | Monday<br>Rest (8) | Tuesday<br>Match (8)[a]<br>~1900–2020 h | Wednesday<br>Rest (8) | Thursday Rest (2)<br>Training (6)<br>~1530–1730 h | Friday<br>Rest (1)<br>Training (7)<br>~1530–1700 h | Saturday<br>Rest (1)<br>Match (7)<br>~1100–1220 h |
| U18 | Wednesday<br>Rest (8) | Thursday<br>Training (8)<br>~1000–1200 h | Friday<br>Training (8)<br>~1000–1130 h | Saturday<br>Match (8)[a]<br>~1100–1230 h | Sunday<br>Rest (8) | Monday<br>Rest (1)<br>Training (7)<br>~1000–1200 h | Tuesday<br>Rest (5)<br>Match (3)<br>~1500–1630 h |

En relación con las exigencias físicas durante las competiciones, parece que los futbolistas profesionales y semiprofesionales muestran mayores exigencias en los partidos que los jugadores sub18 en la distancia esprint (25,2 km/h), distancia de ráfagas de alta intensidad (que se define como cualquiera de las tres actividades de alta intensidad [aceleración (4,0 m/s$^2$), desaceleración (4,0 m/s$^2$) o impactos (11 G)] completadas en sucesión separadas por 20 segundos o menos) y carga de estrés mecánico. Sin embargo, la distancia total, la distancia de alta carga metabólica, la distancia explosiva y la intensidad de la velocidad podrían no diferir entre las edades, por lo que los futbolistas juveniles parecen realizar una carga de partido significativamente menor que en las categorías superiores, pero no en todas las métricas (58).

En resumen, tanto las familias con las que residen los futbolistas como los profesionales del deporte que trabajan con los atletas deben estar alerta para prevenir los malos hábitos alimentarios, con el fin de promover una alimentación sana que optimice su crecimiento biológico, la recuperación de las exigencias físicas y el rendimiento deportivo.

## 1.2. ALIMENTACIÓN, HIDRATACIÓN Y SUPLEMENTACIÓN NUTRICIONAL

### 1.2.1. Necesidades energético-nutricionales

#### 1.2.1.1. Gasto energético

Las necesidades nutricionales de los deportistas tanto para el entrenamiento como para la competición vendrán determinadas principalmente por las reglas del propio deporte, variando en función del tamaño del terreno de juego, la duración y la frecuencia de los partidos, las diferentes fases de la temporada (normalmente pretemporada, competición y descanso), el número de jugadores y las sustituciones permitidas (18).

Se calcula que el gasto energético diario de un futbolista ronda las 2500-4400 kcal/día, aunque hay excepciones tanto por encima como por debajo de este rango (5,13,18,20,59,60). Durante los partidos de competición, se han observado valores de 1100-1700 kcal (5,61,62), superiores a las demandas que se producen en el entrenamiento, aunque esto dependerá del tiempo jugado, la posición de juego o la intensidad del esfuerzo físico. Además, hay que añadir que ciertos deportistas tienden a comer menos en la preparación de los partidos de competición debido al estrés y/o al calendario de viajes o partidos, que tienden a alterar el patrón alimentario y, por tanto, a disminuir la ingesta calórica por debajo de los requisitos deseables (18). En el caso del fútbol femenino de élite, se han registrado gastos energéticos de unas 2300-3200 kcal/día (41,63–65), lo que demuestra que las necesidades energéticas son comparables entre ambos sexos. Por otro lado, en relación con el fútbol base, las demandas energéticas son muy variables debido a la edad del jugador, la categoría en la que compite y su maduración biológica. Aun así, existen algunas referencias para las categorías sub13 (3380 ± 517 kcal/día (66) y 2859 ± 265 kcal/día (57)), sub15 (3568 ± 251 kcal/día (67) y 3029 ± 262 kcal/día (57)) o sub18 (3586 ± 487 kcal/día) (57).

Los porteros, debido a su posición de juego y a las exigencias físicas que requieren, tienen un gasto energético menor (23). En un estudio de caso reciente (14), se evaluó a un portero profesional de la Liga Inglesa durante una semana de competición, con 6 sesiones de entrenamiento y 2 partidos de competición. Se estimó que el gasto energético medio diario era unas 600 kcal/día inferior al del resto de futbolistas con diferentes posiciones de juego.

En un metaanálisis reciente, Steffl y col. (22) observaron que los futbolistas ingerían una media de 42.9 kcal/kg corporal, lo que marca una tendencia decreciente del periodo 2000-2009 al 2009-2019 (Figura 9). En cualquier caso, el valor no parece estar por debajo de la recomendación del Comité Olímpico Internacional (COI) sobre la deficiencia energética relativa en el deporte, que sugiere no bajar la ingesta a ≤30 kcal/kg de masa libre de grasa (MLG)/día (68).

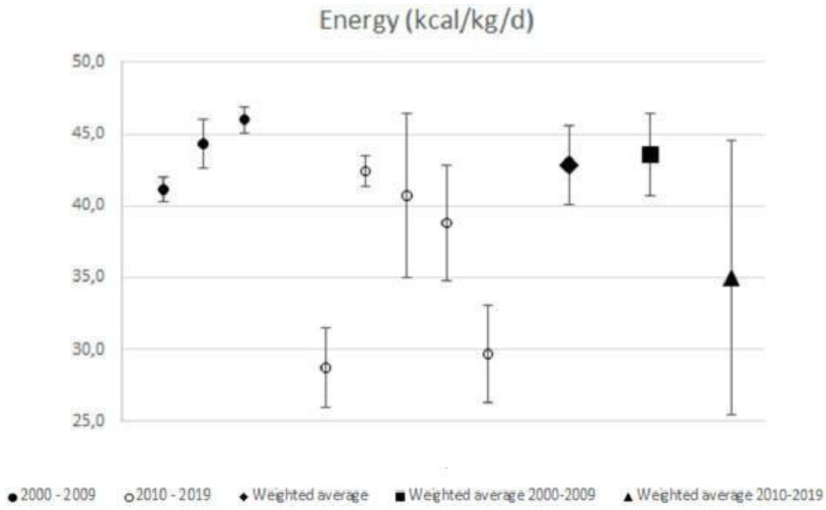


**Figura 9.** Tendencia de la ingesta energética en futbolistas. Fuente: Steffl y col., 2019 (22).

Aun así, las necesidades energéticas pueden variar en función del momento de la temporada, pudiendo ser mayores durante la pretemporada al aumentar las exigencias físicas debido a la mayor frecuencia y/o volumen de las sesiones de entrenamiento (18) y, por el contrario, ser menores durante las fases de descanso al disminuir las exigencias físicas de los futbolistas. Por lo tanto, el análisis individualizado es muy importante a la hora de cuantificar el gasto y la ingesta de energía de los futbolistas profesionales.

#### 1.2.1.2. Hidratos de carbono

Cada vez son más los artículos científicos que defienden los beneficios de la ingesta de CH para las demandas físicas de los futbolistas. La razón se basa principalmente en el aumento del glucógeno muscular, que proporciona (i) una mayor capacidad de resistencia durante el ejercicio de alta intensidad (19,31,69), (ii) un aumento de las distancias totales recorridas (31,70), (iii) una mejora de las habilidades específicas del fútbol (19) o (iv) un aumento del tiempo necesario hasta alcanzar la fatiga (71). No obstante, en otros estudios no se han registrado efectos ergogénicos en los saltos verticales (19), la frecuencia cardíaca, la percepción de la fatiga o en la agilidad (71) tras una ingesta elevada de CH frente a la conseguida con cantidades bajas o placebo.

El glucógeno muscular (especialmente el glucógeno intramiofibrilar) está directamente relacionado con la contracción muscular a través de la salida de calcio del retículo sarcoplásmico y el acoplamiento excitación-contracción, por lo que una baja disponibilidad de glucógeno muscular podría limitar la capacidad contráctil del músculo y perjudicar así el rendimiento (72). San-Millán y col. (72) analizaron el contenido de glucógeno del recto femoral de 9 futbolistas profesionales antes (80 ± 8,6 puntos de media) y después (63,9 ± 10,2 puntos de media) de un partido de fútbol. La importancia de este estudio piloto radica en que, a pesar de que los futbolistas ingirieron un total de 105 gramos de CH, lo que superaba la recomendación estándar de 30-60 gramos CH/h, se detectaron descensos significativos del glucógeno muscular (de hasta el 44,5% en uno de los futbolistas). En otro estudio (73), observaron en 16 futbolistas profesionales que, a pesar de consumir cantidades elevadas de CH y proteínas en comparación con un grupo de control en una simulación de partido, no era suficiente para reponer por completo el glucógeno del músculo vasto lateral (especialmente en las fibras de tipo II) después de 48 h.

La Figura 10 muestra el patrón de agotamiento de glucógeno en las fibras de tipo I y II antes del partido y 48 h después del final del partido. Los bloques que representan el contenido de glucógeno de las diferentes fibras se clasifican como vacíos (barras blancas, 0-20% del total), casi vacíos (barras con líneas laterales, 20-40%), medio llenos (barras con trazo doble, 40-60%), casi llenos (barras grises, 60-80%) y llenos (barras negras, 80-100%). Estas líneas de investigación apoyan la necesidad de que el futbolista, especialmente cuando juega competiciones a tiempo completo, requiera un tiempo de recuperación superior a 48 h.

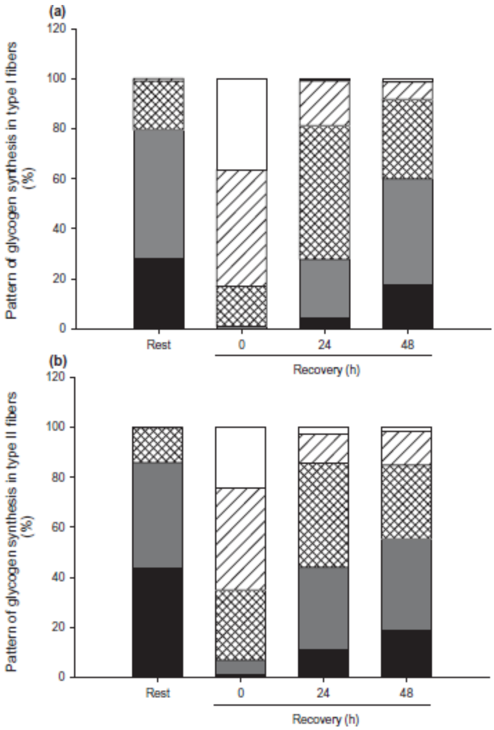


**Figura 10.** Patrón de agotamiento de glucógeno en fibras tipo I (a) y tipo II (b) antes (reposo) y durante las primeras 48 h después de un partido. Fuente: Gunnarsson y col., 2013 (73).

En cuanto a las necesidades de este macronutriente, existen recomendaciones de entidades reconocidas como la *International Society of Sports Nutrition* (ISSN), *American College of Sport Medicine* (ACSM) o la *Union of European Football Associations* (UEFA) (5,74–76). En la Tabla 2 se muestran los valores recomendados para proporcionar al futbolista una alta disponibilidad de CH (es decir, satisfacer las necesidades de CH del músculo y del sistema nervioso central) según diferentes cargas de ejercicio en escenarios en los que es importante la alta calidad y/o alta intensidad de este (76).

**Tabla 3.** Resumen de las directrices para la ingesta de CH en atletas. Fuente: Adaptado de Thomas y col., 2016 (76).

| **Situación** | | **Objetivos de CH/ kg de peso corporal del deportista** |
|---|---|---|
| **NECESIDADES DIARIAS DE CARBOHIDRATOS Y RECUPERACIÓN:** Estas recomendaciones generales deben ajustarse según la consideración individual de las necesidades energéticas totales, las necesidades específicas de entrenamiento y la información sobre el rendimiento durante el entrenamiento. | | |
| Necesidades bajas | Actividades de baja intensidad o basadas en habilidades técnicas | 3–5 g/kg/día |
| Necesidades moderadas | Programa de ejercicio moderado (p. ej., ~1 h al día) | 5–7 g/kg/día |
| Necesidades altas | Programa de resistencia (p. ej., 1-3 h/día de ejercicio de intensidad moderada-alta) | 6–10 g/kg/día |
| Necesidades muy altas | Compromiso extremo (p. ej., 4-5 h/día de ejercicio de intensidad moderada-alta) | 8–12 g/kg/día |
| **ESTRATEGIAS AGUDAS DE CARBOHIDRATOS:** Estas directrices promueven una alta disponibilidad de CH para un rendimiento óptimo durante la competición o en las sesiones de entrenamiento importantes. | | |
| Abastecimiento general | Preparación para eventos <90 min de ejercicio | 7–12 g/kg/día |
| Carga de CH | Preparación para eventos >90 min de ejercicio sostenido/intermitente | 10–12 g/kg/día durante 36-48 h |
| Reposición rápida | <8 h de recuperación entre 2 sesiones exigentes en combustible | 1-1,2 g/kg/h durante las primeras 4 h, después |

| | | |
|---|---|---|
| | | se reanudan las necesidades energéticas diarias |
| Abastecimiento previo al evento | Antes del ejercicio > 60 min | 1-4 g/kg consumidos 1-4 h antes del ejercicio |
| **DURANTE EL EJERCICIO** | | |
| Durante un ejercicio breve (<45 minutos) | | No es necesario |
| Durante un ejercicio sostenido de alta intensidad (45-75 minutos) | | Pequeñas cantidades, incluido el enjuague bucal |
| Durante el ejercicio de resistencia, incluidos los deportes intermitentes (1-2,5 h) | | 30-60 g/h |
| Durante el ejercicio de ultra resistencia (>2,5-3 h) | | Hasta 90 g/h |
| Debe tenerse en cuenta que en deportistas con una gran masa corporal o en atletas con un programa de pérdida de peso, puede ser más apropiado reducir su ingesta de CH a las necesidades de la categoría anterior. | | |

Steffl y col. (22) en su metaanálisis observaron que, en el fútbol, hay una tendencia a la baja en la ingesta de CH desde 2000-2009 hasta 2009-2019, con una ingesta media de 4,7 g CH/kg/día (Figura 11), por debajo de las recomendaciones mencionadas anteriormente en la Tabla 3.

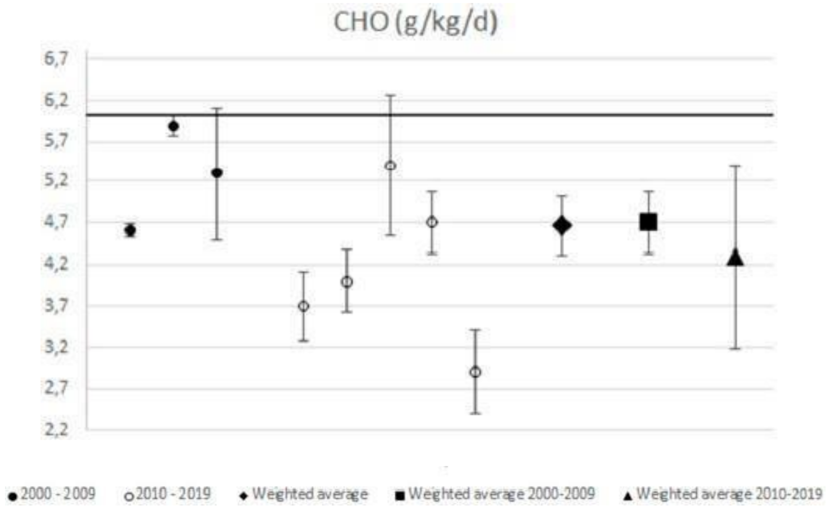


**Figura 11.** Tendencia de la ingesta de CH en futbolistas. Fuente: Steffl y col., 2019 (22).

Por último, cabe señalar que una sobredosis calórica no planificada, basada en cantidades excesivas de CH, podría tener un impacto negativo en la composición corporal (CC) del deportista, por lo que es importante hacer hincapié en mantener los valores dentro de los rangos óptimos recomendados (5). Por esta razón, los deportistas deben ser conscientes de la importancia de la cantidad, la calidad, la frecuencia y el momento de la ingesta de alimentos para los entrenamientos y los partidos. Por ello, se plantea la opción de periodizar la ingesta de CH en función de las exigencias físicas y de la carga de trabajo que exista en un microciclo.

#### 1.2.1.3. Proteínas

El músculo esquelético desempeña un papel fundamental en la salud metabólica y el rendimiento deportivo. También es fundamental para disminuir el riesgo de enfermedades patológicas como la obesidad, las enfermedades cardiovasculares, la resistencia a la insulina, la diabetes y la osteoporosis. Por lo tanto, las estrategias que se centran en preservar o aumentar la masa muscular (MM) son de vital importancia (77). Las proteínas son macromoléculas compuestas de aminoácidos (AA) que desempeñan funciones estructurales y reguladoras esenciales en el cuerpo humano. Son indispensables para el mantenimiento y el desarrollo de los tejidos, la síntesis de hormonas, el transporte de sustancias en la sangre y las células y otras numerosas funciones (78). La oxidación de los AA de las proteínas puede contribuir a incrementar la energía durante periodos de ejercicio intenso prolongado, como el que se produce en un partido de fútbol, pero siempre en condiciones en las que las reservas de glucógeno están muy agotadas y además lo haría a una tasa muy baja, por lo que la contribución energética no es la función más importante en las proteínas (5,79).

Por el contrario, las contracciones excéntricas provocadas por movimientos como la desaceleración o el contacto físico entre jugadores, provocan daños en los tejidos musculares, desempeñando un papel fundamental la proteína alimentaria diaria especialmente después del ejercicio para favorecer las adaptaciones físicas y la recuperación, promoviendo así un balance positivo de nitrógeno (59,80). Los mecanismos potenciales por los que la ingesta de proteínas puede afectar positivamente a la cinética de recuperación del rendimiento en el futbolista son los siguientes (81):

- Una mejora de la bioenergética del músculo esquelético.
- Una mejora del rendimiento neuromuscular.
- Atenuación de la respuesta inflamatoria.
- Aceleración de la regeneración del músculo esquelético.
- Una combinación de las razones anteriores.

Existen múltiples factores que modulan la respuesta de la síntesis de proteínas musculares destacando: las fuentes dietéticas, las cantidades totales aportadas, el momento (en relación con el ejercicio) en que se ingieren las proteínas, así como la administración conjunta de otros nutrientes (80). A la hora de seleccionar el tipo óptimo de proteína alimentaria, es esencial tener en cuenta una serie de elementos clave: (i) la biodisponibilidad y la digestibilidad, (ii) la cantidad total de AA esenciales manteniendo un buen equilibrio entre la ingesta de todos ellos, y (iii) el aporte de leucina de al menos 700-3000 mg por ingesta dietética (75,78,79).

En cuanto a las cantidades, la ACSM recomienda una ingesta diaria de 1,2-2 g proteína/kg corporal (76), la ISSN propone (79) 1,4-2 g proteína/kg corporal para optimizar las adaptaciones fisiológicas inducidas durante el entrenamiento, y por último, la UEFA sugiere que 1,6-2,2 g/kg corporal parecen mejorar la adaptación al entrenamiento (5). A su vez, se recomienda incluir alrededor de 0,25-0,40 g proteína/kg corporal en todas las comidas (5,76,79).

Steffl y col. (22) observaron en su metaanálisis que la ingesta media de proteínas es elevada, con valores medios de 1,8 g proteína/kg corporal (Figura 12).

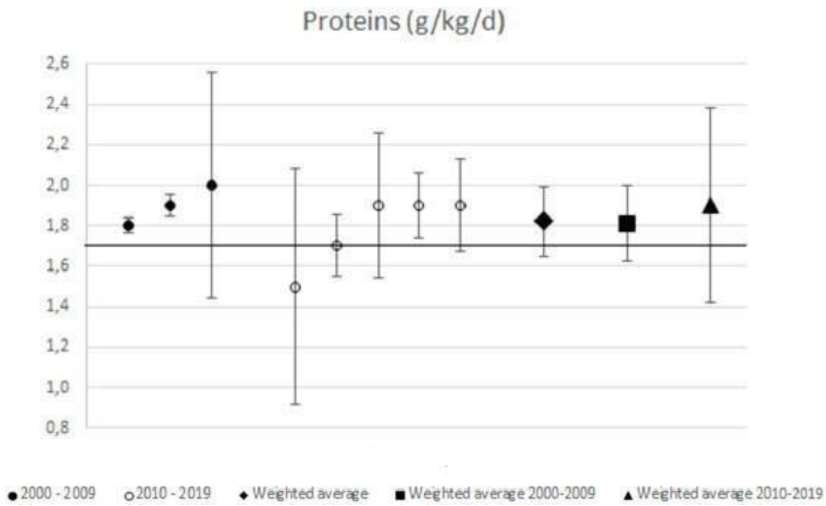


**Figura 12.** Tendencia de la ingesta de proteínas en futbolistas. Fuente: Steffl y col., 2019 (22).

#### 1.2.1.4. Grasas

La grasa es un componente necesario de una dieta sana, ya que proporciona energía, elementos esenciales de las membranas celulares y facilita la absorción de las vitaminas liposolubles (A, D, E y K) (76). La grasa, en forma de ácidos grasos libres plasmáticos, triglicéridos intramusculares y tejido adiposo, proporciona un sustrato energético relativamente abundante para el músculo durante el esfuerzo físico de intensidad baja a moderada (76).
Según la Sociedad Española de Nutrición Comunitaria (SENC), se recomienda que los deportistas consuman estos alimentos de forma similar a la población general, con una ingesta de hasta el 30-35% de la energía total, con ácidos grasos saturados 7-8%, ácidos grasos monoinsaturados 20%, ácidos grasos poliinsaturados 5% y una ingesta de colesterol inferior a 300 mg/día (82). Por otro lado, la ACSM recomienda una ingesta energética diaria total de alrededor del 20-35% (76,83), la ISSN sugiere un 25-35% (75) y, por último, la UEFA

aconseja que la ingesta oscile entre el 20-35% de la energía total de la dieta, evitando cantidades <15-20% (5).

Al igual que ocurre con los CH, una ingesta excesiva y no planificada de grasas puede ser contraproducente para el jugador ya que, por un lado, podría dar lugar a una ingesta calórica superior a la necesaria, lo que provocaría cambios en la CC y, por otro, existe el riesgo de desplazar las cantidades adecuadas de CH o proteínas (5,18). No obstante, Holway y Spriet (18) destacaron que, si la dieta del deportista es muy baja en grasas, podría aumentar el riesgo de ingerir productos de comida rápida a escondidas (como en los dormitorios durante las concentraciones previas a las competiciones), sustituyendo así propuestas dietéticas más interesantes. Esto se debe probablemente a la palatabilidad habitual de los alimentos ricos en grasa (tanto en sabor como en textura) que favorece su consumo. Además, una ingesta baja de grasas alimentarias llevada a cabo con el objetivo de perder peso corporal o mejorar la CC, puede conducir a una disminución en la adquisición de vitaminas liposolubles y ácidos grasos esenciales como el omega-3, que están estrechamente relacionados con la recuperación y la salud del deportista.

En el estudio de Steffl y col. (22), la ingesta media de energía total fue del 33,1%, de acuerdo con las recomendaciones generales, aunque una vez más se observó una tendencia decreciente de 2000-2009 a 2009-2019 (Figura 13). Sin embargo, cabe señalar que en este estudio hubo limitaciones a la hora de cuantificar la ingesta de grasas y no diferenciaron entre grasas saturadas e insaturadas.

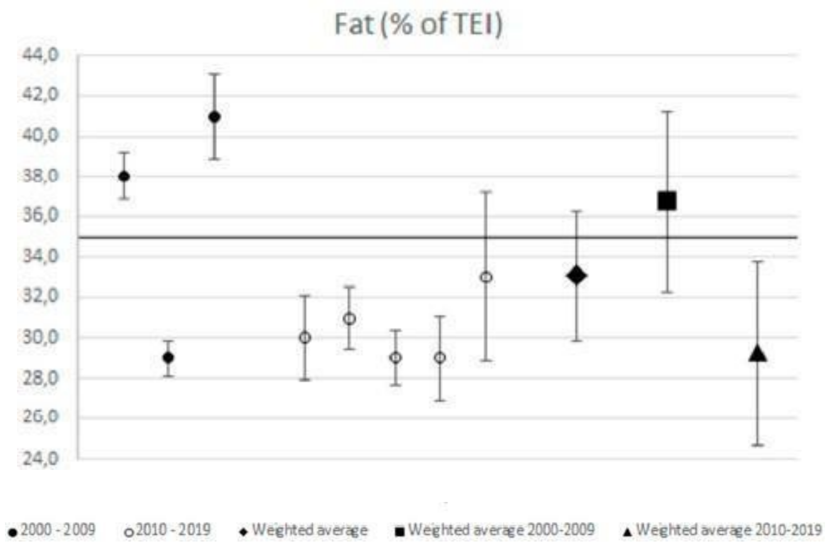


**Figura 13.** Tendencia de la ingesta de grasas en futbolistas. Fuente: Steffl y col., 2019 (22).

### 1.2.2. Hidratación

El agua corporal (AC) es el principal constituyente del cuerpo humano. Una hidratación adecuada es un factor fundamental para una salud óptima en todas las situaciones y a todas las edades. Durante el esfuerzo físico, un gran porcentaje de la energía producida para la contracción muscular se libera en forma de calor, que debe eliminarse para evitar que la temperatura corporal supere un nivel crítico, lo que tendría consecuencias muy negativas para la salud (78). Por este motivo, el organismo utiliza diversos mecanismos para disipar el calor acumulado, el más importante de los cuales es la sudoración (5).

Tanto la hiperhidratación como la hipohidratación son situaciones fisiológicas que deben evitarse en un deportista y debe alcanzarse un estado de mantenimiento ideal del contenido de agua, es decir, la euhidratación (84).

Una revisión reciente (84) analizó el posible impacto de la hipohidratación en la función cognitiva, la capacidad de esprint y el rendimiento intermitente de alta intensidad en el fútbol. Aunque los datos apuntaban a la existencia de efectos negativos significativos, se necesita un mayor número de estudios para llegar a conclusiones más precisas.

Existen múltiples factores que aumentan el riesgo de hipohidratación e hiperhidratación durante el ejercicio, tal como se muestra en la Figura 14.


**Figura 14.** Factores que contribuyen al riesgo de hipohidratación o hiperhidratación durante el ejercicio. Fuente: Adaptado de Belval y col., 2019 (85).

Las pérdidas de fluidos y electrolitos a través del sudor como el sodio (10-90 mmol/l), el potasio (2-8 mmol/l), el cloro (10-90 mmol/l), el lactato (5-40 mmol/l) o la urea (4-12 mmol/l) son muy variables entre los deportistas, por lo que la mejor estrategia para controlar la hidratación es la individualización (86). Para ello, es conveniente iniciar el esfuerzo físico con un adecuado estado de hidratación y reponer líquidos y electrolitos durante el entrenamiento o el partido, considerando la posibilidad de aportar CH a través de alimentos o suplementos ricos en líquidos (87).

En relación con la ingesta de agua recomendada, existen múltiples referencias, como la del COI, que indica, como pauta general, el consumo de 6 ml de líquido por kg de masa corporal cada 2-3 h, lo que equivale a 2-3 l al día. Además, recomienda consumir 1-2 l de líquido/h de ejercicio, más 1 l adicional por cada aumento de 5°C de la temperatura ambiente por encima de 21,5°C (88). A continuación, se recopilan diferentes recomendaciones de agua para adultos en función del sexo (Tabla 4).

**Tabla 4.** Resumen de los valores de referencia para la ingesta total de agua (alimentos + líquidos) en adultos. Elaboración propia.

| | **Autoridad Europea de Seguridad Alimentaria (89)** | **Agencia Española de Seguridad Alimentaria y Nutrición (90)** | ***Institute of Medicine* de Estados Unidos (91)** |
|---|---|---|---|
| **Hombres** | 2,5 l/día | 2,5 l/día | 3,7 l/día |
| **Mujeres** | 2 l/día | 2 l/día | 2,7 l/día |

Por otro lado, también existen recomendaciones específicas sobre el agua para el atleta adolescente (Tabla 5).

**Tabla 5.** Resumen de los valores de referencia para la ingesta total de agua (alimentos + líquidos) en adolescentes. Fuente: Adaptado de Gross, 2021 (92).

| **Edad (años)** | **Sexo** | **Actividad física** | | |
|---|---|---|---|---|
| | | Ligera | Moderada | Intensa |
| **9-13** | Hombres | 2,4 l | 3 l | 3-5 l |
| | Mujeres | 2,1 l | 2,5 l | 2,5-4,5 l |
| **14-18** | Hombres | 3,3 l | 4 l | 4-8 l |
| | Mujeres | 2,3 l | 3 l | 3,7 l |

Una reciente revisión sistemática (93) halló una mayor prevalencia de estados de hipohidratación en futbolistas masculinos (66,0%), de élite (66,2%) y previo al entrenamiento (79,6%) frente a las femeninas (49,4%), recreativos (55,6%) y previo al partido (41,3%).

Hay que tener en cuenta que las mujeres deportistas suelen tener una tasa de sudoración inferior a la de los hombres porque tienen menos tejido muscular que contribuya a la producción de calor metabólico durante el ejercicio, así como tasas de trabajo absolutas inferiores, lo que podría afectar a sus necesidades de agua en comparación con los hombres (94,95). Además, las mujeres experimentan cambios en el equilibrio de fluidos a lo largo del CM debido a las variaciones hormonales. En la fase folicular, aumentan los niveles de estrógeno, hormona luteinizante y hormona foliculoestimulante, lo que afecta a la regulación de los fluidos corporales. Durante la fase lútea, se produce un aumento significativo de la temperatura corporal de 0,3 a 0,5°C en reposo y durante el ejercicio. Esto podría aumentar el riesgo de enfermedades relacionadas con el calor, especialmente si se combina con la deshidratación (96,97). Así, en jugadoras de fútbol de élite, se observó que la pérdida de sodio en el sudor y la tasa de sudoración durante el ejercicio estaban relacionadas con la concentración basal de testosterona, pero no con la concentración basal de cortisol ni con la relación testosterona/cortisol (98). Los cambios hormonales pueden influir en la dinámica de los fluidos, la temperatura corporal, la sed y, en consecuencia, en el rendimiento deportivo y la salud en general (85,96). Sin embargo, es importante señalar que la interacción específica entre el CM y la hidratación requiere más investigación para comprender plenamente su impacto en la salud y el rendimiento de las mujeres.

En cuanto a los futbolistas adolescentes, debido a su mayor superficie corporal en relación con su masa, pueden experimentar un mayor estrés térmico al hacer ejercicio en ambientes calurosos en comparación con los adultos. Esto se debe a que absorben el calor ambiental más fácilmente que los adultos (99,100). Factores como una mayor tasa metabólica basal en los adultos, una mayor relación entre la masa corporal y la superficie corporal, una capacidad termorreguladora más eficiente en los adultos, el desarrollo fisiológico y unos hábitos de hidratación establecidos pueden dar lugar a una mayor necesidad de termorregulación a través del sudor durante el ejercicio (5,93,101). Además, parece existir una tendencia a subestimar sus pérdidas de sudor, lo que puede conducir a una hidratación inadecuada durante el entrenamiento (especialmente en condiciones de calor) (102). En este contexto, la educación alimentaria es crucial para optimizar la nutrición y la hidratación de los jóvenes futbolistas, mejorando sus conocimientos y permitiéndoles aplicarlos durante sus futuras carreras.

A veces, tras los entrenamientos y/o los partidos, pueden producirse celebraciones y/o desánimos ligados a la ingestión de alcohol en cantidades moderadas o elevadas. Esta es una práctica que se recomienda evitar ya que parece provocar una reducción de la tasa de síntesis de proteínas miofibrilares (incluso si el alcohol se ingiere junto con proteínas alimentarias), lo que puede perjudicar la adaptación al ejercicio y la recuperación al disminuir las respuestas anabólicas del músculo esquelético. Además, puede provocar deshidratación en el futbolista en situaciones en las que la rehidratación es importante para futuras exigencias físicas (especialmente cuando hay más de un partido por semana) (59,80,103).

Por último, cabe mencionar que la hidratación puede proporcionarse a través de diferentes fuentes dietéticas (Figura 15), por lo que cuantas más opciones existan, mayor será la garantía de cubrir los requerimientos de los deportistas, evitando así deficiencias en su rendimiento y salud.


**Figura 15.** Herramientas para mejorar la ingesta hídrica en el deporte. Elaboración propia.

#### 1.2.3. Ayudas ergogénicas nutricionales

La palabra "ergogenia" proviene del griego *ergos*, qué significa "trabajo", y *genan*, que significa "generar". Se considera ayuda ergogénica "cualquier maniobra o método (nutricional, físico, mecánico, psicológico o farmacológico) realizado con el fin de aumentar la capacidad para desempeñar un trabajo físico y mejorar el rendimiento” (78). Las ayudas ergogénicas nutricionales no tienen una definición única dentro de la ciencia de la nutrición, ya que, dependiendo de la fuente consultada, se definen de una u otra forma. Una de las definiciones más aceptadas procede del COI, que las describe como “un alimento, componente alimentario, nutriente o compuesto no alimentario que se ingiere intencionalmente además de la dieta consumida habitualmente con el objetivo de lograr un beneficio específico para la salud y/o el rendimiento” (104). En España, se denominan oficialmente complementos alimenticios, y se definen como “productos alimenticios consistentes en fuentes concentradas de nutrientes que se presentan con la finalidad de complementar la ingesta de tales nutrientes en la dieta normal” (105).

El uso de estos compuestos es una práctica muy extendida en el deporte, tanto por atletas de élite como por aficionados, lo que demuestra la independencia de género (106). Sin embargo, uno de los principales problemas asociados a su consumo es el riesgo de exposición a ingredientes dopantes (107), ser víctimas de fraudes debido a los ingredientes que dice contener (108,109) o sufrir efectos secundarios debido a la naturaleza de la propia sustancia o a la interacción alimento-suplemento, suplemento-suplemento o suplemento-fármaco (110). Por lo tanto, si no se dispone de conocimientos suficientes para probar, interpretar y juzgar la seguridad de los suplementos que se van a adquirir, y/o de una justificación sólida para su consumo (como la corrección de una deficiencia diagnosticada o para obtener una ventaja directa sobre el rendimiento deportivo de forma eficaz, legal y segura), no es aconsejable incluir estas sustancias en los programas deportivos (Figura 16).

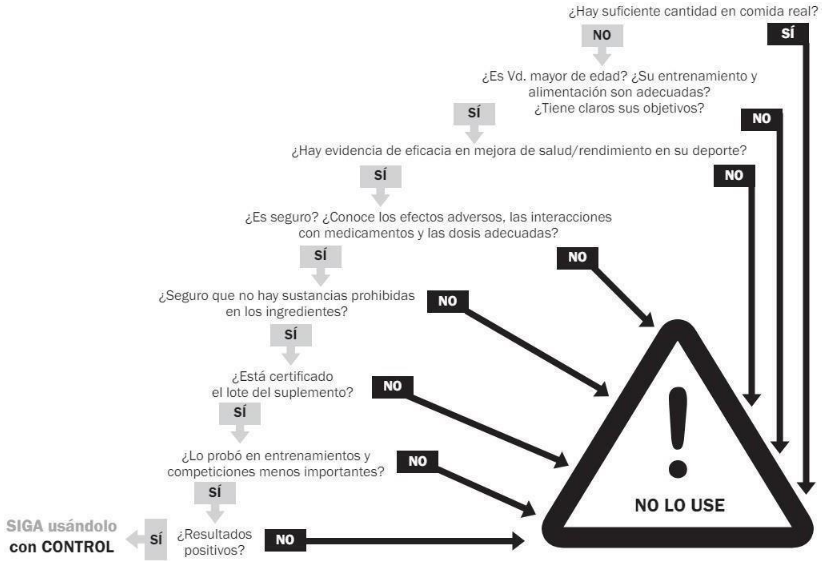


**Figura 16.** Secuencia lógica de la toma de decisiones en relación con la nutrición y el uso de suplementos dietéticos en deportistas. Fuente: Redondo y col., 2019 (78).

Numerosos organismos internacionales como la ISSN (75), el COI (104) el *Australian Institute of Sport* (AIS) (111) o, incluso, a nivel nacional la Sociedad Española de Medicina del Deporte (SEMED) (78) han diseñado y publicado documentos científicos donde recopilan los suplementos nutricionales que tienen mayor grado de validez científica en la práctica deportiva. Entre estos documentos, el de la AIS es el más reciente, así como el más referenciado en la comunidad científica deportiva. La AIS utiliza un sistema de clasificación de cuatro grupos (ABCD), en el que los alimentos para deportistas y los ingredientes de los suplementos se clasifican según las pruebas científicas y otras consideraciones prácticas que determinan si un producto es seguro, está permitido y es eficaz para mejorar el rendimiento deportivo (111):

- **Grupo A**: Sólida evidencia científica para su uso en situaciones específicas en el deporte utilizando protocolos basados en la evidencia. Permitido su uso por deportistas identificados según los protocolos de buenas prácticas. El grupo se subdivide en:

    - Alimentos deportivos: Productos especializados utilizados para proporcionar una fuente conveniente de nutrientes cuando no resulta práctico consumir alimentos cotidianos. Las bebidas deportivas, geles deportivos, confitería deportiva, barritas deportivas, electrolitos, proteínas en polvo o suplementos de macronutrientes mixtos componen esta categoría.

    - Suplementos médicos: Suplementos utilizados para prevenir o tratar problemas clínicos, incluidas las deficiencias nutricionales diagnosticadas. Deben utilizarse bajo la supervisión experta de un médico o un dietista-nutricionista deportivo acreditado. El hierro, calcio, multivitaminas, probióticos, vitamina D y el zinc completan este subgrupo.

    - Suplementos para la mejora del rendimiento: Ingredientes que pueden favorecer o mejorar el rendimiento deportivo. Es preferible utilizarlos con un protocolo individualizado y específico para cada tipo evento y/o deporte. La cafeína, ß-Alanina, nitrato dietético, bicarbonato sódico, creatina y glicerol son los pertenecientes a esta subclase.

- **Grupo B**: Apoyo científico emergente, merecedor de más investigación. Considerado para su uso por deportistas en el marco de un protocolo de investigación o de una situación de seguimiento casuística. El grupo se subdivide en:

- Polifenoles dietéticos: Compuestos alimentarios que pueden tener bioactividad, incluidas propiedades antioxidantes y antiinflamatorias. Pueden consumirse en forma de alimentos (enteros o concentrados) o como extractos aislados. Los polifenoles derivados de la fruta son los incluidos en esta categoría.

- Antioxidantes: Compuestos que suelen encontrarse en los alimentos y que protegen contra el daño oxidativo de los radicales libres. La vitamina C es la sustancia incluida en este subgrupo.

- Saborizantes: Compuestos derivados de los alimentos que interactúan con los receptores de la boca/intestino para activar el sistema nervioso central. El mentol, jugo de pepinillo y la quinina completan esta categoría.

- Otros: Compuestos que despiertan interés por sus posibles beneficios para el funcionamiento, la integridad y/o el metabolismo del organismo. El colágeno, carnitina, cetonas exógenas, aceites de pescado, curcumina y N-acetil cisteína son las incluidas en este nivel.

- **Grupo C**: Las pruebas científicas no apoyan el beneficio entre los atletas. Se identifican suplementos que anteriormente habían sido clasificados como Grupo B, pero basándose en las investigaciones más recientes, el apoyo a su uso es menos convincente. El magnesio, ácido α-lipoico, ácido β-hidroxi β-metilbutírico, AA ramificados y leucina, fosfatos, prebióticos, Vitamina E y tirosina componen este grupo.

- **Grupo D**: Prohibidas o con alto riesgo de contaminación con sustancias que podrían dar lugar a un control antidopaje positivo. La AIS aconseja que debe utilizarse como primer punto de referencia la lista de la Agencia Mundial de Antidopaje (AMA) (112) ya que se actualiza anualmente, para confirmar la lista actual de sustancias y prácticas prohibidas.

Varios estudios (60,113–115), junto con dos consensos científicos, uno de la Federación Portuguesa de Fútbol (116) y otro del grupo de expertos de la UEFA (5), han puesto de relieve el consumo de diferentes suplementos destinados a aumentar o mejorar el rendimiento deportivo. A pesar de la creciente popularidad y de los avances científicos del fútbol femenino en el campo de la suplementación (117–119), la investigación sobre las jugadoras de este deporte sigue siendo significativamente menor en comparación con el fútbol masculino (5). Además, el uso de suplementos en atletas adolescentes es una cuestión controvertida. Por un lado, su consumo puede mejorar el rendimiento y ayudar a la recuperación durante la temporada competitiva. Por otro, existen riesgos potenciales asociados a su uso, como la falta de regulación, los posibles efectos secundarios adversos y la presencia de sustancias prohibidas (107,120).

## 1.3. COMPOSICIÓN CORPORAL

La cineantropometría es el área de la ciencia encargada de medir la composición del cuerpo humano. Los diferentes cambios en los estilos de vida, la nutrición, la actividad física y la composición étnica de las poblaciones son algunos de los factores capaces de provocar alteraciones en las dimensiones corporales (121). En el deporte, la CC es crucial para alcanzar un nivel físico óptimo, lo que puede traducirse en un buen nivel de juego (122), ya que el rendimiento en el fútbol depende de múltiples factores técnicos, biomecánicos, tácticos, mentales y fisiológicos. De hecho, durante la práctica del fútbol hay muchos movimientos afectados por el peso como: aceleraciones, cambios de dirección o saltos verticales, por lo que el entrenamiento muscular, la carga de impacto y la reducción de la grasa corporal son importantes en la preparación física para mejorar el rendimiento futbolístico (5,62,123). Por este motivo, la estimación de la CC del futbolista ha experimentado en los últimos años un mayor protagonismo, hasta el punto de que se premia no sólo en función de la calidad técnica, sino también de las capacidades físicas.

Existen diferentes métodos de evaluación para analizar la CC, entre los que se encuentran (124):

- Métodos directos: Disección de cadáveres.
- Métodos indirectos: Tomografía axial computarizada (TAC), resonancia magnética nuclear (RMN), absorciometría dual de rayos X (DXA) y la pletismografía. Son los de uso más frecuente en investigación y en los medios clínicos, incluyéndose también en este grupo la hidrodensitometría.
- Métodos doblemente indirectos: bioimpedancia (BIA) y antropometría.

Cada uno de ellos presenta ventajas y desventajas en su uso, tal como recoge la Tabla 6.

**Tabla 6.** Ventajas y desventajas de los métodos de evaluación de la CC indirectos y doblemente indirectos. Fuente: Adaptado de Moreira y col., 2015 (124).

| Método | Ventajas | Desventajas |
|---|---|---|
| **TAC** | Gran precisión y repetitividad | Exposición a altas radiaciones y material de alto coste |
| **RMN** | Gran precisión y repetitividad para el tejido adiposo y muscular en todo el cuerpo y zonas específicas | Caro, realización manual de las mediciones, variación dependiente de la configuración del escáner |
| **DXA** | Fácil de usar, baja radiación, muy preciso para extremidades y grasa | Caro y se requiere de un radiólogo especializado para su manejo |
| **Pletismografía** | Precisión y rapidez | Caro y poco preciso en algunas enfermedades |
| **BIA** | Barato, portátil, simple, seguro y rápido | Solo para población específica, mala precisión en determinados individuos y grupos |
| **Antropometría** | Barato, no invasivo | Baja reproducibilidad, sensibilidad y especificidad |

En el ámbito deportivo, concretamente en el fútbol, se utilizan fundamentalmente como métodos de evaluación la antropometría (122,125–130), BIA (122,125,128,131) y DXA (123,125,128,129,132).

### 1.3.1. Antropometría

La antropometría hace referencia a las diferentes mediciones del tamaño y las proporciones del cuerpo humano a través de las cuales, mediante ecuaciones, es posible obtener una estimación del porcentaje de masa grasa (MG) y, por derivación, de la MLG (133). Una de las instituciones de prestigio cuya labor es la difusión de la antropometría es la Sociedad Internacional para el Avance de la Cineantropometría (ISAK), y fue fundada como una organización cuya labor científica y profesional está relacionada con la cineantropometría (121). La ISAK pretende unificar las normas internacionales para la evaluación antropométrica, diseñando así un sistema de acreditación internacional en antropometría dividido en una jerarquía de 4 niveles cuyo objetivo es mantener la garantía de calidad mediante el control constante del error técnico de medición intraobservador o interobservador del antropometrista.

Cuando se utiliza la antropometría, la CC puede abordarse con un modelo bicompartimental (MG y MLG), un modelo tetracompartimental (MG, MM, masa ósea y masa residual) y un modelo pentacompartimental (adiposo (grasa subcutánea), muscular (músculo), residual (vísceras, órganos y pulmones), óseo (huesos) y cutáneo (piel)) (134). De todos ellos, el modelo pentacompartimental es el más fiable, ya que se trata de un modelo matemático que no necesita estimar la densidad corporal, además de que no estima ninguno de los componentes como resultado de restar los demás componentes a la masa corporal total del individuo. Sin embargo, su principal desventaja es el tiempo de medición necesario debido al número de variables incluidas en las fórmulas que lo componen, algunas de las cuales pueden resultar algo invasivas si no se tiene cuidado al tomarlas (135).

En 2010, el Grupo Español de Cineantropometría (GREC) elaboró un documento de consenso (133), enfocado a ocho grupos poblacionales específicos, entre ellos uno para deportistas, diferenciando entre hombres y mujeres. Este documento proponía las fórmulas (Tabla 7) necesarias para evaluar los diferentes componentes corporales (grasa, hueso y músculo) de un deportista en un modelo tetracompartimental, siendo el modelo más utilizado en el fútbol debido a la rapidez de medición.

**Tabla 7.** Fórmulas propuestas para ser evaluadas en un atleta junto con los parámetros antropométricos requeridos para los diferentes componentes corporales. Fuente: Alvero Cruz y col., 2009 (133).

| Componente | Fórmula propuesta | Parámetros antropométricos requeridos |
|---|---|---|
| **Grasa** | Faulkner | Pliegues: Tricipital, subescapular, supraespinal y abdominal. |
| | Carter | Pliegues: Tricipital, subescapular, supraespinal, abdominal, muslo y pierna. |
| | Withers | Edad, pliegues: Abdominal, muslo, pierna y pectoral; perímetros: Cuello y supramaleolar. |
| | Jackson y Pollock (3 y 7 pliegues) | Edad, pliegues: Tricipital, subescapular, cresta iliaca, abdominal, muslo, pectoral y axilar medio; perímetros: Abdominal y antebrazo. |
| **Músculo** | Lee | Talla y perímetros: Brazo, muslo y pierna corregidos. |
| **Hueso** | Rocha | Talla y diámetros: Fémur y muñeca. |
| | Martín | Talla y diámetros: Húmero, muñeca, fémur y tobillo. |

Por último, una de las herramientas más relevantes en el estudio de la CC es el somatotipo, definido como la cuantificación de la forma y la composición del cuerpo humano mediante la calificación numérica de 3 componentes, utilizando diferentes fórmulas y medidas antropométricas. (135,136):

- Endomorfia: Es el primer componente e indica la adiposidad relativa.
- Mesomorfia: Es el segundo componente y hace referencia a la robustez musculo esquelética relativa.
- Ectomorfia: Es el tercer y último componente e indica la predominancia de la linealidad relativa o delgadez.

La endomorfia y la mesomorfia se refieren a la CC de una persona, mientras que la ectomorfia se relaciona más con su forma. Además, un aumento de los componentes endomorfos y/o mesomorfos provoca una disminución de la ectomorfia, mientras que una disminución de la endomorfia o la mesomorfia provoca un aumento de la ectomorfia. (135). Para su cálculo, existe el método fotoscópico mediante la toma de fotografías del sujeto, y el método antropométrico mediante el método Heath-Carter (136), que requiere medidas básicas (masa corporal y estatura), pliegues (tríceps, subescapular, supraespinal y pierna), perímetros (brazo flexionado y contraído, y pierna) y diámetros (húmero y fémur).

Para la representación gráfica del somatotipo se utiliza el triángulo de Franz Reuleaux, más conocido como somatocarta. La somatocarta es la expresión de los tres componentes (endomorfia, mesomorfia y ectomorfia) en un esquema gráfico bidimensional con dos ejes (X, Y) en el que el somatotipo se representa en un único punto denominado somatopunto. Resulta útil en el ámbito deportivo poder situar el somatotipo del deportista evaluado frente a la referencia somatotípica del deporte que practica, basándose en una recopilación exhaustiva de datos (Figura 17) (137).

