Tesis Doctoral

EFECTOS DE UN PROGRAMA DE EJERCICIO FÍSICO ACUÁTICO SOBRE LA CAPACIDAD FUNCIONAL Y LA CALIDAD DE VIDA RELACIONADA CON LA SALUD EN PERSONAS ADULTAS SEDENTARIAS CON DOLOR LUMBAR CRÓNICO

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A mis padres y hermana

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RESUMEN TESIS

El dolor lumbar crónico es aquél que se encuentra delimitado entre el reborde costal y la zona alta de los pliegues glúteos (zona lumbar baja), puede llegar a limitar significativamente las actividades cotidianas, producir discapacidad, deteriorar la calidad de vida y asociarse con altos costos económicos para el individuo y para la sociedad.

El objetivo general de la presente memoria de Tesis es analizar el efecto de un programa de ejercicio físico acuático sobre el grado de dolor, capacidad funcional, calidad de vida relacionada con la salud, composición corporal y parámetros de condición física en sujetos adultos sedentarios con dolor lumbar crónico.

Los principales resultados de la Tesis sugieren que: a) El ejercicio físico acuático se presenta como terapia física apropiada para personas con dolor lumbar crónico que genera discapacidad e incide en su calidad de vida relacionada con la salud. b) Un programa de ejercicio físico acuático de 5 días/semana durante dos meses, disminuye la intensidad de dolor y la discapacidad, mejora la calidad de vida relacionada con la salud, la composición corporal y los parámetros de condición física en sujetos adultos sedentarios con dolor lumbar crónico. c) Un programa de ejercicio acuático de 3 días/semana durante dos meses induce mayores beneficios en dolor, discapacidad, fuerza-resistencia abdominal y frecuencia cardiaca en reposo y post-esfuerzo que un programa con 2 días/semana en sujetos adultos sedentarios con dolor lumbar crónico. d) Cambios en la intensidad del dolor, fuerza-resistencia abdominal y aspectos emocionales son predictores del cambio en discapacidad en pacientes con dolor lumbar crónico tratados con un programa de ejercicio físico acuático.

Los resultados de la presente memoria de Tesis ponen de manifiesto la utilidad del ejercicio físico acuático en el tratamiento del dolor lumbar crónico en sujetos adultos sedentarios.

ABREVIATURAS

ACSM	American College of Sports Medicine
ANCOVA	Analysis of Covariance
ANOVA	Analysis of Variance
ATP	Aquatic Therapy Program
BIA	Bioelectrical Impedance Analysis
BMI	Body Mass Index
CG	Control Group
CLBP	Chronic Low Back Pain
CVRS	Calidad de Vida Relacionada con la Salud
DLC	Dolor Lumbar Crónico
EG	Experimental Group
IMC	Índice de Masa Corporal
MCS SF-36	Mental Composite Summary of SF-36
ODI	Oswestry Disability Index
PCS SF-36	Physical Composite Summary of SF-36
QoL	Quality of Life
RPE	Rating of Perceived Exertion
SF-36	Short-Form Health Survey 36
SEM	Standard Error of the Mean
VAS	Visual Analogue Scale

INTRODUCCIÓN

Las algias vertebrales constituyen hoy día un problema epidemiológico a nivel mundial y una de las causas más frecuentes de consulta médica y de fisioterapia. En España se estima que más del 30% de las consultas en un servicio de Rehabilitación son para tratamiento de dolor vertebral mecánico crónico[1]. Dentro de ellas se encuentra el dolor lumbar, clasificado habitualmente como agudo, subagudo o crónico[2].

El dolor lumbar provoca un gran coste económico asociado a las bajas laborales, lo que hace necesario la creación de infraestructuras para dar cobertura terapéutica a personas que padecen dolor lumbar para mejorar su función, minimizar el dolor, disminuir el grado de discapacidad y mantener o mejorar la calidad de vida relacionada con la salud (CVRS)[3].

Estudios recientes han demostrado que el dolor lumbar crónico (DLC) suele estar asociado con una baja condición física[4,5], lo cual puede estar relacionado con un bajo nivel de práctica de actividad física[6-8]. Dicha circunstancia se refleja en una reducción de la fuerza muscular, resistencia cardiorrespiratoria y amplitud de movimiento, parámetros que suelen relacionarse con los dolores lumbares[9,10].

Déficits en fuerza muscular, resistencia cardiorrespiratoria y amplitud de movimiento, se deben en parte a periodos de inactividad física y limitación de movimientos, provocando cambios neurológicos y fisiológicos en la columna, tales como debilidad en la musculatura paraespinal, con pérdidas en fibras musculares de tipo 2[11], y acortamiento de los músculos y tejido conectivo de la región espinal[12].

Una baja condición física y un exceso de peso corporal son claros factores de riesgo que originan una mayor predisposición a sufrir dolor lumbar (Figura 1), y éste a su vez a un mayor déficit de movimiento[13], generando cierto grado de discapacidad y disminución de la CVRS[14].

Figura 1. Relación de la Condición Física y el Sobrepeso con el Dolor, Discapacidad y la Calidad de Vida relacionada con la Salud (CVRS).

Actividad Física Acuática, DLC, Discapacidad y CVRS

Actualmente la línea de tratamiento marcada para los pacientes con DLC recomienda terapia física para la mejora del dolor y la discapacidad[6-8,15], dos de las principales causas asociadas a las bajas laborales y que ocasionan una disminución en la CVRS de los pacientes.

Los programas de ejercicio físico orientados a la mejora de la fuerza muscular, resistencia cardiorrespiratoria y la amplitud de movimiento para la estabilización de los músculos de la columna, son recomendados en el tratamiento con terapia física de pacientes con DLC[14,16,17]. Sin embargo, no se puede obviar la sobrecarga que supone para la columna la realización de ejercicio fuera del medio acuático[18]. Es conocido que el ejercicio en el medio acuático puede ser una terapia efectiva y útil especialmente en pacientes con multitud de patologías (artrosis, fibromialgia, etc.)[19], con dificultades para realizar ejercicio físico fuera del medio acuático[20], y como una alternativa para la mejora de la condición física, especialmente en personas con bajo nivel de condición física[21,22].

En el medio acuático los ejercicios aeróbicos resultan, para el paciente, menos molestos o dolorosos que el trabajo en tierra, y por tanto pueden ser más apropiados para el individuo con baja condición física, sobrepeso, dolor, discapacidad o de cierta edad, debido a que el efecto de la fuerza de la gravedad sobre el cuerpo es menor[23].

Como consecuencia, dado que la tolerancia al ejercicio es mayor y que el agua tiene mayor densidad que el aire[24], los pacientes suelen ejercitarse por más tiempo, contribuyendo a un incremento del gasto energético[25] y a mayores aumentos en los parámetros relacionados con la condición física[26-28].

La actividad física en el medio acuático, además de proporcionar los efectos beneficiosos de la propia práctica de ejercicio físico, posee además otras características que la diferencian con respecto a la realización de la misma actividad en tierra[21,22], aportando un gran número de ventajas específicas para el tratamiento de multitud de patologías, entre ellas el DLC. El agua es un medio de compensación, donde por su naturaleza, se minimiza la acción de la gravedad, reduciendo la compresión de las fuerzas verticales articulares, proporcionando un ambiente más beneficioso para realizar ejercicio en pacientes con artritis, dolor de espalda, sobrepeso, discapacidades ortopédicas, deterioro del equilibrio u otras condiciones médicas que pueden restringir el ejercicio en tierra[22,29].

Actualmente existen pocos estudios que hayan examinado los efectos conjuntos del ejercicio físico y el medio acuático en personas con DLC y su influencia en la discapacidad y CVRS[16, 30-34]. No obstante, los resultados obtenidos sugieren ciertas ventajas de la realización de ejercicio físico en el medio acuático.

Ventajas de la Realización de Ejercicio Físico en el Medio Acuático sobre el Dolor, la Discapacidad y la CVRS, como Consecuencia de las Características Físicas del Agua

La experiencia clínica nos indica que el ejercicio en medio acuático puede tener ventajas en pacientes con desórdenes musculoesqueléticos (Figura 2), y puede producir mejoras de mayor alcance que el ejercicio realizado fuera del medio acuático sobre la discapacidad, el dolor y la CVRS en personas sedentarias con DLC[16].

La inmersión en el medio acuático disminuye la carga vertical sobre la columna vertebral[18], lo cual unido a la flotación, la presión hidrostática y la temperatura del agua, hacen que ésta sea particularmente apta para pacientes con dolor, limitaciones funcionales o sobrepeso, que pueden realizar en el agua movimientos que en tierra son más difíciles o imposibles[35].

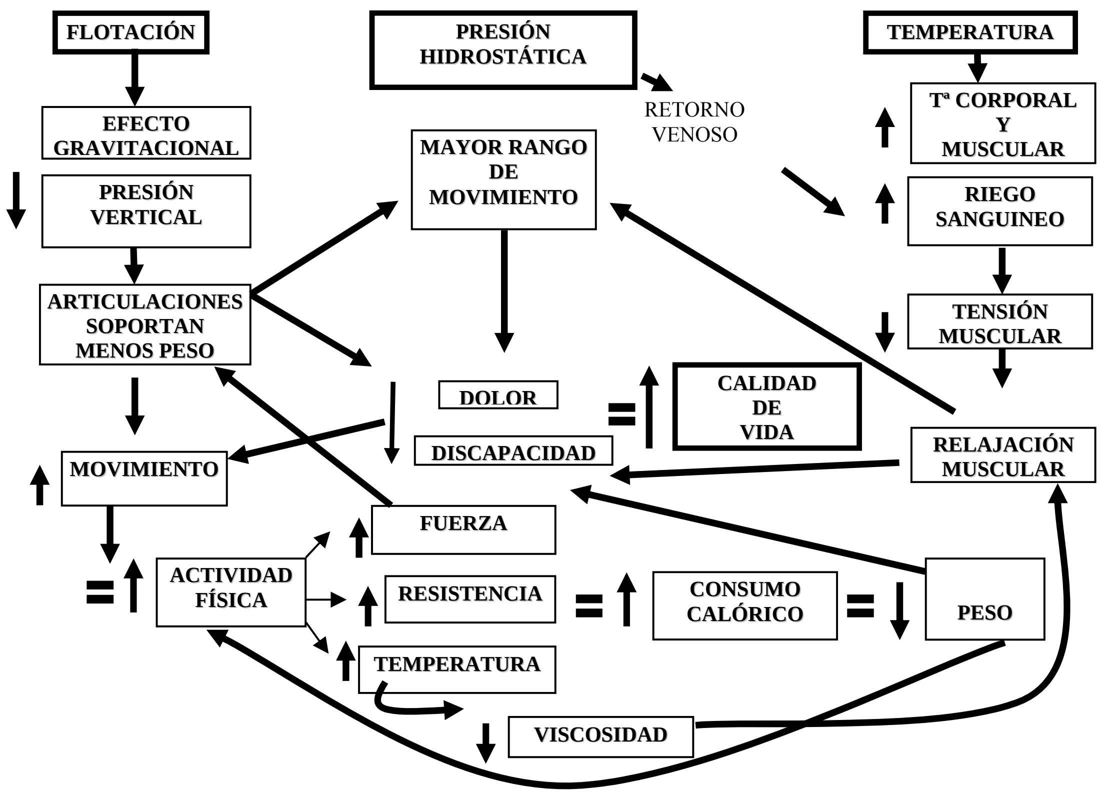

Figura 2. Esquema resumen de la interacción del medio acuático combinado con ejercicio físico en pacientes con DLC.

Aunque diferentes tipos de ejercicio físico pueden producir beneficios en individuos con DLC, el ejercicio acuático tiene particular interés porque combina movimientos articulares suaves, los efectos terapéuticos del agua caliente y los propios beneficios cardiovasculares de la realización de ejercicio aeróbico de baja-media intensidad[22,29,36,37].

Flotación

La flotación permite una disminución de la carga que soportan las articulaciones (el peso del cuerpo tiene un menor efecto gravitacional), disminuyendo así la presión vertical, y facilitando el rango de movimiento articular. Todo ello favorece la disminución del dolor provocado por un exceso de tono muscular al soportar el peso corporal[38].

Cuando se realiza ejercicio en el agua, la flotabilidad y la resistencia a la fricción del agua producen especiales efectos mecánicos en el cuerpo, ya que su densidad y viscosidad actúan como una resistencia al movimiento, que varía con la rapidez del mismo[39]. Por otra parte, los desplazamientos que tienden a oponerse a la flotación (el empuje hacia arriba del tronco) pueden también estimular el desarrollo de la fuerza muscular.

Este soporte para la columna vertebral que ofrece el medio acuático, hace que los pacientes puedan adoptar, al realizar un ejercicio determinado, una posición que les resulte cómoda. Posición ésta que, a veces, les sería imposible de conseguir fuera del agua, pudiéndose realizar correcciones posturales con menor esfuerzo y molestias para el paciente, debido a la disminución consiguiente de las fuerzas que quizás estén comprimiendo la columna vertebral. Dado que el impacto de la carga que actúa sobre la columna vertebral durante los ejercicios puede ser fácilmente controlado al cambiar el grado de inmersión en el agua, hacer ejercicios en el agua puede ser el modo más ventajoso de ejercicio para las personas con DLC[32].

La flotación nos permite realizar más ejercicio físico (mayor número y variabilidad de movimientos, repeticiones y con menos fatiga) que fuera del agua, lo que puede proporcionar un incremento en el nivel de condición física. Cada movimiento realizado en el medio acuático por las extremidades supone un trabajo contra la resistencia del agua, proporcionando un estímulo de entrenamiento para el desarrollo muscular y el sistema cardiovascular[21].

La disminución de la carga con respecto al trabajo en tierra y el mayor volumen de trabajo que se puede realizar, contribuyen a un mayor consumo calórico y a una posible reducción del peso corporal[22].

Presión hidrostática

La presión del fluido (presión hidrostática) se ejerce por igual sobre todos las superficies de un cuerpo inmóvil sumergido a una profundidad determinada. Esta propiedad contribuye a estabilizar las articulaciones, permite una mejora de la circulación sanguínea (retorno venoso), lo que repercute directamente en una disminución del tono muscular, favoreciendo la relajación muscular y reduciendo el dolor ocasionado por un exceso de tono muscular[40].

Temperatura del agua

El ejercicio físico en el medio acuático a una temperatura del agua de 30-32º C produce un aumento en la temperatura corporal y muscular, mejorando el riego sanguíneo[32]. Ello conlleva, a su vez, un mayor aporte de sustratos energéticos al músculo, una mayor retirada de productos de deshecho procedentes del metabolismo celular, y una disminución de la viscosidad intramuscular, lo que hace que el músculo se vuelva más flexible, disminuyendo la tensión muscular y favoreciendo la relajación muscular, y disminuyendo, por tanto, el dolor[41-43].

Componentes de la Condición Física especialmente relevantes en sujetos con DLC

El Colegio Americano de Medicina del Deporte (ACSM)[44] recomienda los programas de actividad física orientados a la mejora de la flexibilidad o amplitud de movimiento, la fuerza muscular, la resistencia cardiorrespiratoria y los parámetros relacionados con la composición corporal para mantener o mejorar la CVRS. El ejercicio físico tiene la capacidad de mejorar o mantener la función músculo-esquelética y cardiovascular, por lo que puede ser útil para mejorar la funcionalidad de la espalda en sujetos con dolor lumbar.

En pacientes con DLC, las pautas de tratamiento que tienen como base la utilización de ejercicio físico como terapia para reducir el dolor y la discapacidad[15], se centran principalmente en la estabilización de la musculatura implicada en la zona lumbar y abdominal, mejorar la flexibilidad, la capacidad cardiorrespiratoria y parámetros relacionados con la composición corporal[14,17,19], ya que déficits en estos parámetros influyen notablemente en el DLC[5].

La inhibición de los movimientos y la disminución de las actividades cotidianas, por lo general comienza en las primeras etapas del dolor de espalda[13]. Una baja condición física como consecuencia del sedentarismo, puede llegar a inducir el dolor lumbar. Para revertir el proceso es posible utilizar el ejercicio físico como terapia. Usualmente la causa del dolor lumbar es desconocida, por tanto, seleccionar ejercicios específicos y diseñar un programa de entrenamiento puede entrañar cierta dificultad. La planificación del volumen y la intensidad del ejercicio se deben basar en una evaluación previa de la condición física[45,46].

Entrenamiento de Fuerza

Existen estudios que han demostrado un déficit de fuerza muscular en sujetos con DLC, cuando se comparan con individuos sanos[11,47]. Payne et al.[48] relacionaron déficits en la resistencia de la musculatura abdominal con DLC. La debilidad de la musculatura abdominal tiene como consecuencia el desequilibrio pélvico, debido a que esta musculatura no es capaz de mantener la inclinación normal de la pelvis, ocasionando un aumento de la lordosis de la curvatura lumbar[32,49,50].

La eficacia de un programa de entrenamiento de fuerza depende de muchos factores, que incluyen: carga, frecuencia, volumen y modo de entrenamiento. Simmonds et al.[51] recomiendan que los pacientes con dolor lumbar deben seguir un plan de trabajo similar a personas sin dolor y disminuir la carga de trabajo cuando tengan dolor. Los ejercicios de entrenamiento muscular deberían tener una frecuencia de al menos dos veces a la semana, con 10-15 repeticiones en pacientes de menos de 50 años y de 8-12 repeticiones en personas mayores. Según McGill[52], en pacientes con dolor lumbar se debería poner mayor énfasis en mejorar aspectos de resistencia muscular y no en fuerza máxima, independientemente de la edad.

Kell et al.[5] obtuvieron beneficios en parámetros de fuerza en sujetos con DLC, con un programa que constó de ejercicios de fuerza de una frecuencia de 3 días a la semana, 2 series de 8-15 repeticiones las 4 primeras semanas y 3 series de 8-15 repeticiones a partir de la cuarta semana hasta el final del programa (16 semanas).

Entrenamiento de la Resistencia Cardiorrespiratoria

Algunos sujetos que padecen DLC presentan una disminución de la capacidad aeróbica en comparación con sujetos sanos[53]. Por este motivo, la mejora de la resistencia cardiorrespiratoria ha sido recomendada en los programas de tratamiento para el DLC[10,53,54]. El trabajo aeróbico es recomendado para disminuir el porcentaje de grasa corporal, lo cual es de suma importancia ya que el sobrepeso se ha correlacionado positivamente con un aumento del dolor en sujetos con DLC[55].

En cuanto al trabajo de resistencia cardiorrespiratoria, las recomendaciones son variables en función de los diferentes estudios consultados, de tal forma que, siguiendo a van der Velde et al.[53], se obtienen beneficios con una duración de 5 a 20 minutos al 60% de la FCmáx. Sculco et al.[56] recomiendan 20 minutos la primera semana, 30 minutos durante la segunda semana y 45 minutos durante las siguientes 8 semanas en ejercicios aeróbicos para el tratamiento del dolor lumbar. Turner et al.[57] indican 10-20 min. al 60-70% de la FC max. Smeets et al.[4] señalan 20 min. al 65-80% de la FC max.; Storheim, et al.[58], prescriben 30 min. al 70-85% de la FC max. Simmonds et al.[51] recomiendan que sujetos con dolor lumbar mejoren su resistencia aeróbica a través de ejercicios funcionales como caminar de forma energética durante 5 min. 3-5 veces a la semana, sentarse y levantarse de una silla durante 1 min. 2-3 veces a la semana, sin dar más detalles sobre la intensidad requerida. Además, este autor está en contra de realizar ejercicios aeróbicos de alta intensidad como correr. Kell et al.[5] obtuvieron beneficios con un programa que constó de ejercicios aeróbicos con una frecuencia de 3 días a la semana, con un volumen que progresó desde 25 min. por sesión al inicio del programa hasta 50 minutos por sesión al finalizar el programa, variando la intensidad del entrenamiento de 10 a 13 según la escala de Borg (6-20).

