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Sumario

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Revista Andaluza de
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Contens

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Editorial

Revista Andaluza de Medicina del Deporte: Balance 2017

Andalusian Journal of Sports Medicine. Stocktaking 2017

Cumpliendo con uno de los requisitos de calidad editorial de las revistas científicas, como de costumbre, incluimos en este primer número del año un balance del anterior, así como un análisis de las expectativas de la revista en el año que hemos iniciado.

El interés que despierta la Revista Andaluza de Medicina del Deporte (RAMD), entre sus lectores se refleja en el número de visitas recibidas en la página web de la RAMD (65 653 visitas) y el número de páginas consultadas a lo largo del año 2017 (196 019 páginas). Los países desde los cuáles se consulta con más asiduidad nuestra revista son España, México, Colombia, Brasil y Chile, reflejando esta distribución nuestra influencia en el área latinoamericana.

El número de artículos recibidos ha seguido aumentando durante 2017 alcanzando la cifra récord de 151 artículos, confirmando el interés que despierta para los autores la publicación de sus trabajos en la RAMD. Lamentablemente, pese a la ingente labor editorial realizada para revisar estos artículos, Elsevier no ha colaborado en la publicación *online* de los manuscritos aceptados para publicación, pues es la intención de esta editorial el dejar de editar la RAMD. No obstante, no queremos dejar pasar la oportunidad de agradecer a los autores el envío de sus manuscritos a la RAMD y esperamos que, en esta nueva etapa que iniciamos, con nuevo proceso editorial, podamos responder, con calidad y en el menor plazo de tiempo, a esta confianza que depositan los autores en nuestra revista. Pese al gran volumen de trabajo (200 manuscritos sobre los que se ha tomado decisiones, 288 revisores invitados de los cuales han colaborado 175) los tiempos de respuesta se han reducido drásticamente, de manera que el envío de una primera decisión a los autores, se ha reducido a un plazo de 79 días, plazo con el que no estamos satisfechos y que aspiramos a reducir durante 2018.

La repercusión de los artículos publicados en la RAMD, también ha mejorado notablemente. Por ejemplo, el número de citaciones en la base de datos SCOPUS ha aumentado de 67 citas en 2016 a 72 en 2017, el Índice H ha pasado de 6 en 2016 a 9 en 2017 (9 artículos de la RAMD han recibido al menos 9 citas) y los artículos publicados en la RAMD reciben un total de 0.40 citas por documento publicado en 2017 (antes 0.308). También hemos mejorado el Indicador de calidad editorial *SCImago Journal Rank* (SJR) en el último año evaluado (0,195). Esta mejora de los índices de valoración de la RAMD, es fruto del riguroso proceso de revisión que realizamos a los manuscritos que recibimos, de manera que el porcentaje de artículos rechazados, en una primera revisión ha aumentado de nuevo (tabla 1).

Tabla 1
Evolución decisión editorial primera revisión de manuscritos

Decisión	Año				
	2013	2014	2015	2016	2017
Aceptados sin modificaciones (%)	1.3	3.9	3.6	8.7	3.3
Grandes cambios (%)	27.3	36.9	30.4	9.6	15.7
Pequeños cambios (%)	27.3	22.4	20.5	8.7	3.3
Rechazados (%)	44.1	36.8	20.5	52.9	66.0
Revisión técnica negativa (%)	*	*	25.0	20.2	11.8

Evolución de las decisiones editoriales adoptadas, en la primera revisión de los manuscritos recibidos en la RAMD.
* La decisión «Revisión técnica negativa» fue establecida en 2015, por lo cual no se reflejan datos de años anteriores.

La inclusión de la RAMD en las principales bases de datos bibliográficas, es uno nuestros objetivos permanentes siendo Medline nuestro próximo objetivo.

Tras la decisión unilateral de Elsevier, de no seguir editando la RAMD a partir de junio, el 2018 supone todo un reto para el Comité Editorial de la RAMD, pues tendremos que poner en marcha todas las herramientas editoriales necesarias para que la RAMD mantenga la calidad alcanzada. En este sentido, más que una dificultad, esta nueva situación, la afrontamos como una oportunidad para mejorar los procesos editoriales de nuestra revista, apostando por la edición en acceso abierto, que propiciará la reutilización óptima de los datos de investigación, mediante las buenas prácticas editoriales emanadas de la Declaración de Sant Joan d'Alacant de noviembre de 2017, a la que esta revista se ha adherido siguiendo las líneas de trabajo de la European Open Science Policy Platform. En definitiva el 2018 se presenta como un año de transición, en el que abordaremos nuevos retos con el objetivo de seguir mejorando nuestros índices de calidad editorial.

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Original

Caso único: el efecto Ringelmann en un bote de remo de elite

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RESUMEN

Objetivo: Analizar si en la tripulación del cuatro sin timonel español seleccionada para el preolímpico de Río de Janeiro 2016 presenta el efecto Ringelmann, consistente en que conforme aumenta el número de componentes de un grupo, la aportación individual, al resultado final, va disminuyendo.
Método: La muestra la componen los cuatro remeros de la tripulación del citado bote con una experiencia de 13, 16, 10 y 13 años respectivamente, y una edad media de 24.25 ± 0.5 años.
Resultados: En la totalidad de los casos se produce un aumento sistemático en la condición del equipo respecto de la individual, con una media de metros recorridos en esta de 1029.25 metros, mientras que en la grupal fue de 1036.75. El número de vatios generados también fue superior en la ejecución colectiva (535.25w. frente a los 524.25w.). Sin embargo, la media de paladas en la condición individual fue inferior (35.5) a la de grupo (37.25). En cuanto a la percepción de esfuerzo (escala de Borg), los remeros puntuaban más bajo individualmente (7.75) que en grupo (8.75).
Conclusiones: Nuestros datos parecen mostrar que el nivel competitivo, la fuerte convicción de equipo y la alta motivación pueden no solo paliar, sino hacer desaparecer el efecto Ringelmann en un bote de cuatro sin timonel. A pesar de que la percepción de esfuerzo es mayor en equipo.

Unique case: The Ringelmann effect on a rowboat elite

Keywords:
Rowing
Ringelmann effect
Coxless four
Performance
Sport psychology

ABSTRACT

Objective: Try to know if the crew of the Spanish boat Coxless four selected for the pre-Olympic 2016 Rio de Janeiro shows the Ringelmann effect, which is that as the number of components of a group, the individual contribution decreases.
Method: The sample is composed of four rowers crew of that boat with an experience of 13, 16, 10 and 13 years, respectively, and an average age of 24.25 years ([DT] = 0.5).
Results: In all cases a systematic increase occurs in the equipment condition regarding individual, with an average of meters traveled in this of 1029.25 meters, while the group was 1036.75. The number of watts generated was also higher in the collective execution (535.25w. versus 524.25w.). However, the average of strokes in the individual condition was lower (35.5) to the group (37.25). As for the perception of effort (Borg scale), the rowers individually scored lower (7.75) than in group (8.75).

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Conclusions: Our data seem to suggest that the competitive level, strong conviction like a team and highly motivated can not only alleviate also remove the Ringelmann effect on a boat Coxless four. Although the effort perception is greater in a team than individual.

Caso único: O efeito Ringelmann em uma atleta barco a remos

Palavras-chave:
Remo
Efeito Ringelmann
Coxless quatro
Desempenho
Psicologia do esporte

R E S U M O

Objetivo: Analisar se a tripulação espanhola do barco, coxless quatro, selecionado para o pré-olímpico do Rio de Janeiro 2016 apresenta o efeito Ringelmann, o que a medida que aumenta o número de componentes de um grupo, a contribuição individual, ao resultado final, vai diminuindo.
Método: A amostra foi composta por quatro remadores da tripulação do bote com uma experiência de 13, 16, 10 e 13 anos, respectivamente, e uma idade média de 24.25 ± 0.5 anos.
Resultados: Em todos os casos, um aumento sistemático ocorre na condição do equipamento relativamente indivídual, com uma média de metros percorridos na presente 1029.25metros, enquanto que o grupo foi de 1036.75 metros. O número de watts gerados também foi maior na execução coletiva (535.25w. vs. 524.25w.). No entanto, a média dos traçados na condição individual era inferior (35.5) para o grupo (37.25). Quanto à percepção de esforço (escala de Borg), os remadores de obtiveram pontuação individual inferior (7.75) do que no grupo (8.75).
Conclusões: Este estudo demonstra que o efeito Ringelmann não ocorre na tripulação espanhola do barco coxless quatro, onde ao contrário de outros estudos nos quais o desempenho individual foi menor na execução coletiva. Nesse caso os sujeitos eram mais jovens. Estes dados parecem sugerir que ao nível competitivo, forte convicção que equipe altamente motivada não só pode aliviar, mas para remover o efeito Ringelmann em um barco coxless quatro. Embora a percepção é maior esforço de equipe.

Introducción

El remo es un deporte escasamente estudiado en el campo de la Psicología (si bien hay algunos estudios de intervención[1–4]), en el que se puede competir de forma individual en un bote denominado *skiff*, aunque lo frecuente es hacerlo en botes de dos, cuatro u ocho con timonel, si bien se puede plantear si dos son en realidad un equipo[5].

Se trató de estudiar si el fenómeno denominado «haraganeo social» o efecto Ringelmann[6,7] se daba en un equipo de remo que iba a competir en un Campeonato de Europa y en la clasificatoria olímpica para los Juegos de Río 2016, dado que según la teoría pone de manifiesto que el esfuerzo de un grupo no es la suma de los esfuerzos máximos individuales y que, por el contrario, hay una tendencia a perder rendimiento cuanto mayor es su tamaño[8]. Dado que se trataba de un bote que iba a competir al máximo nivel era importante estudiar si en la condición de equipo, los remeros perdían rendimiento frente a cuando compiten individualmente como ya se había observado en otros estudios con remeros[1,8], con muestras más grandes pero con competidores más jóvenes, menos experimentados si bien la mayoría competía a nivel nacional con resultado de medallas en campeonatos de España. En el primer estudio[8], en una muestra de 44 remeros, en el 93.18% de los casos se produjo un descenso sistemático en la condición del equipo respecto de la individual, con una media de metros recorridos en esta de 851.32 m, mientras que en la grupal fue de 837 m. ($t = 7028$, $gl = 34$, $p = 0.000$), la media de paladas en la condición individual fue superior (35.02) a la de grupo (34.79), aunque las diferencias entre ambas no resultaron significativas ($t = 0.696$, $gl = 42$, $p = 0.245$). En cuanto a la percepción de esfuerzo (escala de Borg), los remeros puntuaban, de manera significativa, más bajo individualmente (6.03) que en grupo (7.29) ($t = -4769$, $gl = 34$, $p = 0.000$), así pues, este estudio demostró que el efecto Ringelmann se refleja en la variable distancia. En el segundo estudio[1], con una muestra de 47 remeros jóvenes, pero con un mínimo de dos años de experiencia y que, igualmente competían a nivel nacional, los sujetos demostraron rendir más en la condición individual que en la de equipo.

Por todo lo anteriormente expresado, el objetivo de este estudio fue valorar si el efecto Ringelmann estaba presente en el equipo español de remo de cuatro sin timonel.

Método

Muestra

Componentes de la tripulación del cuatro sin timonel de la Federación Española de Remo, que preparaban el Campeonato de Europa y buscaban la clasificación olímpica para los Juegos de Río de Janeiro, con 13 ± 2.45 años y que en todos los casos han sido campeones de España en diferentes botes.

Procedimientos

Se trata de un diseño univariable, condicional multivariado, intrasujeto de medidas repetidas, de diseño cuasiexperimental, puesto que no se realiza una asignación aleatoria de los sujetos a las distintas condiciones experimentales. Los sujetos fueron medidos según una estrategia longitudinal en las diferentes condiciones de la variable independiente. El objetivo de este estudio fue evaluar la influencia de la variable independiente «ejecución» (con dos condiciones: individual y en equipo) sobre la variable dependiente (VD) «rendimiento». Se han utilizado varias medidas dentro de la VD: el número de metros recorridos por cada remero en tres minutos, número de paladas por minuto, las calorías consumidas en tres minutos y los vatios alcanzados por cada remero en tres minutos.

Se realizaron dos test de esfuerzo máximos a cada sujeto, uno individual y otro en grupo, utilizando cuatro remoergómetros, Concept-2 Remo Indoor, Modelo D. Este ergómetro cuenta con un *software*, que proporciona los siguientes parámetros: tiempo total

Tabla 1
Resultados de cada remero en cada una de las dos condiciones experimentales

Sujeto	Prueba	Vatios (w)	Paladas (número)	Metros (m)	Calorías (calorías)	Borg	FC Final (spm)	FC 1′ Rec. (spm)	FC 3′ Rec. (spm)
1	Individual	507	35	1018	93	8	182	148	106
	Equipo	512	37	1022	88	8	175	131	105
2	Individual	531	36	1034	122	7	183	149	116
	Equipo	528	37	1033	136	9	184	142	124
3	Individual	561	33	1053	65	8	176	143	110
	Equipo	596	36	1075	103	9	178	154	129
4	Individual	498	38	1012	65	8	182	142	103
	Equipo	505	39	1017	23	9	187	142	118
Grupo (media)	Individual	524.25	35.50	1029.25	86.25	7.75	180.75	145.50	108.75
	Equipo	535.25	37.25	1036.75	87.50	8.75	181.00	142.25	119.00

FC: frecuencia cardíaca; m: metros; Rec: recuperación; spm: sístoles por minuto; w: vatios; 1′: final primer minuto recuperación; 3′: final tercer minuto recuperación.

de la prueba, tiempo parcial cada 500 metros, metros recorridos, paladas por minuto, intensidad del trabajo en vatios, entre otros, y cuenta con la capacidad de almacenar todos estos datos para su posterior análisis. Una pantalla, en la que se muestran los datos durante el esfuerzo, permite al remero contar, en todo momento, con un *feedback* de su ejecución.

Las pruebas se llevaron a cabo en una sala ventilada y adecuada del Centro Especializado de Alto Rendimiento de la Cartuja (Sevilla), un espacio conocido por los remeros, en el que suelen entrenar y se sienten cómodos y se realizó a cuatro semanas de la máxima competición y cuando ya estaban seleccionados para competir al máximo nivel. La máxima implicación en el esfuerzo se consiguió gracias a las explicaciones de la importancia de su implicación en la realización de ambas pruebas, con la finalidad de estar lo mejor preparado posible para las siguientes competiciones. Además, se les explicó el procedimiento: una prueba máxima de tres minutos primero en ejecución individual y tras el descanso, en grupo. Antes de la realización de cada prueba (individual y grupal), los sujetos realizaron el calentamiento habitual consistente en la realización del propio gesto técnico en el remoergómetro durante unos 15 minutos.

En ambas pruebas un investigador facilitó las mismas instrucciones a cada uno de los sujetos. Se les pidió rendir a la máxima intensidad y sin la presencia de los otros compañeros; las instrucciones eran iguales para todos los sujetos: «*Tienes que tratar de recorrer el máximo número posible de metros en tres minutos de ejecución. Por favor trata de dar tu máximo rendimiento en esta prueba*». En este caso cada remero podía ver la pantalla del ergómetro y con ello tener *feedback* de ejecución. Para comenzar la ejecución, el investigador les indicaba el comienzo de la misma, avisándole a cada remero del tiempo que llevaban de tarea cada minuto de la forma siguiente: en la salida se les cantaba: ¿Preparados? ¿listos? ¡ya!; durante la prueba en los tiempos correspondientes se les indicaba: ¡llevas un minuto!, ¡llevas dos minutos!, ¡te quedan 30 segundos! ¡se acabó! La frecuencia cardíaca (FC) se registró al final de la prueba y al minuto y los tres minutos de recuperación. En estos mismos tiempos se valoró la percepción del esfuerzo. Posteriormente, los remeros se trasladaban a una sala de descanso donde se recuperaban del esfuerzo durante 45 minutos, tiempo considerado como suficiente para estar totalmente recuperados.

Una vez realizada la prueba individual, se les explicaba la prueba de equipo, indicándoseles que el valor que se iba a medir era el número de metros recorridos por la totalidad del bote; es decir, el sumatorio de los metros recorridos por cada uno de ellos durante su prueba.

Para la ejecución de la prueba de grupo se situaron los remeros en línea, en las mismas posiciones en las que iban a competir, y en las que entrenan para preparar el bote. Las instrucciones eran exactamente las mismas que en la condición uno. En esta condición la pantalla permaneció oculta a los remeros para que no tuvieran ninguna información externa, y solo tuvieran sus propias percepciones.

El gasto calórico de cada remero durante la prueba se calculó mediante pulsómetros Garmin modelo Fénix 3, con banda registradora de FC en R1, calibrados con los parámetros corporales de cada remero.

Para autoevaluar el esfuerzo tras cada ejecución, se utilizó la escala de diez ítems de percepción de esfuerzo de Borg[4,9], con la que los remeros se puntuaron en una escala de 0 (ausencia de esfuerzo) hasta 10 (muy, muy intenso). Se administró inmediatamente detrás de cada una de las pruebas. Suponía para el remero interpretar la dureza y la sensación de cansancio tras el esfuerzo, basado en las sensaciones que experimenta durante la tarea.

Análisis estadístico

Se realizaron estadísticos descriptivos (media, desviación estándar, frecuencia y porcentajes) para cada variable, para ello se utilizó el programa Excell del paquete Office para Windows. Posteriormente se realizaron comparaciones entre las ejecuciones del mismo remero a nivel individual y colectivo, mediante el uso del paquete estadístico SPSS 19, para ello se utilizaron las pruebas estadísticas no paramétricas para muestras relacionadas de Wilcoxon y McNemar, poniendo a prueba las hipótesis con un nivel de significación del 0.05 ($p < 0.05$).

Resultados

En la tabla 1 mostramos los resultados de cada sujeto y las medias del grupo, tanto en la condición individual como en la de equipo, para las diferentes variables estudiadas. Como se observa, en casi todos los casos se produce un aumento sistemático, en la condición del equipo respecto de la individual, en los vatios realizados por cada remero, salvo en un sujeto, aunque con una diferencia mínima (3 vatios menos), mientras que los otros tres remeros realizaron más vatios en la condición grupal. En relación con el número de paladas, también fue superior en la condición grupal. No se encontraron diferencias significativas en las calorías consumidas, la FC al final de la prueba y la FC al minuto y a los tres minutos de recuperación. En cuanto a la percepción del esfuerzo, menos en un sujeto que fue igual, en el resto fue superior en la condición de equipo. En las dos últimas filas de la tabla 1 pueden verse los resultados medios del grupo de las diferentes variables estudiadas en ambas condiciones experimentales. Salvo en la FC durante la recuperación, en el resto de variables se aprecia un aumento medio en la condición de equipo.

Tabla 2
Porcentaje de variación de la prueba colectiva, en relación con la individual, en cada uno de los remeros analizados y media de cada variable del grupo

Sujeto	Vatios(w)	Paladas(número)	Metros(m)	Borg
1	+ 0.98%	+5.71%	+0.39%	0%
2	-0.66%	+2.77%	-0.10%	+28.57%
3	+6.23%	+9.09%	+2.09%	+12.50%
4	+1.41%	+2.63%	+0.49%	+12.50%
Grupo	+1.99%	+5.05	+0.72%	+13.39%

En la tabla 2, se muestran las variaciones porcentuales de la prueba colectiva, en relación con la individual, para cada deportista y la media del grupo. Se observa que, salvo el sujeto dos que presenta valores negativos en los vatios desarrollados y en los metros recorridos, esta variación es positiva, a favor de la prueba colectiva, para el resto de sujetos y para el grupo.

Discusión

Los resultados del estudio no confirman la existencia del efecto Ringelmann en este equipo de cuatro sin timonel de alta competición, a diferencia de otros estudios[1,6–8], alguno de ellos realizados en remeros más jóvenes y menos experimentados[1]. Así, como puede comprobarse en la VD metros recorridos, en las dos situaciones contempladas en nuestro estudio, individual y grupal, tres de los remeros aumentaron ligeramente los metros recorridos en la condición de equipo, mientras que el restante tuvo una pérdida de un metro, que en una prueba de remo de tres minutos de esfuerzo, puede considerarse como poco relevante. El comportamiento de la VD número de paladas es similar a la anterior, no existiendo diferencias significativas entre la realización individual o grupal de la prueba ($Z = -1841$, $p > 0.05$), lo que también ocurre en otros estudios[8], si bien los técnicos consideran que el número de paladas diferencia al remero por su estilo y no siempre es una variable que signifique, necesariamente, mayor eficiencia en términos de rendimiento. Adicionalmente, el que la diferencia no sea estadísticamente significativa, puede deberse al reducido tamaño muestral de nuestro estudio, hecho frecuente cuando se realizan en deportistas de alto nivel este tipo de investigaciones y que nos obliga a ser cautelosos en cuanto a nuestras conclusiones.

En cuanto a la VD percepción del esfuerzo, mientras que en el estudio ya mencionado[8], el 74.3% manifestaba estar más fatigado, tras la prueba individual que tras la de equipo, en nuestro caso tres de los cuatro deportistas manifestaron estar más fatigados tras la prueba de equipo, el sujeto restante se sentía igual de cansado. La ausencia de efecto Rigelmann en nuestro estudio podría ser achacada a que los remeros se entregasen más a fondo cuando compitieron como grupo, pero no consideramos que haya sido así, dado que la FC final media de la prueba individual (180.75spm) es prácticamente la misma que la de la prueba de equipo (181spm).

El orden en la realización de las pruebas, primero la individual y después la de equipo, ha podido influir en la ausencia de efecto Rigelmann en nuestro trabajo. De nuevo, el análisis de los resultados medios en cada una de las situaciones no nos permite sostener la anterior afirmación, ya que en la prueba de equipo los remeros alcanzan valores superiores en el número de paladas, el número de metros recorridos y el número de vatios alcanzados. Por lo que, el tiempo de recuperación entre ambas pruebas (45′), puede considerarse como suficiente, hecho que fue corroborado tanto por el seleccionador nacional, como por los cuatro remeros.

La motivación psicológica de los participantes es un factor importante a la hora de interpretar algunos resultados relacionados con el rendimiento deportivo de máximo nivel y, considerando lo expuesto por Aybar[10], que indica que la motivación juega un papel fundamental y es una variable psicológica que mueve a los individuos hacia una meta, podemos argumentar que este puede haber sido el factor que explique la ausencia de efecto Rigelmann en nuestro trabajo. En el grupo de remeros que hemos estudiado la motivación era máxima, dado que se trataba de un equipo altamente competitivo y de nivel olímpico, contaban con una gran conciencia de equipo y un concepto muy claro de que el bote de cuatro sin timonel efectivamente no era individual, por lo que cada remero debía dar lo mejor de sí mismo.

El tamaño de la muestra analizada y la imposibilidad técnica de la realización de la prueba de equipo en un ergómetro conjunto y no en cuatro individuales, suponen las principales limitaciones de nuestro estudio.

Como aplicaciones prácticas de nuestros resultados podemos sugerir la medición del efecto Rigelmann en equipos de remo y la intervención del psicólogo deportivo, para propiciar motivación y sentimiento de equipo, como herramienta eficaz en la mejora del rendimiento de equipos de remo.

Nuestros datos parecen mostrar que el nivel competitivo, la fuerte convicción de equipo y la alta motivación pueden no solo paliar, sino hacer desaparecer el efecto Ringelmann en un bote de cuatro sin timonel.

Responsabilidades éticas

Protección de personas y animales. Los autores declaran que los procedimientos seguidos se conformaron a las normas éticas del comité de experimentación humana responsable y de acuerdo con la Asociación Médica Mundial y la Declaración de Helsinki.

Confidencialidad de los datos. Los autores declaran que han seguido los protocolos de su centro de trabajo sobre la publicación de datos de pacientes.