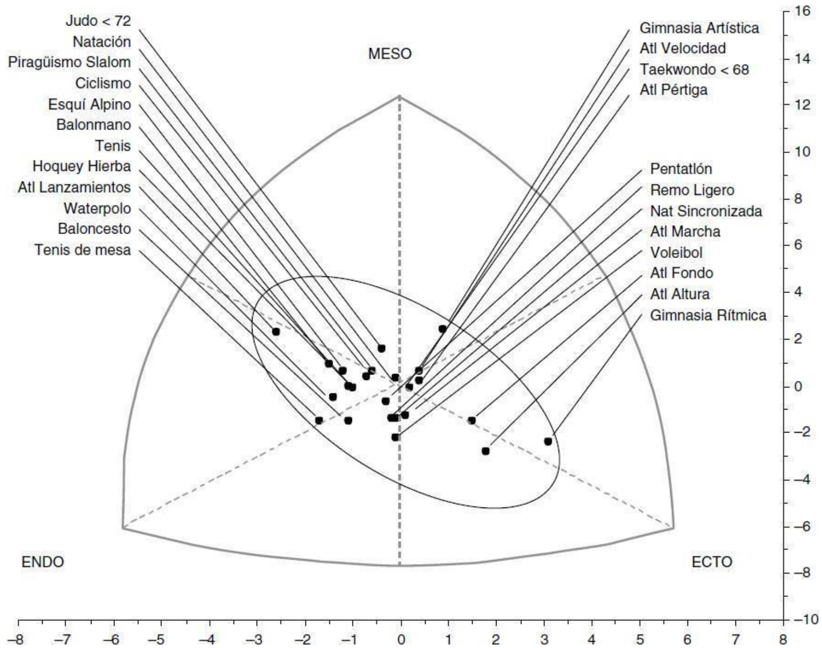


**Figura 17.** Ejemplo de somatocarta de deportistas de alto nivel deportivo. Fuente: Sala y col., 2015 (126).

### 1.3.2. Bioimpedancia

La BIA es un método no invasivo y fácil de aplicar que se basa en el principio de que la conductividad del AC varía entre los distintos compartimentos, por lo que puede utilizarse para el cálculo del AC total, la MLG y la MLG (124,138). El mecanismo consiste en medir la oposición al flujo de una corriente a través del cuerpo. En los compartimentos adiposos habrá mayor resistencia ya que son peores conductores de la electricidad debido a su escaso volumen de agua, por el contrario, los tejidos musculares, al estar compuestos por un

importante contenido acuoso junto con una alta concentración de electrolitos, actuarán como buenos conductores eléctricos (133).
Uno de los inconvenientes de este método es la posible alteración de los resultados debido a la presencia de determinadas enfermedades, tratamientos o situaciones clínicas y la necesidad de que el deportista respete una serie de normas cada vez que se realiza la medición. La Tabla 8 muestra algunas consideraciones a tener en cuenta cuando se utiliza el BIA (138):

**Tabla 8.** Recomendaciones de uso de la BIA en diferentes situaciones y circunstancias. Fuente: Alvero-Cruz y col., 2011 (138).

| Individuos | Comentarios | Recomendaciones |
|---|---|---|
| Comida, bebidas, alcohol | En ayunas o tras 4 h de ayuno<br>Interferencias | No tomar alcohol en las 8 h anteriores a la BIA |
| Ejercicio físico | No en 8 h anteriores | Para seguimiento durante períodos de entrenamiento, realizar siempre a la misma hora |
| Momento del día | Anotar hora de la BIA | Por la mañana en ayunas. Tras 4 h de ayuno |
| Temperatura ambiente | | Anotar temperatura ambiente |
| Piel | Sin lesiones | Pegar bien los electrodos en toda su superficie. No pegar en zonas lesionadas. Limpieza previa con alcohol de 70° |
| Posición de las extremidades | En abducción | Brazos a 30°; Piernas a 45° |
| Posición | Supino. Excepción para las BIA pie-pie, mano-mano | Entre 8 y 10 min de posición en decúbito supino. Protocolizar siempre el mismo tiempo para estudios de investigación. Seguir instrucciones del fabricante. En pacientes encamados (decúbito supino) anotar esta circunstancia |
| Alteraciones de la forma corporal | Anotar anormalidades corporales | Amputaciones, atrofias, escoliosis, distrofias, obesidad |
| Grupo étnico | Anotar | Grandes diferencias según la raza y la ecuación utilizada debe ajustarse a esa circunstancia |
| Control de ejercicio físico/entrenamiento | Anotar hora del día.<br>Tener en cuenta circunstancias de control de entrenamiento en deportistas | Respetar en lo posible normas de ayuno y ejercicio. Realizar BIA tras día/s de compensación de sesiones de entrenamiento |

En el fútbol, el uso de la BIA podría aprovecharse para determinar el estado hídrico antes del entrenamiento y/o las competiciones con el fin de comprobar el estado del jugador antes de las exigencias físicas, así como para mejorar los patrones de hidratación y prevenir efectos adversos, como la deshidratación y la hiperhidratación, que pueden repercutir negativamente en el rendimiento deportivo o aumentar el riesgo de lesiones.

### 1.3.3. DXA

La DXA es un método indirecto utilizado para medir la MM, la MG y la densidad mineral ósea (DMO) mediante la atenuación de fotones. Los tejidos blandos, debido a su alto contenido en agua y compuestos orgánicos, reducen menos el flujo de fotones que el tejido óseo, lo que hace que los píxeles del compartimento óseo se distingan con mayor claridad (124), por ello es considerado como el método de referencia para la evaluación del estado mineral óseo (139). Además, la DXA proporciona estimaciones de MG y MLG específicas para cada extremidad que pueden ser útiles a la hora de realizar un seguimiento de los atletas lesionados y de la magnitud de la pérdida de grasa en los atletas que aumentan de peso (140).

Sin embargo, este modelo tiene importantes limitaciones, como las dimensiones del sujeto a analizar (tanto en altura como en anchura), el elevado coste económico para su adquisición, la variabilidad entre máquinas y fabricantes con sus respectivos software y algoritmos para el cálculo de la CC, y las correspondientes consideraciones legales y éticas a la hora de exponer a los deportistas a bajas dosis de radiación. Actualmente existe un debate sobre el máximo de veces al año que se puede utilizar esta técnica y, por lo tanto, no parece el método ideal si los deportistas necesitan evaluar su CC con regularidad a lo largo de la temporada, es decir, mensualmente en el caso del fútbol. Además, tampoco sería apropiado escanear a mujeres que puedan estar embarazadas (124,140).

En el fútbol, existen referencias bibliográficas donde se observaron problemas en las mediciones mediante esta técnica, debido a las dimensiones corporales de los futbolistas, por lo que como solución se excluyó la medición de la cabeza del futbolista, ya que no se estiman los cambios en la masa mineral de la cabeza (125,132).

## 1.4. VALORACIÓN DEL ESTADO NUTRICIONAL DEL FUTBOLISTA

### 1.4.1. Evaluación cineantropométrica

El proceso de evaluación de la CC en el deporte implica diversas técnicas, entre las que destaca la DXA para evaluar el contenido mineral óseo (CMO), la DMO y la grasa corporal en las extremidades, siempre que las condiciones previas estén controladas. A su vez, la antropometría es una opción práctica y fiable para seguir los cambios a lo largo del tiempo, al estar menos afectada por factores difíciles de controlar en los deportistas. Por otro lado, la BIA podría ser una buena alternativa en caso de no tener conocimientos y experiencia en antropometría o economía para la DXA, además de ser un buen método para la evaluación del AC. En resumen, todos los métodos tienen puntos fuertes y débiles, y a veces pueden considerarse la "mejor práctica" en situaciones específicas y/o para abordar cuestiones concretas (Figura 18) (140).

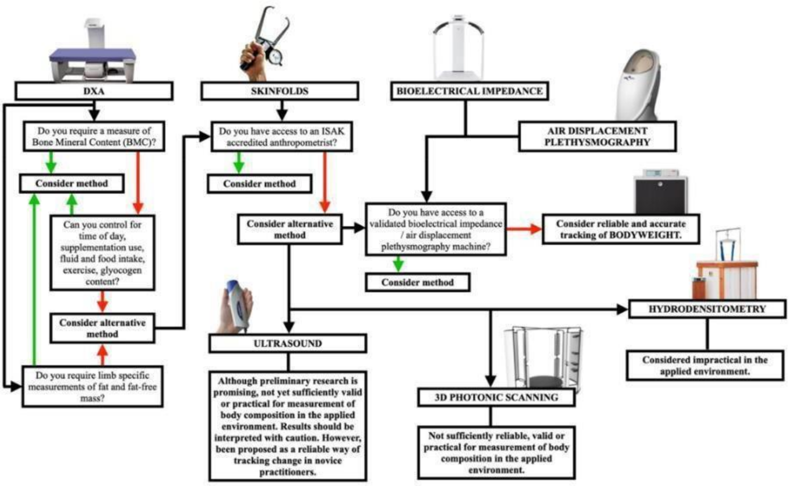


**Figura 18.** Árbol de toma de decisiones propuesto para un método de CC. Fuente: Kasper y col., 2021 (140).

### 1.4.2. Evaluación dietética y del consumo de suplementos

La evaluación dietética surge como una herramienta esencial para conocer el estado nutricional de los atletas, con especial atención a su bienestar y rendimiento en el entorno deportivo. Una ingesta adecuada de energía y nutrientes es un pilar fundamental en la gestión de cualquier régimen deportivo. En consecuencia, la recopilación de datos sobre el patrón dietético y el análisis exhaustivo de su contenido nutricional representan una estrategia indispensable y valiosa para la investigación en este campo (92). A su vez, es importante recopilar información relativa al consumo de suplementos por parte de los deportistas. El análisis de estos datos es esencial para los dietistas-nutricionistas, ya que les permite determinar la idoneidad y la base científica de los suplementos consumidos, con el fin de mejorar el rendimiento y/o la salud. Si los suplementos tienen poca o ninguna evidencia, su ingesta no aportará beneficios al deportista e incluso podría deteriorar su rendimiento o su salud.

Una buena evaluación dietética y de suplementos comienza con el uso de la anamnesis, que se rellena con los datos proporcionados por el paciente (datos personales, motivo de consulta, historial médico, historial familiar, de ocio y social, e historial dietético) (92). Se pueden utilizar herramientas tanto retrospectivas como prospectivas para recopilar información sobre la ingesta alimentaria del deportista (92,141–144):

- Recordatorio de 24 h: El deportista recuerda detalladamente qué, cómo y cuánto ha bebido líquidos, ingerido alimentos y suplementos durante las últimas 24 h anteriores al día de la consulta.

- Cuestionario de frecuencia de consumo de alimentos y de suplementos: El deportista explica la frecuencia habitual de ingesta de un alimento, producto dietético, suplemento o grupo de alimentos durante un periodo de tiempo determinado. Puede ser cualitativa, semicuantitativa o cuantitativa.

- Diario dietético: El deportista completa un diario dietético en el que anota la ingesta de alimentos, bebidas y suplementos durante un periodo de tiempo. En este diario, se puede hacer hincapié en pesar las cantidades, añadir fotos de los platos o adjuntar fotos de las etiquetas de los alimentos. A su vez, dependiendo del deportista, se pueden añadir variables como el ejercicio, el rendimiento físico, las sensaciones emocionales o digestivas, entre otras.

- Historia dietética: El objetivo es obtener información sobre los hábitos alimentarios actuales y pasados a través de preguntas relacionadas con la ingesta diaria de líquidos, variables durante el acto de comer como la velocidad de la ingesta o el líquido acompañante, técnicas culinarias habituales, evaluación de la sensación de hambre y saciedad, disponibilidad de utensilios, picoteo durante el día, hábitos de consumo de suplementos (tipo, marca, dosis, motivo de consumo...), combinadas con las herramientas mencionadas anteriormente (recordatorio de 24 h, cuestionario de frecuencia de consumo de alimentos y diario dietético).

En el fútbol, existen referencias bibliográficas que han utilizado diversas herramientas validadas científicamente para estimar y evaluar la nutrición del deportista. En el fútbol base, existen estudios en los que se utilizaron diarios dietéticos durante tres días (145,146), cuatro días (147), cinco días (67), seis días (148), siete días (149,150), recordatorios de 24 h (150), métodos fotográficos de alimentos (57,66,151,152) y cuestionarios tanto de frecuencia de consumo de alimentos como de conocimientos (153–159). En el fútbol femenino, también existe literatura científica donde se utilizan diarios dietéticos durante tres días (63,65,146,160), siete días (161,161–163), ocho días (164), recordatorios de 24 h (41), métodos fotográficos de alimentos (165) y cuestionarios tanto de frecuencia de consumo de alimentos como de conocimientos (153,162,166,167). Por último, respecto al fútbol masculino de élite, existen referencias bibliográficas donde se usaron diarios dietéticos durante tres días (168,169), siete días (21,170), métodos fotográficos de alimentos (171), recordatorios de 24 h (23) y cuestionarios tanto de frecuencia de consumo de alimentos como de conocimientos (20,172,173).

En relación con el hábito de consumir suplementos, también se encuentra bibliografía acerca del patrón de consumo de los futbolistas masculinos de élite (170,173–176), de las futbolistas femeninas (119,167,174), así como de futbolistas de categorías inferiores (155,157,159,174).

### 1.4.3. Monitorización de la hidratación

A la hora de monitorizar el estado de hidratación, existen múltiples marcadores biológicos si bien su utilidad es variable (Tabla 9) (92,141,177).

**Tabla 9.** Resumen de los marcadores biológicos del estado de hidratación. Elaboración propia.

| Medición | Punto de corte de euhidratación |
|---|---|
| **AC total** | < 2% |
| **Osmolaridad del plasma** | < 290 mOsmol/kg |
| **Densidad específica de la orina** | < 1020 USG |
| **Color de la orina** | ≤ 3 |
| **Osmolaridad de la orina** | < 700 mOsmol/kg |
| **Peso corporal** | < 2% |

- AC total: Por medio de la BIA (preferiblemente la BIA multifrecuencia), es posible evaluar el AC total del deportista. Sin embargo, cuando los niveles de deshidratación son del 2-3%, la BIA no es tan precisa para detectar cambios en el AC, siendo más útil en niveles de deshidratación más elevados (92,138,141).

- Osmolaridad del plasma: La venopunción se utiliza para evaluar la osmolaridad plasmática y se considera el método de referencia para analizar el grado de hidratación, aunque es un método invasivo, lo que dificulta su uso en la práctica. A medida que aumenta la osmolaridad plasmática, también lo hace el grado de deshidratación (92,141,177).

- Densidad específica de la orina: Mediante el uso de tiras reactivas o utilizando un refractómetro, se evalúa la densidad específica de la muestra de orina de un deportista. Cuanto mayor sea su densidad, mayor será el grado de deshidratación. Sin embargo, es posible que los atletas, al tener mayor MM que la población general, presenten valores más altos de densidad específica de la orina sin estar deshidratados debido a un metabolismo proteínico más elevado (92,141).

- Color de la orina: La evaluación visual del color de la orina es un método rápido y sencillo para comprobar el estado de hidratación del deportista. A medida que aumenta el color y la turbidez de la orina, aumenta el grado de deshidratación, utilizando como referencia una escala colorimétrica como la de Armstrong y col., en la que la orina se clasifica con valores de 1 a 3 como patrón subjetivo de hidratación óptima, valores de 4 a 6 como patrón deshidratado y valores de 7 a 8 como patrón gravemente deshidratado. Sin embargo, el color de la orina puede verse alterado por enfermedades como la hematuria, el consumo de medicamentos como la amoxicilina, suplementos como las vitaminas hidrosolubles, alimentos como las moras, aditivos alimentarios como el E162 (rojo remolacha) o situaciones fisiológicas como la menstruación en las mujeres, lo que hace que su precisión sea menor en comparación con otros métodos (92,141,178,179).

- Osmolaridad de la orina: Mediante el análisis de una muestra de orina, es posible evaluar su osmolaridad, considerándose el método más fiable para evaluar el nivel de hidratación. Sin embargo, es un método que requiere procedimientos bioquímicos de laboratorio complejos y costosos. Al igual que ocurre con la osmolaridad del plasma, cuanto mayor sea la osmolaridad de la muestra, mayor será el grado de deshidratación del deportista (92,177).

- Peso corporal: Comparando el peso corporal del deportista antes y después del esfuerzo físico, es posible determinar el grado de deshidratación causado por el ejercicio, ya que se considera que en esfuerzos intermitentes de menos de 3 h y en condiciones ambientales no extremas (entre 5°C y 35°C), la pérdida de agua por la respiración no es significativa en comparación con la producida por la transpiración. Este método supone que 1 g de peso perdido equivale a 1 ml de agua perdida. Sin embargo, tiene la limitación de que otros factores pueden afectar a la pérdida de peso corporal durante el esfuerzo físico, como la oxidación de sustratos energéticos como los CH y las grasas, por lo que la equivalencia de 1 g de peso es igual a 1 ml de agua perdida no es del todo exacta.

- Tasa de sudoración: Aprovechando la variación de peso durante el esfuerzo físico junto con otras variables como la ingesta de líquidos, la orina excretada y el tiempo de ejercicio, es posible obtener la tasa de sudoración del deportista, lo que permite estimar la cantidad de líquido a reponer por cada minuto de actividad física según sus necesidades individuales. Es importante hacerlo en diferentes condiciones, ya que la intensidad del ejercicio, las condiciones climáticas, la ropa deportiva, la genética, el estado de aclimatación del deportista y la fase del CM en las mujeres son variables que pueden afectar a la sudoración. (141,177).

En conclusión, todos los métodos tienen sus ventajas e inconvenientes, por lo que complementar varios procedimientos y no depender exclusivamente de uno es la mejor opción a la hora de controlar la hidratación del deportista.

# SEGUNDO CAPÍTULO: OBJETIVOS

**«***Lo que hacemos en la vida tiene su eco en la eternidad***»**

*Maximus Decimus Meridius* (Interpretado por Russell Crowe)

El objetivo principal de la presente Tesis Doctoral es evaluar y analizar la composición corporal en el fútbol profesional masculino, así como los hábitos dietéticos, hídricos, de consumo de suplementos y el estado de hidratación en futbolistas de élite y su variabilidad entre posiciones de juego, nivel competitivo y sexo. Dentro de este objetivo principal, se desglosan los siguientes objetivos específicos:

1. Describir las características antropométricas, la composición corporal y el somatotipo de los futbolistas profesionales masculinos, y comparar los valores comunicados según los métodos y ecuaciones utilizadas.

2. Analizar las características antropométricas, la composición corporal y somatotipo en los futbolistas profesionales masculinos según la posición de juego.

3. Realizar un análisis descriptivo y comparativo de los hábitos dietéticos en futbolistas pertenecientes a la Academia Valencia C.F. y su asociación entre niveles competitivos, posiciones de juego y sexo.

4. Describir el consumo de suplementos deportivos en futbolistas pertenecientes a la Academia Valencia C.F. y su relación con la categoría competitiva, posición táctica y sexo.

5. Evaluar el balance de fluidos, la tasa de sudoración y los valores de orina en futbolistas pertenecientes a la Academia Valencia C.F. durante entrenamientos con distintas condiciones ambientales, comprobando diferencias entre categorías de edad, rol de juego y sexo.

# TERCER CAPÍTULO: ARTÍCULOS PUBLICADOS

**«***Durante la temporada, nos toca jugar muchos partidos en poco tiempo. Es clave tener una buena planificación nutricional basada en alimentos ricos en hidratos de carbono y proteínas, y rehidratarse correctamente***»**

Lucas Vázquez, futbolista del Real Madrid CF

3.1. *Body Composition of Male Professional Soccer Players Using Different Measurement Methods: A Systematic Review and Meta- Analysis*

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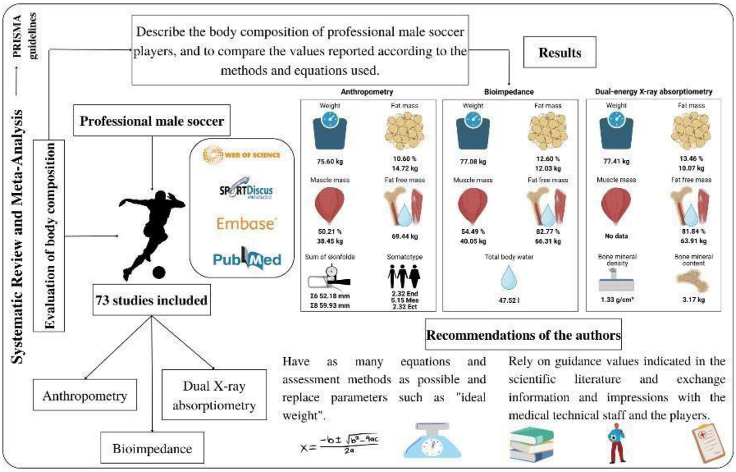
Resumen gráfico:



nutrients

MDPI

*Review*

# Body Composition of Male Professional Soccer Players Using Different Measurement Methods: A Systematic Review and Meta-Analysis

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**Abstract:** The performance of male soccer players (MSP) depends on multiple factors such as body composition. The physical demands of modern soccer have changed, so the ideal body composition (BC) requirements must be adapted to the present. The aim of this systematic review and meta-analysis was to describe the anthropometric, BC, and somatotype characteristics of professional MSP and to compare the values reported according to the methods and equations used. We systematically searched Embase, PubMed, SPORTDiscus, and Web of Science following the PRISMA statement. Random-effects meta-analysis, a pooled summary of means, and 95% CI (method or equation) were calculated. Random models were used with the restricted maximum likelihood (REML) method. Seventy-four articles were included in the systematic review and seventy-three in the meta-analysis. After comparing the groups according to the assessment method (kinanthropometry, bioimpedance, and densitometry), significant differences were found in height, fat mass in kilograms, fat mass percentage, and fat-free mass in kilograms ($p = 0.001$; $p < 0.0001$). Taking into account the equation used to calculate the fat mass percentage and ∑skinfolds, significant differences were observed in the data reported according to groups ($p < 0.001$). Despite the limitations, this study provides useful information that could help medical technical staff to properly assess the BC of professional MSP, providing a range of guidance values for the different BC.

**Keywords:** soccer; body composition; anthropometry; bioimpedance; DXA

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## 1. Introduction

Kinanthropometry is the area of science responsible for measuring the composition of the human body. Changes in lifestyle, nutrition, physical activity, and ethnic composition of populations are some of the factors that can cause alterations in body dimensions [1]. In sports (including soccer), anthropometry, bioelectrical impedance analysis (BIA) and dual X-ray absorptiometry (DXA) are the main methods used to assess body composition [2,3].

Anthropometry refers to the different measurements taken of the size and proportions of the human body by which, through equations, an estimation of the percentage of fat mass (FM), and by derivation, the fat-free mass (FFM), can be obtained [4]. This evaluation method has been described by different institutions, with the International Society for the Advancement of Kinanthropometry (ISAK) being the gold standard institution, according to ISO 7250-1:2017 and the ISAK standard [1]. This method is useful for nutritional and training control and monitoring [2,3].

BIA is a non-invasive and easy-to-apply method based on the principle that states that the conductivity of body water varies between the different compartments and can therefore be used for the calculation of total body water, FM, and FFM [5,6]. The method consists of measuring the resistance of the body to the flow of a current. In the adipose compartments, a greater resistance will be observed as these compartments are poorer conductors of electricity due to their low water volume, whereas muscle tissues, as they have a high-water content, together with a high concentration of electrolytes, will act as good electrical conductors [4].

DXA is an indirect method used to measure muscle mass (MM), FM, and bone mineral density (BMD) through photon attenuation (X-rays). Soft tissues, due to their high water and organic compound content, reduce the photon flux to a lesser extent than bone tissue, and the pixels of the bone compartment are more clearly distinguishable [6]. It is therefore considered the gold standard method for the assessment of bone mineral status [7,8].

Another of the most relevant tools used in the study of body composition is somatotype, defined as the quantification of the shape and composition of the human body through the numerical quantification of three components, by using different anthropometric formulas and measurements [9]. Derived from the somatotype, the somatochart is the expression of the three components (endomorphy, mesomorphy, and ectomorphy) as a graphic representation. In the field of sports, it is useful to be able to compare the somatotype of the athlete being evaluated against the reference somatotype of the sport he/she practices, based on a wide collection of data [10].

Therefore, the assessment of body composition plays a crucial role in athletes, as it directly affects both performance and sporting results in competitions [11]. In soccer, body composition is crucial for achieving an optimal physical level, which can translate into a good level of play, as performance in soccer depends on multiple technical, biomechanical, tactical, mental, and physiological factors, as well as nutritional and training control [12].

The aim of the present systematic review with meta-analysis was to describe the anthropometric characteristics, body composition, and somatotype of professional male soccer players, and to compare the values reported according to the methods and equations used. Consequently, the initial hypotheses were:

**Hypothesis 1 (H1).** *Depending on the measurement instrument used, different values of body composition will be observed for the same compartment, especially in the weight and percentage of the FM.*

**Hypothesis 2 (H2).** *There will be differences between anthropometric equations for the same body compartment.*

## 2. Materials and Methods

### *2.1. Type of Study*

This systematic review and meta-analysis is based on existing evidence on anthropometric characteristics, body composition, and somatotype, of professional male soccer players. It was conducted based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [13].

### *2.2. Information Sources and Search Strategy*

The databases searched to obtain the most current data were PubMed-MEDLINE, Embase, SPORTDiscus, and Web of Science. To find the largest number of available articles related to the research aim, the words used in the search strategy were defined considering: (1) soccer (football); (2) anthropometry, body composition and somatotype; (3) athlete (professional or elite); (4) the descriptors of the Medical Subjects Headings (MeSH); (5) other terms described in MeSH as "entry terms", which include the terminology prior to the setting-up of the MeSH register; and (6) the terms (tiab) or (Title/Abstract) attached to the "entry terms" or MeSH, which allow the localization of these terms in the title and abstract of the articles. The search strategy used for PubMed was: ("Soccer" (Mesh) OR "soccer player" (Title/Abstract) OR "fútbol" (Title/Abstract) OR "soccer" (Title/Abstract) OR "football" (Title/Abstract)) AND ("Anthropometry" (MeSH) OR "Anthropometry" (Title/Abstract) OR "Body composition" (MeSH) OR "Body composition" (Title/Abstract) OR "Skinfolds" (Title/Abstract) OR "Skinfold Thickness" (MeSH) OR "Somatotypes" (Mesh) OR "Somatotypes" (Title/Abstract) OR "Body Build" (Title/Abstract) OR "Body Type" (Title/Abstract) OR "Endomorph" (Title/Abstract) OR "Mesomorph" (Title/Abstract) OR "Ectomorph" (Title/Abstract) OR "Absorptiometry, Photon" (Mesh) OR "Absorptiometry, Photon" (Title/Abstract) OR "Electric Impedance" (Mesh) OR "Electric Impedance" (Title/Abstract) OR "Bioimpedance" (Title/Abstract) OR "DXA" (Title/Abstract) OR "Dual Energy X-ray Absorptiometry" (Title/Abstract)) NOT ("youth" (Title/Abstract) OR "young" (Title/Abstract) OR "semi-professional" (Title/Abstract) OR "amateur" (Title/Abstract) OR "collegiate" (Title/Abstract) OR "pre-adolescent" (Title/Abstract) OR "recreational" (Title/Abstract) OR "adolescent" (Title/Abstract) OR "junior" (Title/Abstract) OR "referee" (Title/Abstract) OR "referees" (Title/Abstract) OR "gaelic" (Title/Abstract) OR "rugby" (Title/Abstract) OR "american football" (Title/Abstract) OR "female" (Title/Abstract) OR "women" (Title/Abstract)) AND ("professional" (Title/Abstract) OR "elite" (Title/Abstract)).

The search strategy was adapted for each of the databases consulted through the Polyglot Search of the Systematic Review Accelerator tool (accessed on 1 December 2021. https://sr-accelerator.com/#/polyglot).

The timeframe for the search included studies from the year 2000 until November 2021. Due to the fact that the physical demands of soccer players have evolved over the decades, they are currently more demanding and require different body composition characteristics [14].

### 2.3. Eligibility Criteria

The Participants, Intervention, Comparison, and Outcomes (PICO) criteria for the inclusion and exclusion criteria are shown on Table 1. No limits were placed in relation to the publication status of the study (pre-print, post-print, first online, or final).

**Table 1.** The inclusion criteria applied in the study followed the Population, Intervention, Comparison, and Outcomes (PICO) strategy.

| Population | Intervention | Comparison | Outcomes |
|---|---|---|---|
| Male soccer players who train with the aim of competing or improving their physical performance (excludes physical activity for health or aesthetics). Professional category. Absence of pathologies (healthy subjects). | Anthropometry. Bioimpedance (BIA). Dual X-ray Absorptiometry (DXA). | Measurement methods. Season. Equations. | Anthropometric characteristics: skinfolds, girth, breadth, heights, lengths, body composition, and somatotype. Percentages and values of fat mass, muscle mass, bone mass and body water. |

The exclusion criteria included: (a) studies published in a language other than Spanish and/or English, and (b) narrative, systematic reviews, and/or meta-analyses.

### 2.4. Article Management Process

All the documents found were incorporated into the Zotero citation manager in a separate folder, depending on the database where they were found. A common folder was created to detect and delete duplicated articles using the software's degree of data overlap.

The final database was exported in RIS format to be imported into the article screening system for further processing by the researchers.

### 2.5. Study Selection

All retrieved articles were screened in duplicate. The first screening, based on the title and abstract, was independently conducted in all the studies by two authors (JS-R and JMM-S). During the processes of identifying and screening, a third researcher was consulted (JMS) to determine if the documents that led to discrepancies between authors had to be included or excluded. The articles eligible for a full-text review were then screened by the same authors (JS-R and JMM-S), independently and in duplicate. The rejected articles were then duly identified using the eligibility criterion previously established. Additional reviewers (JMS, NG-G) provided advice when feedback about doubtful documents was required.

### 2.6. Data Extraction

The studies' information was extracted following a blinded and duplicated protocol by two authors (JS-R and JMM-S) using a previously piloted data extraction survey created for this review. The data extraction protocol for this study consisted of the following variables:

- Study: Authors and year of publication
- Country and competition category: Geographical area and competitive category from which the data comes. The latter was included to differentiate between professional league categories within the same country.
- Sample: Number of subjects.
- Time of Season: Included to differentiate values collected between different cycles of a natural season (if specified).
- Method of analysis: It was included to differentiate the values collected between the three methods of evaluation of body composition.
- Measuring instruments: description of the material used in the evaluation.
- Main results: Kinanthropometric characteristics and values of FM, MM, bone mass (BM), and body water

### 2.7. Study Quality and Data Collection

Two researchers (JS-R and JMM-S) examined the quality of the studies using the Agency for Health Research and Quality (AHRQ) Methodology Checklist [15]. A third reviewer (JMS) was consulted to resolve discrepancies. A score above 8 was considered a high-quality study. Egger's bias statistic [16] was used to assess the risk of bias, and funnel plots were created. When a meta-analysis was based on a small number of studies, the ability of Egger's test to detect bias is limited [17]. Therefore, this test was only performed when there were at least 10 studies included in the meta-analysis [16]

### 2.8. Statistical Analysis

The meta-analysis was performed with the R software version 3.6.0. Copyright (C) 2019 (R Foundation for Statistical Computing). The meta-analysis was performed for continuous data using sample (n), mean (M), and standard deviation (SD) of each output from each study. Some studies had more than one group and were treated as other subgroups in the analysis. In the random-effects meta-analysis, a pooled summary mean, and 95%CI were calculated. Studies were weighted according to sample within and between studies. A pooled summary mean and 95%CI were calculated for subgroups (method or equation) in order to compare the differences between groups. Random models using the restricted maximum likelihood method (REML) were utilized. The heterogeneity was measured using the $I^2$ statistic, considering a high heterogeneity if $I^2 \geq 75\%$. The level of significance adopted was 5% ($p < 0.05$).

## 3. Results

A total of 74 studies were included in the systematic review, of which 32 were based on the use of anthropometry [18–49], 21 in BIA [50–70], 13 in DXA [71–83], 3 combined anthropometry and BIA [84–86], 3 combined anthropometry and DXA [87–89], and 2 combined BIA and DXA [90,91], while 73 articles were included in the meta-analysis (Figure 1).

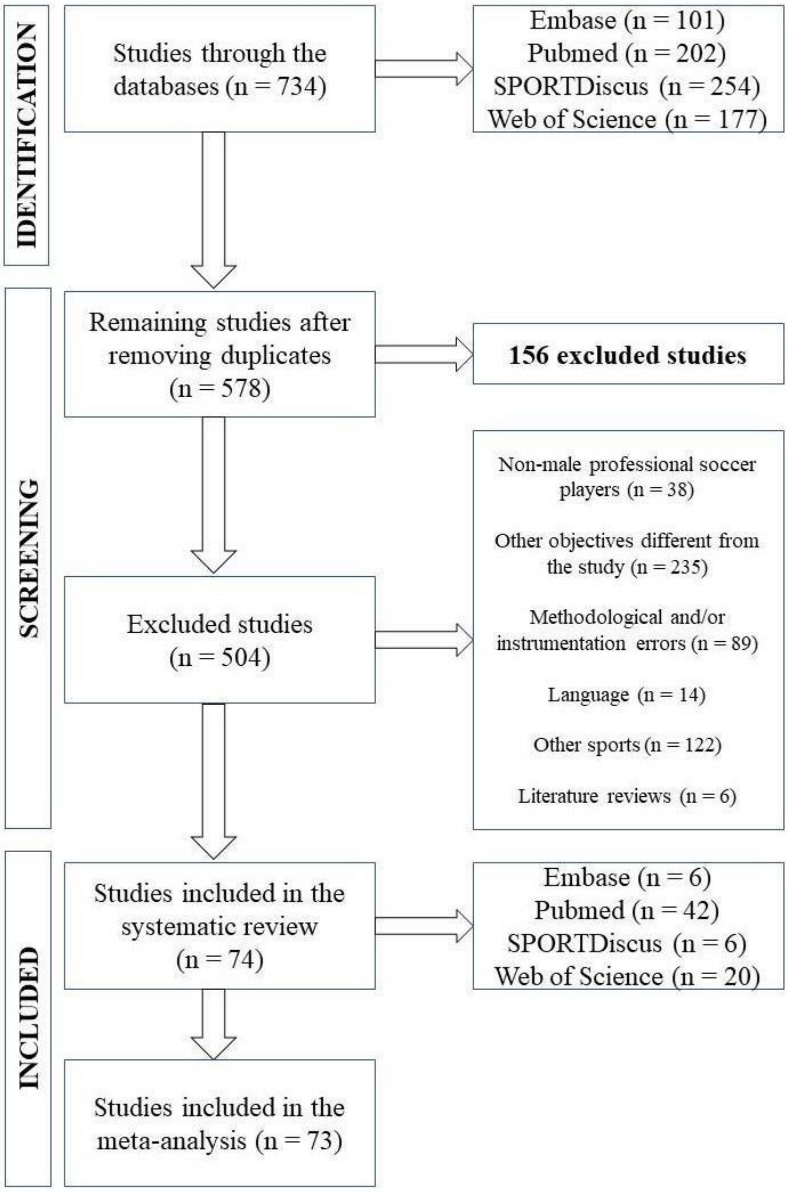



**Figure 1.** Flow diagram showing the process used to select the studies.

Tables 2–4 show the qualitative characteristics of the included articles differentiated by measurement methods (anthropometry, BIA, and DXA, respectively). Table 5 shows the evaluation of methodological quality as assessed with the Methodology Checklist from the Agency for Health Research and Quality (AHRQ) [15].

The sample comprising the different articles included in the review amounted to a total of 5197 soccer players.

In relation to the anthropometric measuring instrument, the main one used was the Harpenden plicometer ($n$ = 25) [18–21,23–26,28,31,33,35–37,39–41,44,46–48,86–89], followed by the Holtain ($n$ = 8) [22,29,34,38,42,43,84,85] and the Slimguide ($n$ = 5) [27,30,32,45,49] ones. For BIA, the most commonly used models were the Tanita BC 418 MA ($n$ = 5) [58,62,64,67,86], Akern BIA 101 ($n$ = 4) [57,65,84,85], and Tanita TBF 543 ($n$ = 2) [52,60]. Lastly, the most common DXA machine models were GE Lunar Prodigy ($n$ = 4) [73,87,89,90], Hologic QDR Series Delphi A ($n$ = 2) [82,91], Hologic QDR Series Discovery A ($n$ = 2) [71,76] and Hologic Discovery W ($n$ = 2) [78,79].

Of the 38 articles included in which anthropometry was used as a method of assessment, 15 used the ISAK protocol [22,28,30–32,34,35,41,43,45,49,85,86,88,89], 2 utilized the protocol from the Anthropometric Standardization Reference Manual (ASRM) [29,38], 1 used the protocol from the International Biological Program (IBP) [47], 1 used the protocol from the American College of Sports Medicine (ACSM) [46], and the remaining 19 articles did not specify the protocol applied [18–21,23–27,33,36,37,39,40,42,44,48,84,87].

As for the sum of skinfolds, the most commonly used formulas were the sum of six skinfolds (triceps, subscapular, supraspinale, abdominal, mid-thigh, and calf) ($n$ = 4) [22,32,34,45], followed by the sum of eight folds (biceps, triceps, subscapular, iliac crest, supraspinale, abdominal, mid-thigh, and calf) ($n$ = 3) [31,40,41].

Regarding the percentage of FM, the most commonly used formula was that of Durnin and Womersley, 1974 ($n$ = 10) [19,21,23–26,31,48,87,89], followed by Jackson and Pollock's seven folds, 1978 ($n$ = 6) [36,39,46,47,87,89], and Faulkner, 1968 ($n$ = 4) [27,34,37,89]. In the case of the MM percentage, the most commonly used formula was Matiegka, 1921 ($n$ = 3) [28,34,44], followed by Kerr, 1988 ($n$ = 1). Finally, for the percentage of bone mass (BM), the two equally used formulas were those of Matiegka, 1921 and Kerr, 1988 ($n$ = 1) [44,89]. Tables S1-S3 show the body composition characteristics of included studies for each of the methods analyzed.

**Table 2.** Descriptive characteristics of the included studies with anthropometry.

| Authors and Year | Sample Size (n) | Age (Years) | Country Competition Category | Time of the SEA | Measuring Instruments | Protocol |
|---|---|---|---|---|---|---|
| Al-Hazzaa et al., 2001 [18] | T = 23 | 25.2 ± 3.3 | SA. National team | Preparation for the FR World Cup | BAS Seca, PLI Harpenden | - |
| Casajús, 2001 [22] | T = 15 | 25.8 ± 3.1 | ES. 1st División | During competitive SEA | EST Rabonne Chesterman, BAS Rabonne Chesterman, Small sliding caliper Rabonne Chesterman, Measuring tape GPM Siber-Hegner Maschinen, PLI Holtain | ISAK |
| Filaire et al., 2003 [26] | T = 20 | 25.1 ± 0.4 | FR. Ligue 1 | Start of pre-SEA, start and end of SEA, start of 2nd pre-SEA | PLI Harpenden | - |
| Ostojic. 2003 [39] | T = 30 | 23.5 ± 3.1 | EN. National League | Start pre-SEA, start, middle and end SEA, and start 2nd pre-SEA | BAS Avery 3306 ABV, PLI Harpenden | - |
| Gutierrez and Monroy, 2005 [28] | T = 20 | 29.0 ± 3.0 | MX. National team | Preparation for the World Cup South Korea and Japan | BAS Bame, Swiss anthropometer type Martin, PLI Harpenden | ISAK |
| Voutselas et al., 2007 [48] | T = 72 | 20.1 ± 5.2 | GR. Super League 1 and 2 | - | PLI Harpenden | - |
| Sotiropoulos et al., 2009 [46] | T = 58; CG = 20; EG = 38 | CG = 24.4 ± 2.9; EG = 23.2 ± 2.5 | GR. Super League GR | Beginning and end of the transition period | PLI Harpenden | ACSM |
| Sporis et al., 2009 [47] | T = 270 | 28.3 ± 5.9 | HR. Prva HNL | 2 consecutive pre-SEAs | BAS Seca, PLI John Bull Caliper | IBP |
| Carling and Orhant, 2010 [21] | T = 26 | 24.4 ± 4.1 | FR. Ligue 1 | 3 consecutive full SEAs (5 moments) | BAS Holtain, PLI Harpenden | - |
| Dey et al., 2010 [24] | T = 150 | 23.3 ± 3.5 | IN. IN Super League | - | PLI Harpenden | - |
| Hazir, 2010 [29] | T = 305; SL = 161; FL = 144; | SL = 25.7 ± 3.7 FL = 24.1 ± 4.2 | TR. Süper Lig (161) and TFF 1. Lig (144) | 5 beginnings of the transition period for the SEA half | BAS Tanita TBF 401A, EST Holtain, Bicondylar caliper Holtain, PLI Holtain | ASRM |

**Table 2.** *Cont.*

| Authors and Year | Sample Size (n) | Age (Years) | Country Competition Category | Time of the SEA | Measuring Instruments | Protocol |
|---|---|---|---|---|---|---|
| Kalapotharakos et al., 2011 [33] | T = 12 | 25 ± 5 | GR. Super League GR | Pre-SEA start, start and mid-SEA | PLI Harpenden | - |
| Boone et al., 2012 [20] | T = 289 | 25.4 ± 4.9 | BE. Jupiler Pro League | 2–4 weeks prior to start of SEA | BAS Seca, PLI Harpenden | - |
| Chaouachi et al., 2012 [23] | T = 23 | 19 ± 1 | TN. Ligue 1 | Last SEA stage | BAS Seca, EST Holtain, PLI Harpenden | - |
| Owen et al., 2012 [40] | T = 15 | 24.5 ± 3.4 | SCO. Scottish Premiership | During a 4-week break SEA | PLI Harpenden | - |
| Henríquez-Olguín et al., 2013 [30] | T = 100 | 23.0 ± 4.4 | CL. Not specified | 2 SEA starts | BAS Tanita TBF 401A, Kit Health & Performance® | ISAK |
| Jorquera et al., 2013 [32] | T = 406; DEF = 124; CEN = 134; DEL = 93; POR = 48 | DEF = 25.3 ± 4; CEN = 25.2 ± 4.7; DEL = 23.5 ± 4.1; POR = 25.1 ± 5.5 | CL. 1st división (326) and 1st B (80) | - | BAS Tanita, Kit Gaucho Pro "Mercosur" | ISAK |
| Lago-Peñas et al., 2013 [34] | T = 42 | 25.0 ± 5.2 | ES. 1st División | During 1st half SEA | PLI Holtain 610 | ISAK |
| Orhan et al., 2013 [38] | 1st team = 24<br>2nd team = 24 | 23.29 ± 2.12<br>25.12 ± 3.60 | TR. Süper Lig | - | PLI Holtain | ASRM |
| Iga et al., 2014 [34] | T = 35 | 20 ± 4 | EN. Not specified | Start and end of pre-SEA, 1st and 2nd half and end of SEA | PLI Harpenden | ISAK |
| Michailidis, 2014 [36] | T = 15 | - | GR. Super League Greece | Start and end pre-SEA, middle and end SEA | BAS Tanita BC 418, EST Seca 208, PLI Harpenden | - |
| Novack et al., 2014 [87] | T = 31 | 21.48 ± 3.38 | BR. Not specified | - | DXA GE Lunar Prodigy software 8.50.093, PLI Harpenden | - |
| Mascherini et al., 2015 [84] | T = 59 | 22.47 ± 5.58 | IT. Serie A | Pre-SEA start and 50 days later | BAS Akern BIA 101 Sport Edition, Measuring tape Holtain, PLI Holtain | - |

**Table 2.** *Cont.*

| Authors and Year | Sample Size (n) | Age (Years) | Country Competition Category | Time of the SEA | Measuring Instruments | Protocol |
|---|---|---|---|---|---|---|
| Najafi et al., 2015 [37] | T = 60 | 24.31 ± 4.20 | IR. Iran Pr o League and Azadeg an League | - | BAS Seca, PLI Harpenden | - |
| Bekris et al., 2016 [19] | T = 24 | 24.3 ± 4.3 | GR. Super League Greece | Start preSEA, start, end 1st half and endSEA | BAS Seca 710, EST Seca, PLI Harpenden | - |
| Fessi et al., 2016 [25] | T = 17 | 23.7 ± 3.2 | QA. Qatar Stars League | Start and end pre-SEA, and mid-SEA | BAS ADE Electronic Column Scales, EST Holtain, PLI Harpenden | - |
| Petri et al., 2016 [42] | T = 28 | 27.88 ± 4.55 | IT. Serie A | Pre-SEA start, SEA start and end | BIO BIA 101 Sport, PLI Holtain | - |
| Lopez-Taylor et al., 2018 [88] | T = 131 | 23.2 (20.5–26.8) | MX. Liga Premier | - | DXA Hologic QDR4500 Explorer software 12.1, BAS Tanita TBF 410, EST Seca 213, Bicondylar calliper Campbell 10, PLI Harpenden | ISAK |
| Owen et al., 2018 [41] | T = 22 | 24.0 ± 3.7 | EU. Not specified | Start and end pre-SEA, mid-SEA, end mid-SEA transition period and end SEA | BAS CIRCA, EST CIRCA, Bicondylar calliper Gulick, PLI Harpenden | ISAK |
| Zuñiga et al., 2018 [49] | T = 78; 1st DIV = 18; 1st “a” DIV = 19; 2nd DIV = 24; 3rd DIV = 17 | 1st DIV = 25.8 ± 5.2; 1st “a” DIV = 23.4 ± 1.6; 2nd DIV = 18.9 ± 1.6; 3rd DIV = 16.0 ± 0.9 | MX. Liga MX (18), Liga de Expansión MX (19), Liga Premier (24) and Liga TDP (17) | Pre-SEA | BAS Tanita Inner Scan BC 532, EST Holtain, Measuring tape Lufkin, Bicondylar caliper Campbell 10, PLI Slimguide | ISAK |
| Pireva, 2019 [44] | T = 118 | - | XK. Superliga | - | BAS Tanita HD-351, EST Seca, PLI John Bull Caliper | - |
| Rodríguez-Rodríguez et al., 2019 [45] | T = 339; DEF = 119; CEN = 133; DEL = 94; POR = 44 | DEF = 25.3 ± 4.8; CEN = 25.2 ± 4.8; DEL = 23.5 ± 4.1; POR = 25.1 ± 5.5 | CL. 1st división | - | Kit Gaucho Pro “Mercosur” | ISAK |

**Table 2.** *Cont.*

| Authors and Year | Sample Size (n) | Age (Years) | Country Competition Category | Time of the SEA | Measuring Instruments | Protocol |
|---|---|---|---|---|---|---|
| Campa et al., 2020 [85] | T = 176 | Development G = 27.4 ± 4.3; Cross-Validation G = 28.0 ± 5.0 | IT. Serie A | - | BAS Seca 877, EST Seca 217, Measuring tape Lufkin, Bicondylar caliper GMP, PLI Holtain | ISAK |
| Grazioli et al., 2020 [27] | T = 23 | 26.3 ± 5.6 | BR. Brasileirão Serie A | Pre-SEA start and 63 days after quarantine | BAS Urano PP180A, PLI Slimguide | - |
| Vega et al., 2020 [35] | T = 41 | - | ES. 1st División and 2nd División | 10 full SEAs | BAS Seca 719, EST Seca 213, PLI Harpenden | ISAK |
| Pietraszewska et al., 2020 [43] | T = 37 | 19–30 | PL. Ekstraklasa | During competitive SEA | Anthropological instruments Siber Hegner Machinery Ltd., PLI Holtain | ISAK |
| Castro Jiménez et al., 2021 [86] | T = 24 | 21.0 ± 1.9 | CO. 1st B | - | BIO InBody 770, EST Seca, Bicondylar caliper Holtain, PLI Harpenden HSK-BI | ISAK |
| Kammerer López et al., 2021 [89] | T = 79 | 23.0 ± 4.4 | CO. 1st A and 1st B | During competitive SEA | DXA GE Lunar Prodigy, BAS Seca 874, EST Seca 213, Measuring tape Lufkin, Bicondylar caliper Slimguide, PLI Harpenden | ISAK |

1st = first; 2nd = second; 3rd = third; ACSM = American College of Sports Medicine; ASRM = Anthropometric Standardization Reference Manual; BAS = scale; BE = Belgium; BIO = bioimpedance; BR = Brazil; CEN = midfielders; CG = control group; CL = Chile; CO = Colombia; DEF = defenders; DEL = Forwards; DXA = Dual X-ray absorptiometry; EG = Experimental group; EN = England; ES = Spain; EST = Stadiometer; EU = European players; FR = France; G = Group; GR = Greece; HR = Croatia; IBP = International Biological Program; IN = India; IR = Iran; IT = Italy; ISAK = International Society for the Advancement of Kinanthropometry; MX = Mexico; PL = Poland; PLI = plicometer; POR = goalkeepers; QA = Qatar; SA = Saudi Arabia; SCO = Scotland; T = Total; SEA = Season; TN = Tunisia; TR = Turkey; XK = Kosovo.