Entrenamiento de Flexibilidad o Amplitud de Movimiento

Diversos estudios han documentado la eficacia de los ejercicios de estiramiento para mejorar la flexibilidad del tronco en pacientes con dolor lumbar[59,60]. Estos ejercicios pueden ser utilizados para mejorar la elasticidad de la musculatura implicada en la zona lumbar y restaurar, de esta manera, el rango articular normal en sujetos con DLC[10].

Un déficit en la flexibilidad de los músculos extensores de cadera dificulta la movilidad de la columna lumbar y la pelvis, ya que los extensores de cadera son activados para controlar la inclinación de la pelvis cuando la columna vertebral se flexiona, siendo ésta la razón por la que los ejercicios de estiramientos de estos músculos son recomendados en el tratamiento del DLC[32].

Existen varios métodos para el entrenamiento de la flexibilidad (balísticos, facilitación neuromuscular propioceptiva, estáticos, etc.) que han demostrado ser eficaces. De todos ellos, por sus características, el estiramiento estático se presenta como un método eficaz, ya que requiere mínima familiarización para su correcta realización y se puede llevar a la práctica sin ayuda adicional, ideal para el trabajo en grupo.

La metodología utilizada en el trabajo de flexibilidad orientada a la mejora del dolor lumbar, varía en función de diversos autores. Klaber et al.[61] incluyen ejercicios de estiramientos de la musculatura de las piernas, muslos, caderas y tronco dos veces a la semana, manteniendo la posición 20 segundos en cada ejercicio, sin especificar el número de repeticiones por estiramiento. Sherman et al.[62] describen un programa que incluye ejercicios de estiramientos una vez a la semana centrados en las piernas, caderas y tronco, manteniendo la posición durante 30 segundos, y tampoco especifican el número de repeticiones. Storheim et al.[58] realizaron ejercicios de estiramientos dos veces a la semana en la musculatura de la cadera en un régimen de 4 repeticiones de 15 segundos de duración.

Simmonds et al.[51] mantienen una postura contraria a realizar ejercicios de estiramientos que aumenten el dolor, principalmente en ejercicios que impliquen la musculatura flexora y extensora de cadera y tronco. Según estos autores, los ejercicios de flexibilidad deberían ser realizados de 2-3 veces a la semana y cada sesión debería incluir tres repeticiones por cada grupo muscular. Se pueden realizar estiramientos estáticos manteniendo la posición durante 10 segundos.

Dada la variedad de programas de ejercicio físico que se han utilizado hasta ahora, recientes revisiones[19,63,64] subrayan la necesidad de nuevos estudios de riguroso carácter metodológico que estudien los efectos del ejercicio físico en el medio acuático, para poder prescribir programas de ejercicio más específicos en cuanto a frecuencia, intensidad y volumen de trabajo en personas con DLC.

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OBJETIVOS

General:

El objetivo general de esta Tesis Doctoral es analizar el efecto de un programa de ejercicio físico acuático sobre el grado de dolor, capacidad funcional, CVRS, composición corporal y parámetros de condición física en sujetos adultos sedentarios con DLC.

Específicos:

- Analizar el papel del ejercicio físico acuático como terapia física en el tratamiento no farmacológico y no invasivo del dolor lumbar crónico (dolor, discapacidad y CVRS) **(Revisión sistemática, Artículo I)**.
- Analizar los efectos en dolor, discapacidad, CVRS, composición corporal y condición física de un programa de ejercicio físico acuático de 5 días a la semana durante dos meses en sujetos adultos sedentarios con DLC **(Artículo II)**.
- Comprobar si el número de días a la semana (2 y 3 días/semana) de un programa de ejercicio físico acuático de dos meses de duración influye sobre el grado de dolor, discapacidad, CVRS, composición corporal y condición física en sujetos adultos sedentarios con DLC **(Artículo III)**.
- Estudiar las relaciones existentes entre la intensidad del dolor, CVRS, condición física y la discapacidad producida por el DLC en pacientes tratados con un programa de ejercicio físico acuático **(Artículo IV)**.

MATERIAL Y METODO

La sección de Material y Métodos de la presente memoria de Tesis se resume en las siguientes tablas que incluyen la información metodológica más relevante de los artículos que componen la memoria de Tesis.

Tabla 1. Tabla resumen de la metodología utilizada en la presente memoria de Tesis.

Artículo	Diseño Experimental	Sujetos	Intervención	Variables	Test/Cuestionarios
I. Ejercicio Físico Acuático en el Tratamiento del Dolor Lumbar Crónico y su Influencia en Dolor, Discapacidad y Calidad de Vida Relacionada con la Salud.	Revisión	No aplicable	No aplicable	No aplicable	No aplicable
II. Aquatic therapy improves pain, disability, quality of life, body composition and fitness in sedentary adults with chronic low back pain	Ensayo Pragmático Controlado	38 sujetos con DLC (16 hombres y 22 mujeres) ▪ PEA, n=21 ▪ GC, n=17	2 meses de PEA basados en ejercicios de F-R, aeróbicos y de flexibilidad (ver Tabla 2 y 3) ▪ PEA, 5 días/semana	Dolor lumbar, discapacidad, CVRS, composición corporal (peso, IMC, masa grasa, porcentaje de masa grasa y masa magra) y parámetros de condición física	VAS, ODI, SF-36, AIB, sit and reach, dinamometría manual, curl-up, test de 1 milla Rockport y FC rep.
III. Effects of different frequencies of aquatic therapy program in adults with chronic low back pain.	Ensayo Pragmático Controlado	54 sujetos con DLC (25 hombres y 29 mujeres) ▪ GE2d, n=18 ▪ GE3d, n=21 ▪ GC, n=15	2-meses de PEA basados en ejercicios de F-R, aeróbicos y de flexibilidad (ver Tabla 2 y 3) ▪ GE2d, 2 días/semana ▪ GE3d, 3 días/semana	Dolor lumbar, discapacidad, CVRS, composición corporal (peso, IMC, masa grasa, porcentaje de masa grasa y masa magra) y parámetros de condición física	VAS, ODI, SF-36, AIB, sit and reach, dinamometría manual, curl-up, test de 1 millaRockport y FC rep.
IV. Change in pain, quality of life and abdominal muscle strength predict improvement in low-back-pain-related disability after aquatic exercise.	Transversal	75 sujetos con DLC (37 hombres y 38 mujeres) ▪ GE, n=60 ▪ GC, n=15	2-meses de PEA basados en ejercicios de F-R, aeróbicos y de flexibilidad	Dolor lumbar, discapacidad, CVRS, IMC y parámetros de condición física	VAS, ODI, SF-36, AIB, sit and reach, dinamometría manual, curl-up y FC rep.

DLC: Dolor Lumbar Crónico, PEA: Programa Ejercicio Acuático, GE2d: Grupo Experimental dos días por semana, GE3d: Grupo Experimental tres días por semana, GC: Grupo Control, VAS: Visual Analogic Scale, ODI: Oswestry Disability Index, CVRS: Calidad de Vida Relacionada con la Salud, SF-36: Quality Short-Form Health Survey 36, AIB: Análisis de Impedancia Bioeléctrica, IMC: Índice de Masa Corporal, F-R: Fuerza-Resistencia, FC rep: Frecuencia Cardiaca en reposo.

Tabla 2: Programa de Ejercicio Físico Acuático: Planificación.

Grupo Experimental 5 días por semana											
TIPO DE EJERCICIO		**SEMANA 1**	**SEMANA 2**	**SEMANA 3**	**SEMANA 4**	**SEMANA 5**	**SEMANA 6**	**SEMANA 7**	**SEMANA 8**	**Número de sesiones**	**Adherencia al programa**
Fuerza	VOLUMEN (series × repts)	3 × 12	3 × 12	3 × 15	3 × 15	3 × 12	3 × 12	3 × 15	3 × 15	40	90%
	INTENSIDAD	Sin material auxiliar de flotación Baja velocidad				Con material auxiliar de flotación Alta velocidad				**Volumen Total de Resistencia Aeróbica** = 875 min.	
Resistencia Aeróbica	VOLUMEN	100 min.	100 min.	125 min.	125 min.	125 min.	100 min.	100 min.	100 min.		
	INTENSIDAD (Escala RPE)	10-12					12-15			**Volumen Total de Ejercicios de Flexibilidad** = 400 min.	
Flexibilidad		10 min. 3 × 20 segundos por ejercicio									

Grupo Experimental 3 días por semana											
TIPO DE EJERCICIO		**SEMANA 1**	**SEMANA 2**	**SEMANA 3**	**SEMANA 4**	**SEMANA 5**	**SEMANA 6**	**SEMANA 7**	**SEMANA 8**	**Número de sesiones**	**Adherencia al programa**
Fuerza	VOLUMEN (series × repts)	3 × 12	3 × 12	3 × 15	3 × 15	3 × 12	3 × 12	3 × 15	3 × 15	24	93%
	INTENSIDAD	Sin material auxiliar de flotación Baja velocidad				Con material auxiliar de flotación Alta velocidad				**Volumen Total de Resistencia Aeróbica** = 525 min.	
Resistencia Aeróbica	VOLUMEN	60 min.	60 min.	75 min.	75 min.	75 min.	60 min.	60 min.	60 min.		
	INTENSIDAD (Escala RPE)	10-12					12-15			**Volumen Total de Ejercicios de Flexibilidad** = 240 min.	
Flexibilidad		10 min. 3 × 20 segundos por ejercicio									

Grupo Experimental 2 días por semana											
TIPO DE EJERCICIO		**SEMANA 1**	**SEMANA 2**	**SEMANA 3**	**SEMANA 4**	**SEMANA 5**	**SEMANA 6**	**SEMANA 7**	**SEMANA 8**	**Número de sesiones**	**Adherencia al programa**
Fuerza	VOLUMEN (series × repts)	3 × 12	3 × 12	3 × 15	3 × 15	3 × 12	3 × 12	3 × 15	3 × 15	16	97%
	INTENSIDAD	Sin material auxiliar de flotación Baja velocidad				Con material auxiliar de flotación Alta velocidad				**Volumen Total de Resistencia Aeróbica** = 350 min.	
Resistencia Aeróbica	VOLUMEN	40 min.	40 min.	50 min.	50 min.	50 min.	40 min.	40 min.	40 min.		
	INTENSIDAD (Escala RPE)	10-12					12-15			**Volumen Total de Ejercicios de Flexibilidad** = 160 min.	
Flexibilidad		10 min. 3 × 20 segundos por ejercicio									

min.: minutos; repts: repeticiones; RPE: escala de percepción subjetiva del esfuerzo

Tabla 3: Programa de Ejercicio Físico Acuático: Sesiones.

<table>
<tr><td>CALENTAMIENTO</td><td>Se realizaron diversos tipos de desplazamientos en el medio acuático intercalados con ejercicios de movilidad articular con y sin material auxiliar de flotación:
□ <u>SIN MATERIAL DE FLOTACIÓN</u>: Caminar moviendo brazos en cruz delante del pecho, flexo-extensión de brazos (marcha militar), desplazamientos laterales, elevando rodillas, talones al glúteo.
□ <u>CON MATERIAL DE FLOTACIÓN</u>: Con el churro entre las piernas se desplazan realizando piernas bicicleta y brazos al estilo braza delante del pecho, ídem pero hacia atrás (brazos se desplazan de atrás hacia delante), piernas estilo espalda.</td></tr>
<tr><td rowspan="4">PARTE PRINCIPAL</td><td>EJECICIOS DE FUERZA-RESISTENCIA</td></tr>
<tr><td>Se realizaron los siguientes ejercicios:
• Flexión-extensión de cadera.
• Abducción-aducción de cadera.
• Abducción-aducción de brazos a la altura del pecho, partiendo de una flexión anterior de hombros de 90 º.
• Abdominales desde posición sentada (con apoyo del material de flotación): piernas tijeras, abrir-cerrar piernas, bicicleta, las dos rodillas al pecho, ídem pero de forma alterna.
• Oblicuos (con apoyo del material de flotación): desde la posición decúbito supino se realiza inclinación lateral del tronco a derecha e izquierda (manos en dirección a los tobillos).</td></tr>
<tr><td>EJECICIOS DE RESISTENCIA AERÓBICA</td></tr>
<tr><td>Se realizaron ejercicios aeróbicos que implicaban la movilización de grandes masas musculares, con y sin material auxiliar de flotación:
• Piernas estilo espalda con churro debajo de los brazos.
• Con churro en la cintura en posición decúbito supino, desplazamientos con los brazos (el movimiento parte con brazos extendidos por encima de la cabeza y finaliza con ambos brazos pegados al tronco).
• Diferentes tipos de desplazamientos caminando por el fondo de la piscina: lateralmente, hacia adelante y hacia atrás ayudándose con los brazos.
• Con churro entre las piernas:
- piernas bicicleta y brazos a braza,
- ídem pero desplazamientos hacia atrás,
- piernas extendidas y los brazos se desplazan de atrás hacia delante a la altura del pecho,
- ídem al anterior, pero con los miembros inferiores flexionados (caderas y rodillas).
• Natación estilo espalda.</td></tr>
<tr><td rowspan="2">VUELTA A LA CALMA</td><td>EJECICIOS DE FLEXIBILIDAD</td></tr>
<tr><td>Se realizaron ejercicios de flexibilidad de los siguientes grupos musculares por parejas o con ayuda del bordillo de la piscina (dentro del medio acuático):
• Glúteos: de pie con apoyo monopodal y la espalda apoyada en el bordillo, se flexiona la cadera y rodilla de la pierna libre. Con ayuda del brazo contrario, agarrando el muslo de la pierna flexionada, se lleva ésta en diagonal hacia atrás.
• Musculatura lumbar: con material auxiliar de flotación (un churro debajo de las axilas y otro churro debajo de las rodillas) mantienen posición fetal.
• Musculatura Isquiotibial: de pie con apoyo monopodal, con la pierna libre levantada descansando sobre los brazos de un compañero. Las piernas permanecen estiradas y las caderas en ángulo recto.</td></tr>
</table>

Sujetos

La muestra que participó en el estudio estuvo compuesta por adultos sedentarios que se iniciaban en el programa de ejercicio físico acuático del Centro Deportivo Massam (La Zubia, Granada). Para el diseño de la muestra se tuvieron en cuenta los siguientes criterios:

- *Criterios de inclusión*: presencia de DLC durante al menos 3 meses (Andersson, 1999) y entre 18 y 65 años de edad.
- *Criterios de exclusión*: padecer síntomas o signos que pudieran sugerir enfermedades graves, embarazadas o recién paridas, problemas graves a nivel reumatológico, neurológico, neoplásico u otra condición que pueda comprometer la completa participación en la intervención, haberse sometido a intervención quirúrgica en la columna vertebral, padecer hernias discales, grave deformidad estructural, osteoporosis, fracturas recientes, enfermedades inflamatorias o infecciosas de la columna, tumores vertebrales, desorden psicológico que pueda afectar a la comprensión y evaluación de los síntomas, y la presencia de graves enfermedades cardiovasculares. Los sujetos fueron excluidos si no tenían la condición de sedentarios, es decir, haber realizado actividad física regular previa ≥ 60 minutos a la semana durante los últimos 12 meses (Haskell et al., 2007).

Los participantes recibieron detallada información verbal, acompañada de una hoja informativa, acerca del proyecto de investigación en el que participaron. Firmaron un consentimiento informado por escrito, aprobado por el Comité de Ética de Investigación Humana de la Universidad de Granada.

RESULTADOS Y DISCUSIÓN

Los resultados y discusión se presentan en la forma en que han sido previamente sometidos en revistas científicas.

1. EJERCICIO FÍSICO ACUÁTICO EN EL TRATAMIENTO DEL DOLOR LUMBAR CRÓNICO Y SU INFLUENCIA EN DOLOR, DISCAPACIDAD Y CALIDAD DE VIDA RELACIONADA CON LA SALUD.

Baena-Beato PA, Arroyo-Morales M, Delgado-Fernández M, Robles-Fuentes A, Artero EG.

(Artículo I: Revisión sistemática)

Ejercicio Físico Acuático en el Tratamiento del Dolor Lumbar Crónico y su Influencia en Dolor, Discapacidad y Calidad de Vida Relacionada con la Salud.

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Declaraciones de autoría

PA. Baena-Beato concibió el estudio y supervisó todos los aspectos de su realización. PA. Baena-Beato y A. Robles-Fuentes obtuvieron los datos y realizaron los análisis. M. Delgado-Fernández, E. G. Artero y M. Arroyo-Morales interpretaron los hallazgos y contribuyeron a la redacción del primer borrador del manuscrito. Todos los autores aportaron ideas, interpretaron los hallazgos, revisaron los borradores del manuscrito y aprobaron la versión final. PA. Baena-Beato es el responsable del artículo.

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Los autores declaran no tener ningún conflicto de intereses.

Ejercicio Físico Acuático en el Tratamiento del Dolor Lumbar Crónico y su Influencia en Dolor, Discapacidad y Calidad de Vida Relacionada con la Salud.

RESUMEN

Objetivo: Analizar el papel del ejercicio físico acuático como terapia física en el tratamiento no farmacológico y no invasivo del dolor lumbar crónico (dolor, discapacidad y calidad de vida relacionada con la salud).

Métodos: Se seleccionaron aquellas publicaciones científicas desde enero de 1990 a febrero de 2011, en inglés, centradas en la utilización de la actividad física como terapia física en personas con dolor lumbar crónico mediante las bases de datos MEDLINE/Pubmed y SportDiscus. También se examinaron las listas de referencias de los estudios seleccionados.

Resultados: Se incluyeron 7 estudios randomizados que emplearon un programa de actividad física en medio acuático en personas con dolor lumbar crónico, cuyos principales resultados se centran en la mejora de parámetros de condición física (incluyendo composición corporal).

Conclusiones: En base a la literatura revisada, es posible sugerir la idoneidad del ejercicio físico acuático como terapia física apropiada para personas con dolor lumbar crónico que genera discapacidad e incide en su calidad de vida relacionada con la salud.

PALABRAS CLAVE: Dolor lumbar crónico, Ejercicio físico acuático, Discapacidad, Calidad de vida, Revisión.

Aquatic physical exercise in the treatment of chronic low back pain and its influence on pain, disability and quality of life

Abstract:

Objective: To analyze the role of aquatic physical exercise as a physical therapy in the non-pharmacological and non-invasive treatment for chronic low back pain management (pain, disability, quality of life).

Methods: Those publications focused on aquatic physical activity as a physical therapy in people with chronic low back pain, from January 1990 to February 2011, in English, were selected using the MEDLINE/PubMed and SPORTSDiscus databases. The reference lists of the selected studies were also examined.

Results: Seven studies were selected as they included an aquatic physical activity program in people with chronic low back pain. Improvement in health-related fitness (including body composition) was the main outcome in most studies.

Conclusions: Based on the revised literature, it is possible to suggest the suitability of aquatic physical exercise as a physical therapy appropriate for patients with chronic low back pain that generates disability and affects their quality of life.

Key words: Chronic low back pain, Aquatic physical activity, Disability, Quality of life, Review.