Derecho a la privacidad y consentimiento informado. Los autores han obtenido el consentimiento informado de los pacientes y/o sujetos referidos en el artículo. Este documento obra en poder del autor de correspondencia.

Conflicto de intereses

Los autores declaran no tener ningún conflicto de intereses.

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Influencia de la actividad física sobre la eliminación urinaria de minerales y elementos traza en sujetos que viven en la misma área geográfica

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RESUMEN

Objetivo: El objetivo de este estudio fue conocer las concentraciones de los macroelementos magnesio y fósforo, y de los elementos traza arsénico, boro, litio, cesio, rubidio, estaño y estroncio, en orina de sujetos sedentarios y deportistas, que viven en la misma región.
Método: Se analizó la concentración urinaria de los metales descritos antes. La muestra estaba constituida por un grupo de 21 atletas de fondo y un grupo control formado por 26 sujetos sedentarios. Se registraron medidas antropométricas, la frecuencia cardíaca y la presión arterial en reposo. Fueron sometidos a una prueba de esfuerzo para determinar la frecuencia cardíaca máxima, el consumo máximo de oxígeno, la ventilación pulmonar y el cociente respiratorio. Se tomaron muestras de la primera orina de la mañana de todos los sujetos.
Resultados: Los atletas presentaron valores significativamente inferiores ($p < 0.001$) en índice de masa corporal, grasa corporal ($p < 0.001$) y frecuencia cardíaca de reposo ($p < 0.001$). La frecuencia cardíaca máxima, el consumo máximo de oxígeno ($p < 0.001$) y la ventilación pulmonar ($p < 0.05$) fueron mayores en el grupo de atletas respecto al grupo control. No existieron diferencias significativas en las concentraciones urinarias de fósforo, arsénico, boro, litio, rubidio y estroncio. Las concentraciones urinarias de magnesio ($p < 0.001$) y estaño ($p < 0.05$) fueron menores en los atletas que en el grupo control. Además, las concentraciones urinarias de cesio ($p < 0.05$) eran mayores en deportistas respecto al grupo control.
Conclusiones: Los concentraciones de los elementos analizados se encuentran en rangos normales, no existiendo, por tanto, riesgo para la salud. La realización de entrenamiento sistemático provoca una menor eliminación de magnesio y estaño y mayor de cesio, que evitaría la toxicidad por su acumulación, no perjudicando su rendimiento.

Influence of physical activity on urinary excretion of minerals and trace elements in subjects who live in the same geographic area

Keywords:
Macroelements
Metals
Exercise
Urine
Athletes

ABSTRACT

Objective: The aim of this study was to determine the concentrations of macroelements magnesium and phosphorus, and the trace elements arsenic, boron, lithium, cesium, rubidium, tin and strontium in urine of sedentary subjects and long distance athletes, who live in the same area.
Method: It was evaluated the urinary concentration of the metals mentioned before. The sample consisted of a group of 21 long-distance athletes. Twenty-six sedentary subjects formed the control group. The procedure consisted of recording anthropometric measurements, heart rate and blood pressure at rest. Then a stress test was performed to determine the maximum heart rate, maximum oxygen consumption, pulmonary ventilation and respiratory exchange ratio. Samples of the first morning urine of all subjects were obtained.

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Results: Athletes had significantly lower levels ($P < .001$) of body mass index, body fat ($P < .001$) and resting heart rate ($P < .001$). Maximum heart rate and maximum oxygen consumption ($P < .001$) and pulmonary ventilation ($P < .05$) were higher in the group of athletes. No differences were observed in urinary concentrations of phosphorus, arsenic, boron, lithium, rubidium and strontium. Urinary concentrations of magnesium ($P < .001$) and tin ($P < .05$) were lower in athletes than the control group. However, urinary concentrations of cesium ($P < .05$) were higher in athletes compared to the control group.
Conclusions: Mineral concentrations analyzed are in normal values, so there is no risk to health. Training induces a less urinary excretion for magnesium and tin and an increase in cesium excretion, avoiding the toxicity because of cesium accumulation, without a performance decrease.

Influencia da atividade física sobre a excressão urinária de minerais e oligoelementos em sujeitos que vivem em mesma área geográfica

Palavras-chave:
Macroelementos
Metais
Exercicio físico
Urina
Atleta

R E S U M O

Objetivo: O objetivo deste estudo foi determinar as concentrações do macroelementos magnésio e fósforo, e oligoelementos arsênio, boro, lítio, césio, rubídio, estanho e estrôncio de urina indivíduos sedentários e atletas que vivem na mesma região.
Método: Foi avaliada a concentração urinária dos metais acima mencionados. A amostra foi constituída por um grupo de 21 atletas de fundo e um grupo de 26 indivíduos sedentários para grupo controle. Medidas antropométricas, frequência cardíaca e pressão arterial de repouso foram registrados. Eles foram submetidos a um teste de estresse para determinar frequência cardíaca máxima, o consumo máximo de oxigênio, ventilação pulmonar e quociente respiratório. Foram coletados as amostras da primeira urina da manhã de todas os sujeitos.
Resultados: Atletas tiveram valores significativamente menores ($p < 0.001$) no índice de massa corporal, gordura corporal ($p < 0.001$) e frequência cardíaca em repouso ($p < 0.001$). A frequência cardíaca máxima, o consumo máximo de oxigênio ($p < 0.001$) e ventilação pulmonar ($p < 0.05$) foram maiores no grupo de atletas no grupo de controle. Não houve diferenças significativas em concentrações urinárias de fósforo, arsénio, boro, lítio, rubídio e estrôncio. As concentrações urinárias de magnésio ($p < 0.001$) e estanho ($p < 0.05$) foram mais baixas nos atletas do que no grupo de controle. Além disso, as concentrações urinárias de césio ($p < 0.05$) foram maiores em atletas em comparação com o grupo de controle.
Conclusões: As concentrações dos elementos analisados se encontram em intervalos normais, portanto, não há risco para a saúde. A realização de treinamentos sistemáticos provoca uma menor excreção de magnésio, estanho e césio que evita maior toxicidade por acumulo, não prejudicando o desempenho.

Introducción

En los últimos años, los avances en la evaluación biomédica de los atletas ha hecho que los científicos consideren nuevos factores que pueden ser modificados por la actividad física intensa, y que puedan influir de manera importante en el rendimiento de los deportistas[1]. Un creciente énfasis se ha puesto en el papel de los metales macro y traza en la salud humana y la enfermedad[2].

Así, el magnesio (Mg) es un cofactor en más de 300 reacciones enzimáticas en las que se metabolizan los alimentos y se forman nuevos productos químicos[3]. Está también involucrado en la producción de energía celular y la degradación del glucógeno. Las pruebas acumuladas han mostrado una relación directa entre el Mg y el rendimiento deportivo. Algunos estudios han informado que la concentración en suero o plasma se redujo después del ejercicio[4–6]. En general, a largo plazo, ejercicios de alta intensidad, como senderismo o natación, dieron como resultado una disminución en los niveles de Mg.

El fósforo (P) juega un importante papel en el metabolismo de los hidratos de carbono, contribuyendo a la absorción intestinal de la glucosa mediante el proceso de la fosforilación. Estimula la reabsorción tubular renal de la glucosa por el mismo sistema y se une a los lípidos para formar fosfolípidos que forman parte de las membranas celulares. El P orgánico forma parte de un compuesto de los glóbulos rojos conocido como 2,3-difosfoglicerato, que facilita la liberación de oxígeno desde los eritrocitos a las células musculares[7]. El P es básico en la formación de moléculas fundamentales para la producción de energía, como el adenosín trifosfato, el creatinfosfato y el ácido fosfoenolpirúvico.

El arsénico (As) está presente en los tejidos humanos en un rango que oscila de los 10 a los 500 $\mu g/kg^{-1}$, encontrándose en menores concentraciones en el corazón y mayores en el hígado[8]. El As es conocido por ser tóxico para el hombre[9]. La concentración en orina es un buen indicador sobre la exposición al mismo[10]. Varios compuestos de As pueden interferir con la actividad de diversas enzimas, especialmente aquellas con grupos sulfidrilos. Así, puede estar involucrada en el ciclo de Krebs[11]. La toxicidad por As procedente de los alimentos y del agua ingeridos puede desencadenar varios problemas de salud, tales como mutaciones, carcinogénesis y efectos teratogénicos que pueden desencadenar varias disfunciones orgánicas[12,13].

El contenido de boro (B) en los tejidos humanos varía entre los < 0.2 y < 0.5 mg/kg^{-1}; sus concentraciones más elevadas se encuentran en los riñones y el hígado, y las más bajas, en la piel[8]. Penland planteó que el B puede jugar un papel en la función de la membrana celular, el metabolismo mineral y hormonal y las reacciones enzimáticas[14]. Nielsen[15] indicó que el B es requerido y beneficioso para los animales y los humanos en relación con el desarrollo embrionario, el crecimiento óseo y la calcificación, la función inmune, las habilidades psicomotoras y la función cognitiva.

El cesio (Cs) está presente en los tejidos humanos en un rango que oscila de 0.01 a los 0.05 mg/kg^{-1}, encontrándonos sus concentraciones más elevadas en el hígado y el corazón[8].

El litio (Li) se encuentra en los tejidos humanos en un rango de < 0.02 a 0.08 mg/kg^{-1}, estando más concentrado en la piel[8]. Estudios clínicos evidencian que el Li causa desensibilización de los receptores α-2, mostrando que su principal lugar de acción se centra en los mecanismos de comunicación intercelular. Así mismo, ejerce una inhibición directa de la adenilato ciclasa, y altera procesos mediados por el adenosín monofosfato cíclico y mecanismos de transporte iónico[11].

El rubidio (Rb) está presente en los tejidos humanos en un rango entre 8 y 30 mg/kg^{-1}, con un valor más bajo en la piel y el más alto en el hígado[8]. Existen algunas evidencias de que el Rb está involucrado en funciones cerebrales, pero no se han encontrado, hasta el momento, funciones específicas[16].

Los tejidos humanos contienen estaño (Sn) en un rango de < 0.2-0.85 mg/kg^{-1}, estando las concentraciones más bajas en el cerebro y las más elevadas en el hígado y los riñones[8]. Altas concentraciones de Sn en las comidas pueden causar irritación gástrica, afectar a la reproducción y disminuir la fuerza muscular[17].

Por su parte, el estroncio (Sr) está presente en los tejidos humanos en unas concentraciones que van de 0.09 a 0.24 mg/kg^{-1}, siendo su concentración más elevada en los riñones y la más baja en el cerebro[8]. Las funciones bioquímicas no son bien conocidas, pero D'Haese et al.[18] han indicado que son necesarias pequeñas cantidades de Sr para un apropiado proceso de calcificación de huesos y dientes.

Por todo lo anterior, el objetivo del presente estudio fue conocer las concentraciones de los macroelementos Mg y P, y de los elementos traza As, B, Li, Rb, Sn y Sr en orina de sujetos sedentarios y atletas de alto nivel deportivo, en modalidades de fondo, que viven en Extremadura (España).

Método

Sujetos

Veintiún atletas varones de larga y media distancia de categoría nacional fueron seleccionados antes de iniciar su periodo anual de entrenamiento. Seguían un programa de entrenamiento sistemático con una media anual de 120 km por semana. El grupo control estaba formado por 26 estudiantes varones que no realizaban ejercicio físico de forma regular. Los dos grupos vivían en la misma área geográfica (Extremadura, España).

Todos los participantes fueron informados del propósito del estudio y dieron su consentimiento para participar en el mismo, cumpliendo con las normas éticas de la Declaración de Helsinki. Todos ellos completaron un cuestionario en relación con sus hábitos nutricionales con el fin de asegurar que no ingerían ninguna vitamina ni mineral u otras suplementaciones, que garantizara que llevaban dietas similares (se preguntó el tipo y la frecuencia con que se ingerían los alimentos).

Procedimiento

Las medidas antropométricas fueron realizadas por el mismo operador, especialista en las técnicas cineantropométricas, siguiendo las recomendaciones del Grupo Español de Cineantropometría[19]. Todas las medidas se realizaron por la mañana y siempre a la misma hora. La altura del cuerpo se midió con una precisión de 0.1 cm utilizando un estadiómetro montado en la pared (Seca 220), y el peso corporal se midió utilizando una báscula electrónica (Seca 769). El índice de masa corporal se calculó dividiendo el peso en kg por la altura en metros al cuadrado.

La frecuencia cardíaca en reposo y la presión arterial fueron determinadas usando un esfigmógrafo automático (Omron HEM-780) después de un periodo de cinco minutos en reposo en la posición de decúbito supino.

Los sujetos fueron sometidos a una prueba de esfuerzo incremental máxima hasta la extenuación voluntaria sobre tapiz rodante (marca PowerJog) para establecer diferencias entre ambos grupos, en la que se determinó el consumo máximo de oxígeno, la ventilación pulmonar, el cociente respiratorio y la frecuencia cardíaca máxima. Los sujetos realizaron un calentamiento de diez minutos de carrera continua a 8 km/h, comenzando la prueba a 10 km/h. La velocidad se iba incrementando progresivamente en 1 km/h cada dos minutos, hasta el momento en el que los participantes no podían mantener la velocidad requerida. La respuesta fisiológica en parámetros ergoespirométricos era controlada mediante un analizador de gases (MGC, modelo n.º 762014-102) y un pulsómetro (Polar Vantage NV™). Los datos obtenidos fueron analizados con el software Polar Precision Performance de Polar tras la transmisión de los datos con el interfaz (Polar Advantage Interface, Kempele, Finlandia), propio de la marca finlandesa.

Se tomó la primera orina de la mañana, que fue depositada en tubos de 10 mL, previamente lavados con ácido nítrico diluido, y congelados a −20 °C hasta el análisis. Antes de este, las muestras se descongelaron y se homogeneizaron por agitación.

Los elementos Mg, P, As, B, Cs, Li, Rb, Sn y Sr se analizaron por ICP-MS de acuerdo con el tratamiento hecho en muestras de sangre por Sarmiento-González et al.[20]. La descomposición de la matriz orgánica se realizó calentándola 10 h a 90 °C tras la adición de 0.8 mL de NO_3H y 0.4 mL de H_2O_2 a 2 mL de orina. Después, las muestras se secaron en un termo bloque a 200 °C. La reconstitución de las muestras se realizó añadiéndole 0.5 mL de ácido nítrico, 10 μL de In (10 mg/L) como patrón interno y agua destilada suprapura hasta 10 mL. Los blancos de reactivos, los patrones de elementos y el material de referencia certificado (Seronorm™, lote 0511545, Billingstad, Noruega) se prepararon de la misma manera y se usaron para las pruebas de precisión. Antes del análisis, los materiales de control se diluyeron de acuerdo con la recomendación del fabricante. Las soluciones digeridas se analizaron por ICP-MS en un ELAN® 9000 (Perkin Elmer, Waltham, MA, EE. UU.).

La creatinina se midió en todas las muestras de orina para tener en cuenta la posible dilución de las muestras[21], mediante el kit de creatinina de Sigma (555-A) usando un espectrofotómetro UNICAM 5625.

Análisis estadístico

El análisis estadístico se realizó con el programa SPSS® 19.0. Los resultados se expresaron como media ± desviación estándar. La normalidad de la distribución de las variables se comprobó mediante el test de Shapiro-Wilks. Para comprobar la significación de las diferencias en la concentración urinaria de los elementos estudiados entre el grupo control y los atletas se usó el test t-Student. Un valor de $p < 0.05$ se consideró estadísticamente significativo.

Resultados

Hábitos dietéticos

Los hábitos dietéticos fueron similares en ambos grupos. Ninguno de los participantes seguía ninguna dieta especial. Declararon una ingesta similar de leche, pescado, carne, frutas y verduras.

Tabla 1
Características antropométricas, cardiovasculares y ergoespirométricas de los grupos del estudio

	Control (n = 26)	Atletas (n = 21)
Edad (años)	22.65 ± 3.65	21.62 ± 4.27
Altura (m)	1.77 ± 0.05	1.75 ± 0.06
Peso (kg)	76.94 ± 11.07	64.68 ± 7.25**
IMC (kg/m^2)	21.81 ± 3.14	18.25 ± 1.73**
Suma 6 pliegues (mm)	85.33 ± 31.74	47.57 ± 10.68**
% muscular	45.04 ± 3.24	49.19 ± 1.46
% óseo	16.5 ± 3.37	18.4 ± 1.47
% graso	14.27 ± 3.45	8.4 ± 1.11**
PAS (mmHg)	125.36 ± 8.65	124.71 ± 6.90
PAD (mmHg)	84.64 ± 6.64	80.62 ± 6.77
FC reposo (ppm)	72.79 ± 14.72	53.76 ± 11.91**
FCmáx (ppm)	190.34 ± 8.65	192.71 ± 7.61
VO_2máx (mL/kg/min)	43.93 ± 7.28	66.95 ± 9.70**
VE (L/min)	102.89 ± 11.77	136.04 ± 22.58*
RER	1.08 ± 0.25	1.04 ± 0.04*

FC: frecuencia cardíaca; FCmáx: frecuencia cardíaca máxima; IMC: índice de masa corporal; PAD: presión arterial diastólica; PAS: presión arterial sistólica; RER: cociente respiratorio; VE: ventilación pulmonar; VO_2máx: consumo máximo de oxígeno.
Test t-Student. Datos expresados como media ± desviación estándar.
* $p < 0.05$.
** $p < 0.001$ en comparación grupo control vs. atletas.

Tabla 2
Concentración urinaria de elementos minerales en el grupo control y el grupo de atletas

Elemento y unidades	Grupo	
	Control (n = 26)	Atletas (n = 21)
Magnesio		
mg/L	186.10 ± 131.80	65.97 ± 49.10**
mg/g creatinina	111.3 ± 91.32	44.92 ± 36.81**
Fósforo		
mg/L	1 754 ± 1 116	2 146 ± 1 162
mg/g creatinina	1 024 ± 692	1 407 ± 909
Arsénico		
µg/L	109.46 ± 199.7	63.56 ± 78.84
µg/g creatinina	56.08 ± 92.64	37.69 ± 41.29
Boro		
µg/L	1.256 ± 838.1	936.79 ± 305.9
µg/g creatinina	738.7 ± 568.9	690.1 ± 442.5
Litio		
µg/L	26.31 ± 13.56	32.19 ± 16.82
µg/g creatinina	15.38 ± 9.25	22.95 ± 12.39
Estaño		
µg/L	2.49 ± 1.49	1.146 ± 1.873
µg/g creatinina	1.16 ± 1.68	0.675 ± 0.92*
Cesio		
µg/L	5.55 ± 2.58	8.41 ± 5.94*
µg/g creatinina	3.20 ± 1.60	5.05 ± 2.65**
Rubidio		
mg/L	1 791 ± 1 207	1 988 ± 1 291
µg/g creatinina	1 018 ± 737.9	1 182.4 ± 563.9
Estroncio		
µg/L	121.96 ± 72.23	116.9 ± 45.01
µg/g creatinina	73.20 ± 43.35	70.15 ± 27.09

Test t-Student. Datos expresados como media ± desviación estándar.
* $p < 0.05$.
** $p < 0.001$ en comparación grupo control vs. atletas.

Características antropométricas, cardiovasculares y ergoespirométricas

La tabla 1 describe los datos antropométricos y cardiovasculares de los participantes. Al comparar los resultados entre los grupos observamos que los atletas presentaron valores significativamente inferiores ($p < 0.001$) de índice de masa corporal, grasa corporal ($p < 0.001$) y frecuencia cardíaca de reposo ($p < 0.001$).

Así mismo, se pueden observar los datos ergoespirométricos del grupo control y del grupo de atletas. Tanto la frecuencia cardíaca máxima como el consumo máximo de oxígeno ($p < 0.001$) y la ventilación pulmonar ($p < 0.05$) fueron mayores en el grupo de atletas respecto al grupo control. Con relación al cociente respiratorio, fue más elevado en el grupo control ($p < 0.05$).

Concentración urinaria de los metales

La tabla 2 muestra las concentraciones urinarias de cada elemento, sin corrección y con corrección para la creatinina, en los atletas y el grupo control. Los resultados muestran la falta de diferencias significativas en las concentraciones urinarias de ambos grupos para los elementos P, As, B, Li, Rb y Sr. Las concentraciones urinarias de Mg ($p < 0.001$ y $p < 0.001$, sin corrección y con corrección para la creatinina, respectivamente) y Sn ($p < 0.05$) eran menores en los atletas que en el grupo control. Sin embargo, las concentraciones urinarias de Cs ($p < 0.05$ y $p < 0.001$, sin corrección y con corrección para la creatinina, respectivamente) eran superiores en los deportistas respecto al grupo control.

Discusión

En nuestro estudio podemos ver que la realización de un entrenamiento aeróbico puede producir cambios en la eliminación de algunos elementos traza. Así, los resultados obtenidos muestran que todos los elementos estudiados presentaban valores dentro de los considerados como normales en otros estudio de similares características, expresados como en nuestro estudio en µg/L, y utilizando una técnica similar[22-24].

Algunos estudios han informado que la concentración de Mg en suero o plasma se reducía después del ejercicio[3,4,6]. Los resultados presentaron concentraciones significativamente menores en el caso de los atletas ($p < 0.001$). Esta menor eliminación de Mg en los atletas podría formar parte de un proceso adaptativo en estos para evitar pérdidas de un elemento de gran importancia para el rendimiento del deportista como es el Mg[3].

Por otra parte, se observó también una menor eliminación urinaria para el Sn. El hombre está expuesto al Sn por su ingesta, inhalación y absorción por la dermis. Sin embargo, la principal fuente de ingestión es a través de la alimentación, especialmente en las comidas enlatadas, con la excepción de las áreas industriales, donde la concentración en el agua y en el aire es más elevada[25]. Los resultados obtenidos no muestran concentraciones elevadas que podrían poner en peligro la salud de los sujetos. Sin embargo, esta menor eliminación en los atletas haría a estos sujetos más susceptibles a una posible intoxicación por Sn.

El estudio pone de manifiesto una significativamente mayor eliminación de Cs en los deportistas respecto a los controles. El Cs exhibe una reacción antagónica contra el potasio con respecto a la disponibilidad biológica[17], y el potasio ejerce importantes funciones celulares tanto en reposo como en el ejercicio. Por tanto, si se produjera un aumento en las concentraciones de Cs podría producir una dificultad en la función del potasio en la célula y, con ello, una disminución en el rendimiento deportivo, por ello una mayor eliminación de Cs evitaría esta mala situación metabólica para el deportista, mejorando su rendimiento.

Los pocos estudios en la bibliografía de estos elementos en relación con la actividad física, un control nutricional más minucioso y el número de participantes son las principales limitaciones del estudio. En cualquier caso, el conocimiento de estos resultados podrían tener implicaciones importantes para la salud y el rendimiento del deportista.

Por todo lo anterior podemos concluir en nuestro estudio que los niveles encontrados en los elementos analizados se encuentran dentro de rangos normales, no existiendo, por tanto, riesgo para la salud, y que la realización de entrenamiento físico sistemático provoca una menor eliminación de Mg y Sn y un incremento en la eliminación de Cs que evitaría la toxicidad por su acumulación, no perjudicando su rendimiento.

Responsabilidades éticas

Protección de personas y animales. Los autores declaran que los procedimientos seguidos se conformaron a las normas éticas del comité de experimentación humana responsable y de acuerdo con la Asociación Médica Mundial y la Declaración de Helsinki.

Confidencialidad de los datos. Los autores declaran que han seguido los protocolos de su centro de trabajo sobre la publicación de datos de pacientes.

Derecho a la privacidad y consentimiento informado. Los autores han obtenido el consentimiento informado de los pacientes y/o sujetos referidos en el artículo. Este documento obra en poder del autor de correspondencia.

Conflicto de intereses

Los autores declaran no tener ningún conflicto de intereses.