**Table 3.** Descriptive characteristics of the included studies with BIA.

| Authors and Year | Sample Size (n) | Age (Years) | Country. Competition Category | Time of the SEA | Measuring Instruments |
|---|---|---|---|---|---|
| Andreoli et al., 2003 [50] | T = 48; Serie A = 16; Serie B = 14; Serie C = 18 | Serie A = 25.9 ± 4.2; Serie B = 25.1 ± 2.6; Serie C = 25.1 ± 5.7 | IT. Serie A (16), Serie B (14) and Serie C (18) | - | BAS Invernizzi, EST Invernizzi, Xitron 4000B |
| Matkovic´ et al., 2003 [51] | T = 57 | 23.2 ± 3.4 | HR. Prva HNL | During competitive SEA | Body analyzer Danninger |
| Dupont et al., 2004 [52] | T = 22 | 20.2 ± 0.7 | FR. Ligue 1 | During competitive SEA 1st and 2nd periods | Tanita TBF 543 |
| Al-Jaser and Hasan, 2006 [53] | T = 9 | 24 ± 4.7 | KW. Not specified | 5 pre-SEA matches | Biodynamics 310e |
| Clark et al., 2008 [54] | T = 42 | 26.0 ± 4.3 | EN. Football League Championship | 3 complete SEAs (pre-SEA start, mid and end SEA) | EST Seca 240, Tanita TBF 551 |
| Svantesson et al., 2008 [90] | T = 17 | 24.1 ± 3.8 | SE. Allsvenskan | Spring | DXA GE Lunar Prodigy, EST Hultafors, Xitron Hydra 4200 |
| Hoppe et al., 2013 [55] | T = 11 | 23.8 ± 3.0 | DE. Dritte Liga | 1st week pre-SEA | Bodystat QuadScan 4000 |
| Suda et al., 2013 [56] | T = 21 | 24.7 ± 5.2 | JP. J2 League | Pre-SEA final, mid-term and SEA final | Tanita MC 190 |
| Micheli et al., 2014 [57] | T = 219 | 26.1 ± 4.4 | IT. Serie A and Serie B | 1st half SEA | Akern BIA 101 |
| Mascherini et al., 2015 [84] | T = 59 | 22.47 ± 5.58 | IT. Serie A | Pre-SEA start and 50 days later | Measuring tape Holtain, PLI Holtain, Akern BIA 101 Sport Edition |
| Semjon et al., 2016 [58] | T = 120; central DEF = 18; full DEF = 15; central CEN = 24; wingers = 18; DEL = 34; POR = 11 | n.r.; 27.3 ± 6.2; 26.7 ± 4.8; 25.8 ± 5.3; 25.3 ± 4.2; 24.0 ± 3.6; 26.6 ± 6.5 | RC. Cˇeskou fotbalovou ligu | 6 consecutive pre-SEAs | BAS Leifheit Soehnle 7307, Tanita BC 418 MA |
| Aras et al., 2017 [59] | T = 12 | 18.33 ± 0.98 | TR. Not specified | - | BAS Jawon Medical |
| Requena et al., 2017 [60] | T = 19 | 26.2 ± 2.8 | ES. 1ª División | Mid SEA, SEA final and start of pre-SEA | Tanita TBF 543 |
| Kafedžic´ et al., 2018 [61] | T = 39 | 23.5 ± 4.6 | BA. Premier League | 2 pre-SEA starts | Holton Anthropometer, Tanita BC 420SMA |

**Table 3.** *Cont.*

| Authors and Year | Sample Size (n) | Age (Years) | Country. Competition Category | Time of the SEA | Measuring Instruments |
|---|---|---|---|---|---|
| Marcos et al., 2018 [62] | T = 233 | 25.37 ± 5.06 | CY. 1st División | Start pre-SEA | EST Leicester, Tanita BC 418 MA |
| Suarez-Arrones et al., 2018 [91] | T = 18 | 27.6 ± 3.0 | IT. Serie A | SEA final | DXA Hologic QDR Series Delphi A software 13.3:3, BAS OHAUS, EST Seca 213, Tanita MC-180 MAIII |
| Clemente et al., 2019 [63] | T = 23 | 24.7 ± 2.8 | PT. 2nd Liga | Pre-SEA start and SEA start | EST Seca 242, Seca mBCA 515 |
| Gardasevic et al., 2019 [64] | T = 70 | 22.84 ± 4.47 | ME. Prva Crnogorska Liga | SEA final | Tanita BC 418 MA |
| Pietraszewska et al., 2019 [65] | T = 29 | 25.6 ± 5.8 | PL. Ekstraklasa | During competitive SEA | Akern BIA 101 Sport Edition |
| Campa et al., 2020 [85] | T = 176 | Development G = 27.4 ± 4.3; Cross-Validation G = 28.0 ± 5.0 | IT. Serie A | - | BAS Seca 877, EST Seca 217, Measuring tape Lufkin, Bicondylar calliper GMP, PLI Holtain, Akern BIA 101 |
| Dag˘cilar and Öztürk, 2020 [66] | T = 191 | 24.7 ± 5.5 | CY. 1st División | During competitive SEA | Tanita SC 330 |
| Gardasevic and Bjelica, 2020 [67] | T = 53 | 22.75 ± 4.16 | XK. Superliga | SEA final | Tanita BC 418 MA |
| Granero-Gil et al., 2020 [68] | T = 30 | 26.57 ± 5.56 | RU. Russian Premier League | During competitive SEA | EST Seca, Tanita SC-240 |
| Ksia̧z˙ek et al., 2020 [69] | T = 26 | 27.0 ± 3.7 | PL. Ekstraklasa | Pre-SEA | Akern |
| Radzimiński et al., 2020 [70] | T = 23 | 27.9 ± 4.58 | Europa League participants | 13 weeks during competitive SEA | Tanita MC-780 |
| Castro Jiménez et al., 2021 [86] | T = 24 | 21.0 ± 1.9 | CO. 1st B | - | EST Seca, Bicondylar calliper Holtain, PLI Harpenden HSK-BI, Tanita BC 418 MA |

1st = first; 2nd = second; BA = Bosnia and Herzegovina; BAS = scale; CEN = midfielders; CO = Colombia; CY = Cyprus; DE = Germany; DEF = defenders; DEL = forwards; DXA = dual X-ray absorptiometry; ES = Spain; EST = stadiometer; FR = France; G = group; HR = Croatia; IT = Italy; JP = Japan; KW = Kuwait; ME = Montenegro; PL = Poland; PLI = plicometer; POR = goalkeepers; PT = Portugal; RC = Czech Republic; RU = Russia; SE = Sweden; T = Total; SEA = season; TR = Turkey; XK = Kosovo; n.r. = not reported.

**Table 4.** Descriptive characteristics of the included studies with DXA.

| Authors and Year | Sample Size (n) | Age (Years) | Country. Competition Category | Time of the SEA | Measuring Instruments |
|---|---|---|---|---|---|
| Wittich et al., 2001 [72] | T = 42 | 23.2 ± 3.5 | AR. 1st División | 3 pre-SEAs | GE Lunar DPX-L software 1.33 |
| Svantesson et al., 2008 [90] | T = 17 | 24.1 ± 3.8 | SE. Allsvenskan | Spring | BAS The Advanced Weighing System 31, EST Hultafors, GE Lunar Prodigy |
| Reinke et al., 2009 [73] | T = 10 | 25.3 ± 5.1 | DE. Bundesliga | SEA final, final of the transitional summer period and final of the pre-SEA | GE Lunar Prodigy software Lunar enCORE 2002 |
| Sutton et al., 2009 [71] | T = 64 | 26.2 ± 4.0 | EN. Premier League | - | BAS y EST Seca 702, Hologic QDR Series Discovery A software 12:4:3 |
| Gerosa-Neto et al., 2014 [74] | T = 82 | 23.6 ± 4.2 | BR. Brasileirão Serie A | Pre-SEA | BAS Filizola, EST Sanny, GE Lunar DPX-MD software 4.7 |
| Novack et al., 2014 [87] | T = 31 | 21.48 ± 3.38 | BR. Not specified | - | PLI Harpenden, GE Lunar Prodigy software 8.50.093 |
| Milanese et al., 2015 [75] | T = 29 | 27.5 ± 4.38 | IT. Serie A | 3 full SEAs | BAS Tanita BWB-800MA, EST Harpenden, QDR Explorer W software 12.6.1 |
| Milsom et al., 2015 [76] | T = 27 | 24.1 ± 3.9 | EN. Premier League | 3 full SEAs (different periods) | BAS Seca, Hologic QDR Series Discovery A |
| Sánchez-Ureña et al., 2016 [77] | T = 106 | 24.53 ± 4.77 | CR. Fútbol de 1st División | - | BAS Tanita HD-313, EST Tanita, GE enCORE 2011 software 13.6 |
| Devlin et al., 2017 [78] | T = 18 | 27 ± 5 | AU. A-League | Pre-SEA final | BAS Wedderburn WM203, EST Seca SE206, Hologic Discovery W |
| Devlin et al., 2017b [79] | T = 18 | 25 ± 5 | AU. A-League | Pre-SEA start, SEA start, SEA middle and SEA final | BAS Wedderburn WM203, EST Seca SE206, Hologic Discovery W |
| Lopez-Taylor et al., 2018 [88] | T = 131 | 23.2 (20.5–26.8) | MX. Liga Premier | - | Bicondylar caliper Campbell 10, PLI Harpenden, BAS Tanita TBF 410, EST Seca 213, Hologic QDR4500 Explorer software 12.1 |

**Table 4.** *Cont.*

| Authors and Year | Sample Size (n) | Age (Years) | Country. Competition Category | Time of the SEA | Measuring Instruments |
|---|---|---|---|---|---|
| Suarez-Arrones et al., 2018 [91] | T = 18 | 27.6 ± 3.0 | IT. Serie A | SEA final | BAS OHAUS, EST Seca 213, BIO Tanita MC-180 MAIII, Hologic QDR Series Delphi A software 13.3:3 |
| Khalladi et al., 2019 [80] | T = 111 | 23.7 ± 4.8 | QA. Qatar Stars League | During competitive SEA | EST Seca 242, GE Medical SysSEA Lunar software enCORE 12.10 |
| Randell et al., 2019 [81] | T = 16 | 25 ± 4<br>26 ± 4 | ES. 1st División | 2 consecutive pre-SEAs | GE Lunar iDXA |
| Suarez-Arrones et al., 2019 [82] | T = 10 | 27.3 ± 2.8 | IT. Serie A | SEA final, start and pre-SEA final | BAS OHAUS, EST Seca 213, Hologic QDR Series Delphi A software 13.3:3 |
| McEwan et al., 2020 [83] | T = 20 | 25.1 ± 4.1 | ES. 1st División | Start and end of two pre-SEAs | GE Lunar |
| Kammerer López et al., 2021 [89] | T = 79 | 23.0 ± 4.4 | CO. 1st A y 1st B | During competitive SEA | Measuring tape Lufkin, Bicondylar caliper Slimguide, PLI Harpenden, BAS Seca 874, EST Seca 213, GE Lunar Prodigy |

1st = first; 2nd = second; AR = Argentina; AU = Australia; BAS = Scale; BIO = bioimpedance; BR = Brazil; CO = Colombia; CR = Costa Rica; DE = Germany; EN = England; ES = Spain; EST = stadiometer; IT = Italy; MX = Mexico; PLI = plicometer; QA = Qatar; SE = Sweden; T = Total; SEA = season.

**Table 5.** Analysis of methodological quality according to the Agency for Health Research and Quality (AHRQ) Methodology Checklist.

| Authors and Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | Total * |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Al-Hazzaa et al., 2001 [18] | 1 | 0 | 1 | 1 | 0 | - | 0 | 0 | 0 | 1 | 0 | 4 |
| Al-Jaser and Hasan, 2006 [53] | 1 | 0 | 1 | 1 | 0 | - | 1 | 1 | 0 | 1 | 1 | 7 |
| Andreoli et al., 2003 [50] | 1 | 0 | 0 | 1 | 0 | - | 0 | 1 | 0 | 1 | 0 | 4 |
| Aras et al., 2017 [59] | 1 | 0 | 0 | 1 | 0 | - | 0 | 0 | 0 | 1 | 0 | 3 |
| Bekris et al., 2016 [19] | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 7 |
| Boone et al., 2012 [20] | 1 | 0 | 1 | 1 | 0 | - | 0 | 1 | 0 | 1 | 0 | 5 |
| Campa et al., 2020 [85] | 1 | 0 | 0 | 1 | 0 | - | 0 | 1 | 0 | 1 | 0 | 4 |
| Carling and Orhant, 2010 [21] | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 8 |
| Casajús, 2001 [22] | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 7 |
| Castro Jiménez et al., 2021 [86] | 1 | 1 | 0 | 1 | 0 | - | 0 | 1 | 0 | 1 | 0 | 5 |
| Chaouachi et al., 2012 [23] | 1 | 0 | 1 | 1 | 0 | - | 0 | 1 | 0 | 1 | 0 | 5 |
| Clark et al., 2008 [54] | 1 | 1 | 1 | 1 | 0 | - | 0 | 1 | 0 | 1 | 1 | 7 |
| Clemente et al., 2019 [63] | 1 | 1 | 1 | 1 | 0 | - | 0 | 1 | 0 | 1 | 1 | 7 |
| Dag˘cilar and Öztürk, 2020 [66] | 1 | 0 | 1 | 1 | 0 | - | 1 | 0 | 0 | 1 | 0 | 5 |
| Devlin et al., 2017 [78] | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 6 |
| Devlin et al., 2017b [79] | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 7 |
| Dey et al., 2010 [24] | 1 | 1 | 0 | 1 | 0 | - | 0 | 0 | 0 | 1 | 0 | 4 |
| Dupont et al., 2004 [52] | 1 | 0 | 1 | 1 | 0 | - | 0 | 1 | 0 | 1 | 1 | 6 |
| Fessi et al., 2016 [25] | 1 | 0 | 1 | 1 | 0 | - | 1 | 1 | 0 | 1 | 1 | 7 |
| Filaire et al., 2003 [26] | 1 | 1 | 1 | 1 | 0 | - | 0 | 0 | 0 | 1 | 1 | 6 |
| Gardasevic and Bjelica, 2020 [67] | 1 | 0 | 1 | 1 | 0 | - | 0 | 0 | 0 | 1 | 0 | 4 |
| Gardasevic et al., 2019 [64] | 1 | 0 | 1 | 1 | 0 | - | 0 | 0 | 0 | 1 | 0 | 4 |
| Gerosa-Neto et al., 2014 [74] | 1 | 0 | 1 | 1 | 0 | - | 0 | 0 | 0 | 1 | 0 | 4 |
| Granero-Gil et al., 2020 [68] | 1 | 1 | 1 | 1 | 0 | - | 0 | 0 | 0 | 1 | 0 | 5 |
| Grazioli et al., 2020 [27] | 1 | 0 | 1 | 1 | 0 | - | 0 | 1 | 0 | 1 | 1 | 6 |
| Gutierrez and Monroy, 2005 [28] | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 6 |
| Hazir, 2010 [29] | 1 | 0 | 1 | 1 | 0 | - | 0 | 1 | 0 | 1 | - | 5 |
| Henríquez-Olguín et al., 2013 [30] | 1 | 0 | 1 | 1 | 0 | - | 0 | 0 | 0 | 1 | 1 | 5 |
| Hoppe et al., 2013 [55] | 1 | 0 | 1 | 1 | 0 | - | 0 | 1 | 0 | 1 | 0 | 5 |
| Iga et al., 2014 [34] | 1 | 0 | 1 | 1 | 0 | - | 0 | 1 | 0 | 1 | 1 | 6 |
| Jorquera et al., 2013 [32] | 1 | 0 | 0 | 1 | 0 | - | 0 | 1 | 0 | 1 | 0 | 4 |
| Kafedžic´ et al., 2018 [61] | 1 | 0 | 1 | 1 | 0 | - | 0 | 1 | 0 | 1 | 1 | 6 |
| Kalapotharakos et al., 2011 [33] | 1 | 0 | 1 | 1 | 0 | - | 0 | 0 | 0 | 1 | 1 | 5 |
| Kammerer López et al., 2021 [89] | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 7 |
| Khalladi et al., 2019 [80] | 1 | 1 | 1 | 1 | 0 | - | 1 | 0 | 0 | 1 | 0 | 6 |
| Ksia̧z˙ek et al., 2020 [69] | 1 | 1 | 1 | 1 | 0 | - | 0 | 1 | 0 | 1 | 0 | 6 |
| Lago-Peñas et al., 2013 [34] | 1 | 1 | 1 | 1 | 0 | - | 0 | 1 | 0 | 1 | 0 | 6 |
| Lopez-Taylor et al., 2018 [88] | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 6 |
| Marcos et al., 2018 [62] | 1 | 1 | 1 | 1 | 0 | - | 0 | 1 | 0 | 1 | 0 | 6 |
| Mascherini et al., 2015 [84] | 1 | 1 | 1 | 1 | 0 | - | 1 | 1 | 0 | 1 | 1 | 8 |
| Matkovic´ et al., 2003 [51] | 1 | 0 | 1 | 1 | 0 | - | 0 | 0 | 0 | 1 | 0 | 4 |
| McEwan et al., 2020 [83] | 1 | 0 | 1 | 1 | 0 | - | 0 | 1 | 0 | 1 | 1 | 6 |
| Michailidis, 2014 [36] | 1 | 0 | 1 | 1 | 0 | - | 1 | 1 | 0 | 1 | 1 | 7 |
| Micheli et al., 2014 [57] | 1 | 0 | 1 | 1 | 0 | - | 0 | 1 | 0 | 1 | 0 | 5 |
| Milanese et al., 2015 [75] | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 8 |
| Milsom et al., 2015 [76] | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 7 |
| Najafi et al., 2015 [37] | 1 | 0 | 0 | 1 | 0 | - | 0 | 0 | 0 | 1 | 0 | 3 |
| Novack et al., 2014 [87] | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 6 |
| Orhan et al., 2013 [38] | 1 | 0 | 0 | 1 | 0 | - | 0 | 1 | 0 | 1 | 0 | 4 |
| Ostojic. 2003 [39] | 1 | 0 | 1 | 1 | 0 | - | 0 | 0 | 0 | 1 | 1 | 5 |
| Owen et al., 2012 [40] | 1 | 0 | 1 | 1 | 0 | - | 0 | 1 | 0 | 1 | 0 | 5 |
| Owen et al., 2018 [41] | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 7 |
| Petri et al., 2016 [42] | 1 | 0 | 1 | 1 | 0 | - | 0 | 1 | 0 | 1 | 1 | 6 |
| Pietraszewska et al., 2019 [65] | 1 | 0 | 1 | 1 | 0 | - | 0 | 1 | 0 | 1 | 0 | 5 |
| Pietraszewska et al., 2020 [43] | 1 | 1 | 0 | 1 | 0 | - | 0 | 1 | 0 | 1 | 0 | 5 |
| Pireva, 2019 [44] | 1 | 1 | 0 | 1 | 0 | - | 0 | 0 | 0 | 1 | 0 | 4 |
| Radzimin´ski et al., 2020 [70] | 1 | 1 | 1 | 1 | 0 | - | 0 | 1 | 0 | 1 | 1 | 7 |
| Randell et al., 2019 [81] | 1 | 0 | 1 | 1 | 0 | - | 0 | 1 | 0 | 1 | 1 | 6 |
| Reinke et al., 2009 [73] | 1 | 0 | 1 | 1 | 0 | - | 0 | 0 | 0 | 1 | 1 | 5 |
| Requena et al., 2017 [60] | 1 | 0 | 1 | 1 | 0 | - | 1 | 1 | 0 | 1 | 1 | 7 |
| Rodríguez-Rodríguez et al., 2019 [45] | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 6 |

**Table 5.** *Cont.*

| Authors and Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | Total * |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sánchez-Ureña et al., 2016 [77] | 1 | 0 | 0 | 1 | 0 | - | 0 | 1 | 0 | 1 | 0 | 4 |
| Semjon et al., 2016 [58] | 1 | 1 | 1 | 1 | 0 | - | 1 | 0 | 0 | 1 | 1 | 8 |
| Sotiropoulos et al., 2009 [46] | 1 | 1 | 1 | 1 | 0 | - | 0 | 1 | 0 | 1 | 0 | 6 |
| Sporis et al., 2009 [47] | 1 | 1 | 1 | 1 | 0 | - | 0 | 1 | 0 | 1 | 1 | 7 |
| Suarez-Arrones et al., 2018 [91] | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 6 |
| Suarez-Arrones et al., 2019 [82] | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 8 |
| Suda et al., 2013 [56] | 1 | 0 | 1 | 1 | 0 | - | 0 | 1 | 0 | 1 | 1 | 6 |
| Sutton et al., 2009 [71] | 1 | 0 | 0 | 1 | 0 | - | 0 | 1 | 0 | 1 | 0 | 4 |
| Svantesson et al., 2008 [90] | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 6 |
| Vega et al., 2020 [35] | 1 | 1 | 1 | 1 | 0 | - | 0 | 1 | 0 | 1 | 1 | 7 |
| Voutselas et al., 2007 [48] | 1 | 0 | 0 | 1 | 0 | - | 0 | 1 | 0 | 1 | 0 | 4 |
| Wittich et al., 2001 [72] | 1 | 0 | 1 | 1 | 0 | - | 1 | 0 | 1 | 1 | 1 | 7 |
| Zuñiga et al., 2018 [49] | 1 | 0 | 1 | 1 | 0 | - | 0 | 1 | 0 | 1 | 0 | 5 |

* 0 = worst; 11 = best value; - = unclear.

Table 6 and Supplementary Figures S1–S9 show the meta-analysis grouped according to the method of variable assessment (1 = anthropometry, 2 = BIA, 3 = DXA) mean, standard deviation, sample size, weight, and subgroup meta-analysis (pooled summary mean, 95%CI, Tau2, Chi2, *df*, *p*, $I^2$) and for the total (pooled summary mean, 95%CI, Tau2, Chi2, *df*, *p*, $I^2$ and test for subgroup differences: Chi2, *df*, *p*). The sample had a mean age of 24.50 years old, and the following mean values were found: 179.76 cm in height, 76.29 kg in weight, 12.48 kg of FM, 11.85% of FM, 66.10 kg of FFM, 81.36% of FFM, 39.28 kg of MM and 52.03% of MM. The comparison of the groups according to the assessment method (anthropometry, BIA, and DXA) did not show significant differences in age ($p$ = 0.45), (Supplementary Figure S1), weight ($p$ = 0.11) (Supplementary Figure S3), percentage of FFM ($p$ = 0.59) (Supplementary Figure S7), kilograms of MM ($p$ = 0.37) (Supplementary Figure S8) or percentage of MM ($p$ = 0.38) (Supplementary Figure S9). However, there were significant differences in height, with method 2 (BIA) showing the greatest height ($p$ = 0.001) (Supplementary Figure S2); in kilograms of FM, with method 1 showing the highest value ($p < 0.0001$) (Supplementary Figure S4), in the percentage of FM, with method 3 showing the highest value ($p < 0.0001$) (Supplementary Figure S5), in kilograms of FFM, with method 1 showing the highest value ($p$ = 0.0004) (Supplementary Figure S6).

Taking into account the equation used for the calculation of the percentage of FM, a mean of 10.19% was obtained, with significant differences in the data reported according to groups ($p < 0.001$), with equations 3 (Durnin and Womersley, 1974) and 6 (Faulkner, 1968) indicating the highest values, and equations 1 (Carter, 1982) and 26 (Yuhasz, 1974) the lowest values (Table 7 and Figure 2).

According to the equation used to calculate the sum of skinfolds, Equation (5) (triceps, subscapular, supraspinale, abdominal, anterior thigh, calf) showed a mean of 52.18 mm, while Equation (6) (triceps, biceps, subscapular, iliac crest, supraspinale, abdominal, anterior thigh, calf) showed a value of 59.93 mm (Table 7 and Figure 3).

Likewise, the data (pooled summary mean, 95%CI, Tau2, Chi2, *df*, *p*, $I^2$) for endomorphy, ectomorphy, and mesomorphy are shown in Figure 4. The studies report a mean of 2.32 points for endomorphy, 2.32 points for ectomorphy, and 5.15 points for mesomorphy. Figure 5 shows the data for bone mineral content (BMC), BMD, and water body. With respect to BMC, mean values of 3.17 kg were reported, with respect to BMD values, 1.33 g/cm$^3$, and with respect to water values, 47.52 l mean values were reported.

**Table 6.** Meta-analysis by groups according to the evaluation method used.

| | Authors | G | M | CI 95% | Weight (%) | M | CI95% | *p* |
|---|---|---|---|---|---|---|---|---|
| Age | | | | | | | | |
| Anthropometry | [18–34,37–43,45–49,84–89] | 48 | 24.20 | 23.45; 24.95 | 49.3 | | | |
| BIA | [50–70,84–86,90,91] | 35 | 24.79 | 24.02; 25.56 | 34.1 | 24.50 | 24.04; 24.97 | 0.45 |
| DXA | [71–83,87–91] | 17 | 24.78 | 23.90; 25.67 | 16.7 | | | |
| Height | | | | | | | | |
| Anthropometry | [18–26,28–35,37–49,84–89] | 120 | 179.01 | 178.32; 179.70 | 58.4 | | | |
| BIA | [50–70,84–86,90,91] | 52 | 181.17 | 180.17; 182.16 | 24.1 | 179.76 | 179.22; 180.30 | <0.01 |
| DXA | [71–83,87–91] | 38 | 180.37 | 178.91; 181.83 | 17.5 | | | |
| Weight | | | | | | | | |
| Anthropometry | [18–49,84–89] | 70 | 75.60 | 74.57; 76.62 | 56.8 | | | |
| BIA | [50–70,84–86,90,91] | 38 | 77.08 | 75.88; 78.27 | 30.5 | 76.27 | 75.51; 77.03 | 0.11 |
| DXA | [71–83,87–91] | 16 | 77.41 | 74.41; 80.19 | 12.7 | | | |
| Fat mass kilograms | | | | | | | | |
| Anthropometry | [34,41,44,45,89] | 14 | 14.72 | 12.82; 16.61 | 40.7 | | | |
| BIA | [50,56,57,65,69,85] | 9 | 12.03 | 10.41; 13.66 | 25.6 | 12.48 | 11.41; 13.55 | <0.01 |
| DXA | [72–76,78,79,81–83,87,89] | 12 | 10.07 | 9.35; 10.79 | 33.7 | | | |
| Fat mass percentage | | | | | | | | |
| Anthropometry | [18–28,31,33–37,39,44,46–48,87–89] | 44 | 10.60 | 9.73; 11.47 | 44.8 | | | |
| BIA | [50–70,85,86,90,91] | 40 | 12.60 | 11.76; 13.44 | 38.4 | 11.85 | 11.28; 12.43 | <0.01 |
| DXA | [71–83,87–91] | 17 | 13.46 | 12.20; 14.73 | 16.8 | | | |
| Fat-Free mass kilograms | | | | | | | | |
| Anthropometry | [21,22,36,39,41,42,44] | 9 | 69.44 | 67.56; 71.32 | 22.9 | | | |
| BIA | [50,51,56,57,65,66,69,84,85,90] | 13 | 66.31 | 64.67; 67.96 | 37.2 | 66.10 | 64.65; 67.55 | <0.01 |
| DXA | [72–77,80–83,87,89,90] | 14 | 63.91 | 61.09; 66.74 | 39.9 | | | |
| Fat-Free mass percentage | | | | | | | | |
| BIA | [63,65,69] | 3 | 82.77 | 75.55; 89.98 | 48.9 | 82.36 | 80.30; 84.42 | 0.59 |
| DXA | [71,72,89] | 3 | 81.84 | 79.84; 83.81 | 51.1 | | | |
| Muscle mass kilograms | | | | | | | | |
| Anthropometry | [34,44,45,89] | 7 | 38.45 | 36.17; 40.73 | 48.7 | 39.28 | 37.34; 41.23 | 0.37 |
| BIA | [64,65,67,69,86] | 8 | 40.05 | 36.46; 43.64 | 51.3 | | | |
| Muscle mass percentage | | | | | | | | |
| Anthropometry | [28,34,44,89] | 4 | 50.21 | 45.45; 54.97 | 57.3 | 52.03 | 46.90; 57.17 | 0.38 |
| BIA | [61,65,69] | 3 | 54.49 | 34.67; 74.31 | 42.7 | | | |

G = groups; M = mean.

**Table 7.** Meta-analysis by groups according to the equation used.

| | Authors | G | M | CI 95% | Weight (%) | M | CI95% | *p* |
|---|---|---|---|---|---|---|---|---|
| Fat mass | | | | | | | | |
| Equation (1) | [22,89] | 3 | 8.19 | 7.24; 9.15 | 8.5 | | | |
| Equation (3) | [19,21,23–26,31,48,87,89] | 13 | 12.18 | 11.06; 13.30 | 35.9 | | | |
| Equation (6) | [27,34,37,89] | 4 | 11.16 | 10.42; 11.9 | 11.3 | | | |
| Equation (9) | [36,39,46,47,87,89] | 6 | 9.54 | 7.45; 11.62 | 16.8 | 10.19 | 9.41; 10.97 | <0.01 |
| Equation (11) | [33,87] | 2 | 9.23 | −6.33; 24.78 | 5.3 | | | |
| Equation (20) | [31,88,89] | 2 | 10.02 | 9.77; 10.27 | 5.7 | | | |
| Equation (26) | [87,88] | 6 | 7.14 | 6.87; 7.41 | 16.6 | | | |
| Sum of skinfold | | | | | | | | |
| Equation (5) | [22,32,34,45] | 11 | 52.18 | 49.49; 54.87 | | 53.95 | 51.19; 56.70 | <0.01 |
| Equation (6) | [31,40,41] | 4 | 59. 93 | 55.34; 64.52 | 21.6 | | | |

Fat mass: Equation (1) = Carter, 1982; Equation (3) = Durnin and Womersley, 1974; Equation (6) = Faulkner, 1968; Equation (9) = Jackson and Pollock 7 folds, 1978; Equation (11) = Jackson and Pollock 3 folds, 1978; Equation (20) = Reilly, 2009; Equation (26) = Yuhasz, 1974. Sum of skinfolds: Equation (5) = Σ6 skinfolds (triceps, subscapular, supraspinale, abdominal, mid-thigh, and calf); Equation (6) = Σ8 folds (biceps, triceps, subscapular, iliac crest, supraspinale, abdominal, mid-thigh, and calf). G = groups; M = mean.

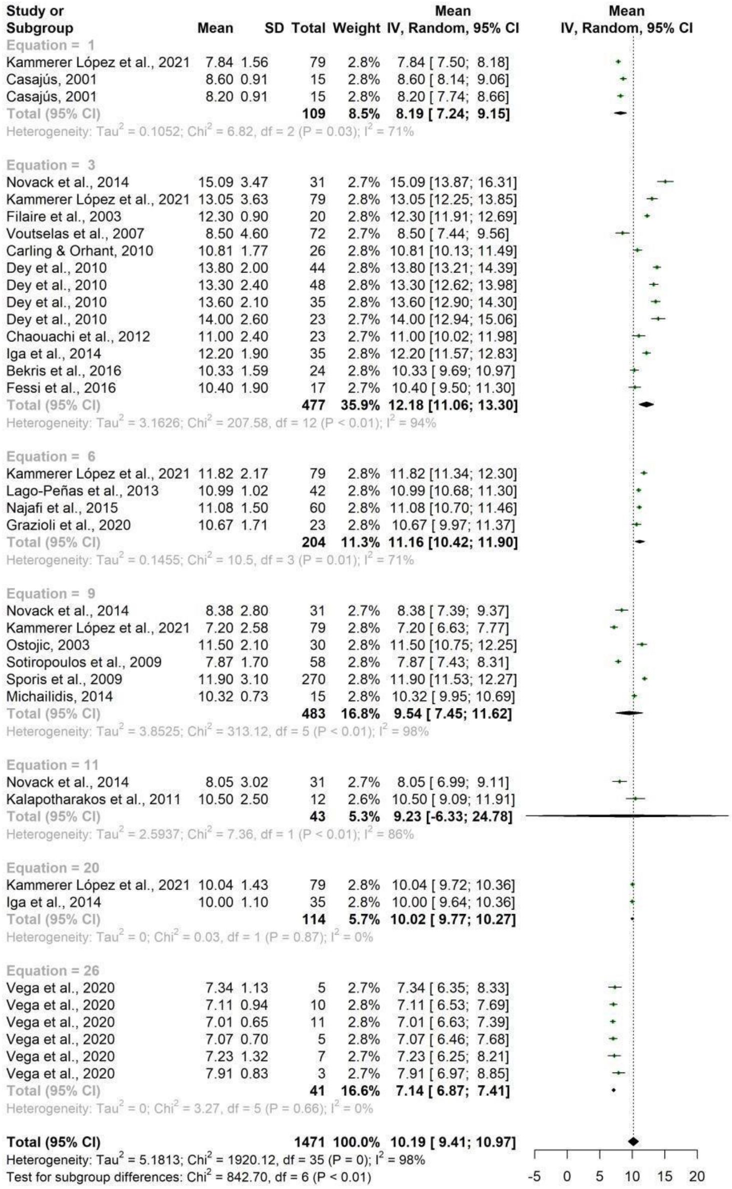



**Figure 2.** Forest plot fat mass percentage according to equation.

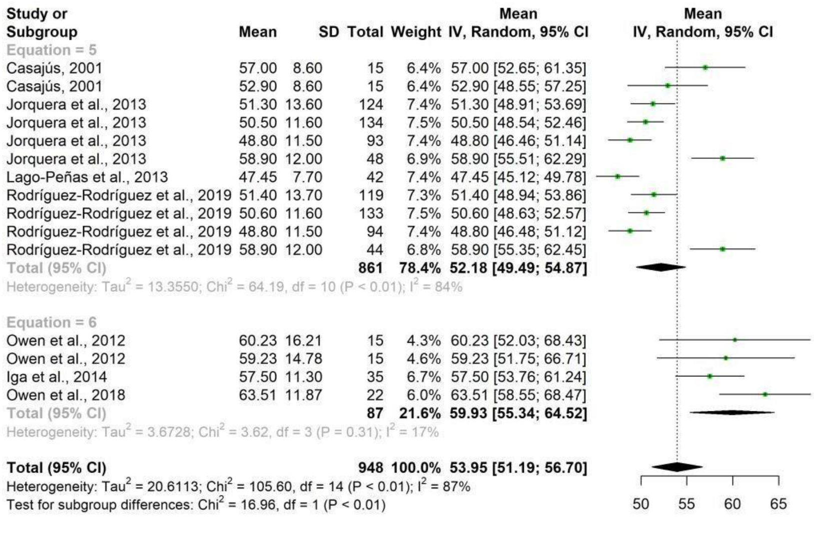



**Figure 3.** Forest plot sum of folds according to equation.

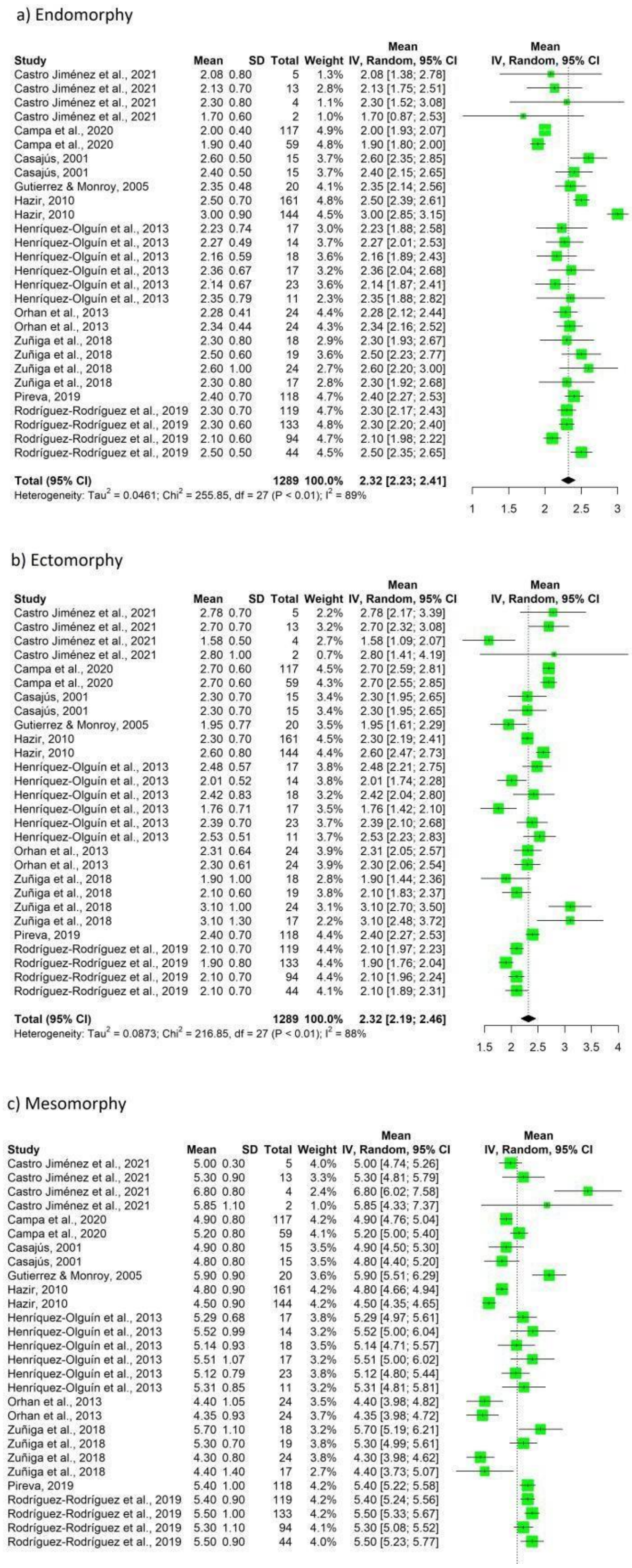



**Figure 4.** Forest plot (**a**) endomorphy, (**b**) ectomorphy, and (**c**) mesomorphy.

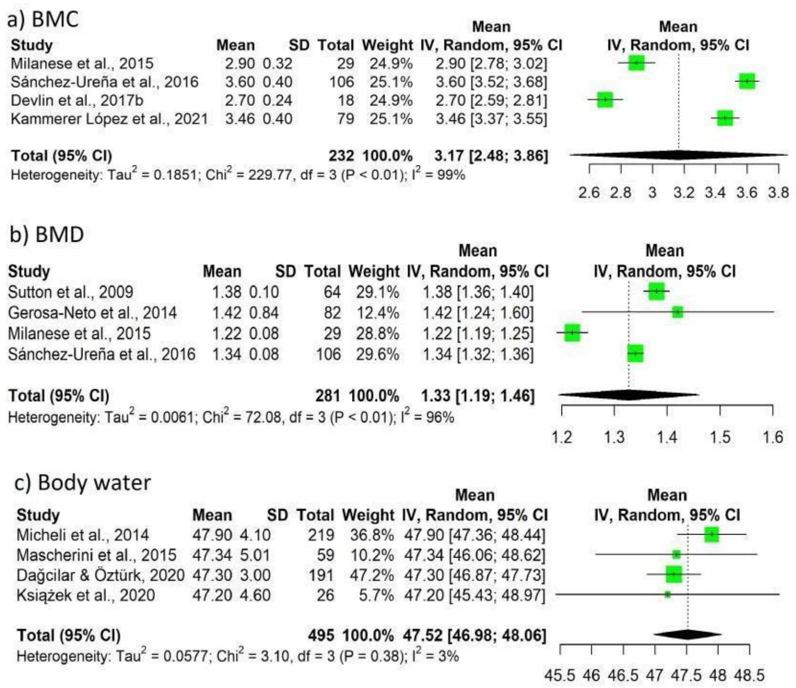



**Figure 5.** Forest plot (**a**) BMC, (**b**) BMD, and (**c**) body water.

## 4. Discussion

This is the first systematic review with meta-analysis to assess the body composition of professional male soccer players, as well as the influences of the measurement method used. The main findings of this work were: (1) there are differences in the FM assessed between the different methods, with higher percentages using DXA followed by BIA and anthropometry, with a mean value of 11.85%; (2) there are significant differences between the different anthropometric formulas to assess the percentage of FM, with higher values in Durnin and Womersley, 1974 and Faulkner, 1968, and lower values in Yuhasz, 1974 and Carter, 1982; (3) no significant differences were observed in the measurement of MM through anthropometry and BIA, with a mean of 52.03% and 39.28 kg; (4) the weight of the FFM was higher with anthropometry, followed by BIA and DXA, with a mean value of 66.10 kg, although no significant differences were observed in the percentage of FFM through BIA and DXA, with a mean of 82.36%; (5) the mean somatotype was balanced mesomorphic.

### *4.1. Measurement Instruments*

The anthropometric method is one of the most widely used methods in soccer to assess body composition, as it is inexpensive, easy to transport, non-invasive, simple to apply, and validated by the scientific community, although it requires the anthropometrist to be trained and qualified [6,8]. There are many types of plicometers available on the market, some of which are cheap and accessible, but not valid because they do not meet the technical specifications in relation to the pressure exerted on the subcutaneous tissue and/or an erroneous calibration [4,92]. In our work, the Harpenden model was the most commonly used, followed by the Holtain and Slimguide ones. This coincides with the literature, as Harpenden is the most traditionally used model in scientific research, being considered the gold standard method [93,94]. Recently, the agreement of these three analog models, together with a fourth digital model, Lipowise, was evaluated to establish the differences between the sum of skinfolds, and the estimation of FM and adipose tissue using different formulas. The authors concluded that the measurement data were similar, although the Holtain and Slimguide models were more similar to each other and tended to overestimate the result as compared to the Harpenden model [95]. It is therefore recommended that measurements be made with the same model of plicometer to monitor an individual or to compare the measured results with other studies [8,95,96].

In addition, there are many formulas for estimating the different compartments of body composition, which have an impact on the results obtained, and which are heterogeneous and not comparable with each other [97,98]. Recently, Martínez-Ferran et al. tested 21 professional soccer players from the Spanish league to discover which FM formula and sum of skinfolds correlated best with DXA as the gold standard method when assessing FM. The formula proposed by Suarez-Arrones et al., 2018, and the sum of four skinfolds (triceps, subscapular, supraspinale, and abdominal) were found to have the highest agreement [99]. In addition, this formula required only the triceps and iliac crest fold, which could reduce the time spent on the anthropometric assessment of soccer teams that are assessed on the same day and at different times in the season [99]. This correlation has been previously investigated in soccer players [89,91,100], but their results pointed to a higher correlation to formulas such as Faulkner, 1968 [101], Eston, 2005 [102], Withers et al., 1987 [103] or Durnin and Womersley, 1974 [104]. In our work, neither of the two proposals by Martínez-Ferran et al. were included, with the formula from Durnin and Womersley, 1974 [104], and the sum of six skinfolds (triceps, subscapular, supraspinale, abdominal, mid-thigh, and calf) being the most widely used in the studies included. For this reason, caution should be exercised in the selection of the formulas to be used when assessing soccer players, and the validity of the proposals by Martínez-Ferran et al. should be further verified [97].

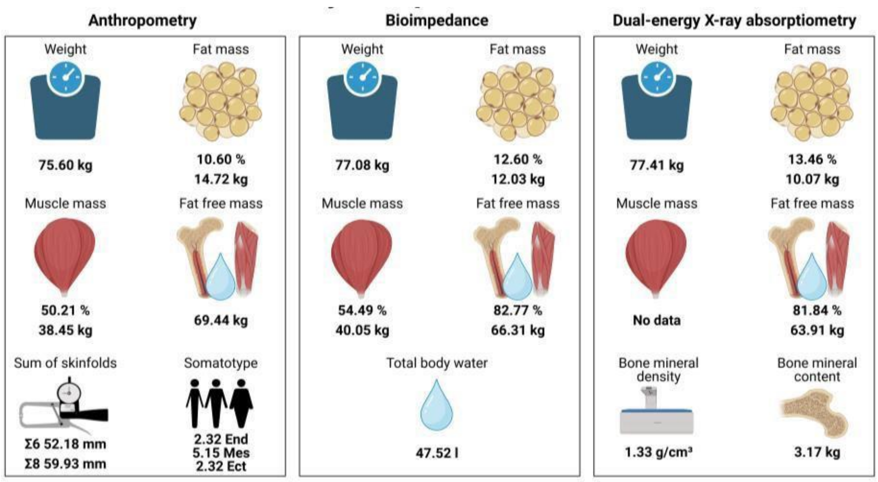
With respect to BIA, it is frequently used in soccer due to the ease of transport (for some models) and speed of use [6]. However, it is probably not the most appropriate method, as the presence of certain diseases, treatments, or clinical situations, as well as the rules of use, can alter the results of this instrument [5,6]. In addition, several published studies point to the existence of a low correlation of FM results between BIA and DXA in professional soccer players, in contrast to some anthropometric formulas [91,99], in agreement with the results of this work. However, the combination of anthropometry and BIA could allow for a more complete assessment of body composition, as BIA adequately assesses water status and cell mass, thus complementing the anthropometric method [84]. Determining water status prior to training and/or competitions could improve hydration patterns and prevent adverse effects such as dehydration and hyperhydration, which have an impact on sports performance or risk of injury [105,106]. Despite their usefulness, the percentage and weight of body water were only collected in a few articles included in the present review, with a value of 47.52 L on average [57,64,66,69,84] (Supplementary Figure S10), as more importance has been traditionally given to the total weight and FM than to the rest of the components [8]. In relation to DXA, although it is considered the gold standard method, it has limitations that can affect the calculations of the measurements, such as the dimensions of the subject to be analyzed (both in height and width), the high economic cost, the experience needed for processing and interpreting the results, or software updates with new algorithms to calculate body composition [6,8,75,107]. In the UEFA expert group statement, the average values of FM of elite male soccer players measured by DXA varied between 8–13%, although lower and higher values have also been reported [2]. Several of the included studies agreed with this range [71–73,75,76,78,90], with most of them exceeding it [74,77,79–83,87–89,91], but in no case was it below this value. In fact, the mean of the meta-analysis performed provided a value of 13.46%. This does not necessarily translate into poorer performance, as optimal physique varies according to playing position, physiology, and style of play depending on the team and/or coach [2]. Finally, despite being considered the reference method for the evaluation of bone mineral status [7,8], few studies assessed the BMC [75,77–79,89], with a value of 3.17 kg (Supplementary Figure S11), or BMD [71,74,75,77–79,89] with a value of 1.33 $g/cm^3$ (Supplementary Figure S12).

### *4.2. Body Composition Values*

Presently, there are multiple body composition references for all professional sports modalities, many of them being considered a goal to achieve for athletes [108,109]. Body composition is crucial for achieving an optimal physical level, which can translate into a good level of play, as performance in soccer depends on multiple technical, biomechanical, tactical, mental, and physiological factors [2,12]. In fact, during soccer practice, there are a multitude of movements that are affected by weight, such as accelerations, changes in direction, or vertical jumps, so muscle training, impact loading, and body fat reduction are important in physical preparation to improve performance in soccer [71,110]. For this reason, the physiological assessment of a soccer player has become more important in recent years, to the extent that it is not only based on technical quality, but also on the physical abilities of the player [111]. Moreover, the physical demands of elite soccer players have been increasing in recent decades, not only in the amount of training and/or competitions, but also in the intensity of effort during matches, and a shorter recovery period between competitions or training sessions [14,112,113]. It is coherent to think that body composition has also evolved over time. However, there are only a few reference values of the different body components in professional soccer players that can be used by the medical technical staff [2,3].

This is not the case in other team sports such as basketball [114] or handball [115], where reference values for some body components, such as FM, are available, although these studies did not specify either the formulas for estimating FM, MM, or BM, or the model of the instrument used. These limitations may influence reliability, reproducibility, and application in clinical practice.

In relation to FM, Radzimiński et al. evaluated the relationship between speed, aerobic capacity, body composition (through BIA), and distance covered during official matches, of 23 professional players participating in the international competition Europa League, concluding that players with a lower percentage of FM and higher aerobic capacity covered the longest distances and at a higher speed during competitions [70,116,117]. It has also been observed that a higher percentage of FM is negatively associated with the 20 m sprint speed [118]. Regarding MM, Ayotte et al. assessed whether body mass gain from strength training would impair the aerobic capacity of 11 elite soccer players, with the results showing that it did not negatively impact aerobic capacity, but significantly increased it [2,119,120]. In our work, for the first time to our knowledge, it was possible to make a proposal of ranges of guidance values for the different body compartments (Figure 6).




**End = endomorphy; Mes = mesomorphy; Ect = ectomorphy.**

**Figure 6.** Guidance values for body composition differentiated by measurement method.

Recently, Moya-Amaya et al. verified the somatotype trend in the last few decades, of professional male soccer players, observing a decrease in the endomorphic component, evolving from balanced mesomorphy to ecto-mesomorphy [121]. This may be important, because the somatotype that is most prone to injury is the balanced ectomorph (85%), as opposed to the ecto-mesomorph (50%), meso-ectomorph (45%), or balanced mesomorph (44%) [98]. In our study, similar results were observed [22,28–30,32,38,44,45,49,85,86], although the total mean endomorphy, ectomorphy, and mesomorphy values were 2.32, 2.32, and 5.15, respectively, resulting in a balanced mesomorph somatotype. These findings relate to the usefulness of the rest of the body compartments, beyond FM, for the performance and health of the soccer player.

### 4.3. Limitations

This study has limitations. Firstly, the existing heterogeneity in the equations for estimating body composition using the anthropometric method, times in the season in which the assessment was carried out, playing positions, and measuring instruments for evaluating the different body components, made it difficult to compare the results. In addition, not all studies that used the anthropometric method provided details on which measurement protocol they applied, so the methodology and anthropometrists could be biased. Moreover, while certain measurement instruments were excluded in the anthropometry section, as they were not valid according to the ISAK protocol, no limiting criteria were applied for BIA or DXA instruments. This is an important aspect, as there is a risk of unifying tetrapolar and octapolar BIA values, as well as single and multi-frequency methods. Another limitation is that although the data collection was limited to male soccer players, not all countries show the same professional level of soccer, with some countries having higher Fédération Internationale de Football Association (FIFA) rankings than others [122]. While it is true that they are all professional players, they do not have the same economic level, sporting facilities, or physical demands, which can affect many factors that could influence their body composition and sporting performance.

In spite of this, and the limitations of our study, it is the only study currently available in the scientific literature that provides a complete description of the main instruments for assessing body composition of male professional soccer players. Based on the current situation of the sport, our research aims to be the first study to propose a range of guidance values of anthropometric measurements, FM, MM, and BM in general male professional soccer players.

### 4.4. Future Research and Practical Application

Although the importance of assessing MM, BM, and body water, and their relationship to sports performance has been highlighted in recent years, studies continue to focus on total weight and FM. For future studies it is recommended to (1) clearly describe the procedures and protocols applied when performing the measurements, (2) specify the reliability, calibration of the measuring instruments, and the technical error of measurement, (3) clearly monitor and report the hydration and nutrition status prior to the measurement, (4) specify the competitive level of the athlete, (5) specify the level of the athlete's performance, (6) specify the competitive level of the sample by reporting the country and/or region and the name of the league in which the players were competing at the time of the study, (7) report the playing position of the players and the exact time in the season in which the measurements were taken, (8) show all body composition characteristics of the different methods used, as well as the anthropometric and somatotype values, and (9) investigate body composition values through different assessment methods and different playing positions in women's professional soccer.