Introducción

Las algias vertebrales constituyen hoy día un problema epidemiológico a nivel mundial y una de las causas más frecuentes de consulta médica y de fisioterapia. En España se estima que más del 30% de las consultas en un servicio de rehabilitación son para tratamiento de dolor vertebral mecánico crónico[1]. Dentro de ellas se encuentra el dolor lumbar, clasificado habitualmente como agudo, subagudo o crónico[2]. El dolor lumbar provoca un gran coste económico asociado a las bajas laborales, lo que hace necesario la creación de infraestructuras para dar cobertura terapéutica a personas que padecen dolor lumbar para mejorar su función, minimizar el dolor, disminuir el grado de discapacidad y mantener o mejorar su calidad de vida[3] (Figura 1).

Estudios recientes han demostrado que el dolor lumbar crónico suele estar asociado con una baja condición física[4,5], lo cual puede estar relacionado con un bajo nivel de práctica de actividad física[6-8]. Dicha circunstancia se refleja en una fuerza muscular y resistencia cardiorrespiratoria reducidas[9], dos parámetros que suelen relacionarse con los dolores lumbares.

Estos déficit en fuerza muscular y resistencia cardiorrespiratoria se deben en parte a periodos de inactividad física y limitación de movimientos como resultado de cambios neurológicos y fisiológicos en la columna, tales como debilidad en la musculatura paraespinal, con pérdidas en fibras musculares de tipo II[10], falta de flexibilidad en la zona[11], y acortamiento de los músculos y tejido conectivo de la región espinal. La inactividad física y el sobrepeso inducen al dolor lumbar y éste a su vez a un mayor déficit de movimiento[12], generando cierto grado de discapacidad y disminución de la calidad de vida[13].

Aunque existen algunas revisiones previas sobre los beneficios de la actividad física (acuática y no acuática) en personas con dolor lumbar crónico [7,14-17], creemos necesaria una actualización en lengua española de las investigaciones publicadas al respecto. La presente revisión sistemática pretende analizar el papel de la actividad física acuática como terapia física en el tratamiento no farmacológico y no invasivo del dolor lumbar crónico (dolor, discapacidad y calidad de vida), como alternativa al ejercicio en tierra.

Métodos

Selección de los estudios

Se llevó a cabo una búsqueda bibliográfica exhaustiva para seleccionar estudios científicos centrados en la utilización de la actividad física acuática en el tratamiento del dolor lumbar crónico, publicados entre enero de 1990 y febrero de 2011. Se emplearon las bases de datos internacionales MEDLINE/PubMed y SportDiscus, utilizando las palabras clave que aparecen en la figura 2.

En primer lugar fueron identificados los títulos y resúmenes de los estudios seleccionados para establecer su relevancia. A continuación se analizaron los listados de referencias de las revisiones más relevantes y se identificaron los ensayos clínicos randomizados o controlados. Como complemento a lo anterior, también se examinaron las listas de referencias de los estudios publicados acerca de la utilización de la actividad física en el medio acuático en el dolor lumbar crónico, especialmente revisiones sobre el tema.

Criterios para inclusión y exclusión de los estudios

Sólo los ensayos clínicos randomizados o controlados fueron incluidos en esta revisión sistemática. Se incluyeron aquellos estudios que presentaban al menos un grupo de tratamiento con terapia física en el medio acuático (ejercicios de movilidad, ejercicios dinámicos contra resistencia, ejercicios aeróbicos, ejercicios de flexibilidad, etc.). La etiología del dolor lumbar (discopatía, dolor mecánico, radiculopatía, etc...) no fue tenida en cuenta a la hora de seleccionar los estudios. Se excluyeron aquellos artículos que no se centraban en el dolor lumbar crónico sino en agudo o subagudo; trabajos que no presentaran entre sus variables de estudio el dolor, ni la discapacidad ni la calidad de vida; y aquellos estudios que no incluyeran actividad física realizada en el medio acuático.

Análisis de la revisión de la literatura científica

Para la selección final de los estudios de esta revisión, 2 autores (PABB y ARF) de forma independiente aplicaron todos los criterios al texto completo de los artículos que habían pasado el filtro inicial y fueron elegibles. Los desacuerdos y/o dudas fueron resueltos/as a través de discusión entre los autores.

Los artículos encontrados fueron analizados detenidamente en cuanto a: 1) la metodología de los diferentes programas de actividad física acuática empleados en el tratamiento del dolor lumbar crónico, discapacidad y calidad de vida, 2) las ventajas que aporta la actividad física realizada en el medio acuático en el tratamiento del dolor lumbar crónico, discapacidad y calidad de vida, 3) los resultados obtenidos por los programas de actividad física acuática referentes al dolor, discapacidad y calidad de vida.

Resultados

En la figura 2 se detallan el número de artículos científicos encontrados en cada base de datos (SportDiscus o MEDLINE/PubMed) en base a las palabras clave empleadas (I-V) o combinación de las mismas (VI-X). Tras el proceso de selección de los estudios, se identificaron 7 trabajos que cumplían con los criterios establecidos en la presente revisión sistemática (figura 3).

Actualmente existen pocos estudios que hayan examinado los efectos conjuntos de la actividad física y el medio acuático en personas con dolor lumbar crónico, y su influencia en discapacidad y calidad de vida. No obstante, los resultados obtenidos sugieren posibles ventajas de la actividad física en el medio acuático en comparación con el ejercicio en tierra (tabla 1).

Dundar et al.[18] compararon un protocolo de ejercicios en tierra con un programa acuático durante 1 mes a 5 sesiones por semana, ambos de 60 minutos de duración. El programa terrestre (16 mujeres y 17 hombres, edad media 34,8 ± 8,3 años) consistió en un calentamiento con ejercicios básicos de estiramientos y movilidad articular, seguido de un trabajo de fuerza de los principales grupos musculares (15 a 20 repeticiones por ejercicio), ejercicios aeróbicos (correr) y una fase final de vuelta a la calma. El programa acuático (15 mujeres y 17 hombres, 35,3 ± 7,8 años se realizó en una piscina a 33º C**,** y consistió en 15 minutos de calentamiento, 40 minutos de ejercicios en la piscina (ejercicios aeróbicos: saltar, correr, correr en el sitio; ejercicios de amplitud activa del rango de movimiento de las articulaciones de los miembros superiores e inferiores; estiramientos de los músculos del tronco y extremidades; ejercicios de fuerza de flexión y extensión de caderas, aducción y abducción de caderas, flexo-extensión de rodillas; desplazamientos con piernas bicicleta ayudado de los brazos), y 5 minutos de vuelta a la calma. Ambos grupos obtuvieron mejoras significativas en todos los parámetros excepto en Schober test (flexibilidad), si bien los progresos en discapacidad y calidad de vida fueron mayores en el grupo de ejercicio acuático ($p < 0,001$).

Yozbatiran et al.[19] compararon un protocolo de fitness con uno de aquafitness durante 1 mes a 3 sesiones por semana. En ambos grupos (fitness: 13 mujeres y 2 hombres, 38,6 ± 6,6 años; aquafitness: 10 mujeres y 5 hombres, 39,6 ± 6,3 años) el programa de ejercicios consistió en un calentamiento con ejercicios básicos de estiramientos, 15 ejercicios progresivos de fuerza en circuito y una fase final de vuelta a la calma (estiramientos y ejercicios aeróbicos suaves), de acuerdo con el programa propuesto por Frost et al.[20]. Los autores indicaron mejoras significativas ($p < 0,05$) en ambos grupos en intensidad del dolor (VAS), discapacidad (OLBDQ), fuerza isométrica de los extensores del tronco (Sorensen test), resistencia aeróbica (12 min walking test), equilibrio con ojos cerrados (single leg balance), flexibilidad (sit and reach test) y en fuerza-resistencia de los flexores de tronco (dynamic sit up test). El índice de masa corporal (IMC) mejoró sólo en el grupo de fitness ($p = 0,027$), mientras que el grupo de aquafitness no obtuvo ninguna mejora ($p = 0,293$). El porcentaje de grasa corporal sufrió un ligero descenso en ambos grupos, pero no alcanzó significación estadística. No hubo diferencias significativas entre ambos grupos.

Saggini et al.[21] realizaron un estudio a sujetos con dolor crónico lumbar asociado a lesiones discales, donde compararon dos protocolos de tratamiento 3 veces por semana durante 7 semanas. El protocolo de rehabilitación acuática (12 mujeres y 8 hombres, edad media 43,8 años, rango 28-50 años) consistió en tres fases: una primera centrada en corrección postural basada en el trabajo de la musculatura del tronco; una segunda fase centrada en aumentar el rango de movimiento y el número de actividades sin dolor; y una tercera fase basada en ejercicios de resistencia muscular y control postural dinámico. El otro protocolo de tratamiento (13 mujeres y 7 hombres, edad media 42,7 años, rango 29-50 años) consistió en ejercicios en descarga con un sistema mecánico de descompresión que se realizó en otras tres fases: una primera fase basada en 20 minutos de descarga, 40 minutos de ejercicios de estiramientos; una segunda fase que consistió en 20 minutos de descarga, 20 minutos de ejercicios de estiramientos y 20 minutos de ejercicios isocinéticos del tronco con el instrumento de Moflex; la tercera fase consistió en 30 minutos de descarga, 15 minutos de ejercicios de estiramientos y 15 minutos de ejercicios isocinéticos del tronco con el instrumento de Moflex. Ambos tratamientos produjeron mejoras significativas en dolor (VAS, $p < 0,01$), un incremento en valores de Backill scale ($p < 0,01$) y una disminución en la toma de medicamentos (cuestionario sobre uso de analgésicos y antiinflamatorios no esteroideos, $p < 0,01$). Como particularidad, el grupo que realizó el programa de descarga mantuvo las mejoras con respecto al grupo de rehabilitación acuática un año después del tratamiento.

Ariyoshi et al.[22] estudiaron a 25 mujeres y 10 hombres con una media de edad de 49 años (rango 23-72) y un IMC de 22,6 ± 2,3. Todos los participantes se ejercitaron en medio acuático, con una frecuencia de 1 vez a la semana para 7 participantes, 2 veces a la semana para 19 participantes, y 3 o más veces a la semana para el resto. El programa consistió en ejercicios de fuerza de abdominales, glúteos y miembros inferiores, estiramientos de la musculatura de la espalda, isquiotibiales y gemelos, y ejercicios aeróbicos como caminar bajo el agua y nadar. Los autores indicaron -a través de un cuestionario- mejoras significativas en parámetros de condición física y psicológica, sólo en aquellos sujetos que realizaron la actividad con una frecuencia de 2 o más días a la semana. No obtuvieron mejoras significativas en IMC.

Mc Ilveen et al.[23] emplearon personas con dolor lumbar y dolor en miembros inferiores, divididos en dos grupos: un grupo experimental (hidroterapia) formado por 28 mujeres y 17 hombres, con una media de edad de 57,2 ± 15,2 años, y un grupo control (sin tratamiento) de 29 mujeres y 21 hombres, con una media de edad de 58,4 ± 15,0 años. El grupo de hidroterapia realizó 2 sesiones semanales de 60 minutos, durante 4 semanas, basadas en 20 ejercicios de espalda de movilidad articular y suave resistencia, con 10 repeticiones por ejercicio. Los resultados mostraron mejoras significativas en discapacidad (OLBDQ $p < 0,05$) en el grupo experimental, sin diferencias entre grupos en dolor (Mc Gill Pain Questionnaire), reflejos tendinosos (cuadriceps, isquiotibiales y gemelos), grado de fuerza en flexión de cadera, extensión de rodilla, dorsi-flexión y eversión del tobillo y extensores de los dedos de cada pierna, evaluada mediante resistencia manual de un fisioterapeuta (Oxford rating scale de 0 a 5). Tampoco hubo diferencias en rango de movimiento en flexión y extensión lumbar (Schober test modificado), elevación pasiva del miembro inferior estirado (goniómetro), y sensibilidad cutánea a la palpación (regiones comprendidas desde L1 a S2).

Sjogren et al.[24] realizaron un estudio con un grupo de 21 mujeres y 9 hombres, de edad media 58,1 años (rango 26-78), que realizaron ejercicio en agua, y otro grupo de 22 mujeres y 8 hombres de 57,4 años (rango 29-80) que se ejercitaron en tierra, 2 veces por semana, 50 minutos por sesión, durante 6 semanas. El programa de ejercicios fue el mismo para ambos grupos, centrados en aumentar el rango de movilidad articular del tronco, ejercicios de fuerza general y resistencia cardiorrespiratoria. Ambos grupos obtuvieron mejoras significativas en discapacidad (OLBDQ, $p = 0,03$) y disminución del dolor (VAS, $p = 0,001$), sin diferencias entre los dos tipos de tratamiento. En el walking test (100 m andando a la máxima velocidad posible) hubo una disminución en el tiempo ($p = 0,0005$) para ambos grupos, de nuevo sin diferencias entre grupos. No hubo mejoras significativas en movilidad articular del tronco (Schober test modificado, $p = 0,16$), y se produjo un leve descenso en la toma de medicamentos (antiinflamatorios y antidepresivos) en cuanto a la dosis y potencia del fármaco.

Smit et al.[25] estudiaron a 17 mujeres y 3 hombres de 59 ± 14,3 años con diagnóstico de espondilosis, que realizaron tratamiento individualizado de ejercicio en agua, 3 veces a la semana de 20 minutos la primera semana, 25 minutos la segunda y 30 minutos la tercera y cuarta semanas, durante un total de 4 semanas. El programa de ejercicios se adaptó a las características de cada paciente y estuvo centrado en aumentar el rango de movilidad articular del tronco y ejercicios de fuerza general, donde se realizaron de 3 a 10 repeticiones por ejercicio. Tras la intervención se produjeron mejoras significativas en intensidad del dolor (VAS, $p < 0,05$) y rango de movilidad de tronco: flexión ($p < 0,05$), extensión ($p = 0,001$), inclinación lateral izquierda ($p = 0,001$) e inclinación lateral derecha ($p < 0,05$). El 77% de los pacientes indicó encontrarse mejor o mucho mejor tres meses después del tratamiento acuático, a través de un cuestionario para evaluar dolor, dosis de medicación y aspectos sobre la vida diaria (caminar, estar sentados o de pie, limpieza del hogar, etc.).

Discusión

Entre enero de 1990 y febrero de 2011, empleando 2 bases de datos (SportDiscus, PubMed) y numerosas palabras clave, nuestro equipo de investigación identificó sólo 7 estudios científicos que analizan la utilización de ejercicio acuático como terapia física en el tratamiento del dolor lumbar crónico, lo que indica que aún existe poca evidencia científica acerca de la eficacia terapéutica de este recurso.

Actualmente la línea de tratamiento marcada para los pacientes con dolor lumbar crónico recomienda terapia física para la mejora del dolor y la discapacidad [6-8,26], dos de las principales causas asociadas a las bajas laborales y que ocasionan una disminución en la calidad de vida de los pacientes. Los programas de actividad física orientados a la mejora de la fuerza muscular, resistencia cardiorrespiratoria y la flexibilidad para la estabilización de los músculos de la columna, son recomendados en el tratamiento con terapia física de pacientes con dolor lumbar crónico[13,15,18]. Sin embargo, no se puede obviar la carga que supone para la columna la realización de ejercicio fuera del medio acuático[27].

Es conocido que el ejercicio en el medio acuático puede ser una terapia efectiva y útil especialmente en pacientes con multitud de patologías (artrosis, dolor crónico, etc.)[14], con dificultades para realizar ejercicio físico fuera del medio acuático[28], y como una alternativa para la mejora de la condición física, especialmente en personas con bajo nivel de actividad física[29,30].

En el medio acuático los ejercicios aeróbicos resultan para el paciente menos dolorosos que el trabajo en tierra, y por tanto pueden ser más apropiados para el individuo con baja condición física, sobrepeso, dolor, discapacidad o de cierta edad, debido a que el efecto de la fuerza de la gravedad sobre el cuerpo es menor[31]. Como consecuencia, dado que la tolerancia al ejercicio es mayor y que el agua tiene mayor densidad que el aire[32], los pacientes suelen ejercitarse por más tiempo, contribuyendo a un incremento del gasto energético[33] y a mayores aumentos en los parámetros relacionados con la condición física, que en periodos de trabajo de menor duración[34-36]. Los movimientos en el agua son similares a los movimientos en tierra, por lo que la actividad física en el medio acuático, además de los propios beneficios del ejercicio físico, posee otras características que la diferencian con respecto a la actividad física en tierra[29,30], aportando un gran número de ventajas específicas para el tratamiento de multitud de patologías, entre ellas el dolor crónico lumbar. El agua es un medio de compensación, donde por su naturaleza, se minimiza la acción de la gravedad, reduciendo la compresión de las fuerzas verticales articulares, proporcionando un ambiente más beneficioso para realizar ejercicio en pacientes con dolor lumbar crónico que el ejercicio en tierra [30,37].

Fortalezas y limitaciones del estudio

El presente estudio supone la primera revisión sobre la utilización de la actividad física acuática en el tratamiento del dolor lumbar crónico en lengua española publicada hasta el momento, y permite acercar los últimos avances sobre esta reciente línea de investigación a la población hispanoparlante. Al tratarse de una revisión sistemática, cuenta con la ventaja de su replicabilidad. Sin embargo, una de las limitaciones de los estudios llevados a cabo en este campo, y por lo tanto de la revisión que se presenta, es la heterogeneidad de las metodologías utilizadas (metodologías de evaluación, número de sesiones semanales, presencia o no de grupo control, y programas de ejercicios), lo que dificulta las comparaciones entre los estudios y la valoración de sus resultados. La cautela es, pues, especialmente necesaria al comparar resultados, dada la gran variedad de métodos utilizados en el medio acuático para el tratamiento del dolor lumbar crónico. Futuros trabajos en esta línea deberán tener en cuenta estos aspectos.

Algunos criterios de selección fueron comunes en los estudios aquí presentados. Aún así, pudo existir algún sesgo de selección debido a las diferencias en la elegibilidad para la participación en los distintos estudios. El sesgo de publicación puede ser considerado también una limitación. Aunque centramos la búsqueda en artículos de lengua inglesa, no encontramos artículos publicados en otras lenguas. Tampoco llevamos nuestro análisis al contraste con sociedades científicas o especialistas en la materia.

Conclusión

En base a la literatura revisada, es posible sugerir la idoneidad del ejercicio físico acuático como terapia física apropiada para personas con dolor lumbar crónico. Sin embargo, existen pocos estudios que hayan examinado los efectos conjuntos del medio acuático en personas con dolor lumbar crónico y su influencia en la discapacidad y calidad de vida relacionada con la salud. Una mayor evidencia científica, en base a nuevos estudios de riguroso carácter metodológico, se antojan por tanto necesarios para poder prescribir programas de ejercicio más específicos en cuanto a frecuencia, intensidad y volumen de trabajo, con los que dar cobertura terapéutica a este problema de gran prevalencia en la población adulta y de tan alto coste económico por las bajas laborales asociadas.

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Tabla 1 Estudios sobre actividad física acuática y dolor lumbar crónico (enero 1990 – febrero 2011).