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Original

Remando contracorriente: facilitadores y barreras para compaginar el deporte y los estudios

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RESUMEN

Objetivo: El objetivo del presente estudio fue analizar los facilitadores y barreras que influyen en la compaginación de los aspectos académicos y deportivos en remeros de alto rendimiento.
Método: Participaron 11 remeros (n = 5 chicos y n = 6 chicas). Este estudio se desarrolló desde un enfoque cualitativo, enmarcado en el modelo holístico de desarrollo de la carrera deportiva, a través de entrevistas semiestructuradas. Se realizó un análisis del contenido de las entrevistas y se presentaron cinco niveles procedentes del modelo teórico utilizado: nivel deportivo, nivel psicológico, nivel psicosocial, nivel académico/vocacional y nivel financiero. Estos niveles se analizaron en función de dos criterios: facilitadores y barreras.
Resultados: Se muestran los facilitadores y barreras en los niveles deportivo, psicológico, psicosocial, académico y financiero. Los facilitadores son: motivación intrínseca, reducción de la presión diaria, flexibilidad del profesorado, beca (académica y deportiva) y el apoyo de grupos sociales. Como barreras: largas concentraciones, coincidencia de los entrenamientos con las clases, estrés, cansancio, poco tiempo para el ocio, distancia del centro educativo al lugar de entrenamiento y la no compensación económica como deportista.
Conclusiones: Conociendo los beneficios de compatibilizar la formación educativa con la carrera deportiva desde el desarrollo personal, social, salud, financiero-laboral y anticipando la retirada deportiva, es fundamental que el psicólogo del deporte proporcione a los remeros, directa o indirectamente (a través del entrenador), recursos básicos de gestión del tiempo, así como estrategias para que sean autosuficientes en su carrera dual.

Paddling upstream: facilitators and barriers to combine sport and studies

Keywords:
Dual career
Facilitators
Barriers
Paddling
Education

ABSTRACT

Objective: The aim of this study is to analyze the facilitators and barriers in the arrangement of academic and athletic aspects in high performance rowers.
Method: Participated 11 rowers (n = 5 boys and n = 6 girls). The research conducted from a qualitative approach, framed holistic career development model, by means of semi-structured interviews. A content analysis of the interviews was conducted in five levels from the theoretical model used: athletic level, psychological level, psychological level, academic/vocational level and financial level. These categories were analyzed in terms of two others: facilitators and barriers.
Results: Facilitators and barriers in sports, psychological, psychosocial, academic and financial levels are shown. Facilitators are: Intrinsic motivation, reducing daily pressure, flexibility teacher, academic scholarship and sports and support of social groups. As barriers: Long concentrations coincidence workouts/classes, stress, fatigue, little time for leisure, distance from the school to the training and non-economic compensation as an athlete.

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Conclusions: Knowing the benefits of educational training compatible with career from the personal, social development, health, financial and labor and anticipating sports withdrawal, it is essential that the sport psychologist provide, directly or indirectly (through rowers coach), basic time management resources and strategies to become self-sufficient in his dual career.

Remando contracorrente: facilitadores e barreiras para combinar esportes e os estudos

Palavras-chave:
Carreira dupla
Facilitadores
Barreiras
Remo
Educação

R E S U M O

Objetivo: O objetivo do presente estudo foi analisar os facilitadores e barreiras que influenciam a disposição dos aspectos acadêmicos e desportivos em remadores de alta performance.
Método: Participaram 11 remadores (n = 5 homens e n = 6 mulheres). O estudo foi realizado a partir de uma abordagem qualitativa, emoldurado em um modelo de desenvolvimento de holístico, através de entrevistas semi-estruturadas. A análise do conteúdo das entrevistas foi realizada em cinco níveis a partir do modelo teórico utilizado: nível atlético, nível psicológico, nível psicossocial, nível acadêmico/profissional e nível financeiro. Estas categorias foram analisadas de acordo com dos critérios: facilitadores e barreiras.
Resultados: Facilitadores e barreiras nos níveis desportivos, psicológicos, psicossociais, acadêmicos e níveis financeiros são mostrados. Os facilitadores são: motivação intrínseca, redução da pressão diária, flexibilidade do corpo docente, bolsas de estudos e de esportes, e apoio dos grupos sociais. Como barreiras: concentrações longas, coincidência dos treinamentos com as aulas, estresse, fadiga, pouco tempo para o lazer, a distância da escola para o local de treinamento e baixa compensação econômica como um atleta.
Conclusões: Conhecendo os benefícios de compatibilizar a formação educacional com a carreira desportiva desde o desenvolvimento pessoal, social, saúde, financeiro-laboral e antecipando a retirada esportiva, é fundamental que o psicólogo do esporte proporcione aos remadores direta ou indiretamente (através treinador), recursos e estratégias básicas de gestão de tempo para ser autossuficientes em sua dupla carreira.

Introducción

El remo es un deporte minoritario en España del cual pocos pueden vivir profesionalmente. Para entrenar y estudiar se requiere un gran sacrificio físico-mental y recursos económicos. Este deporte ha sido estudiado específicamente presentando pautas de entrenamiento psicológico aplicadas en intervenciones en casos concretos[1]. En un estudio de caso único, se realizó una intervención conductual a una remera de nivel internacional que ejecutaba un error técnico debido a un déficit atencional[2]. También se estudió el llamado efecto Ringelmann en remeros, demostrando tener mayor sensación de fatiga y menor rendimiento en situación de grupo que cuando remaban individualmente[3]. En otro estudio con remeras durante su primer año universitario se evaluó el perfil de estados de ánimo y la automotivación[4]. Sin embargo, no se han encontrado estudios, en la literatura científica consultada, donde se analicen las posibilidades de compatibilizar aspectos académicos y deportivos en remeros de alto rendimiento. Combinar la carrera deportiva con una formación académica y/o un empleo se denomina carrera dual (CD)[5]. A lo largo de la última década, distintas instituciones públicas se han involucrado en mayor grado en facilitar la CD en el deporte. Desde la Comisión Europea se ha declarado un esfuerzo para abordar este tema, apoyando algunos proyectos como el European Athlete as Student o el Programa Erasmus Plus, desarrollado con perspectivas al período 2014-2020[6].

Durante la trayectoria deportiva existen diversas etapas que los deportistas deben ser capaces de afrontar de manera eficiente. El paso de una de las etapas hacia otra, constituye una transición deportiva, con sus respectivos cambios y consecuencias. Es preciso cuestionarse si es adecuado centrar toda su formación a la preparación deportiva en detrimento de otros aspectos necesarios para entender al deportista de una manera armónica y completa[7].

Por consiguiente el modelo teórico, sobre el que se sustenta este estudio, es el modelo holístico de desarrollo de la carrera deportiva de Wylleman et al.[8] basado en el modelo original de Wylleman y Lavalle[9], ya que valora al deportista desde diferentes niveles. El modelo queda establecido en cinco niveles: (a) nivel deportivo, comprendido en iniciación, desarrollo, maestría y retirada; (b) nivel psicológico, estructurado en infancia, adolescencia y adultez; (c) nivel psicosocial, organizado acorde con el entorno más próximo del deportista: familia-amigos en primer lugar, seguido del entrenador, y por último, compañeros de equipo-clase, apoyo del cuerpo técnico y la pareja; (d) nivel académico/vocacional, constituido en educación primaria, secundaria, universitaria y formación-ocupación profesional; (e) nivel financiero, hace referencia a las diferentes fuentes de obtención de ingresos, a través de la familia, federaciones deportivas, patrocinadores y empleo.

En línea con este modelo teórico, el objetivo de la investigación consistió en analizar los facilitadores y las barreras que influyen en la compaginación de los aspectos académicos y deportivos de remeros de alto rendimiento. La aportación a la comunidad científica radicó en plasmar esos factores que facilitan y dificultan esta conciliación.

Método

Sujetos

Participaron 11 remeros (6 remeras) en activo que acumulan medallas de oro, plata y bronce en Campeonatos de España de Remo, Campeonatos de España de Remoergómetro, Europeos y Mundiales, algunos de ellos en el proceso de preparación de los Juegos Olímpicos de Río de Janeiro 2016. Se utilizó la técnica de

Tabla 1
Descripción de los remeros entrevistados en el presente estudio

Remero	Sexo	Edad	Categoría	Nivel educativo
1	Masculino	18	Sub 23. Individual	Grado universitario
2	Masculino	22	Sub 23 y Absoluta. Equipo	Ciclo formativo de grado superior
3	Masculino	22	Sub 23. Equipo	Grado universitario
4	Masculino	19	Sub 23. Equipo	Grado universitario
5	Masculino	23	Absoluta. Equipo	Grado universitario
6	Femenino	17	Juvenil y Absoluta. Equipo	2.° Bachillerato
7	Femenino	22	Sub 23. Equipo	Grado universitario
8	Femenino	17	Juvenil. Equipo	2.° Bachillerato
9	Femenino	19	Sub 23 y Absoluta. Equipo	Grado universitario
10	Femenino	18	Sub 23. Equipo	Ciclo formativo de grado superior
11	Femenino	17	Juvenil. Equipo	2.° Bachillerato

muestreo por criterio, los cuales eran: (a) alto rendimiento en remo y (b) estudiar y/o trabajar[10]. En la tabla 1 se muestran las características de los participantes entrevistados.

Procedimientos

Se elaboró un guión de entrevista basado en el modelo teórico de Wylleman et al.[8]. Se estructuró en tres temas principales: (a) conciliación de los estudios con la carrera deportiva; (b) conciliación del nivel económico con la carrera deportiva y los estudios/actividad complementaria; (c) conciliación del nivel psicosocial con la carrera deportiva y los estudios/actividad complementaria. El guión está disponible solicitándolo al primer autor.

Se realizó un contacto individual con cada deportista por teléfono para acordar la fecha y el lugar para hacer las entrevistas. Se les expuso el consentimiento informado, notificando el carácter confidencial y una breve explicación del estudio. Se grabaron las entrevistas con una duración entre 10-15 min y posteriormente fueron trascritas. El primer autor ocupó el rol de entrevistador.

Análisis estadístico

Se realizó un análisis de contenido de las entrevistas semiestructuradas. El procedimiento fue el siguiente: (a) se comprobaron las transcripciones de las 11 entrevistas realizadas con la intención de verificar que estaban correctamente reproducidas, (b) se anotaron unas ideas principales del contenido de las entrevistas afines con los objetivos del estudio, (c) se codificaron las entrevistas en función de los niveles del modelo teórico expuesto, (d) se analizaron los cinco niveles en función de dos criterios, facilitadores y barreras.

Resultados

En las tablas 2 y 3 mostramos los factores, encontrados en nuestro estudio, que actúan como facilitadores (tabla 2) o barreras (tabla 3), en la compaginación de los aspectos académicos y deportivos de los remeros de élite entrevistados.

Facilitadores

Deportivo
Todos los remeros y remeras señalan la óptima gestión del descanso para poder llevar el ritmo de los entrenamientos, desplazamientos y estudios. También algunos explican cómo la organización deportiva incide favorablemente para conciliar los entrenamientos con acudir a clases. Por ejemplo, comenta R.2.: «En el centro donde entrenamos lo bueno es que hacen el plan entreno basándose en el horario que tenemos de clase».

Psicológico
Todos los remeros explican cómo el remo se ha convertido en una filosofía de vida promovida por una motivación intrínseca. Comenta R.9.: «Fui a probar, empecé y me gustó bastante y seguí remando y me vieron cualidades, me fui enganchando poco a poco, entonces cuando empecé a competir pues no podía dejarlo, era ya un vicio más, más y más». La organización personal y el compromiso

Tabla 2
Facilitadores en la compaginación de los aspectos académicos y deportivos de los remeros entrevistados para el presente estudio

Niveles	Citas
Nivel deportivo	
- Gestión del descanso	«. . .cuando empecé yo no sabía ni lo que era y ahora es que mi vida no la concibo sin el remo. . .»
- Horario entreno/clases	«. . .necesito siesta, media horita tal y si no pues a estudiar hasta las 17:00h. . .»
Nivel psicológico	
- Motivación intrínseca - Organización personal - Compromiso - Reducción de la presión diaria	«. . .te sientes como que siempre vas a tener gente con la que estar y todos los días te relajas. A lo mejor si has tenido un día duro en el instituto o lo que sea, vas a entrenar, estás con tus amigos, te relajas, haces deporte, el ambiente es muy bueno. . .»
Nivel psicosocial	
- Apoyo compañeros equipo/amigos - Apoyo familiar - Apoyo pareja - Apoyo entrenador/a	«. . .mis padres nunca me han dicho que me pensara dejar de remar y estudiar más, siempre han estado conmigo, tanto en el deporte como en los estudios como en todo. . .»
Nivel académico/vocacional	
- Afinidad con compañeros de clase - Flexibilidad profesorado - alumnado - Tutor universitario/tutor CSD - Beca académica	«. . .tengo mis amigas y mis amigos que sí me apoyan más, venga no sé qué, que me tienen que ayudar con los trabajos, me tienen que pasar apuntes, pero son amigos más que compañeros. . .»
Nivel financiero	
- Beca deportiva	«. . .yo tuve beca de la Federación, por haber quedado bien en los campeonatos del mundo, y gracias a eso me ha servido para financiarme los estudios y vivir bien, aunque vivo con mis padres pero bueno, los estudios los tengo pagados. . .»

Tabla 3
Barreras en la compaginación de los aspectos académicos y deportivos de los remeros entrevistados para el presente estudio

Niveles	Citas
Nivel deportivo	
- Largas concentraciones - Solapamiento de horarios	«. . .ahora estamos concentrados dos semanas y estoy perdiendo clase, tendría que estar en clase. . .»
Nivel psicológico	
- Estrés y agobio - Presión - Miedo - Cansancio en las fases entrenamiento-clase-entrenamiento - Escaso tiempo para actividades de ocio	«. . .me genera estrés un viaje, yo he estado muy estresada y asustada y agobiada y de todo. Cuando me levanto me tengo que tomar un café y otro al medio día y cuando voy a dormir me pongo muy nerviosa y tengo que tomarme una tila. . .»
Nivel psicosocial	
- Adaptación en la relación profesorado - alumnado	«. . .bueno siempre llevaba la justificación oficial de mi club por si me lo pedían porque algunos no lo aceptan. . .»
Nivel académico/vocacional	
- Poco tiempo para estudiar - Faltas de asistencia a clase - Distancia entre centros educativo y deportivo - Abandono de otras actividades	«. . .pues del poco tiempo que me queda, que son 2 h al día no más, intento hacer los trabajos y estudiar un poco, pero vamos que no me queda mucho tiempo. Estudio sobre todo antes de los exámenes. A los trabajos sí tengo que dedicarle algo más de tiempo. . .»
Nivel financiero	
- Compensación económica	«. . . mucho dinero no dan la verdad, yo tengo una beca pero pequeña que me dieron hace poco por competir internacionalmente. Tienes que ir a Mundiales sabes, si no pues no, ir todos los años a mundiales y eso es difícil, que no dan beca fácilmente vaya. . .»

son esenciales, por ejemplo, dice R.7.: «Si te organizas y eres capaz y estás dispuesto a levantarte a las 7:00 h y no parar hasta las 22:00 h es posible, obviamente es un esfuerzo pero es posible».

Psicosocial

Los remeros son conscientes del importante papel que juega el apoyo de los diversos grupos sociales. El apoyo es percibido como satisfactorio por parte de los compañeros de equipo, amigos, familia y pareja. El apoyo del entrenador es piedra angular en esta compatibilización, atendiendo al rendimiento deportivo sin descuidar el papel académico. Explica R.7.: «El entrenador siempre te anima. Lo típico si tú lo dices que vas a faltar por un examen o lo que sea, no te hace una fiesta pero lo comprende».

Académico

Los remeros explican que no pueden asistir todos los días a clase. Por lo tanto, tener compañeros de clase que entiendan sus situaciones, posibilita en gran medida solventar los problemas que vayan surgiendo a lo largo del curso. Por otro lado, la manera en la que el profesorado gestiona las distintas dificultades durante el curso, repercute de manera significativa en la vida de los deportistas (faltas de asistencia a clase, cambio de fecha de exámenes o volver a explicar un contenido en una tutoría). Además, cuentan con la disponibilidad de un tutor académico para tratar los diversos asuntos educativos con el resto del profesorado, así como ejercer de vía comunicativa con el propio deportista. Por ejemplo, relata R.3.: «Todo genial, además tenía un tutor allí en la universidad que me ayudó mucho también en este tema, tutorías, si tenía alguna duda, alguna clase que no había asistido o algo me la daba sin problemas».

Financiero

Los deportistas de alto rendimiento tienen una beca académica. Esta proporciona una ayuda en el acceso en una carrera universitaria. Como explica R.11.: «Tenemos una beca que solo tienes que tener un cinco de media entre selectividad y bachillerato para entrar en la carrera que tú quieras. El 3% de todas las plazas de todas las carreras están destinadas a deportistas de alto rendimiento y a deportistas de élite».

Barreras

Deportivo

La mayoría de los remeros afirman cómo las largas concentraciones deportivas interfieren en los hábitos de estudio. No todos los clubes planifican los entrenamientos en función del horario de las clases. Por ejemplo, explica R.1.: «Es duro, es duro. . . y más el remo que no es un deporte fácil, ósea fácil en plan que con entrenar media horita te llega, si no dedicas fácil 3-4 h al día, no consigues nada».

Psicológico

Relatan que a lo largo de su trayectoria deportiva han experimentado estrés, presión, miedo y agobio, sobre todo con la llegada de competiciones y exámenes. Algunos también señalan la dificultad que tienen para aislar los entrenamientos de la vida académica debido al cansancio acumulado. Además argumentan que durante los periodos de competiciones y/o exámenes finales, el tiempo de ocio se convierte casi en inexistente. Comenta R.4.: «Terminas de entrenar, llegas a casa, cenas, desconectas un poco viendo la televisión o algo y te tienes que poner a estudiar porque si no llevas los estudios al día, al final es imposible».

Psicosocial

Relatan cómo en ocasiones amigos y compañeros de clase no comprenden la situación en la que se encuentra un deportista de alto rendimiento. De la misma forma que pueden tener dificultades con el profesorado en el aspecto académico. Explica R.10.: «Bien, bueno a veces tenía que faltar mucho y algunos no lo entendían (risas). Siempre llevaba la justificación por si me lo pedían y claro tienen que aceptarlo».

Académico

Algunos de los remeros señalan la falta de tiempo para estudiar, para poder asistir a las clases así como el hecho de tiempo libre. Tras la sesión de entrenamiento es difícil acudir a clase, sobre todo cuando la distancia entre lugar de entrenamiento y centro educativo es considerable. Por todo ello, dedicar tiempo a otras facetas, como pueden ser avanzar en algún idioma o iniciarse en la música, quedan habitualmente descartadas. Comenta R.8.: «Hasta el año pasado estuve en el conservatorio allí en La línea y tocaba el clarinete pero lo tuve que dejar, no se puede compaginar».

Financiero

Algunos de los remeros narran la dificultad que supone no tener una compensación económica como deportista. Como explica R.11.: «No puedo decir me voy a matar a entrenar porque puedo ser buena y el remo me va a dar de comer, no, como no me va a dar de comer, pues no voy a poder entrenar tanto porque tengo que sacarme una carrera y de mayor tendré que tener una familia, una casa, un algo». Los recursos económicos influyen en el momento de competir y estudiar de manera paralela. Algunos explican el nivel económico como una limitación, mientras que otros no necesariamente. Esto se debe a que las becas económicas están destinadas en función de buenos resultados deportivos en competiciones internacionales. Explica R.5.: «Si tú no consigues unos resultados en un mundial, no tienes beca. Entonces es que no te pasan ni un duro en el año y tienen que ayudarte tus padres o quien pueda. En cambio si tienes beca pues sí es una gran ayuda porque te dan como mínimo 8.000€. Entonces con eso pues mucho mejor, lo que te digo, si no tienes resultados, no tienes ni un duro».

Discusión

Los resultados aportan los factores que facilitan y dificultan la compaginación de los aspectos académicos y deportivos en remeros de alto rendimiento. Estos resultados son pioneros en el sentido de poder valorar la CD en el mundo del remo.

Desde el nivel deportivo, puntualizar que el remo requiere gran cantidad de tiempo de entrenamiento diario (tres a cinco h). Dado que un 90% de los deportistas de alto nivel (DAN) no llegan a ser olímpicos, estudiar de manera paralela se convierte en un objetivo justificado con su presente y futuro[11]. De esta forma, la gestión del tiempo y las horas de descanso son determinantes en relación directa en esta compaginación académica-deportiva.

Desde el nivel psicológico, los resultados revelan cómo los remeros están sometidos a presión, agobio y estrés a lo largo de la temporada, repercutiendo de manera negativa en la compatibilización académica-deportiva, tal como sugieren otros autores[12]. Surge la necesidad de que los psicólogos del deporte trabajen en esta problemática y no solo en optimizar el rendimiento deportivo[13].

En cuanto al nivel psicosocial, el apoyo social juega un papel determinante en la carrera deportiva y educativa durante esta transición. Tal como manifiestan otras investigaciones, la familia, amigos (compañeros de equipo y clase), así como la pareja, inciden de manera satisfactoria en esta compaginación académica-deportiva[14].

Respecto al nivel académico, la variable gestión del tiempo es la principal barrera para compaginar ambas actividades, como sugiere Stambulova[15]. En España el Programa de Atención al Deportista de Alto Nivel, ha mostrado efectos positivos en este plano. Dicho programa consiste en aconsejar a deportistas de élite sobre educación, empleo y asuntos sociales. Los programas existentes para el asesoramiento del deportista en universidades son el Tutorsport (Universidad Autónoma de Barcelona), el Tudan (Universidad de La Laguna) y el Programa de becas DAN (UPO), con el objetivo de dar respuesta a las necesidades académicas y deportivas. Aun así el 84.8% de las universidades no ofrecen asesoramiento laboral a los DAN[16]. Las comunidades autónomas reservarán, para quienes acrediten su condición de DAN, un porcentaje mínimo del tres por ciento de las plazas ofertadas por los centros universitarios. Los centros que impartan los estudios y enseñanzas en Ciencias de la Actividad Física y del Deporte, Fisioterapia y maestro de Educación Física, reservarán un cupo adicional equivalente como mínimo al cinco por ciento de las plazas ofertadas para los DAN[17].

Desde el nivel financiero, los remeros no reciben compensación económica alguna por sus regatas y conseguir una beca deportiva exige buenos resultados en competiciones internacionales, con lo cual muchos deportistas se quedan sin recibir ingresos económicos. Para los DAN, que luchan en una disciplina olímpica, se creó en España en 1988 el Programa ADO, el cual aporta ayuda económica, material deportivo y apoyo técnico a nuestros deportistas en las diferentes ediciones de los Juegos Olímpicos[18].

Los beneficios de compatibilizar la formación educativa con la carrera deportiva han sido analizados desde diferentes vías. Desde el desarrollo personal y social, la formación de la identidad se amplía con diferentes roles, se mejoran las habilidades sociales y por consiguiente, las relaciones sociales tienden a expandirse. Desde la vía de la salud, se adquieren estilos de vida más saludables y equilibrados. Desde el punto de vista financiero-laboral, se consiguen ampliar cargos a ocupar en el mercado laboral debido a la formación en diferentes áreas. Y por último, desde la retirada deportiva, se produce una mejor adaptación, así como una prevención en la crisis de identidad tras la retirada[13,19–23].

Una de las limitaciones de esta investigación consiste en que, durante la toma de datos, los remeros estaban concentrados en el Centro Especializado de Alto Rendimiento de Remo y Piragüismo «La Cartuja» (Sevilla. España), pero procedían de diferentes clubes de la geografía española. Con lo cual hay que tener en cuenta que no todos los clubes son iguales a la hora de organizar y promover su deporte. Sin embargo este estudio proporciona información valiosa específica sobre la CD en el remo. Se proponen como futuras líneas de investigación: (a) aumentar el tamaño muestral a través de la propagación de nuestra metodología a diferentes clubes de remo; (b) crear un programa de CD específico para remeros y remeras de alto rendimiento y c) analizar el potencial de los programas de ayuda al deportista por parte de las universidades.