Based on the observed results and the experience of the authors, it is proposed (1) to have as many equations and assessment methods as possible; (2) to replace parameters such as "ideal weight" with the sum of skinfolds; (3) to rely on guidance values indicated in the scientific literature, as well as on the evolution of the team and/or players during the season; and finally (4) to work with the medical technical staff and the players and exchange information and impressions.

## 5. Conclusions

This systematic review with meta-analysis provides useful information that could help medical technical staff to adequately assess the body composition of male professional soccer players. In conclusion: (1) the somatotype tendency is balanced mesomorphic; (2) the mean Σ6 and Σ8 skinfolds are 52.18 and 59.93 mm, respectively; (3) there are significant differences in the measurement of the height, percentage, and kilograms of FM, and kilograms of FFM, with oscillating values depending on the method and/or formula applied; and (4) there are no significant differences between measurement methods for the calculation of the weight, percentage of FFM, and percentage and kilograms of MM.

**Supplementary Materials:** The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/nu15051160/s1, Table S1: Body composition characteristics of included studies with anthropometry; Table S2: Body composition characteristics of included studies with BIA; Table S3. Body composition characteristics of included studies with DXA; Figure S1. Forest plot of age according to assessment method; Figure S2. Forest plot of height according to assessment method; Figure S3. Forest plot of weight according to assessment method; Figure S4. Forest plot of fat mass kilograms according to assessment method; Figure S5. Forest plot of fat mass percentage according to assessment method; Figure S6. Forest plot of fat-free mass kilograms according to assessment method; Figure S7. Forest plot of fat-free mass percentage according to assessment method; Figure S8. Forest plot of muscle mass kilograms according to assessment method; Figure S9. Forest plot of muscle mass percentage according to assessment method; Figure S10. Forest plot of total body water; Figure S11. Forest plot of bone mineral content; Figure S12. Forest plot of bone mineral density

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## Abbreviations

ACSM: American College of Sports Medicine; AHRQ: Agency for Health Research and Quality; ASRM: Anthropometric Standardization Reference Manual; BIA: bioelectrical impedance analysis; BM: bone mass; BMC: bone mineral content; BMD: bone mineral density; DXA: dual X-ray absorptiometry; FIFA: Fédération Internationale de Football Association; FFM: fat-free mass; FM: fat mass; IBP: International Biological Program; ISAK: International Society for the Advancement of Kinanthropometry; MM: muscle mass; PICO: Population/Intervention/Comparison/Outcomes; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses; REML: restricted maximum likelihood.

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### 3.2. *Differences in Body Composition between Playing Positions in Men's Professional Soccer: A Systematic Review with Meta-Analysis*

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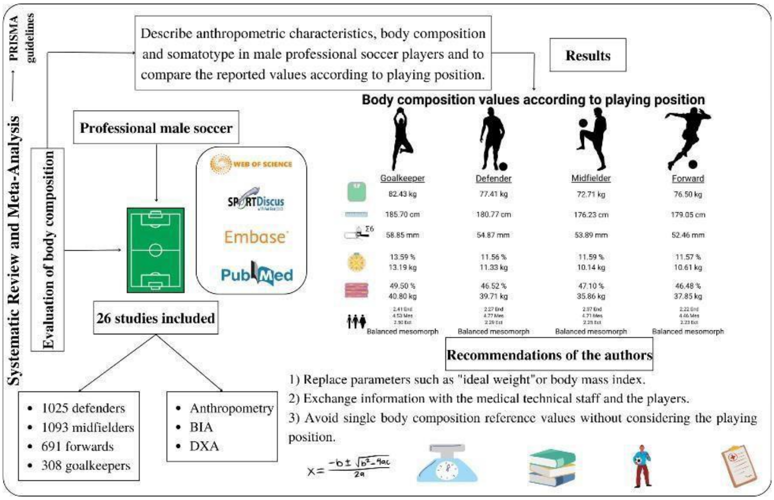
Resumen gráfico:



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MDPI

*Review*

# Differences in Body Composition between Playing Positions in Men's Professional Soccer: A Systematic Review with Meta-Analysis

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**Featured Application: This research shows the results of the body composition of male professional soccer players differentiated by playing positions, which until now had not been analyzed. These results could be a guide for the medical and technical staff when focusing on and individualizing training objectives to achieve maximum performance.**

**Abstract:** The performance of male soccer players (MSPs) depends on multiple factors, such as body composition. It is understandable to think that, due to the physical demands and specific functions during play, body composition may vary depending on the playing position. The aim of this systematic review and meta-analysis was to describe the anthropometric, BC, and somatotype characteristics of professional MSPs and to compare the reported values according to playing position. We systematically searched Embase, PubMed, SPORTDiscus, and Web of Science following the PRISMA statement. Random-effects meta-analysis, a pooled summary of means, and 95% CI (method or equation) were calculated. Random models were used with the Restricted Maximum Likelihood (REML) method. Twenty-six articles were included in the systematic review and the meta-analysis. After comparing the groups according to the playing position (goalkeeper, defender, midfielder, and forward), significant differences were found in age, height, weight, the sum of skinfolds, kilograms of muscle mass, and kilograms of fat-free mass ($p = 0.001$; $p < 0.0001$). No significant differences were observed in fat mass, percentage of fat-free mass, percentage of muscle mass, bone mass, and somatotype. Despite the limitations, this study provides useful information to help medical–technical staff to properly assess the BC of professional MSPs, providing reference values for the different positions.

**Keywords:** soccer; body composition; anthropometry; bioimpedance; DXA



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## 1. Introduction

In soccer, athletes cover an average total distance during a full match (90 min plus added injury time) of around 8–14 km and are characterized by a highly variable pattern of actions such as walking, jogging, running at high and low speeds, sprinting, moving backward, kicking, jumping, or tackling [1–8]. However, the distances covered depend mainly on (i) the time played (linked to substitutions during the match), (ii) the team's style of play, (iii) the number of matches in the same week, or (iv) the different playing positions [8].

Barros et al. [2] observed a greater distance covered by lateral defenders, midfielders, and wingers compared to forwards and central defenders. These results are similar to another study [3], where midfielders and wingers covered greater distances than lateral defenders, forwards, and central defenders after analyzing 20 Spanish league matches and 10 Champions League matches. In addition, goalkeepers during training and matches tend to cover a total distance of around 50% less than other positions [9,10]. It is, therefore, plausible that, due to the physical demands and specific roles during play, body composition may vary according to playing position.

Kineanthropometry is the area of science responsible for measuring the composition of the human body. Changes in nutrition, lifestyle, physical activity, and ethnic composition of populations are some of the factors that can modify body dimensions [11]. In sports (including soccer), the main assessment methods used are anthropometry, bioelectrical impedance analysis (BIA), and dual X-ray densitometry (DXA) [12,13]. The somatotype is another relevant tool in the study of body composition, defined as the quantification of the shape and composition of the human body through the numerical qualification of three components using different anthropometric formulas and measurements [14]. Derived from the somatotype, the somatocarta is a graphic representation expressed in endomorphy, mesomorphy, and ectomorphy (three components). It is useful in the field of sports to be able to situate the somatotype of the athlete being evaluated against the reference somatotype of the sport he/she practices based on a wide collection of data [15]. In soccer, body composition is decisive for reaching an optimal physical level, which can translate into a good level of play, as performance in this sport depends on multiple technical, biomechanical, tactical, mental, and physiological factors [16]. Recently, our research group studied, through a systematic review and meta-analysis, the existing differences in the analysis of body composition in male professional soccer players between different measurement methods (anthropometry, BIA, and DXA) [17]. However, due to the limitations of the study, it was not possible to specify these values between the different playing positions.

The aim of the present systematic review with meta-analysis was to describe anthropometric characteristics, body composition, and somatotypes in male professional soccer players and to compare the reported values according to playing position. Accordingly, it was initially hypothesized that:

**Hypothesis (H1).** *There will be significant differences between the different playing positions, especially in height, weight, skinfold sum, and muscle mass (MM).*

**Hypothesis (H2).** *Goalkeepers have the most different body composition values compared to the rest of the playing positions, with a higher weight, height, skinfold sum, and MM due to their sporting role.*

## 2. Materials and Methods

### *2.1. Type of Study*

A systematic review and meta-analysis were conducted based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) about the evidence on anthropometric characteristics, body composition, and somatotype of professional male soccer players by playing position [18].

### *2.2. Information Sources and Search Strategy*

The databases searched were PubMed-MEDLINE, Embase, SPORTDiscus, and Web of Science. To find the largest number of available articles related to the research aim, the words used in the search strategy were defined considering: (1) soccer (football); (2) anthropometry, body composition, and somatotype; (3) athlete (professional or elite);

(4) the descriptors of the Medical Subjects Headings (MeSH); (5) other terms described in MeSH as "entry terms", which include the terminology prior to the setting-up of the MeSH register; and (6) the terms [tiab] or [Title/Abstract] attached to the "entry terms" or MeSH, which allow the localization of these terms in the title and abstract of the articles.

The words and the search strategy are in Appendix A. The search strategy was adapted for each of the databases through the Polyglot Search of the Systematic Review Accelerator tool (https://sr-accelerator.com/#/polyglot, accessed on 1 February 2023).

The timeframe for the search included studies from the year 2000 until January 2023. Due to the fact that the physical demands of soccer players have evolved over the decades, they are currently more demanding and require different body composition characteristics [19].

### 2.3. Eligibility Criteria

The Participants, Intervention, Comparison, and Outcomes (PICO) criteria for the inclusion and exclusion criteria are shown in Table 1. No limits were placed in relation to the publication status of the study (pre-print, post-print, first online, or final).

**Table 1.** The inclusion criteria applied in the study followed the Population, Intervention, Comparison, and Outcomes (PICO) strategy.

| Population | Intervention | Comparison | Outcomes |
|---|---|---|---|
| Male soccer players who train with the aim of competing or improving their physical performance (excludes physical activity for health or aesthetics).<br>Professional category.<br>Absence of pathologies (healthy subjects). | Anthropometry.<br>Bioimpedance (BIA).<br>Dual X-ray Absorptiometry (DXA). | Playing position. | Anthropometric characteristics: skinfolds, girth, breadth, heights, lengths, body composition, and somatotype.<br>Percentages and values of fat mass, muscle mass, and bone mass. |

The exclusion criteria included: (a) studies published in a language other than Spanish and/or English and (b) narrative, systematic reviews, and/or meta-analyses.

### 2.4. Article Management Process

All the documents found were incorporated into the Zotero citation manager in a separate folder by the database in which they were found. A common folder was created to detect and delete duplicated articles using the software's degree of data overlap. The final database was exported in RIS format to be imported into the article screening system for further processing by the researchers.

### 2.5. Study Selection

All retrieved articles were screened in duplicate. The first screening, based on the title and abstract, was independently conducted in all the studies by two authors (JS-R and JMM-S). During the processes of identifying and screening, a third researcher was consulted (JMS) to determine if the documents that led to discrepancies between authors had to be included or excluded. The articles eligible for a full-text review were then screened by the same authors (JS-R and JMM-S), independently and in duplicate. The rejected articles were then duly identified using the eligibility criterion previously established. Additional reviewers (JMS, NG-G) provided advice when feedback about doubtful documents was required.

### 2.6. Data Extraction

The studies' information was extracted following a blinded and duplicated protocol by two authors (JS-R and JMM-S) using a previously piloted data extraction survey created for this review. The data extraction protocol for this study consisted of the following variables:

- Study: Authors and year of publication.
- Sample size: Number of subjects and playing position.

- Country and competition category: Geographical area and competitive category from which the data comes. The latter was included to differentiate between professional league categories within the same country.
- Time of Season: Included to differentiate values collected between different cycles of a natural season (if specified).
- Measuring instruments: Description of the material used in the evaluation.
- Evaluation method: It was included to differentiate the values collected between the three methods of evaluation of body composition (anthropometry with the protocol used, BIA, and DXA).
- Main results: Kinanthropometric characteristics and values of FM, MM, bone mass (BM), and body water (Supplementary Tables S1–S3).

### *2.7. Study Quality and Data Collection*

Two researchers (JS-R and JMM-S) examined the quality of the studies using the Agency for Health Research and Quality (AHRQ) Methodology Checklist [20]. A third reviewer (JMS) was consulted to resolve discrepancies. A score above 8 was considered a high-quality study. The bias statistic of Egger's [21] was used to assess the risk of bias, and funnel plots were created. When a meta-analysis was based on a small number of studies, the ability of Egger's test to detect bias is limited [22]. Therefore, this test should be performed when there are at least 10 studies included in the meta-analysis [21].

### *2.8. Statistical Analysis*

The meta-analysis was performed with the R software version 3.6.0. Copyright (C) 2019 (R Foundation for Statistical Computing). The meta-analysis was performed for continuous data using sample (n), mean (M), and standard deviation (SD) of each output from each study. Some studies had more than one group and were treated as other subgroups in the analysis. In the random-effects meta-analysis, a pooled summary mean, and 95%CI were calculated. Studies were weighted according to the samples within and between studies. A pooled summary mean and 95% CI were calculated for subgroups (method or equation) in order to compare the differences between groups. Random models using the Restricted Maximum Likelihood Method (REML) were utilized. The heterogeneity was measured using the $I^2$ statistic, considering a high heterogeneity if $I^2 \geq 75\%$. The level of significance adopted was 5% ($p < 0.05$).

## 3. Results

A total of 26 studies were included in this study (Figure 1). The sample comprising the different papers included in the review amounted to a total of 3117 soccer players, being 1025 defenders (combining central defenders and lateral defenders), 1093 midfielders (combining defensive midfielders, central defenders, offensive midfielders, and wingers), 691 forwards, and 308 goalkeepers.

Table 2 shows the qualitative characteristics of the included articles. Figure 2 shows the risk of bias summary: authors' judgments broken down for each risk of bias criterion across all included studies.

In relation to the method of measurement, on 12 occasions, they were based on the use of anthropometry [23–34], six in BIA [35–40], seven in DXA [41–47], and one combined anthropometry and BIA [48].

In relation to the anthropometric measuring instrument, the main one used was the Harpenden picometer (n = 7) [23,24,26,27,31,32,48]. For BIA, the most commonly used model was the Tanita BC 418 MA (n = 3) [37,38,48]. Lastly, the most common DXA machine model was Hologic QDR Series Discovery A (n = 2) [43,44].

Of the 13 articles included where anthropometry was used as a method of evaluation, seven used the International Society for the Advancement of Kinanthropometry protocol (ISAK) [24,25,29,30,32,33,48], one utilized the Anthropometric Standardization Reference Manual (ASRM) protocol [28], one used the International Biological Program

(IBP) protocol [26], one used Sistema de Acreditación en Técnicas Antropométricas (SATA) protocol [34], and the remaining three articles did not specify the protocol applied [23,27,31].

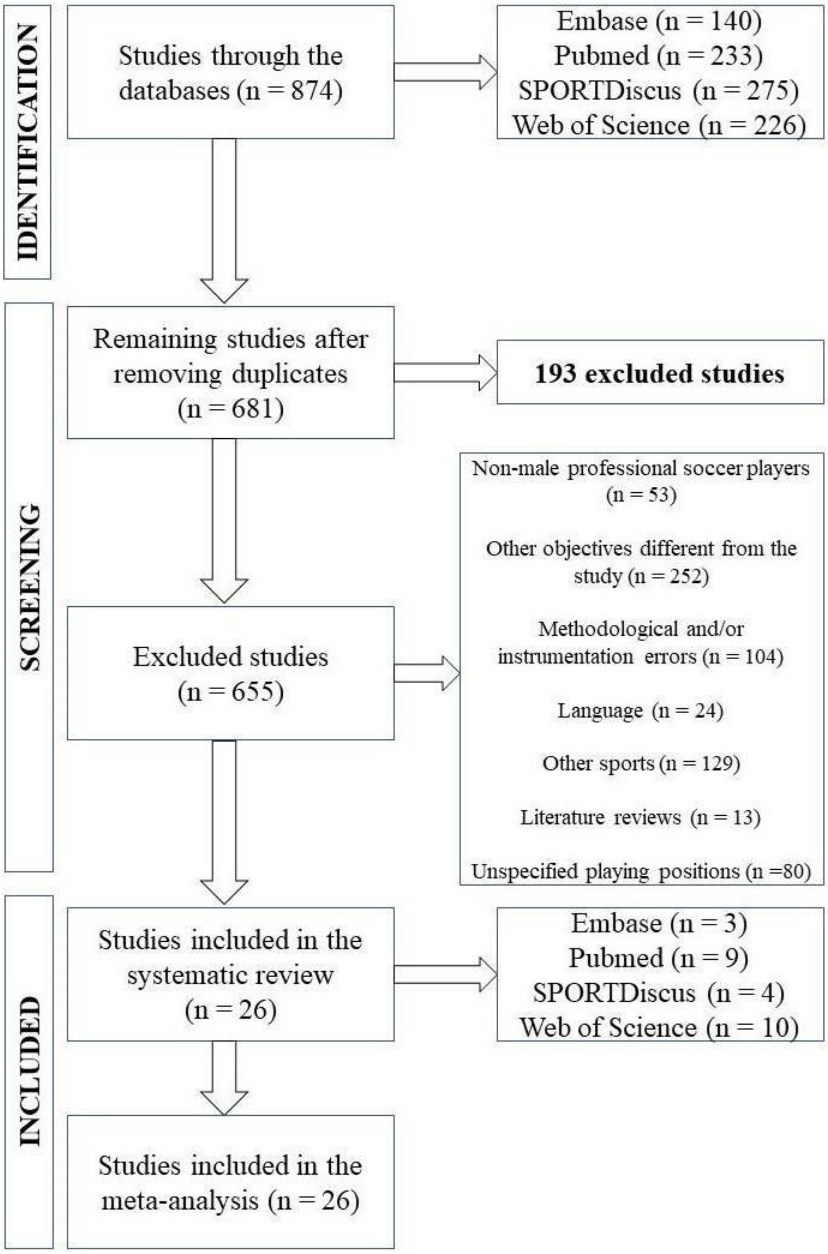


**Figure 1.** Flow diagram showing the process used to select the studies.

As for the sum of skinfolds, the most commonly used formulas were the sum of six skinfolds (triceps, subscapular, supraspinal, abdominal, mid-thigh, and calf) (n = 3) [25,30,33]. Regarding the percentage of FM, none of the seven equations predominated, being present in only one article each. Information on the anthropometric FM equations used in each of the studies is available in the Supplementary Tables S1–S3.

Meta-analysis grouped according to the playing position (1 = goalkeeper; 2 = defender, 3 = midfielder; 4 = forward) is shown in Table 3 and Supplementary Figures S1–S14. The sample had a mean age of 24.4 years old, 180 cm in height, 76.8 kg in weight, 54.56 of the sum of skinfolds, 11.89% of FM, 11.14 kg of FM, 47.01% of MM, 38.59 kg of MM, 64.7 kg of FFM, 2.31 of endomorphy, 2.30 of ectomorphy, 5.06 of mesomorphy, 1.35 for bone mineral density (BMD), and 3.33 for bone mineral content (BMC).

**Table 2.** Descriptive characteristics of the included studies.

| Authors and Year | Sample Size (n) | Age (Years) | Country. Competition Category | Time of the SEA | Measuring Instruments | Evaluation Method |
|---|---|---|---|---|---|---|
| Wittich et al. [45] | T = 42; DEF = 14; CEN = 14; DEL = 14; POR = 4 | 23.2 ± 3.50; 22.0 ± 2.90; 24.0 ± 3.60; 22.0 ± 1.70; - | AR. 1st División | 3 pre-SEAs | GE Lunar DPX-L software 1.33 | DXA |
| Sporis et al. [26] | T = 270; DEF = 80; CEN = 80; DEL = 80; POR = 30 | 28.3 ± 5.90; 27.3 ± 2.30; 25.1 ± 3.10; 24.2 ± 3.20; 31.5 ± 2.30 | HR. Prva HNL | 2 co | BAS Seca, PLI John Bull Caliper | A-IBP |
| Sutton et al. [44] | T = 64; DEF = 20; CEN = 22; DEL = 14; POR = 8 | 26.2 ± 4.00; 26.7 ± 4.40; 26.5 ± 3.90; 25.6 ± 4.30; 25.0 ± 3.30 | EN. Premier League | - | BAS y EST Seca 702, Hologic QDR Series Discovery A software 12:4:3 | DXA |
| Dey et al. [27] | T = 150; DEF = 44; CEN = 48; | 23.3 ± 3.50; 23.1 ± 3.20; 23.3 ± 3.60; 23.2 ± 3.40; 23.3 ± 3.9 | IN. Super League | - | PLI Harpenden | A-n.s. |
| Hazir [28] | T = 305; DEF = 90; CEN = 120; DEL = 56; POR = 39 | SL = 25.7 ± 3.70 FL = 24.1 ± 4.20 | TR. Süper Lig (161) y TFF 1. Lig (144) | 5 beginnings of the transition period for the SEA half | BAS Tanita TBF 401A, EST Holtain, Bicondylar caliper Holtain, PLI Holtain | A-ASRM |
| Boone et al. [23] | T = 289; central DEF = 60; lateral DEF = 82; CEN = 62; DEL = 62; POR = 17 | 25.4 ± 4.90; -; -; -; - | BE. Jupiler Pro League | 2–4 weeks prior to start of SEA | BAS Seca, PLI Harpenden | A-n.s. |
| Henríquez-Olguín et al. [29] | T = 100; central DEF = 17; lateral DEF = 14; deffensive CEN = 18; offensive CEN = 17 DEL = 23; POR = 11 | 23.0 ± 4.40; 24.8 ± 4.00; 23.2 ± 2.60; 23.8 ± 4.90; 23.3 ± 3.8; 23.2 ± 4.5; 23.0 ± 4.4 | CL. Not specified | 2 SEA starts | BAS Tanita TBF 401A, Kit Health & Performance® | A-ISAK |
| Jorquera et al. [30] | T = 406; DEF = 124; CEN = 134; DEL = 93; POR = 48 | -; 25.3 ± 4.80; 25.2 ± 4.70; 23.5 ± 4.10; 25.1 ± 5.50 | CL. 1st División (326) y 1st B (80) | - | BAS Tanita, Kit Gaucho Pro “Mercosur” | A-ISAK |
| Gerosa-Neto et al. [46] | T = 82; DEF = 10; central CEN = 25; lateral CEN = 15; DEL = 22; POR = 10 | 23.6 ± 4.20; 24.8 ± 4.70; 22.7 ± 6.50; 24.0 ± 8.60; 23.6 ± 8.20; 23.5 ± 9.60 | BR. BReirão Serie A | Pre-SEA | BAS Filizola, EST Sanny, GE Lunar DPX-MD software 4.7 | DXA |
| Milanese et al. [42] | T = 29; DEF = 13; CEN = 7; DEL = 5; POR = 4 | 27.5 ± 4.38; -; -; -; - | IT. Serie A | 3 full SEAs | BAS Tanita BWB-800MA, EST Harpenden, QDR Explorer W software 12.6.1 | DXA |
| Milsom et al. [43] | T = 27; DEF = 10; CEN = 9; DEL = 4; POR = 4 | 24.1 ± 3.90; -; -; -; - | EN. Premier League | 3 full SEAs (different periods) | BAS Seca, Hologic QDR Series Discovery A | DXA |

**Table 2.** *Cont.*

| Authors and Year | Sample Size (n) | Age (Years) | Country. Competition Category | Time of the SEA | Measuring Instruments | Evaluation Method |
|---|---|---|---|---|---|---|
| Najafi et al. [31] | T = 60; DEF = 18; CEN = 20; DEL = 14; POR = 8 | 24.3 ± 4.20; -; -; -; - | IR. Iran Pro League y Azadegan League | - | BAS Seca, PLI Harpenden | A-n.s. |
| Sánchez-Ureña et al. [47] | T = 106; central DEF = 21; lateral DEF = 14; CEN = 34; DEL = 22; POR = 15 | 24.5 ± 4.77; 25.0 ± 5.00; 24.9 ± 4.40; 22.5 ± 3.40; 23.4 ± 4.60; 26.4 ± 6.00 | CR. 1st División | - | BAS Tanita HD-313, EST Tanita, GE enCORE 2011 software 13.6 | DXA |
| Semjon et al. [37] | T = 120; central DEF = 18; lateral DEF = 15; central CEN = 24; W = 18; DEL = 34; POR = 11 | -; 27.3 ± 6.20; 26.7 ± 4.80; 25.8 ± 5.30; 25.3 ± 4.20; 24.0 ± 3.06; 26.6 ± 6.50 | RC. Českou fotbalova liga | 6 consecutive pre-SEAs | BAS Leifheit Soehnle 7307, Tanita BC 418 MA | BIA |
| Kafedžić et al. [36] | T = 39; central DEF = 4; lateral DEF = 8; CEN = 14; W = 5; DEL = 8 | 23.5 ± 4.60; 22.3 ± 3.40; 24.9 ± 4.40; 22.1 ± 5.00; 24.4 ± 3.00; 24.6 ± 5.80 | BA. Premier League | 2 pre-SEA starts | Holton Anthropometer, Tanita BC 420SMA | BIA |
| Owen et al. [24] | T = 22; DEF = 8; CEN = 8; DEL = 6 | 24.0 ± 3.70; -; -; - | EU | Start and end pre-SEA, mid-SEA, end mid-SEA transition period, and end SEA | BAS CIRCA, EST CIRCA, Bicondylar caliper Gulick, PLI Harpenden | A-ISAK |
| Rodríguez-Rodríguez et al. [25] | T = 339; DEF = 119; CEN = 133; DEL = 94; POR = 44 | -; 25.3 ± 4.80; 25.2 ± 4.80; 23.5 ± 4.10; 25.1 ± 5.50 | CL. 1st División | - | Kit Gaucho Pro "Mercosur" | A-ISAK |
| Granero-Gil et al. [35] | T = 30; central DEF = 4; lateral DEF = 5; central CEN = 8; lateral CEN = 5; DEL = 8 | 26.5 ± 5.56; 33.7 ± 5.59; 28.3 ± 3.55; 24.2 ± 4.51; 25.0 ± 4.27; 23.7 ± 2.93 | RU. Russian Premier League | During competitive SEA | EST Seca, Tanita SC-240 | BIA |
| McEwan et al. [41] | T = 20; DEF = 7; CEN = 7; DEL = 6 | 25.1 ± 4.10; -; -; - | ES. 1st División | Start and end of two pre-SEAs | GE Lunar | DXA |
| Vega et al. [32] | T = 41; central DEF = 5; lateral DEF = 10; central CEN = 11; lateral CEN = 5; DEL = 7 | - | ES. 1st División y 2nd División | 10 full SEAs | BAS Seca 719, EST Seca 213, PLI Harpenden | A-ISAK |
| Castro Jiménez et al. [48] | T = 24; DEF = 5; CEN = 13; DEL = 4; POR = 2 | 21.0 ± 1.90; -; -; -; - | CO. 1st B | - | BIOInBody 770, EST Seca, Bicondylar caliper Holtain, PLI Harpenden HSK-BI | A & BIA -ISAK |

**Table 2.** *Cont.*

| Authors and Year | Sample Size (n) | Age (Years) | Country. Competition Category | Time of the SEA | Measuring Instruments | Evaluation Method |
|---|---|---|---|---|---|---|
| Hernández-Mosqueira et al. [33] | T = 158; DEF = 46; CEN = 58; DEL = 34; POR = 20 | 24.1 ± 4.70; 25.3 ± 5.20; 24.5 ± 4.90; 23.9 ± 3.90; 22.8 ± 4.80 | CL. 1st División | 5 consecutive pre-SEAs | EST Seca 700, Kit Gaucho Pro "Mercosur" | A-ISAK |
| Moya-Amaya et al. [34] | T = 23; DEF = 6; CEN = 10; DEL = 5; POR = 2 | 24.0 ± 3.25; 23.8 ± 3.25; 23.9 ± 4.23; 25.0 ± 1.58; 23.0 ± 1.41 | IT. Serie A | Half SEA | EST Seca 264, Measuring tape SATA, PLI Slimguide | A-SATA |
| Parpa & Michaelides [38] | T = 308; central DEF = 69; lateral DEF = 53; CEN = 87; W = 41; DEL = 40 | 25.4 ± 4.66; -; -; -; - | EM. 1st División | 2 consecutive pre-SEAs | EST Tanita, Tanita BC418 MA | BIA |
| Stas´kiewicz et al. [40] | T = 38; DEF = 12; CEN = 15; DEL = 6; POR = 5 | 25.9 ± 5.22; 27.5 ± 4.50; 24.1 ± 4.69; 25.5 ± 5.89; 27.8 ± 7.19 | PL. Ekstraklasa | Full SEA | InBody 770 | BIA |
| Stas´kiewicz et al. [39] | T = 38; DEF = 12; CEN = 15; DEL = 6; POR = 5 | 25.89 ± 5.22; 27.5 ± 4.5; 24.13 ± 4.69; 25.5 ± 5.89; 27.8 ± 7.19 | PL. Ekstraklasa | Full SEA | InBody 770 | BIA |

A = Anthropometry; AR = Argentina; ASRM = Anthropometric Standardization Reference Manual; BA = Bosnia and Herzegovina; BAS = Scale; BE = Belgium; BIA: bioimpedance; BR = Brazil; CEN = Midfielders; CL = Chile; CO = Colombia; CR = Costa Rica; DEF = Defenders; DEL = Forwards; DXA: Dual X-ray densitometry; EM = Eastern Mediterranean players; EN = England; ES = Spain; EST = Stadiometer; EU = European players; FL = Turkish 1 Lig; HR = Croatia; IBP = International Biological Program; IR = Iran; IT = Italy; ISAK = International Society for the Advancement of Kinanthropometry; PL = Poland; PLI = Plicometer; POR = Goalkeepers; RC = Czech Republic; RU = Russia; SATA = Sistema de Acreditación en Técnicas Antropométricas; SL = Turkish Süper Lig; T = Total; SEA = Season; TR = Turkey; W = Wingers.

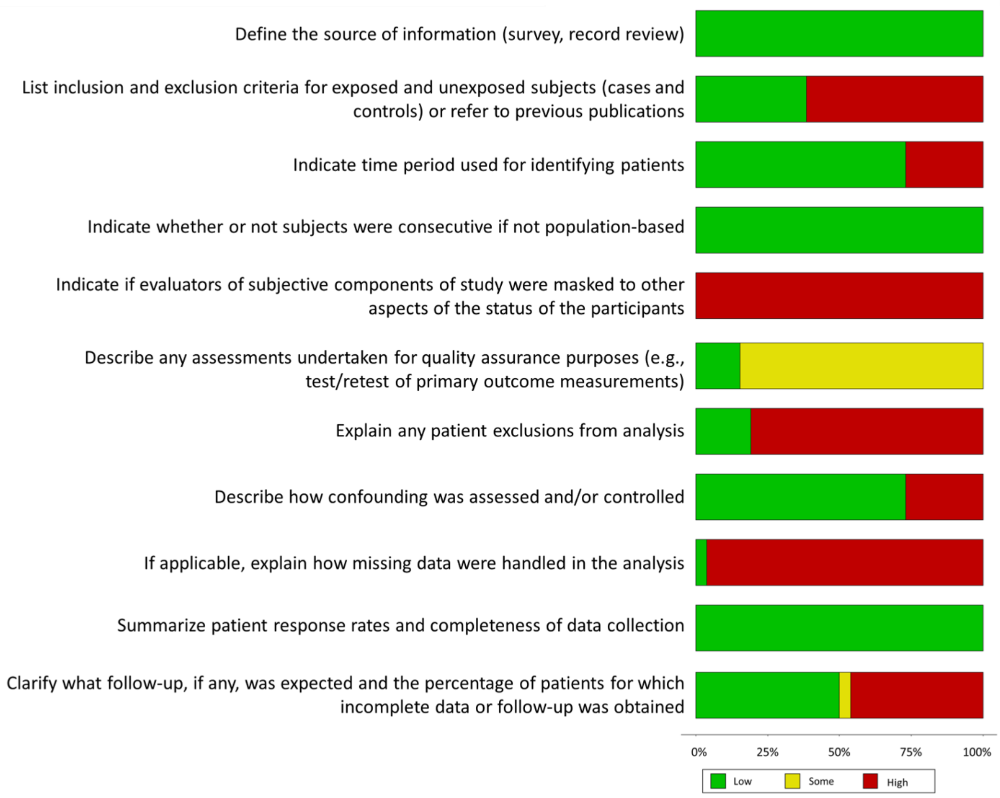


**Figure 2.** Risk of bias summary: authors' judgments broken down for each risk of bias criterion across all included studies.

**Table 3.** Meta-analysis by groups according to the playing position. G = groups; M = mean.

| | Authors | G | M | 95% CI | Weight (%) | M | 95% CI | *p* |
|---|---|---|---|---|---|---|---|---|
| | | | | Age | | | | |
| Goalkeeper | [25–30,33,34,37,39,40,44,46,47] | 16 | 25.7 | 24.2; 27.3 | 17.0 | 24.9 | 24.4; 25.3 | 0.002 |
| Defender | [25–30,33–37,39,40,44–47] | 24 | 25.5 | 24.6; 26.3 | 29.1 | | | |
| Midfielder | [25–30,33–37,39,40,44–47] | 22 | 24.4 | 23.9; 24.9 | 27.7 | | | |
| Forward | [25–30,33–37,39,40,44–47] | 21 | 24.0 | 23.6; 24.4 | 26.2 | | | |
| | | | | Height | | | | |
| Goalkeeper | [23,25–34,37,39,40,43,44,46–48] | 22 | 186 | 184; 188 | 19.1 | 180 | 179; 181 | <0.001 |
| Defender | [23,25–40,43–48] | 34 | 181 | 179; 182 | 29.8 | | | |
| Midfielder | [23,25–40,43–48] | 30 | 176 | 175; 178 | 26.4 | | | |
| Forward | [23,25–40,43–48] | 29 | 179 | 178; 180 | 24.7 | | | |
| | | | | Weight | | | | |
| Goalkeeper | [23,25–34,37,39,40,43,44,46–48] | 22 | 82.4 | 80.2; 84.7 | 18.7 | 76.9 | 75.9; 77.9 | <0.001 |
| Defender | [23,25–41,43–48] | 35 | 77.4 | 75.8; 79.0 | 29.5 | | | |
| Midfielder | [23,25–41,43–48] | 31 | 72.7 | 71.3; 74.1 | 27.4 | | | |
| Forward | [23,25–41,43–48] | 30 | 76.5 | 75.1; 77.9 | 24.4 | | | |
| | | | | Sum of 6 skinfolds | | | | |
| Goalkeeper | [25,30,33] | 3 | 58.9 | 58.3; 59.4 | 19.4 | 54.6 | 54.5; 57.7 | 0.038 |
| Defender | [24,25,30,33] | 4 | 54.9 | 43.0; 66.7 | | | | |
| Midfielder | [24,25,30,33] | 4 | 53.9 | 46.2; 61.6 | 27.6 | | | |
| Forward | [24,25,30,33] | 4 | 52.5 | 41.0; 64.0 | 25.5 | | | |

**Table 3.** *Cont.*

| | Authors | G | M | 95% CI | Weight (%) | M | 95% CI | p |
|---|---|---|---|---|---|---|---|---|
| | | | | Fat mass percentage | | | | |
| Goalkeeper | [23,26,27,31–33,37,39,42–44,46–48] | 14 | 13.6 | 11.5; 15.7 | 15.7 | | | |
| Defender | [23,26,27,31–33,35–39,41–48] | 26 | 11.6 | 10.5; 12.6 | | 11.9 | 11.2; 12.6 | 0.285 |
| Midfielder | [23,26,27,31–33,35–39,41–48] | 22 | 11.6 | 10.1; 13.1 | 26.8 | | | |
| Forward | [23,26,27,31–33,35–39,41–48] | 22 | 11.6 | 10.3; 12.8 | 26.1 | | | |
| | | | | Fat mass kg | | | | |
| Goalkeeper | [25,33,39,42,43,46] | 6 | 13.2 | 8.58; 17.8 | 18.8 | | | |
| Defender | [24,25,33,39,41–43,46] | 8 | 11.3 | 8.12; 14.5 | | 11.1 | 9.77; 15.5 | 0.539 |
| Midfielder | [24,25,33,39,41–43,46] | 9 | 10.1 | 7.35; 12.9 | 29.3 | | | |
| Forward | [24,25,33,39,41–43,46] | 8 | 10.6 | 7.83; 13.4 | 25.9 | | | |
| | | | | Muscle mass percentage | | | | |
| Goalkeeper | [33] | 1 | 49.5 | 48.1; 50.9 | 11.5 | | | |
| Defender | [33,36] | 3 | 46.5 | 41.4; 51.7 | | 47.0 | 45.5; 48.6 | 0.065 |
| Midfielder | [33,36] | 2 | 47.1 | 30.0; 64.2 | 24.1 | | | |
| Forward | [33,36] | 3 | 46.5 | 40.1; 52.9 | 32.8 | | | |
| | | | | Muscle mass kg | | | | |
| Goalkeeper | [25,33,39,48] | 4 | 40.8 | 38.4; 43.2 | 23.5 | | | |
| Defender | [25,33,39,48] | 4 | 39.7 | 36.0; 43.4 | | 38.6 | 37.2; 40.0 | 0.001 |
| Midfielder | [25,33,39,48] | 4 | 35.9 | 32.4; 39.4 | 26.5 | | | |
| Forward | [25,33,39,48] | 4 | 37.9 | 36.2; 39.5 | 24.5 | | | |
| | | | | Fat-free mass kg | | | | |
| Goalkeeper | [39,42,43,46,47] | 5 | 69.1 | 64.1; 74.2 | 17.1 | | | |
| Defender | [24,39,41–43,46,47] | 8 | 65.0 | 59.7; 70.2 | | 64.7 | 62.7; 66.6 | 0.009 |
| Midfielder | [24,39,41–43,46,47] | 8 | 61.9 | 59.3; 64.5 | 29.7 | | | |
| Forward | [24,39,41–43,46,47] | 7 | 64.4 | 60.5; 68.4 | 23.7 | | | |
| | | | | Endomorphy | | | | |
| Goalkeeper | [25,28,29,33,34,48] | 7 | 2.41 | 1.78; 3.04 | 21.3 | | | |
| Defender | [25,28,29,33,34,48] | 8 | 2.27 | 1.94; 2.60 | | 2.31 | 2.13; 2.50 | 0.890 |
| Midfielder | [25,28,29,33,34,48] | 8 | 2.37 | 2.03; 2.71 | 28.2 | | | |
| Forward | [25,28,29,33,34,48] | 7 | 2.22 | 1.72; 2.72 | 23.0 | | | |
| | | | | Ectomorphy | | | | |
| Goalkeeper | [25,28,29,33,34,48] | 7 | 2.50 | 2.18; 2.81 | 19.6 | | | |
| Defender | [25,28,29,33,34,48] | 8 | 2.29 | 2.09; 2.49 | | 2.30 | 2.18; 2.42 | 0.425 |
| Midfielder | [25,28,29,33,34,48] | 8 | 2.25 | 1.94; 2.55 | 29.9 | | | |
| Forward | [25,28,29,33,34,48] | 7 | 2.23 | 1.91; 2.55 | 20.9 | | | |
| | | | | Mesomorphy | | | | |
| Goalkeeper | [25,28,29,33,34,48] | 7 | 4.53 | 4.52; 5.43 | 19.5 | | | |
| Defender | [25,28,29,33,34,48] | 8 | 4.77 | 4.77; 5.37 | | 5.06 | 4.88; 5.23 | 0.963 |
| Midfielder | [25,28,29,33,34,48] | 8 | 4.71 | 4.71; 5.42 | 28.7 | | | |
| Forward | [25,28,29,33,34,48] | 7 | 4.46 | 4.46; 5.83 | 22.0 | | | |
| | | | | Bone mineral density | | | | |
| Goalkeeper | [42,44,46,47] | 4 | 1.35 | 1.21; 1.49 | 22.1 | | | |
| Defender | [42,44,46,47] | 5 | 1.34 | 1.23; 1.45 | | 1.35 | 1.31; 1.39 | 0.983 |
| Midfielder | [42,44,46,47] | 5 | 1.36 | 1.28; 1.45 | 27.4 | | | |
| Forward | [42,44,46,47] | 4 | 1.35 | 1.22; 1.47 | 22.0 | | | |
| | | | | Bone mineral content | | | | |
| Goalkeeper | [42,47] | 2 | 3.47 | −1.36; 8.30 | 22.3 | | | |
| Defender | [42,47] | 3 | 3.39 | 2.07; 4.71 | | 3.33 | 3.01; 3.64 | 0.916 |
| Midfielder | [42,47] | 2 | 3.19 | −0.94; 7.31 | 22.1 | | | |
| Forward | [42,47] | 2 | 3.20 | −0.47; 6.88 | 21.4 | | | |

When comparing the results by playing position, a significant difference was found in age (0 = 0.002), with goalkeepers and defenders being older and forwards being younger; height ($p$ < 0.001), with midfielders being the shortest in height and goalkeepers the tallest; weight ($p$< 0.001), with goalkeepers being the heaviest and midfielders the lightest; skinfold sum ($p$ = 0.038), with the goalkeeper presenting the highest sum, followed by the defenders, midfielders, and forwards; kilograms of MM ($p$ = 0.001), with goalkeepers and defenders showing greater MM and midfielders and forwards showing less MM; and kilograms of FFM ($p$ = 0.009), with goalkeepers having more kilograms of FFM. No significant differences were found for the other variables.

## 4. Discussion

This is the first systematic review with meta-analysis that evaluates body composition in male professional soccer players differentiated by playing positions. The main findings of this study were: (1) goalkeeper is the playing position showing the highest height, age, total weight, sum of six skinfolds, and MM; (2) defender is the position showing the highest age and MM (next to goalkeepers); (3) midfielder has been shown to be the playing position with the lowest height, total weight, and MM; (4) forwards appear to be the youngest, with lower skinfold summation and lower MM (next to midfielders); (5) no significant differences were observed in BMC, BMD, somatotype, weight, and percentage of FM.

### *4.1. Body Composition Values*

In soccer, there are different playing positions with their own demands and characteristics [2,3,9,10,49]; several working groups have tested whether or not there are significant differences in body composition [16,44,50]. While most studies apply a horizontal subdivision for playing positions (goalkeeper, defender, midfielder, and forward), it would be advisable to also make a vertical subdivision (central defender, lateral defender, attacking midfielder, central midfielder, defensive midfielder, and winger) to further specify the anthropometric characteristics, activity profiles, and/or physiological demands of each player [49].

Previously some studies investigated the differences in body composition between different playing positions. In a study of 64 professional players from four different English Premier League teams, body composition was analyzed by DXA, dividing the subjects by playing positions (goalkeeper, defender, midfielder, and forward). Goalkeepers differed from the other positions in both anthropometric and body composition variables, being the tallest (1.90 ± 0.03 m), heaviest (91.2 ± 4.60 kg), and with the highest percentage of FM (12.9 ± 2.00%) [44]. Most recently, Cavia et al. also analyzed the differences between the different playing positions (goalkeeper, defense, midfielder, and forward) in 57 soccer players of the same Spanish league club through anthropometry and BIA. The highest fat percentages were obtained in goalkeepers (9.40 ± 1.40%), followed by defenders (8.00 ± 1.60%) with respect to the rest of the positions (midfielders 7.40 ± 1.30% and forwards 7.70 ± 1.40%) [16]. Ziv & Lidor published a review where they evaluated the physical characteristics and physiological attributes of goalkeepers, highlighting that they are generally taller than 180 cm, with a body weight over 77.0 kg and a percentage of FM around 12.0–14.0% [50]. Lastly, the Union of European Football Associations (UEFA) expert group statement [12] also reported that the goalkeeper was the playing position with the highest values for height, weight, and FM.

In our work, in relation to goalkeeper height and weight, with the exception of one study [27], all show these characteristics [23,25,26,28–32,37,43,44,46–48,51,52]. Although the percentages of FM coincide in several studies [27,31,42,44,48,51], there are exceptions above [23,26,46,47,52] and below the range suggested by Ziv & Lidor [32,37,43,51]. Although the goalkeeper is often attributed as the position with the highest FM, as shown in Table 3, there were no statistically significant differences for both the percentage and weight of FM compared to the other playing positions. However, the sum of six skinfolds, which is correlated with FM, did show statistical differences, with the goalkeeper having the highest sum of skinfolds (58.8 mm). These results could be justified due to the fact that the goalkeeper, during training and especially in matches, in general, travels shorter distances than the rest of the playing positions, so it is reasonable that the goalkeeper is the playing position with the highest sum of skinfolds. In addition, due to their sporting role, they need to have a vertical jump and a developed wingspan in order to block the shots of the opposing team, which would justify the results obtained in relation to height, weight, and muscle mass [9,10,12,50].

In the case of the defenders, they appear to be in the position with the highest total weight and MM together with the goalkeepers. This makes sense because, due to their role in the game, it is a very physical position in which they must stop attackers by intercepting plays both on the ground and in the air and initiate offensive plays on many occasions. Midfielders are the shortest and lightest, as well as showing similar values to forwards in MM and FM. This body composition is justified in order to favor agility and speed during the game, especially in counter-attacking plays, being the main roles of midfielders and forwards (although this role may vary depending on the strategic alignment of the team, the coach's style of play, etc.) [2,3,8,53].

### 4.2. Somatotype Values

In relation to somatotype, Cavia et al. [16] analyzed the somatotype between playing positions, where goalkeepers (endomorphy 2.80 ± 0.60, mesomorphy 4.80 ± 1.30, and ectomorphy 2.30 ± 0.70) and forwards (endomorphy 2.10 ± 0.40, mesomorphy 4.50 ± 0.90, and ectomorphy 2.60 ± 0.90) presented a balanced mesomorphic somatotype similar to that described in other studies [54], while midfielders (endomorphy 2.20 ± 0.60, mesomorphy 4.30 ± 0.90, and ectomorphy 2.80 ± 0.60) and defenders (endomorphy 2.20 ± 0.40, mesomorphy 4.50 ± 0.50, and ectomorphy 2.90 ± 0.40) maintained an ecto-mesomorphic profile. However, in one of the studies included in our work, somatotype by playing position was also evaluated in a sample of 23 professional soccer players from the Italian league, although on this occasion, no significant differences were observed [34]. In our work, no significant differences were observed between the different playing positions, with mean values of endomorphy 2.31, mesomorphy 5.06, and ectomorphy 2.30, resulting in a balanced mesomorph somatotype, similar to the result obtained in the first study of our research group [17].

### 4.3. Models and Equations to Estimate Body Composition

All the methods to estimate body composition have advantages and defects, and sports-health professionals have to choose methods with a better benefit-to-cost ratio [55]. The anthropometric method is easy, inexpensive, easy to transport, and quick to apply. This method also has sufficient validity and reliability to be considered a useful tool in the assessment of FM in the athlete population [56], but the reliability can be affected by the error introduced by the researcher (varying between 3.0% and 11.0% between a trained/expert and untrained/expert researcher) [57,58]. One of the problems of the anthropometry method is the existence of multiple equations to estimate body composition, mainly FM [57,59]. Equations for estimating FM commonly assume a constant value for the density of FM and free FM [53,57]. While using a constant value for fat mass is generally accepted, free FM has been shown to be influenced by age, gender, and race, which introduces another potential source of bias [60,61]. Additionally, while several equations have been validated to estimate FM, only Kerr□s equation has been validated using a direct method, whereas the others were validated using indirect methods [62]. Therefore, it is possible that there may be errors in estimating FM using these equations. Kerr's equation allows the estimation of subcutaneous adipose tissue, which considers adipose tissue, including in its estimation of other non-lipid components (such as water and proteins) that are part of adipocytes [59,62].

Therefore, the use of the sum of skinfolds is effective, especially considering that other methods are affected by factors that are difficult to control and standardize, especially in the clinical setting, such as food intake, hydration levels, or daily physical activity [63,64].

Another problem is the level of fractionation of body composition used, specifically the adipose component. There is confusion in using the terms fat, lipids, and adiposity as synonyms when they are not [57]. There are five different levels to understanding how body mass is composed. The first model looks at the number of different atoms, including hydrogen, carbon, oxygen, nitrogen, calcium, phosphorus, and others. The second model considers body mass in terms of the different types of molecules it contains, including lipids, water, proteins, carbohydrates, and minerals. The third model takes into account the different types of matter that make up the body's cells, including fat, water, and solids. The fourth model looks at body mass in terms of different types of tissues, such as adipose tissue, muscle, bone, and connective tissue. Finally, the fifth model considers the body as a whole and breaks it down into different segments, such as the head, trunk, and limbs, to understand how mass is distributed throughout the body [57,59,65]. The anthropometric method is possible to approach adiposity using molecular and tissue models [53,57].

In conclusion, for the first time to our knowledge, it has been possible to establish indicative reference values for the different body compartments (Figure 3).