Autor (año)	Participantes	Intervención en Medio Acuático	Test/Cuestionarios	Principales resultados
Dundar et al.[18] (2009)	Total n = 65 Ejercicio acuático n = 32 Ejercicio en tierra n = 33 No Grupo Control	Fuerza muscular Resistencia cardiorrespiratoria Flexibilidad 4 sem, 5x60 min/sem	VAS OLBDQ modificado SF-36 Schober test Spinal mobility (goniómetro e inclinómetro)	Ambos grupos obtuvieron mejoras significativas en todos los parámetros excepto en Schober test. El grupo de ejercicio acuático obtuvo mayores ganancias en OLBDQ modificado y SF-36.
Yozbatiran et al.[19] (2004)	Total n = 30 Ejercicio acuático n = 15 Ejercicio en tierra n = 15 No Grupo Control	Fitness Acuático formado por 15 ejercicios progresivos: Flexibilidad Resistencia cardiorrespiratoria 4 sem, 3 s/sem	VAS OLBDQ Sorensen test 12 min walk test Single leg balance Sit and reach Dynamic sit up test Antropometría (IMC, % grasa, RCC)	Sin diferencias entre grupos tras la intervención. Ambos mejoraron en todos los parámetros excepto en IMC (sólo mejoró en el grupo de ejercicio en tierra). Aunque hubo una disminución en % grasa en ambos grupos, no fue significativa. El RCC no se modificó en ningún grupo.
Saggini et al.[21] (2004)	Total n = 40 Ejercicio acuático n = 20 Otro tratamiento n = 20 No Grupo Control	Tres estadios progresivos de programa acuático 7 sem, 3 s/sem	VAS Backill scale Medicación (analgésicos y AINES)	Ambos grupos mejoraron en VAS y Backill scale y redujeron significativamente la toma de medicamentos, pero sin diferencias entre grupos.
Ariyoshi et al.[22] (1999)	Total n = 35 Ejercicio acuático n = 35 No Grupo Control	Fuerza muscular Flexibilidad Resistencia cardiorrespiratoria 6 meses 1 s/sem para 7 participantes 2 s/sem para 19 participantes ≥ 3 s/sem para 9 participantes	Cuestionarios sobre condición física y psicológica IMC	Obtuvieron mejoras significativas en parámetros relacionados con la condición física y psicológica sólo en aquellos que realizaron 2 o más sesiones a la semana. No hubo diferencias significativas en IMC.

min: minutos; sem: semanas; s: sesiones; VAS: Visual Analog Scale; OLBDQ: Oswestry Low Back Disability Questionnaire; SF-36: Quality Short-Form Health Survey 36; IMC: Indice Masa Corporal; RCC: Ratio Cintura-Cadera; AINES: Antiinflamatorios no esteroideos.

Tabla 1 (continuación)

Autor (año)	Participantes	Intervención en Medio Acuático	Test/Cuestionarios	Principales resultados
Mc Ilveen et al.[23] (1998)	Total n = 95 Ejercicio acuático n = 45 Grupo Control n = 50	Fuerza muscular Flexibilidad Resistencia cardiorrespiratoria 4 sem, 2x60 min/sem	Schober test modificado Passive straight leg raise (goniómetro) Reflejos tendinosos Oxford rating scale (fuerza) Mc Gill Pain Questionnaire Sensibilidad cutánea a la palpación OLBDQ IMC	Mejoras significativas en OLBDQ en el grupo de ejercicio acuático. No obtuvieron mejoras significativas en ningún otro parámetro.
Sjogren et al.[24] (1997)	Total n = 60 Ejercicio acuático n = 30 Ejercicio en tierra n = 30 Grupo Control = 60 (los mismos sujetos 3 semanas antes del tratamiento)	Flexibilidad Fuerza muscular Resistencia cardiorrespiratoria 6 sem, 2x50 min/sem	Schober test modificado VAS OLBDQ Walking Test Medicación (antiinflamatorios y antidepresivos)	Ambas intervenciones mejoraron en VAS, OLBDQ, Walking test y un descenso en la toma de medicamentos sin diferencias significativas entre los grupos. No obtuvieron mejoras significativas en Schober test modificado.
Smit et al.[25] (1991)	Total n = 20 Ejercicio acuático n = 20 No Grupo Control	Flexibilidad Fuerza muscular 4 sem, 3x 20-30 min/sem	Movilidad toraco-lumbar VAS Cuestionario	Obtuvieron mejoras significativas en movilidad toracolumbar (flexión, extensión, inclinación lateral derecha e izquierda de tronco) y en VAS. Indican mejoras en aspectos relacionados con la calidad de vida.

min: minutos; sem: semanas; s: sesiones; VAS: Visual Analog Scale; OLBDQ: Oswestry Low Back Disability Questionnaire; SF-36: Quality Short-Form Health Survey 36; IMC: Indice Masa Corporal; RCC: Ratio Cintura-Cadera; AINES: Antiinflamatorios no esteroideos.

Figura 1. Relación de la Condición Física y el Sobrepeso con el Dolor, Discapacidad y la Calidad de Vida relacionada con la Salud (CVRS).

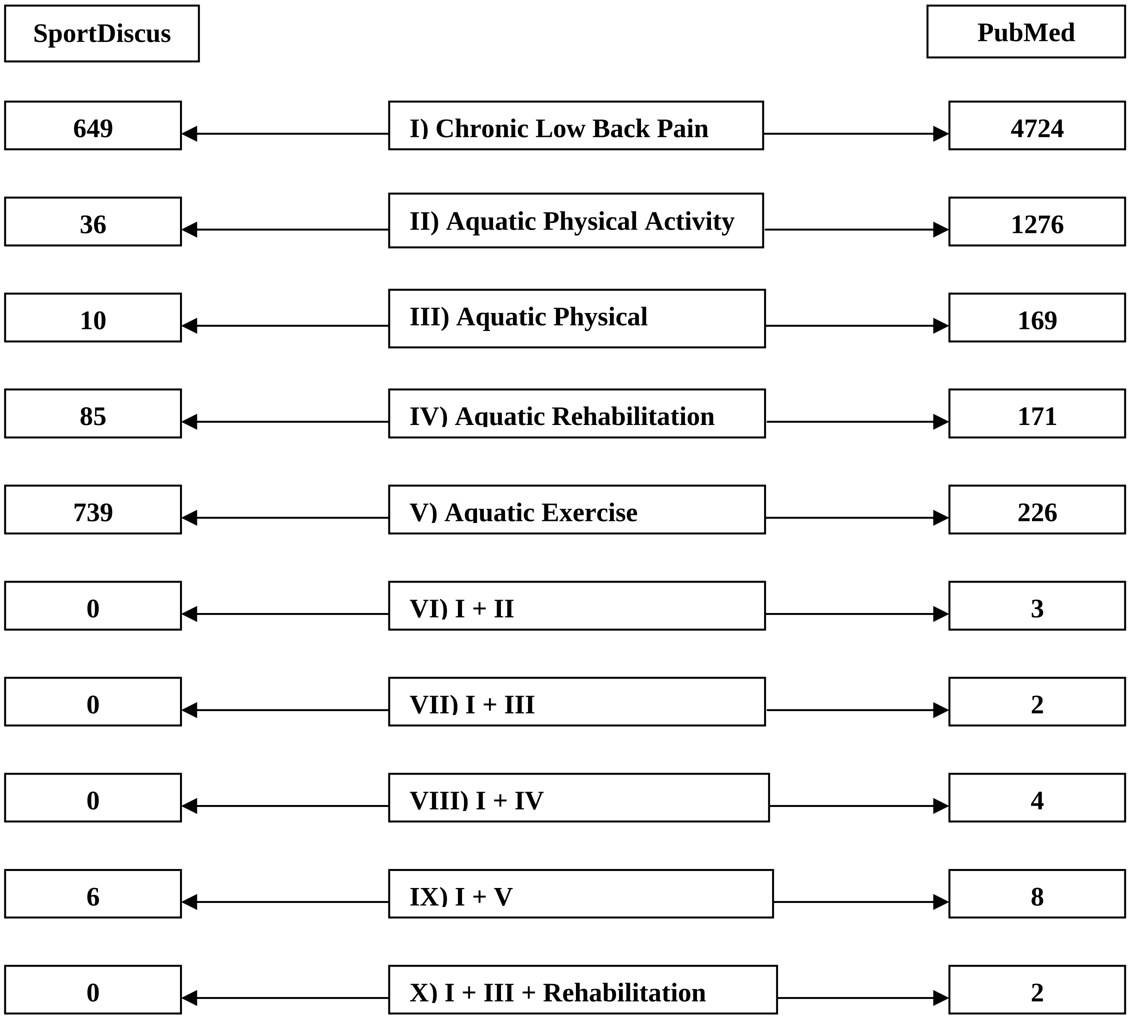

Figura 2: Número de artículos científicos encontrados en cada base de datos (SportDiscus o MEDLINE/PubMed) en base a las palabras clave empleadas (I-V) o combinación de las mismas (VI-X).

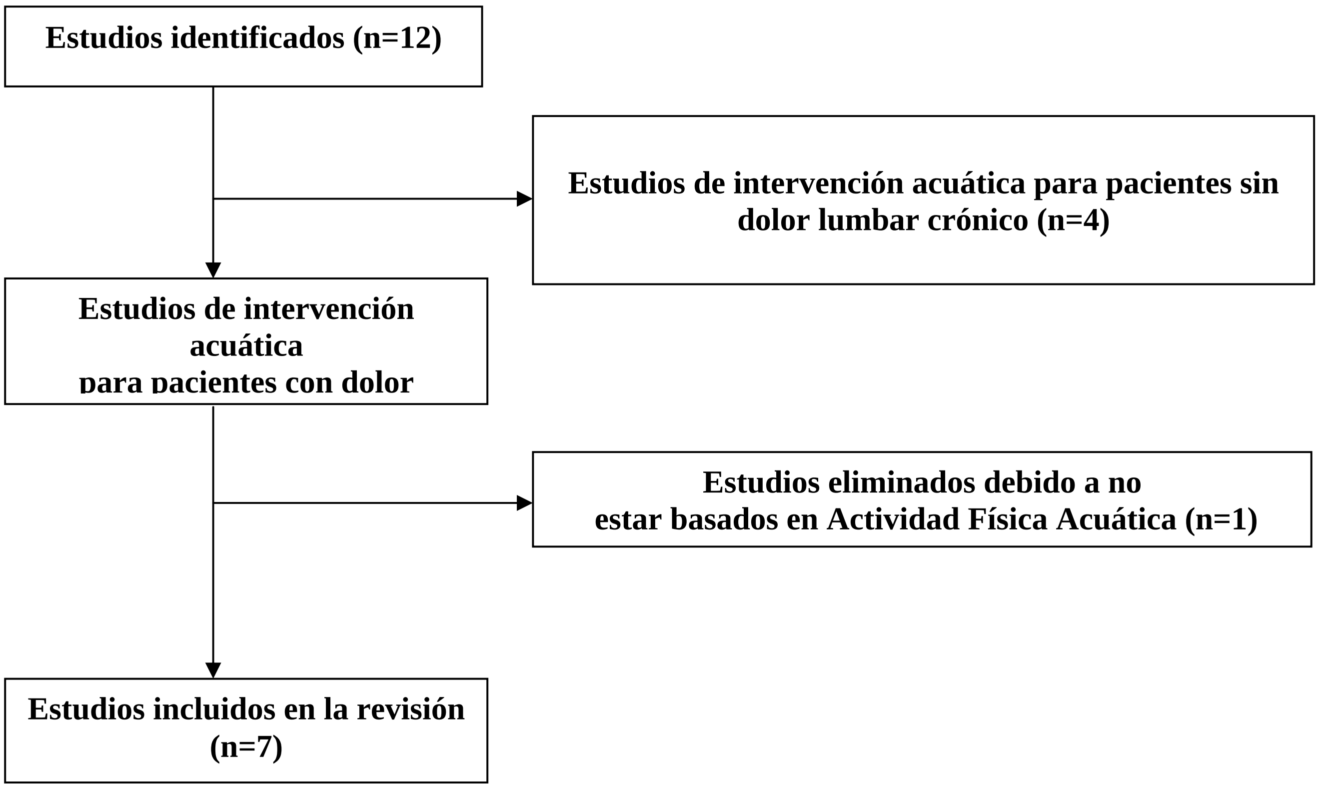

Figura 3. Proceso de selección de los estudios (revisión sistemática de artículos publicados entre enero de 1990 y febrero de 2011).

2. EFECTO DE UN PROGRAMA DE EJERCICIO FÍSICO ACUÁTICO SOBRE EL GRADO DE DOLOR, CAPACIDAD FUNCIONAL, CALIDAD DE VIDA RELACIONADA CON LA SALUD, COMPOSICIÓN CORPORAL Y PARÁMETROS DE CONDICIÓN FÍSICA EN SUJETOS ADULTOS SEDENTARIOS CON DOLOR LUMBAR CRÓNICO.

(Artículos II, III, IV)

2.1. AQUATIC THERAPY IMPROVES PAIN, DISABILITY, QUALITY OF LIFE, BODY COMPOSITION AND FITNESS IN SEDENTARY ADULTS WITH CHRONIC LOW BACK PAIN.

Baena-Beato PA, Artero EG, Arroyo-Morales M, Robles-Fuentes A, Gatto-Cardia MC, Delgado-Fernández M.

(Artículo II)

Aquatic therapy improves pain, disability, quality of life, body composition and fitness in sedentary adults with chronic low back pain

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Conflicts of interest: none

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ABSTRACT

Background. Low levels of physical fitness are associated with back pain and disability, generating a reduced quality of life (QoL). There are evidences that exercise can decrease pain, disability, time off work in patients with chronic low back pain (CLBP).

Aim. To determine the effects of a 2-month aquatic therapy program (ATP) on back pain, disability, QoL (primary outcomes), body composition and health-related fitness (secondary outcomes) in sedentary adults with CLBP.

Design. This was a pragmatic controlled trial.

Setting. Community.

Population. Forty-nine sedentary patients with CLBP were enrolled.

Methods: Patients were allocated into ATP group (n = 24, 2 months, five times/week) or usual care group (n = 25). The outcomes variables were pain (visual analog scale), disability (Oswestry disability index) and QoL (quality short-form health survey), body composition (weight, body mass index, body fat mass, body fat percentage and skeletal muscle mass) and health-related fitness (sit and reach, handgrip strength, curl-up, Rockport 1-mile test and resting heart rate).

Results: ATP group significantly improved low back pain and disability ($p < 0.001$). In QoL domains, there was a significant effect on Physical Role ($p < 0.05$), Bodily Pain, General Health, Standardized Physical Component ($p < 0.001$), and Vitality ($p = 0.001$). In relation with body composition and fitness, ATP group showed significant improvements (all p values < 0.01). Usual care group presented no significant change in any parameter.

Conclusions: A 2-month ATP of high frequency (five times/week) decreases levels of back pain and disability, increases QoL, and improves body composition and health-related fitness, in sedentary adults with CLBP.

Clinical rehabilitation impact: A short duration and high frequency ATP seems to be a powerful tool for the management of CLBP.

Key words: Aquatic Therapy Program, Chronic Low Back Pain, Disability, Quality of Life, Fitness.

Introduction

The high prevalence and significant economic costs of low back pain make critical the establishment of cost-effective management strategies and community-based approaches, to help individuals prolong function, minimize pain, and maintain quality of life (QoL).[1] Low levels of physical fitness are associated with back pain and disability, generating a reduced QoL in patients with low back pain.[2,3] There are evidences that exercise can decrease pain, disability, time off work, and increase QoL in patients with chronic low back pain (CLBP).[4,5] Physical treatments are based on the assumption that increased muscle strength, aerobic capacity and flexibility are crucial for the resumption of activities, and hence for the restoration of functional abilities.[6]

Many types of physical treatment are recommended for the management of pain and disability in patients with CLBP as non-invasive non-pharmacological treatments.[7-9] Among them, aquatic exercise is of particular interest because the unique properties of water (floatability, resistance, and temperature) reduce stress in joints and decrease axial loading of the spine.[10] Moreover, continuous limb movements against the water resistance result in muscle strength[11] and cardiovascular benefits,[12] and general physical condition improvements[13,14] especially in individuals with low levels of physical fitness.[15,16] The aquatic environment enables the participant to perform movements that are normally difficult or impossible on land.[17] These findings suggest the potential benefits of aquatic exercise for people with CLBP.

Several studies indicate that therapeutic aquatic exercise can be a safe and effective treatment modality for patients with CLBP.[14,18-21] However, there is limited evidence about the expected greater benefits of intensive aquatic exercise programs. Only one study, using sessions of higher duration,[22] suggested additional benefits in the treatment of pain, disability, and QoL in CLBP.[23,24]

Thus, although it appears that therapeutic aquatic exercise may be a suitable exercise modality for sedentary adults with CLBP, little is known about the effects a more intensive aquatic exercise programs. The aim of this study was to assess the effects of a 2-month aquatic therapy program (ATP), with five sessions per week, on back pain, disability, QoL, body composition and health-related fitness in sedentary adults with CLBP.

Materials and methods

Subject populations

A total of 56 participants signed up for ATP, all recruited in Massam Sport Center (Granada, Spain), this contact followed their referral for hydrotherapy by their medical practitioner or physiotherapist, and received written and oral instructions about the intervention, test protocol and the possible risks and benefits of the study. The inclusion criteria for this study were: age between 18 and 65 years, and presence of self-reported low back pain for more than 12 weeks;[25] exclusion criteria were: symptoms or signs that might suggest serious medical illness, pregnancy or recent childbirth, major rheumatologic, neurologic, neoplastic, or other conditions that may prevent full participation in the intervention, previous spinal surgery, inflammatory, infectious, or malignant diseases of the vertebra, presence of severe cardiovascular disease, presence of any psychiatric disorder which might affect the compliance and the assessment of symptoms, and engagement in physical activity ≥ 60 minutes per week during the last 12 months.[26]

A total of seven patients were not included in the study (five not meeting inclusion criteria and two refused to participate). A final sample of 49 patients with CLBP completed all requirements of this study. The study flow of patients is presented in figure 1. The sociodemographic characteristics of participants in the intervention and usual care groups are shown in table I.

Study design

The present study was a pragmatic, parallel group, controlled trial with allocation of participants into the intervention (n = 24, ATP group) or waiting list (n = 25, Control Group: CG), according to order of arrival and time availability, as our sport centre only accepts 8 subjects per group in a total of 3 groups of aquatic exercise therapy. For practical and ethical reasons, it was not possible to randomise the patients. We had an ethical obligation with the Massam Sport Center to provide treatment to all patients willing to participate in the study, but due to limitation of resources we created a waiting list. Patients from the waiting list agreed to be part of the usual care group (CG) and were offered the intervention program at the end of the follow-up period. For those subjects in the waiting list, data collected only during the control period were included in the current analysis.

Throughout the study, all participants (including those in the CG) were encouraged to maintain their normal dietary habits and physical activity level. Written informed consent was obtained before participation. The study was approved by the Ethical Committee of the University of Granada and was performed in accordance with the Helsinki Declaration.

Intervention program

The 2-month ATP consisted of 40 sessions 5 days per week (see Table II), and no exercise sessions in CG. The ATP was carried out in an indoor pool sized 25 x 6 m, with 140 cm water depth, 29 ± 1 ºC of water temperature, and 32 ºC of room temperature. Before ATP, participants took part in one session of exercises with no external resistance to familiarize with the movements in the aquatic environment and with the flotation material. During this session, the participants also familiarized themselves with the use of the rating of perceived exertion (RPE) scale from 6 to 20, exercising at different intensities.[27] The aim was to use this scale during the 8 weeks to control the intensity of the aerobic exercises.

Participants were asked not to change their medication during the 2-month intervention period.

Aquatic Therapy Program

Each aquatic therapy session was conducted in reduced groups of 8 participants and lasted 55-60 minutes. They were closely supervised by trained exercise specialists and a physiotherapist. Each session included 10 minutes of warm-up, 15-20 minutes of resistance exercise, 20-25 minutes of aerobic exercise, and 10 minutes of cool-down (stretching exercises).