El deporte de alto rendimiento lleva inmerso la etiqueta de no saludable, no obstante, se debe prestar atención a la difícil tarea de garantizar la correcta integración académica-deportiva por los beneficios ya mencionados. Es fundamental que el psicólogo del deporte proporcione a los remeros, directamente o indirectamente (a través del entrenador), conceptos básicos de gestión del tiempo, así como estrategias para que sean autosuficientes en su rutina diaria.

Responsabilidades éticas

Protección de personas y animales. Los autores declaran que para esta investigación no se han realizado experimentos en seres humanos ni en animales.

Confidencialidad de los datos. Los autores declaran que en este artículo no aparecen datos de pacientes.

Derecho a la privacidad y consentimiento informado. Los autores han obtenido el consentimiento informado de los pacientes y/o sujetos referidos en el artículo. Este documento obra en poder del autor de correspondencia.

Conflicto de intereses

Los autores declaran no tener ningún conflicto de intereses.

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Original article

Energy cost and physiological responses during upper body exercise with different postures

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ABSTRACT

Objective: The physiological and energy demand responses to upper body aerobic exercises performed with different postures are not well known. The aim of the present study was to compare energy cost and physiological responses to upper body aerobic exercises performed with different postures.
Method: Eight physically active males (>1 year active), untrained in upper body aerobic exercises, with 28.2 ± 5.7 years, ht 173.7 ± 7.4 cm, body mass 74.1 ± 11.4 kg, VO_{2Peak} 30.2 ± 2.09 ml/kg/min and Body Mass Index 24.4 ± 2.5 kg/m^2 performed a preliminary maximal test and two upper body aerobic exercises 30-min sessions in different days.
Results: Metabolic and hemodynamic responses to upper body aerobic exercises performed in sit-position and vertical-position were compared. The vertical-position trial showed greater total energy cost (14.3%; $p = 0.01$), higher lipid catabolism ($p = 0.001$) and a higher double product ($p = 0.04$), when compared to the sit-position trial.
Conclusion: The upper body aerobic exercises performed in vertical-position induces a higher energetic demand and cardiovascular load than in sit-position.

Gasto energético y respuestas fisiológicas durante el ejercicio de miembros superiores en diferentes posturas

Palabras clave:
Ergometría
Metabolismo energético
Postura
Ejercicio

RESUMEN

Objetivo: Poco se conoce sobre la influencia de la variación de la postura sobre las respuestas fisiológicas y el gasto energético durante ejercicios con miembros superiores. El objetivo de este estudio fue comparar las respuestas fisiológicas durante ejercicios con miembros superiores realizados en diferentes posturas.
Método: Ocho hombres físicamente activos (>1 año), no practicantes de ejercicio con miembros superiores, con 28.2 ± 5.7 años de edad, 173.7 ± 7.4 cm de talla, 74.1 ± 11.4 kg de masa corporal, VO_{2Pico} de 30.2 ± 2.09 ml/kg/min e índice de masa corporal de 24.4 ± 2.5 kg/m^2, fueron sometidos a un test máximo preliminar y a 2 sesiones de ejercicios con miembros superiores de 30 min de duración, en días distintos.
Resultados: Las respuestas metabólicas y hemodinámicas, en la postura de sentado y vertical, fueron comparadas. La sesión de ejercicio con miembros superiores realizado en postura vertical generó mayor gasto energético total (14.3%; p = 0.01), mayor catabolismo lipídico (p = 0.001) y mayor doble producto (p = 0.04), en comparación con la sesión realizada en postura sentado.

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Conclusiones: El ejercicio con miembros superiores realizados en postura vertical eleva el gasto energético y la sobrecarga cardiovascular, en comparación con ejercicios con miembros superiores en postura sentado.

Custo energético e respostas fisiológicas durante exercício de membros superiores realizado em diferentes posturas

Palavras-chave:
Ergometria
Metabolismo energético
Postura
Exercício

R E S U M O

Objetivo: As respostas fisiológicas e de custo energético durante exercícios aeróbios de membros superiores realizados em diferentes posturas não são bem conhecidas. O objetivo do presente estudo foi comparar o custo energético e as respostas fisiológicas durante exercícios aeróbios de membros superiores realizados em diferentes posturas.

Método: Oito homens fisicamente ativos e não praticantes de exercícios aeróbios de membros superiores, com 28.2 ± 5.7 anos de idade, 173.7 ± 7.4 cm de estatura, 74.1 ± 11.4 kg de massa corporal, VO_{2Pico} de 30.2 ± 2.09 ml/kg/min e Índice de Massa Corporal de 24.4 ± 2.5 kg/m^2, foram submetidos a um teste máximo preliminar e a 2 sessões de exercícios aeróbios de membros superiores com duração de 30 min, em dias distintos.

Resultados: Respostas metabólicas e hemodinâmicas obtidas nas posturas sentada e verticalizada foram comparadas. A sessão de exercícios aeróbios de membros superiores realizado na postura verticalizada gerou maior gasto energético total (14.3%; p = 0.01), maior catabolismo lipídico (p = 0.001) e maior duplo produto (p = 0.04), quando comparado com a sessão postura sentada.

Conclusões: O exercícios aeróbio de membros superiores realizado em postura verticalizada eleva o custo energético e a sobrecarga cardiovascular, quando comparado com oexercício aeróbio de membros superiores em postura sentada.

Introduction

Upper-body exercises (UBE) can be inserted in training programs for health or improvement of athletic performance, especially in subjects with physical limitations or restrictions to perform lower-limbs exercises.[1] When prescribed with the appropriate relationship between intensity and duration, UBE in a cycloergometer can compose a weight loss programs.[2–4]

The energetic cost of exercise be determined by, among other factors, the posture body assumed during performance.[5] Thus, the posture is directly associated with mechanical power produced and the physiological demands.[2,6,7] For example, changes on the posture during exercise causes redistribution of blood flow by changing the cardiac output and other hemodynamic responses such as: heart rate (HR), blood pressure (BP) and double-product (DP).[8,9]

Changes in posture can also change in the gas exchange during exercise. Ashe et al.[6] compared cyclists in two different trunk positions: (a) vertical; and (b) parallel to the ground (aerodynamics), and found that the vertical posture changed the ventilation (VE) and increase the O_2 consumption (VO_2). The results demonstrated that the vertical posture increase the thorax expansion, allowing increased inspiratory volume and lower respiratory rate. Thus, it was suggested that changes in posture on UBE sessions with same intensity, produce different hemodynamic and metabolic adjustments, resulting also in a different energy cost exercise.

According to manufacturers, thousands of UBE were sold are present in clubs and gyms in many countries.[4] Some equipment can be used in the seated position (SP) and in the vertical or orthostatic position (VP) and allow their cranks are moved independently, backward or forward, allowing great variability of movements.[4,10] Indeed, the use of these devices may represent an advance on the inclusion of the paraplegics, because the exercise training can be realized completely seated. Considering also the growth of Paralympic sport,[11] we believe that the use of UBE can be a training strategy for wheelchair cyclists on rainy days. Although, the use of this equipment can represent major expansion for this population, or between athletes with different levels of cardiopulmonary fitness,[4,10] we consider poorly the scientific knowledge about the physiological responses during the UBE in different posture. It is possible that different posture adopted during UBE result in changes on energy cost. It is assumed that there is an increased energy cost in UBE sessions with VP, which could be characterized by greater VO_2 response, VE and hemodynamic.

Therefore, we believe that the likely changes induced by manipulating the posture on the physiological responses and energy cost of UBE may contribute to the appropriate prescription of these exercises, supporting coaches with respect to greater effectiveness and safety of planning.[12-14] Thus, the aim of this study was to compare the physiological responses during UBE realized in different posture.

Method

Sample

Based on our pilot study (n = 4) and the available literature, the sample size was calculated based on energy expenditure. To achieve 80% statistical power, it was calculated that a minimum sample of eight subjects would be necessary to detect an increase of 20 kcal energy expenditure between group's (Granmo 5.2, IMIM®, Barcelona, Spain). The final sample was composed by 8 physical active men, with 28.2 ± 5.7 years, 173.7 ± 7.4 cm of height, 74.1 ± 11.4 kg of body mass, 30.2 ± 2.1 ml/kg/min of VO_{2Peak} and 24.4 ± 2.5 kg/m^2 of Body Mass Index (BMI). On the experimental period, the volunteers were classified how physically active for at least 12 months and did not practice any type of aerobic exercises of the upper limbs. They do not present respiratory, neurological and vestibular disorders, changes in the electrocardiogram and blood pressure. After presented the risks and benefits of this study, the participants signed a free and informed consent form. All researches procedures were previously approved by the Ethics Committee of the University in which the study was conducted (protocol n.48/2014).

The data collection was divided into four stages: (I) an initial assessment with anamneses and pre-test examinations; (II) ergometry; (III) familiarization with the upper body cycle ergometer; (IV) UBE experimental sessions of 30 min. The evaluations were conducted in a laboratory, with controlled temperature at ~21 °C, in the same period of the day. Volunteers were requested to make a light diet until two hours before the tests, and abstain from strenuous exercise for 24 hours prior to the data collection.

Procedures

A standard anamneses was initially applied to trace the lifestyle and record the presence/occurrence of diseases and injuries of the participants. Then all volunteers rested (10 min) on a stretcher to measure of the electrocardiographic signal (ECG) of 12 derivations. (Marquette Hellige v.3.0, CardioSmart®, Milwaukee, USA), rest Heart-rate (HR_R) and rest blood pressure (BP_R) (Missouri, Mikatos®, Embu das Artes, Brazil). A physician examined the results for ECG, HR_R and BP_R in comparison to the normal values for the health, in a presence of abnormality, the volunteer would be excluded from the final sample. Finally, anthropometric measurements of body mass and height were held in platform scale with coupled stadiometer (Personal Line, Filizola®, São Paulo, Brazil).

An upper-limbs CT was performed in a mechanic cycloergometer (M4100, CEFISE®, Nova Odessa, Brazil) how the beginning evaluation. After 60-seconds warm-up 15 W load and 60 RPM cadence, the CT was beginning with increase of 15 W/2 min and fix cadence by 60 RPM to exhaustion. The end of test was determined by inability to maintain the pedal cadence at 60 RPM. The cardiopulmonary responses were obtained, breath-to-breath, by a gas analyzer (VO_{2000}, MedGraphics®, St. Paul, MN, USA) with a software Ergo PC Elite 3.3 (Micromed®, Brasília, Brazil). Measurements how VO_2 (ml/kg/min), VE (L/min), carbon dioxide (VCO_2, ml/kg/min), respiratory quotient (RQ) and the ventilatory equivalents of O_2 and CO_2 (VE/VO_2 and VE/VCO_2, respectively) was obtained during the CT.

Before each test, the gas analyzer was calibrated according to the manufacturer's specifications, using known gas mixture of 17.0% O_2 and 5.0% CO_2. Peak VO_2 being established as the arithmetic average VO_2 in the final 20 seconds on the last stage completed. In addition, ventilatory threshold (VT1 and VT2) were determinate[15] considering the VT1 at the time of test in which we observed a non-linear increase of RQ, concomitantly with lower values of VE/VO_2. Whereas the VT2 was determined at the last point before the gradual increase in the VE values.[15] The HR was measured during the CT through a bypass digital electrocardiograph (CM5, Micromed®, Brasília, Brazil).

For familiarization with the cycloergometer (III stage), each volunteer underwent two UBE sessions, lasting 30 min. During these pre-tests participants performed consecutively: (I) 10 min sitting by turning the handle forward and/or backward; (II) 10 min in vertical position, turning the cranks forward and/or backward; (III) 10 min of free movement. Each participant chose the direction that would like to turn the crank and this standard out for the experimental sessions. In pre-test exercise the intensity was monitored by Borg Scale (6–20).[16] We stipulated that volunteers should keep the exercise intensity between 11 and 14 points of perceived exertion for 30 min. The intake of ~120 ml of water was allowed.

The total energy cost for each UBE trial was calculated using the equation: 1 L O_2 consumed = 5 kcal/min; and 5.5 kcal/L to 100% carbohydrate catabolism and 4.69 for fat catabolism.[12] Given the limitations in obtaining the nitrogen balance in the exercise, we assumed the RQ non-protein. Thus, the catabolism rates of energy substrates such as fat and carbohydrate were obtained by kinetic response RQ (VCO_2/VO_2) throughout the exercise trial.

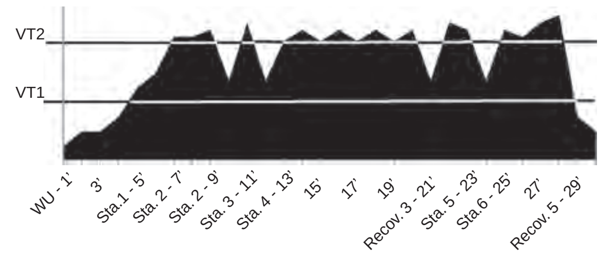

Fig. 1. Intensities of effort during the UBE trials. VT1: intensity compatible to the ventilatory threshold 1; VT2: intensity compatible to the ventilatory threshold 2; WU: warm-up; Sta.: stages; Recov.: recovery; ': min.

The experimental trial were random (phase IV) on two different days separated by 48–96 hours and were composed by interval exercises with 30 min each. Both UBE sessions SP and VP were performed with self-selected pace, the intensity was calculated by VT1 and VT2, to generate the metabolic demands: 20% intensity <VT1, 20% in intensity >VT1 and <VT2 and 60% in intensity >VT2. This exercise protocol was adapted from Boyer et al.[4] (Fig. 1).

During the UBE trial, VO_2, VCO_2, RQ, VE and HR were obtained continuously as previously described. Additionally, measurements of blood lactate (Accusport BM, Roche Diagnostics®, USA), systolic (SBP) and diastolic blood pressure (DBP) (Missouri, Mikatos®) were obtained two minutes before and immediately after the trial. Also, the estimated double product was calculated by multiplying HR by SBP for pre and post-trial.

Statistical analysis

The average and standard deviation, minimum and maximum values were determined to describe the results. The Shapiro–Wilk test was applied to determine the normal distribution. To compare trials (SP and VP) we applied *t*'-Student test for dependent samples (normal distribution) and Wilcoxon (non-normal distribution). The probability established was 5% and analyze were performed using SPSS version 10.0.

Results

Table 1 presents the descriptive characteristics of the sample.

The results show that the total energy expenditure, lipid catabolism and the blood lactate concentration were lower ($p < 0.05$) at the SP trial (Table 2).

In VP was performed in a greater cardiovascular stress, considering the response of the double product when compared to the SP trial ($p < 0.05$) (Table 3).

Discussion

The results of this study suggest that UBE performed in the vertical posture increases the metabolic and hemodynamic responses. In fact, there was a 14.3% increase in total energetic costs as well as increased cardiovascular load associated with orthostatic stress (VP), corroborating previous findings.[5] Only one study has investigated energy expenditure in specific cyclic trials of aerobic exercises in the upper limbs, Boyer et al.[4] estimated energy expenditure of 269 ± 87.8 kcal for 30 min sessions, an energy cost 8.5% higher in comparison with the present study. The higher energy costs[4] depending on three factors: (I) the energetic cost of the trial was

Table 1
Descriptive characteristics ($n = 8$) and thresholds VT1 and VT2.

Measures	Average	SD	Min.	Max.
VT1				
VO_{2LV1} (ml/kg/min)	14.7	2.4	11.0	17.6
$\%VO_{2Peak}$	48.5	6.8	37.5	57.3
VO_2 (W)	43.1	9.6	30.0	60.0
HR (BPM)	11. 5	10.2	94.0	126.0
VT2				
VO_{2LV2} (ml/kg/min)	21.6	4.5	14.6	26.6
$\%VO_{2Peak}$	71.2	11.3	50.0	83.1
VO_2 (W)	80.6	19.5	60.0	120.0
HR (BPM)	140.4	14.8	115.0	161.0
ME				
VO_{2Peak} (ml/kg/min)	30.2	2.1	26.6	33.0
VO_{2Peak} (W)	112.5	25.4	75.0	150.0
HR (BPM)	153.8	17.7	125.0	178.0

SD: standard deviation; Min.: minimum value; Max.: maximum value; VT1: ventilatory threshold 1; VT2: ventilatory threshold 2; ME: Maximum effort; VO_2: peak oxygen consumption; $VO_{2Peak}\%$: percentage peak oxygen consumption; VO_2 (W) load intensity is related to the consumption of oxygen or submaximal peak; HR: heart rate.

Table 2
Metabolic measurements for sitting (SP) and vertical position (VP).

Measures	SP Average (SD)	VP Average (SD)	*t*	*p*
Metabolism				
Total cost (kcal-30′)	215.4 ± 44.8[a]	246.2 ± 18.0	7.960	0.01
CHO cost (kcal-30′)	199.1 ± 8.1	222.2 ± 17.9	4.652	0.49
Fat Cost (kcal-30′)	16.3 ± 9.4[a]	24.7 ± 11.0	11.930	0.001
Lac Pre (mmol/L)	2.4 ± 0.6	2.2 ± 0.2	0.540	0.82
Lac Post (mmol/L)	6.3 ± 2.0[a]	7.6 ± 1.7	5.871	0.03

SP: sitting position; VP: vertical position; SD: standard deviation; CHO: carbohydrate; Lac: blood lactate.
[a] $p < 0.05$ VP vs. SP.

estimated by indirectly by HR and VO_2; (II) the sample composed by more trained individuals; and (III) trial with alternating postures.

The lipid catabolism was altered, and matched the altered energetic expenditure between the two postures, so that the lipid catabolism was 51.53% in VP than in SP ($p = 0.001$), despite the higher post-exercise blood lactate ($p = 0.03$). Similar results were observed in subjects alternated body posture, however, without performing exercise.[5] It can be suggested that the vertical position increase the lipid oxidation rates during the upper-limbs exercise.

In addition, other factors should be highlighted. In this study, the energy cost was established by indirect calorimetry, Boyer et al.[4] predicted by a mathematical model. In addition, the sample of this study was formed by physically active subjects not practicing the UBE. Thus, it is suggested that the lower accuracy of the predictive model used in the study of Boyer et al.,[4] compared to indirect calorimetry,[12] well as the characteristics of the sample (trained individuals tend to choice higher self-selected intensities) can justify, at least in part, the differences in results between this study and other to which it was compared.

Table 3
Hemodynamic measurements by sitting (SP) and vertical position (VP).

Measures	SP Average (SD)	VP Average (SD)	*t*	*p*
Hemodynamics				
HR Pre (BPM)	59.6 ± 3.3	61.5 ± 6.9	1.432	0.25
HR Post (BPM)	95.6 ± 14.9	101.9 ± 6.5	1.160	0.30
HR Max (BPM)	154.0 ± 12.2	159.0 ± 11.3	0.053	0.82
SBP Pre (mmHg)	120.0 ± 6.6	114.0 ± 8.8	1.224	0.28
SBP Post (mmHg)	129.3 ± 7.9	130.8 ± 10.0	0.015	0.91
DBP Pre (mmHg)	73.1 ± 8.9	77.5 ± 9.9	0.180	0.67
DBP Post (mmHg)	70.5 ± 9.2	71.0 ± 9.6	0.016	0.90
DP Pre	714.6 ± 489.1	7032.3 ± 1094.9	3.333	0.08
DP Post	12,401.8 ± 2276.1[a]	13,286.3 ± 865.7	5.343	0.03

SP: sitting position; VP: vertical position; SD: standard deviation; HR (BPM): heart rate in beats per minute; SBP (mmHg): systolic blood pressure in millimeters of mercury; DBP (mmHg): Diastolic blood pressure in millimeters of mercury; DP: double product.
[a] $p < 0.05$ VP vs. SP.

Possibly exercise in the vertical posture raise the energy demands of the muscle groups responsible for maintaining stand body posture, especially on the trunk and lower-limbs.[7] Two studies[17,18] showed that the contraction of muscles of the lower-limbs is dependent on the high perfusion pressure developed in the standing posture to generate muscle contraction. Thus, the change from the sitting to vertical position triggers, a compensatory response, that increase the modulation of the central command and yours afferent, increasing blood pressure during exercise.[19,20] This compensatory mechanism is dependent on the increased sympathetic activity and the consequent reduction of the vagal modulation, for mediating the regulation of distribution of blood flow and maintaining blood pressure in the VP during physical exertion, which might justify the higher energetic cost in VP compared to SP.[13]

Regarding the hemodynamic adjustments, although most of the variables have not shown significant differences between the conditions, the data obtained in the VP condition had higher average values after exercise, compared to SP. These results can be interpreted as a major cardiovascular work for the maintenance of homeostasis in the VP.[14]

Despite the lower energy expenditure measured, UBE at SP presents itself as an exercise alternative for people that have difficulty in exercising in stand up position, for example, wheelchair users, obese and unable elderly.[10,20] The concern in prescribing exercise to these populations is linked to the limited mobility of subjects, which increases the propensity to sedentary behavior.[21,22] Certainly, studies on energetic expenditure have pointed out the total time sitting as responsible for the chronic diseases such as obesity and diabetes type II.[23,24] Among the limitations of this study, the volunteers realized the exercise trial of free choice, since the ergometer used allows. Another factor would be to perform the measurement in a single trial, most measures may have a better metabolic profile as the energetic cost on VP or SP, as well as conducting classes with mixed posture and monitoring of post-exercise energy expenditure.

We conclude that upper body aerobic exercises in a vertical position raise the energetic cost, lipid catabolism and cardiovascular stress, compared to siting trial with the same intensity. These results should be considered in the systematization of upper-limb exercise training, since understanding the effects of posture change on the energetic cost and physiological responses allows a better prescription for the different goals of exercise practitioners.

Conflicts of interest

The authors have no conflicts of interest to declare.

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Original article

Predictors of health-related quality of life among Brazilian former athletes

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ABSTRACT

Objective: To identify predictors of health-related quality of life (HRQoL) among former athletes.
Method: This cross-sectional study included 186 subjects (64% male, aged 40–64 years), representing 51.4% of former athletes from the *Jogos Abertos de Santa Catarina* (1960–2006). The Short Form Health Survey (SF-36) was used to assess HRQoL (Physical Health and Mental Health summary scores). Sociodemographic variables (gender, age, education, occupation, marital status and income), health status (body mass index, medication use, chronic problems, sports injuries that affect current daily living and health guidance from their coaches), time since they stopped competing and leisure-time physical activity were exploratory variables. Multivariate linear regression models were used.
Results: Sports injuries that affect current daily living (standardised score [β] = −0.430 and −0.133), body mass index (β = −0.226 and −0.238) and chronic problems (β = −0.138 and −0.144) were predictors of both *Physical Health and Mental Health*. Prescription medicine (β = −0.177) and occupation (β = 0.095) predicted only *Physical Health* scores, and income (β = 0.224) predicted only *Mental Health* scores (all $p < 0.05$).
Conclusion: These variables can be focused on HRQoL promotion strategies among former athletes.