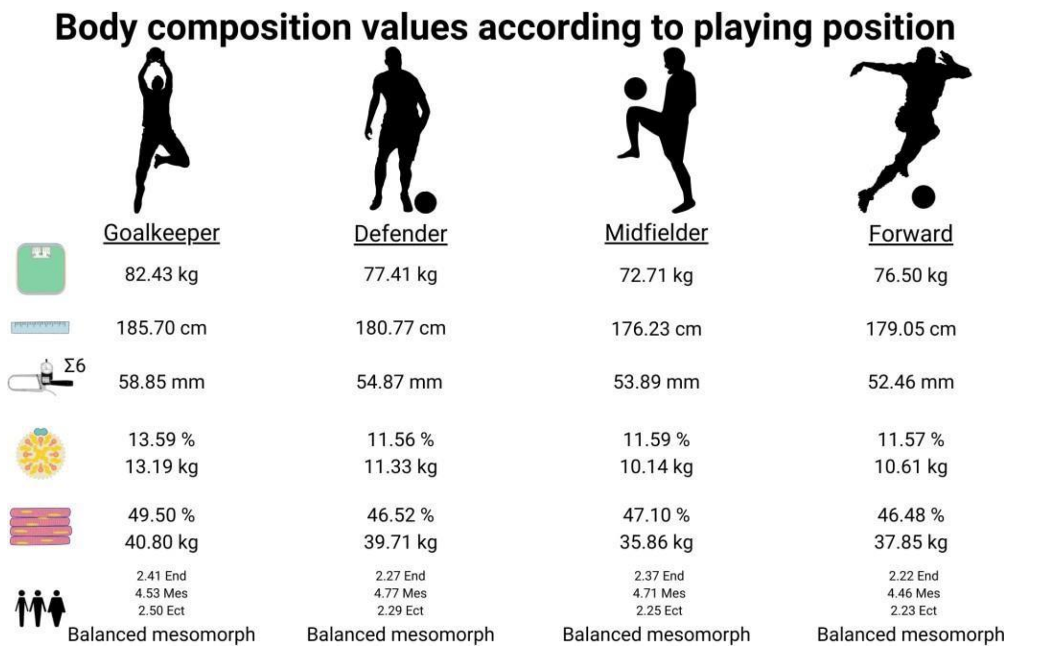


**Figure 3.** Body composition values differentiated by playing position (Weight, height, sum of six skinfolds (triceps, subscapular, supraspinal, abdominal, mid-thigh, and calf), fat mass percentage and kilograms, muscle mass percentage and kilograms, somatotype). End = endomorphy; Mes = mesomorphy; Ect = ectomorphy.

### 4.4. Limitations

This study has limitations. In the first place, the existing heterogeneity in the equations for estimating body composition using the anthropometric method, moments of the season in which the assessment is performed, playing positions, and measuring instruments to evaluate the different body components make it difficult to compare the results. In addition, not all the studies that used the anthropometric method detail the measurement protocol applied, so the methodology and evaluators could be biased. On the other hand, although for the anthropometry section, we excluded certain measurement instruments that were not valid for the ISAK protocol, we did not apply any limiting criteria for the BIA and DXA instruments. This is important since, for example, there is a risk of unifying tetrapolar and octapolar BIA values, as well as monofrequency and multifrequency. In addition, it would have been interesting to incorporate total body water data by playing position, but only one study or none described these body composition values. In a recent publication by the authors [17], the total body water values can be observed without differentiating by playing position. Another limitation is that, although data collection was limited to male professional soccer players, not all countries show the same soccer level, with some countries having higher Fédération Internationale de Football Association (FIFA) rankings than others [66]. Although it is true that they are all professional soccer players, they do not show the same degree of professionalism in terms of economic level, sports facilities, and physical demands, which could affect many factors that could influence their body composition and sports performance. Finally, due to the limited number of studies included, the body composition values of anthropometry, BIA, and DXA were unified. This may affect the usefulness of FM, MM, and FFM values, as body composition values obtained through the different measurement instruments do not always show a high correlation [53,57,67,68]. However, the usefulness of the sum of skinfolds and somatotype as values exclusive to anthropometry, BMC, and BMD as they are specific to DXA, and age, height, and total weight as parameters that do not require specific equations, do not show any limitation when using them as reference values.

Despite all this, it is the only study currently found in the scientific literature that provides a complete description of body composition differentiated by the different playing positions. Based on the current situation, our work aims to be the first study to suggest indicative ranges of anthropometric values, FM, MM, and BM, in detail in the different playing positions of men's professional soccer.

### *4.5. Future Research and Practical Application*

The importance of assessing WM, BM, and body water and their relationship with sports performance has increased in recent years; studies continue to focus on total weight and FM. For future studies, it is recommended to (1) specifically describe the procedures, protocols, and variables applied when performing the measurements; (2) specify the reliability, calibration of the measuring instruments, and the technical error of measurement; (3) clearly control and report the state of hydration and nutrition before the measurement; (4) to indicate the competitive level of the sample by reporting the country and/or region and the competition league name at the time of the study; (5) report the playing position and the exact time of the season in which the measurements were taken; (6) show all the body composition characteristics of the different methods used, as well as the anthropometric and somatotype values; (7) to evaluate the body composition at the tissue level (fractionation in five components) at different times of the season; and (8) to characterize kinanthropometrically (heights, breadths, and lengths) according to the playing position. All this will allow us to relate, compare, and differentiate the kinanthropometric profile of the player depending on the playing position, physical characteristics, level of competition, and sports performance.

## 5. Conclusions

This systematic review with meta-analysis provides useful information to help medical–technical staff to adequately assess the body composition of male professional soccer players, concluding that: (1) the goalkeeper is the playing position that shows the greatest height, age, total weight, sum of skinfolds, and MM; (2) defender is the position that shows the greatest age and MM (like goalkeepers); (3) the midfielder has shown to be the playing position with the lowest height, total weight, and MM; (4) the forwards seem to be the youngest, with the lowest sum of skinfolds and the lowest MM (like midfielders); (5) no significant differences were observed in BMC, BMD, somatotype, weight, and FM percentage.

**Supplementary Materials:** The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/app13084782/s1, Table S1: Body composition characteristics of included studies with anthropometry by playing position; Table S2: Body composition characteristics of included studies with BIA by playing position; Table S3. Body composition characteristics of included studies with DXA by playing position; Figure S1. Forest plot of age according to playing position; Figure S2. Forest plot of height according to playing position; Figure S3. Forest plot of weight according to playing position; Figure S4. Forest plot of the sum of skinfold according to playing position; Figure S5. Forest plot of fat mass percentage according to playing position; Figure S6. Forest plot of fat mass kilograms according to playing position; Figure S7. Forest plot of muscle mass percentage according to playing position; Figure S8. Forest plot of muscle mass kilograms according to playing position; Figure S9. Forest plot of fat-free mass kilograms according to playing position; Figure S10. Forest plot of endomorphy according to playing position; Figure S11. Forest plot of mesomorphy according to playing position; Figure S12. Forest plot of ectomorphy according to playing position; Figure S13. Forest plot of bone mineral density according to playing position; Figure S14. Forest plot of bone mineral content according to playing position.

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## Abbreviations

AHRQ: Agency for Health Research and Quality; ASRM: Anthropometric Standardization Reference Manual; BIA: Bioelectrical impedance; BM: Bone mass; BMC: Bone mineral content; BMD: Bone mineral density; DXA: Dual X-ray densitometry; FIFA: Fédération Internationale de Football Association; FFM: Fat-free mass; FM: Fat mass; IBP: International Biological Program; ISAK: International Society for the Advancement of Kinanthropometry; MM: Muscle mass; PICO: Population/Intervention/Comparison/Outcomes; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses; REML: Restricted Maximum Likelihood; SATA: Sistema de Acreditación en Técnicas Antropométricas; UEFA: Union of European Football Associations.

## Appendix A

Words and search strategy in PubMed: (“Soccer” [Mesh] OR “soccer player” [Title/Abstract] OR “fútbol” [Title/Abstract] OR “soccer” [Title/Abstract] OR “football” [Title/Abstract]) AND (“Anthropometry” [MeSH] OR “Anthropometry” [Title/Abstract] OR “Body composition” [MeSH] OR “Body composition” [Title/Abstract] OR “Skinfolds” [Title/Abstract] OR “Skinfold Thickness” [MeSH] OR “Somatotypes” [Mesh] OR “Somatotypes” [Title/Abstract] OR “Body Build” [Title/Abstract] OR “Body Type” [Title/Abstract] OR “Endomorph” [Title/Abstract] OR “Mesomorph” [Title/Abstract] OR “Ectomorph” [Title/Abstract] OR “Absorptiometry, Photon” [Mesh] OR “Absorptiometry, Photon” [Title/Abstract] OR “Electric Impedance” [Mesh] OR “Electric Impedance” [Title/Abstract] OR “Bioimpedance” [Title/Abstract] OR “DXA” [Title/Abstract] OR “Dual Energy X-ray Absorptiometry” [Title/Abstract]) NOT (“youth” [Title/Abstract] OR “young” [Title/Abstract] OR “semi-professional” [Title/Abstract] OR “amateur” [Title/Abstract] OR "collegiate" [Title/Abstract] OR "pre-adolescent" [Title/Abstract] OR "recreational" [Title/Abstract] OR "adolescent" [Title/Abstract] OR "junior" [Title/Abstract] OR "referee" [Title/Abstract] OR "referees" [Title/Abstract] OR "gaelic" [Title/Abstract] OR "rugby" [Title/Abstract] OR "american football" [Title/Abstract] OR "female" [Title/Abstract] OR "women" [Title/Abstract]) AND ("professional" [Title/Abstract] OR "elite" [Title/Abstract]).

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### 3.3. *Dietary Habits of Elite Soccer Players: Variations According to Competitive Level, Playing Position and Sex*

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# Dietary Habits of Elite Soccer Players: Variations According to Competitive Level, Playing Position and Sex

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**Abstract:** Soccer is a sport practiced worldwide by both men and women, where nutrition plays a fundamental role in the performance of soccer players, providing them with the nutrients necessary for energy, muscle recovery and injury prevention. The aim of this study is to describe the dietary habits in elite soccer players and their association with their competitive level, playing position and sex. A descriptive and non-experimental comparative study was conducted during the 2021–2022 competitive season. A total of 105 players belonging to a Spanish elite soccer team completed a food frequency questionnaire (FCFQ). It was observed that male players presented a higher consumption of carbohydrate-rich foods ($p < 0.05$), fermented foods ($p = 0.014$), frozen foods ($p = 0.049$) and red meat ($p = 0.012$) compared to female players, with the exception of lean meats, which were higher in females ($p = 0.012$). Furthermore, the U16-15 categories stand out for consuming carbohydrate-rich foods such as pasta ($p = 0.000$), bread ($p = 0.004$) and sweets ($p = 0.046$), as well as frozen foods ($p = 0.002$). Finally, alcohol consumption is higher in the senior categories (42.9%), where men are more likely to drink mixed drinks (6.2%), and beer and wine by women (10.7%). Practically no differences were found between the playing positions. In conclusion, differences were found in FCFQ according to competitive level and sex.

**Keywords:** proteins; football; food; soccer; sport nutrition; carbohydrates; dietary fats

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## 1. Introduction

Soccer is a team sport played by men and women in constant evolution, as it has experienced an increase in the physical and technical demands, as well as increased economic implications of winning or losing [1]. It consists of 22 male or female players on the field, grouped into two teams of 11 members, that confront each other with the aim of scoring a goal [2]. During training sessions and matches, players engage in a wide range of activities, which encompass both low- and high-intensity efforts. These activities include intermittent exercises of extended duration, such as walking, jogging, running at various speeds (both high and low), sprinting, moving in reverse, kicking, jumping, and tackling [1]. Moreover, studies have determined that, on average, players exhibit an oxygen uptake of approximately 70% of their maximum capacity during a match, with heart rates typically maintained at around 85% of their maximum levels [1,3]. There are two main categories: the base and the professional one, with the base category (U19-10) being the one played by young people before reaching the professional leagues (1st and 2nd in Spain) [4]. It is well known that body composition [5–7], as well as hydration, healthy eating habits and supplementation [3,8,9], are associated with physical performance among elite athletes. Understanding how these factors, along with playing position, may influence the nutritional intake of soccer players is essential for the design of nutrition education programs.

A study that analyzed the distance covered by soccer players found that wide defenders, central midfielders and wide midfielders covered a greater distance than center forwards, meanwhile the distance covered by center forwards was greater than central defenders' distance [10]. Moreover, the intensity used to cover this distance also changes from one position to another, with the wide defenders, center forwards and wide midfielders being the ones who performed the greatest number of runs at very high intensity [11]. In addition, it has recently been observed that, depending on the playing position, the soccer player shows different body composition characteristics [7]. These results imply that individual differences in playing style need to be taken into account when planning nutritional and training strategies [12].

As mentioned above, nutrition plays a huge role in providing athletes the energy they require to meet their physical demands [3,8]. In addition, young athletes are in a phase of growth, development and dealing with body changes [13,14], which can be a great opportunity to promote healthy behaviors towards physical activity and diet, since these behaviors will continue into adulthood and impact long-term health and weight [15,16]. A few studies [17–19] that assessed the eating habits of professional male and female soccer players found that their nutrition intake was inadequate to sustain optimized performance throughout training and match play. This meta-analysis [20] gave an insight into the development of a macronutrient diet in senior and junior soccer players, finding a higher protein intake than the recommended and a carbohydrates (CHO) intake below the recommendations.

This other study that assessed the eating habits of junior soccer players showed a deficit in nutrient-rich foods, especially vegetables and fruits, and an excessive consumption of low-nutrient foods, highlighting above all the consumption of alcoholic beverages and soft drinks [21]. Those are valid reasons to think that nutrition education interventions are needed in team sports [22], since it has been shown that increasing an athlete's nutrition knowledge can optimize physical performance [19,23,24] and lead to better dietary behaviors [25]. In this matter, there are several intervention tools that can be used to promote healthy eating behaviors in soccer players (i.e., posters, web apps, through activities), but the combination of a poster and a web app seems to be the most practical one in terms of providing the right information and helping them maintain those habits [26].

Lastly, the COVID-19 pandemic affected both daily training and absence from competitions, highlighting the importance of adjusting players' dietary habits and eating patterns in order to preserve both their optimal health and performance in a context characterized by constant change [27,28].

Despite the fact this sport is widely practiced and accepted in our society, there is limited evidence about the eating habits of minors who play soccer and further differentiating between males and females. Therefore, the aim of this study is to describe the eating habits in elite soccer players and their association with their competitive level, playing position and sex. Accordingly, the following was initially hypothesized:

**Hypothesis (H1).** *Dietary habits will be similar among the different playing positions.*

**Hypothesis (H2).** *Dietary quality will be worse in the lower categories compared to the senior categories.*

**Hypothesis (H3).** *Men will consume more CHO, while women will consume more foods rich in healthy fats and lean proteins.*

## 2. Materials and Methods

### 2.1. Type of Study

This is a descriptive, cross-sectional and non-experimental study of dietary habits in elite soccer players of both sexes belonging to the Valencia C.F. Academy. The assessment was made in the month of May during the competitive season 2021–2022. The sample size calculation was performed with Rstudio software (version 3.15.0, Rstudio Inc., Boston, MA, USA). The significance level was set a priori at $p = 0.05$. The standard deviation (SD) was set according to the total SS data from previous studies on elite Spanish athletes (DE = 2.1) [29]. With an estimated error (d) of 0.49, the sample size needed was 70 athletes. The study population was selected by non-probabilistic, non-injury, convenience sampling among elite soccer players of both sexes belonging to the Valencia C.F. Academy.

### 2.2. Participants

A total of 100% of the Valencia Mestalla (n = 21), Juvenil A (n = 22), Juvenil B (n = 23), Cadete A (n = 32), Cadete Fundacions (n = 33), Valencia CF Femenino (n = 15) and Valencia CF Femenino B (n = 13) templates were included for the food consumption frequency questionnaire (FCFQ). However, as it was a voluntary questionnaire, it was finally completed by 110 of 159 soccer players (69.2%) (13 Valencia Mestalla players, 17 Juvenil A players, 16 Juvenil B players, 17 Cadete A players, 18 Cadete Fundacions players and all Valencia CF Femenino players (15) and Valencia CF Femenino B players (13)). All players had at least 4 years of soccer training experience and performed from 4 up to 7 regular training sessions per week (approximately 90 to more than 120 min per day), playing a theoretical official soccer match per week. The criteria for inclusion in this study were as follows: (a) be a healthy subject with medical authorization for the practice of federated sport; (b) belong to a team Valencia C.F. Academy; (c) being federated in soccer; (d) training a minimum of 4 days per week. The exclusion criteria for this study were as follows: (a) having been injured or having become ill during this study. Food portion size was estimated using photographs of a standardized portion, as well as an exact amount in grams or mL.

### 2.3. Procedure

In order to select the sample, the Valencia C.F. Academy sent a statement informing players of the execution of this study, instructions and inviting resident and non-resident players to collaborate. Before the players filled out/completed the questionnaire, subjects were informed about the purpose of this study. Informed consent was obtained and signed by those responsible for this study, as well as by the medical and coaching staff of the Valencia C.F. Academy. Each participant and their respective parents or legal guardians also signed it. The questionnaire was delivered electronically through a Google Form. The protocol complies with the Declaration of Helsinki for human research and is approved by the Ethics Committee of the University of Valencia (1534145).

### 2.4. Instruments

This study utilized a questionnaire that had been previously used in similar studies [21,30,31]. The selected questionnaire was validated for content, applicability, structure and presentation by University College Dublin and Crème Software Ltd., (Food4Me FFQ). It is a self-administered, online and semiquantitative food frequency questionnaire [32], with its Spanish version prepared by Bejar LM and collaborators [33]. It contains a total of 24 questions divided into two main sections. The first section collects the age, the team in which the subject plays (which identifies the subject's sex) and the playing position. This section consists of 3 questions. The second section includes 21 questions that collated the consumption of several food and beverage groups over the previous month (average consumption of 157 food items): fruits, vegetables, pulses, white fish, blue fish, white meat, red meat, soft drinks and juices, sweets and 'snacks', 'fast food', and alcohol (beer, wine, mixed drinks, etc.). Frequency of consumption was measured by selecting one of the following options: never or less than once a month, 1–3 times a month, once a week, 2–4 times a week, 5–6 times per week, once a day, 2–3 times per day, 5–6 times per day, and >6 times per day.

The questionnaire can be found in the Supplementary Material section.

### *2.5. Statistical Analysis*

The Kolmogorov–Smirnov normality test was performed to evaluate that all variables had a normal distribution. Kurtosis was also evaluated and Mauchly's test of sphericity was performed to test the hypothesis of sphericity. Given the normal distribution of the data and with the aim of analyzing the frequency of food group and alcohol consumption, the chi-square test ($\chi^2$) was performed, segmenting the sample according to sex, category and playing positions. The minimum level of statistical significance was set at $p < 0.05$. All data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 25.0 (IBM, Armonk, NY, USA).

## 3. Results

Table 1 shows the frequency of food consumption according to category. Significant differences were found for the consumption of pasta ($p$ = 0.000), bread ($p$ = 0.004), chicken and turkey ($p$ = 0.042), eggs and egg products ($p$ = 0.040), red meat ($p$ = 0.035), sweets ($p$ = 0.046) and prepared or frozen foods ($p$ = 0.002). It was observed that cadets had a higher consumption of pasta, bread, sweets and prepared or frozen foods, but a lower consumption of chicken and turkey, while juveniles were the category with the highest consumption of eggs and their derivatives and red meat. In relation to the different playing positions, significant differences were only found for red meat consumption ($p$ = 0.012), with a higher consumption by forwards.

Table 2 shows the frequency of food consumption according to sex. Significant differences were found for the consumption of fruits ($p$ = 0.022), legumes ($p$ = 0.001), pasta ($p$ = 0.000), rice ($p$ = 0.014), chicken and turkey ($p$ = 0.012), red meat ($p$ = 0.012), fermented foods ($p$ = 0.014) and prepared or frozen foods ($p$ = 0.049). In all these food groups, and with the exception of chicken and turkey consumption, it was observed that men had a higher consumption than women, while for chicken and turkey consumption, it was women who had a higher consumption.

Table 3 shows the frequency of alcohol consumption according to category. Significant differences were found for the question of whether or not they consumed alcohol ($p$ = 0.000), showing that the frequency increased as the category increased, with the senior category consuming the most. Significant differences were also found for the type of alcohol consumed ($p$ = 0.000), with juniors drinking more mixed drinks and seniors drinking more beer and wine. In relation to the different playing positions, significant differences were found for the question of whether or not they consumed alcohol ($p$ = 0.028), with goalkeepers (30%) and midfielders (27.6%) consuming the most. Significant differences were also found for the type of alcohol consumed ($p$ = 0.034), with beer being the most consumed by goalkeepers, and combined drinks and beer the most consumed by midfielders.

Table 4 shows the frequency of alcohol consumption according to sex. Significant differences were only found for the type of alcohol consumed ($p$ = 0.024), with women consuming more beer and wine, and men consuming more mixed drinks.

**Table 1.** Frequency (%) of food group consumption by soccer players of different competitive levels.

| Items | Category (%) | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | U16-15 (n = 35) | | | | | | U19-17 (n = 46) | | | | | | Senior (n = 28) | | | | | | |
| | <1 Week | 1–2 Week | 3–4 Week | 5–6 Week | 1–2 Day | ≥3 Day | <1 Week | 1–2 Week | 3–4 Week | 5–6 Week | 1–2 Day | ≥3 Day | <1 Week | 1–2 Week | 3–4 Week | 5–6 Week | 1–2 Day | ≥3 Day | *p* |
| Fruits | 0.0 | 2.9 | 8.6 | 25.7 | 57.1 | 5.7 | 2.2 | 0.0 | 15.2 | 28.3 | 39.1 | 15.2 | 0.0 | 10.7 | 21.4 | 25.0 | 35.7 | 7.1 | 0.228 |
| Vegetables | 2.9 | 17.1 | 28.6 | 22.9 | 28.6 | 0.0 | 0.0 | 15.2 | 26.1 | 21.7 | 28.3 | 8.7 | 0.0 | 3.6 | 17.9 | 25.0 | 46.4 | 7.1 | 0.397 |
| Vegetables rich in nitrates | 28.6 | 22.9 | 31.4 | 17.1 | 0.0 | 0.0 | 19.6 | 28.3 | 28.3 | 13.0 | 10.9 | 0.0 | 21.4 | 35.7 | 32.1 | 3.6 | 7.1 | 0.0 | 0.441 |
| Legumes | 2.9 | 65.7 | 28.6 | 2.9 | 0.0 | 0.0 | 4.3 | 56.5 | 34.8 | 4.3 | 0.0 | 0.0 | 17.9 | 53.6 | 21.4 | 7.1 | 0.0 | 0.0 | 0.246 |
| Tubers | 2.9 | 34.3 | 48.6 | 14.3 | 0.0 | 0.0 | 4.3 | 23.9 | 45.7 | 21.7 | 4.3 | 0.0 | 3.6 | 21.4 | 50.0 | 17.9 | 7.1 | 0.0 | 0.834 |
| Pasta | 0.0 | 11.4 | 42.9 | 37.1 | 8.6 | 0.0 | 0.0 | 13.0 | 56.5 | 21.7 | 8.7 | 0.0 | 14.3 | 46.4 | 21.4 | 14.3 | 3.6 | 0.0 | 0.000 |
| Rice | 0.0 | 45.7 | 31.4 | 17.1 | 5.7 | 0.0 | 0.0 | 45.7 | 41.3 | 8.7 | 4.3 | 0.0 | 14.3 | 50.0 | 21.4 | 10.7 | 3.6 | 0.0 | 0.056 |
| Bread | 11.4 | 17.1 | 31.4 | 20.0 | 20.0 | 0.0 | 23.9 | 19.6 | 15.2 | 17.4 | 19.6 | 4.3 | 60.7 | 10.7 | 3.6 | 14.3 | 10.7 | 0.0 | 0.004 |
| Whole grains | 8.6 | 20.0 | 28.6 | 17.1 | 25.7 | 0.0 | 17.4 | 28.3 | 21.7 | 4.3 | 26.1 | 2.2 | 25.0 | 28.6 | 17.9 | 7.1 | 21.4 | 0.0 | 0.503 |
| Chicken/turkey | 0.0 | 22.9 | 45.7 | 17.1 | 14.3 | 0.0 | 0.0 | 15.2 | 39.1 | 41.3 | 4.3 | 0.0 | 7.1 | 7.1 | 53.6 | 21.4 | 10.7 | 0.0 | 0.042 |
| Eggs and egg products | 0.0 | 34.3 | 45.7 | 8.6 | 8.6 | 2.9 | 4.3 | 17.4 | 30.4 | 34.8 | 13.0 | 0.0 | 0.0 | 42.9 | 17.9 | 28.6 | 10.7 | 0.0 | 0.040 |
| Fish | 8.6 | 40.0 | 37.1 | 8.6 | 5.7 | 0.0 | 8.7 | 39.1 | 39.1 | 13.0 | 0.0 | 0.0 | 7.1 | 35.7 | 50.0 | 3.6 | 3.6 | 0.0 | 0.755 |
| Red meat | 8.6 | 45.7 | 34.3 | 2.9 | 8.6 | 0.0 | 6.5 | 39.1 | 41.3 | 10.9 | 2.2 | 0.0 | 25.9 | 37.0 | 25.9 | 0.0 | 3.7 | 7.4 | 0.035 |
| Nuts | 22.9 | 25.7 | 20.0 | 8.6 | 22.9 | 0.0 | 26.1 | 30.4 | 17.4 | 15.2 | 10.9 | 0.0 | 21.4 | 25.0 | 10.7 | 35.7 | 7.1 | 0.0 | 0.189 |
| Fermented foods | 2.9 | 37.1 | 20.0 | 28.6 | 11.4 | 0.0 | 8.7 | 34.8 | 17.4 | 26.1 | 13.0 | 0.0 | 25.0 | 21.4 | 35.7 | 10.7 | 7.1 | 0.0 | 0.070 |
| Soft drinks | 45.7 | 37.1 | 14.3 | 2.9 | 0.0 | 0.0 | 76.1 | 19.6 | 2.2 | 2.2 | 0.0 | 0.0 | 78.6 | 17.9 | 3.6 | 0.0 | 0.0 | 0.0 | 0.052 |
| Pastries | 37.1 | 54.3 | 8.6 | 0.0 | 0.0 | 0.0 | 67.4 | 30.4 | 2.2 | 0.0 | 0.0 | 0.0 | 57.1 | 42.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.046 |
| Frozen foods | 40.0 | 51.4 | 8.6 | 0.0 | 0.0 | 0.0 | 69.6 | 30.4 | 0.0 | 0.0 | 0.0 | 0.0 | 82.1 | 17.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.002 |

**Table 2.** Frequency (%) of food group consumption by male and female soccer players.

| Items | Gender (%) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Women (n = 28) | | | | | | Men (n = 81) | | | | | | *p* |
| | <1 Week | 1–2 Week | 3–4 Week | 5-6 Week | 1–2 Day | ≥3 Day | <1 Week | 1–2 Week | 3–4 Week | 5–6 Week | 1–2 Day | ≥3 Day | |
| Fruits | 3.6 | 10.7 | 25.0 | 21.4 | 28.6 | 10.7 | 0.0 | 1.2 | 11.1 | 28.4 | 49.4 | 9.9 | 0.022 |
| Vegetables | 0.0 | 7.1 | 32.1 | 17.9 | 32.1 | 10.7 | 1.2 | 14.8 | 22.2 | 24.7 | 33.3 | 3.7 | 0.491 |
| Vegetables rich in nitrates | 25.0 | 32.1 | 21.4 | 10.7 | 10.7 | 0.0 | 22.2 | 27.2 | 33.3 | 12.3 | 4.9 | 0.0 | 0.671 |
| Legumes | 21.4 | 53.6 | 14.3 | 10.7 | 0.0 | 0.0 | 2.5 | 60.5 | 34.6 | 2.5 | 0.0 | 0.0 | 0.001 |
| Tubers | 7.1 | 32.1 | 42.9 | 17.9 | 0.0 | 0.0 | 2.5 | 24.7 | 49.4 | 18.5 | 4.9 | 0.0 | 0.518 |
| Pasta | 14.3 | 42.9 | 25.0 | 14.3 | 3.6 | 0.0 | 0.0 | 13.6 | 49.4 | 28.4 | 8.6 | 0.0 | 0.000 |
| Rice | 14.3 | 42.9 | 32.1 | 7.1 | 3.6 | 0.0 | 0.0 | 48.1 | 33.3 | 13.6 | 4.9 | 0.0 | 0.014 |
| Bread | 50.0 | 17.9 | 7.1 | 14.3 | 10.7 | 0.0 | 22.2 | 16.0 | 21.0 | 18.5 | 19.8 | 2.5 | 0.085 |
| Whole grains | 25.0 | 28.6 | 25.0 | 3.6 | 17.9 | 0.0 | 13.6 | 24.7 | 22.2 | 11.1 | 27.2 | 1.2 | 0.521 |
| Chicken/turkey | 7.1 | 3.6 | 39.3 | 32.1 | 17.9 | 0.0 | 0.0 | 19.8 | 46.9 | 27.2 | 6.2 | 0.0 | 0.012 |
| Eggs and egg products | 3.6 | 28.6 | 28.6 | 25.0 | 14.3 | 0.0 | 1.2 | 29.6 | 33.3 | 24.7 | 9.9 | 1.2 | 0.914 |
| Fish | 7.1 | 46.4 | 39.3 | 3.6 | 3.6 | 0.0 | 8.6 | 35.8 | 42.0 | 11.1 | 2.5 | 0.0 | 0.720 |
| Red meat | 25.9 | 29.6 | 25.9 | 3.7 | 7.4 | 7.4 | 7.4 | 44.4 | 38.3 | 6.2 | 3.7 | 0.0 | 0.012 |
| Nuts | 32.1 | 32.1 | 10.7 | 14.3 | 10.7 | 0.0 | 21.0 | 25.9 | 18.5 | 19.8 | 14.8 | 0.0 | 0.603 |
| Fermented foods | 28.6 | 21.4 | 21.4 | 21.4 | 7.1 | 0.0 | 4.9 | 35.8 | 23.5 | 23.5 | 12.3 | 0.0 | 0.014 |
| Soft drinks | 82.1 | 17.9 | 0.0 | 0.0 | 0.0 | 0.0 | 61.7 | 27.2 | 8.6 | 2.5 | 0.0 | 0.0 | 0.162 |
| Pastries | 67.9 | 32.1 | 0.0 | 0.0 | 0.0 | 0.0 | 50.6 | 44.4 | 4.9 | 0.0 | 0.0 | 0.0 | 0.195 |
| Frozen foods | 82.1 | 17.9 | 0.0 | 0.0 | 0.0 | 0.0 | 56.8 | 39.5 | 3.7 | 0.0 | 0.0 | 0.0 | 0.049 |

**Table 3.** Frequency (%) of alcohol consumption by soccer players of different competitive levels.

| **Variables** | **Category (%)** | | | | | | **Statistical Value** |
|---|---|---|---|---|---|---|---|
| | **U15-16 (n = 35)** | | | | | | |
| Alcoholic beverages | | No<br>100.0 | | | Yes<br>0.0 | | *p*<br>0.000 |
| Type | Nothing<br>100.0 | Mixed drinks<br>0.0 | | Beer<br>0.0 | Wine<br>0.0 | Champagne<br>0.0 | *p*<br>0.000 |
| Frequency | <1 week<br>100.0 | 1–2 week<br>0.0 | 3–4 week<br>0.0 | 5–6 week<br>0.0 | 1–2 day<br>0.0 | ≥3 day<br>0.0 | *p*<br>0.248 |
| Variables | U19-17 (n = 46) | | | | | | Statistical value |
| Alcoholic beverages | | No<br>89.1 | | | Yes<br>10.9 | | *p*<br>0.000 |
| Type | Nothing<br>89.1 | Mixed drinks<br>8.7 | | Beer<br>2.2 | Wine<br>0.0 | Champagne<br>0.0 | *p*<br>0.000 |
| Frequency | <1 week<br>95.7 | 1–2 week<br>0.0 | 3–4 week<br>4.3 | 5–6 week<br>0.0 | 1–2 day<br>0.0 | ≥3 day<br>0.0 | *p*<br>0.248 |
| Variables | Senior (n = 28) | | | | | | Statistical value |
| Alcoholic beverages | | No<br>57.1 | | | Yes<br>42.9 | | *p*<br>0.000 |
| Type | Nothing<br>57.1 | Mixed drinks<br>3.6 | | Beer<br>21.4 | Wine<br>14.3 | Champagne<br>3.6 | *p*<br>0.000 |
| Frequency | <1 week<br>100.0 | 1–2 week<br>0.0 | 3–4 week<br>0.0 | 5–6 week<br>0.0 | 1–2 day<br>0.0 | ≥3 day<br>0.0 | *p*<br>0.248 |

**Table 4.** Frequency (%) of alcohol consumption by male and female soccer players.

| **Variables** | **Gender (%)** | | | | | | **Statistical Value** |
|---|---|---|---|---|---|---|---|
| | **Women (n = 28)** | | | | | | |
| Alcoholic beverages | | No<br>75.0 | | | Yes<br>25.0 | | *p*<br>0.161 |
| Type | Nothing<br>75.0 | Mixed drinks<br>0.0 | | Beer<br>10.7 | Wine<br>10.7 | Champagne<br>3.6 | *p*<br>0.024 |
| Frequency | <1 week<br>100.0 | 1–2 week<br>0.0 | 3–4 week<br>0.0 | 5–6 week<br>0.0 | 1–2 day<br>0.0 | ≥3 day<br>0.0 | *p*<br>0.401 |
| Variables | Men (n = 81) | | | | | | Statistical value |
| Alcoholic beverages | | No<br>87.7 | | | Yes<br>12.3 | | *p*<br>0.161 |
| Type | Nothing<br>87.7 | Mixed drinks<br>6.2 | | Beer<br>4.9 | Wine<br>1.2 | Champagne<br>0.0 | *p*<br>0.024 |
| Frequency | <1 week<br>97.5 | 1–2 week<br>0.0 | 3–4 week<br>2.5 | 5–6 week<br>0.0 | 1–2 day<br>0.0 | ≥3 day<br>0.0 | *p*<br>0.401 |

## 4. Discussion

The aim of this study was to analyze the differences in the eating habits in elite soccer players by different competitive level, playing position and sex. To our knowledge, this is the first study analyzing these factors in elite soccer players from different level competitions, playing positions, and differentiating males and females. The main results showed a different food and alcohol intake according to the level of competition and sex.

### 4.1. Influence of Competitive Level on Nutrition

Dietary and physical exercise habits developed during the early years of life can have a lasting impact on long-term health and weight [34]. The nutritional approach aimed at young players faces the particular challenge of targeting individuals whose bodies undergo changes as they mature biologically, a process that does not always coincide with chronological age [3]. It was found that adolescents who were part of youth sports activities presented a greater tendency to consume fruits, vegetables and dairy products, although they also showed a greater inclination to ingest fast food and sugar-sweetened beverages compared to those who did not participate [35]. In addition, parents report poor availability of healthy food and beverage options at sporting events for youth athletes, contributing to the increased consumption of these products [36]. This was similar to our results, as the U16-15 were the soccer players who consumed the most sweets and frozen foods, with 8.6% of the subjects studied consuming both food groups between 3–4 times a week, and 54.3% and 51.4%, respectively, between 1–2 times a week. It is important to comply with the minimum recommendations for the frequency of consumption of some food groups such as ultra-processed foods because, although it has not been established for athletes as such, but for the general population, these are necessary in order to take care of health, physical recovery and body composition [3,37].

However, although there are previous studies highlighting a very low intake of healthy foods such as fruits and vegetables in youth stages, this has not been observed in our results, since in the case of the U16-15 category their daily consumption of one serving or more of fruits and vegetables was 62.8% and 28.6%, respectively, while consumption in the U19-17 categories was 54.3% and 37% [21]. Even so, it is true that there is still margin for improvement and it is necessary to continue applying food education so that all soccer players consume these foods on a daily basis, since fruits and vegetables are essential to obtain a correct supply of water, vitamins, minerals, antioxidants and fiber [3].

Moreover, the consumption of legumes was more frequent compared to other previous studies, where a frequency of 3–4 times a week or more was observed in the U16-15 categories of 31.5%, in the U19-17 categories of 39.1% and in the senior categories of 28.5% [21]. It is important to educate soccer players to consume not only animal protein, but also vegetable protein, especially from legumes, since they are very complete foods with a high contribution of CHO with a low glycemic index, fiber and micronutrients such as iron and vitamins, highlighting that in young ages, the contributions of these are superior in some cases compared to adults [3,30,38]. Regarding animal protein, it was abundant in lean meats, eggs and by-products and fish, with results similar to other previous studies [21,39,40].

In relation to foods rich in CHO such as cereals, whole grains, pasta, rice or tubers, it was high in all categories. There is increasing scientific evidence defending the benefits of high CHO intake compared to low CHO intake in preparation for competitions [3,20,41]. The reason is mainly based on the increase in muscle glycogen which provides (i) a greater endurance capacity in high-intensity exercises [42–44], (ii) an increase in the total distances covered [43,45], (iii) an improvement in specific soccer skills [42] or (iv) an increase in the time required until fatigue is reached [46]. However, it is important to apply CHO periodization during the week according to physical demands in order to properly maintain body composition and promote physiological adaptations to optimize sports performance [3,47].

### 4.2. Influence of Sex on Nutrition

Although women's soccer has gained popularity and has experienced significant scientific advances, the amount of research on female players in this sport remains markedly lower compared to men's soccer [3]. However, in the last decade, there has been a rapid increase in interest in women's soccer, which has spurred the creation of better professional conditions for training and competition for female players [48,49].

In general, there could be a tendency for women to control their eating habits more than boys and to follow patterns that are considered healthier, both for health reasons and because of body dissatisfaction, at least in adolescence [50]. In a study that evaluated differences in dietary patterns between male and female soccer players, women showed significantly lower consumption of pork, bread, olive oil and soft drinks compared to men, and significantly higher consumption of seafood, natural fruit juice and fruit [30]. However, the lower consumption of red meat is the only similarity with our results, as women consumed less fruit among other differences. If we focus on micronutrients, it is worth highlighting the dietary needs of iron, where women require higher amounts (18 mg·d$^{-1}$) than men (8 mg·d$^{-1}$), being abundant in foods such as mollusks, red meat or legumes such as soybeans or lentils [3,51]. Our results highlighted that women consumed less red meat and legumes than men, so this could lead, if the athlete's diet is not well structured through food or supplements, to suffering from pathologies such as anemia [3].

If we analyze the most relevant data on the frequency of consumption of the food groups, we observe a lower consumption of CHO (fruit, legumes, rice and pasta) by the female teams, which is in accordance with the literature reviewed in a study conducted with professional athletes who participated in several sports [52] and in another focused on male and female soccer players [30]. Although the reason for our female sample to consume less CHO is unknown, it could be due to misunderstandings about the impact of CHO intake on body composition, fear of weight gain and associated impacts on body image [53,54] and, for this reason, they tend to restrict foods high in this macronutrient.

In general, during prolonged submaximal aerobic exercise, women tend to rely more on fatty acids compared to men, especially when exercising at equivalent relative workload [55–57]. This observation could imply that women may require less CHO than male soccer players [58]. However, future research involving both female and male elite soccer players, matched under match and training conditions, is needed to determine whether energy substrate choice differs between genders. In fact, it is suggested that most female players may even minimize daily protein intake to prioritize higher carbohydrate intake for glycogen restoration, due to the low prevalence of their consumption [58].

Finally, in case the optimal intake of CHO through food is not reached, the use of CHO-rich sports foods such as gels, sports bars, gummies or isotonic drinks is recommended, as they can promote glycogen replenishment and improve performance, as observed in previous studies [3,59,60].

### 4.3. *Influence of Playing Position on Nutrition*

It has been seen that widefielder, fullback, center midfielder and center forward seem to be the most physically active playing positions during a match [61–63], which would mean that they are the most demanding in terms of energy expenditure and could explain the higher CHO requirements. Although there is a study where in some of these playing positions a higher consumption of CHO was observed, in our study, significant differences were only found for red meat consumption, with a higher consumption by forwards [12]. However, the questionnaire only includes the weekly frequency of the different food groups and not specific amounts of nutrients, so the results should not be misinterpreted. In addition, it should be remembered that the club has a dietician-nutritionist, so that nutrition, especially around training and matches, will be well advised.

Nutrient intake can have a profound impact on a player's body composition and performance favoring a similarity with elite soccer patterns, where scientific literature advocates that each playing position shows specific characteristics due to different physical demands and roles during training and, especially, in competitions [3,6,7,64]. Therefore, it is recommended to take care of the nutrition of all players and, if possible, to individualize the nutrition based on the playing position.

### 4.4. *Alcohol Consumption*

There are multiple factors that are capable of interfering in the recovery of the soccer player, such as high muscle damage caused by eccentric movements (related to an inhibitory effect of muscle glycogen resynthesis in type II fibers [65]), sports injuries, poor sleep quality or excessive alcohol intake [3,66,67]. After training and/or matches, celebratory events and/or discouragement linked to the ingestion of alcohol in moderate or high amounts may occur. This is a practice that is recommended to be avoided as it seems to cause a reduction in the rate of myofibrillar protein synthesis (even if alcohol is ingested together with dietary protein), which may impair exercise adaptation and recovery by decreasing the anabolic responses of skeletal muscle [3]. Furthermore, let us not forget that it can produce dehydration in the soccer player in situations where rehydration is important for future physical demands (especially when there is more than one match per week) [3,67,68].

In our study, we observed that alcohol intake was higher as soccer players increased in age, which would be consistent due to the legality of consuming this type of beverages. Regarding the type of beverages, male players consumed mixed drinks more often than female players, which can also be seen in this study [30]. However, these authors observed a higher intake in older boys, while it comes from the youngest ones in our results. This could be due to the fact that younger boys have poorer nutritional knowledge, hence why it is important to intervene from an early age so that good decisions are maintained throughout the years [26]. Regardless of the type of beverage, it is advisable to consume the least amount of alcohol in order to ensure proper player health, as well as to optimize athletic performance, recovery from energy demands and body composition [3].

For the first time to our knowledge, it was possible to assess the dietary habits of soccer players differentiated by competitive level, playing position and gender (Figure 1).

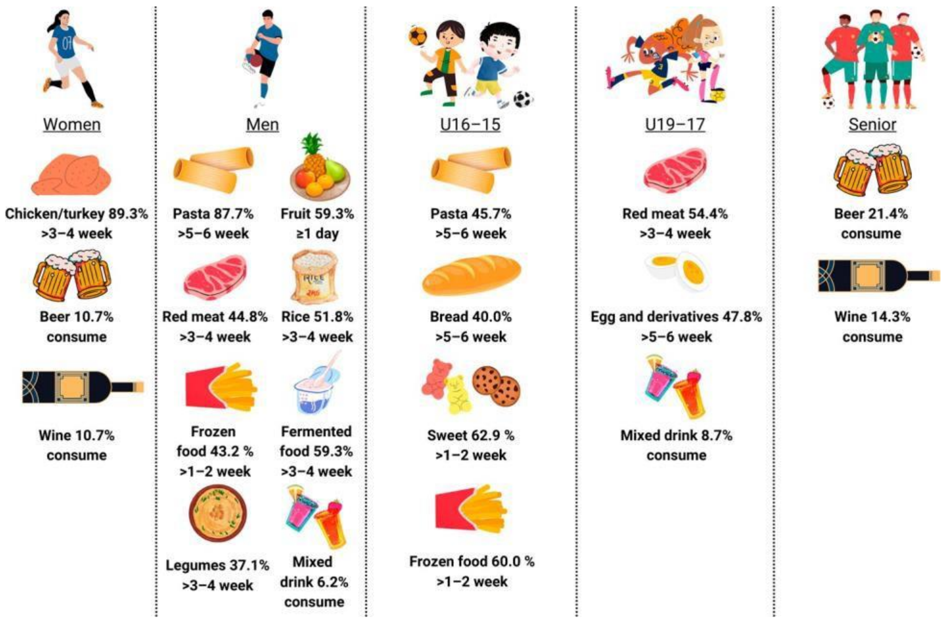


**Figure 1.** Most-consumed food and beverages classified by competitive level and gender.

### 4.5. Limitations

This research had some limitations that should be discussed to improve its applicability to soccer sport contexts. Despite having a small study population, 100% of the Spanish soccer players of the selected sample were recruited, which is a significant sample size according to the statistical principles applied.

Using a food frequency questionnaire allows one to estimate the usual intake and is quick and easy to administer since it does not alter the habitual intake of the individual, it does not require trained interviewers, and it has a low administration cost, but the consumption information was collected in a self-reported and retrospective manner based on the memory of the soccer players. This could lead to errors in the number and type of foods declared. Although the questionnaire was useful to describe the eating habits of the sample, it is not accurate to quantify the portions eaten, sports supplements intake or the intake of vitamins and minerals. In addition, the actual intake of CHO, proteins and fats could not be quantified either. Despite this, this study has achieved its goal of describing the dietary habits and practices of elite soccer players, little studied previously. Another limitation was the sample; it was small in each category and there is heterogeneity between sex groups. Soccer players may change their eating habits over time, whether due to changes in their nutritional needs, professional recommendations or body composition goals among other reasons. The questionnaire may not capture these changes or require periodic updates to reflect changing consumption. Finally, the food frequency questionnaire used was a validated tool, although one of its limitations was that the information on consumption was collected in a self-reported and retrospective manner, based on the memory of the soccer players. In addition, they may have a tendency to respond in a socially desirable manner, which may influence the veracity of the information provided. However, in general, athletes tend to care about their diet and training, as their performance depends on it, and they tend to be knowledgeable about their eating habits. This might make them remember their food intake better compared to the general population.

It should be noted that the pandemic caused by COVID-19 may have influenced the eating habits of soccer players, but during the pandemic season (2020–2021 season), all soccer players had online counselling by the dietitian-nutritionist in order to avoid changing dietary habits from a healthy eating approach. In the 2021–2022 season, the operation of the club, picnics for matches, etc. functioned normally.

## 5. Conclusions

In conclusion, differences in the eating habits according to competitive level and sex were found in our sample. Men tend to consume more CHO-rich foods, fermented foods, frozen foods and red meat compared to women, while women frequent lean meats more than men. In terms of competitive levels, a higher intake of certain CHO-rich foods, in addition to unhealthy foods such as sweets and frozen foods, was observed in the lower categories. Practically no differences were found between the playing positions. In summary, it is recommended that daily consumption of alcohol, sweets and frozen food be reduced as much as possible, regardless of competitive level, playing position and gender.

**Supplementary Materials:** The following supporting information can be downloaded at the following: https://www.mdpi.com/article/10.3390/nu15204323/s1, File S1: Food consumption frequency questionnaire in elite soccer players.

**Author Contributions:** Conceptualization, J.M.M.-S., J.M.S. and J.S.-R.; methodology, J.M.M.-S., J.M.S., J.S.-R., D.R.-G., J.S.-C., M.A.-C. and P.L.-M.; data curation, J.S.-R., D.R.-G. and J.S.-C.; formal analysis, J.S.-R., D.R.-G., J.S.-C., M.A.-C. and P.L.-M.; investigation, J.M.M.-S., J.M.S., J.S.-R., J.S.-C., M.A.-C. and P.L.-M.; visualization, J.M.M.-S., J.M.S. and J.M.S.; writing—original draft preparation, J.S.-R., D.R.-G., J.S.-C., M.A.-C. and P.L.-M.; writing—review and editing, J.M.M.-S., J.M.S., J.S.-R., D.R.-G., J.S.-C., M.A.-C. and P.L.-M. All authors have read and agreed to the published version of the manuscript.

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## Abbreviations

CHO: Carbohydrates.

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### 3.4. *Supplement Consumption by Elite Soccer Players: Differences by Competitive Level, Playing Position, and Sex*

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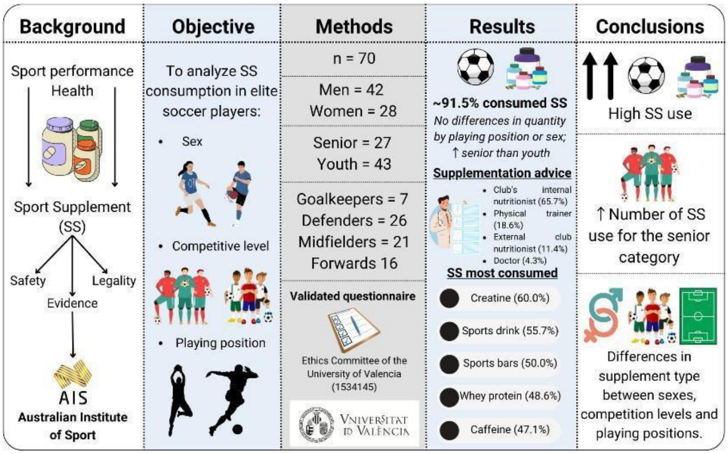

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# Supplement Consumption by Elite Soccer Players: Differences by Competitive Level, Playing Position, and Sex

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**Abstract:** Soccer is a sport practiced all over the world and whose practice begins in young athletes. Currently, the consumption of nutritional supplements is essential to achieve the maximum performance of players. The aim of this study was to describe the consumption of sports supplements (CSS) by elite soccer players and its association with their competitive level, playing position, and sex. A comparative descriptive and non-experimental study was performed during the 2021–2022 competitive season. A total of 70 elite players completed one online questionnaire about their CSS. We found that sports drinks (55.7%), sports bars (50.0%), whey protein (48.6%), caffeine (47.1%), and creatine (60.0%) were the most consumed supplements by the total sample. Relative to the categories, the CSS was higher in the senior teams for both men and women. Regarding playing positions, caffeine was more consumed by midfielders and forwards ($p = 0.013$). Finally, in relation to sex, significant differences were found in the consumption of sports confectionery ($p = 0.036$), whey protein ($p = 0.002$), β-alanine ($p = 0.013$), and melatonin ($p = 0.016$). Soccer club SS questionnaires gather data to understand patterns, assess effectiveness and risks, and aid research. In conclusion, differences were found in the CSS according to competitive level, sex, and playing position.