Resistance exercises

The resistance exercises progressed throughout the program by changing the number of repetitions per set (volume), by including specific resistance material that increase the resistance offered by the water, and by increasing the velocity of the movements.[12] Noodles and cuff devices were used for upper-body and lower-body exercises, respectively. Each training session included the following resistance exercises: hip flexion-extension, hip abduction-adduction, arms abduction-adduction at chest level, curl-ups, scissors leg, backstroke kick with water noodle under the waist.

Aerobic exercises

The planning of the aerobic exercises was done considering the intensity (Borg scale 6 to 20) and the volume (minutes). The aerobic exercises incorporated large muscle mass and consisted of lateral displacements, long-lever pendulum-like movements of the extremities, forward and backward jogging with arms pushing, pulling, and pressing, leaps, kicks, leg crossovers and hopping movements focusing on travelling in multiple directions, and bounding off the bottom of the pool.

Flexibility exercises

Lower-body stretching exercises were performed at the end of each session, as part of the cool-down. The muscle groups to stretch were gluteus, lumbar back and hamstrings. A static stretching technique was used, where the posture was achieved in 5 seconds, maintained during 20 seconds in its maximum amplitude without pain, and 5 seconds to go back to the initial posture, repeated 3 times per exercise.[28]

Outcome measures

After agreeing to participate and completing the informed consent form, all participants attended two initial measurement sessions, where back pain, disability, QoL, body composition and health-related fitness were measured. Assessment sessions were carried out prior to the start and immediately after the exercise therapy intervention. All testing sessions were conducted by the same researcher.

Testing took place in laboratory conditions at 24ºC temperature in two sessions. In the first day participants were evaluated for (in this order) body composition, sit and reach test, handgrip strength and curl-up test. In the second day, the questionnaires Quality Short-Form Health Survey 36 (SF-36), Oswestry low back pain disability questionnaire (Oswestry Disability Index, ODI) and visual analogue scale (VAS), as well as the Rockport 1-mile test, were administered. Resting heart rate was also measured.

Back Pain (primary outcome)

Back pain was assessed at rest and during movement (flexion and extension) using a VAS, ranging from 0 to 10 cm (0 means no pain, 10 means highest level of pain). The reliability and validity of VAS has been found to be acceptable,[29] and the minimal clinical important change is considered 15 mm in patients with low back pain.[30]

Low back pain disability (primary outcome)

The Spanish version of the Oswestry low back pain disability questionnaire[31] was used to measure back-related disability of activities of daily living. The Oswestry low back pain disability questionnaire is comprised of 10 questions about pain and pain-related disability in activities of daily life and social participation. The sum of the response scores was calculated and presented as a percentage, where 0 % represents no pain or disability and 100 % represents the worst possible pain and disability. The reliability and validity of the Spanish version of the Oswestry low back pain disability questionnaire has been found to be acceptable,[31] and the minimal clinical important change is considered 10 % in patients with low back pain.[30]

Quality of life (primary outcome)

The Quality Short-Form Health Survey 36 is a generic instrument assessing health related QoL. In this study we used the Spanish version of SF-36. [32] It contains 36 items and yields 8 domains (parameters): physical functioning, physical role, bodily pain, general health, vitality, social functioning, emotional role and mental health. These 8 parameters can be used to derive 2 composite scoring summaries: physical composite summary (PCS: physical functioning, physical role, bodily pain and general health perceptions) and mental composite summary (MCS: vitality, social functioning, mental health and emotional role).The SF-36 is a sensitive measure of treatment success in patients with low back pain.[33] Each domain is scored on a scale from 0 (worst possible health) to 100 (best possible health).

Body composition (secondary outcome)

Body composition was measured using octapolar bioimpedance analyses (Biospace Inbody 720; Biospace Company, Ltd., Seoul, Korea). Biospace Inbody analyse has been found to be reliable in the calculation of body composition.[34] We measured weight (kg), body fat mass (kg), body fat percentage (%) and skeletal muscle mass (kg). Height (cm) was measured in the Frankfurt plane with a telescopic height measuring instrument (SECA 225; range, 60 to 200 cm; precision, 1 mm). Body mass index (BMI) was calculated (kg/m^2).

Health-related fitness (secondary outcome)

Lower-body flexibility

Trunk flexion and hamstring tone were determined via the sit and reach test, as described by the American College of Sports Medicine's (ACSM) protocol. [28] The test was performed twice, and the best result in centimetres was recorded. If the ruler was somewhere between two centimetres, the lower one was scored.

Abdominal muscular endurance

Abdominal muscular endurance was measured using the curl-up test.[28] The cadence for the test was 40 beats/min, paced by a metronome. The test was terminated when the subject was unable to maintain the required cadence or unable to maintain the proper curl-up technique for 2 consecutive repetitions despite feedback from the researcher. A maximum of 3 corrections were allowed by the appraiser before termination of the test. The highest number of repetitions completed while maintaining proper form was recorded.

Upper-body muscular strength (secondary outcome)

Upper body isometric strength was assessed by using handgrip strength test. A hand dynamometer with adjustable grip (TKK 5101 Grip D; Takey, Tokio Japan) was used. The patients squeezed gradually and continuously for at least two seconds, performing the test with the right and left hands in turn, with the elbow in full extension. The test was performed twice and the maximum score for each hand was recorded in kilograms. Optimal grip was noted for each participant in the pre-test, and repeated in the post-test. The sum of the scores achieved by left and right hands was used in the analysis.[35]

Cardiorespiratory fitness

Cardiorespiratory fitness was determined by using the Rockport 1-mile test. This test is recommended by the ACSM[28] to choose the level of practice in cardiovascular exercises for people with low fitness (sedentary). The time (minutes and seconds) employed by each participant to cover the distance, together with his/her heart rate at the end of the test, were registered. Maximal oxygen uptake (VO_2max) was estimated as described by Berger,[36] considering gender, age, weight, time and heart rate. The validity of Rockoport 1-mile test has been found to be acceptable.[37]

Resting heart rate

Patients were instructed in the procedure of measuring their pulse, and then were asked to register resting heart rate manually at home, from the carotid artery using a stopwatch. They registered resting heart rate in four non-consecutive days during pre- and post-test weeks: in the morning before getting up or after staying in prone position for at least 30 min. The average heart rate among the four measurements was used as resting heart rate before and after the intervention.

Statistical analysis

An independent t test and χ^2 – Pearson test were used to compare demographic variables between groups. One-way analysis of the covariance (ANCOVA) was used to compare participants' characteristics by groups, both at baseline (pre-test) and follow-up (post-test). In these models the outcome variables (back pain, disability, quality of life, body composition, or fitness) were entered as dependent variables, group was used as fixed factor, while age and gender were used as confounders. To analyze the effects of the ATP we used ANCOVA with post – pre differences as dependent variables, group as fixed factor, and age, gender and the baseline level of the variable as confounders. The analyses were not adjusted for the number of sessions actually performed, as the adherence to the intervention was very high: all participants performed at least 90 % (36 from a total of 40) of the sessions in ATP.

Data analyses were performed using PWSA statistical package version 18.0 (SPSS Inc., Chicago, IL, USA). Significance level was set at $p < 0.05$.

Results

Two participants from the ATP group discontinued the programme due to work commitments and personal problems, and another one was excluded for attending less than 90% of the programme (attendance: 78.4%). During the study period, three patients (12.0%) changed from the CG (waiting list) to the intervention group (not included in this analysis), and five patients (20.0%) did not attend the final assessment. Finally, a total of 21 (87.4%) patients from the intervention group and 17 (68.0%) from the usual care group completed both pre- and post intervention assessments and were included in the analysis (Figure 1). There were no statistically significant differences in the demographic features between groups (Table 1).

Back pain (VAS at rest, in flexion and extension) and disability (ODI) results are shown in table III. The ANCOVA with post – pre differences showed significant differences between groups in VAS and ODI ($p < 0.001$): ATP group presented a decrease in back pain (VAS) and disability (ODI).

The results related with QoL are given in table IV. The ANCOVA with post – pre differences showed significant differences between groups in Physical Role ($p < 0.05$), Bodily Pain ($p < 0.001$), General Health ($p < 0.001$), Vitality ($p = 0.001$) and Standardized Physical Component ($p < 0.001$). No significant differences were observed in Physical Functioning, Social Functioning, Emotional Role, Mental Health or Standardized Mental Component.

Intervention effects on body composition are displayed in table V. Post – pre differences were significantly different between groups in weight, BMI, body fat mass, and body fat percentage (all p values < 0.01): ATP group presented a decrease in all these body composition parameters. Skeletal muscle mass lightly increased in the ATP group, with a p value between groups very close to be significant ($p = 0.056$).

Results on health-related fitness are shown in table VI. We observed significant post-pre differences ($p < 0.001$) between groups in sit and reach, curl-up, handgrip, VO_{2max} and resting heart rate: ATP group improved all fitness parameters after the intervention.

Discussion

The present study shows that a 2-month ATP is well tolerated by sedentary adults with CLBP. We observed that back pain and disability decreased in the intervention group beyond the minimal clinical change accepted in patients with low back pain.[30] We also observed an increase in many domains of health-related QoL in the ATP group. These changes were accompanied by improvements in body composition and fitness, suggesting a possible mechanism by which aquatic exercise could be effective for the management of CLBP.

Effect of ATP on back pain and disability

We observed significant improvements in back pain levels of 62% from baseline in VAS at rest, 75% in VAS at flexion, and 77% in extension, as well as a decrease of 44% in disability. This concurs with the results observed by Dundar et al.,[22] who studied 65 patients with CLBP, allocated to either aquatic therapy group (n = 32, 15 women and 17 men) or land therapy group (n = 33, 16 women and 17 men). Aquatic therapy group achieved a total of 20 sessions of 60 minutes, 5 per week during 4 weeks. The aquatic program consisted of resistance, aerobic and flexibility exercises, similarly to our intervention. At the end of the study, patients improved back pain and disability, although they did not have control group to compare with. Similarly, Yozbatiran et al.[14] observed a reduction in back pain and disability after an aquatic program of 3 days per week during 4 weeks, and Mc Ilveen et al.[19] observed a reduction in disability after a program of 2 days per week for 4 weeks. Saggini et al.[21] also reported a reduction in back pain using a 7-week aquatic program with 3 days per week. Sjogren et al.[18] used aquatic and land-based treatments during 6 weeks, 2 x 50 minutes per week, with resistance, aerobic and flexibility exercises. Both groups improved in disability and decreased pain levels, with no differences between the 2 types of treatment. Because of this heterogeneity, no standard guidelines exist for aquatic exercises in CLBP, particularly regarding number of sessions and duration. In our study, patients received a more intensive program, as ATP consisted of 40 sessions, 5 times per week during 2 months, each session lasting 60 minutes.

A possible mechanism to explain the improvements in back pain and disability could be that hydrotherapy provides the optimal environment for patients to exercise aerobically, and at higher intensities than would be possible on land. More intensive aquatic exercise programs with a higher frequency and duration of sessions, may have a greater effect on the treatment of back pain and disability in CLBP.

Effect of ATP on QoL

We observed a significant improvement in parameters of the SF-36 (Physical Role, Bodily Pain, General Health, Vitality and Standardized Physical Component), which concurs with the results observed by Dundar et al. [22] They observed an increase in all parameters of QoL after four weeks of aquatic therapy. We did not observe improvement in certain dimensions such as Physical Functioning, Social Functioning, Emotional Role, Mental Health and Standardized Mental Component, what could be related to the fact that we did not intervene on psychosocial aspects. Landgridge et al.[39] and Smit et al.[40] did record an improvement in QoL after strength exercises and spinal movements in the hydrotherapy sessions, but in their study no specific QoL measurements were taken and they did not have control group. Our improvements in QoL could be possibly explained by the decrease in pain and disability,[41] and the improvement in health-related fitness.

Effect of ATP on body composition

We observed significant improvements in weight, BMI, body fat mass and body fat percentage. Skeletal muscle mass showed a slight improvement although not statically significant. The results of Yozbatiran et al.[14] showed a very slight decrease in body fat after 4 weeks, maybe because the aquatic program was mainly based on strength exercises rather than aerobic exercise. In our study, body composition was monitored to provide an indicator of the training program's effectiveness, and also because some authors have suggested a relationship between CLBP and obesity.[42] In our study, ATP included 20-25 minutes of aerobic exercise 5 days per week during 8 weeks, which -combined with resistance exercises- seemed to be sufficient to improve body composition.

Effect of ATP on health-related fitness

Lower-body flexibility

We observed a significant improvement in lower-body flexibility, as it happened to Yozbatiran et al.[14] after a program of 3 days per week during 4 weeks. Smit et al.[40] also reported a significant improvement in thoracolumbar mobility: flexion, extension, left side flexion, and right side flexion ($p < 0.05$), after a hydrotherapy program of 3 individual sessions per week for a period of 4 weeks. It was not the case of Sjogren et al.,[18] who conducted treatments twice a week for a period of six weeks.

The posterior hip muscles are active in controlling the forward tilting of the pelvis as the spine is flexed. Flexibility of these muscles allows the smooth motion of the pelvis and lumbar spine, which is the reason why stretching of these muscles is recommended.[20] Stretching exercise can be used to eliminate impaired flexibility and restore normal trunk range of motion in patients with CLBP.[43] In our study, a higher intensity and time were devoted to flexibility exercises (3 sets of 20 seconds per muscle group) compared with other studies, following the ACSM's recommendations.[28] It could also helped the fact that floatability reduces joint compressive forces and increases range of movement and muscle length.[44]

Abdominal muscular endurance and upper body isometric strength

Abdominal muscular endurance and upper body isometric strength are strongly correlated with functional ability, a strong predictor of disability.[45] The improvements in our study are in agreement with those by Ariyoshi et al.,[20] who treated 35 patients with aquatic exercises for more than 6 months. The frequency was once a week for 7 patients, twice a week for 19, and 3 or more times a week for the remaining patients. Those patients who exercised twice or more in a week showed a higher improvement in the physical score that those who exercised only once a week. More than 90% of the patients felt they had improved after 6 months of participation in the program. However, they did not have control group and all assessments used questionnaires.

Abdominal muscular endurance is suggested to be reduced in patients with CLBP,[46] since weakened abdominal muscles cannot maintain normal inclination of the pelvis, which increases lordosis of the lumbar spine.[20] We observed a significant improvement in abdominal muscular endurance in the intervention group, which may be explained because one of the principles of abdominal exercise develop in water is their ability to proximal muscle activation, providing interactive moments that would allow efficient distal muscle function.[47]

Upper body isometric strength was also improved after the intervention. Dumbbell- and barbell-type as well as leg pads were used to perform upper and lower body resistance training, so that the patient needed to apply more propelling force to execute the required movements, and consequently to overcome the resistance imposed by the water.

Cardiorespiratory fitness

Our results indicated an improvement in cardiorespiratory fitness, with a significant reduction in resting HR and an increase in VO_2max. Yozbatiran et al.[14] observed in their study a significant improvement in the 12 min walking test. Sjogren et al.[18] also reported improvements in time score in the 100m walking test. Some individuals with CLBP exhibit a reduced aerobic capacity compared with healthy controls,[48] what means that improving endurance is a reasonable exercise goal for patients with CLBP. Water-based exercise is a potentially viable way to improve cardiorespiratory fitness, given that water has 700 times the density of air and this promotes increase of energy expenditure for work done.[49]

Limitations of the study

The fact that we were not able to randomise the participants into the intervention or usual care group is a limitation of our study. Despite this, there were no baseline differences between groups in almost any parameter. There are pitfalls to estimating maximum aerobic power (indirect measure of VO_2max) as opposed to precise measurement with cardiopulmonary gas exchange; however, those inconveniences pertain to both baseline exercise capacity as well as the change after the exercise training programs. Another limitation of our study was the use of RPE as a subjective method to control the intensity of aerobic exercise, although it has been used in previous studies in patients with CLBP.[50] We had no data on medication use or dietary habits during the intervention, so future studies should include such information whenever possible. Long-term outcomes were not performed in these subjects so it cannot be determined if the effect of the treatment can be maintained over time. Also, the notable physical performance improvements observed in our study may be related with the low baseline level of our participants (sedentary); thus, future research should examine if the improvement in exercise group was not an educational effect of the short-term exercise.

Conclusions

Our results showed that a 2 months ATP of five times/week decreases levels of back pain and disability, increases QoL, and improves body composition and fitness in sedentary adults with CLBP.

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Table I. Sociodemographic characteristics of participants by group.

Variable	Control Group (n=17)	AETP Group (n=21)	p Value[a]
Gender, n (%)			0.328
Men	7 (41.2)	9 (42.9)	
Women	10 (58.8)	12 (57.1)	
Age, years ± SD	46.2 ± 9.8	50.9 ± 9.6	0.143
Civil status, n (%)			0.324
Married	9 (52.9)	15 (71.4)	
Unmarried	7 (41.2)	4 (19.0)	
Separated/Divorced/Widowed	1 (5.9)	2 (9.5)	
Educacional status, n (%)			0.365
Unfinished studies	0 (0.0)	0 (0.0)	
Primary school	3 (17.6)	8 (38.1)	
Secondary school	10 (58.8)	10 (47.6)	
University degree	4 (23.5)	3 (14.3)	
Occupational status, n (%)			0.171
Housewife	2 (11.8)	7 (33.3)	
Student	0 (0.0)	0 (0.0)	
Working	12 (70.6)	8 (38.1)	
Unemployed	2 (11.8)	2 (9.5)	
Retired	1 (5.9)	4 (19.0)	

[a] Independent t test or χ^2 – Pearson test

Table II: Aquatic Therapy Program.

<table>
<tr><th colspan="12">ATP Group 5 days per week</th></tr>
<tr><th>TYPE OF EXERCISE</th><th></th><th>WEEK 1</th><th>WEEK 2</th><th>WEEK 3</th><th>WEEK 4</th><th>WEEK 5</th><th>WEEK 6</th><th>WEEK 7</th><th>WEEK 8</th><th>Number of sessions</th><th>Adherence to the program</th></tr>
<tr><td rowspan="2">Resistance</td><td>VOLUME (sets × repts)</td><td>3 × 12</td><td>3 × 12</td><td>3 × 15</td><td>3 × 15</td><td>3 × 12</td><td>3 × 12</td><td>3 × 15</td><td>3 × 15</td><td>40</td><td>90%</td></tr>
<tr><td>INTENSITY</td><td colspan="4">No resistance material
Low velocity</td><td colspan="4">With resistance material
High velocity</td><td colspan="2" rowspan="2">Total volume of
Aerobic Exercise
= 875 min</td></tr>
<tr><td rowspan="2">Aerobic</td><td>VOLUME</td><td>100 min</td><td>100 min</td><td>125 min</td><td>125 min</td><td>125 min</td><td>100 min</td><td>100 min</td><td>100 min</td></tr>
<tr><td>INTENSITY (RPE scale)</td><td colspan="5">10-12</td><td colspan="3">12-15</td><td colspan="2" rowspan="2">Total volume of Flexibility exercises
= 400 min</td></tr>
<tr><td>Flexibility</td><td></td><td colspan="8">10 min, 3 × 20 sec per exercise</td></tr>
</table>

min: minutes; repts: repetitions; RPE: rating of perceived exertion; sec: seconds; ATP: aquatic therapy program.

Table III. Effects of 2-month ATP on VAS (at rest, flexion and extension) and Oswestry Disability Index.