Predictores de la calidad de vida relacionada con la salud entre los ex atletas brasileños

Palabras clave:
Psicología del deporte
Enfermedad crónica
Conducta de salud
Determinantes de la salud
Gestión de la lesión
Salud mental

RESUMEN

Objetivo: Identificar predictores de calidad de vida relacionada con la salud (CVRS) en exatletas.
Método: Este estudio transversal incluyó 186 sujetos (64% hombres, con edades entre 40-64 años), lo que representa el 51.4% de los exatletas de los *Jogos Abertos de Santa Catarina* (1960-2006). El *Short Form Health Survey* (SF-36) se utilizó para evaluar la CVRS. Las variables sociodemográficas (sexo, edad, educación, ocupación, estado civil e ingresos económicos), el estado de salud (índice de masa corporal, uso de medicamentos, problemas crónicos, lesiones deportivas que afectan a la vida diaria actual y la orientación hacia la de salud de sus entrenadores), el tiempo desde que dejaron de competir y la actividad física en el tiempo libre fueron las variables exploratorias. Se utilizaron modelos de regresión lineal multivariante.
Resultados: Las lesiones deportivas que afectan a la vida diaria actual (*standardised score* [β] = –0.430 y –0.133), el Índice de Masa Corporal (β = –0.226 y –0.238) y los problemas crónicos (β = –0.138 y –0.144)

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fueron predictores tanto de la salud física como de la salud mental. El uso de medicamentos (β = –0.177) y la ocupación (β = 0.095) predijeron sólo las puntuaciones de salud física, y los ingresos (β = 0.224) predijeron sólo las puntuaciones de salud mental (todas las p < 0.05).
Conclusión: Estas variables pueden ser focos importantes para las estrategias de promoción de la CVRS en los exatletas.

Preditores da qualidade de vida relacionada à saúde em ex-atletas brasileiros

R E S U M O

Palavras-chave:
Psicologia do esporte
Doença crônica
Comportamento em saúde
Determinantes em saúde
Gestão de lesões
Saúde mental

Objetivo: Identificar os preditores da qualidade de vida relacionada à saúde (QVRS) em ex-atletas.
Método: Estudo transversal que incluiu 186 indivíduos (64% de homens, idades de 40-64 anos), representando 51.4% dos ex-atletas medalhistas do atletismo nos Jogos Abertos de Santa Catarina (1960-2006). O *instrumento Short Form Health Survey* (SF-36) foi utilizado para mensurar a QVRS (sumários *saúde física* e *saúde mental)*. Variáveis sociodemográficas (sexo, idade, educação, ocupação, estado civil e renda), estado de saúde (índice de massa corporal [IMC], uso de medicamentos, doenças crônicas, lesões esportivas que atrapalham o cotidiano atual e orientações de saúde pelos treinadores), o tempo aposentado de competições e atividade física no lazer foram variáveis exploratórias. A regressão linear multivariada foi utilizada.
Resultados: Lesões esportivas que atrapalham o cotidiano (escore padronizado [β] = –0.430 e –0.133), índice de massa corporal (β = –0.226 e –0.238) e doenças crônicas (β = –0.138 e –0.144) foram preditores da *saúde física* e *saúde mental*. Medicamentos prescritos (β = –0.177) e ocupação (β = 0.095) predisseram a *saúde física*, enquanto que renda (β = 0.224) foi preditor da *saúde mental* ($p < 0.05$).
Conclusão: Essas variáveis podem ser focadas na promoção de QVRS em ex-atletas.

Introduction

Research in Sport Science has been focused on former athletes, especially to understand how these individuals are affected (i.e., their metabolic health, fitness and quality of life [QoL]) when the sports career is or has come to an end.[1,2] In general, former athletes tend to partake harmful health process more than active athletes, including having increased fat-mass,[3] reduced performance,[3,4] risky behaviours (e.g., unhealthy eating)[7] and poor mental health (e.g., risk of anxiety/depression).[5,6] Economic and social problems have also been found in former athletes including their difficulty in finding work and maintaining income,[6] low social support and low social activities.[5] However, in comparison to the general population, former athletes have shown better health factors (e.g., health behaviours and cardiovascular health),[2,7–9] lower risk of depression/anxiety[8,9] and better health-related QoL (HRQoL).[10]

HRQoL involves evaluating the behavioural functioning, subjective well-being, and perceptions of overall health to determine the physical and mental status of each person: it is usually measured by instruments such as the Short Form Health Survey (SF-36).[11,12] Measuring HRQoL can help determine the burden of preventable diseases, injuries and disabilities, especially in middle and old ages.[11] In particular, HRQoL assessment among former athletes may be important in order to measure the health benefits of sports participation and whether these outweigh the risks.[1] Additionally, it is important to identify whether post-sports life conditions (e.g., chronic injuries, lifestyle and socioeconomic conditions) have an impact on physical and mental aspects.[1,13]

Studies were conducted with former athletes in order to identify psychological aspects such as depression/anxiety,[5,9,14] self-rated health,[8] perception of physical limitations[15,16] and life satisfaction.[13] However, the specific aspects of HRQoL (i.e., *Physical Health* and *Mental Health* measured with the SF-36) in a sample of former athletes are still unknown.

Studies on predictors (i.e., factors that can explain the outcome) of the psychological aspects among former athletes included sociodemographic factors (e.g., age, income, education)[8,9,13] and health conditions (e.g., chronic problems, physical activity).[5,8,9,15] Among the clinical conditions, injuries during the sporting career have been shown to be negatively associated with QoL[17] and HRQoL[18] among adult active athletes, and the symptoms of depression/anxiety[5] and aggression[14] among former athletes. However, the predictive power of former athletes' HRQoL from demographic, economic and health conditions is something that needs clarification. A study that fills these gaps can indicate the main variables (at different levels, from the demographic to behavioural aspects) to be focused in health and QoL promotion among former athletes. This will contribute to more effective interventions among professionals (i.e., coaches, Performance and Health professionals, Physiotherapists) and people involved with athletes who are close to or already done with their sports careers.

Thus, this study aimed to verify whether sociodemographic factors (gender, age, education, occupation, marital status and income), medical and health conditions (body mass index [BMI], medicine use, chronic problems, sports injuries that affect current daily living, time since they stopped competing and health guidance from their coaches) and leisure-time physical activity (LTPA) are predictors of HRQoL (*Physical Health* and *Mental Health* summary scores) among middle-aged former athletes.

Method

Subjects

This was a cross-sectional study. The process of defining the study population and sample selection is detailed in Fig. 1. The study population involved former athletes who participated

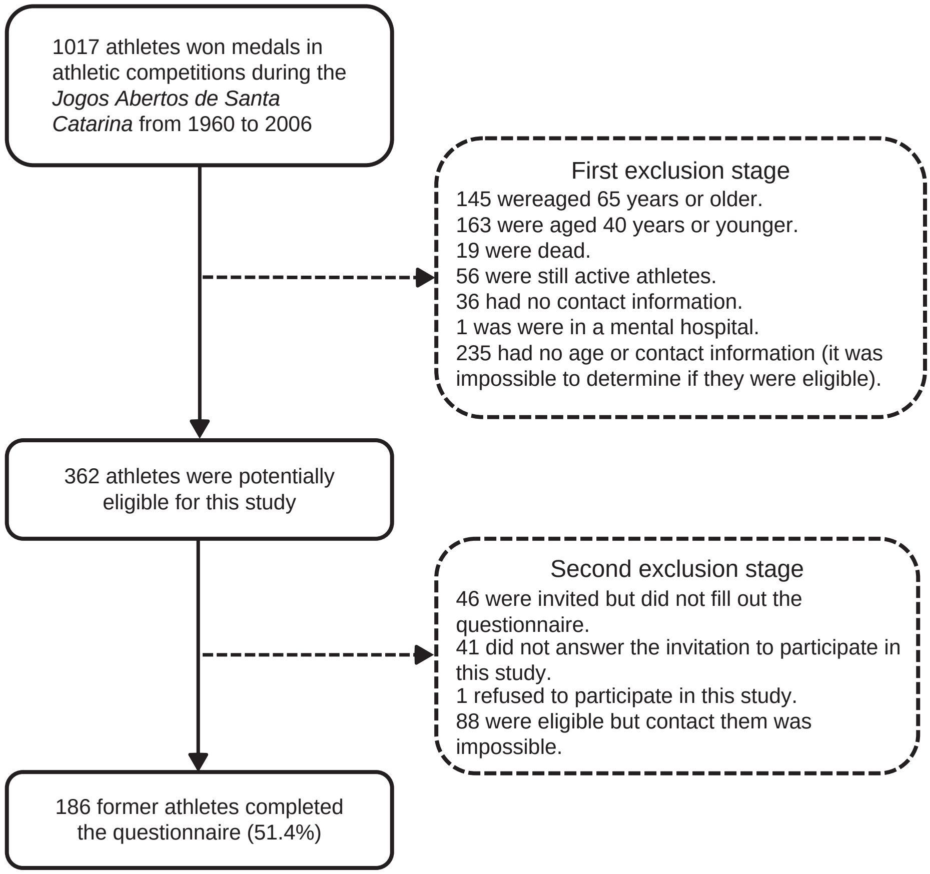

Fig. 1. Flowchart of the sample selection of former athletes ($n = 186$).

in the *Jogos Abertos de Santa Catarina* (*JASC*) and were medallists in at least one of the individual and collective modes of athletics. The *Jogos Abertos* (Open Games in Portuguese) occur annually in several Brazilian states and represent the largest multisport competition in the state of Santa Catarina, southern Brazil. The athletics games have been included in JASC since its first edition in 1960. The athletics games were chosen because there is a medallist record, which would allow for the determination of and contact with the population of interest to the study. The study population included the medallists from the JASC's 1st edition in 1960 to the 47th edition in 2006. In this period, 1017 athletes won medals in the athletics games.

A list of the medallists was obtained from the Santa Catarina Sports Foundation website (www.fesporte.sc.gov.br), the Municipal Sports Foundation and the Athletics Federation of Santa Catarina. Individuals were eligible (inclusion criteria) for this study if they: (1) won at least one medal (1st, 2nd, or 3rd place) in the JASC; (2) had personal data (e.g., home address, or telephone number) to available so they could be contacted and invited; (3) ended their sports career five or more years before the study (i.e., in 2006 or before); and (4) were aged from 40 to 64.9 years.

A total of 362 former athletes were considered eligible for the study. All former athletes were thoroughly invited to participate in this study, through personal, telephone and/or electronic contacts. A minimum of four contact attempts were carried out for each individual. In the end, 186 former athletes agreed to participate and they effectively answered the questionnaire (51.4% of those who were eligible, exclusion reasons in Fig. 1). This sample included former athletes who resided in 31 municipalities from Santa Catarina and eight other different states in Brazil.

The calculation of the sample's statistical power was carried out a posteriori using the G*Power v.3.0 software. The sample of 186 former athletes identified prediction percentages of 34.4% and 13.5% of the variation of scores of Physical Health and Mental Health, with a statistical power greater than 90% ($\alpha = 0.05$). Additionally, this study had a ratio between the number of participants and predictor variables higher than 10:1.

The study's procedures were approved by the Ethics Committee of the Federal University of Santa Catarina (protocol no. 167 678). Before answering the questionnaire, former athletes were informed of the objectives, methods of collection, the voluntary nature of participation and guarantee of confidentiality of individual responses. The participants signed the consent form.

Experimental procedures

The SF-36 questionnaire was used to assess HRQoL. This instrument was translated and validated previously and it had adequate proprieties to assess HRQoL in the Brazilian population.[19] SF-36 considers the last four weeks of the respondent's life and includes 36 items that are grouped into eight dimensions (functional capacity, physical aspects, pain, general health, vitality, social functioning, emotional and mental health) of the individual's health status. The scores for each dimension were converted to a scale from 0 (worst health status for that dimension) to 100 (best health).[12] This instrument also allowed the grouping of HRQoL aspects into two summary scores: *Physical Health* and *Mental Health*.

Different variables were studied as potential predictors of HRQoL (*Physical Health* and *Mental Health* summary scores) among former athletes. The questionnaire included items on gender (male; female), age groups (40–49; 50–59; 60–64.9 years), education (up to completed high school; college or higher education) occupational status (still working; retired/never worked), income (up to

6 minimum wages; 6–9 minimum wages; 10+ minimum wages) and marital status (living without a partner; married/living with partner). These items considered the questionnaire from the Brazilian Institute of Geography and Statistics.[20]

Some health variables were studied. Weight and height were self-reported and BMI (weight/height^2) was calculated and classified according to international criteria for normal weight (BMI < 25.0 kg/m^2), overweight (BMI between 25.0 and 29.9 kg/m^2) and obesity (BMI ≥ 30.0 kg/m^2) in adults.[21] Other questions were structured to assess the regular use of prescription (no; yes) and non-prescription medicines (no; yes), self-reported chronic problems (no; yes), sports injuries that affect current daily living (e.g., bathing, sleeping or walking: no; yes), time since they stopped competing (5–10 years; 11–15 years; over 15 years), and health guidance from their coaches (no; yes). The questions were based on an instrument previously used with the Brazilian population.[22]

LTPA was assessed using the leisure-time domain from the International Physical Activity Questionnaire (IPAQ) long version.[23] This domain assesses the frequency and duration (which allows us to calculate the weekly volume) of walking, and moderate and vigorous LTPA during the week prior to the survey. The weekly time of each LTPA type was calculated by multiplying the weekly frequency by the daily duration for each LTPA type.

Data collection was conducted from September to November 2012. Data were collected through a self-administered questionnaire, that was sent to respondents as an electronic or printed document. The completion of the questionnaires, when necessary, was accompanied online or in person by the researchers to clarify any questions that arose during the filling-out process.

Statistical analysis

Mean values, standard deviation, and minimum and maximum values were used for continuous variables. The absolute and relative frequency was used to describe categorical variables. The Kolmogorov–Smirnov test was used to identify the distribution of the data (parametric or non-parametric). The transformation of logarithmic data was used for the variables that did not present parametric distributions (weekly LTPA time and HRQoL summaries).

Linear regression models were used in order to verify the potential predictors of two HRQoL summaries (*Physical Health* and *Mental Health*) among former athletes. The sociodemographic variables (gender, age, education, occupation, marital status and income), health status (nutritional status, use of prescription and non-prescription drugs, chronic problems, sports injuries, time since they stopped competing, and health guidance from their coaches) and the weekly time of LTPA were considered independent variables. The bivariate association was tested between each variable and HRQoL summaries. Multivariate regression models analysed the association between each variable and HRQoL summaries, controlling the presence of other variables in the same model. The inclusion of variables in the model was performed in forward mode. Standardised scores (β), predictive values (R^2) and p-values are presented for each variable included in the raw and adjusted regression models.

Results

The final sample consisted of 186 former athletes aged 40–64 years (mean = 50.51 years, SD = 6.54 years). The sample had a higher participation of male former athletes (64.0%) and who had ended their sports careers over 15 years ago (60.2%). Most of them reported that they were still working (84.4%), had completed their college education (86.0%), were married (75.8%) and earned up to six minimum-wages (36.6%, Table 1).

Table 1
Characteristics of the former athletes included in this study (n = 186).

Continuous variables	Mean (SD)	Minimum–maximum
Physical Health summary	80.96 (18.86)	14.25–100.00
Mental Health summary	80.24 (16.02)	31.88–100.00
Age (years)	50.51 (6.54)	40.00–64.30
Body weight (kg)	79.24 (15.29)	44.00–119.00
Height (m)	1.74 (0.09)	1.50–2.02
BMI (kg/m^2)	25.77 (3.41)	17.30–43.00

Categorical variables	*n*	%
Gender		
Male	119	64.0
Female	67	36.0
Occupational status		
Still working	157	84.4
Did not working/retired	29	15.6
Education		
Up to completed high school	26	14.0
Completed college school	160	86.0
Income		
Up to 6 minimum-wages	68	36.6
6–9 minimum-wages	51	27.4
10 or more minimum-wages	67	36.0
Marital status		
Living without a partner	45	24.2
Married/living with partner	141	75.8
BMI status		
Normal weight (<25.0 kg/m^2)	79	42.5
Overweight (25.0–29.9 kg/m^2)	90	48.4
Obesity (≥30.0 kg/m^2)	17	9.1
Use of prescription medicine		
No	123	66.1
Yes	63	33.9
Use of non-prescription medicine		
No	157	84.4
Yes	29	15.6
Chronic problems		
No	128	68.8
Yes	58	31.2
Sports injuries that affect current daily living		
No	150	80.6
Yes	36	19.4
Time since they stopped competing		
5–10 years	49	26.3
11–15 years	25	13.4
Over 15 years	112	60.2
Health guidance from their coaches		
No	106	57.0
Yes	80	43.0

BMI: body mass index; SD: standard deviation.

Considering clinical and health conditions, most former athletes were overweight (48.4%) and reported that they did not have chronic problems (68.8%) and were not using prescribed (66.1%) or non-prescribed (84.4%) medicines. Two out of ten (19.4%) former athletes reported that sports career injuries affected their current daily living. Most former athletes reported that they did not receive health guidance from the person who coached them during their sports career (57.0%, Table 1).

In the crude regression analysis, occupation and vigorous LTPA were positively and significantly associated with *Physical Health*. BMI, use of prescription medicine, use of non-prescription medicine, chronic problems and sports injuries that affect current daily living were negatively associated with *Physical Health* (Table 2).

Table 2
Standardised coefficient score (β), predictive value (R^2 in percentage) and statistical significance for crude and adjusted analyses between *Physical Health*[a] and predictor variables.

Variables	Unadjusted analysis			Adjusted analysis		
	β	% of prediction	*p*-Value	β	% of prediction	*p*-Value
Age (years)	–0.061	0.4	0.411	0.057	0.4	0.397
Gender (male = 1)	0.040	0.2	0.588	–0.113	0.1	0.124
BMI (kg/m^2)	**–0.321**	**10.3**	**<0.001**	**–0.226**	**10.6**	**0.001**
Education (college = 1)	0.069	<0.1	0.349	0.019	0.7	0.762
Marital status (married = 1)	–0.054	<0.1	0.464	–0.051	0.3	0.407
Income (6–9 MW = 1; 10 or more MW = 2)	0.067	<0.1	0.366	0.055	0.6	0.424
Occupation (working = 1)	**0.184**	**3.4**	**0.012**	**0.095**	**3.5**	**0.011**
Use of prescription medicine (yes = 1)	**–0.338**	**11.4**	**<0.001**	**–0.177**	**6.9**	**0.013**
Use of non-prescription medicine (yes = 1)	**–0.153**	**2.3**	**0.038**	–0.079	1.2	0.189
Chronic problems (yes = 1)	**–0.320**	**10.3**	**<0.001**	**–0.138**	**2.7**	**0.042**
Sports injuries that affect current daily living (yes = 1)	**–0.525**	**27.6**	**<0.001**	**–0.430**	**10.7**	**<0.001**
Time since they stopped competing (10–15 years = 1; over 15 years = 2)	0.037	<0.1	0.612	0.115	0.8	0.074
Health guidance from their coaches (yes = 1)	0.129	1.7	0.080	0.020	0.1	0.741
Walking as LTPA (min/week)[a]	0.104	1.1	0.156	–0.007	0.2	0.922
Moderate LTPA (min/week)[a]	0.116	1.3	0.115	–0.040	<0.1	0.533
Vigorous LTPA (min/week)[a]	**0.231**	**5.3**	**0.001**	0.127	1.0	0.074

BMI; body mass index; LTPA: leisure-time physical activity; MW: minimum-wages.
Bold values were statistically significant ($p < 0.05$).
[a] These variables were log-transformed before being included in the linear regression model.

After adjustment for confounders, the variables that remained significantly associated with *Physical Health* were occupation, BMI, use of prescription medicine, chronic problems and sports injuries that affect current daily living. These variables predicted 34.4% of the variation in the *Physical Health* scores among former athletes. The variables with the largest association with *Physical Health* were BMI (β = –0.226; R^2 = –0.106) and sports injuries that affect current daily living (β = –0.430; R^2 = –0.107). The use of non-prescription medicine ($p = 0.189$), the time since they stopped competing ($p = 0.074$) and vigorous PA ($p = 0.074$) lost association with *Physical Health* after adjusting for other independent variables (Table 2).

In the crude analysis, income and vigorous LTPA were positively and significantly associated with *Mental Health*. BMI, use of prescription medicine, chronic problems and sports injuries that affect current daily living were negatively associated will *Mental Health* (Table 3).

In the adjusted analysis, BMI, income, chronic problems and sports injuries that affect current daily living remained significantly associated with *Mental Health* (all $p < 0.05$). These variables predicted 13.5% of the variation in the *Mental Health* scores among former athletes. The variables with the largest association with *Mental Health* were BMI (β = –0.238; R^2 = 0.069) and income (β = 0.224; R^2 = 0.030). The use of non-prescription medicine ($p = 0.169$), marital status ($p = 0.109$) and vigorous LTPA ($p = 0.052$) lost significant association with *Mental Health* after adjusting for confounders (Table 3).

Discussion

This study found that BMI, sports injuries that affect current daily living and chronic problems were significant predictors of *Physical Fitness* and *Mental Health* scores among former athletes. Economic factors such as employment and income were also predictors of HRQoL summaries (*Physical Fitness* and *Mental Health*, respectively. These variables predicted more than 30% of the variation in scores of *Physical Health*, and 13.5% of the *Mental Health* scores among former athletes. Thus, this evidence indicates that

Table 3
Standardised coefficient score (β), predictive value (R^2 in percentage) and statistical significance for crude and adjusted analyses between *Mental Health*[a] and predictor variables.

Variables	Unadjusted analysis			Adjusted analysis		
	β	% of prediction	*p*-Value	β	% of prediction	*p*-Value
Age (years)	0.012	<0.1	0.866	0.044	<0.1	0.584
Gender (male = 1)	–0.115	1.3	0.117	–0.132	1.3	0.090
BMI (kg/m^2)	**–0.182**	**3.3**	**0.013**	**–0.238**	**6.9**	**0.004**
Education (college = 1)	0.089	0.8	0.229	0.051	0.8	0.489
Marital status (married = 1)	–0.032	0.1	0.663	–0.118	0.5	0.109
Income (6–9 MW = 1; 10 or more MW = 2)	**0.196**	**3.9**	**0.007**	**0.224**	**3.0**	**0.007**
Occupation (working = 1)	0.119	1.4	0.107	0.037	1.1	0.648
Use of prescription medicine (yes = 1)	**–0.151**	**2.3**	**0.039**	0.015	0.9	0.858
Use of non-prescription medicine (yes = 1)	–0.075	0.6	0.309	–0.100	1.0	0.169
Chronic problems (yes = 1)	**–0.196**	**3.8**	**0.007**	**–0.144**	**1.4**	**0.077**
Sports injuries that affect current daily living (yes = 1)	**–0.218**	**4.8**	**0.003**	**–0.133**	**2.2**	**0.033**
Time since they stopped competing (10–15 years = 1; over 15 years = 2)	–0.055	0.3	0.456	–0.091	0.2	0.240
Health guidance from their coaches (yes = 1)	0.080	0.6	0.277	0.001	<0.1	0.985
Walking as LTPA (min/week)[a]	0.123	1.5	0.093	0.013	0.5	0.872
Moderate LTPA (min/week)[a]	0.045	0.2	0.543	–0.079	0.1	0.311
Vigorous LTPA (min/week)[a]	**0.185**	**3.4**	**0.011**	0.166	1.8	0.052

BMI: body mass index; LTPA: leisure-time physical activity; MW: minimum-wages.
Bold values were statistically significant ($p < 0.05$).
[a] These variables were log-transformed being included in the linear regression model.

studied variables tended to have better predictive power of the physical aspects of HRQoL, while the variables had a discreet precision power (but still were statistically significant) for the mental aspects of HRQoL.

Employment and income were significant predictors of *Physical Health* and *Mental Health*, respectively. Similar results were observed for self-rated health[8] and depression/anxiety[16] in two studies with a mixed sample of former athletes and the general population. It is plausible to think that the motor requirements that occur in the workplace (e.g., crafts, concentration activities, and others) are important for a better understanding of functionality between former athletes.[8] Additionally, ensuring a regular income appears to provide opportunities for better environmental conditions (e.g., better housing) and involvement in social activities (e.g., conversations, social gatherings) which are important for mental health.[8,9,22]

Agresta et al.[6] studied Brazilian former football players and found that 59.6% had low-income levels and 41.1% had to receive financial help from family members; just only a few received help from clubs that they represented during their sports careers. In this study, approximately four out of ten former athletes earned up to six minimum-wages. These results support the importance of planning for the financial and professional futures of athletes in order to having create economic conditions and subsequent HRQoL after the end of their sports careers.