**Keywords:** ergogenic aids; football; performance; soccer; sports nutrition; supplementation

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## 1. Introduction

Soccer is a physically demanding intermittent sport that requires high physical and metabolic demands [1], recognized as one of the most popular and practiced sports worldwide. The game involves two teams of 11 players, in both men's and women's soccer, competing against each other to score goals [2]. There are two main categories: the base and the professional. The base category (U19-10) is played by young people before reaching the professional leagues, such as the First and Second Divisions in Spain [2]. It is widely recognized that an athlete's physical performance is associated with their body composition [3], hydration, healthy eating habits, and supplementation [4–7]. Understanding how playing position and other variables can impact the nutrition habits of soccer players is crucial for creating effective nutrition education programs [5].

In recent years, supplements have become increasingly popular in the sports industry due to their ability to enhance performance, especially in energy-intensive sports where dietary intake alone may not be sufficient. However, the supplement industry is driven by economic motives and responds to consumer demand, so there is sometimes a lack of evidence for the consumption of certain supplements and there may be industry-driven publication or advertising biases [5]. The detection and prevention of contamination of ergogenic supplements with banned substances is crucial to ensure the safety of athletes. Without proper control in the selection of supplements, there is a risk of adverse effects [8].

In 2000, the Australian Institute of Sport (AIS) established a nutritional supplement classification system (known as the ABCD system) for athletes. This system differentiates supplements according to the level of existing scientific evidence, as well as other parameters related to safety, legality, and effectiveness in improving sports performance [9]. Therefore, supplements belonging to group A are those that have a high level of scientific evidence to improve performance. These are divided into sports foods (specialized products are utilized to offer a convenient nutrient source in situations where consuming regular foods is not feasible, such as sports drinks, bars and gels, and whey protein), medical supplements (supplements used to prevent or treat clinical issues including diagnosed nutrient deficiencies, such as iron, calcium, zinc, and probiotics), and performance supplements (supplements/ingredients that can support or enhance sports performance, such as caffeine, B-alanine, creatine, sodium bicarbonate, nitrates, and glycerol) [9]. Group B includes supplements that may have a positive effect on certain conditions, although further research is needed (e.g., menthol, curcumin, vitamin C, and fish oils), while there is insufficient scientific evidence to support the benefits of Group C supplements among athletes, or no research has been conducted to guide an informed opinion (e.g., magnesium, vitamin E, leucine, and phosphate). Lastly, group D includes those supplements banned or at high risk of contamination with substances that could lead to a positive doping test, so they cannot be used by athletes (e.g., higenamine, ostarine, sibutramine, and androstenedione) [9].

Several studies [4,10], along with two consensus statements, one from the Portuguese Football Federation [6] and another from the Union of European Football Associations (UEFA) expert group [5], have highlighted the consumption of different supplements aimed at increasing or improving sports performance. Despite the growing popularity and scientific advancements in women's soccer, research on female players in this sport remains significantly lower compared to men's soccer [5]. Furthermore, the use of supplements in adolescent athletes is a controversial topic. While some argue that consumption can enhance performance and aid in recovery during the competitive season, there are potential risks associated with their use. These risks include lack of regulation, possible adverse side effects, and the presence of banned substances [8,11].

Accordingly, the aim of this study was to describe the consumption of sports supplements (SS) by elite soccer players and its association with their competitive level, playing position, and sex. The initial hypothesis was that:

**Hypothesis 1 (H1).** *Higher category soccer players will have higher consumption of SS.*

**Hypothesis 2 (H2).** *Male and female soccer players will have similar SS intake, but not SS type.*

**Hypothesis 3 (H3).** *The amount and type of SS consumed will be similar in the different playing positions.*

## 2. Materials and Methods

### 2.1. Type of Study

A descriptive, cross-sectional, and non-experimental study was conducted to determine the consumption and regular use of dietary supplements by elite soccer players of both sexes attending the Valencia C.F. Academy. The assessment was made in the month of May during the competition season 20–21. Sample size calculation was performed using Rstudio software (version 3.15.0, Rstudio Inc., Boston, MA, USA). The significance level was set a priori at $p$ = 0.05. The standard deviation (SD) was set according to the total SS data from previous studies in Spanish elite athletes (DE = 2.1) [10]. With an estimated error (d) of 0.49, the required sample size was 70 athletes. The study population was selected by non-probability, non-injury, convenience sampling among elite soccer players of both sexes attending the Valencia C.F. Academy.

### 2.2. Participants

The SS consumption questionnaire included templates from 100% of Valencia Mestalla (n = 21), Juvenil A (n = 22), Juvenil B (n = 23), Valencia CF Femenino (n = 15), and Valencia CF Femenino B (n = 13). However, only 70 out of 94 soccer players (74.5%) completed the voluntary questionnaire, including 12 Valencia Mestalla players, 15 Juvenil A players, 15 Juvenil B players, and all players from Valencia CF Femenino (15) and Valencia CF Femenino B (13). All players had at least 9 years of soccer training experience and performed from 4 up to 7 regular training sessions per week (approximately 90 to more than 120 min per day), playing a theoretical official soccer match per week. The criteria for inclusion in this study were as follows: (a) be a healthy subject with medical authorization for the practice of federated sport; (b) belong to a team of Valencia C.F. Academy; (c) being federated in soccer; and (d) training a minimum of 4 days per week. The exclusion criteria for this study were as follows: (a) having been injured or having become ill during this study. The study population overlaps with that of a previous study published in Nutrients [7].

### 2.3. Procedure

In order to select the sample, the C.F. Valencia Academy sent out a statement informing local and non-resident players about the study, instructions, and an invitation to participate. Before the players completed the questionnaire, they were informed of the purpose of the study. Informed consent was obtained and signed by those responsible for the study, as well as the medical and coaching staff of the Valencia C.F. Academy. It was also signed by each participant and their respective parents or legal guardians. The research team was present at the Valencia CF sports center while the players filled out the questionnaires in order to clarify any doubts.

The protocol conforms to the tenets of the Declaration of Helsinki for research involving human participants and has been approved by the Ethics Committee of the University of Valencia (1534145).

### 2.4. Instruments

This study used a questionnaire that had previously been used in similar studies [12,13]. The selected questionnaire about the consumption of sports supplements (CSS) was validated for content, applicability, structure, and presentation by Sánchez-Oliver [14]. This questionnaire was developed by a team of three sports scientists and 25 experts in sports science, sports medicine, nutrition, chemistry, and pharmacology to ensure its construction validity [14]. In fact, in a study conducted by Knapik et al. [15], who analyzed the quality of questionnaires designed to determine the prevalence of SS use by athletes, this form obtained a methodological score of 54%. It stood out as one of the 57 questionnaires reviewed (out of a total of 164) that was considered adequate to collect accurate information on the SS used by athletes. The questionnaire consists of 28 questions divided into three main sections. The first section collects the subject's age, team (which identifies the subject's gender), and playing position. This section has 3 questions. The second section includes 7 questions that collect the sport practice and its context, such as years of practice and number of weekly training sessions. The third section includes 4 questions focused on nutrition, such as whether he/she follows any type of diet and who advises him/her on nutrition. The last section, the most extensive, focuses on diet and supplement consumption. It contains 14 questions, such as what supplements the respondents used, why they used them, who advised them to use them, where they bought them, when they took them, and their perception of the results after use. The questionnaire can be obtained by contacting the authors via email.

### *2.5. Stadistical Analysis*

The Kolmogorov–Smirnov test was applied to check whether the variables had a normal distribution and the Levene test was used to verify homoscedasticity. For the descriptive analysis, the mean and standard deviation (M ± SD) were used. An ANOVA analysis was performed according to sex (male-female), category (senior-base), and positions (goalkeeper, defense, midfielder, and forward) to analyze the differences in the SS consumed from the different categories determined by the AIS. For supplements that were consumed by more than 10% of the sample, a chi-square test ($\chi^2$) was performed to verify possible differences according to sex, category, and positions. The level of statistical significance was set at $p < 0.05$. Statistical analysis was performed with the Statistical Package for Social Sciences v.20 (SPSS).

## 3. Results

Table 1 shows the characteristics of the players (age, training days, and extra training days) by gender, competition level, and position.

**Table 1.** Descriptive data on age and training days as a function of sex, category, and playing positions.

| Variable | Sex (Media ± DE) | | Category (Media ± DE) | | Playing Position (Media ± DE) | | | |
|---|---|---|---|---|---|---|---|---|
| | Men (n = 42) | Women (n = 28) | Senior (n = 27) | Youth (n = 43) | Goalkeepers (n = 7) | Defenders (n = 26) | Midfielders (n = 21) | Forwards (n = 16) |
| Age | 20.02 ± 2.87 | 22.04 ± 4.38 | 24.44 ± 3.45 | 18.56 ± 0.98 | 21.57 ± 3.87 | 19.73 ± 3.25 | 21.76 ± 3.88 | 21.06 ± 3.77 |
| Training days | 5.62 ± 0.76 | 5.43 ± 0.96 | 5.96 ± 0.52 | 5.28 ± 0.91 | 5.14 ± 0.90 | 5.50 ± 0.86 | 5.62 ± 0.86 | 5.69 ± 0.79 |
| Extra-training days | 2.60 ± 1.43 | 2.21 ± 1.52 | 2.30 ± 0.95 | 2.53 ± 1.72 | 3.43 ± 2.15 | 2.46 ± 1.45 | 2.29 ± 1.27 | 2.19 ± 1.37 |

Table 2 shows the mean with its standard deviation and the ANOVA of the age, training days, and SS consumed of the segmented sample according to sex and category. Regarding sex, significant differences were found in age (F = 5.402; $p$ = 0.023), with greater age being observed in women, while for the rest of the variables no significant differences were found (F = 0.020–2.885; $p$ = 0.889–0.094). Regarding the category, significant differences were found for age (F = 111.883; $p$ = 0.000) and days of training (F = 12.676; $p$ = 0.001), both in the total and in all of the supplements of group A (F = 4.531–8.781; $p$ = 0.037–0.004) and in the supplements of group C (F = 9.693; $p$ = 0.003), observing in all cases higher values in the senior category.

Table 3 shows the mean with its standard deviation and the ANOVA of the age, training days, and SS consumed of the segmented sample according to playing position. All players trained an average of 5 days and 2 extra days, with the exception of the goalkeepers who trained 1 day more on average. Regarding the consumption of supplements, it was observed that, in all positions, sports foods belonging to group A supplements were the most consumed, while group D supplements were the least consumed. It was also observed that in all positions the supplements belonging to group C were more consumed than those belonging to group B. And regarding the differences between the positions, no significant differences were found for any of the analyzed variables (F = 0.342–2.424; $p$ = 0.795–0.074).

**Table 2.** Descriptive data and ANOVA of age, training days, and SS consumed in the different categories established by the AIS, according to teams.

| Variable | | Sex (Media ± DE) | | | | Category (Media ± DE) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Men (n = 42) | Women (n = 28) | F | p | Senior (n = 27) | Youth (n = 43) | F | p |
| Age | | 20.02 ± 2.87 | 22.04 ± 4.38 | 5.402 | 0.023 | 24.44 ± 3.45 | 18.56 ± 0.98 | 111.883 | 0.000 |
| Training days | | 5.62 ± 0.76 | 5.43 ± 0.96 | 0.850 | 0.360 | 5.96 ± 0.52 | 5.28 ± 0.91 | 12.676 | 0.001 |
| Extra-training days | | 2.60 ± 1.43 | 2.21 ± 1.52 | 1.129 | 0.292 | 2.30 ± 0.95 | 2.53 ± 1.72 | 0.433 | 0.513 |
| Supplements Group A | Sports food | 2.02 ± 1.44 | 2.50 ± 1.62 | 1.661 | 0.202 | 2.78 ± 1.72 | 1.86 ± 1.28 | 6.508 | 0.013 |
| | Medical supplements | 0.95 ± 1.46 | 1.11 ± 1.34 | 0.220 | 0.641 | 1.48 ± 1.55 | 0.72 ± 1.12 | 5.654 | 0.020 |
| | Ergogenic aids | 1.36 ± 1.10 | 1.32 ± 0.94 | 0.020 | 0.889 | 1.67 ± 0.83 | 1.14 ± 1.10 | 4.531 | 0.037 |
| | Total | 4.33 ± 3.25 | 4.93 ± 3.14 | 0.579 | 0.449 | 5.93 ± 3.22 | 3.72 ± 2.91 | 8.781 | 0.004 |
| Supplements Group B | | 0.69 ± 0.87 | 0.79 ± 1.20 | 0.149 | 0.701 | 1.00 ± 1.27 | 0.56 ± 0.76 | 3.306 | 0.073 |
| Supplements Group C | | 1.31 ± 1.97 | 2.25 ± 2.66 | 2.885 | 0.094 | 2.70 ± 2.92 | 1.05 ± 1.53 | 9.693 | 0.003 |
| Supplements Group D | | 0.02 ± 0.15 | 0.00 ± 0.00 | 0.663 | 0.418 | 0.04 ± 0.19 | 0.00 ± 0.00 | 1.607 | 0.209 |

DE: Standard deviation.

**Table 3.** Descriptive data and ANOVA of age, training days and SS consumed in the different categories established by the AIS, according to teams.

| Variable | | Playing position (Media ± DE) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Goalkeepers (n = 7) | Defenders (n = 26) | Midfielders (n = 21) | Forwards (n = 16) | F | *p* |
| Age | | 21.57 ± 3.87 | 19.73 ± 3.25 | 21.76 ± 3.88 | 21.06 ± 3.77 | 1.375 | 0.258 |
| Training days | | 5.14 ± 0.90 | 5.50 ± 0.86 | 5.62 ± 0.86 | 5.69 ± 0.79 | 0.748 | 0.527 |
| Extra-training days | | 3.43 ± 2.15 | 2.46 ± 1.45 | 2.29 ± 1.27 | 2.19 ± 1.37 | 1.307 | 0.279 |
| Supplements Group A | Sports food | 2.14 ± 1.07 | 1.92 ± 1.26 | 2.52 ± 1.96 | 2.31 ± 1.45 | 0.624 | 0.602 |
| | Medical supplements | 1.14 ± 1.46 | 0.73 ± 0.87 | 1.24 ± 1.81 | 1.13 ± 1.26 | 0.625 | 0.601 |
| | Ergogenic aids | 1.57 ± 0.53 | 0.92 ± 0.80 | 1.62 ± 1.24 | 1.56 ± 1.09 | 2.424 | 0.074 |
| | Total | 4.86 ± 2.12 | 3.58 ± 2.42 | 5.38 ± 4.09 | 5.00 ± 3.20 | 1.428 | 0.242 |
| Supplements Group B | | 0.86 ± 0.69 | 0.58 ± 0.99 | 0.86 ± 1.15 | 0.75 ± 1.00 | 0.342 | 0.795 |
| Supplements Group C | | 1.29 ± 1.38 | 1.27 ± 2.15 | 2.38 ± 2.87 | 1.63 ± 1.96 | 0.998 | 0.399 |
| Supplements Group D | | 0.00 ± 0.00 | 0.04 ± 0.20 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.553 | 0.648 |

DE: Standard deviation.

Table 4 shows those supplements that were consumed by more than 10% of the total sample and according to sex, category, and playing positions. It was observed that sports drinks (55.7%), sports bars (50.0%), whey protein (48.6%), caffeine (47.1%), and creatine (60.0%) were the most consumed supplements by the total sample. Regarding sex, significant differences were found in the consumption of sports confectionery ($p$ = 0.036), whey protein ($p$ = 0.002), β-alanine ($p$ = 0.013), and melatonin ($p$ = 0.016), observing a higher consumption in women, with the exception of sports confectionery, which was consumed more by men. Regarding the category, significant differences were found in whey protein ($p$ = 0.016), carbohydrate gainers ($p$ = 0.011), β-alanine ($p$ = 0.001), leucine ($p$ = 0.004), and melatonin ($p$ = 0.001), observing a higher consumption in all of these cases in the senior category. And finally, with respect to playing positions, significant differences were only found for caffeine consumption ($p$ = 0.013), where midfielders and forwards had higher values.

Of the 70 participants, 42 (60.0%) followed some type of diet, with the Mediterranean diet being the most popular (83.3%) followed by the flexible diet (9.52%) and intermittent fasting (7.18%). The main reasons for dieting were to improve performance (71.5%), to take care of their health (26.5%), and to treat injuries (2.3%). Of all dieters, they were mainly advised by the club's internal nutritionist (80.9%) or by a dietitian/nutritionist external to the club (9.55%), although some of them did not seek advice (9.55%).

In relation to the opinion of the consumption of SS, 62 soccer players were in favor of their consumption (88.5%), while 6 did not answer (8.6%) and 2 were not in favor (2.9%). However, most soccer players have consumed SS at some stage in their career (91.5%). In relation to the intake of SS, soccer players mainly consume them both in training and on match days (78.5%), especially after sports practice (60.0%), although there were 20 players who ingested them before, during, and after sports practice (28.6%), and 8 who only consumed them before sports practice (11.4%).

The main reasons for consuming these SS were to improve sports performance (80.0%), to take care of health (27.1%), and to improve physical appearance (20.0%). Soccer players obtained supplements mainly through the club itself (94.2%), but also through the Internet (14.2%), pharmacies (7.1%), and herbalists (7.1%); being motivated to take them especially by the club's internal nutritionist (65.7%), physical trainer (18.6%), external club dietitian/nutritionist (11.4%), and doctor (4.3%).

**Table 4.** Distribution (%) of the most consumed supplements by position according to the categories established by the AIS.

| Category | | Supplement | Total (%) | Sex (%) | | | Category (%) | | | Playing position (%) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | **Women** | **Men** | ***p*** | **Senior** | **Youth** | ***p*** | **Goalkeepers** | **Defenders** | **Midfielders** | **Forwards** | ***p*** |
| Supplements Group A | Sports food | Sports drinks | 55.7 | 53.6 | 57.1 | 0.768 | 59.3 | 53.5 | 0.636 | 42.9 | 42.3 | 61.9 | 75.0 | 0.165 |
| | | Sports confectionery | 14.3 | 3.6 | 21.4 | 0.036 | 18.5 | 11.6 | 0.423 | 14.3 | 3.8 | 19.0 | 25.0 | 0.240 |
| | | Sports bars | 50.0 | 42.9 | 54.8 | 0.329 | 44.4 | 53.5 | 0.461 | 71.4 | 50.0 | 47.6 | 43.8 | 0.663 |
| | | Whey protein | 48.6 | 71.4 | 33.3 | 0.002 | 66.7 | 37.2 | 0.016 | 42.9 | 53.8 | 42.9 | 50.0 | 0.881 |
| | | Carbohydrate gainers | 15.7 | 25.0 | 9.5 | 0.081 | 29.6 | 7.0 | 0.011 | 28.6 | 7.7 | 23.8 | 12.5 | 0.348 |
| | Medical supplements | Iron | 21.4 | 28.6 | 16.7 | 0.234 | 33.3 | 14.0 | 0.054 | 28.6 | 7.7 | 38.1 | 18.8 | 0.084 |
| | | Vitamin D | 32.9 | 25.0 | 38.1 | 0.253 | 44.4 | 25.6 | 0.102 | 42.9 | 26.9 | 19.0 | 56.3 | 0.089 |
| | | Multivitamin | 21.4 | 28.6 | 16.7 | 0.234 | 33.3 | 14.0 | 0.054 | 28.6 | 15.4 | 28.6 | 18.8 | 0.687 |
| | | Multimineral | 11.4 | 14.3 | 9.5 | 0.540 | 11.1 | 11.6 | 0.947 | 14.3 | 7.7 | 19.0 | 6.3 | 0.563 |
| | | Probiotics | 11.4 | 10.7 | 11.9 | 0.878 | 18.5 | 7.0 | 0.140 | 0.0 | 15.4 | 9.5 | 12.5 | 0.706 |
| | Ergogenic aids | Caffeine | 47.1 | 42.9 | 50.0 | 0.558 | 63.0 | 37.2 | 0.036 | 42.9 | 23.1 | 66.7 | 62.5 | 0.013 |
| | | B-alanine | 12.9 | 25.0 | 4.8 | 0.013 | 29.6 | 2.3 | 0.001 | 28.6 | 3.8 | 19.0 | 12.5 | 0.246 |
| | | Creatine | 60.0 | 60.7 | 59.5 | 0.921 | 66.7 | 55.8 | 0.367 | 85.7 | 61.5 | 52.4 | 56.3 | 0.465 |
| Supplements Group B | | Omega 3 | 24.3 | 25.0 | 23.8 | 0.909 | 29.6 | 20.9 | 0.409 | 14.3 | 26.9 | 23.8 | 25.0 | 0.922 |
| | | Vitamin C | 28.6 | 25.0 | 31.0 | 0.589 | 37.0 | 23.3 | 0.214 | 42.9 | 19.2 | 33.3 | 31.3 | 0.552 |
| | | Carnitine | 11.4 | 14.3 | 9.5 | 0.540 | 14.8 | 9.3 | 0.480 | 28.6 | 7.7 | 19.0 | 0.0 | 0.129 |
| Supplements Group C | | Essential amino acids | 12.9 | 17.9 | 9.5 | 0.308 | 22.2 | 7.0 | 0.064 | 0.0 | 15.4 | 19.0 | 6.3 | 0.471 |
| | | Magnesium | 31.4 | 39.3 | 26.2 | 0.248 | 44.4 | 23.3 | 0.063 | 28.6 | 26.9 | 33.3 | 37.5 | 0.901 |
| | | Leucine | 14.3 | 14.3 | 14.3 | 1.000 | 29.6 | 4.7 | 0.004 | 14.3 | 11.5 | 19.0 | 12.5 | 0.899 |
| | | Vitamin E | 11.4 | 7.1 | 14.3 | 0.357 | 11.1 | 11.6 | 0.947 | 28.6 | 7.7 | 14.3 | 6.3 | 0.394 |
| | | Melatonin | 15.7 | 28.6 | 7.1 | 0.016 | 33.3 | 4.7 | 0.001 | 0.0 | 7.7 | 33.3 | 15.7 | 0.055 |
| | | Glutamine | 18.6 | 21.4 | 16.7 | 0.616 | 25.9 | 18.6 | 0.210 | 28.6 | 15.4 | 23.8 | 12.5 | 0.704 |

## 4. Discussion

To our knowledge, this is the first study to analyze the differences in SS consumption among elite soccer players by different categories, playing positions, and genders. The main findings of this study were: (1) senior soccer players were more likely to consume SS; (2) although similar patterns were observed between sexes, differences emerged in the consumption of sports confectionery, whey protein, β-alanine, and melatonin; (3) only differences in caffeine consumption were highlighted among the different playing positions, with higher levels among midfielders and forwards.

### 4.1. Influence of Competitive Level, Playing Position, and Sex

It is increasingly common to see athletes taking supplements to improve their performance, health, aesthetics or for other reasons such as sponsorship or advertising [16,17]. In our study, 88.5% of the soccer players were in favor of SS consumption and at least 91.5% had consumed them at some time, so this is a population susceptible to the consumption of these products. However, nutritionists were primarily responsible for advising on the consumption of SS in our soccer player sample, with a 77.1% presence of both internal and external club nutritionists. Sports clubs should have nutritionists oversee the implementation of dietary and SS recommendations and provide education on the subject. These professionals should be qualified to critically evaluate the translational potential of research and the applicability of these results in practice [18–20]. It is worth noting that soccer players who followed a dietary strategy were often advised by a nutritionist, with 90.45% of cases involving both internal and external nutritionists. This is similar to the advice provided about SS in our work and other sports [12,13,21].

In addition, the main motive for consumption was the pursuit of sports performance, followed by health care and improving physical appearance. This last motive is important to mention, as demanding a physique with a high lean mass and a very low fat mass can be detrimental to performance and increase the risk of injury [5,22]. Like athletes in any other sport, soccer players are not immune to developing and suffering from eating disorders such as anorexia, orthorexia, and vigorexia. These disorders can harm not only sports performance but also the athlete's health [23]. Excessive perfectionism is a key psychopathological trait that underlies the development of eating disorders in soccer players, despite the multifactorial nature of the pathology [24]. In fact, the use of Lycra sportswear has been one of the factors driving the interest in body aesthetics over performance [25].

In relation to scientific studies, there are several studies whose results show that the SS most consumed by athletes are caffeine, vitamins and minerals, creatine, antioxidants, and protein supplements [16,26–28]. In our study, sports drinks and sports bars were also two of the most consumed supplements by the sample, something that was also observed in the "División de Honor" soccer players [26]. Scientific studies have shown a correlation between carbohydrate intake from food and SS, such as sports drinks and bars, and improved performance in soccer [29–33]. Therefore, it is understandable that consumption of these supplements was high in our sample of soccer players at all competitive levels, sexes, and playing positions. As mentioned above, caffeine and creatine are two of the most consumed SS by athletes, both of them being supplements classified by the AIS in category A, focused on improving sports performance [34]. These two supplements are popular among soccer players [5,6,35] as they are both used to improve performance and are considered legal.

Creatine is a non-essential organic nitrogenous compound from the amine group that increases muscle creatine reserves, leading to a higher rate of phosphocreatine resynthesis [36]. This has been well demonstrated in soccer, as it translates into improved performance, particularly in high-intensity intermittent efforts [37–41]. Caffeine is an alkaloid of the methylated xanthine family and is considered a stimulant with well-established benefits for athletic performance and decreased fatigue [36,42]. In addition to its effects on alertness and fatigue during physical exertion, caffeine has also been found to enhance soccer-specific skills such as jumping, sprinting, agility, ball control, and passing accuracy. This explains its widespread use among athletes and its popularity in scientific research [5,6,43–49].

Regarding women's soccer, there are few studies that have examined the prevalence of SS use. A recent study evaluated the use of dietary supplements in 103 elite soccer players, with 82% reporting use within the last 12 months, a result consistent with our findings [50]. However, the main reason for consuming these products was to take care of their health (66.0%) and they were mainly advised by physicians (46.0%), followed by dieticians/nutritionists. The most commonly used supplements were vitamin D (52.0%), omega-3 fatty acids (49.0%), and protein powder (45.0%). In our study, while whey protein was also frequently used (71.4%), the consumption of Vitamin D (25.0%) and omega-3 fatty acids (25.0%) was not prominent. However, creatine, caffeine, sports drinks, and sports bars were popular choices. While there is a high incidence of vitamin D deficiency among soccer players [51,52] and vitamin D supplementation has been extensively studied in this population [53–56], we hypothesize that, in most cases, the players in our study do not require vitamin D supplements due to the favorable weather conditions in the region where they train and compete, regular monitoring of their blood levels through periodic clinical analysis, and dietary advice from the club's nutritionist or, in some cases, an external dietician/nutritionist. This last reason could also justify the low consumption of omega-3 fatty acids through supplements, since with well-structured dietary guidelines by a dietician/nutritionist and the absence of sports injuries or pathologies, supplementation is not necessarily required [57,58].

Comparing our own results between sexes, the consumption of melatonin (28.6% vs. 7.1%) and β-alanine (25.0% vs. 4.8%) was higher than in men, although men consumed more sports confectionery (21.4% vs. 3.6%). β-alanine is classified by the AIS in category A for sports performance enhancement [34]. It is a nonessential amino acid synthesized in the liver and acts as a limiting precursor for carnosine dipeptide synthesis in human skeletal muscle, as opposed to L-histidine [36]. Baseline intramuscular carnosine levels are 12–72% lower in women compared to men [59,60]. Additionally, it has been observed that females may require lower levels of β-alanine supplementation to achieve similar relative increases in carnosine compared to males [60]. Although the evidence in female soccer players is inconclusive [61,62], there is a strong scientific rationale for supplementing with β-alanine in both men and women [4,5,10,63,64].

Melatonin is a peptide hormone commonly used as a nutritional supplement to regulate the sleep/wake cycle. However, it also has other physiological effects that can improve athletic performance [36]. In soccer, melatonin is often used to improve sleep hygiene and mitigate the negative effects of jet lag after international travel [5]. Several studies have evaluated the impact of melatonin on elite male soccer players, both adult and youth, with promising results [65–71]. However, there is a lack of research on the effects of melatonin on female soccer players. The authors suggest that female soccer players may consume more melatonin due to a need for better quality rest and higher levels of daily stress caused by personal, social, cultural, and economic conditions that differ from those of male soccer players. In many cases, female soccer players need to balance sports competitions with work or study, resulting in increased stress levels [72].

The use of supplements in adolescent athletes is a contentious issue. First, certain supplements may be beneficial for improving athletic performance and optimizing muscle recovery [5]. Nevertheless, it is important to keep in mind that adolescents are still developing and their bodies have specific nutritional needs that can be met by a balanced diet [73]. In our work, we have found that the consumption of SS is less frequent among youth categories compared to senior categories. However, it is important to consider the dietary needs of young soccer players, such as calcium, iron, and vitamin D, as their requirements differ from those of adults [5,74]. Therefore, if there is a deficiency in these nutrients, supplementing them would be a beneficial intervention by the club's medical team. This should be performed in addition to interventions focused on performance enhancement, as long as the doses and forms of administration are appropriate for the young athlete [5,75]. Research suggests that during a match, the midfielder and forward positions are the most physically active playing positions [76–78]. Furthermore, research has shown that these positions are associated with lower levels of body fat [79], indicating a higher energy expenditure. Our study found a positive association between these positions and a higher caffeine intake. However, the club has a budget for the provision of sports supplements and the support of dietitians/nutritionists. Therefore, it is reasonable to assume that there are no significant differences in the amount and type of supplements consumed, as they are mostly sports foods suitable for any soccer player [5,6,34]. To our knowledge, the present study is the first to analyze the consumption of dietary supplements by elite soccer players, differentiating by competitive level, gender, and playing position (Figure 1).

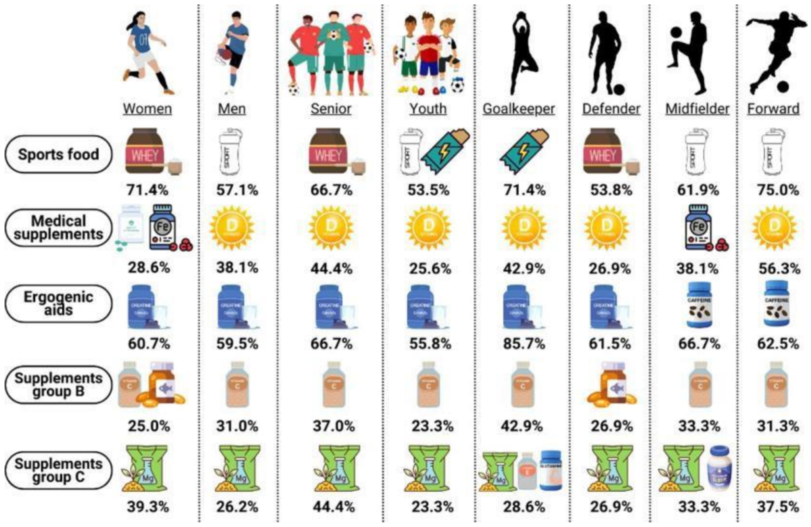


**Figure 1.** Most used supplements according to competitive level, gender, and playing position.

Finally, SS consumption may vary among teams based on the club's budget. However, as a general rule, men's and higher category squads have a larger budget than lower category or women's squads. Additionally, supplement consumption may be recommended by the club's specialized sports nutritionist based on scientific evidence and tailored to the individual's competitive level, gender, age, and budget.

### 4.2. Limitations

The current study presents important information regarding the prevalence and usage of SS in elite soccer. However, there are limitations that must be considered to improve its applicability. Firstly, the sample size in each category was small and there was heterogeneity between groups. Nevertheless, a significant sample size was used in this type of population according to the statistical principles applied. However, the authors caution against generalizing the findings to other sports populations due to the limitations of the data. This study achieved its objective of describing the supplementation habits and practices of elite soccer players of both sexes, which has been little studied so far. Additionally, the information on supplement use was collected through self-reported and retrospective methods, relying on the athletes' memory. This could lead to errors in the number and type of SS reported. However, in general, athletes tend to be knowledgeable about their dietary habits and concerned about their diet and training, as their performance depends on it. Additionally, supplementation is primarily overseen by the club nutritionist and the coaching and medical staff to promote optimal athletic performance and health in these athletes. Though the CSS is a validated tool and proven to be efficient in elucidating the behavioral patterns of the sampled population, it bears intrinsic limitations in the precise quantification of supplement usage, both in the context of training and competitive events. In addition, the questionnaire does not consider the doses or protocols of the SS consumed, nor does it ask about the brand of supplements. Therefore, it is not possible to estimate the energy and nutritional intake derived from SS. This limitation is present in all questionnaires regarding SS consumption frequency [12,13].

Lastly, this survey was conducted at a single point in the season. Nevertheless, the decision was made to conduct it in the middle of the season so that the soccer players would already be familiar with the consumption of SS. This makes it less likely that they would forget what kind of supplements they have been consuming. Soccer players may exhibit shifts in their supplementation habits over time, owing to alterations in nutritional requirements, evolving professional recommendations, or the influence of dietary supplement trends. The CSS may not comprehensively capture such dynamic variations and might require periodic updates to accurately reflect alterations in consumption trends.

### *4.3. Practical Applications*

SS consumption questionnaires can be used in soccer clubs to collect data on the types and amounts of supplements consumed by soccer players. This provides useful information on SS consumption patterns and may help assess the effectiveness and perception of supplements used by elite soccer players. The use of a questionnaire can reveal risky practices related to the consumption of supplements in elite soccer players, such as inappropriate doses or non-recommended combinations of supplements due to possible interactions, or over-reliance on them. This information is crucial in promoting responsible use of supplements among soccer players. Additionally, the questionnaire allows for the collection of data for scientific research in the field of sports supplementation.

## 5. Conclusions

In summary, a substantial portion of the sample regularly includes various SS in their routine, including sports drinks, energy bars, caffeine, creatine, and whey protein. Notably, this consumption is more prevalent among individuals in higher categories, reflecting the growing interest among athletes in enhancing their capabilities. Nevertheless, it is essential to underscore the necessity for further research focused on supplement use among younger populations. Furthermore, when it comes to the quantity of supplements consumed, both sexes exhibited similar patterns, but distinctions emerged in the consumption of sports confectionery, whey protein, β-alanine, and melatonin. Additionally, differences were observed only in caffeine consumption among playing positions, with midfielders and forwards displaying higher levels.

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**Data Availability Statement:** The data presented in this study are available in the tables of this article. The data presented in this study are available on request from the corresponding author.

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## Abbreviations

AIS: Australian Institute of Sport; CSS: Consumption of sports supplements; SS: Sports supplements; UEFA: Union of European Football Associations.

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### 3.5. *Analysis of Fluid Balance and Urine Values in Elite Soccer Players: Impact of Different Environments, Playing Positions, Sexes, and Competitive Levels*

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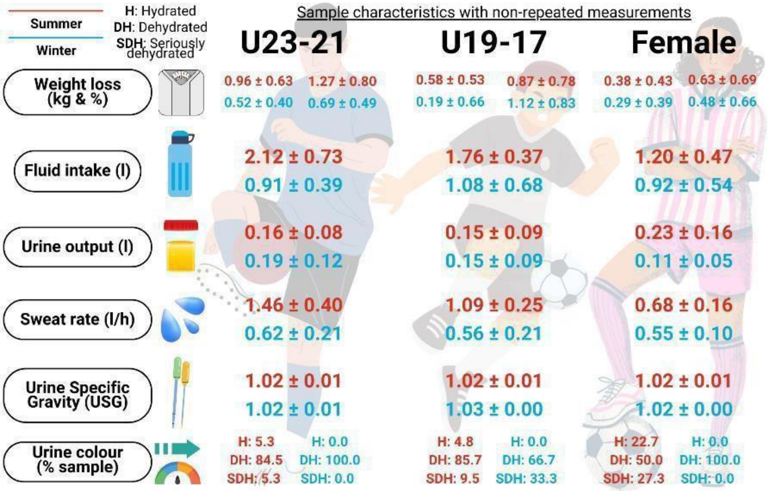
Resumen gráfico:



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*Article*

# Analysis of Fluid Balance and Urine Values in Elite Soccer Players: Impact of Different Environments, Playing Positions, Sexes, and Competitive Levels

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**Abstract:** Exercise can disrupt the fluid balance, hindering performance and athlete health. Limited data exist on fluid balance responses in varying climates, sexes, and ages. This study aimed to measure and compare fluid balance and urine values among elite soccer players during training at high and low temperatures, examining the differences between sexes, playing positions, and competitive levels within men's soccer. During the 2022–2023 competitive season, a descriptive observational study was conducted on 87 soccer players from an elite Spanish soccer team. The study found that none of the groups exceeded weight loss values of 1.5% of their body mass. Additionally, the soccer players studied experienced higher weight loss, fluid intake, and a higher sweat rate (SR) during summer training compared to winter training. During the summer, male U23-21 soccer players exhibited higher levels of weight loss, fluid intake, and a higher SR compared to female soccer players or the U19-17 male category. No significant differences were found between playing positions. In conclusion, differences in the fluid balance were observed based on the climatic conditions, competitive level, and sex.

**Keywords:** hydration; football; sweat rate; soccer; dehydration; fluid balance

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## 1. Introduction

In soccer, players cover an average total distance of approximately 8–14 km during a complete match, including 90 min of play and added extra time [1–4], characterized by a highly variable pattern of actions, such as walking, jogging, running at high and low speeds, sprinting, moving backwards, kicking, jumping, and tackling. In addition, it has been calculated that the average oxygen consumption during a match is around 70% of the maximum oxygen consumption ($VO_2$ max), while the heart rate is approximately 85%, with it being rare to find values below 65% of the maximum values [4,5]. However, when soccer players are dehydrated, they experience a significantly higher heart rate, rate of perceived exertion, blood lactate level, and core body temperature [6].

Exercise can disrupt the fluid balance, which can hinder performance and athlete safety [7]. Both hyperhydration and dehydration are physiological states that should be avoided in athletes [8]. Several factors can increase the risk of dehydration or overhydration, including environmental conditions, such as humidity, altitude, and airflow; fluid availability, such as water stations and hydration breaks; exercise structure, such as the number of daily sessions, duration, and intensity of the exercise; and athlete factors, such as gender, acclimatization status, and body composition; as well as factors specific to the sport being played [7,9,10].

Advance planning through an understanding of each player's individual sweat loss patterns, customized hydration plans, and education on hydration can help ensure that each player receives the appropriate amount of fluid to meet their needs [4]. It is important to note that the sensation of thirst may not always accurately reflect the body's fluid needs [11]. Additionally, the high-intensity nature of soccer, coupled with limited fluid availability during competitions, may increase the risk of dehydration for players [4,12].

It is commonly accepted that during exercise lasting for about two hours or less, the amount of water lost through respiration in the lungs is trivial, and the associated changes in metabolic mass can be ignored [13,14]. Therefore, it is often assumed that for a soccer player, every 1 kg of body mass lost after physical exertion represents approximately 1 L of water loss. This makes it easy to calculate the amount of sweat lost by measuring the change in body mass after correcting for fluid intake [15,16]. Studies indicate that a 2% loss of body weight can negatively impact athletic performance [8], as well as increase the likelihood of heat-related illness [11] and injury [17]. Other methods of assessing hydration levels besides body weight change include thirst level, urine color, urine osmolality, sweat rate (SR), sweat analysis, and urine specific gravity (USG) [4,18,19]. Consequently, the athlete should try to reach the state of euhydration, which represents the optimal water balance in the human body, essential for metabolic function, thermoregulation, and general health, in order to achieve optimal athletic performance and minimize thermoregulatory and physiological stress [11,20].

Female athletes typically have a lower SR than males because they have less muscle tissue to contribute to metabolic heat production during exercise, as well as lower absolute work rates, which could affect their water requirements compared to males [21,22]. In addition, different playing positions have varying anthropometric characteristics and physical demands during matches. Therefore, hydration needs may differ between matches and training [23–26]. Finally, it is important to consider that total daily fluid requirements may vary with age. Adolescents, due to their larger body surface area relative to their mass, may experience greater heat stress when exercising in hot environments compared to adults. This is because they absorb ambient heat more readily than adults [9,11].

In summary, a soccer player's water requirements are influenced by various factors, such as gender, age, daily physical activity, and the environment in which they are playing. However, published studies evaluating parameters related to fluid status in soccer players have not compared all of these characteristics in the same study. Therefore, the aim of this study was to measure and compare the SR, fluid balance, and urine values in elite soccer players during training at high and low temperatures, looking for differences between sexes, playing positions, and competitive levels within men's soccer. Accordingly, it was initially hypothesized that:

**Hypothesis (H1).** *During training, fluid intake will be insufficient according to the official recommendations and calculated SR.*

**Hypothesis (H2).** *The SR and fluid intake will be higher when training at higher temperatures.*

**Hypothesis (H3).** *For physiological reasons, there will be significant differences in the fluid balance, SR, and urine values between the sexes (female team and U23-21) and male competition levels (U23-21 and U19-17). However, there will be no significant differences between playing positions.*

## 2. Materials and Methods

### 2.1. Study Design

This is a descriptive observational study on the fluid balance, SR, and urine values in elite soccer players of both sexes, who belong to the Valencia C.F. Academy. The sample size calculation was performed with the RStudio software (version 3.15.0, RStudio Inc., Boston, MA, USA). The significance level was set a priori at $p = 0.05$. The standard deviation (SD) was set according to the total sweat rate (L/h) data from previous studies on male elite Spanish soccer players (DE = 0.21) [27]. With an estimated error (d) of 0.057, the sample size needed was 62 soccer players. The study population was selected by non-probabilistic, non-injury, convenience sampling among elite soccer players of both sexes belonging to the Valencia C.F. Academy. In addition, the study design, as well as the development of the manuscript, followed the STROBE statement [28].

### 2.2. Participants

The study included all soccer players from the Valencia Mestalla (U23-21), Juvenil A (U19-17), and Valencia CF Femenino teams. However, some players did not return to the club after the first trial, while others were unavailable due to sports-related injuries or promotion to the first team. Therefore, 19 players from the U23-21, 21 from the U19-17, and 22 from Valencia CF Femenino completed the warm environment training, while 12 from the U23-21, 6 from the U19-17, and 7 from Valencia CF Femenino completed the cold environment training. Thus, the sample was analyzed by dividing it into two subgroups: (1) the sample with repeated measurements (RM), and (2) the sample with non-repeated measurements (n-RM). All athletes have competed for at least nine years and perform five regular training sessions, along with two additional sessions per week, lasting approximately 90 to 120 min per day. They play one official soccer match per week. Women who were menstruating were excluded from the study, as this situation may affect urine samples. Table 1 shows the characteristics of the players, differentiating between players who took the test in both weather conditions and players who only participated in one measurement.

**Table 1.** Characteristics of the sample.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **RM Sample** | | | | | | | | | |
| | Males (n = 16) | | | Females (n = 11) | | | Total (n = 27) | | |
| Age (years) | 19.9 (2.4) | | | 22.6 (3.5) | | | 21.0 (3.15) * | | |
| Weight (kg) | 72.9 (4.1) | | | 61.6 (8.7) | | | 68.3 (8.4) * | | |
| Height (cm) | 181.2 (6.0) | | | 165.0 (5.9) | | | 173.1 (8.1) * | | |
| **n-RM sample** | | | | | | | | | |
| | Males | | | Females | | | Total | | |
| | W (n = 40) | C (n = 18) | T (n = 58) | W (n = 22) | C (n = 7) | T (n = 29) | W (n = 62) | C (n = 25) | T (n = 87) |
| Age (years) | 18.4 (2.4) | 19.2 (2.9) | 18.7 (2.5) | 21.0 (3.7) | 25.0 (4.8) | 22.0 (4.3) † | 19.3 (3.1) * | 20.8 (4.3) * | 19.8 (3.6) * |
| Weight (kg) | 70.8 (6.7) | 72.6 (7.3) | 71.3 (6.8) | 59.0 (7.8) | 63.5 (4.8) | 60.1 (7.4) | 66.6 (9.0) * | 70.0 (7.8) * | 67.6 (8.8) * |
| Height (cm) | 181.3 (6.2) | 181.7 (6.9) | 181.5 (6.5) | 165.4 (5.7) | 165.4 (5.9) | 165.4 (5.8) | 173.4 (7.9) * | 173.6 (8.1) * | 173.5 (8.0) * |

W: summer measurement; C: winter measurement; T: total. Variables are expressed as mean (SD). * $p < 0.05$ males vs. females. † $p < 0.05$ warm vs. cool.

### 2.3. Procedure

The assessment was conducted during two training sessions in the month of January and August, during the competition season 2022–2023 in Paterna, Valencia (Spain). One session occurred in the winter (cool), while the other took place in the summer (warm) (Table 2). According to the coach's guidelines, the intensity of the training was considered to be high (MD-3) and was similar in both cases. The sessions were representative of those normally performed by the team on typical days of the week and times in the season. The training sessions consisted of a 20 min warm-up on both the field and in the gym, followed by intervals of running, ball exercises, and 100 min soccer matches. All training sessions took place between 10:00 a.m. and 12:30 p.m., and all players followed the same training protocol. The players wore standard training and match equipment, including shorts, T-shirts, sports bras (for women), socks, shin guards, and soccer boots. The coach conducted the training without any interference from the research team. The players were not required to undergo any dietary control as part of the research. However, they were asked to urinate and defecate prior to the pre-training measurements. The club's nutritionist insisted that the players follow the general hydration and nutrition protocol the day before the sample collection to ensure that all the players were well hydrated before the test.

**Table 2.** Weather conditions during the three training sessions of testing.

| | U23-21 | | U19-17 | | Female | |
|---|---|---|---|---|---|---|
| | C | W | C | W | C | W |
| Initial temperature (°C) | 6 | 26 | 12 | 23 | 13 | 23 |
| Final temperature (°C) | 10 | 29 | 15 | 29 | 18 | 27 |
| Initial relative humidity (%) | 36 | 77 | 88 | 44 | 82 | 49 |
| Final relative humidity (%) | 28 | 59 | 72 | 35 | 51 | 37 |
| Initial wind speed (km·h$^{-1}$) | 12 | 6 | 14 | 11 | 11 | 16 |
| Final wind speed (km·h$^{-1}$) | 6 | 12 | 12 | 22 | 4 | 11 |

W: summer measurement; C: winter measurement.

The athletes were instructed to drink only from their assigned flasks. They were informed to notify the researcher when their flask was empty and needed to be refilled. After the training, the liquid from the canisters was poured into a beaker. The amount of liquid consumed by the athlete during training was calculated by subtracting the volume of liquid poured into the beaker from the total volume of liquid in the canister. To measure the volume of urine excreted by the soccer players, we recorded the volume of urine from the start of each training session until the end. For this purpose, soccer players may urinate before the pre-training weigh-in without the need to measure the volume of urine excreted. However, after the initial weigh-in, they must use an aseptic container with a 2 L capacity for urine collection. The protocol complies with the Declaration of Helsinki for human research and is approved by the Ethics Committee at the University of Valencia (1534145).

### 2.4. *Instruments*

The kinanthropometric measurements were conducted in accordance with ISO 7250-1:2017 [29] and the International Society for the Advancement of Kynanthropometry (ISAK) standard [30], by an accredited ISAK 1 anthropometrist. The body mass and height measurements were taken using a Seca 515/514 bioimpedance machine with an accuracy of 50 g and a Seca 213 transportable stadiometer with an accuracy of 1 mm, respectively. The soccer players were weighed in their underwear and barefoot before the start of training. They were instructed to urinate or defecate before the initial weigh-in. After training, the athletes wiped sweat from their faces, torso, and legs before being weighed again. To record the temperature, relative humidity, and wind speed at the research site, we utilized data from the Agencia Estatal de Meteorología (AEMET) to record the meteorological parameters. These environmental parameters were recorded from the warm-up's start until the end of the training sessions and documented on a record sheet.

The percentage of weight lost was calculated using the equation proposed by Martins [31]: Percentage (%) Weight Lost or Dehydration = [(Weight before − Weight after)/Weight before] − 100. Weight expressed in kg. The calculation of the SR was carried out using the following formula, taken from Murray [19]: SR = (Weight Lost + Fluid Ingested − Urine)/Minutes Activity. Weight expressed in kg.

After the training session, the hydration status was estimated by the urine specific gravity (USG), measured with a digital refractometer (REC-200ATC, Gain Express Holdings Ltd., Hong Kong, China), and the urine color, using the Armstrong scale of 1 to 3 hydrated, 4 to 6 dehydrated, and 7 or 8 seriously dehydrated [32]. The hydration status using the

USG was classified as follows: hydrated (USG ≤ 1.020), dehydrated (USG 1.021–1.024), and seriously dehydrated (USG > 1.024) [20]. The urine color was analyzed in all players who were able to urinate before training; all of them being in a hydrated state.

### 2.5. Stadistical Analysis

The normal distribution of the variables was evaluated using the Kolmogorov–Smirnov and Shapiro–Wilk tests. The homogeneity of variances was analyzed with the Levene test. Categorical variables are described as absolute (n) and relative (%) frequencies, and quantitative variables as the mean (SD). Comparisons between the parametric quantitative variables of 2 independent samples (sample of subjects with one measurement) were made with Student's *t*-test, while the Mann–Whitney U test was employed for the non-parametric ones. Depending on the normality of the variables, comparisons of the quantitative variables of paired samples (sample of subjects with two measurements) were evaluated using Student's *t*-test for repeated measurements or the Wilcoxon W test. The comparison between more than 2 independent means of parametric variables was analyzed by the variance analysis (ANOVA) test; however, the Kruskal–Wallis test was employed when the variables did not follow normal distribution. The comparison between more than 2 means of parametric variables from the sample with repeated measurements were studied using the ANOVA test for repeated measures or the Friedman test if the variables were non-parametric. Differences in the categorical variables were evaluated with the chi-square test. Statistical significance was set at $p < 0.05$. Statistical analysis was performed with the statistical package SPSS 26.0 for Windows.