	Pretest [a] **Mean ± SEM**	**Postest** [a] **Mean ± SEM**	**Diferencies (Post-Pre)** [b] **Mean ± SEM**
VAS at rest (cm, 0-10)			
CG	6.14 ± 0. 52	6.42 ± 0. 43	0.26 ± 0.39
ATP	6.22 ± 0. 47	2.37 ± 0.38	-3.83 ± 0.35
p (groups)	0.905	<0.001	<0.001
VAS at flexion (cm, 0-10)			
CG	6.45 ± 0.45	6.83 ± 0.45	0.35 ± 0.33
ATP	6.64 ± 0.41	1.62 ± 0.40	-4.99 ± 0.30
p (groups)	0.760	<0.001	<0.001
VAS at extension (cm, 0-10)			
CG	5.76 ± 0.72	6.00 ± 0.57	0.30 ± 0.40
ATP	5.53 ± 0.64	1.28 ± 0.51	-4.29 ± 0.36
p (groups)	0.815	<0.001	<0.001
Oswestry Disability Index (scores, 0-100)			
CG	29.6 ± 4.0	31.7 ± 3.6	2.2 ± 1.4
ATP	29.1 ± 3.6	16.4 ± 3.3	-12.7 ± 1.3
p (groups)	0.920	<0.01	<0.001

CG indicates control group (n=17); ATP: aquatic therapy program (n=21). [a] ANCOVA with age and gender as confounders. [b] ANCOVA with age, gender and baseline level as confounders.

Table IV. Effects of 2-month ATP on Quality of Life.

	Pretest [a] Mean ± SEM	Postest [a] Mean ± SEM	Diferencies (Post-Pre) [b] Mean ± SEM
Physical Functioning (scores, 0-100)			
CG	76.4 ± 5.9	77.8 ± 4.9	4.4 ± 3.6
ATP	63.4 ± 5.3	76.3 ± 4.4	10.5 ± 3.2
p value	0.114	0.828	0.225
Physical Role (scores, 0-100)			
CG	66.0 ± 10.1	62.4 ± 9.6	3.6 ± 7.9
ATP	33.5 ± 9.0	66.2 ± 8.6	26.9 ± 7.0
p value	<0.05	0.774	<0.05
Bodily Pain (scores, 0-100)			
CG	44.7 ± 4.4	36.6 ± 6.0	-6.9 ± 5.2
ATP	36.6 ± 3.9	64.4 ± 5.4	26.8 ± 4.7
p value	0.179	<0.01	<0.001
General Health (scores, 0-100)			
CG	59.2 ± 4.5	55.9 ± 4.4	-1.4 ± 2.8
ATP	43.4 ± 4.0	60.1 ± 3.9	15.2 ± 2.5
p value	<0.05	0.492	<0.001
Vitality (scores, 0-100)			
CG	58.4 ± 4.0	52.3 ± 4.6	-5.3 ± 3.1
ATP	46.8 ± 3.6	57.7 ± 4.1	10.2 ± 2.8
p value	<0.05	0.397	0.001
Social Functioning (scores, 0-100)			
CG	84.3 ± 3.9	85.4 ± 4.1	0.5 ± 2.9
ATP	88.3 ± 3.6	90.9 ± 3.7	3.1 ± 2.6
p value	0.472	0.333	0.523
Emotional Role (scores, 0-100)			
CG	90.9 ± 7.7	96.1 ± 5.4	6.8 ± 4.1
ATP	85.1 ± 6.9	87.3 ± 4.9	0.8 ± 3.7
p value	0.583	0.243	0.288
Mental Health (0-100)			
CG	73.0 ± 3.6	72.4 ± 3.1	-0.5 ± 1.5
ATP	71.7 ± 3.2	75.3 ± 2.8	3.4 ± 1.3
p value	0.794	0.493	0.065
Standardized Physical Component (scores, 0-100)			
CG	41.2 ± 2.4	39.2 ± 2.6	-1.5 ± 1.5
ATP	33.1 ± 2.2	43.7 ± 2.4	10.3 ± 1.4
p value	<0.05	0.218	<0.001
Standardized Mental Component (scores, 0-100)			
CG	52.2 ± 2.3	52.9 ± 1.8	-0.4 ± 0.9
ATP	53.7 ± 2.1	51.9 ± 1.6	-1.5 ± 0.8
p value	0.640	0.682	0.114

CG indicates control group (n=17); ATP: aquatic therapy program (n=21). [a] ANCOVA with age and gender as confounders. [b] ANCOVA with age, gender and baseline level as confounders.

Table V. Effects of 2-month ATP on body composition.

	Pretest [a] Mean ± SEM	Postest [a] Mean ± SEM	Diferencies (Post-Pre) [b] Mean ± SEM
Weight (Kg)			
CG	76.5 ± 5.1	76.6 ± 5.1	0.2 ± 0.5
ATP	88.3 ± 4.5	86.3 ± 4.6	-2.0 ± 0.5
p (groups)	0.096	0.174	<0.01
Body Mass Index (kg/m^2)			
CG	26.9 ± 1.2	26.9 ± 1.2	0.1 ± 0.2
ATP	29.4 ± 1.1	28.7 ± 1.1	-0.7 ± 0.2
p (groups)	0.141	0.291	0.01
Body Fat Mass (Kg)			
CG	24.0 ± 2.4	24.2 ± 2.4	0.1 ± 0.7
ATP	27.5 ± 2.1	24.7 ± 2.2	-2.8 ± 0.6
p (groups)	0.286	0.884	<0.01
Body Fat Percentage (%)			
CG	31.0 ± 1.6	31.2 ± 1.5	0.2 ± 0.7
ATP	30.7 ± 1.5	28.0 ± 1.3	-2.8 ± 0.6
p (groups)	0.889	0.125	<0.01
Skeletal Muscle Mass (Kg)			
CG	29.2 ± 1.9	29.2 ± 1.9	-0.1 ± 0.2
ATP	34.1 ± 1.7	34.6 ± 1.7	0.6 ± 0.2
p (groups)	0.077	<0.05	0.056

CG indicates control group (n=17); ATP: aquatic therapy program (n=21). [a] ANCOVA with age and gender as confounders. [b] ANCOVA with age, gender and baseline level as confounders.

Table VI. Effects of 2-month ATP on physical fitness.

	Pretest [a] Mean ± SEM	Postest [a] Mean ± SEM	Diferencies (Post-Pre) [b] Mean ± SEM
Sit and reach (cm)			
CG	9.8 ± 2.2	8.8 ± 2.1	-0.9 ± 0.5
ATP	10.3 ± 1.9	14.9 ± 1.9	4.6 ± 0.5
p (groups)	0.863	<0.05	<0.001
Curl up (number of repetitions)			
CG	12.8 ± 1.2	12.2 ± 1.1	-0.5 ± 0.6
ATP	11.6 ± 1.1	22.1 ± 0.9	10.3 ± 0.5
p (groups)	0.464	<0.001	<0.001
Handgrip Strength (kg)			
CG	67.4 ± 5.0	65.3 ± 4.9	-2.5 ± 1.6
ATP	76.2 ± 4.5	84.4 ± 4.3	8.5 ± 1.4
p (groups)	0.204	<0.01	<0.001
VO_{2max} (ml/kg/min)			
CG	33.1 ± 2.4	30.3 ± 2.3	-2.1 ± 1.2
ATP	25.1 ± 2.2	34.9 ± 2.1	9.2 ± 1.1
p (groups)	<0.05	0.162	<0.001
Resting heart rate (bpm)			
CG	68.9 ± 2.5	70.4 ± 2.1	1.2 ± 0.8
ATP	71.8 ± 2.2	64.9 ± 1.9	-6.6 ± 0.8
p (groups)	0.391	0.063	<0.001

CG indicates control group (n=17); ATP: aquatic therapy program (n=21). [a] ANCOVA with age and gender as confounder. [b] ANCOVA with age, gender and baseline level as confounders.

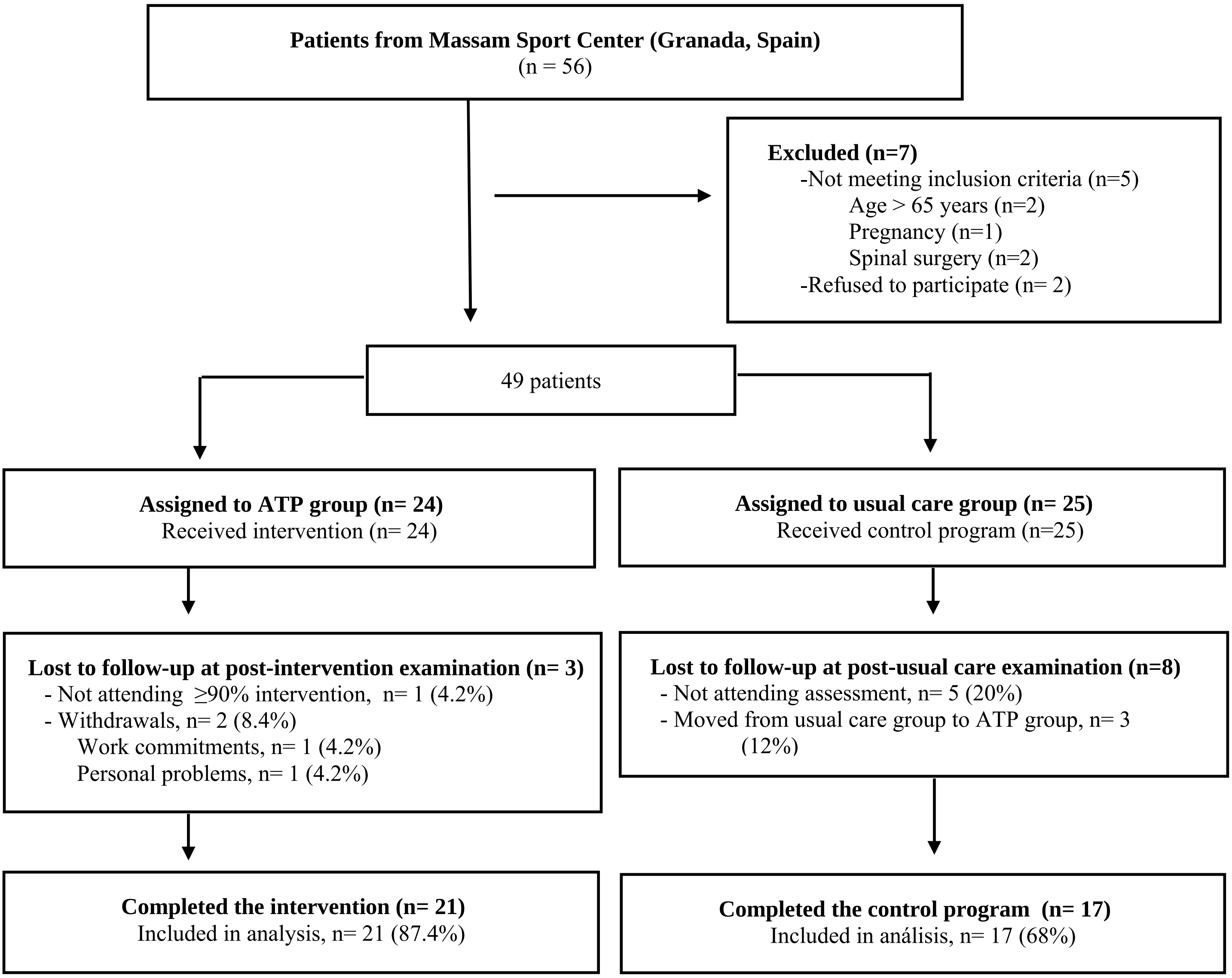

Figure 1: Flow of participants throughout the trial.

2.2. EFFECTS OF DIFFERENT FREQUENCIES OF AQUATIC THERAPY PROGRAM IN ADULTS WITH CHRONIC LOW BACK PAIN.

Baena-Beato PA, Arroyo-Morales M, Delgado-Fernández M, Gatto-Cardia, MC, Artero EG.

(Artículo III)

Running head: Chronic low back pain and hydrotherapy

Title: Effects of different frequencies of aquatic therapy program in adults with chronic low back pain.

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ABSTRACT

Objective: To study the effects of an aquatic therapy program with different frequencies (two vs three days per week) in chronic low back pain.

Desing: Pragmatic controlled trial.

Setting: Community.

Subjects: Seventy eight adults with chronic low back pain (48.9 ± 10.0 years).

Intervention: 8-weeks aquatic therapy program.

Outcome Measures: Pain (visual analog scale), disability (Oswestry disability index) and quality of life (SF-36), body composition (weight, body mass index, body fat mass, body fat percentage and skeletal muscle mass) and health-related fitness (sit and reach, handgrip strength, curl-up, Rockport 1-mile test).

Results: Both experimental groups presented significant improvements in low back pain and disability ($p < 0.001$) compared to control group. The 3 days/week group showed significantly greater benefits at VAS flexion and disability ($p < 0.001$) than the 2 days/ week group. Regarding quality of life, both intervention groups presented significant differences for Physical Role ($p < 0.05$), Bodily Pain ($p < 0.001$), General Health ($p = 0.012$), and Standardized Physical Component ($p < 0.001$) compared to control group. Both experimental groups significantly improved all health-related fitness parameters ($p < 0.01$). The 3 days/week group showed significantly greater benefits at curl-up and heart rate ($p < 0.001$) than the 2 days/week group.

Conclusions: 8 weeks of aquatic therapy program decrease levels of back pain and disability, increase quality of life and improve health-related fitness in adults with chronic low back pain. A dose-response effect was observed in some parameters, with greater benefits when exercising 3 days per week compared with 2 days.

Key words: Hydrotherapy, Chronic Low Back Pain, Disability, Quality of Life, Body Composition, Physical Fitness.

INTRODUCTION

Exercise therapy is recommended as first-line treatment for patients with chronic low back pain (CLBP) (1). Given the high prevalence and significant economic costs of low back pain, cost-effective management of low back pain requires community-based approaches that use existing infrastructure to help individuals prolong function, minimize pain, and maintain quality of life (QoL) (2).

Research has consistently demonstrated that impairments in strength (3, 4), flexibility (5, 6), endurance (7), and obesity (8) are present in many patients with CLBP. Recent systematic reviews of exercise have each concluded that exercise is an effective therapy for CLBP (9, 10). These exercise programs, according to several clinical trials, are effective in decreasing the incidence and duration of CLBP episodes by improving strength and endurance of muscles, by increasing flexibility of soft tissues and aerobic capacity, thus reducing pain, disability and improving QoL (1, 11, 12).

Exercising in water has become increasingly popular, and it has been reported that therapeutic aquatic exercise appears to be a safe and effective treatment modality for patients with low back pain (13, 14). Water immersion decreases axial loading of the spine and, through the effects of buoyancy, allows the performance of movement that are normally difficult or impossible on land (15). By utilizing the unique properties of water (buoyancy, resistance, flow and turbulence) a graded exercise programme from assisted to resisted movements can be created to suit the patients´ needs and function. Aquatic exercise may improve pain, disability, and maintain QoL in patients with CLBP (16), especially in individuals with low levels of physical fitness (17, 18). These findings suggest the potential benefits of aquatics exercise for people with CLBP.

In previous studies on therapeutic aquatic exercise and CLBP, authors found that most trials demonstrated major flaws in their methodology and were in most cases not well reported;

often the details of the intervention were completely absent (19, 20). The frequency of the aquatic exercise sessions per week and outcomes measured varied considerably in the different studies, and some of them did not have a control group, what makes comparison difficult. To the best of the authors' knowledge, only one study has investigated the effects of different amounts of sessions per week of aquatic therapy, with 7 patients exercising once per week, 19 patients twice per week, and 9 patients 3 or more times per week (21). However, the program consisted of exercise performed outside or inside the swimming pool, not only aquatic therapy. Thus, more controlled trials are needed to clarify the frequency of the aquatic exercise sessions per week in the management of CLBP.

The purpose of the present pragmatic controlled trial was to study the effects of an 8-weeks aquatic therapy program (ATP) with a frequency of two and three days per week, on pain, disability and QoL (primary outcomes), and body composition and health-related fitness (secondary outcomes) in men and women with self-reported CLBP.

METHODS

Participants

A total of 78 sedentary adults with CLBP volunteered to participate in this study. They were all recruited in Massam Sport Center (Granada, Spain), this contact followed their referral for hydrotherapy by their medical practitioner, and received written and oral instructions about the intervention, test protocol and the possible risks and benefits of the study. The inclusion criteria for this study were: age between 18 and 65 years, and presence of self-reported low back pain for more than 12 weeks (22). Exclusion criteria were: symptoms or signs that might suggest serious medical illness, pregnancy or recent childbirth, major rheumatologic, neurologic, neoplastic, or other conditions that may prevent full participation in the intervention, previous spinal surgery, inflammatory, infectious, or malignant diseases of the vertebra, presence of severe cardiovascular disease, presence of any psychiatric disorder which might affect the compliance and the assessment of symptoms, and engagement in physical activity ≥ 60 minutes per week during the last 12 months (23).

A total of four patients were eventually not included in the study (three not meeting inclusion criteria and one refused to participate). Therefore, a final sample of 74 completed all requirements of this study. The study flow of participants is presented in figure 1. The sociodemographic characteristics of participants in the intervention and usual care groups are shown in table 1.

Study design

The present study was a pragmatic, parallel group, controlled trial with allocation of participants into the two experimental groups, Experimental Group 2 days per week (EG2d, n = 24) and Experimental Group 3 days per week (EG3d, n = 24), or waiting list (Control Group, n = 26), following as criteria: the order of arrival and time availability, as sport centre only accepts 8 subjects per group in a total of 6 groups of aquatic physical therapy (3 for

EG2d and 3 for EG2d). For practical and ethical reasons, it was not possible to randomize the patients. We had an ethical obligation with the Massam Sport Center (Granada, Spain) to provide treatment to all patients willing to participate in the study, but due to limitation of resources, we created a waiting list. Patients from the waiting list agreed to be part of the usual care group (CG) and were offered the intervention program at the end of the follow-up period. For those subjects in the waiting list, data collected only during the control period were included in the current analysis. Throughout the study, all participants (including those in the CG) were encouraged to maintain their normal dietary habits and physical activity level. Written informed consent was obtained before participation. The study was approved by the Ethical Committee of the University of Granada and was performed in accordance with the Helsinki Declaration, last modified in 2000.

Intervention program

The eight weeks ATP consisted of 16 and 24 sessions in EG2d and EG3d respectively (see Table 2), and no exercise sessions in CG. The ATP was carried out in an indoor pool sized 25 x 6 m, with 140 cm water depth, 29 ± 1 ºC of water temperature, and 32 ºC of room temperature. Before ATP, participants took part in one session of exercises with no external resistance to familiarize with the movements in the aquatic environment and the flotation material. During this session, the participants also familiarized themselves with the use of the rating of perceived exertion (RPE) scale from 6 to 20 (24) exercising at different intensities. The aim was to use this scale during the 8 weeks to control the intensity of the aerobic exercises.

Participants were asked not to change their medication during the 2-month intervention period.

Aquatic Therapy Program

Each aquatic therapy session was conducted in reduced groups of 8 participants and lasted 55-60 minutes. They were closely supervised by trained exercise specialists and a physiotherapist with five year of previous experience with similar programmes. Each session included 10 minutes of warm-up, 15-20 minutes of resistance exercise, 20-25 minutes of aerobic exercise, and 10 minutes of cool-down (stretching exercises).