BMI had the most predictive power of HRQoL among former athletes. This result is similar to the findings of Jurakic et al.[24] in a study of Croatian non-athlete adults. Differently, Backmand et al.[8] found no association between BMI and self-rated health among former older athletes. However, studies on BMI and HRQoL among former athletes were not found. The intense routine of eating control and exercise during a sports career can do that athletes are less dedicated to nutritional and body weight control after they ended the competitive period.[5] This supposition can explain the finding that almost 50% of this study's sample was overweight. Thus, programmes that emphasise the individual's need to remain active while maintaining eating habits, and how these can strongly contribute to HRQoL among former athletes.

The presence of chronic problems (*Physical Health* and *Mental Health*) and the use of prescription medicine (*Physical Health*) were associated with HRQoL summaries. Similar results were obtained in older adults,[22] but there is no study that examined the association between these variables in former athletes. Special attention should be given to former athletes who have chronic problems and use medications frequently. Promoting healthy lifestyles during and after sports careers is important because chronic diseases (including high blood pressure which was the most frequently mentioned disease in this sample) during adulthood are strongly determined by risk behaviour.

Sports injuries that affect current daily living were another variable strongly associated with both *Physical Health* and *Mental Health* among former athletes. Gouttebarge et al.[5] did not find a significant association between multiple lesions and symptoms of depression/anxiety in former professional football players from six countries. No study evaluated the predictive power of HRQoL from sports injuries, which represents a relevant aspect of this study.

This study did not find a significant association between LTPA and HRQoL summaries. A systematic review indicated a positive and strong association between PA and QoL among older adults, but this association can vary according to QoL aspects or PA domains.[25] Backmand et al.[16] found a positive and longitudinal association between PA and perceived functional capacity among former older athletes who only participated in team sports, but not in other sports (i.e., individual sports, fighting). Backmand et al.[8] also showed a positive association between PA and self-rated health among former athletes.

Vigorous LTPA had a non-significant trend (p-value of 0.074 and 0.052 for *Physical Health* and *Mental Health*, respectively) for predicting the HRQoL scores. Probably, these results indicate that former athletes need high-intensity PA in order to achieve the benefits in HRQoL. However, this topic has few studies and still needs to be discussed and tested in the literature, especially in studies with designs that ensure temporality control (i.e., longitudinal studies).

Practical implications for professionals involved with athletes were obtained with these results. Appropriate energy balance, especially through regular PA and healthy eating can be a key element in achieving a healthy body weight, as well as the prevention of chronic conditions. Economic and occupational support for former athletes is needed to guarantee higher HRQoL perception in this population. In addition, professionals should pay attention to the prevention of sports injuries among athletes, because the impact of injuries on momentary limitations is obvious, but also, they can negatively and strongly affect future HRQoL aspects (*Physical Health* and *Mental Health*). Athletes who are close to sports retirement and former athletes can receive interventions to improve functional capacity and social and emotional involvement in order to contribute to a better HRQoL among people who have sports injuries.

Some strong points of this study should be highlighted. First, HRQoL among former athletes which is something that deserves a special attention,[1] especially when different constructs of HRQoL (i.e., *Physical Health* and *Mental Health*) were considered. Second, the sample included former athletes from 31 municipalities in eight different states in Brazil. Third, the amount and extension of variables, including demographic, economic, health conditions, and LTPA allowed a strong and significant predictive power of HRQoL summaries among former athletes.

The present study also had limitations. The response rate was approximately 50% and may have reduced the participation of former athletes with lower economic or health conditions. However, this response rate is common in studies that used electronic and printed mail for data collection.[14] Another limitation was the use of self-reported information (e.g., HRQoL, LTPA, weight and height), which may explain the lack of association between LTPA and HRQoL summaries. Considering the difficulties of objectively-measured PA in studies with samples from different locations, using validated instruments, such as the IPAQ and SF-36, was viable and acceptable. This study assessed only LTPA and, although this is one of the most important PA domains among Brazilian adults[23] and it can greatly predict some health conditions,[24] other PA domains (e.g., occupation-time PA) could show different results. Finally, the sample of medallists from a specific competition and sport makes extrapolating the results to other former athletic groups (e.g., non-medallists and other sports) impossible. These limitations do not reduce the importance of this study, but suggest caution in extrapolating the results to other populations and reinforces the importance of other studies focused on HRQoL among this population.

In conclusion, economic factors (employment and income) and clinical and health conditions (IMC, sports injuries that affect current daily living, chronic problems and use of prescription medicine) were significant predictors of HRQoL aspects among former athletes. However, the set of variables had a higher predictive power for *Physical Health* summary than for *Mental Health* summary of HRQoL.

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Conflicts of interest

The authors have no conflicts of interest to declare.

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Original article

Anthropometric and fitness profile of high-level basketball, handball and volleyball players☆

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ABSTRACT

Objective: The aim of this study was to compare several anthropometric and physiological variables between high-level basketball, handball and volleyball players.
Method: Forty-six Spanish first division professional players took part in our study. Height, standing reach, body weight, body fat percentages (by using Jackson & Pollock equation), vertical jumps (assessed by Bosco tests), 4 m × 5 m agility test and maximal power output in a bench press exercise were assessed.
Results: A one-way ANOVA, showed that basketball players had significant higher average height and standing reach values ($p < 0.01$) while volleyball players displayed the lowest body mass and handball players presented the highest body mass values. Body fat percentage was significantly lower ($p < 0.05$) in basketball and volleyball. Jump levels were significantly better in volleyball for the countermovement ($p < 0.05$) and the countermovement jump with arm swing ($p < 0.001$). Results of the agility test were significantly better in basketball ($p \leq 0.01$). In the concentric actions of maximal power tests basketball players obtained a higher mean power output for all loads ($p < 0.05$). In the eccentric phase volleyball players presented the lower outcome ($p < 0.001$).
Conclusions: There is evidence of anthropometric and physiological differences among the high-level team sports analyzed. Its assessment seems capital for the improvement of training strategies and accurate talent identification processes.

Perfil antropométrico y de aptitud física de jugadores de alto nivel de baloncesto, balonmano y voleibol

Palabras clave:
Rendimiento deportivo
Perfil fisiológico
Deportes de equipo

RESUMEN

Objetivo: El objetivo del presente estudio fue comparar variables antropométricas y fisiológicas entre jugadores de baloncesto, balonmano y voleibol de alto nivel.
Método: Cuarenta y seis deportistas profesionales de primera división de España fueron evaluados. Valores de altura, alcance, masa corporal, porcentaje graso (mediante ecuación de Jackson y Pollock), salto vertical (mediante test de Bosco), test de agilidad de 4 × 5 m y potencia máxima de press banca fueron registrados.
Resultados: El análisis mediante ANOVA mostró que los jugadores de baloncesto presentaban mayores alturas y alcances ($p < 0.01$). Los jugadores de voleibol mostraban los valores más bajos de masa corporal

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y los de balonmano los más altos de la muestra. El porcentaje de grasa en baloncesto y voleibol fue el más bajo ($p < 0.05$). Los valores de salto fueron mejores en voleibol para el salto con contra movimiento ($p < 0.05$) y salto con contra movimiento y uso de brazos ($p < 0.001$). Los resultados del test de agilidad fueron mejores en baloncesto ($p \leq 0.01$). En las acciones concéntricas del *press banca*, los baloncestistas obtuvieron mayor potencia media en todas las cargas ($p < 0.05$). En la fase excéntrica los jugadores de voleibol presentaron los valores menores ($p < 0.001$).
Conclusiones: Se muestran diferencias antropométricas y fisiológicas entre deportes de equipo. Su evaluación parece clave para la mejora del entrenamiento y para conducir mejores procesos de selección de talentos.

Perfil antropométrico e de aptidão física de jogadores de alto rendimento de basquetebol, andebol e voleibol

Palavras-chave:
Performance atlética
Perfil antropométrico
Equipas desportivas

R E S U M O

Objetivo: O objetivo do presente estudo foi comparar variáveis antropométricas e fisiológicas entre jogadores de basquetebol, andebol e voleibol de alto rendimento.
Método: Quarenta e seis jogadores profissionais da primeira divisão profissional da Espanha fizeram parte desse estudo. Valores de altura, alcance, massa corporal, percentual de gordura (utilizando equação de Jackson & Pollock), salto vertical (medido com o teste de Bosco), teste de agilidade 4×5 e potência máxima no exercício supino reto foram registrados.
Resultados: Uma ANOVA one-way mostrou que os jogadores de basquetebol apresentavam uma média significativamente maior na altura e alcance ($p < 0.01$), enquanto que os jogadores de voleibol apresentaram os valores mais baixos de massa corporal e os jogadores de andebol os valores mais altos da amostra. O percentual de gordura foi significativamente menor ($p < 0.05$) nos jogadores de basquetebol e voleibol. Os valores de salto foram significativamente melhores no jogadores de voleibol para o salto com contramovimento ($p < 0.05$) e no salto com contramovimento com utilização do balanço dos braços ($p < 0.001$). Os resultados do teste de agilidade foram significativamente melhores no basquete ($p \leq 0.01$). Nas ações concêntricas dos testes de potência máxima os jogadores de basquetebol obtiveram uma média maior de potência para todas as cargas ($p < 0.05$). Na fase excêntrica os jogadores de voleibol apresentaram o resultado mais baixo ($p < 0.001$).
Conclusões: Há diferenças antropométricas e fisiológicas entre as equipas de desportosde alto nível analisadas. A sua avaliação parece primordial para a melhoria das estratégias de treino e processos de identificação de talentos precisos.

Introduction

One of the most recent and relevant research topics in the field of team sports training has been the establishment of a reference fitness profile for every single sport. Although it is commonly accepted that team sports training needs a multifaceted approach to understand all of the performance factors affecting competition, it is also well known that the enhancement of fitness levels is relevant to obtain a better result. Each one of these team disciplines seems to present a particular anthropometric and physiological profile due to specific functions and requirements for each position of the game. However, some common characteristics can be defined when comparing different sports. The correct definition of reference profiles in sport is not only important for proper coaching of elite populations; it is also essential to conduct proficient talent selection processes.

Sprinting performance, strength, and muscular power are thought to be important for successful participation in basketball.[1] Anthropometrically, basketball players have shown a notable average height in several studies[2,3] even when conducted with players from different nationalities.[4] Most notably, several authors have found that anaerobic performance is crucial in basketball, with critical elements in the game such as quick change of direction, acceleration, deceleration and jumping ability.[1,3,5] However, physical characteristics are not homogeneous for all the positions of the game. Centers and forwards are taller, heavier, and show a higher percentage of body fat than guards.[3] Previous studies suggest that the characteristics of junior basketball players differ slightly, in the above-mentioned parameters, from those playing in high-performance situations.[1]

Differing definitions of the sport of handball have been discussed within the literature. Gorostiaga et al.[6] define team handball as an intermittent, high-intensity sport that stresses running, jumping, and throwing abilities with high demands of physical capacity. The authors support the idea that handball requires great strength levels to hit, block, push, turn, change speeds and grab opponents during games. Hermassi et al.[7] stated that handball is a strenuous contact sport that places emphasis on running, jumping, sprinting, throwing, hitting, blocking, and pushing. From the authors' point of view, muscular strength and power, technical and tactical skills are the factors that give a clear advantage in high-level competitions. Marques[8] defined handball as an explosive sport with continuous sprints, jumps, changes of direction and explosive ball throwing, including body contact. Several studies describe the anthropometric characteristics of handball players,[9,10] and similar to basketball, particular characteristics for the different positions of the game exist. Pivots and backs tend to be the tallest players, while goalkeepers present the higher percentage of body fat.[9] Also, significant differences can be found in the body mass and hand-length of the backs.[11]

Volleyball physiological profiles seem to be similar to those of basketball and handball. Sheppard et al.[12] defined volleyball as a sport characterized by short and frequent explosive activities such as jumping, diving, and ball play. Jumping activities can include movements with horizontal approaches or without any approach, but generally involving a countermovement (jump setting, jousts, and blocking). Several studies have related an optimized fitness in volleyball to a remarkable and durable jumping ability.[8,13] Fontani et al.[14] identified an average of 96.5 jumps performed by a high-level volleyball player in the course of a match, supporting previous findings.[15] Stretch-shortening cycle performance and the ability to tolerate high stretch loads, appear to be critical for a proficient volleyball performance.[16] Regarding anthropometric profiles, great height, lean body and low fat percentage seem good markers of high-level volleyball players.[17] Middle blockers are typically heavier and taller than setters and outside hitters. Setters are the players with lowest average height, weight and standing reach.[13] However, studies considering right side hitters as a specific position of the game, point to these players as the second group in height and weight behind the middle blockers.[12] Several studies have explored the differences between high-level and development players in volleyball. Sheppard et al.[13] conducted a study with players from the U-21 teams of Australia and Brazil and the U-19 team of Brazil. The authors found similar general and positional characteristics to those described earlier in this article. In all of these studies there is a consistent assessment of jump ability, being this expression of power highly correlated with the strength output in squat exercise.[18]

Thus, the final purpose of this investigation was to perform a comparative anthropometric and physiologic study between high-level basketball, handball and volleyball players, helping future talent selection processes and athletic orientation, while carrying out a new proposal of tests for team sports.

Method

A transversal descriptive study with first division basketball, handball and volleyball players from three different Spanish professional clubs was conducted. To study the different anthropometrical and physiological variables a battery of anthropometric measurements (height, standing reach, body weight and body fat percentage) and functional tests (vertical jumps, 4 m × 5 m agility test and maximal power output in a bench press exercise) was performed during a competitive period. This approach allowed comparisons between sports to define a fitness profile in each of them.

Subjects

Forty-six male first division professional Spanish players (age 26.1 ± 4.8 years; height 194.0 ± 7.3 cm; standing reach 234.1 ± 30.3 cm; body mass 91.9 ± 9.0 kg; body fat 9.2 ± 2.7%) from three different sports took part in our study (basketball, n = 18; handball, n = 15; volleyball, n = 13). The participants came from 14 different countries and 22 of them had been selected in the past, at least once, to participate in activities of their senior national teams. Three ethnic groups were represented within the sample. All the subjects received a clear explanation of the study, including the risks and benefits of participation, and provided written informed consent in accordance with the Declaration of Helsinki, and the requirements of the Ethics Committee of the University of Vic (Barcelona, Spain) for human testing and data analysis.

Procedures

Testing was conducted over three separate sessions. In the first session the subjects were tested for anthropometric measures and jump performances. Weight was assessed on a calibrated platform scale (Carry, Korona, UK) with an accuracy of ±0.1 kg. Height was measured on a height scale (Height Rod, Soenhle, Germany) with an accuracy of ±0.01 m. Standing reach was assessed using a vertical jump-measuring device (Vertec, Gill Athletics, USA). Body fat percentages were calculated using the equation of Jackson & Pollock[19] and measuring the skinfold thickness at seven sites (chest, axilla, triceps, abdominal, subscapular, suprailiac and thigh) by using a caliper (Holtain Skinfold Caliper, Holtain, UK). One experienced anthropometrist carried out all the anthropometric tests following the anthropometric measurement protocols established by the International Society for the Advancement of Kinanthropometry (ISAK). Vertical jumps were measured using a contact mat (Ergojump-Plus, Ergotest Innovation, Norway) consisting on a switch mat connected to a digital timer (with an accuracy of ±0.001 s). This system has been demonstrated to be reliable for the measurement of flight time.[20] The assessed jumps were the squat jump (SJ), countermovement jump (CMJ) and countermovement jump with arm swing (CMJas). All subjects were familiar with the jump techniques, and performed two jumps of each type, with a resting period of 10 s between them. During the second session, the players were tested in the 4 m × 5 m agility test. The 4 m × 5 m agility test consisted of a four times back and forth run, covering a five meters distance. The runs were performed on a basketball court with a wooden floor and the time was recorded using photocell beams (MuscleLab, Ergotest Innovation, Norway) placed at the start and finish lines. Every subject completed two bouts, with a three-minute resting period between them. In the third session, maximal power output was tested in a bench press exercise using a flat bench and an Olympic barbell (Olympic Flat Bench, Technogym, Italy). Mean power was measured with a linear encoder (Muscle Lab linear encoder, Ergotest Innovation, Norway) attached to the bar. One end of the linear encoder cord was attached to the barbell, and the other end was coiled around a spool on the floor positioned perpendicular to the movement of the barbell. The linear encoder measured velocity and displacement of the barbell from the spinning movement of the spool, while mass was entered via a keypad into the software tool. The sensitivity of load displacement was approximately ±0.075 mm, with data sampled and velocity calculated at a frequency of 100 Hz. Power was calculated as the product of force and velocity. The entire displacement and time for the concentric phase were used to calculate the mean values for velocity ($m\,s^{-1}$), force (N), and power (W). Subjects performed two separated attempts executing two maximal lifts with loads of 20, 40, 60 and 80 kg, and a three-minute resting period between bouts. The mean power output was recorded for each lift, and the highest mean power during eccentric and concentric phases recorded was used for the analysis.

Statistical analysis

Descriptive data is presented as mean and standard deviation, with range values expressed as minimum and maximum. Differences between disciplines were analyzed using a one-way ANOVA for most variables. For those cases that failed in the normality or equal variance tests, we performed a Kruskal–Wallis one-way ANOVA on ranks. The significance level for the tests was established at $p \leq 0.05$. When significant differences were found, we proceeded to compare between groups with a Holm–Sidak post hoc analysis in the case of the ANOVA, and Dunn's post hoc analysis for Kruskal–Wallis ANOVA. These methods are widely accepted

Table 1
Characteristics and anthropometric values of the subjects participating in the study (values are mean ± standard deviation).

	Basketball ($n = 18$)		Handball ($n = 15$)		Volleyball ($n = 13$)	
	Mean (±SD)	Range	Mean (±SD)	Range	Mean (±SD)	Range
Age (yr)	25.40 (5.20)	20.0–34.0	25.50 (4.10)	19.0–33.0	27.90 (4.90)	20.0–40.0
Height (cm)[*,a]	197.10 (8.81)	179.0–211.0	191.03 (5.66)	182.0–202.0	193.23 (5.90)	185.0–201.0
Standing reach (cm)[**,a,b]	256.40 (13.08)	234.0–279.0	249.40 (9.24)	231.0–262.0	249.69 (8.64)	239.0–263.0
Weight (kg)	92.64 (9.76)	79.0–108.6	94.01 (8.89)	82.6–106.8	88.49 (7.37)	73.3–97.0
Body fat (%)[**,a,c]	7.42 (0.99)	6.2–10.4	12.54 (1.73)	9.7–15.8	7.85 (1.05)	6.5–10.2

Body fat was calculated using Jackson & Pollock equation, 2004.
[a] Basketball vs. handball.
[b] Basketball vs. volleyball.
[c] Handball vs. volleyball.
[*] $p < 0.05$.
[**] $p < 0.01$.

as the first procedure to find statistical differences between groups.

Results

Anthropometrically, players from the three disciplines showed different characteristics (Table 1). Basketball players were significantly the tallest ($p < 0.01$) and presented the highest average standing reach value ($p < 0.05$) among the three sports. Basketball and volleyball players showed significant lower percentage of body fat ($p < 0.05$) than handball players. Volleyball players showed non-significant better average values than handball players in height and standing reach, and displayed lower average weight. Despite not having the heaviest player in their group, handball had the highest average body weight values in our study.

Jump tests indicated significant differences between disciplines in the CMJ ($p < 0.05$) and CMJas jumps ($p < 0.001$). No significant differences were found when the SJ was tested (ranges for volleyball 31.80–56.50 cm; basketball 31.20–56.75 cm; handball 33.90–43.80 cm). Volleyball players (range 40.70–56.40 cm) showed better performances in the CMJ when compared to basketball (range 30.88–57.38 cm) and handball players (range 35.20–47.00 cm). Same results were observed in the CMJas jump (ranges for volleyball 52.07–67.56 cm; basketball 35.92–65.79 cm; handball 44.60–53.20 cm). We found no significant differences between basketball and handball players in any type of jump (Fig. 1).

Volleyball players were the ones presenting larger increases between jump modalities, with an average improvement of 4.72 cm between SJ and CMJ and 16.56 cm between CMJ and CMJas jumps (which represented a gain of 10.09% and 26.16%). The increase between SJ and CMJ jumps in handball players was 1.35 cm (5.95%) and in basketball players 2.98 (6.19%). These improvements were 6.19 cm (12.04%) and 8.05 cm (15.42%) respectively in each of these sports, between CMJ and CMJas jumps.

Agility tests indicated significant differences between the three groups (Fig. 2). Basketball players (range 4.65–5.45 s) performed significantly better ($p < 0.001$) than handball (range 5.11–5.81 s) and volleyball players (range 5.36–6.13 s). On the other hand handball players showed better values than volleyball players ($p < 0.005$).

Maximal power tests showed differences between groups, loads and movement phases (Table 2). For the 20 kg load, during the concentric phase we found significant differences ($p < 0.005$) between the three groups. Basketball players reached a higher mean power output followed by handball players and both groups obtained higher values than volleyball players ($p < 0.001$ vs. basketball; $p < 0.05$ vs. handball). When the load was increased (40, 60 and 80 kg) we observed the same pattern: basketball players obtained significant higher values than those from handball and volleyball ($p < 0.001$). Handball and volleyball players showed no significant differences for any of the three higher load values. During the eccentric phase, volleyball players presented the lower outcome of the sample compared to basketball players and handball players, except in the 80 kg load, at which no differences with handball average outcomes were detected. No significant differences between

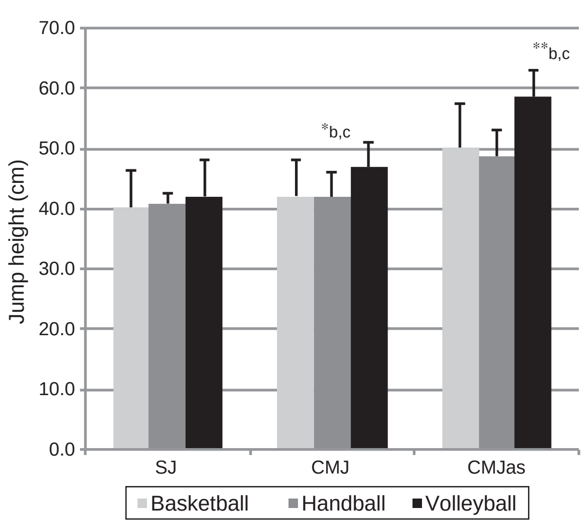

Fig. 1. Comparison of jump tests among the three sports. $^*p \leq 0.05$; $^{**}p \leq 0.01$; a: basketball vs. handball; b: basketball vs. volleyball; c: handball vs. volleyball.

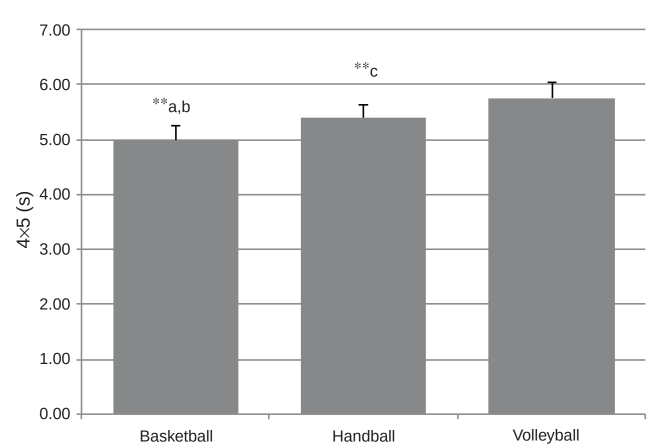

Fig. 2. Comparison of 4 m × 5 m agility tests among the three sports. $^*p \leq 0.05$; $^{**}p \leq 0.01$; a: basketball vs. handball; b: basketball vs. volleyball; c: handball vs. volleyball.