## 3. Results

### 3.1. Fluid Balance and Sweat Rate

Table 3 shows the fluid balance, SR, and USG values for the two samples analyzed by sex, and in both winter and summer training. During summer training, U23-21 players experienced higher weight loss (RM: 0.87 ± 0.59 kg; 1.17 ± 0.82%/n-RM: 0.96 ± 0.63 kg; 1.27 ± 0.8%), fluid intake (RM: 1.97 ± 0.88 L/n-RM: 2.12 ± 0.73 L), SR (RM: 1.34 ± 0.46 L/h/n-RM:1.46 ± 0.40 L/h), and USG in RM (1.03 ± 0.01) compared to winter training. However, there were no statistically significant differences in the urine output. Female players presented a significantly higher SR during summer training (RM: 0.72 ± 0.17 L/h/n-RM: 0.68 ± 0.16 L/h) in comparison with winter training (RM: 0.63 ± 0.14 L/h/n-RM: 0.55 ± 0.10 L/h). When compared by sex, males had higher weight loss (RM: 0.87 ± 0.59 kg; 1.17 ± 0.82%/n-RM: 0.96 ± 0.63 kg; 1.27 ± 0.8%), fluid intake (RM: 1.97 ± 0.88 L/n-RM: 2.12 ± 0.73 L), SR (RM: 1.34 ± 0.46 L/h/n-RM:1.46 ± 0.40 L/h), and USG (RM: 1.03 ± 0.01/n-RM: 1.02 ± 0.01) during summer training, as well as in the total sample. No statistically significant differences were observed between playing positions during summer and winter training in n-RM. However, midfielders showed higher weight loss (1.07 ± 0.68 kg/1.56 ± 0.90%), fluid intake (1.96 ± 0.82 L), and SR (1.39 ± 0.55 L/h) in the warm training session and lower USG (1.02 ± 0.01) than the other playing positions in the RM (File S1: Results according to playing position).

Table 4 shows the hydration values and fluid balance between the competitive levels for men in both winter and summer training. U19-17 athletes had a higher SR (RM: 1.18 ± 0.31 L/h/n-RM: 1.09 ± 0.25 L/h), fluid intake (RM: 1.72 ± 0.28 L/n-RM: 1.76 ± 0.37 l), and weight loss in RM (0.82 ± 0.62 kg/1.15 ± 0.86%) during warm training, while the USG in n-RM was higher during cool training (1.03 ± 0.00). No statistically significant differences were found in the urine output. When comparing the two levels of competition, U23-21 players showed a higher weight loss (U23-21: 0.96 ± 0.63 kg/U19-17: 0.58 ± 0.53 kg), fluid intake (U23-21: 2.12 ± 0.73 L/U19-17: 1.76 ± 0.37 L), and SR (U23-21: 1.46 ± 0.40 L/h/U19-17: 1.09 ± 0.25 L/h) during summer training in n-RM.

**Table 3.** Hydration and fluid balance values of the sample, as a function of gender.

| | Female | | | U23-21 | | |
|---|---|---|---|---|---|---|
| | W | C | T | W | C | T |
| **RM sample** | | | | | | |
| n | | | 11 | | | 10 |
| Weight loss: | | | | | | |
| kg | 0.40 (0.52) | 0.31 (0.39) | - | 0.87 (0.59) * | 0.42 (0.45) | - |
| % | 0.61 (0.80) | 0.48 (0.59) | - | 1.17 (0.82) | 0.53 (0.58) | - |
| Fluid intake (L) | 1.32 (0.57) | 1.10 (0.40) | - | 1.97 (0.88) *† | 0.83 (0.44) | - |
| Urine output (L) | 0.27 (0.17) | 0.15 (0.11) | - | 0.15 (0.08) | 0.14 (0.08) | - |
| SR: | | | | | | |
| L/h | 0.72 (0.17) † | 0.63 (0.14) | - | 1.34 (0.46) *† | 0.55 (0.16) | - |
| mL/min | 12.05 (2.81) † | 10.46 (2.37) | - | 22.38 (7.67) *† | 9.24 (2.75) | - |
| USG | 1.02 (0.01) † | 1.02 (0.01) | - | 1.03 (0.01) *† | 1.03 (0.00) * | - |
| **n-RM sample** | | | | | | |
| n | 22 | 7 | 29 | 19 | 12 | 31 |
| Weight loss: | | | | | | |
| kg | 0.38 (0.43) | 0.29 (0.39) | 0.35 (0.41) | 0.96 (0.63) | 0.52 (0.40) | 0.79 (0.59) † |
| % | 0.63 (0.69) | 0.48 (0.66) | 0.60 (0.67) | 1.27 (0.8) | 0.69 (0.49) | 1.05 (0.76) † |
| Fluid intake (L) | 1.20 (0.47) | 0.92 (0.54) | 1.13 (0.49) | 2.12 (0.73) | 0.91 (0.39) | 1.65 (0.86) † |
| Urine output (L) | 0.23 (0.16) | 0.11 (0.05) | 0.20 (0.15) | 0.16 (0.08) | 0.19 (0.12) | 0.17 (0.09) |
| SR: | | | | | | |
| L/h | 0.68 (0.16) | 0.55 (0.10) | 0.65 (0.16) † | 1.46 (0.40) | 0.62 (0.21) | 1.14 (0.54) † |
| mL/min | 11.28 (2.65) | 9.12 (1.69) | 10.77 (2.60) † | 24.39 (6.73) | 10.27 (3.49) | 18.9 2 (8.97) † |
| USG | 1.02 (0.01) | 1.02 (0.00) | 1.02 (0.01) | 1.02 (0.01) | 1.02 (0.01) | 1.02 (0.01) |

W: summer measurement; C: winter measurement; SR: sweat rate; T: total; USG: urine specific gravity; variables are expressed as mean (SD). * $p < 0.05$ males vs. females. † $p < 0.05$ warm vs. cool.

**Table 4.** Hydration values and fluid balance of the sample, as a function of male competitive level.

| | U19-17 | | | U23-21 | | |
|---|---|---|---|---|---|---|
| | W | C | T | W | C | T |
| **RM sample** | | | | | | |
| n | | | 6 | | | 10 |
| Weight loss: | | | | | | |
| kg | 0.82 (0.62) † | 0.27 (0.21) | - | 0.87 (0.59) | 0.42 (0.45) | - |
| % | 1.15 (0.86) † | 0.37 (0.27) | - | 1.17 (0.82) | 0.53 (0.58) | - |
| Fluid intake (L) | 1.72 (0.28) † | 0.88 (0.14) | - | 1.97 (0.88) † | 0.83 (0.44) | - |
| Urine output (L) | 0.18 (0.08) | 0.14 (0.04) | - | 0.15 (0.08) | 0.14 (0.08) | - |
| SR: | | | | | | |
| L/h | 1.18 (0.31) † | 0.51 (0.05) | - | 1.34 (0.46) † | 0.55 (0.16) | - |
| mL/min | 19.69 (19.41) † | 8.45 (0.88) | - | 22.38 (7.67) † | 9.24 (2.75) | - |
| USG | 1.03 (0.00) | 1.03 (0.01) | - | 1.03 (0.01) | 1.03 (0.00) | - |
| **n-RM sample** | | | | | | |
| n | 21 | 6 | 27 | 19 | 12 | 31 |
| Weight loss: | | | | | | |
| kg | 0.58 (0.53) | 0.19 (0.66) | 0.50 (0.57) | 0.96 (0.63) | 0.52 (0.40) | 0.79 (0.59) † |
| % | 0.87 (0.78) | 1.12 (0.83) | 0.74 (0.81) | 1.27 (0.8) | 0.69 (0.49) | 1.05 (0.76) † |
| Fluid intake (l) | 1.76 (0.37) | 1.08 (0.68) | 1.61 (0.53) † | 2.12 (0.73) | 0.91 (0.39) | 1.65 (0.86) † |
| Urine output (l) | 0.15 (0.09) | 0.15 (0.09) | 0.15 (0.09) | 0.16 (0.08) | 0.19 (0.12) | 0.17 (0.09) |
| SR: | | | | | | |
| L/h | 1.09 (0.25) | 0.56 (0.21) | 0.98 (0.33) † | 1.46 (0.40) | 0.62 (0.21) | 1.14 (0.54) † |
| mL/min | 18.24 (4.19) | 9.38 (3.45) | 16.27 (5.47) † | 24.39 (6.73) | 10.27 (3.49) | 18.9 2 (8.97) † |
| USG | 1.02 (0.01) | 1.03 (0.00) | 1.03 (0.00) † | 1.02 (0.01) | 1.02 (0.01) | 1.02 (0.01) |

W: summer measurement; C: winter measurement; SR: sweat rate; T: total; USG: urine specific gravity; variables are expressed as mean (SD). † $p<0.05$ warm vs. cool.

Figure 1 shows the SR values by team and by season of the year in which the evaluation was carried out. During the summer training, the female team had the lowest SR value (RM: 0.72 ± 0.17 L/h/n-RM: 0.68 ± 0.16 L/h), followed by the U19-17 (RM: 1.18 ± 0. 31 L/h/n-RM: 1.09 ± 0.25 L/h), while the U23-21 (RM: 1.34 ± 0.46 L/h/n-RM: 1.46 ± 0.40 L/h) had the highest value (RM: 1.34 ± 0.46 L/h/n-RM: 1.46 ± 0.40 L/h). In addition, the female team exhibited the lowest mean SR (n-RM: 0.65 ± 0.16 L/h), followed by the U19-17 (n-RM: 0.98 ± 0.33 L/h), and the U23-21 (n-RM: 1.14 ± 0.54 L/h).

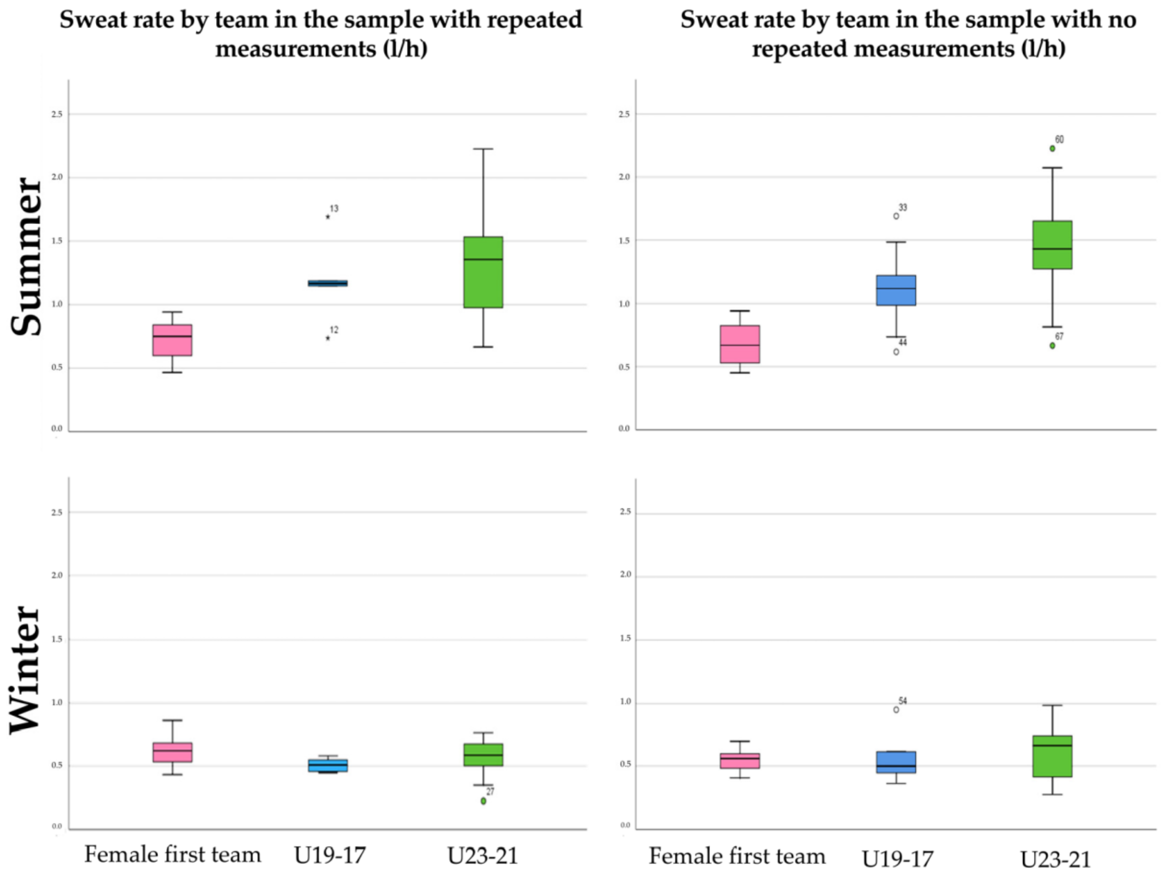


**Figure 1.** Sweat rate by team.

### 3.2. Hydration Status

Table 5 shows the hydration status as a function of sex in both winter and summer training. No statistically significant differences in the urine color status and USG were observed, regardless of the type of training. No statistically significant differences were observed between the playing positions during summer and winter training (File S1: Results according to playing position).

Table 6 shows the hydration status as a function of the level of competition in both winter and summer training. Statistically significant differences in the urine color were observed during winter training in n-RM, with the entire sample of the U23-21 team in the DH category. No statistically significant differences in the USG and urine color were observed during summer training. Figure 2 shows the hydration status by team and by season of the year in which the evaluation was carried out.

**Table 5.** Hydration status as a function of sex.

| | | Female | | U23-21 | |
|---|---|---|---|---|---|
| | | **CO** | **USG** | **CO** | **USG** |
| **RM sample. (n (%))** | | | | | |
| n | | 11 | | 10 | |
| H: | W | 3 (27.3) | 6 (54.5) | 0 (0.0) | 2 (20.0) |
| | C | 0 (0.0) | 5 (45.5) | 0 (0.0) | 1 (10.0) |
| DH: | W | 5 (45.5) | 2 (18.2) | 9 (90.0) | 3 (30.0) |
| | C | 11 (100.0) | 1 (9.1) | 10 (100.0) | 2 (20.0) |
| SDH: | W | 3 (27.3) | 3 (27.3) | 1 (10.0) | 5 (50.0) |
| | C | 0 (0.0) | 5 (45.5) | 0 (0.0) | 7 (70.0) |
| **n-RM sample. (n (%))** | | | | | |
| n | | 29 | | 31 | |
| H: | W | 5 (22.7) | 9 (40.1) | 1 (5.3) | 4 (21.1) |
| | C | 0 (0.0) | 2 (28.6) | 0 (0.0) | 4 (33.3) |
| DH: | W | 11 (50.0) | 7 (31.8) | 17 (84.5) | 5 (26.3) |
| | C | 7 (100.0) | 2 (28.6) | 12 (100.0) | 2 (16.7) |
| SDH: | W | 6 (27.3) | 6 (27.3) | 1 (5.3) | 10 (52.6) |
| | C | 0 (0.0) | 3 (42.9) | 0 (0.0) | 6 (50.0) |

W: summer measurement; C: winter measurement; CO: urine color; DH: dehydrated; H: hydrated; SDH: seriously dehydrated; USG: urine specific gravity. Variables are expressed as n (%).

**Table 6.** Hydration status as a function of the male competitive level.

| | | U19-17 | | U23-21 | |
|---|---|---|---|---|---|
| | | **CO** | **USG** | **CO** | **USG** |
| **RM sample. (n (%))** | | | | | |
| n | | 6 | | 10 | |
| H: | W | 0 (0.0) | 0 (0.0) | 0 (0.0) | 2 (20.0) |
| | C | 0 (0.0) | 1 (16.7) | 0 (0.0) | 1 (10.0) |
| DH: | W | 4 (66.7) | 2 (33.3) | 9 (90.0) | 3 (30.0) |
| | C | 6 (100.0) | 2 (33.3) | 10 (100.0) | 2 (20.0) |
| SDH: | W | 2 (33.3) | 4 (66.7) | 1 (10.0) | 5 (50.0) |
| | C | 0 (0.0) | 3 (50.0) | 0 (0.0) | 7 (70.0) |
| **n-RM sample. (n (%))** | | | | | |
| n | | 27 | | 31 | |
| H: | W | 1 (4.8) | 3 (14.3) | 1 (5.3) | 4 (21.1) |
| | C | 0 (0.0) | 0 (0.0) | 0 (0.0) * | 4 (33.3) |
| DH: | W | 18 (85.7) | 9 (42.9) | 17 (84.5) | 5 (26.3) |
| | C | 4 (66.7) | 1 (16.7) | 12 (100.0) * | 2 (16.7) |
| SDH: | W | 2 (9.5) | 9 (42.9) | 1 (5.3) | 10 (52.6) |
| | C | 2 (33.3) | 5 (83.3) | 0 (0.0) * | 6 (50.0) |

W: summer measurement; C: winter measurement; CO: urine color; DH: dehydrated; H: hydrated; SDH: seriously dehydrated; USG: urine specific gravity. Variables are expressed as n (%). * $p < 0.05$ hydration status vs. team.

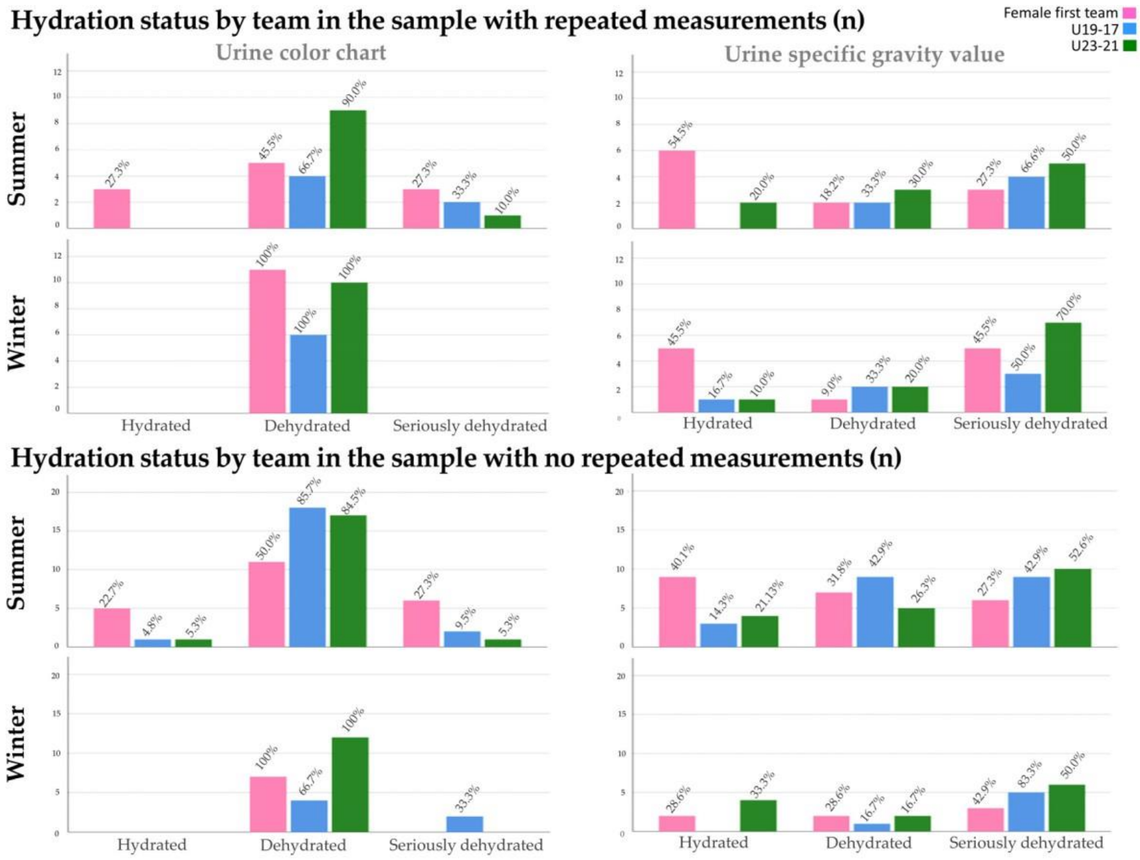


**Figure 2.** Hydration status by team.

## 4. Discussion

To our knowledge, this is the first study to analyze the fluid balance, SR, and urine values during training in different climatic conditions in elite soccer players, comparing them across playing positions, sexes, and male competitive levels. The main results were as follows: (1) neither group consumed the recommended amount of fluids based on the official recommendations and calculated SR, but they did not exceed weight loss values of 1.5% of their body mass; (2) weight loss, fluid intake, and SR were higher during summer training than winter training in all the groups of soccer players studied. Nonetheless, urine collected did not vary. (3) During summer, U23-21 players showed higher values for weight loss, fluid intake, and SR than female athletes, or the U19-17 male category; (4) no differences in the hydration status or SR were observed between playing positions.

### 4.1. Fluid Balance and Sweat Rate

The International Olympic Committee (IOC) recommends, as a general guideline, the consumption of 6 mL of fluid per kg of body mass every 2–3 h, which amounts to 2–3 L per day. Additionally, it is recommended to consume 1–2 L of fluid per hour of exercise and 1 L for every 5 °C increase in ambient temperature above 21.5 °C [33]. However, the SR of athletes varies significantly due to factors such as environmental conditions, metabolic rate, clothing, and heat acclimatization [7,33]. The amount of fluid lost through sweating can range from less than 1 to more than 3 L per hour [33]. Therefore, it is difficult to establish an absolute recommendation for fluid intake during exercise. Additionally, limiting the rate of gastric emptying affects the amount of fluid an athlete can ingest during competition [33].

In a recent study, data were collected from different sports modalities, where 268 soccer players were included, obtaining mean values of 0.94 ± 0.38 L/h in SR and 795 ± 441 mg/h (34.6 ± 19.2 mmol/h) in lost sodium [34]. However, it should be noted that they did not differentiate between level categories or sexes. In a second study, they included

497 soccer players (415 male and 82 female) and found a mean SR range of 0.3–2.5 L/h, although, as in the previous study, the data were not differentiated between athletes [8]. In addition, the review assessed the potential impact of hypohydration on cognitive function, sport-specific skills, sprinting ability, and high-intensity intermittent performance in soccer. The data indicate significant negative effects; however, additional research is required for more precise conclusions. The average results for the SR in the U23-21 category (1.14 ± 0.54 L/h), both in summer (RM: 1.34 ± 0.46 L/h/n-RM: 1.46 ± 0.40 L/h) and winter (RM: 0.55 ± 0.16 L/h/n-RM: 0.62 ± 0.21 L/h), are consistent with the previously mentioned reviews, thus supporting the consistency of our findings.

In relation to weight lost, Shirreffs et al. evaluated fluid intake (830 ± 380 mL) and weight loss (1.5 ± 0.5%) after a 90 min training session in 67 soccer players, from three European professional teams [35]. However, the study did not find any relationship between body mass and sweat loss or volume of fluid consumed. Therefore, factors such as activity rate, heat acclimatization status, and genetic differences likely contribute to the large variability observed among soccer players. Another study collected data from 19 semi-professional soccer players on their SR (0.86 ± 0.42 L/h), fluid intake (768 ± 292 mL), body weight loss (1.07 ± 0.62 kg and 1.46 ± 0.84%), and environmental conditions (23.9 ± 2.63 °C) over an 11-week period [36]. Although most soccer players did not match fluid loss during training, the results showed that a fluid intake above ~10 $mL \cdot kg^{-1}$ body weight was associated with an increase in the total distance traveled and high-speed running distance during prolonged training sessions (>110 min) [36].

The weight loss values observed in our study were lower than those reported in the literature. The mean weight loss values for U23-21 soccer players were 1.05 ± 0.76%, for U19-17 players it was 0.74 ± 0.81%, and for female players it was 0.60 ± 0.67%. Our results found that fluid intake during training was higher than previously reported. Specifically, the mean values for U23-21 (1.65 ± 0.86 L), U19-17 (1.61 ± 0.53 L), and female players (1.13 ± 0.49 L) were all higher than in previous studies. This trend was also observed in both summer and winter values across all three groups of soccer players. Possible reasons for the observed differences between players may include environmental factors such as temperature or humidity, variations in training intensity, differences in acclimatization status, body composition (including fat and muscle mass), and variations in dietary education and hydration habits.

When quantifying a player's hydration, it is important to consider training intensity. Several studies have shown that higher intensity training is associated with greater weight loss, greater loss of sodium in sweat, and a higher SR [27,37]. Therefore, the hydration needs of soccer players should be increased accordingly. Our research was conducted during MD-3 in both summer and winter to ensure that all soccer players were subjected to the same physical demands and to eliminate bias.

Women experience changes in fluid balance throughout the menstrual cycle due to hormonal variations. In the follicular phase, estrogen, luteinizing hormone, and follicle-stimulating hormone levels increase, affecting the regulation of body fluids. During the luteal phase, there is a significant increase in body temperature of 0.3 to 0.5 °C at rest and during exercise. This could increase the risk of heat-related illness, especially if combined with dehydration [38,39]. Thus, in female elite soccer players, it was observed that sweat sodium loss and SR during exercise were related to basal testosterone concentration, but not to basal cortisol concentration or the testosterone/cortisol ratio [40]. Hormonal changes can impact fluid dynamics, body temperature, thirst, and, consequently, athletic performance and overall health [8,38]. Nevertheless, it is important to note that the specific interaction between SR, the menstrual cycle, and hydration requires further research to fully understand its impact on women's health and performance.

Studies have shown that women generally have lower SR values due to their lower body mass and lower absolute work rates [12,21]. Our results are consistent with the scientific literature, indicating lower values in female soccer players (0.65 ± 0.16 L/h) compared to U23-21 male soccer players (1.14 ± 0.54 L/h), particularly during summer training in both RM (0.72 ± 0.17 L/h vs. 1.34 ± 0.46 L/h) and n-RM (0.68 ± 0.16 L/h vs. 1.46 ± 0.40 L/h).

A recent study assessed the fluid balance of eight female professional soccer players during a training session and a match [12]. During training, the athletes experienced a slight increase in weight (0.2 ± 0.3 kg; 0.29 ± 0.57%) and a urine output of 104 ± 257 mL, along with a SR of 0.49 ± 0.26 L/h. In contrast, during the match, the athletes experienced a decrease in weight (0.7 ± 0.5 kg; 1.12 ± 0.86%) and a urine output of 107 ± 83 mL, along with a SR of 0.85 ± 0.30 L/h [12]. Our study found that weight decreased after training (0.35 ± 0.41 kg; 0.60 ± 0.67%), while the urine output (0.20 ± 0.15 L) and SR (0.65 ± 0.16 L/h) remained similar.

Concerning young soccer players, there seems to be a tendency to underestimate their sweat losses, which can lead to inadequate hydration during training (especially in hot conditions) [41]. Food education is crucial for optimizing the nutrition and hydration of young soccer players. It can enhance their knowledge and enable them to apply it during their future careers. Effective interventions include talks, informative posters, infographics, and web or mobile applications. These interventions have been shown to improve knowledge and habits in young soccer players [42–44]. In our study, we found that U19-17 soccer players had lower values for SR, fluid intake, and weight loss after exercise compared to U23-21 soccer players, particularly during summer training. Physiological differences may contribute to discrepancies in these values. Factors such as a higher basal metabolic rate in adults, a higher body mass to body surface area ratio, more efficient thermoregulatory capacity in adults, physiological development, and established hydration habits may result in a greater need for thermoregulation through sweating during exercise [4,42,45].

### *4.2. Hydration Status and Environment*

The prevalence of starting exercise in a hypohydrated state has been observed in soccer players. The prevalence of hypohydration was observed to be 63.3% using the USG as a measurement method, 37.4% using urine osmolarity, and 58.8% using urine color [45]. Male, elite soccer players during pre-training had a higher prevalence of hypohydration states (66.0%, 66.2%, and 79.6%, respectively) compared to female, recreational, and pre-game players (49.4%, 55.6%, and 41.3%, respectively) [45]. Furthermore, the scientific literature documents instances of young athletes arriving at training sessions and competitions already dehydrated [4].

Exercise in hot conditions led to significant increases in heart rate, the rate of perceived exertion, and skin temperature, while the temperature gradient decreased [33,46]. Conversely, no significant changes in blood lactate concentration were observed during exercise in cold conditions [46]. These results suggest that the environmental temperature has a significant impact on the physiological response during exercise, which may affect perceived fatigue and performance. During prolonged exercise in hot environmental conditions, the IOC recommends consuming fluids containing diluted carbohydrates and electrolytes to improve the overall fluid intake. On the one hand, the diluted carbohydrates and electrolytes increase the palatability of fluids [33]. On the other hand, carbohydrate intake during exercise can increase the time to exhaustion and decrease the heart rate during tests [46]. None of the soccer players studied consumed carbohydrate-rich beverages during training. This may be due to personal preference or nutritional recommendations from the nutritionist based on the caloric and/or carbohydrate load of the microcycle, which focuses on carbohydrate periodization [47].

Regarding low temperatures, they may lead to reduced hydration needs. However, the relationship between sweat loss and fluid intake is complex and can vary between individuals. Additionally, in these conditions, athletes may experience a decreased thirst sensation, which could increase the risk of dehydration if proper hydration habits are not maintained [14]. A study was conducted to analyze the fluid and electrolyte balance of 17 professional soccer players during a training session at 5.1 ± 0.7 °C. The players experienced a weight loss of 1.62 ± 0.55% (1.27 ± 0.47 kg), their water intake was 423 ± 215 mL, and their SR was 1.13 ± 0.30 L/h [14]. Another study assessed the fluid balance of 14 professional soccer players in response to low and high cold training intensities. The study found that the SR (0.98 ± 0.21 L/h) and fluid intake (505 ± 265 mL) were higher at a high intensity compared to a low intensity (0.55 ± 0.20 L/h and 394 ± 160 mL, respectively), while maintaining a similar USG (1.023 ± 0.004 at high intensity and 1.024 ± 0.005 at low intensity) [27].

Considering the IOC's recommendation to keep USG levels below 1.020 [33], our results showed that most of the players in all categories ended up dehydrated or severely dehydrated, especially the U19-17 in winter training (RM: 1.03 ± 0.01/n-RM: 1.03 ± 0.00). There could be several reasons for this. Firstly, it may be due to inadequate hydration or poor dietary intake prior to training, although it should be noted that the club's nutritionist provided and implemented the necessary dietary and hydration recommendations to the players the day before the test. Additionally, it could be attributed to the intensity of the training, as it was demanding for all players. However, it is important to note that these players are considered elite and have at least 9 years of competitive experience.

In addition to testing the USG, another method to assess the hydration of soccer players is through bioimpedance (BIA). BIA is a non-invasive and easy-to-apply method based on the principle that body water conductivity varies between different compartments and can be used to calculate fat mass and fat-free mass (including total body water) [48]. Determining the water status prior to training and/or competitions could enhance hydration patterns and prevent adverse effects, such as dehydration and hyperhydration, which can negatively impact sports performance or increase the risk of injury [49]. However, it is important to note that certain diseases, treatments, clinical situations, and individual conditions (such as ethnicity and extremity position), as well as the type of bioimpedance (including the number of electrodes and frequency), and rules of use, may affect the results of this instrument [50]. Therefore, it is advisable to combine methods to avoid measurement errors.

### 4.3. Limitations

This research had some limitations that should be discussed. Although the study population was small, all Spanish soccer players in the selected sample were recruited, which is a significant sample size according to the statistical principles applied. In addition, the concentrations of electrolytes, such as sodium or potassium, in sweat were not analyzed due to logistical reasons, which is useful for the quality control of sweat samples. Another limitation of the present study was that fluid intake was only assessed during exercise. Assessing the first morning USG, 24 h urine volumes, and/or 24 h fluid intake before training would provide information on the influence of basal hydration on the SR and urine color. Additionally, the second evaluation was completed 5 months after the initial tests conducted in August. It is unclear whether the sweat rate and fluid intake of the players were influenced by acclimatization, food education by the club dietitian-nutritionist, or changes in their physical condition during the observed period. In addition, none of the players consumed carbohydrates during exercise, and future studies could explore how carbohydrate sources, such as gels, bars, and sports drinks, may affect players' ad libitum water intake. Lastly, although the sample incorporating n-RM is larger, it is important to consider both intra- and inter-individual variability when interpreting the results. However, we included the RM sample to enhance the sensitivity and reliability of the results.

### 4.4. Practical Applications

The following practices are recommended for soccer clubs due to the variability of fluid balance and urine values:

1. Food education: Implement food education programs for soccer players, especially in youth categories, to promote understanding about and the importance of adequate fluid and food intake to support sports performance and recovery. The use of info-

graphics, presentations, or posters can contribute to this. In addition, it is advisable to encourage the consumption of seasonal foods that can contribute to hydration, such as vegetables like beet, cucumber, and tomato, and fruits like watermelon, orange, and melon, as well as animal milk or vegetable drinks.

2. Body composition monitoring: To monitor changes in hydration and adjust nutritional and hydration strategies, body composition assessment methods, such as electrical bioimpedance, should be used.
3. Sex: It is important to consider sex differences when it comes to hydration. Recognize and address differences in hydration needs between males and females, including the influence of the menstrual cycle on the sweat rate and sodium loss.
4. Climate adaptation: To prepare athletes for competing in high temperature conditions and minimize the risk of heat-related illnesses, climate adaptation programs should include acclimatization to different temperatures and relative humidity.
5. Urinary values: Urinary indices can be used as a tool to assess the hydration status of athletes before and after physical demands. This information can be used to make timely adjustments in fluid intake.
6. Hydration interventions during training and competitions: It is recommended to establish hydration practices and protocols during exercise sessions. This includes providing regular drinking breaks and making hypotonic, isotonic, or hypertonic beverages available, according to individual needs.
7. Individualized hydration strategies: It is crucial to develop individualized hydration plans for athletes, since hydration affects cognitive, technical, and physical performance. To achieve this, it is desirable to know certain values, such as the sweat rate or sodium concentration in sweat, not only at the team level but also on an individual basis.

## 5. Conclusions

The main findings indicate that the soccer players did not meet the recommended fluid intake based on the official guidelines and calculated SR; however, they did not exceed a 1.5% body mass loss. Furthermore, summer training sessions consistently resulted in higher weight loss, fluid intake, and SR compared to winter sessions across all player categories. Among the U23-21 male football players, these values were higher than those of their female counterparts and the U19-17 male category. Lastly, no significant differences were observed between the various playing positions.

**Supplementary Materials:** The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/nu16060903/s1, File S1: Results according to playing position. Table S1. Hydration values and fluid balance of the sample as a function of playing position. Table S2. Hydration values and fluid balance of the sample as a function of playing position. Figure S1. Sweating rate by player position of the sample with repeated measurements. Figure S2. Sweating rate by player position of the sample with non-repeated measurements. Figure S3. Hydration status by player position of the sample with repeated measurements. Figure S4. Hydration status by player position of the sample with non-repeated measurements.

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## Abbreviations

AEMET: Agencia Estatal de Meteorología; BIA: bioimpedance; n-RM: non-repeated measurements; RM: repeated measurements; SR: sweat rate; USG: urine specific gravity.

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# CUARTO CAPÍTULO: CONCLUSIONES

**«***Podría estar haciendo esto todo el día***»**

Capitán América (interpretado por Chris Evans)

1. La tendencia de la CC del futbolista profesional es mostrar un somatotipo mesomorfo balanceado, una suma media de 6 y 8 pliegues cutáneos de 52,18 y 59,93 mm respectivamente; un valor de AC total de 47,52 l, una DMO de1,33 g/cm³ y un CMO de 3,17 kg.

2. Existen diferencias significativas en la medición de la talla, el porcentaje y peso de MG, y el peso de MLG, con valores oscilantes en función del método y/o fórmula aplicada. En cambio, no parece haber diferencias significativas entre los métodos de medición para el cálculo del peso, porcentaje de MLG, y el porcentaje y peso de MM.

3. En relación con las diferencias en las posiciones de juego, el portero muestra la mayor estatura, edad, peso corporal, sumatorio de pliegues cutáneos y MM; el defensa la mayor edad y MM (al igual que los porteros); el centrocampista la menor estatura, peso total y MM; y los delanteros los más jóvenes, con la menor suma de pliegues cutáneos y la menor MM (al igual que los centrocampistas).

4. Entre posiciones de juego de futbolistas profesionales masculinos, no se observaron diferencias significativas en el CMO, DMO, somatotipo, peso y porcentaje de MG.

5. Los hombres tienden a consumir más alimentos ricos en CH, alimentos fermentados, alimentos congelados y carnes rojas en comparación con las mujeres, mientras que las mujeres frecuentan más las carnes magras que los hombres.

6. Los futbolistas más jóvenes mostraron una dieta con una mayor ingesta de CH y alimentos poco saludables como dulces y alimentos congelados en comparación con los jugadores de

mayor nivel competitivo. Además, no se observaron diferencias significativas en los patrones alimentarios entre las diferentes posiciones de juego.

7. Los futbolistas de la Academia Valencia C.F. mayoritariamente consumen suplementos, destacando las bebidas deportivas (55,7%), barritas energéticas (50,0%), cafeína (47,1%), creatina (60,0%) y proteína de suero (48,6%). Además, el consumo de suplementos es más frecuente en los futbolistas de mayor nivel competitivo frente a las categorías inferiores.

8. Hubo diferencias en el consumo de suplementos entre sexos. Los hombres consumían más confitería deportiva (21,4%), mientras que las mujeres consumían más proteína de suero (71,4%), β-alanina (25,0%) y melatonina (28,6%). Además, se encontraron diferencias en el consumo de cafeína entre las diferentes posiciones de juego, siendo más prevalente entre los centrocampistas (66,7%) y los delanteros (62,5%).

9. Los futbolistas no alcanzaron la ingesta de líquidos recomendada según las directrices oficiales y la tasa de sudoración calculada, aunque no superaron una pérdida de peso corporal del 1,5%.

10. Durante el entrenamiento de verano, se observó un aumento en la pérdida de peso, la ingesta de líquidos y la tasa de sudoración en comparación con el entrenamiento de invierno en todos los futbolistas. Los jugadores masculinos de mayor categoría mostraron valores más altos en estos aspectos en comparación con las jugadoras femeninas y los jugadores masculinos más jóvenes. Además, no hubo diferencias significativas en los niveles de hidratación entre las diferentes posiciones de juego.

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# ANEXO

El comité Ético de Investigación en Humanos de la Comisión de Ética en Investigación Experimental de la Universitat de València,

CERTIFICA:

Que el Comité d'Ètica d'Investigació en Humans , en la reunión celebrada el día , una vez estudiado el proyecto de tesis doctoral : *"Valoración cineantropométrica, nutricional y consumo de suplementos en futbolistas de élite "*, con número de registro1534145 .

Cuyo/a responsable es D/Dña.

JAIME SEBASTIA RICO , dirigida por D/Dña. JOSE MIGUEL

SORIANO DEL CASTILLO

ha acordado informar favorablemente el mismo.

Y para que conste, se firma el presente certificado

Av. Blasco Ibáñez, 13 tel: 963864109 vicerec.investigacio@uv.es
València 46010 fax: 963983221 www.uv.es/serinves

The Ethics Committee of Research in Humans of the Ethics Commission in Experimental Research of University of Valencia,

CERTIFY:

Hereby certify that the Ethics Committee of Research in Humans, in the session which took place on , analysed the project of doctoral thesis entitled *"Kinanthropometric, nutritional assessment and consumption of supplements in elite soccer players "*, with register code 1534145 .

Whose researcher in charge is JOSE MIGUEL SORIANO DEL CASTILLO , and agreed with this project.

And in witness whereof, I hereby sign this certificate

Av. Blasco Ibáñez, 13 tel: 963864109 vicerec.investigacio@uv.es
València 46010 fax: 963983221 www.uv.es/serinves

Comité d'Ètica d'Investigació en Humans de la Comissió d'Ètica en Investigació Experimental de la Universitat de València,

CERTIFICA:

Que Comité d'Ètica d'Investigació en Humans , en la reunió que tingué lloc el dia , una vegada estudiat el projecte de tesi doctoral titulat:*"Avaluació cineantropomètrica, nutricional i consum de suplements en futbolistes d'elit "*, amb codi de registre 1534145 .
que té com a responsable
JAIME SEBASTIA RICO , i que va dirigir JOSE MIGUEL SORIANO DEL CASTILLO ,
ha acordat emetre'n un informe favorablement .

I perquè així conste, signa aquest certificat.

Av. Blasco Ibáñez, 13   tel: 963864109   vicerec.investigacio@uv.es
València 46010   fax: 963983221   www.uv.es/serinves

## INFORMACIÓN AL SUJETO DE EXPERIMENTACIÓN.

*El proyecto de investigación para el cual le pedimos su participación se titula*:
Valoración cineantropométrica, nutricional y consumo de suplementos en futbolistas de élite

Para que usted pueda participar en este estudio es necesario contar con su consentimiento, y que conozca la información básica necesaria para que dicho consentimiento pueda considerarse verdaderamente informado. Por ello, le ruego que lea detenidamente la siguiente información. Si tuviera alguna duda exprésela, antes de firmar este documento, al investigador principal del proyecto, bien personalmente, bien a través del teléfono o por correo electrónico. Los datos del investigador principal del proyecto aparecen también en el presente documento.

La información básica que debe conocer es la siguiente:

## OBJETIVOS DEL ESTUDIO

Objetivo General:
Evaluar y analizar la composición corporal, nutrición, hidratación y consumo de suplementos en futbolistas. Para llevar a cabo el objetivo general se desarrollarán los siguientes objetivos específicos.

Objetivos específicos:

- Describir las características antropométricas y de composición corporal, los hábitos de alimentación e hidratación, consumo de suplementos deportivos y la autopercepción de salud de los jugadores antes, durante y al finalizar la temporada.

- Relacionar y comparar, en diferentes momentos de la temporada, los cambios producidos en la composición corporal y hábitos de alimentación, hidratación y consumo de suplementos.

- Estudiar las diferencias antropométricas y de composición corporal, así como los hábitos alimentarios, hidratación y consumo de suplementos entre los jugadores de futbol de diferentes categorías de edad.

Los resultados de los proyectos de investigación pueden derivar del uso de estas muestras biológicas pueden contribuir a la mejora en el diagnóstico y tratamiento de enfermedades. Tanto las muestras como los datos asociados a las mismas serán custodiados y en su caso cedidos a terceros con fines de investigación biomédica en los términos previstos en la Ley 14/2007, de 3 de julio, y en el Real Decreto 1716/2011, de 18 de noviembre.

## METODOLOGÍA

Se trata de un estudio de seguimiento clínico, de carácter retrospectivo. Se recopilaran de la historia clínica que obra en la *Clínica Universitaria de Nutrición, Actividad Física y Fisioterapia (CUNAFF) los* siguientes datos: Datos antropométricos, datos obtenidos de cuestionarios y datos de muestras biológicas relacionadas con la orina y sudoración.

Toda ésta información, está en la historia clínica y no se le van a realizar pruebas o exploraciones adicionales.

El acceso a la historia clínica, la realizará una persona en formación, debidamente autorizada y con un código de registro de acceso, que conoce la normativa emanada de la *Orden SSI/81/2017, de 19 de enero, por la que se publica el Acuerdo de la Comisión de Recursos Humanos del Sistema Nacional de Salud, por el que se aprueba el protocolo mediante el que se determinan pautas básicas destinadas a asegurar y proteger el derecho a la intimidad del paciente por los alumnos y residentes en Ciencias de la Salud*. *(En caso de que se trate de otra persona, especificar)*

En ningún caso se compartirá la información recopilada utilizando sistemas de información y/o herramientas informáticas/redes sociales, que no se encuentren sujetos a los sistemas de seguridad del Centro y estará supervisado por el responsable de los procesos asistenciales en el centro, de acuerdo con lo dispuesto en el artículo 104 de la LGS en relación con lo previsto en el Real Decreto 1558/1986.

**BENEFICIOS ESPERADOS**

Los resultados de éste proyecto de investigación pueden contribuir a la mejora del rendimiento futbolístico como para una adecuada composición corporal y, con ello, una óptima salud.

**CONSECUENCIAS PREVISIBLES DE SU NO PARTICIPACIÓN Y DERECHO DE REVOCACIÓN DEL CONSENTIMIENTO**

La participación en este estudio es voluntaria y puede cancelarse en cualquier momento. Si rechaza participar, no habrá consecuencias negativas para usted. Si se retira del proyecto, puede decidir sin los datos utilizados hasta éste momento, deben borrarse o si se pueden seguir utilizando tras haberlos convertido en anónimos (p. ej., eliminando los datos de la información identificativa, incluido el código, para que resulte imposible volver a identificarlos). No percibirá ninguna compensación económica o de otro tipo por participar en ésta investigación.

**PROTECCIÓN DE DATOS PERSONALES Y CONFIDENCIALIDAD**

Se han adoptado las medidas oportunas para garantizar la completa confidencialidad de los datos personales de los sujetos de experimentación que participen en este estudio, de acuerdo con la Ley de Protección de Datos de Carácter Personal (LOPD) 3/2018, de 5 de diciembre.

A cada participante se le asignará un código numérico, que no guardará relación con el número de historia ni con ningún dato identificativo del paciente, por lo que el tratamiento de los datos se realizará de forma anónima por parte de los investigadores. Dicho código le será asignado por el responsable del Centro, Consulta, Departamento o Unidad Clínica.

En el caso que se utilicen los resultados del estudio, con fines de docencia, investigación y/o publicación, se respetará siempre la debida anonimización de los datos de carácter personal, de modo que los sujetos de la investigación no resultarán identificados o identificables.

El titular de los datos personales podrá ejercitar los derechos de acceso, rectificación, cancelación y oposición al tratamiento de datos de carácter personal, y de revocación del consentimiento, en los términos previstos en la normativa aplicable. *(Si lo considera oportuno, puede detallar más esas medidas)*

**INFORMACIÓN DE CONTACTO**

Si tienen alguna pregunta sobre este proyecto de investigación, puede consultar en cualquier momento al Investigador responsable del estudio: Jaime Sebastiá Rico tf: +34 638968102 email: Jaime.sebastia@fundacions.uv.es . Si deciden participar en este proyecto, rellenen y firmen el formulario de consentimiento que aparece a continuación.

**CONSENTIMIENTO INFORMADO DEL PACIENTE PARA LA UTILIZACIÓN DE DATOS CLÍNICOS**

*EJEMPLAR PARA EL PACIENTE*

*Si la persona es mayor de edad, se recomienda utilizar esta fórmula:*

D./Dña. ______________________________ mayor de edad, titular del DNI: ____________________, por el presente documento manifiesto los siguientes consentimientos:

*Si la persona es menor de edad o está incapacitada legalmente, se recomienda utilizar esta fórmula:*

D./Dña. _____________________________, mayor de edad, titular del DNI: ____________________, [padre, madre o tutor legal de ____________________________], por el presente documento manifiesto los siguientes consentimientos:

**DECLARO**

- Que he leído la hoja de información que se me ha entregado.
- Que he comprendido las explicaciones que se me han facilitado.
- Que he podido realizar observaciones y me han sido aclaradas las dudas que he planteado.
- Que puedo revocar el consentimiento en cualquier momento sin tener que dar explicaciones y sin que esto tenga ninguna repercusión negativa.
- Que de forma libre y voluntaria cedo los datos que se hallan recogidos en la historia clínica de mi hijo para el estudio que se me ha propuesto
- Que puedo incluir restricciones sobre el uso de las mismas.

**CONSIENTO**

Que se utilicen los datos que se hallan recopilados en mi historia clínica para el mencionado estudio.
Que el investigador pueda acceder a mis datos en la medida en que sea necesario y manteniendo siempre su confidencialidad.
Que el personal del centro me contacte en el futuro en caso de que se estime oportuno añadir nuevos datos a los recogidos y/o tomar nuevas muestras. ☐ Sí ☐ No
☐ Deseo incluir la siguiente restricción al uso de mis datos:
……………………………………………………………………………………………………

| Nombre y apellidos | Nombre y apellidos |
|---|---|
| Firma PADRE / MADRE / TUTOR<br>*Sólo utilizar en caso de que sea menor o tenga declaración de incapacidad* | Firma |

**Si el sujeto del estudio es un adolescente capaz intelectual y emocionalmente de entre 12 y 16 años debe de ser oída su opinión y autorizar su participación en el estudio firmando también este consentimiento. Cuando se trate de menores no incapaces ni incapacitados, pero emancipados o con 16 años cumplidos, no cabe prestar el consentimiento por representación y será el propio sujeto del estudio quien firmará el consentimiento (Ley 41/2002).**

**Declaración Investigador:**

He informado debidamente al representante legal y/o y al paciente arriba mencionado

Fdo.: ................................................................................ DNI ..........................

En ............................... a ....... de ...................... de 20…

**REVOCACIÓN**

Fdo.: D./Dña ......................................................................................

Revoco el consentimiento cedido para la utilización de los datos de mi hijo/a para el estudio propuesto

En .............................. a....... de ...................... de 20…

**CONSENTIMIENTO INFORMADO DEL PACIENTE PARA LA UTILIZACIÓN DE DATOS CLÍNICOS**

| |
|---|
| *EJEMPLAR PARA EL CENTRO*<br>*Si la persona es mayor de edad, se recomienda utilizar esta fórmula:*<br>D./Dña. ____________________________ mayor de edad, titular del DNI: ____________________, por el presente documento manifiesto los siguientes consentimientos: |

| |
|---|
| *Si la persona es menor de edad o está incapacitada legalmente, se recomienda utilizar esta fórmula:*<br>D./Dña. ____________________________, mayor de edad, titular del DNI: ____________________, [padre, madre o tutor legal de ____________________________], por el presente documento manifiesto los siguientes consentimientos: |

**DECLARO**

- Que he leído la hoja de información que se me ha entregado.
- Que he comprendido las explicaciones que se me han facilitado.
- Que he podido realizar observaciones y me han sido aclaradas las dudas que he planteado.
- Que puedo revocar el consentimiento en cualquier momento sin tener que dar explicaciones y sin que esto tenga ninguna repercusión negativa.
- Que de forma libre y voluntaria cedo los datos que se hallan recogidos en la historia clínica de mi hijo para el estudio que se me ha propuesto
- Que puedo incluir restricciones sobre el uso de las mismas.