Resistance exercises

The resistance exercises progressed throughout the program by changing the number of repetitions per set (volume), by including specific resistance material that increase the resistance offered by the water, and by increasing the velocity of the movements (25). Noodles and cuff devices were used for upper-body and lower-body exercises, respectively. Each training session included the following resistance exercises: hip flexion-extension, hip abduction-adduction, arms abduction-adduction at chest level, curl-ups, scissors leg, backstroke kick with water noodle under the waist.

Aerobic exercises

The planning of the aerobic exercises was done considering the intensity (Borg scale 6 to 20) and the volume (minutes). The aerobic exercises incorporated large muscle mass and consisted of lateral displacements, long-lever pendulum-like movements of the extremities, forward and backward jogging with arms pushing, pulling, and pressing, leaps, kicks, leg crossovers and hopping movements focusing on travelling in multiple directions, and bounding off the bottom of the pool.

Flexibility exercises

Lower-body stretching exercises were performed at the end of each session, as part of the cool-down. The muscle groups to stretch were gluteus, lumbar back and hamstrings. A static stretching technique was used, where the posture was achieved in 5 seconds, maintained during 20 seconds in its maximum amplitude without pain, and 5 seconds to go back to the initial posture, repeated 3 times per exercise (26).

Testing procedure

After agreeing to participate and completing the informed consent form, all participants attended two initial measurement sessions, where back pain, disability, QoL, body composition and health-related fitness were measured. Assessment sessions were carried out prior to the start and immediately after the exercise therapy intervention. All testing sessions were conducted by the same researcher.

Testing took place in laboratory conditions at 24ºC temperature in two sessions. In the first day participants were evaluated for (in this order) body composition, sit and reach test, handgrip strength and curl-up test. In the second day, the questionnaires Quality Short-Form Health Survey 36 (SF-36), Oswestry low back pain disability questionnaire (Oswestry Disability Index, ODI) and visual analogue scale (VAS), as well as the Rockoport 1-mile test were administered. Resting heart rate was also measured.

Pain, disability and QoL (primary outcomes)

Three different questionnaires were used to evaluate self-estimated participants' level of pain, disability and QoL.

1. Back pain was assessed at rest and during movement (flexion and extension) with a VAS, ranging from 0 to 10 cm (0 means no pain, 10 means highest level of pain). The reliability and validity of VAS has previously been found to be acceptable (27), and the minimal clinical important change has been estimated to be 15 mm in patients with low back pain (28).

2. The Spanish version of the Oswestry low back pain disability questionnaire (29) was used to measure back-related disability of activities of daily living. The Oswestry low back pain disability questionnaire is comprised of 10 questions about pain and pain-related

disability in activities of daily life and social participation. The sum of the response scores was calculated and presented as a percentage, where 0% represents no pain or disability and 100% represent the worst possible pain and disability. The reliability and validity of ODI has previously been found to be acceptable (29), and the minimal clinical important change has been estimated to be 10 % (28).

3. The Quality Short-Form Health Survey 36 is a generic instrument assessing health related QoL. In this study we used the Spanish version of SF-36 (30). It contains 36 items in 8 domains (parameters): physical functioning, physical role, bodily pain, general health, vitality, social functioning, emotional role and mental health. These 8 parameters can be used to derive 2 composite scoring summaries: physical composite summary (PCS: physical functioning, role physical, bodily pain and general health perceptions) and mental composite summary (MCS: vitality, social functioning, mental health and role emotional).The SF-36 is a sensitive measure of treatment success in patients with low back pain (31). Each domain is scored on a scale from 0 (worst possible health) to 100 (best possible health).

Body composition (secondary outcome)

Body composition was measured using Octapolar bioimpedance analyses (Biospace Inbody 720; Biospace Company, Ltd., Seoul, Korea). Biospace Inbody analyse has been found in the literature to be reliable in the calculation of body composition (32). The participants were instructed to stand upright and to grasp the handles of the analyzer, thereby providing contact with a total of 8 electrodes (2 for each foot and hand). The participant's identification number, height, age, and sex were entered into the analyzer, and the participant was instructed to slightly abduct his or her arms and remain still during the assessment. We measured weight (kg), body fat mass (kg), body fat percentage (%) and skeletal muscle mass (kg). Height was measured in the Frankfurt plane with a telescopic height measuring instrument (Type SECA 225; range, 60 to 200 cm; precision, 1 mm). Body mass index (BMI) was calculated (kg/m^2).

Health-related fitness (secondary outcome)

1. Trunk flexion and hamstring tone were determined via the sit and reach test, as described by the American College of Sports Medicine's (ACSM) protocol (26), in a standardized box with the following dimensions: length 35 cm; width 45 cm; height 32 cm. The top plate's dimensions were: length 55 cm; width 45 cm. This top plate extends 15 cm over the side supporting the foot. A scale from 0 to 55 cm is marked in the middle of the top plate. A ruler of 30 cm loose on the top of the box and it is displaced by the subject as he/she moves his/her hands over the top of the box. The test was performed twice, and the best result in centimetres was recorded. If the ruler was somewhere between two centimetres, the lower one was scored.

2. Upper body isometric strength was assessed by using handgrip strength test. A hand dynamometer with adjustable grip was used (TKK 5101 Grip D; Takey, Tokio Japan). The patients squeezed gradually and continuously for at least two seconds, performing the test with the right and left hands in turn, with the elbow in full extension. The test was performed twice and the maximum score for each hand was recorded in kilograms. Optimal grip was noted for each participant in the pre-test, and repeated in the post-test. The sum of the scores achieved by left and right hands was used in the analysis (33).

3. Abdominal muscular endurance was measured using the curl-up test (26). Subject lied supine on mat with knees bent at 90° and feet on floor. The arms were extended to placing hands on thighs and curling up until hands reached knee caps. The subjects were allowed to practice a few repetitions before testing. The cadence for the test was 40 beats/min, paced by a metronome. At the first beep, the subject slowly lifts the shoulder blades off the thighs by flexing spine until finger tips reach the knee caps. At the next beep, the subject slowly returns shoulder blades to mat by flattening lower back. Subjects repeated curl-up in time with the metronome. The test was terminated when the subject was unable to maintain the required

cadence or unable to maintain the proper curl-up technique for 2 consecutive repetitions despite feedback from the researcher. A maximum of 3 corrections were allowed by the appraiser before termination of the test. The highest number of repetitions completed while maintaining proper form was recorded.

4. Cardiorespiratory fitness was determined by using the Rockport 1-mile test. This test is recommended by the ACSM (26) to choose the level of practice in cardiovascular exercises for people with low fitness (sedentary). The time (minutes and seconds) employed by each participant to cover the distance, together with his/her heart rate at the end of the test, were registered. Maximal oxygen uptake (VO_{2max}) was estimated as described by Berger (34), considering gender, age, weight, time and heart rate. The validity of Rockoport 1-mile test has previously been found to be acceptable (35).

5. Resting heart rate

Patients were instructed in the procedure of measuring their pulse, and then were asked to register resting heart rate manually at home, from the carotid artery using a stopwatch. They registered resting heart rate in four non-consecutive days during pre- and post-test weeks: in the morning before getting up or after staying in prone position for at least 30 min. The average heart rate among the four measurements was used as resting heart rate before and after the intervention.

Statistical Analyses

One-way analysis of the covariance (ANCOVA) was used to compare participants' characteristics by groups, both at baseline (pre-test) and follow-up (post-test). In these models the outcome variables (pain, disability, quality of life, body composition, and fitness) were entered as dependent variables, group was used as fixed factor, while sex and age were used as confounders. To analyze the effects of the training programme we used ANCOVA with post – pre differences as dependent variables, group as fixed factor, and sex, age and the baseline level of the variable as confounders. Bonferroni's adjustments were used for pair wise comparisons (*post-hoc*). The analyses were not adjusted for the number of sessions actually performed, as the adherence to the intervention was very high: all participants performed at least 97% (15 from a total of 16) and 93% (22 from 24) of the sessions in EG2d and EG3d, respectively.

Due to the small number of missing data, we included in the analyses those subjects who completed both the pre-test and post-test evaluations and, thus, it was not necessary to employ imputation methods. Data analyses were performed using PWSA statistical package version 18.0 (SPSS Inc., Chicago, IL, USA). Significance level was set at $p < 0.05$.

RESULTS

Six participants from the intervention groups discontinued the program due to withdrawals or work commitments (three in each intervention group), and other three participants were excluded for attending less than 97% of the program in the EG2d group (attendance: 76.6%). During the study period, nine patients (34.6 %) changed from the CG (waiting list) to the intervention group –their data were not included in this report-, and two more patients from CG (7.7%) did not attend final assessment. Finally, a total of 21 (87.4%) patients from the EG3d, 18 (74.8%) from the EG2d and 15 (57.7%) from the CG completed both pre- and post intervention assessments and were included in the analysis (Figure 1).

Back pain (VAS at rest, in flexion and extension) and disability (ODI) results are shown in table 3. The ANCOVA with post – pre differences showed significant differences in both experimental groups in VAS and ODI ($p < 0.001$) compared to CG. Significant differences were also noted between EG2d and EG3d: EG3d experimented significantly greater improvements at VAS flexion and disability compared with EG2d ($p < 0.001$).

QoL results are given in table 4. We observed significant post – pre differences between groups in Physical Role ($p < 0.05$), Bodily Pain ($p < 0.001$), General Health ($p < 0.05$), and Standardized Physical Component ($p < 0.001$). All these parameters improved in EG2d and EG3d compared to CG.

Intervention effects on body composition are displayed in table 5. The ANCOVA with post – pre differences showed no significant differences between groups in body composition. The results in health-related fitness are given in table 6. Significant post – pre differences ($p < 0.001$) were observed between groups in sit and reach, handgrip, curl-up, VO_{2max} and resting heart rate. Both experimental groups (EG2d and EG3d) improved all these fitness parameters compared to the CG. EG3d presented significantly greater improvements compared to EG2d in curl-up, resting HR and HR in the Rockport 1-mile test ($p < 0.05$).

DISCUSSION

This study sought to determine the effectiveness of an ATP, with a frequency of two and three sessions per week, as a rehabilitation strategy for patients with CLBP. In general, the present data provide further support that ATP is effective at inducing meaningful changes in back pain, disability and QoL, musculoskeletal strength, aerobic fitness and flexibility using either 2 or 3 days per week. We observed significant improvements in back pain levels from baseline, where VAS at rest decreased 49% and 61%, VAS in flexion decreased 39% and 68%, and VAS in extension decreased 46% and 74% in EG2d and EG3d, respectively. We observed significant improvements in disability levels from baseline, where ODI decreased 27% and 57% in EG2d and EG3d, respectively. Our results in these parameters (back pain and disability) exceeded the estimated minimal clinical important changes in patients with low back pain (28) in both experimental groups.

We also observed an increase in several domains of health-related QoL in both experimental groups. These changes were accompanied by improvements in fitness, suggesting a possible mechanism by which aquatic exercise could be effective for the management of CLBP. Body composition parameters (weight, BMI, body fat mass and percentage, and skeletal muscle mass) showed a very slight improvement, but the differences before and after the intervention were not statistically significant. These findings were similar to those reported in previous studies (14, 36), suggesting that these aquatic exercise programs were not enough stimulus to affect body composition.

Regarding the number of sessions per week, in our study the findings indicate that ATP 3 days per week had a greater effect than 2 days per week in VAS at flexion, ODI, curl-up, and heart rate at rest and post effort. Both experimental groups presented significant improvements in back pain (VAS) after the intervention, but EG3d had a greater improvement than EG2d in VAS at flexion. These findings are similar to those reported in previous studies where patients exercised 3 sessions per week. Yozbatiran et al. (14) studied 30 patients with CLBP, allocated to either aquafitness group (n = 15) or land based fitness group (n = 15), where aquafitness group achieved a total of 12 sessions, 3 per week for 4 weeks. The aquafitness program consisted of warm-up and stretching exercises followed by a circuit of 15 progressive exercises, and cool down with stretching and light aerobic exercise, according to the programme described by Frost et al. (37). At the end of this study, patients improved significantly in back pain ($p < 0.05$), with a reduction of 65% in VAS. Similarly, Saggini et al. (13) observed a reduction of back pain of 70% in VAS after an aquatic program of 3 days per week for 7 weeks ($p < 0.01$). However, none of these studies had a control group in their study making comparison difficult. In our study, we had a control group and our study registered more variables in VAS (at rest and at movement: flexion and extension) than previous studies (13, 14).

Our study and previous studies (13, 14) registered better results in percentage of back pain improvement compared to those reported by Sjogren et al. (38), whose participants attended 2 sessions of 50 minutes per week during 6 weeks in resistance, aerobic and flexibility exercises. At the end of the study, results indicated that hydrotherapy group had a 25% improvement in VAS, compared with improvements of 65% - 74% in our study and others using 3 days per week (13, 14). A possible mechanism to explain these improvements in back pain could be that hydrotherapy provides the optimal environment for patients to exercise aerobically, and at higher intensities than would be possible on land. More intensive aquatic exercise programs, with a frequency of 3 sessions per week, seem to have a greater effect than 2 sessions per week on the treatment of back pain in CLBP.

Our results also indicate that both experimental groups had significant improvements in disability levels (ODI), with EG3d showing a greater improvement than EG2d (57% vs. 27%). These findings were similar to those reported by Yozbatiran et al. (14), who observed an improvement of 48% in disability. Sjogren et al. (38) showed, in contrast, an improvement in disability of only 9% in the hydrotherapy group (2 days per week of 50 minutes), which can be insufficient and more intensive aquatic exercise programs, with a higher frequency and duration of sessions, may have a greater effect on the treatment of disability in CLBP.

Abdominal muscular endurance presented an improvement of 39% and 75% in EG2d and EG3d, respectively. Abdominal muscular endurance is suggested to be reduced in patients with CLBP (39), since weakened abdominal muscles cannot maintain normal inclination of the pelvis, which increases lordosis of the lumbar spine (21). We observed a significant improvement in abdominal muscular endurance in both experimental groups, with EG3d showing a greater improvement than EG2d. These findings were similar to Kell et al. (40), who studied 27 patients with CLBP in a land rehabilitation program, allocated to either resistance training group (n = 9), aerobic training group (n = 9), or control group (n = 9), 3 sessions per week for 16 weeks. From baseline to week 8, they had an improvement in abdominal muscular endurance of 11% and 39% in aerobic and resistance training groups, respectively. It is likely that the early changes (~ 8 weeks) in these musculoskeletal performance outcomes (i.e., strength) associated with our ATP were attributable largely to neural adaptations (41). After week 8, muscular hypertrophy seems to be increasingly important, contributing to musculoskeletal performance (42). The greater results in our study compared to Kell et al. (40) (75% vs 39%) may be explained because one of the principles of abdominal exercise develop in water is their ability to proximal muscle activation, providing interactive moments that would allow efficient distal muscle function (43).

Our results indicated an improvement in cardiorespiratory fitness, with a significant reduction in resting HR of 2% and 7%, HR post effort of 2% and 9%, and an increase in VO2 max. of 11% and 21% in EG2d and EG3d respectively. Improvements in EG3d were higher than in EG2d only for HR at rest and HR post effort. These findings were similar to Kell et al. (40), from baseline to week 8, as they reported improvements of 14% and 7% in VO_{2max} and 2% and 1% in HR at rest in aerobic and resistance training groups respectively. Yozbatiran et al. (14) observed in their study a significant improvement in the 12 min walking test. Sjogren et al. (38) also reported improvements in time score in the 100m walking test. Individuals with CLBP usually exhibit a reduced aerobic capacity compared with healthy controls (7), what means that improving endurance is a reasonable exercise goal for patients with CLBP. Water-based exercise is a potentially viable way to improve cardiorespiratory fitness, given that water has 700 times the density of air and this promotes increase of energy expenditure for work done (44).

Limitations of the study

The fact that we were not able to randomise the participants into the intervention or usual care group is a limitation of our study. Despite this, there were no baseline differences between groups in almost any parameter. There are pitfalls to estimating maximum aerobic power (indirect measure of VO2max) as opposed to precise measurement with cardiopulmonary gas exchange; however, those inconveniences pertain to both baseline exercise capacity as well as the change after the exercise training programs. Another limitation of our study was the use of RPE as a subjective method to control the intensity of aerobic exercise, although it has been used in previous studies in patients with CLBP (40). We had no data on medication use or dietary habits during the intervention, so future studies should include such information whenever possible. Long-term outcomes were not performed in these subjects so it cannot be determined if the effect of the treatment can be maintained over time. Also, the notable physical performance improvements observed in our study may be related with the low baseline level of our participants (sedentary); thus, future research should examine if the improvement in exercise group was not an educational effect of the short-term exercise.

CONCLUSION

Our results showed that 8-weeks of ATP decrease levels of back pain and disability, increase QoL and improve health-related fitness, in sedentary adults with CLBP. A dose-response effect was observed in some parameters, with greater benefits when exercising 3 days per week compared with 2 days in VAS at flexion, ODI, curl-up, and heart rate at rest and post effort.

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Disclosures None.

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Table 1. Sociodemographic characteristics of participants by group.

Variable	CG (n=15)	EG2d (n=18)	EG3d (n=21)	p Value[a]
Gender, n (%)				0.905
Men	7 (46.7)	9 (50.0)	9 (42.9)	
Women	8 (53.8)	9 (50.0)	12 (57.1)	
Age, years ± SD	44.93 ± 9.70	50.17 ± 9.72	50.67 ± 10.22	0.197
Civil status, n (%)				0.025
Married	9 (60.0)	17 (94.4)	13 (61.9)	
Unmarried	5 (33.3)	0 (0.0)	3 (14.3)	
Separated/Divorced/Widowed	1 (6.7)	1 (5.6)	5 (23.8)	
Educacional status, n (%)				0.003
Unfinished studies	0 (0.0)	3 (16.7)	0 (0.0)	
Primary school	3 (20.0)	5 (27.8)	9 (42.9)	
Secondary school	10 (66.7)	2 (11.1)	4 (19.0)	
University degree	2 (13.3)	8 (44.4)	8 (38.1)	
Occupational status, n (%)				0.811
Housewife	2 (13.3)	3 (16.7)	4 (19.0)	
Student	0 (0.0)	0 (0.0)	0 (0.0)	
Working	10 (66.7)	8 (44.4)	9 (42.9)	
Unemployed	2 (13.3)	3 (16.7)	3 (14.3)	
Retired	1 (6.7)	4 (22.2)	5 (23.8)	

[a] Independent t test or χ^2 – Pearson test. CG indicates control group; EG2d: experimental group 2 days per week; EG3d: experimental group 3 days per week.

Table 2. Aquatic therapy program in each experimental group.

Experimental Group 3 days per week (EG3d)											
TYPE OF EXERCISE		**WEEK 1**	**WEEK 2**	**WEEK 3**	**WEEK 4**	**WEEK 5**	**WEEK 6**	**WEEK 7**	**WEEK 8**	**Number of sessions**	**Adherence to the program**
Resistance	VOLUME (sets × repts)	3 × 12	3 × 12	3 × 15	3 × 15	3 × 12	3 × 12	3 × 15	3 × 15	24	93%
	INTENSITY	No resistance material Low velocity				With resistance material High velocity				**Total volume of Aerobic Exercise** = 525 min	
Aerobic	VOLUME	60 min	60 min	75 min	75 min	75 min	60 min	60 min	60 min		
	INTENSITY (RPE scale)	10-12					12-15			**Total volume of Flexibility exercises** = 240 min	
Flexibility		10 min, 3 × 20 sec per exercise									

min: minutes; repts: repetitions; RPE: rating of perceived exertion; sec: seconds.