Table 2
Values obtained from bench press power test (expressed in watts) in concentric (C) and eccentric (E) actions (normal values are mean ± standard deviation and range, not normal values are median and range).

	Basketball (*n* = 18)		Handball (*n* = 15)		Volleyball (*n* = 13)	
	Mean (±SD)	Range	Mean (±SD)	Range	Mean (±SD)	Range
20C (W)[**,a,b,c]	607 (52)	537–696	539 (69)	401–643	487 (68)	357–601
20E (W)[**,b,c]	540 (112)	385–707	575 (121)	392–861	267 (93)	76–428
40C (W)[**,a,b]	793 (68)	667–897	629 (93)	525–839	569 (87)	439–702
40E (W)[**,b,c]	782 (112)	549–962	756 (138)	549–1003	463 (131)	183–633
60C (W)[†,**,a,b]	781 (–)	589–880	570 (–)	272–915	589 (–)	340–697
60E (W)[**,b,c]	820 (136)	524–1011	854 (192)	575–1332	502 (163)	227–787
80C (W)[†,**,a,b]	708 (–)	489–780	512 (–)	391–709	501 (–)	149–669
80E (W)[†,**,b]	776 (–)	544–949	727 (–)	221–1092	466 (–)	226–1001

** $p < 0.01$.
a Basketball vs. handball.
b Basketball vs. volleyball.
c Handball vs. volleyball.
† Kruskal–Wallis ANOVA on ranks.

basketball and handball were observed in this phase of the movement.

Discussion

The main results of the present study indicate that the anthropometric and physiological profiles of basketball, handball and volleyball players are significantly different. Basketball players are taller than handball players. Volleyball and basketball players show higher standing reach values than handball players, whereas the latter have the higher body fat percentages among the three sports. Although significant differences were not found, handball is the discipline where players have the highest body weight and body fat percentages, presenting a height and standing reach values closer to volleyball than to basketball players. Thus, our findings regarding basketball anthropometric profile match those from the literature[2,4,21] even presenting the highest standard deviation values in height, standing reach and weight among the three sports. These findings reinforce the idea that in basketball, there are important anthropometric differences between backcourt and frontcourt players.[3] Our findings are similar to those from Toriola et al.[22] who compared Nigerian basketball and volleyball players, finding similar weight values in the two sports, although basketball players were taller and had higher fat percentage. Regarding team handball, our study also found similar anthropometric profiling values to others within the literature.[8] The fact that team handball is a sport with continuous body contact, explains a profile with the highest average values of body weight.[7] Similar demands seem to be common in basketball frontcourt players (centers and power forwards).[3] Handball players showed interesting differences between players, when analyzing the different ranges, indicating specific adjustments to the different requirements of each position.[9,11] Volleyball players, in our study, had lower body weight but similar body fat percentages to those found in basketball. These findings concur with the lean body mass and a low percentage of body fat found in volleyball players by some other studies.[16] The average height and standing reach of volleyball players, indicated the relevance of these anthropometric characteristics in a sport where most players are involved in attack and blocking actions.[14,17,18] The lack of body contact during volleyball games supports the idea that those players do not need to develop high body mass to improve their performances.[16] To reinforce this idea, studies like the one from Berg et al.[21] identified that high body contact, and the much shorter duration of high-intensity actions, could explain a higher weight, higher fat mass and higher fat free mass in sports like American football when compared to basketball players.

Differences in jump performances among the athletes of the three sports have been found. Volleyball players displayed significant higher levels than basketball and handball players in CMJ and CMJas jumps. Likewise, volleyball players showed higher but non-significant performances in SJ. These outcomes appear to be a consequence of the great similarities of the tested jumps with the movements of volleyball blocking actions and the high demand that volleyball has for this action in the games,[12,16,17] with the largest number of jumps per player and match[14] when comparing with basketball[23] and handball.[24] Squat jump performances were similar in all three sports, due to common requirements of muscular strength and power in all of the disciplines, showing similar levels for the three sports when performing nonspecific technical actions.[18] Additional literature data match with our results in the case of basketball.[25]

As previously discussed, agility and the ability to change the direction are important in all team sports. This aspect seems even more relevant in small-sided sports as those in our study.[1,4,8] It is interesting to notice that sports with larger courts (basketball and handball) performed significantly better than volleyball. This is more than likely due to the smallest distances covered in volleyball rallies that, in most cases, are even shorter than those in the test. The differences in performance between basketball and handball players can be attributed to the low requirements of movement in positions such as goalkeepers or defensive specialists in handball. Basketball does not have similar profiles, and all the players on the court should perform a greater percentage of the total movements, fast breaks and transitions between courts. Interestingly, in previous years Berg et al.[21] found exact average values on sprinting performance between basketball and football players, indicating that not only the covered distance is important in the development of the different abilities of the athletes, but also the distance per player ratio and the number of contact actions during the game can be important factors.

Volleyball players had lower mean power outputs in the maximal power tests performed in our study during both, concentric and eccentric phases. There are several explanations for this result. Firstly, volleyball players do not have contact with the opponent during their game. Therefore, their needs of carrying and moving heavy loads are low in absolute terms. On the other hand, the ball used in this sport is the lightest among disciplines, and setting and hitting techniques involve chest muscles less than in the other two sports. The values obtained in basketball and handball are similar in eccentric and concentric phases in almost all loads. The only exception is the lower load (20 kg) wherein basketball players showed significant differences ($p < 0.05$). These results must be interpreted with caution because to our knowledge, this may be due simply to a higher affinity of certain specific movement patterns of the sport with those performed in the test. The use of both arms while passing, shooting, rebounding or fighting for the ball is common in basketball, while in handball this is almost an exception. This aspect should be taken into account by adjusting the load parameters to the specific strength needs of each discipline. No important differences were observed in the results of the concentric and eccentric phases of the bench press tests. That led us to conclude that the use of the concentric phase is enough to assess the power qualities of different team sport players.

In conclusion, this research has found significant differences in the anthropometric and physiologic characteristics of high-level male basketball, handball and volleyball players. Basketball and volleyball players presented more height and higher standing reach and lower weight and fat mass when compared to handball players. CMJ jump tests favored volleyball players whereas handball and basketball players showed higher maximal upper body power output. Basketball players also stood out in the agility tests compared with the other sports.

Although there is no consensus in the scientific literature on the use of a single battery of tests to assess fitness in team sports, our proposal seems valid finding significant differences between three different disciplines. Coaches and practitioners may take in consideration our findings for a proper orientation of physical training. Thus, even though some similarities among the three analyzed sports were found, a different orientation of strength and conditioning sessions in every sport is recommended. Our main findings can also be useful to improve player selection processes based on fitness characteristics, as well as for establishing reference anthropometric and physiological baselines. However, further work needs to be done to generalize these findings and to establish a baseline age at which the physiological differences between high-level profile individuals appear.

Conflicts of interest

The authors have no conflicts of interest to declare.

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Original article

Carbohydrate intake results in lower suppression of salivary immunoglobulin A in judokas

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A R T I C L E   I N F O

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A B S T R A C T

Objective: This study investigated the salivary immunoglobulin A response to carbohydrate supplementation during judo training.
Method: Sixteen judokas were randomly assigned to one of two conditions: Carbohydrate solution and Placebo solution in a double-blind design. Saliva samples were collected at rest, immediately after the training session and 1 h after the training session.
Results: The concentration of the salivary immunoglobulin A decreased during the training session in both conditions ($p = 0.0002$) as well as at 1 h after the training session in the placebo solution condition ($p = 0.035$). The rate of salivary flow decreased during the training session in the placebo solution condition ($p = 0.04$).
Conclusion: Carbohydrate solution consumption during training session did not affect the athletes oral immunity, however, in the recovery period an upper-respiratory tract protection was observed.

La ingesta de carbohidratos induce una menor supresión de la inmunoglobulina A salival en yudocas

Palabras clave:
Artes Marciales
Fenómenos Fisiológicos en la Nutrición Deportiva
Inmunidad Mucosa
Inmunoglobulina A

R E S U M E N

Objetivo: El presente estudio investigó la respuesta de la inmunoglobulina A salival a la suplementación de hidrato de carbono durante el entrenamiento de judo.
Método: Dieciséis yudocas fueron asignados de forma aleatoria a una de dos condiciones: solución de carbohidratos y solución de placebo en un diseño doble ciego. Las muestras de saliva fueron recogidas en reposo, inmediatamente después de la sesión de entrenamiento y una hora después de la sesión de entrenamiento.
Resultados: La concentración de inmunoglobulina A salival disminuyó durante la sesión de entrenamiento en ambas condiciones ($p = 0.0002$), al igual que una hora después de la sesión de entrenamiento en la condición de solución de placebo ($p = 0.035$). La tasa de flujo salival decreció durante la sesión de entrenamiento en la condición de solución de placebo ($p = 0.04$).
Conclusión: El consumo de la solución de carbohidratos durante la sesión de entrenamiento no afectó a la inmunidad oral de los atletas; sin embargo, en el período de recuperación se observó una protección del tracto respiratorio superior.

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Ingestão de carboidrato resulta em menor supressão da imunoglobulina A salivar em judocas

R E S U M O

Objetivo: O presente estudo investigou a resposta imunoglobulina A Salivar frente a suplementação de carboidrato durante o treino de judô.

Método: Dezesseis judocas foram aleatoriamente randomizados, em delineamento duplo-cego nas condições: solução carboidrato e solução placebo. Para mensuração da imunoglobulina A Salivar, a saliva foi coletada no início da sessão de treino, imediatamente após o término e uma hora após o término (1-h Pós-E).

Resultados: A concentração de imunoglobulina A Salivar diminuiu logo após o treino, independente da solução ($p = 0.0002$). No momento uma hora apos o termino frente ao imediatamente apos o termino, houve menor concentração de imunoglobulina A Salivar somente para a condição solução placebo ($p = 0.035$). A taxa de fluxo salivar diminuiu significativamente somente na condição solução placebo ($p = 0.04$).

Conclusão: A Ingestão de solução carboidrato durante a sessão de treino não impediu a imunodepressão da imunoglobulina A Salivar de judocas imediatamente após o treino, mas exerceu proteção à imunidade do trato respiratório superior 1-h após.

Palavras-chave:
Artes marciais
Fenômenos Fisiológicos da Nutrição Esportiva
Imunidade nas Mucosas
Imunoglobulina A

Introduction

The main role of salivary immunoglobulin A (S-IgA) is to protect the upper respiratory tract against colonization of pathogens and virus replication.[1] Such protective effect appears to be dependent mainly on its amount and rate of secretion into the mucosa surface.[2] Thus, it suggests that changes in the secretion of S-IgA can be a potential indicator for the exercise-mediated effects on mucosal protection.[1]

The secretion rate of S-IgA is inversely associated with the incidence of upper respiratory tract infections (URTI),[1] however, scientific evidences suggest that athletes engaged in intense training exhibit an increased risk of URTI, as compared to moderate training.[2] The physiological mechanisms underlying this clinical manifestation are not completely clear, nevertheless, there are speculations regarding immune system changes, such as decrease in S-IgA concentration associated with exercise.[1] For instance, Gleeson et al[3] found that elite swimmers, submitted to intense training, showed URTI associated with concentration of S-IgA. In addition, athletes competing in combat grappling sports (i.e. judo, wrestling and jiu-jitsu) are subjected to pre-competitive anxiety and body contact which increases even more the stress that fighters are submitted.[4] It is believed that such condition may predispose combat athletes to immunosuppressive response.

During prolonged exercise, the immune responses associated to physical stress can be amended by the carbohydrate, possibly it is related with a higher concentration of blood glucose.[3,5] There is no consensus on the influence of carbohydrate intake in the S-IgA response. While some studies show no benefits of either aerobic[6] or resistance training[7] against placebo, others observed protective effect on the mucosal immunity.[8,9] This issue is relevant to combat sports and studies have investigated the effect such sports training on S-IgA.[4,10–14] However, studies on the immune responses of S-IgA after combat sports training with carbohydrate consumption are rare. Therefore, the present study was designed to assess the responses of S-IgA in judo athletes with or without carbohydrate intake during a training session. We hypothesized that the carbohydrate consumption during training session induces immunoprotective responses.

Method

Subjects

Based on our pilot study ($n = 4$), as well as the specific literature,[5,10,14] we estimated a representative sample size based on the S-IgA response. To achieve 80% statistical power, we calculated a minimum sample of 14 subjects to reach a decrease in 10 mg mL^{-1} when comparing S-IgA concentration between groups (5.2 Granmo, IMIM, Barcelona, Spain). The final sample consisted of 16 male judokas (age: 24.1 ± 2.6 years; Body mass: 76.8 ± 9.4 kg, Body fat: 14.5 ± 4.3%). The following criteria were used: previous experience (≥Purple belt) and fitness level (≥1 year training for competition). All individuals were in the pre-competitive phase (<2 months to the regional championship) and none had a rapid weight loss and/or consumption of immunomodulatory drug. This study was approved by the Institutional Research Ethics Committee.

Experimental design

This was a double-blind crossover design study. The sample collections underwent two training sessions with three days interval between them. In the first session, eight subjects were randomly assigned to one of two conditions: (a) consumption of carbohydrate solution (CHO); and (b) consumption of placebo solution (PLA). The treatments were reversed in the second session. Fig. 1 shows the organization flow chart of data collection.

Each session lasted for 120-min (40-min gymnastics, 40-min technical training and 40-min *Randori*). The gymnastics training was composed of warm-up, stretching and local and conditioning exercises. The technical training was composed of specific judo movements (ukemi), techniques (uchi- komi) and throwing (nage-komi). The *Randori* consisted of 10 fights of 4 minutes each, 3 groundwork (ne-waza) and 7 standing combats (tachi-waza). This training protocol was previously applied to Brazilian[5] and Japoneses judokas.[10] After the training session, athletes rested for 60 min in the dojo and waited for the last collection of saliva.

The subjects were recommended to abstain of exercise training (24 h) and fasting (8 h) before the experimental training session.

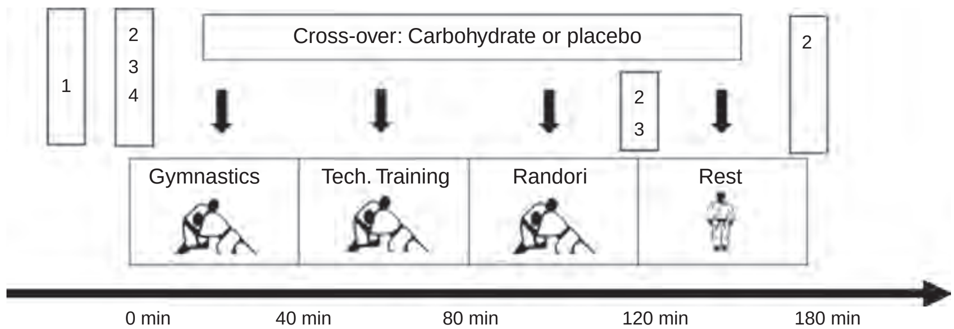

Fig. 1. Organization of procedures followed in data collection. The numbers on the bars represent the measurements in pre, post-E and 1-h post-E. 1, sample selection and anthropometry; 2, saliva collection; 3, body mass; 4, pre-exercise meal.

The experimental procedures started at 07:00 AM when the first collection of saliva occurred (pre-E). Soon after, we offered a personalized breakfast (pre-exercise meal). An hour after breakfast, the athletes started the training session. Immediately after the training session (post-E) and 1 h later (1 h post-E) were collected other saliva samples.

The athletes' height was determined and their body mass was measured at the beginning and the end of each training session. Body composition was estimated using a skinfold equation (triceps, subscapular and abdominal).[15] The body density was estimated using the Wrestlers equation for college Thorland et al.[15] The percentage of body fat (% BF) was estimated using the Brožek et al[16] equation.

Saliva samples were collected in plastic tubes (7 mL) during a period of 2 min at resting position (seated)[17] and stored at −20 °C for future analysis. The mass in grams of saliva was assumed to be equal to milliliters of secreted saliva, since the specific density is very close to 1.0 g mL^{-1}.[18] Then, the salivary flow rate (mL min^{-1}) was obtained. The concentration of S-IgA (mg dL^{-1}) was determined by enzymatic immunoassay (ELISA).[19] The intra-assay coefficient of variation was 7.6%.

After evaluation of eating habits through 24-h recording, we calculated the personal diet consumption during the three days prior to the beginning of each experimental training session.[20] The International Physical Activity Questionnaire (IPAQ) was applied to estimate the athlete's physical activity level. The diet content 90–110% [408 ± 49 kcal; carbohydrate (1 g^{-1}kg^{-1} BM) and 18 g protein (0.4 g kg^{-1} BM)] of Estimated Energy Requirement (EER) according to gender, age, weight, height and physical activity level of each athlete.[21] The pre-exercise meal corresponded to 14% of energy of individual EER and included industrialized juice, white bread, cream cheese and apple. Diets were calculated using the Diet- Pro software – version 4.0. The nutritional procedures in this study were adapted from Brito et al.[5]

A commercial sport drink (Gatorade®) with the following composition was used [carbohydrate – sucrose and fructose (6 g/100 mL); sodium (45 mg/100 mL); potassium (12 mg/100 mL); and chloride (42 mg/100 mL)] as carbohydrate solution. The PLA solution was composed of sodium (87 mg/100 mL) and chloride (80 mg/100 mL). The athletes were hydrated at 0, 15, 30, 45, 60, 75, 90, 105 and 120 min of the training session and 135, 150, 165 and 180 min during the post-training recovery. The solutions were served by an external researcher, thus ensuring the double-blind nature of this study, and the amount of fluid intake was monitored.

Statistical analysis

Normal distribution of the data was checked by Shapiro–Wilks test. Homogeneity and sphericity of variance were checked before statistical analysis (Mauchly test). To verify the changes in S-IgA induced by exercise and conditions (i.e. hydration type), we used repeated measures ANOVA (carbohydrate or PLA ×3 times of measurement). When differences were significant, the post hoc Bonferroni test was applied. To compare means obtained by different conditions we used the independent *t*-test. Data were analyzed using SAS software (IBM® software's) and significance was at $p < 0.05$.

Table 1
Body mass and fluid intake at different times and conditions.

Condition	Pre-E (kg)	Post-E (kg)	Fluid intake (L)	*p* Value
CHO	77.4 ± 9.8	76.0 ± 9.6	~2.1	$p = 0.342$
PLA	77.3 ± 9.5	76.4 ± 9.3	~2.1	$p = 0.401$

CHO: group carbohydrate solution; PLA: group placebo solution; Pre-E: pre-training; Post-E: immediately post-training.

Results

The body weight did not change ($p > 0.05$) significantly between measurements and conditions (Table 1).

S-IgA data are presented in Fig. 2. There was a reduction of S-IgA concentration from pre- to post-E in both conditions (CHO: 21.7 μg mL^{-1} vs 8.6 μg mL^{-1}, respectively, $p = 0.0002$ and PLA: 20.2 μg mL^{-1} vs 7.1 μg mL^{-1}, respectively, $p = 0.0012$) (Fig. 2A). There was no difference in the concentration of S-IgA between conditions ($p = 0.98$) measured at different times. We observed a reduction in the concentration of S-IgA from Post-E to 1 h Post-E, only for the PLA condition (7.1 μg mL^{-1} vs 5.7 mL^{-1}, $p = 0.035$). Salivary flow rate decreased significantly from pre- to post-E, only for the PLA condition (2.3 mL min^{-1} vs. 1.4 mL min^{-1}, $p = 0.012$, respectively) (Fig. 2B).

Discussion

This study investigated the S-IgA secretion after a judo training session with or without carbohydrate intake. The principal outcomes indicated that carbohydrate intake during judo training results in immunoprotective mucosal effect 1 h after the training session.

We believe that the nutritional action that preceded the training has offered a substantial amount of carbohydrate (1 g kg BM^{-1}) which maintained the blood glucose concentration. It is possible that the pre-exercise meal lead to similar immune and hormonal responses after the 120-min exercise session in both experimental conditions in this study. There is evidence that exogenous carbohydrate intake during exercise can influence the immune response by maintaining the blood glucose level, thereby reducing the expression of catabolic hormones.[22] In fact, it has been shown that carbohydrate intake reduces disturbances in the immune system of endurance athletes[8,23] as well as in judokas during training sessions.[5,22]

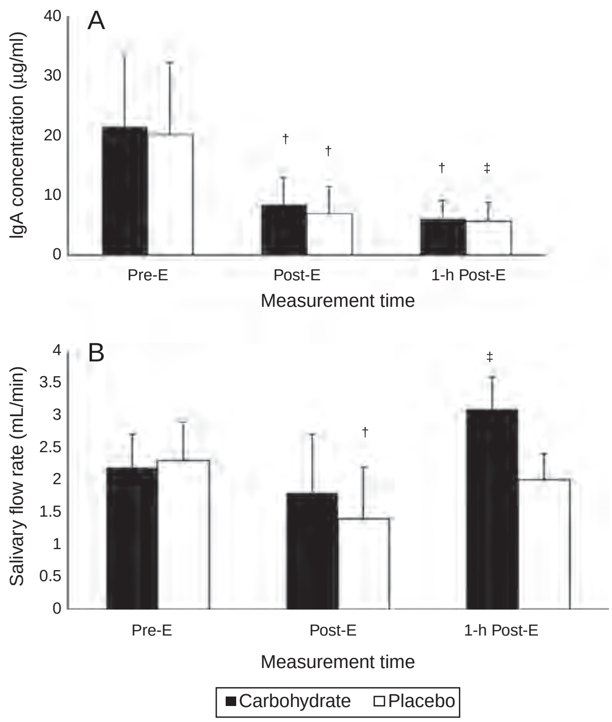

Fig. 2. (A) Average IgA-S in pre, post- E and 1-h post-E times. (B) Average salivary flow rate in pre, post-E and 1-h post-E times. †, significant difference as compared to pre-E ($p < 0.05$); ‡, significant difference between post-E and 1-h post-E ($p < 0.05$).

The concentration of S-IgA during exercise is influenced by the sympathetic nervous system. Although we did not observe statistically significant difference in S-IgA between conditions at Post-E, there was a reduction in the salivary flow rate for the PLA condition. S-IgA concentration decreased by 60% and 65% after 120 min of training in athletes who consumed carbohydrate and PLA, respectively, thus confirming the results found by Nieman et al[24] in ultramarathon after 160-km race. Nieman et al[24] observed that 25% of athletes had URTI two weeks after the race. In the present study, only one out of 16 athletes developed symptoms of URTI a week after the training sessions (i.e. throat infection). Although S-IgA is not the unique determining factor for URTI, it could be used as an index to check immunosuppression and possible causal factor for susceptibility to URTI in athletes.

Evidence indicates that chronic exercise has a cumulative effect on S-IgA.[2] Excessive training and competition associated with psychological stress appears to reduce the S-IgA concentration, and it is suggested that overtraining is associated to psychological stress and chronic suppression of antibodies produced by B cells.[1] In fact, Umeda et al.[14] observed a significant decrease in plasma IgA in judokas after training of similar duration as that in the present study. In addition, highly trained judokas presented plasma IgA suppression after training either immediately or after 3 months.[11] It should be noted, however, that IgA immunosuppression was avoided in judokas who underwent progressive reduction in precompetition training load (tapering), which allowed appropriate recover and adequate preparation to competition.[12]

The average time of 1 h after training to restore the S-IgA to resting values has been reported.[6] In contrast, Mackinnon et al[2] demonstrated a complete recovery of S-IgA to resting levels 24 h after an intense cycling session. Hübner-wozniak et al.[25] did not observe recovery of S-IgA to resting levels 1 h after the cycling exercise. In line with these findings, our study also demonstrated that athletes who consumed PLA tended to exhibit more intense immunosuppressive response. Such divergent times to restore S-IgA concentration to resting values warrant further investigations, especially in combat sports athletes.