**CONSIENTO**

Que se utilicen los datos que se hallan recopilados en mi historia clínica para el mencionado estudio.
Que el investigador pueda acceder a mis datos en la medida en que sea necesario y manteniendo siempre su confidencialidad.
Que el personal del centro me contacte en el futuro en caso de que se estime oportuno añadir nuevos datos a los recogidos y/o tomar nuevas muestras. ☐ Sí ☐ No
☐ Deseo incluir la siguiente restricción al uso de mis datos:
……………………………………………………………………………………………………

| Nombre y apellidos | Nombre y apellidos |
|---|---|
| Firma PADRE / MADRE / TUTOR<br>*Sólo utilizar en caso de que sea menor o tenga declaración de incapacidad* | Firma |

**Si el sujeto del estudio es un adolescente capaz intelectual y emocionalmente de entre 12 y 16 años debe de ser oída su opinión y autorizar su participación en el estudio firmando también este consentimiento. Cuando se trate de menores no incapaces ni incapacitados, pero emancipados o con 16 años cumplidos, no cabe prestar el consentimiento por representación y será el propio sujeto del estudio quien firmará el consentimiento (Ley 41/2002).**

**Declaración Investigador:**

He informado debidamente al representante legal y al paciente arriba mencionado

Fdo.: ............................................................................... DNI ..........................

En .............................. a ....... de ..................... de 20…

**REVOCACIÓN**

Fdo.: D./Dña ......................................................................................
Revoco el consentimiento cedido para la utilización de los datos de mi hijo/a para el estudio propuesto

En ............................... a....... de ...................... de 20……

**COMPENDIO DE PUBLICACIONES**

**INFORME PROFESORADO DIRECTOR DE LA TESIS DOCTORAL**

## DATOS DEL/DE LA DOCTORANDO/A

Apellidos: Sebastiá Rico

Nombre: Jaime, D.N.I. 21803201Y

Teléfono: 638968102, e-mail: jaiseri@alumni.uv.es, Jaime.sebastia@fundacions.uv.es

## DATOS DEL PLAN DE INVESTIGACIÓN

Programa de Doctorado 3139 Medicina

Línea de Investigación: Salud Pública

Título del plan de investigación: Valoración cineantropométrica, nutricional y consumo de suplementos en futbolistas de élite

## INFORME DE IDONEIDAD

El doctorando ha cumplido con los objetivos y cronograma establecidos en el plan de investigación de su proyecto de tesis doctoral, desarrollando la metodología propuesta para la consecución de los objetivos e hipótesis planteados. Los resultados del plan de investigación han derivado en la publicación de 5 artículos científicas indexadas en el Journal Citation Reports (JCR) en diferentes cuartiles (3 en Q1, 1 en Q2 y 1 en Q3). Estas publicaciones cumplen con los criterios establecidos por la Escuela de Doctorado de la Universidad de Valencia la presentación y defensa de la tesis doctoral por compendio de publicaciones.

Las publicaciones y características de estas, así como la contribución de autoría por parte de la doctoranda en cada publicación, se detallan a continuación:

Artículo 1: **Sebastiá-Rico J**, Soriano JM, González-Gálvez N, Martínez-Sanz JM. Body Composition of Male Professional Soccer Players Using Different Measurement Methods: A Systematic Review and Meta-Analysis. Nutrients. 2023 Feb 25;15(5):1160. doi: 10.3390/nu15051160.

IF (202): 5.9. 17/88 (Q1). Categoria: Nutrition & Dietetics. Contribución de autoría: El doctorando es primer autor y ha participado en el desarrollo de la metodología, recogida y análisis de datos, así como en la elaboración del artículo y sus posteriores revisiones.

Artículo 2: **Sebastiá-Rico J**, Martínez-Sanz JM, González-Gálvez N, Soriano JM. Differences in Body Composition between Playing Positions in Men's Professional Soccer: A Systematic Review with Meta-Analysis. Applied Sciences. 2023; 13(8):4782. https://doi.org/10.3390/app13084782.

IF (2022): 2.7. 42/90 (Q2). Categoria: ENGINEERING, MULTIDISCIPLINARY. Contribución de autoría: El doctorando es primer autor y ha participado en el desarrollo de la metodología, recogida y análisis de datos, así como en la elaboración del artículo y sus posteriores revisiones.

Artículo 3: **Sebastiá-Rico J**, Soriano JM, Sanchis-Chordà J, Alonso-Calvar M, López-Mateu P, Romero-García D, Martínez-Sanz JM. Dietary Habits of Elite Soccer Players: Variations According to Competitive Level, Playing Position and Sex. Nutrients. 2023 Oct 10;15(20):4323. doi: 10.3390/nu15204323.

IF (2022): 5.9. 17/88 (Q1). Categoria: Nutrition & Dietetics. Contribución de autoría: El doctorando es primer autor y ha participado en el desarrollo de la metodología, recogida y análisis de datos, así como en la elaboración del artículo y sus posteriores revisiones.

Artículo 4: **Sebastiá-Rico J**, Martínez-Sanz JM, Sanchis-Chordà J, Alonso-Calvar M, López-Mateu P, Romero-García D, Soriano JM. Supplement Consumption by Elite Soccer Players: Differences by Competitive Level, Playing Position, and Sex. Healthcare (Basel). 2024 Feb 19;12(4):496. doi: 10.3390/healthcare12040496.

IF (2022): 2.8. 57/106 (Q2). Categoria: Health Care Sciences & Services. Contribución de autoría: El doctorando es primer autor y ha participado en el desarrollo de la metodología, recogida y análisis de datos, así como en la elaboración del artículo y sus posteriores revisiones.

Artículo 5: **Sebastiá-Rico J**, Soriano JM, Sanchis-Chordà J, García-Fernández AF, López-Mateu P, De la Cruz Marcos S, Martínez-Sanz JM. Analysis of Fluid Balance and Urine Values in Elite Soccer Players: Impact of Different Environments, Playing Positions, Sexes, and Competitive Levels. Nutrients. 2024; 16(6):903. https://doi.org/10.3390/nu16060903

IF (2022): 5.9. 17/88 (Q1). Categoria: Nutrition & Dietetics. Contribución de autoría: El doctorando es primer autor y ha participado en el desarrollo de la metodología, recogida y análisis de datos, así como en la elaboración del artículo y sus posteriores revisiones.

Se hace constar que ninguno de los coautores de las publicaciones que forman parte de los trabajos presentados en la tesis doctoral ha utilizado, implícita o explícitamente, estos trabajos para la realización de otra tesis doctoral. Además, en todos los trabajos publicados se indica *"This study is part of the doctoral thesis of Jaime Sebastiá Rico".*

**Valencia, a 31 de mayo de 2024**

**El/La (co)director/a**

JOSE MIGUEL| SORIANO|DEL CASTILLO

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**Firmado:** José Miguel Soriano del Castillo

**El/La (co)director/a**

JOSE MIGUEL| MARTINEZ| SANZ

Firmado digitalmente por JOSE MIGUEL| MARTINEZ|SANZ
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**Firmado:** José Miguel Martínez Sanz

# Cuestionario de frecuencia de consumo de alimentos en futbolistas de élite

Estimad@ deportista, estamos realizando un estudio sobre la frecuencia de consumo de alimentos en futbolistas de élite. El objetivo de este trabajo es realizar un análisis descriptivo y comparativo de los hábitos alimentarios en futbolistas pertenecientes a los diferentes equipos del Valencia C.F. Su colaboración nos será de gran ayuda, estándole agradecidos enormemente al contestar a estas preguntas.

Su identidad permanecerá en el anonimato, y sólo se usarán los datos de manera estadística para conocer la realidad del consumo de suplementos nutricionales en fútbol. La Ley Orgánica de Protección de Datos será respetada en todo momento. Este estudio ha sido aprobado por el comité de ética de la Universidad de Valencia con número de registro 1534145.

CONSENTIMIENTO

- He sido informado/a de las características del Proyecto de Investigación titulado: "Valoración cineantropométrica, nutricional y consumo de suplementos en futbolistas de élite".
- He leído la información del proyecto, y he podido formular las dudas que me han surgido al respecto. Considero que he entendido dicha información.
- Estoy informado/a de la posibilidad de retirarme en cualquier momento del estudio.
- Estoy informado del modo en que serán tratados mis datos.

En virtud de tales condiciones, consiento participar en este estudio. El consentimiento se manifiesta con la realización de la encuesta

No rellenar más de una inscripción por persona y escribir en MAYÚSCULAS todas las respuestas que requieran texto.

* Indica que la pregunta es obligatoria

1. ¿A qué equipo perteneces?

*Marca solo un óvalo.*

- Valencia Mestalla
- Juvenil A
- Juvenil B
- Cadete A
- Cadete Fundacions
- Valencia CF Femenino
- Valencia CF Femenino B
- Valencia CF Femenino C

## DATOS INICIALES

2. AÑO DE NACIMIENTO *

*Ejemplo: 7 de enero de 2019*

3. POSICIÓN DE JUEGO (Solo una opción) *

*Marca solo un óvalo.*

- Portero
- Defensa Lateral
- Defensa Central
- Mediocentro defensivo
- Centrocampista
- Extremo
- Delantero central

## Cuestionario Frecuencia Consumo de Alimentos

4. 1.¿Cuántas piezas de fruta has consumido en los últimos 28 días?(1 pieza = aproximadamente 100 g) (incluido zumos de fruta) (1 porción = Aprox. 200 ml) *


*Marca solo un óvalo.*

- Menos de una vez a la semana
- Una o dos veces a la semana
- 3-4 veces a la semana
- 5-6 Veces a la semana
- Una o dos veces al día
- 3 veces o más al día

5. 2.¿Cuántas porciones de verduras has consumido en los últimos 28 días? (1 porción = aproximadamente 150 g) *


*Marca solo un óvalo.*

- Menos de una vez a la semana
- Una o dos veces a la semana
- 3-4 veces a la semana
- 5-6 Veces a la semana
- Una o dos veces al día
- 3 veces o más al día

6. 3.¿Cuántas porciones de las siguientes verduras has consumido en los últimos 28 días? (1 porción = aproximadamente 150 g): Apio, remolacha, espinaca, rúcula, endivia, puerro, rábano, pak choi/bok choy/col asiática *


*Marca solo un óvalo.*

- Menos de una vez a la semana
- Una o dos veces a la semana
- 3-4 veces a la semana
- 5-6 Veces a la semana
- Una o dos veces al día
- 3 veces o más al día

7. 4. ¿Cuántas porciones de legumbres (lentejas, garbanzos, judías blancas, etc.) has consumido en los últimos 28 días? (1 porción = aprox. 60 g) *


*Marca solo un óvalo.*

- Menos de una vez a la semana
- Una o dos veces a la semana
- 3-4 veces a la semana
- 5-6 Veces a la semana
- Una o dos veces al día
- 3 veces o más al día

8. 5. ¿Cuántas porciones de tubérculos (patata, boniato, yuca, etc.) has consumido en los últimos 28 días? (1 porción = aprox. 250 g) *


*Marca solo un óvalo.*

- Menos de una vez a la semana
- Una o dos veces a la semana
- 3-4 veces a la semana
- 5-6 Veces a la semana
- Una o dos veces al día
- 3 veces o más al día

9. 6. ¿Cuántas porciones de pasta (macarrón, espagueti, fideo, tallarín, canelón, etc.) has consumido en los últimos 28 días? (1 porción = aprox. 75 g) *


*Marca solo un óvalo.*

- Menos de una vez a la semana
- Una o dos veces a la semana
- 3-4 veces a la semana
- 5-6 Veces a la semana
- Una o dos veces al día
- 3 veces o más al día

10. 7. ¿Cuántas porciones de arroz has consumido en los últimos 28 dias? (1 porción = aprox. 75 g) *


*Marca solo un óvalo.*

- Menos de una vez a la semana
- Una o dos veces a la semana
- 3-4 veces a la semana
- 5-6 Veces a la semana
- Una o dos veces al día
- 3 veces o más al día

11. 8. ¿Cuántas porciones de pan (molde, barra, tostado, etc.) has consumido en los últimos 28 dias? (1 porción = aprox. 50 g) *


*Marca solo un óvalo.*

- Menos de una vez a la semana
- Una o dos veces a la semana
- 3-4 veces a la semana
- 5-6 Veces a la semana
- Una o dos veces al día
- 3 veces o más al día

12. 9. ¿Cuántas porciones de cereales integrales (pan integral, cereal tipo muesli, harina integral, etc.) has consumido en los últimos 28 dias? (1 porción = aprox. 50 g) *


*Marca solo un óvalo.*

- Menos de una vez a la semana
- Una o dos veces a la semana
- 3-4 veces a la semana
- 5-6 Veces a la semana
- Una o dos veces al día
- 3 veces o más al día

13. 10. ¿Cuántas porciones de pollo / pavo has consumido en los últimos 28 días? *
(1 porción = aproximadamente 150 g)


*Marca solo un óvalo.*

- Menos de una vez a la semana
- Una o dos veces a la semana
- 3-4 veces a la semana
- 5-6 Veces a la semana
- Una o dos veces al día
- 3 veces o más al día

14. 11. ¿Cuántas porciones de huevo y derivados has consumido en los últimos 28 días? (1 porción = aproximadamente 2 huevos de gallina) *


*Marca solo un óvalo.*

- Menos de una vez a la semana
- Una o dos veces a la semana
- 3-4 veces a la semana
- 5-6 Veces a la semana
- Una o dos veces al día
- 3 veces o más al día

15. 12. ¿Cuántas porciones de pescado has consumido en los últimos 28 días (1 porción = aproximadamente 150 g) *


*Marca solo un óvalo.*

- Menos de una vez a la semana
- Una o dos veces a la semana
- 3-4 veces a la semana
- 5-6 Veces a la semana
- Una o dos veces al día
- 3 veces o más al día

16. 13. ¿Cuántas porciones de carne roja (carne, cerdo, cordero) has consumido en los últimos 28 días? (1 porción = aproximadamente 150 g)


*Marca solo un óvalo.*

- Menos de una vez a la semana
- Una o dos veces a la semana
- 3-4 veces a la semana
- 5-6 Veces a la semana
- Una o dos veces al día
- 3 veces o más al día

17. 14. ¿Cuántas porciones de frutos secos (almendra, pistacho, nuez, etc.) has consumido en los últimos 28 días? (1 porción = aproximadamente 30 g pelados)


*Marca solo un óvalo.*

- Menos de una vez a la semana
- Una o dos veces a la semana
- 3-4 veces a la semana
- 5-6 Veces a la semana
- Una o dos veces al día
- 3 veces o más al día

18. 15. ¿Cuántas porciones de alimentos fermentados (chucrut, kéfir, kombucha, kimchi, yogur natural, etc.) has consumido en los últimos 28 días? (1 porción = aproximadamente 125 g)


*Marca solo un óvalo.*

- Menos de una vez a la semana
- Una o dos veces a la semana
- 3-4 veces a la semana
- 5-6 Veces a la semana
- Una o dos veces al día
- 3 veces o más al día

19. 16. ¿Cuántas porciones de refrescos has consumido en los últimos 28 días? (1 porción = aproximadamente 250 ml) *


*Marca solo un óvalo.*

- Menos de una vez a la semana
- Una o dos veces a la semana
- 3-4 veces a la semana
- 5-6 Veces a la semana
- Una o dos veces al día
- 3 veces o más al día

20. 17. ¿Cuántas porciones de dulces producidos comercialmente (no hechos en casa) (Galletas / pasteles / bollería) has consumido en los últimos 28 días? (1 pieza = aproximadamente 100 g) *


*Marca solo un óvalo.*

- Menos de una vez a la semana
- Una o dos veces a la semana
- 3-4 veces a la semana
- 5-6 Veces a la semana
- Una o dos veces al día
- 3 veces o más al día

21. 18. ¿Cuántas porciones de alimentos preparados / congelados has consumido * (Croquetas, pizza, etc.) en los últimos 28 días? (1 porción = Aprox. 80 g)


*Marca solo un óvalo.*

- Menos de una vez a la semana
- Una o dos veces a la semana
- 3-4 veces a la semana
- 5-6 Veces a la semana
- Una o dos veces al día
- 3 veces o más al día

22. 19. ¿Ha consumido bebidas alcohólicas en los últimos 28 días? *

*Marca solo un óvalo.*

- Sí
- No

23. 20. ¿Qué tipo de bebidas alcohólicas ha consumido en los últimos 28 días? *

*Marca solo un óvalo.*

- Cerveza
- Vino
- Bebidas mezcladas
- Otros: ____________________

24. 21. ¿Cuántas porciones de cerveza / vino / licores o bebidas mezcladas has consumido en los últimos 28 días? (1 porción de cerveza = aproximadamente 200 ml / 1Vaso de vino = aprox. 100 ml / 1 porción de licores o bebidas mezcladas =Aprox. 50 ml (de alcohol) *


*Marca solo un óvalo.*

- Menos de una vez a la semana
- Una o dos veces a la semana
- 3-4 veces a la semana
- 5-6 Veces a la semana
- Una o dos veces al día
- 3 veces o más al día

# Estudio de hábitos y del consumo de suplementos nutricionales en futbolistas de élite

Estimad@ deportista, estamos realizando un estudio sobre los hábitos y el uso de suplementos en futbolistas de élite. El objetivo de este trabajo es realizar un análisis descriptivo y comparativo del consumo de suplementos alimenticios en futbolistas pertenecientes a los diferentes equipos del Valencia C.F. Su colaboración nos será de gran ayuda, estándole agradecidos enormemente al contestar a estas preguntas.

Su identidad permanecerá en el anonimato, y sólo se usarán los datos de manera estadística para conocer la realidad del consumo de suplementos nutricionales en fútbol. La Ley Orgánica de Protección de Datos será respetada en todo momento. Este estudio ha sido aprobado por el comité de ética de la Universidad de Valencia con número de registro 1534145.

CONSENTIMIENTO

- He sido informado/a de las características del Proyecto de Investigación titulado: “Valoración cineantropométrica, nutricional y consumo de suplementos en futbolistas de élite”.
- He leído la información del proyecto, y he podido formular las dudas que me han surgido al respecto. Considero que he entendido dicha información.
- Estoy informado/a de la posibilidad de retirarme en cualquier momento del estudio.
- Estoy informado del modo en que serán tratados mis datos.

En virtud de tales condiciones, consiento participar en este estudio. El consentimiento se manifiesta con la realización de la encuesta

No rellenar más de una inscripción por persona y escribir en MAYÚSCULAS todas las respuestas que requieran texto.

* Indica que la pregunta es obligatoria

1. ¿A qué equipo perteneces?

*Marca solo un óvalo.*

- ◯ Valencia Mestalla
- ◯ Juvenil A
- ◯ Juvenil B
- ◯ Valencia CF Femenino
- ◯ Valencia CF Femenino B

DATOS INICIALES

2. AÑO DE NACIMIENTO *

_Ejemplo: 7 de enero de 2019_

3. POSICIÓN DE JUEGO (Solo una opción) *

*Marca solo un óvalo.*

- Portero
- Defensa Lateral
- Defensa Central
- Mediocentro defensivo
- Centrocampista
- Extremo
- Delantero central

ENTRENAMIENTO Y COMPETICIÓN

4. INDICA EL NÚMERO DE AÑOS APROXIMADO QUE LLEVAS COMPITIENDO *

*Marca solo un óvalo.*

- 1 año
- 2 años
- 3 años
- 4 años
- 5 años
- 6 años
- 7 años
- 8 años
- 9 años
- 10 o más años

5. ¿CUÁNTOS DÍAS DE MEDIA DEDICAS AL ENTRENAMIENTO A LA SEMANA? APROXIMADAMENTE *

*Marca solo un óvalo.*

- 1 día
- 2 días
- 3 días
- 4 días
- 5 días
- 6 días
- 7 días

6. ¿CUÁNTO TIEMPO, APROXIMADAMENTE, DEDICAS CADA DÍA AL ENTRENAMIENTO? *

Elige el intervalo de tiempo que más se ajuste a tu tiempo de entrenamiento

*Marca solo un óvalo.*

- <30 minutos
- Entre 30 minutos y 1 hora
- Entre 1 hora y 1,5 horas
- Entre 1,5 horas y 2 horas
- >2 horas

7. ¿CUÁNTOS DÍAS DE MEDIA DEDICAS A ENTRENAMIENTOS EXTRA A LA SEMANA? (TANTO EN LA CIUDAD DEPORTIVA COMO FUERA) *

APROXIMADAMENTE

*Marca solo un óvalo.*

- 1 día
- 2 días
- 3 días
- 4 días
- 5 días
- 6 días
- 7 días

8. ¿CUÁNTO TIEMPO, APROXIMADAMENTE, DEDICAS A LA SEMANA A LOS ENTRENAMIENTOS EXTRA? (TANTO EN LA CIUDAD DEPORTIVA COMO FUERA) *

Elige el intervalo de tiempo que más se ajuste a tu tiempo de entrenamiento

*Marca solo un óvalo.*

- <30 minutos
- Entre 30 minutos y 1 hora
- Entre 1 hora y 1,5 horas
- Entre 1,5 horas y 2 horas
- >2 horas

9. SUELES ENTRENAR... *

Elige el intervalo de tiempo que más se ajuste a tu tiempo de entrenamiento

*Marca solo un óvalo.*

- Por la mañana
- Por la tarde
- Por la mañana y la tarde
- Otros: ____________________

10. SUELES COMPETIR... *

Elige el intervalo de tiempo que más se ajuste a tu tiempo de entrenamiento

*Marca solo un óvalo.*

- Por la mañana
- Por la tarde
- Por la mañana y la tarde
- Otros: ______________________

DIETA

11. ¿SIGUES EN LA ACTUALIDAD ALGÚN TIPO DE DIETA O FORMA CONCRETA DE ALIMENTARSE? *

*Marca solo un óvalo.*

- Si *Ir a la pregunta 12*
- No *Ir a la pregunta 15*

DIETA CONTINUACIÓN

12. ¿QUÉ TIPO DE DIETA ES? *

*Marca solo un óvalo.*

- Vegetariana
- Vegana
- Mediterránea
- Ovolactovegetariana
- Paleo
- Disociada
- Macrobiotica
- Flexible
- Cetogénica
- Ayuno intermitente
- Alcalina
- Detox
- Carnívora
- Low carb (baja en carbohidratos)
- Otros: ____________

13. ¿POR QUÉ LA HACES? *

*Marca solo un óvalo.*

- Para cuidar tu salud
- Por estética
- Por enfermedad
- Por rendimiento
- Por religión o creencias
- Otros: ____________

14. ¿TE LLEVA ALGUIEN O TE APOYAS EN ALGO PARA LLEVAR LA DIETA? *
EN CASO AFIRMATIVO INDICA LA RESPUESTA ADECUADA.

*Marca solo un óvalo.*

- No
- Dietista-Nutricionista interno del club
- Dietista-Nutricionista externo del club
- Médico
- Farmaceutico
- Entrenado Personal
- Fisioterapeuta
- Alguien sin ningula titulación
- Me apoyo en un libro
- Me apoyo en un blog
- Me apoyo en un amigo
- Me apoyo en Redes Sociales
- Otros: ______________________

SUPLEMENTOS

15. ¿ESTÁS A FAVOR DEL CONSUMO DE SUPLEMENTOS EN LA ACTIVIDAD FÍSICA DENTRO DE LA LEGALIDAD? *

*Marca solo un óvalo.*

- Si
- No
- No sabes/No contestas

16. ¿HAS CONSUMIDO EN ALGUNA OCASIÓN ALGÚN SUPLEMENTO NUTRICIONAL? *

*Marca solo un óvalo.*

- Si *Ir a la pregunta 17*
- No

SUPLEMENTOS CONTINUACIÓN

17. SEÑALA CUALES DE ESTOS SUPLEMENTOS HAS CONSUMIDO *

ESTÁN ORDENADOS ALFABÉTICAMENTE. PUEDES SEÑALAR TANTOS CUANTO HAYAS CONSUMIDO.

*Selecciona todas las opciones que correspondan.*

- [ ] 5-HTP (5-Hidroxitriptofano)
- [ ] ATP
- [ ] Ácido Aspártico
- [ ] Ácido Alfa Lipoico (ALA)
- [ ] Ácido Fosfatídico
- [ ] Ácido Hialurónico
- [ ] Ácidos Grasos ω-3 (Omega 3)
- [ ] Ácidos Grasos ω-6 (Omega 6)
- [ ] Ácidos Grasos ω-9 (Omega 9)
- [ ] Ácido Linoleico Conjugado (CLA)
- [ ] Aceite de Coco
- [ ] Aceite de Hígado de Bacalao
- [ ] Aceite de Lino
- [ ] Aceite de Onagra
- [ ] Aceite de Prímula
- [ ] Amilopectina
- [ ] Aminoácidos esenciales (EEAA)
- [ ] Aminoácidos ramificados (BCAA)
- [ ] Arginina
- [ ] Barritas Energéticas
- [ ] Bebida Isotónica
- [ ] Beta Alanina
- [ ] Bicarbonatos
- [ ] Bloqueadores de Carbohidratos
- [ ] Cafeína
- [ ] Carbohidratos ("Gainers")
- [ ] Carnitina (Acetil-L-Carnitina)
- [ ] Carnitina (L-Carnitina)
- [ ] Cartílago de Tiburón
- [ ] Caseína Micelar
- [ ] Chitosan
- [ ] Ciclodextrinas
- [ ] Cinc
- [ ] Citrulina (Malato o L-citrulina)
- [ ] Complejo Mineral
- [ ] Complejo Vitamínico
- [ ] Condroitina
- [ ] Creatina (Monohidrato)

- [ ] Creatina (Kre-Alkalyn)
- [ ] Creatina (Etil Éster)
- [ ] Curcumina
- [ ] Dextrosa
- [ ] Dimetilglicina
- [ ] Diuréticos
- [ ] Electrolitos (en polvo o pastillas)
- [ ] Epicatequina
- [ ] Epigalocatequina-3-galato (EGCG)
- [ ] Espirulina
- [ ] Fórmulas pre-entreno
- [ ] Fosfato de sodio
- [ ] Ginseng
- [ ] Glicerol
- [ ] Glucosamina
- [ ] Glutamina
- [ ] Gominolas
- [ ] Greens
- [ ] Guarana
- [ ] Hidrolizado de caseína
- [ ] Hidroximetilbutirato (HMB)
- [ ] Hierro
- [ ] Isomaltulosa
- [ ] Jalea Real
- [ ] Lecitina de Soja
- [ ] Leucina
- [ ] Levadura de Cerveza
- [ ] Magnesio
- [ ] Maltodextrina
- [ ] Melatonina
- [ ] Metil-sulfonil-metano (MSM)
- [ ] Nitrato (zumo de remolacha)
- [ ] Nootrópicos
- [ ] Picolinato de Cromo
- [ ] Polen
- [ ] Potenciador de Testosterona
- [ ] Precursor Hormonal
- [ ] Probióticos
- [ ] Proteína de Carne
- [ ] Proteína de Suero (Whey Protein)
- [ ] Proteína Vegetal (soja, cáñamo…)
- [ ] Quercetina
- [ ] Ribosa

- [ ] Sinefrina (p-sinefrina)
- [ ] Suplemento de cereza ácida (Tart cherry)
- [ ] Taurina
- [ ] Teanina
- [ ] Teacrina
- [ ] Té verde (completo o extractos)
- [ ] Tribulus
- [ ] Tirosina
- [ ] Triglicéridos de cadena media (MCT)
- [ ] Vitamina C
- [ ] Vitamina D
- [ ] Vitamina E
- [ ] Vitamina K
- [ ] Yohimbina
- [ ] ZMA
- [ ] Otros: ____________________

18. ¿CONSUMES ALGÚN SUPLEMENTO DE LOS MARCADOS EN LA ACTUALIDAD? *

*Marca solo un óvalo.*

- ( ) Si
- ( ) No

19. INDICA QUÉ DÍAS DE PRACTICA DEPORTIVA SUELES CONSUMIRLOS *

*Selecciona todas las opciones que correspondan.*

- [ ] Entrenamiento
- [ ] Competición
- [ ] Entrenamiento y competición
- [ ] Periodo vacacional o de descanso
- [ ] En todos lo casos anteriormente mencionados
- [ ] Otros: ____________________

20. INDICA CUANDO SUELES CONSUMIRLOS *

*Marca solo un óvalo.*

- Antes de la práctica deportiva
- Durante la práctica deportiva
- Después de la práctica deportiva
- En todos los casos anteriores
- Indiferentemente
- Otros: ______________________

21. ¿CON QUÉ FIN LOS CONSUMÍAS? *

*Selecciona todas las opciones que correspondan.*

- [ ] Para cuidar tu salud
- [ ] Por problemas de salud
- [ ] Por necesidad
- [ ] Por obligación
- [ ] Para mejorar su aspecto físico
- [ ] Para buscar rendimiento deportivo
- [ ] Por paliar algún déficit de la dieta
- [ ] Otros: ______________________

22. ¿DÓNDE SUELES OBTENER LOS SUPLEMENTOS? *

*Selecciona todas las opciones que correspondan.*

- [ ] Del club
- [ ] En Internet
- [ ] A un Dietista-Nutricionista externo al club
- [ ] En una Farmacia
- [ ] En un Gimnasio
- [ ] A un Amigo
- [ ] A un Monitor
- [ ] En un Herbolario
- [ ] En un Centro Comercial
- [ ] En una Parafarmacia
- [ ] En una Tienda especializada
- [ ] Patrocinio de marca personal
- [ ] Otros: ______________________

23. ¿QUÉ/QUIEN TE MOTIVÓ A TOMARLOS? *

*Selecciona todas las opciones que correspondan.*

- [ ] Compañero de equipo
- [ ] Entrenador
- [ ] Dietista-Nutricionista interno del club
- [ ] Dietista-Nutricionista externo del club
- [ ] Internet
- [ ] Monitor
- [ ] Publicidad
- [ ] Revista especializada
- [ ] Televisión
- [ ] Preparador Físico
- [ ] Médico
- [ ] Amigo
- [ ] Otros: ______________________

24. EN GENERAL, ¿CREES QUE TE DIERON RESULTADOS? *

*Marca solo un óvalo.*

NINGÚN RESULTADO

1 ◯

2 ◯

3 ◯

4 ◯

5 ◯

MUCHO RESULTADO

25. SI FUERA EL CASO, ESCRIBE ALGÚN/OS DE LOS SUPLEMENTOS QUE CREES QUE NO TE DIERON NINGÚN RESULTADO

26. SI FUERA EL CASO, ESCRIBE ALGÚN/OS DE LOS SUPLEMENTOS QUE CREES QUE SI TE DIERON RESULTADO

27. ¿HAS CONSUMIDO O CONSUMIRÍAS ALGÚN SUPLEMENTO QUE FUERA PERJUDICIAL PARA LA SALUD PERO QUE TE AYUDARA A CONSEGUIR TUS OBJETIVOS? *

*Marca solo un óvalo.*

- Si
- No
- No sabe/No contesta

28. EN EL CASO QUE LA PREGUNTA ANTERIOR SEA AFIRMATIVA, SEÑALA CUÁL/ES DE LA SIGUIENTE LISTA HAS CONSUMIDO O CONSUMIRÍAS

*Selecciona todas las opciones que correspondan.*

- [ ] Esteroides anabolizantes
- [ ] Hormona de crecimiento
- [ ] Insulina
- [ ] Efedrina
- [ ] Pseudoanfetaminas
- [ ] Otros: ______________________

| | PESO DEL FUTBOLISTA | | | LIQUIDO DEL ENTRENAMIENTO | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Futbolista | Antes (kg) | Después (kg) | Peso perdido (kg) | Antes (l) | Después (l) | Líquido consumido (l) | Orina recolectada (l) | Tasa sudoración (l/h) | Color de la orina | Densida específica | Duración del ejercicio ( | Temperatura inicial | Temperatura final | Humedad relativa inicial | Humedad relativa final | Velocidad del viento inicial | Velocidad del viento final |
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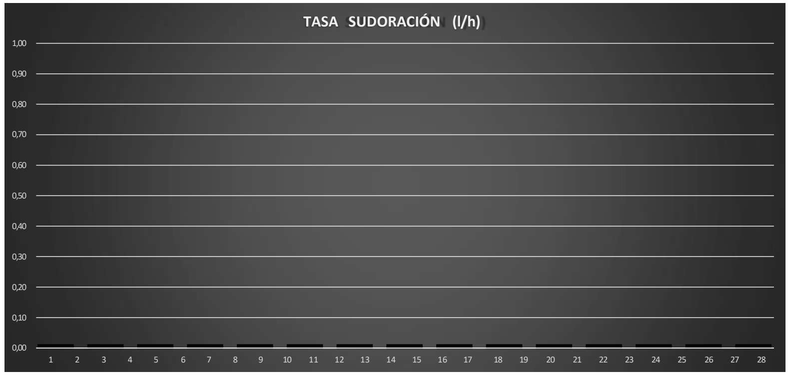


| | PESO DEL FUTBOLISTA | | | LIQUIDO DEL ENTRENAMIENTO | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Futbolista | Antes (kg) | Después (kg) | Peso perdido (kg) | Antes (l) | Después (l) | Líquido consumido (l) | Orina recolectada (l) | Tasa sudoración (l/h) | Color de la orina | Densida específica | Duración del ejercicio ( | Temperatura inicial | Temperatura final | Humedad relativa inicial | Humedad relativa final | Velocidad del viento inicial | Velocidad del viento final |
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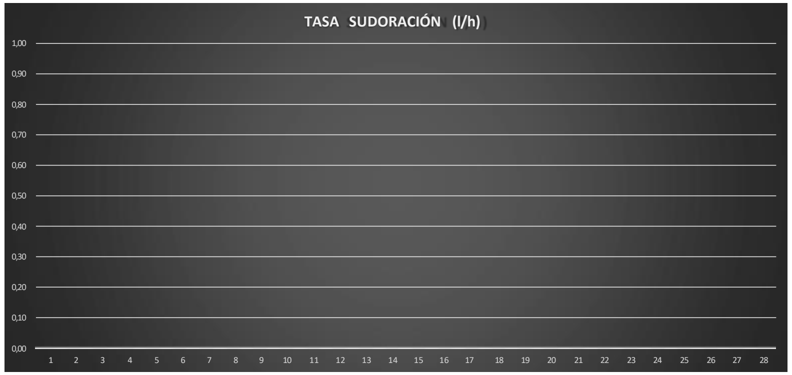

A continuación, se presentan algunas de los modelos de e-mail, imágenes y difusiones de los artículos publicados de la presente Tesis Doctoral:

- Modelo mail para estudio de consumo de alimentos y suplementos:

**PARA EL MESTALLA, JUVENIL A, JUVENIL B:**

Buenos días,

Para seguir mejorando en el proceso de tu formación deportiva , estamos participando en un estudio relacionado con la alimentación, hidratación y suplementación deportiva donde nos gustaría que completases dos cuestionarios online. Los accesos se muestran a continuación:

- Acceso al cuestionario sobre el consumo general de suplementos y demandas físicas (10-15 minutos): https://forms.gle/o4Hsd6xentpdANTG8

- Acceso al cuestionario sobre el consumo de alimentos y bebidas (5-10 min): https://forms.gle/r1HyBmpUGQtmw2Tj9

Un saludo y muchas gracias por la colaboración.

**PARA EL CADETE A, CADETE FUNDACIONS:**

Buenos días,

Para seguir mejorando en el proceso de tu formación deportiva, estamos participando en un estudio relacionado con la alimentación e hidratación donde nos gustaría que completases un cuestionario online. El acceso se muestra a continuación:

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Un saludo y muchas gracias por la colaboración.

**PARA EL FEMENINO A Y FEMENINO B:**

Buenos días,

Para seguir mejorando en el proceso de tu formación deportiva , estamos participando en un estudio relacionado con la alimentación, hidratación y suplementación deportiva donde nos gustaría que completases dos cuestionarios online. Los accesos se muestran a continuación:

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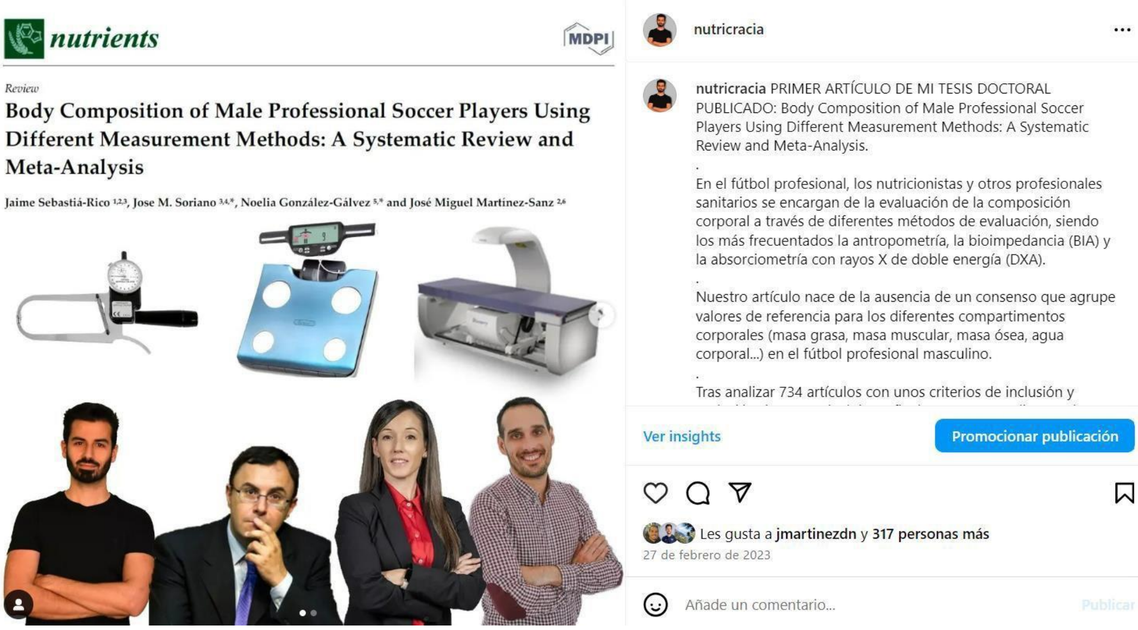
- Acceso al cuestionario sobre el consumo de alimentos y bebidas (5-10 min): https://forms.gle/r1HyBmpUGQtmw2Tj9

Un saludo y muchas gracias por la colaboración.

- Mensajes de difusión en redes sociales de los estudios publicados:

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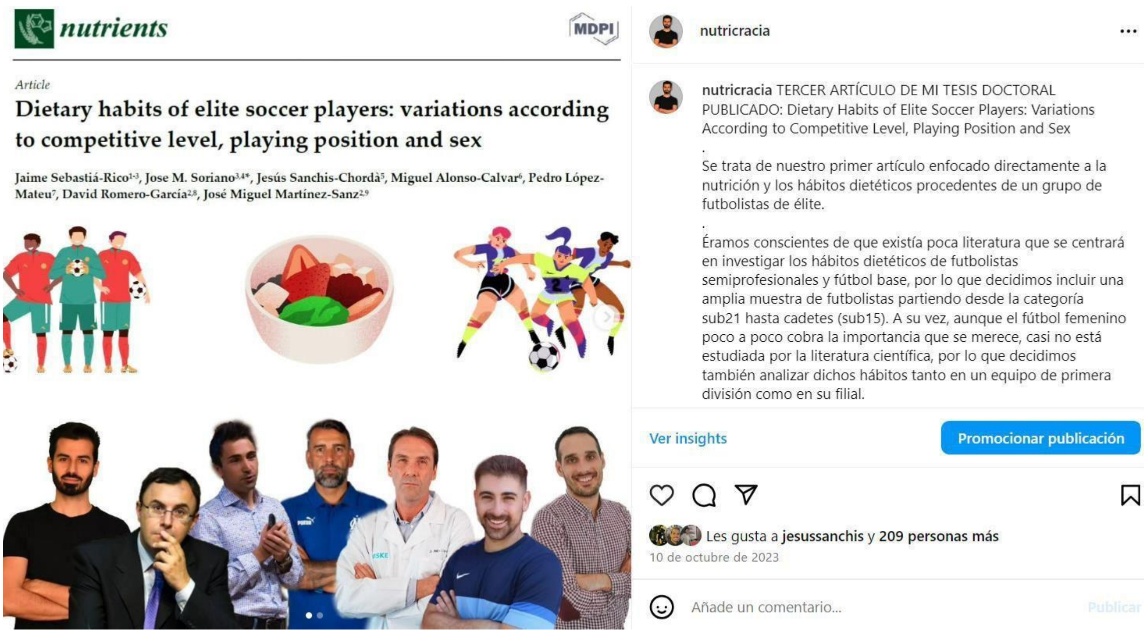


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nutricracia
y
sandra_dc_nutri

**nutricracia** QUINTO Y ÚLTIMO ARTÍCULO DE MI TESIS DOCTORAL PUBLICADO: Analysis of Fluid Balance and Urine Values in Elite Soccer Players: Impact of Different Environments, Playing Positions, Sexes, and Competitive Levels

.

Además de las estrategias nutricionales durante las competiciones, los atletas también deben mantener estos hábitos a diario, incluidos los días de entrenamiento. Es importante señalar que la hidratación es crucial, ya que la literatura muestra cierta prevalencia de futbolistas que comienzan el entrenamiento en un estado deshidratado y/o no siguen las prácticas adecuadas durante el esfuerzo físico, lo que resulta en un consumo insuficiente de líquidos.

.

En esta ocasión, el objetivo fue medir y comparar la tasa de sudoración, el balance de fluidos y los valores de orina (color y

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21 de marzo

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Publicar

https://www.instagram.com/p/C4x_o0jtBQL/?img_index=1

Producción científica durante el periodo de tesis doctoral:

- Artículos científicos publicados:
  - Sanchis-Chordà, J Sebastiá-Rico, J. Las proteínas dietéticas como ayuda ergogénica en el rendimiento del futbolista. Revista Fútbol PF. 2021 Sep;1(37):1
  - Porta M, Sebastiá-Rico J, Martínez-Sanz JM, Contreras C, Vaquero-Cristóbal R, López-Cáceres PA. Anthropometric Values in Spanish Elite Soccer: Differences between Divisions and Playing Positions. Applied Sciences. 2023 Jan;13(20):11441.
  - Sebastiá-Rico J, Cabeza-Melendre D, Anderson L, Martínez-Sanz JM. Nitric Oxide in the Field: Prevalence and Use of Nitrates by Dietitians and Nutritionists in Spanish Elite Soccer. Nutrients. 2023 Dec 16;15(24):5128.
  - Romero-García D, Martínez-Sanz JM, Sebastiá-Rico J, Manchado C, Vaquero-Cristóbal R. Pattern of Consumption of Sports Supplements of Spanish Handball Players: Differences According to Gender and Competitive Level. Nutrients. 2024 Jan 20;16(2):315.

- Libros y capítulos de libro:
  - Ebook: Asencio Mas, Nuria Isabel; Rubio-Quintanilla Puig, Noelia; Jiménez Alfageme, Rubén; Sebastiá Rico, Jaime; Castillo Martínez, Mónica; Martínez-Sanz, José Miguel. Recetario aplicado al deporte. Alacant: Universitat d'Alacant, 2021, 46 p. http://hdl.handle.net/10045/116482.
  - Jiménez-Alfageme R, Sebastia-Rico J, Sospedra I, Giménez-Monzo D, Lozano M, Gutiérrez-Hervás A, et al. Sports Supplements in Endurance Sports: Practical Applications. In: Duncan LT, editor. Advances in Health and Disease volume 55. Nova Medicine and Health; 2022. p. 95–117.

- Comunicaciones y pósteres en congresos científicos:
  - Jaime Sebastiá-Rico, Rubén Jiménez-Alfageme, Jesús Sanchís-Chordá, Miguel Alonso- Calvar, José M. Soriano, José Miguel Martínez-Sanz. (Comunicación) Revisión de las características cineantropométricas en futbolistas profesionales masculinos. I Congreso de Nutrición Deportiva, Rendimiento y Salud SEEND CODINMA, organizado por la Sociedad Española para el Estudio-Avance de la Nutrición y Dietética Deportiva (SEEND) y el Colegio Profesional de Dietistas-Nutricionistas de la Comunidad de Madrid (CODINMA). 2021.
  - Rubén Jiménez-Alfageme, Isabel Sospedra, Antonio Jesús Sánchez-Oliver, Raúl Domínguez, Jaime Sebastiá, José Miguel Martínez-Sanz. (Comunicación) Consumo de suplementos con baja evidencia científica por corredores de montaña. I Congreso de Nutrición Deportiva, Rendimiento y Salud SEEND CODINMA, organizado por la Sociedad Española para el Estudio-Avance de la Nutrición y Dietética Deportiva (SEEND) y el Colegio Profesional de Dietistas-Nutricionistas de la Comunidad de Madrid (CODINMA). 2021.
  - Jaime Sebastiá-Rico, Rubén Jiménez-Alfageme, José M. Soriano, Jesús Sanchis-Chordà, Miguel Alonso-Calvar, José Miguel Martínez-Sanz, Alberto Férriz-Valero. (Póster) Revisión sistemática de la composición corporal en futbolistas profesionales masculinos: comparación entre diferentes métodos. XVII World Conference of Kinanthropometry (ISAK-UA). 2022.
  - Jaime Sebastiá Rico, Rubén Jiménez-Alfageme, José M. Soriano, Jesús Sanchis-Chordà, Miguel Alonso-Calvar, Noelia Gonzalez-Gálvez, José Miguel Martinez-Sanz. (Póster) Diferencias cineantropométricas entre posiciones de juego en el fútbol profesional masculino: una revisión sistemática con

metaanálisis. X Congreso de Nutrición Humana y Dietética de la Associació de Dietistes i Nutricionistes Universitaris de Valencia (ADINU). 2023.

- David Romero-García, Raquel Vaquero-Cristóbal, Mario Albaladejo-Saura, Francisco Esparza- Ros, Jaime Sebastiá-Rico, José Miguel Martínez Sanz. (Póster) Influencia de la maduración biológica en las características cineantropométricas, aptitud física y dieta en jugadores jóvenes de balonmano. X Congreso de Nutrición Humana y Dietética de la Associació de Dietistes i Nutricionistes Universitaris de Valencia (ADINU). 2023.
- Jaime Sebastiá-Rico, José Miguel Martínez-Sanz, Jesús Sanchis-Chordà, David Romero-García, Fernando Mata Ordoñez, Jose M. Soriano. (Póster) Consumo de suplementos en futbolistas de élite: diferencias por nivel competitivo, posición de juego y sexo. Congreso Internacional SAMEDE "Ejercicio Físico y Salud en la Infancia y la Adolescencia abordaje multidisciplinar" (SAMEDE). 2023.
- David Romero-García, José Miguel Martínez-Sanz, Carmen Manchado-López, Jaime Sebastiá-Rico, Fernando Mata Ordoñez, Raquel Vaquero-Cristóbal. (Póster) Patrón de consumo de suplementos deportivos en deportistas de balonmano: diferencias según sexo y nivel competitivo. Congreso Internacional SAMEDE "Ejercicio Físico y Salud en la Infancia y la Adolescencia abordaje multidisciplinar" (SAMEDE). 2023.

- Docencia universitaria:
  - Máster Universitario Nutrición Personalizada y Comunitaria UV. Cursos 20/21 - 23/24. "Fundamentos de la suplementación deportiva".
  - Máster de Formación Permanente en Preparación Física y Prevención de Lesiones en el/la Futbolista UV. Cursos 21/22. "Control y seguimiento en el/la futbolista. Valoraciones antropométricas y análisis clínico".
  - Máster Universitario en Fisioterapia en el Deporte UCAM. Curso 22/23 y 23/24. "Nutrición en el deporte".
  - Máster Universitario en Fisioterapia Deportiva CEU. Curso 23/24. "Nutrición en el deporte".
  - Master de Formación Permanente en Nutrición y Dietética en el Deporte UV. Curso 23/24. "Taller de suplementos deportivos: De la teoría a la práctica".
  - Maestría en Entrenamiento Deportivo Universidad Europea del Atlántico. Curso 22/23. "Etiquetado nutricional en alimentos y suplementos" y "Nutrición en deportes de equipo".
  - Grado Nutrición Humana y dietética UA. Cursos 21/22 - 23/24. Planificación dietético-nutricional en deportes de equipo. Colaboración en la asignatura "Planificación Dietética Deportiva".

- Premios y menciones especiales:
  - Primer premio en la modalidad Exponente de póster-doctorado. X Congreso de Nutrición Humana y Dietética (2023). Póster "Diferencias cineantropométricas entre posiciones de juego en el fútbol profesional masculino: una revisión sistemática con metaanálisis".
  - Primer premio en la modalidad Póster. I Congreso Internacional SAMEDE: "Ejercicio Físico y Salud en la Infancia y la Adolescencia: abordaje multidisciplinar" (2023). Póster "Consumo de suplementos en futbolistas de élite: diferencias por nivel competitivo, posición de juego y sexo".
  - Colaborador honorífico en el Departamento de Enfermería en el curso 2023-2024 por la Universidad de Alicante.