The hydration protocol used in the present study aimed to avoid significant reduction in body mass from pre- to post-E. Indeed, the maintenance of body mass has allowed us to eliminate the bias associated with dehydration on immunity, thus isolating the effect of training and energy intake. Reductions in circulating S-IgA were observed in Japanese judokas subjected to dehydration (~3.5%).[13] Moreover, Chishaki et al.[10] observed a decrease in plasma concentrations of IgA in judokas with moderate or severe dehydration during training session of about 120 min.

Our results have practical applications as it indicate to coaches and athletes the benefit of energy replenishment, allowing the judokas to prepare adequately for competitions avoiding IgA suppression. However, it is noteworthy that the main effect of carbohydrate occurred after training. In addition, forced stops during training could be counterproductive, therefore, carbohydrate consumption either after training or during *randori* interval is indicated.

Future studies on catabolic hormones (e.g. cortisol, adrenaline) associated with the S-IgA response in simulated competition or competition would be interesting since the demands of physical and mental stress are different in training session,[26] competition or simulated competition.[4,26]

In conclusion, the consumption of sport drink containing carbohydrate contributes to the maintenance of the salivary flow rate with no effect on the S-IgA concentration. However, after 1 h of training recovery carbohydrate intake attenuated the decrease in S-IgA concentration in judokas.

Ethical disclosures

Protection of human and animal subjects. The authors declare that the procedures followed were in accordance with the regulations of the relevant clinical research ethics committee and with those of the Code of Ethics of the World Medical Association (Declaration of Helsinki).

Confidentiality of data. The authors declare that no patient data appear in this article.

Right to privacy and informed consent. The authors declare that no patient data appear in this article.

Conflicts of interest

The authors have no conflicts of interest to declare.

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Original

Teste de uma repetição máxima em exercício multi e monoarticulares em distintos protocolos de privação visual

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INFORMAÇÃO SOBRE O ARTIGO

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Palavras-chave:
Força muscular
Levantamento de pesos
Aptidão física

R E S U M O

Objetivo: Verificar os valores do teste de uma repetição máxima nos exercícios multi e monoarticulares, com e sem privação visual.
Método: Doze homens treinados (23.00 ± 4.80 anos; 80.76 ± 8.09 kg; 1.76 ± 0.05 cm) realizaram 4 visitas (2 para cada exercício) constando de testes de uma repetição máxima para exercícios multi (agachamento na barra guiada) e monoarticulares (rosca bíceps), com ou sem privação visual.
Resultados: O teste T não verificou diferenças importantes entre os métodos de privação visual para o exercício multiarticular, tanto para a força absoluta ($\Delta\%$ = - 6.13%; $p = 0.422$), quanto para a força relativa ($p = 0.397$). O mesmo ocorreu para o exercício monoarticular, tanto para a força absoluta ($\Delta\%$ = 1.43%; $p = 0.220$), como para a relativa ($p = 0.230$). Adicionalmente, um pequeno tamanho do efeito foi verificado entre os testes de uma repetição máxima nos exercícios multi e monoarticulares, nos protocolos com e sem privação visual.
Conclusão: De acordo com os resultados do estudo, podemos concluir que, para os exercícios multi e monoarticulares, o método de privação visual não promove diferenças importantes no deslocamento de cargas na execução do teste de uma repetição máxima.

Prueba de una repetición máxima para ejercicios multi y monoarticulares con diferentes protocolos con y sin deprivación visual

Palabras clave:
Fuerza muscular
Elevación de peso
Aptitud física

R E S U M E N

Objetivo: Determinar los valores del test de una repetición máxima en los ejercicios multi y monoarticulares con y sin deprivación visual.
Método: Doce hombres entrenados (23.00 ± 4.80 años; 80.76 ± 8.09 kg; 1.76 ± 0.05 m) realizaron 4 visitas (2 para cada ejercicio) que consiste en prueba de una repetición máxima para el ejercicio multiarticular (sentadilla con barra guiada) y el ejercicio de una sola articulación (flexión del codo), con y sin deprivación visual.
Resultados: La prueba T no encontró diferencias significativas entre los métodos de deprivación visual para el ejercicio multiarticular, tanto en la fuerza absoluta ($\Delta\%$ = - 6.13%; $p = 0.422$) como fuerza relativa ($p = 0.397$). Lo mismo ocurrió para el ejercicio monoarticular, para la fuerza absoluta ($\Delta\%$ = 1.43%; $p = 0.220$) y la fuerza relativa ($p = 0.230$). Además, se observó un tamaño de efecto pequeño entre las pruebas de una repetición máxima en los ejercicios multiarticulares y monoarticulares en ambos protocolos visuales.

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Conclusiones: De acuerdo con los resultados del estudio, se puede concluir que para los ejercicios multiarticulares y monoarticulares el protocolo de deprivación visual no causa diferencias significativas en el desplazamiento de cargas en la prueba de una repetición máxima.

One repetition maximum tests for multi-joint exercise and single-joint exercise in different visual deprivation protocols

Keywords:
Muscle strength
Weight lifting
Physical fitness

A B S T R A C T

Objective: The aim of the study was to determine values of the 1RM test in multi and single-joint exercises with and without visual deprivation.
Method: Twelve trained men (23.00 ± 4.80 years; 80.76 ± 8.09 kg; 1.76 ± 0.05 cm) performed four visits (two for each exercise) consisting in 1RM tests for multi-joint exercise (guided bar squat) and single-joint exercise (biceps curl), with or without visual deprivation.
Results: The T test found no significant differences between the visual deprivation methods for multi-joint exercise both in absolute strength (Δ% = - 6.13%; p = 0.422) as for relative strength (p = 0.397). The same occurred for the single-joint exercise for absolute strength (Δ% = 1.43%; p = 0.220) and for relative strength (p = 0.230). Additionally, a small effect size was observed between 1RM tests in multi and single-joint exercises in both visual protocols.
Conclusion: According to the study results, we can conclude that for multi and single-joint exercises protocol visual deprivation do not cause significant differences in the displacement of loads in 1RM test execution.

Introdução

O treinamento resistido (TR) vem sendo apresentado como um estímulo para ganhos de força, potência, hipertrofia e resistência muscular[1]. Assim, estudos com o propósito de avaliar as adequadas manipulações das variáveis metodológicas do TR (como, por exemplo, volume, intensidade, ordem do exercício, intervalo entre as séries em sessões de treinamento ou para exercícios multi e monoarticulares) parecem ser relevantes para a compreensão e prescrição do TR[2–6].

O teste de uma repetição máxima (1RM) é recomendado para a avaliação da força dinâmica muscular[7] e considerado *gold standard* para a avaliação desta valência física. Ainda, é comumente utilizado como parâmetro para a manipulação da intensidade das cargas[8] no TR. Alguns fatores podem influenciar na aplicação do teste de 1RM, como familiarização ao teste[9], aquecimento prévio[10], seguimento corporal avaliado[11], amplitude de movimento[12] e ainda relutância em continuar o teste, devido ao medo do risco de lesão pelo elevado valor da carga[13].

Assim, estratégias que possam minimizar a influência (muitas vezes, psicológica) do avaliado no valor dos resultados de testes parecem ser interessantes, para que se obtenha a maior fidedignidade e reprodutibilidade no teste. A privação visual pode diminuir estabilidade dinâmica de caminhada e aceleração, quando comparada a condições sem privação visual[14]. Contudo, Maior et al.[15] mostraram que o teste de 1RM em homens, realizado com privação visual, obteve no supino horizontal (5.37%), *leg press* 45° (8.25%) e puxada pela frente (5.12%), valores significativamente maiores comparado com os testes (1RM) realizados nos mesmos exercícios sem privação visual. Adicionalmente, Maior et al.[16] verificaram que a privação visual acarretou em valores de carga absoluta e relativa em mulheres treinadas significativamente mais elevados no supino horizontal, *leg press* e puxada pela frente, comparado ao protocolo sem privação visual.

Apesar de já estar demonstrada influência da privação visual na obtenção das cargas de 1RM[15,16], são escassos os estudos que verificam esta estratégia na obtenção das cargas em exercícios multi e monoarticulares. Desta forma, conhecer o padrão de influência de condições de privação visual no teste de 1RM para distintos exercícios (multi e monoarticulares) poderá contribuir para quantificação das cargas do TR, possibilitando assim testes e prescrições mais precisas. Por estes motivos, o objetivo do presente estudo foi verificar os valores do teste de 1RM nos exercícios multi e monoarticulares (agachamento na barra guiada [AG] e rosca bíceps direta [RD]), com e sem privação visual. É hipotetizado que não ocorrerão diferenças estatísticas entre os testes com e sem privação visual, tanto para ambos os tipos de exercícios (multi e monoarticulares).

Método

Amostra

A amostra foi composta por doze homens (23.00 ± 4.80 anos; 80.76 ± 8.09 kg; 1.76 ± 0.05 cm) aparentemente saudáveis, selecionados voluntariamente e que estavam engajados há pelo menos doze meses no TR, se exercitando com duração aproximada de uma hora, no mínimo três vezes por semana. Foram excluídos deste experimento os indivíduos que, nos últimos seis meses, foram acometidos de lesões articulares, contraturas musculares, comprometimentos cardiovasculares nos últimos doze meses e os indivíduos submetidos a cirurgias articulares. Foram excluídos do experimento os indivíduos que faziam uso de qualquer tipo de recurso ergogênico, ou esteroide anabólico. Ainda, não foi permitida a utilização de cafeína ou álcool nos dias de verificação. Os voluntários foram previamente esclarecidos sobre os objetivos do estudo e os procedimentos aos quais seriam submetidos, e responderam negativamente ao *Physical Activity Readiness Questionnaire* (PAR-Q)[17]. Todos assinaram o Termo de Consentimento Livre e Esclarecido, conforme a Resolução 466/2012 do Conselho Nacional de Saúde do Brasil. O estudo foi aprovado pelo Comitê de Ética

Figura 1. Agachamento na barra guiada.

Figura 2. Rosca direta.

do Centro Universitário da Fundação Educacional de Barretos sob o protocolo n.° 17774513.9.0000.5433.

Procedimentos

Os testes de 1RM, para os exercícios de AG e de RD, foram realizados em sessões distintas (cada sessão separada por 48 horas). Os procedimentos de testes de 1RM seguiu as recomendações da *American College of Sports Medicine*[7]. Resumidamente, após o aquecimento, um máximo de cinco tentativas foram realizadas para cada sessão de testes de 1RM (com ou sem privação visual), com um mínimo de cinco minutos de recuperação entre as tentativas máximas. Um intervalo de cinco minutos foi respeitado entre as tentativas. Assim, a maior carga levantada com sucesso em cada sessão foi anotada com precisão.

Os sujeitos foram orientados a não realizar exercícios físicos 48 horas antes de cada teste, vestir roupas adequadas, estarem devidamente hidratados e alimentados há, no mínimo dois horas, antes do teste. Todos os testes foram realizados no mesmo horário do dia. O aquecimento para cada sessão foi constituído de dois séries com 40% da carga utilizada pelos avaliados em seus treinos cotidianos, especificamente no exercício testado (AG ou RD). Encorajamento verbal foi realizado para todos os sujeitos e em todas as sessões, de forma padronizada.

Todos os testes iniciaram na fase excêntrica do movimento, foi caracterizado 1RM o valor em kg da tentativa realizada anteriormente à tentativa que houve falha concêntrica. A execução dos exercícios seguiu recomendações previamente estabelecidas[18]. Resumidamente, o AG (fig. 1) teve sua posição inicial no ângulo de 90° de amplitude, a partir da articulação do joelho, para cada participante. Em seguida, o avaliado estendia totalmente os joelhos. Um marcador sensorial (tato) foi utilizado como parâmetro para execução correta da amplitude. O aquecimento e o teste de 1RM foram realizados rigorosamente, seguindo a determinação da marca sensorial.

A RD (fig. 2) realizou-se apoiando a parte dorsal do tronco na parede e com os joelhos flexionados, utilizando uma barra reta. A partir da extensão completa, o participante realizou a flexão e extensão total dos cotovelos, sem movimentar nenhuma outra articulação.

Quatro sessões de familiarização foram conduzidas, com o intuito de minimizar os erros do estudo. Uma excelente reprodutibilidade das cargas de 1RM foi verificada durante as dois últimas sessões de familiarização, tanto para o AG ($r = 0.98$; $p < 0.01$) como para RD ($r = 0.99$; $p < 0.01$) (sem privação visual). Após 48 horas das dois sessões de familiarização, os indivíduos completaram quatro visitas ao laboratório de coleta de dados. Em dois visitas, os avaliados realizaram os procedimentos do teste de 1RM (descrito anteriormente) nos exercícios selecionados (um a cada dia) sem privação visual. Logo após, em mais dois dias não consecutivos, os avaliados executaram os mesmos procedimentos do teste de 1RM (descrito anteriormente) nos exercícios selecionados (um a cada dia) com privação visual. No protocolo de privação visual, o participante foi submetido a uma condição de privação do sentido da visão por um tecido preto amarrado na cabeça na altura dos olhos, impedindo totalmente a visualização das barras e anilhas destinadas aos exercícios selecionados. A seleção do exercício e a estratégia visual realizada em cada teste foram definidas aleatoriamente. A maior carga de cada teste foi anotada, como a carga de 1RM para os distintos exercícios e protocolos de privação visual.

Analise estatística

Todos os resultados foram apresentados segundo sua média ± desvio padrão. Inicialmente, foi testada a normalidade dos dados pelo teste de Shapiro-Wilk. Todos os resultados apresentaram distribuição normal. Assim, em seguida, foi realizado o teste t de Student para amostras pareadas entre os protocolos com e sem privação visual para cada exercício selecionado (multi e monoarticular). Adicionalmente, para determinar a magnitude dos resultados de carga de 1RM nos distintos protocolos (com ou sem privação visual), o tamanho do efeito (a diferença entre o protocolo com privação visual e sem privação visual, dividido pelo desvio padrão do protocolo com privação visual), foi calculado. Os limites propostos por Cohen[19] foram aplicados para determinar a magnitude do efeito do protocolo. O nível de significância adotado foi de $p < 0.05$. Para os tratamentos estatísticos descritos, foi utilizado o *software* Prisma versão 5.0 (GraphPad, Inc).

Resultados

No exercício de multiarticular (AG) não houve diferença estatística significativa entre as comparações de protocolos visuais, tanto para a força máxima absoluta (1RM) ($p = 0.422$), quanto para a força relativa ($p = 0.397$). Para o exercício monoarticular (RD), diferenças não importantes foram observadas entre os protocolos com ou sem privação visual, para a força máxima absoluta ($p = 0.220$) e força relativa ($p = 0.230$). Adicionalmente, a magnitude da diferença de ambos os protocolos visuais foi pequena para ambos os exercícios testados, tanto para a força máxima como relativa. A tabela 1 apresenta claramente os dados e estatísticas de força máxima absoluta e relativa para os exercícios multi (AG) e monoarticulares (RD) testados.

Tabela 1
Comparação dos exercícios AG e RD, com e sem privação visual

	Com privação visual	Sem privação visual	Tamanho do efeito	p
1RM (kg)				
AG	102.00 ± 17.18	98.00 ± 18.43	0.23 (pequeno)	0.422
RD	41.50 ± 5.20	42.17 ± 5.62	-0.13 (pequeno)	0.220
Força relativa				
AG	1.27 ± 0.22	1.22 ± 0.22	0.25 (pequeno)	0.397
RD	0.52 ± 0.05	0.52 ± 0.06	-0.16 (pequeno)	0.230

1RM: uma repetição máxima; AG: agachamento na barra guiada; p: nível de significância de $p < 0.05$; RD: rosca bíceps direta.

Discussão

O principal achado do presente estudo observou que distintos protocolos visuais (com ou sem privação visual) durante o teste de 1RM não proporcionaram diferenças significativas para a carga de 1RM testada. Este achado sugere que, independentemente do tipo de exercício (multi ou monoarticulares), a privação visual pode não interferir no teste de 1RM. O teste de 1RM é usualmente utilizado com método *gold standard* e recomendado pelo ACSM[7] para verificação da força muscular máxima. Há mais de 40 anos que testes de força com esta metodologia (1RM)[20] são aplicados, contudo, a privação visual gera discussões sobre as possibilidades de uma maior acurácia no teste, principalmente por questões psicológicas[16].

Em estudo anterior[15], foi comparado o efeito de distintas metodologias de privação visual na força muscular máxima (teste de 1RM). Neste estudo, doze homens treinados possibilitaram aos autores concluírem que a utilização de privação visual no teste de 1RM pode possibilitar um incremento da carga avaliada para os exercícios multiarticulares de supino horizontal com barras e anilhas, *leg press* de anilhas e puxada pela frente. Estes resultados demonstram que, aparentemente, a privação parece ser um método para se elevar a acurácia das respostas de força máxima para homens treinados.

Em outro estudo, Maior et al.[16] compararam o valor de carga deslocada por mulheres durante a execução do teste 1RM em distintas situações, com e sem privação visual. Onze mulheres treinadas realizaram o teste de 1RM para o exercício de supino horizontal, *leg press* e puxada de frente, com e sem o método de privação visual. Foi verificado aumento significativo da força muscular absoluta e relativa para os testes de 1RM com privação visual, em relação ao teste sem privação visual em todos os exercícios avaliados (todos multiarticulares). Os autores concluíram que com privação visual o teste de 1RM, hipoteticamente, tem sua autoeficácia cognitiva aumentada, pelo fato de evitar que o sujeito visualize a carga de teste e, consequentemente, subestime o seu desempenho. Contudo, nossos dados não corroboram com este estudo, pois tanto para exercícios multi e monoarticulares não verificamos diferenças entre os métodos com ou sem privação visual durante o teste de 1RM. Possivelmente, o elevado número de sessões de familiarização (4) possibilitou maior segurança aos avaliados, influenciando no desempenho no teste de 1RM, independentemente do método de privação visual.

Realizamos este protocolo de familiarização, pois esta é uma estratégia utilizada a fim de eliminar qualquer efeito de aprendizado motor ao longo dos testes de força[21,22]. O *American College of Sports Medicine*[7] recomenda a realização de sessões de familiarização com o equipamento específico, com a finalidade de obter um valor reprodutível para verificações de 1RM, o qual tem sido amplamente utilizado como teste *gold standard* para a verificação da força dinâmica muscular máxima[23]. Entretanto, os resultados provenientes de estudos atuais[21,22,24] não permitem inferências quanto ao número ideal de sessões de familiarização necessárias para uma boa correlação entre o teste e o reteste. Entretanto, com o intuito de minimizar quaisquer riscos com relação a ganhos de força relacionados à aprendizagem motora durante os testes, realizamos um número familiarizações recomendados anteriormente[24].

Em deslocamentos curtos não se mostra fundamental na relação entre a manutenção postural e privação visual. Pelo fato de que a privação visual não exclui formas de atualização da posição e da direção a ser realizada por ações motoras, mas sim pelo conhecimento prévio sobre a postura desejada[15]. Conseguirmos discriminar a falta das informações visuais (pelo método de privação visual), através da utilização de outras fontes sensoriais[25]. Nesse caso, o sistema vestibular e somato-sensorial provavelmente teria sua ação aumentada, para que não diminua a força do acoplamento entre as informações visuais e a oscilação corporal[25]. Assim, estas afirmações corroboram com os nossos resultados, em que a privação visual não mostrou qualquer relação com desvios posturais e de equilíbrio corporal. E ainda não demonstrou alteração significativa entre os métodos com e sem privação visual nos testes de 1RM para exercícios multi e monoarticulares.

A elevada acurácia na realização do teste de 1RM pode ajudar na definição da intensidade e o volume de treinamento, que são variáveis de extrema importância para o desenvolvimento da força muscular. Técnicos e treinadores devem compreender e aplicar os conhecimentos científicos sobre a correta forma de execução do teste de 1RM, a fim de minimizar erros no teste e, consequentemente, alcançar objetivos específicos ao longo de sessões de treinamento.

De acordo com os resultados do estudo, podemos concluir que, para exercícios multi e monoarticulares, o método de privação visual não promove diferenças importantes no deslocamento de cargas na execução do teste de 1RM. Este resultado relata que homens jovens não subestimam o seu desempenho e, de nenhuma forma, são influenciados pelo método de privação visual. Entretanto, pouco se sabe sobre o mecanismo pelo qual o indivíduo subestimaria a sua carga de treinamento. Assim, novas pesquisas devem ser realizadas sobre o método de privação visual, que se encontra pouco esclarecido na literatura científica.

Responsabilidades éticas

Proteção de pessoas e animais. Os autores declaram que os procedimentos seguidos estavam de acordo com os regulamentos estabelecidos pelos responsáveis da Comissão de Investigação Clínica e ética e de acordo com os da Associação Médica Mundial e da Declaração de Helsinki.

Confidencialidade dos dados. Os autores declaram ter seguido os protocolos do seu centro de trabalho acerca da publicação dos dados de pacientes.

Direito à privacidade e consentimento escrito. Os autores declaram ter recebido consentimento escrito dos pacientes e/ ou sujeitos mencionados no artigo. O autor para correspondência deve estar na posse deste documento.

Conflito de interesses

Os autores declaram não haver conflito de interesses.

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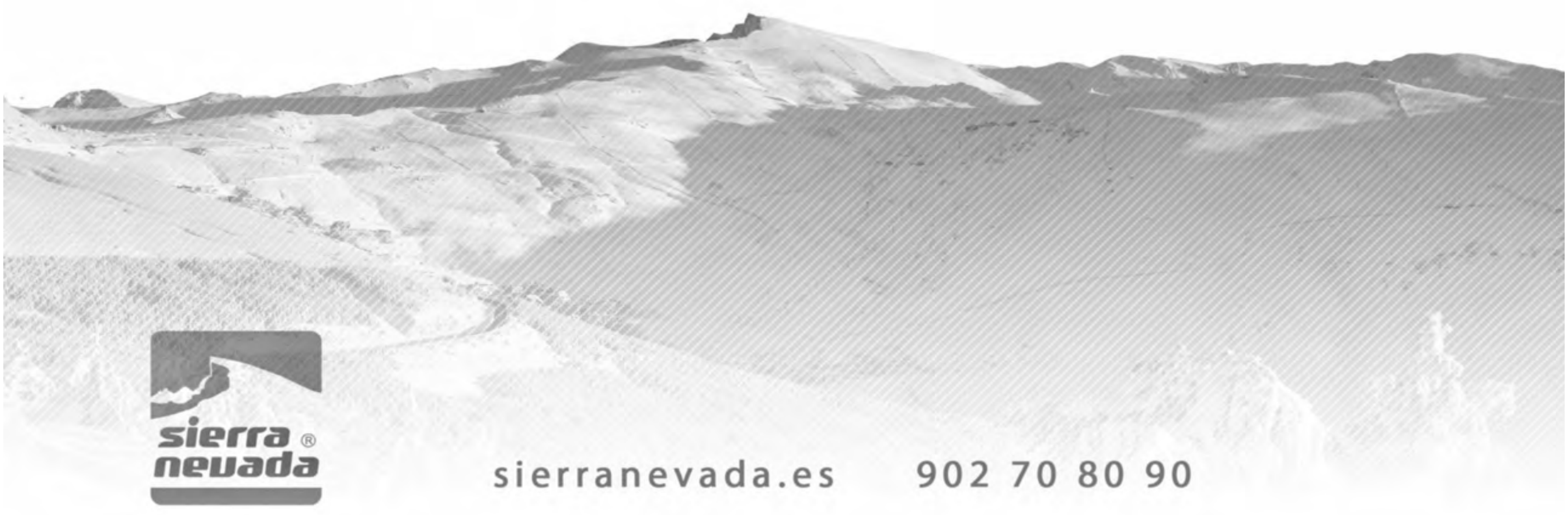

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