Table 2 (Cont)

<table>
<tr><th colspan="12">Experimental Group 2 days per week (EG2d)</th></tr>
<tr><th>TYPE OF EXERCISE</th><th></th><th>WEEK 1</th><th>WEEK 2</th><th>WEEK 3</th><th>WEEK 4</th><th>WEEK 5</th><th>WEEK 6</th><th>WEEK 7</th><th>WEEK 8</th><th rowspan="2">Number of sessions
16</th><th rowspan="2">Adherence to the program
97%</th></tr>
<tr><td rowspan="2">Resistance</td><td>VOLUME (sets × repts)</td><td>3 × 12</td><td>3 × 12</td><td>3 × 15</td><td>3 × 15</td><td>3 × 12</td><td>3 × 12</td><td>3 × 15</td><td>3 × 15</td></tr>
<tr><td>INTENSITY</td><td colspan="4">No resistance material
Low velocity</td><td colspan="4">With resistance material
High velocity</td><td colspan="2" rowspan="2">Total volume of Aerobic Exercise = 350 min</td></tr>
<tr><td rowspan="2">Aerobic</td><td>VOLUME</td><td>40 min</td><td>40 min</td><td>50 min</td><td>50 min</td><td>50 min</td><td>40 min</td><td>40 min</td><td>40 min</td></tr>
<tr><td>INTENSITY (RPE scale)</td><td colspan="5">10-12</td><td colspan="3">12-15</td><td colspan="2" rowspan="2">Total volume of Flexibility exercises = 160 min</td></tr>
<tr><td>Flexibility</td><td></td><td colspan="8">10 min, 3 × 20 sec per exercise</td></tr>
</table>

min: minutes; repts: repetitions; RPE: rating of perceived exertion; sec: seconds.

Table 3. Effects of an 8-weeks ATP on pain (VAS at rest, flexion and extension) and back-related disability (Oswestry Disability Index).

	Pre-test [a]	**Post-test** [a]	**Differences** (Post-Pre) [b]
VAS at rest (cm, 0-10)			
CG	6.6 ± 0.6	7.0 ± 0.5	0.5 ± 0.4
EG2d	5.9 ± 0.5	3.2 ± 0.5	-2.9 ± 0.3 [c]
EG3d	6.4 ± 0.5	2.5 ± 0.5	-3.9 ± 0.3 [c]
p value	0.643	< 0.001	< 0.001
VAS at flexion (cm, 0-10)			
CG	6.6 ± 0.6	7.2 ± 0.5	0.7 ± 0.4
EG2d	6.1 ± 0.6	3.8 ± 0.4	-2.4 ± 0.3 [c]
EG3d	6.2 ± 0.5	2.1 ± 0.4	-4.2 ± 0.3 [c, d]
p value	0.829	< 0.001	< 0.001
VAS at extension (cm, 0-10)			
CG	6.0 ± 0.8	6.1 ± 0.6	0.5 ± 0.4
EG2d	5.4 ± 0.7	2.8 ± 0.5	-2.5 ± 0.3 [c]
EG3d	4.6 ± 0.6	1.5 ± 0.5	-3.4 ± 0.3 [c]
p value	0.383	< 0.001	< 0.001
Oswestry Disability Index (scores, 0-100)			
CG	32.2 ± 3.5	33.7 ± 3.0	2.1 ± 1.5
EG2d	26.2 ± 3.1	19.9 ± 2.7	-7.1 ± 1.3 [c]
EG3d	30.8 ± 2.9	13.1 ± 2.5	-17.5 ± 1.2 [c, d]
p value	0.395	< 0.001	< 0.001

Data are estimated means ± standard errors. CG indicates control group (n=15); EG2d: experimental group 2 days per week (n=18); EG3d: experimental group 3 days per week (n=21); VAS: Visual Analogue Scale. [a] ANCOVA with sex and age as confounders. [b] ANCOVA with sex, age and baseline level as confounders, and Bonferroni's adjustments for *post-hoc* comparisons. [c] Significantly different from CG. [d] Significantly different from EG2d.

Table 4. Effects of an 8-weeks ATP on quality of life (Short-Form 36 Health Survey, SF-36).

	Pre-test [a]	**Post-test** [a]	**Differences** (Post-Pre) [b]
Physical Functioning (scores, 0-100)			
CG	73.5 ± 6.0	75.5 ± 4.2	3.7 ± 3.9
EG2d	71.3 ± 5.4	81.1 ± 3.7	9.9 ± 3.4
EG3d	69.2 ± 5.0	80.3 ± 3.5	9.8 ± 3.2
p value	0.862	0.585	0.424
Physical Role (scores, 0-100)			
CG	64.7 ± 11.7	58.0 ± 10.8	0.3 ± 8.6
EG2d	44.2 ± 10.4	73.6 ± 9.6	28.0 ± 7.5 [c]
EG3d	38.6 ± 9.7	69.3 ± 9.0	27.0 ± 7.0 [c]
p value	0.233	0.551	0.038
Bodily Pain (scores, 0-100)			
CG	41.7 ± 4.9	33.4 ± 4.5	-5.2 ± 4.3
EG2d	35.0 ± 4.4	55.3 ± 4.0	19.1 ± 3.8 [c]
EG3d	35.1 ± 4.1	63.4 ± 3.8	27.1 ± 3.5 [c]
p value	0.531	< 0.001	< 0.001
General Health (scores, 0-100)			
CG	55.3 ± 4.8	52.7 ± 4.6	-2.4 ± 3.4
EG2d	51.1 ± 4.2	63.7 ± 4.1	11.4 ± 3.0 [c]
EG3d	57.1 ± 4.0	64.4 ± 3.8	8.1 ± 2.8
p value	0.578	0.126	0.012
Vitality (scores, 0-100)			
CG	56.9 ± 4.4	49.9 ± 4.3	-4.4 ± 3.7
EG2d	51.7 ± 3.9	57.3 ± 3.8	5.6 ± 3.3
EG3d	47.9 ± 3.7	55.0 ± 3.5	5.3 ± 3.1
p value	0.318	0.434	0.098
Social Functioning (scores, 0-100)			
CG	82.4 ± 6.0	82.0 ± 4.6	2.0 ± 3.8
EG2d	77.0 ± 5.4	83.9 ± 4.0	6.2 ± 3.4
EG3d	76.3 ± 5.0	86.7 ± 3.8	9.3 ± 3.1
p value	0.723	0.725	0.352

Data are estimated means ± standard errors. CG indicates control group (n=15); EG2d: experimental group 2 days per week (n=18); EG3d: experimental group 3 days per week (n=21). [a] ANCOVA with sex and age as confounders. [b] ANCOVA with sex, age and baseline level as confounders, and Bonferroni's adjustments for *post-hoc* comparisons. [c] Significantly different from CG.

Table 4 (cont)

	Pre-test [a]	**Post-test** [a]	**Differences** (Post-Pre) [b]
Emotional Role (scores, 0-100)			
CG	88.9 ± 10.8	94.0 ± 8.8	13.0 ± 7.8
EG2d	72.5 ± 9.6	83.6 ± 7.9	9.4 ± 6.8
EG3d	68.1 ± 8.9	80.3 ± 7.4	8.0 ± 6.4
p value	0.333	0.498	0.892
Mental Health (scores, 0-100)			
CG	70.0 ± 3.8	70.0 ± 3.4	0.3 ± 2.5
EG2d	72.8 ± 3.4	75.0 ± 3.1	3.5 ± 2.2
EG3d	65.5 ± 3.2	68.9 ± 2.9	2.1 ± 2.1
p value	0.283	0.322	0.632
Standardized Physical Component (scores, 0-100)			
CG	40.1 ± 2.5	37.9 ± 2.4	-1.6 ± 1.7
EG2d	37.1 ± 2.2	44.9 ± 2.1	7.4 ± 1.5 [c]
EG3d	38.2 ± 2.1	46.4 ± 2.0	8.2 ± 1.4 [c]
p value	0.673	0.030	< 0.001
Standardized Mental Component (scores, 0-100)			
CG	51.2 ± 2.8	51.9 ± 2.5	1.6 ± 1.9
EG2d	49.6 ± 2.5	49.9 ± 2.2	0.5 ± 1.7
EG3d	46.7 ± 2.3	47.7 ± 2.1	0.1 ± 1.6
p value	0.449	0.445	0.841

Data are estimated means ± standard errors. CG indicates control group (n=15); EG2d: experimental group 2 days per week (n=18); EG3d: experimental group 3 days per week (n=21). [a] ANCOVA with sex and age as confounders. [b] ANCOVA with sex, age and baseline level as confounders, and Bonferroni's adjustments for *post-hoc* comparisons. [c] Significantly different from CG.

Table 5. Effects of an 8-weeks ATP on body composition.

	Pre-test [a]	**Post-test** [a]	**Differences** (Post-Pre) [b]
Weight (kg)			
CG	77.3 ± 3.2	77.4 ± 3.2	0.2 ± 0.4
EG2d	68.3 ± 2.9	67.8 ± 2.9	-0.5 ± 0.4
EG3d	73.8 ± 2.7	73.2 ± 2.7	-0.5 ± 0.3
p value	0.118	0.092	0.312
Body Mass Index (kg/m^2)			
CG	27.0 ± 1.2	27.0 ± 1.1	0.0 ± 0.1
EG2d	24.6 ± 1.0	24.5 ± 1.0	-0.1 ± 0.1
EG3d	26.7 ± 1.0	26.5 ± 1.0	-0.2 ± 0.1
p value	0.225	0.223	0.280
Body Fat (kg)			
CG	23.5 ± 2.1	24.1 ± 2.2	0.5 ± 0.6
EG2d	20.1 ± 1.9	19.2 ± 2.0	-0.8 ± 0.5
EG3d	22.6 ± 1.8	22.0 ± 1.9	-0.6 ± 0.5
p value	0.433	0.273	0.227
Body Fat (%)			
CG	30.2 ± 1.8	30.8 ± 2.1	0.6 ± 0.7
EG2d	29.1 ± 1.6	28.1 ± 1.8	-1.0 ± 0.6
EG3d	29.9 ± 1.5	29.2 ± 1.7	-0.6 ± 0.5
p value	0.909	0.643	0.210
Skeletal Muscle Mass (kg)			
CG	29.9 ± 1.0	29.8 ± 1.1	-0.2 ± 0.3
EG2d	26.4 ± 0.9	26.8 ± 1.0	0.5 ± 0.2
EG3d	28.4 ± 0.8	28.5 ± 0.9	0.1 ± 0.2
p value	0.042	0.126	0.201

Data are estimated means ± standard errors. CG indicates control group (n=15); EG2d: experimental group 2 days per week (n=18); EG3d: experimental group 3 days per week (n=21). [a] ANCOVA with sex and age as confounders. [b] ANCOVA with sex, age and baseline level as confounders, and Bonferroni's adjustments for *post-hoc* comparisons.

Table 6: Effects of an 8-weeks ATP on physical fitness

	Pre-test [a]	**Post-test** [a]	**Differences** (Post-Pre) [b]
Sit and reach (cm)			
CG	11.4 ± 2.2	10.3 ± 2.1	-0.9 ± 0.8
EG2d	9.4 ± 2.0	13.0 ± 1.9	3.5 ± 0.7 [c]
EG3d	8.4 ± 1.9	13.2 ± 1.8	4.6 ± 0.7 [c]
p value	0.616	0.552	< 0.001
Handgrip Strength (kg)			
CG	69.0 ± 3.0	67.4 ± 3.0	-1.5 ± 1.1
EG2d	61.1 ± 2.7	64.2 ± 2.7	2.9 ± 1.0 [c]
EG3d	70.0 ± 2.5	75.0 ± 2.5	5.2 ± 0.9 [c]
p value	0.041	0.016	< 0.001
Curl-up (number of repetitions)			
CG	13.3 ± 1.4	13.0 ± 1.6	-0.3 ± 0.5
EG2d	15.0 ± 1.2	20.9 ± 1.4	5.8 ± 0.5 [c]
EG3d	11.7 ± 1.2	20.5 ± 1.3	8.8 ± 0.4 [c, d]
p value	0.181	0.001	< 0.001
VO_{2max} (ml/kg/min)			
CG	32.8 ± 2.3	30.1 ± 2.3	-2.5 ± 1.5
EG2d	31.2 ± 2.0	34.8 ± 2.1	3.4 ± 1.3 [c]
EG3d	32.1 ± 1.9	38.7 ± 1.9	6.7 ± 1.2 [c]
p value	0.876	0.025	< 0.001
Time Rockport 1-mile test (minutes)			
CG	16.7 ± 0.7	17.2 ± 0.7	0.5 ± 0.5
EG2d	16.7 ± 0.6	15.9 ± 0.6	-0.8 ± 0.4
EG3d	16.3 ± 0.6	14.9 ± 0.6	-1.4 ± 0.4 [c]
p value	0.823	0.055	0.007
Heart rate Rockport 1-mile test (bpm)			
CG	104.5 ± 4.7	111.1 ± 4.2	2.7 ± 2.8
EG2d	124.1 ± 4.1	119.7 ± 3.7	-2.6 ± 2.4
EG3d	122.3 ± 3.9	109.5 ± 3.5	-11.6 ± 2.2 [c, d]
p value	0.006	0.116	0.001
Resting Heart Rate (bpm)			
CG	68.1 ± 2.2	69.7 ± 2.0	1.7 ± 0.8
EG2d	66.8 ± 1.9	65.3 ± 1.8	-1.6 ± 0.7 [c]
EG3d	68.6 ± 1.8	63.5 ± 1.6	-4.9 ± 0.7 [c, d]
p value	0.789	0.069	< 0.001

Data are estimated means ± standard errors. CG indicates control group (n=15); EG2d: experimental group 2 days per week (n=18); EG3d: experimental group 3 days per week (n=21). [a] ANCOVA with sex and age as confounders. [b] ANCOVA with sex, age and baseline level as confounders, and Bonferroni's adjustments for *post-hoc* comparisons. [c] Significantly different from CG. [d] Significantly different from EG2d.

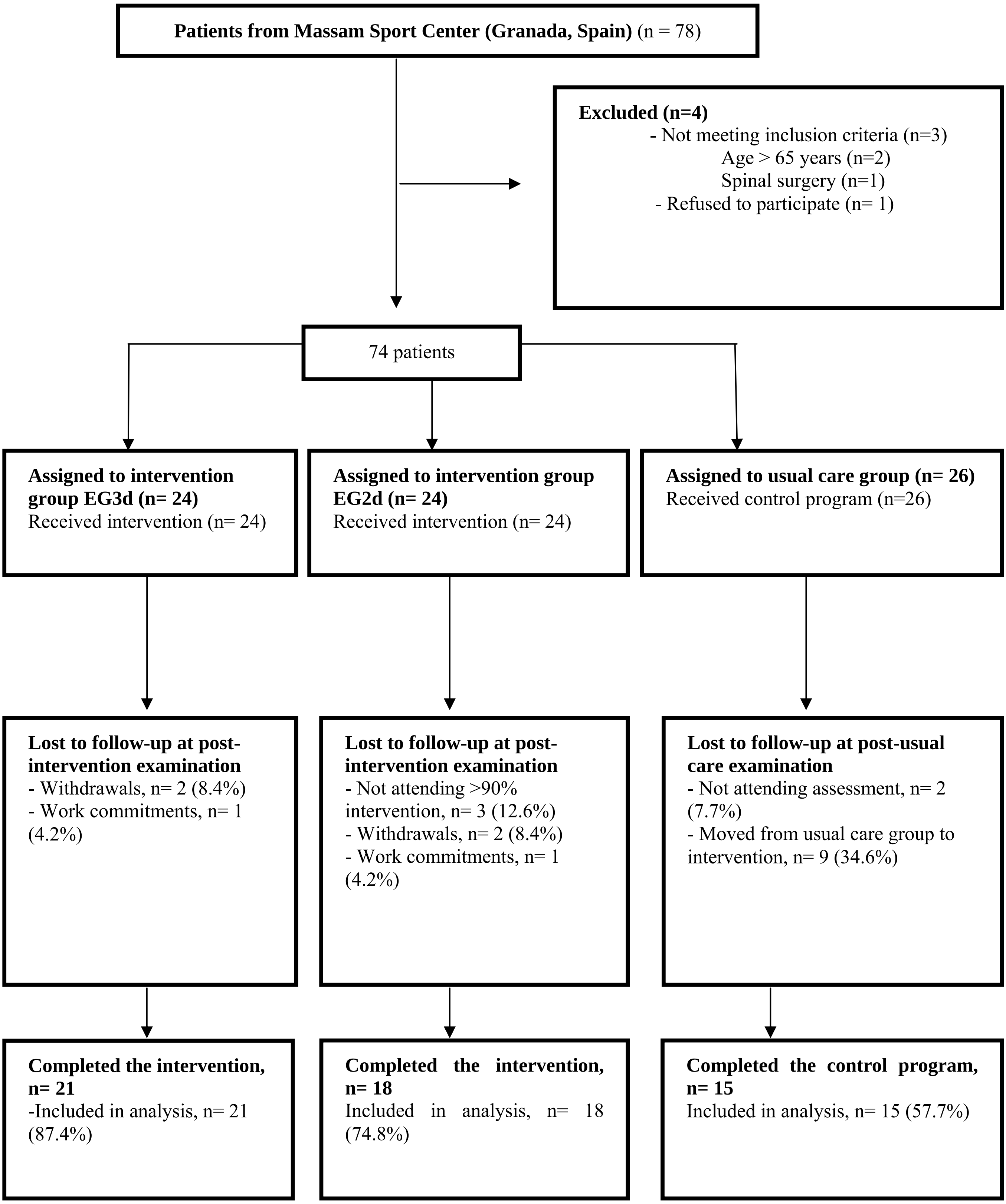

Figure 1 Flow of patients throughout the trial

2.3. CHANGES IN PAIN, QUALITY OF LIFE AND ABDOMINAL MUSCLE STRENGTH PREDICT IMPROVEMENT IN LOW-BACK-PAIN-RELATED DISABILITY AFTER AQUATIC EXERCISE.

Baena-Beato PA, Delgado-Fernández M, Artero EG, Robles-Fuentes A, Gatto-Cardia MC, Arroyo-Morales M.

(Artículo IV)

Changes in pain, quality of life and abdominal muscle strength predict improvement in low-back-pain-related disability.

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ABSTRACT

Disability has commonly been found to have high levels in patients with chronic low back pain. The current study is a cross-sectional analysis of the factors influencing self-rated disability associated with chronic low back pain and prospective study of the relationship between changes in back pain intensity, quality of life and health-related fitness and in disability following physical therapy. Significant correlations between disability and VAS at rest ($r = 0.582$, $p < 0.01$), MCS SF-36 ($r = -0.270$; $p < 0.05$); curl up ($r = - 0.35$, $p < 0.01$) and handgrip ($r = -0.431$; $p < 0.01$), were found. Changes in pain intensity, abdominal muscular endurance and mental component were significant predictors of change in disability in patients with chronic low back pain post-therapy. Multidimensional programmes with pain-control strategies and strength exercise could help patients to cope with disability-related CLBP.

Key Words: Disability, Chronic Low Back Pain, Muscle Endurance, Quality of Life.

Disclosures None.

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INTRODUCTION

Patients with chronic low back pain (CLBP) suffer from clinical manifestations, including physical and psychological symptoms that have an impact on their health status.[1] Most low back pain related costs to society derive from patients' disability, not pain, which is also the main determinant of patients' quality of life (QoL).[2,3] Disability have commonly been found to have high levels in patients with CLBP,[4] which is the third leading cause of functional disability chronicle after respiratory conditions and injuries.[5] Therefore, treating disability is as important as treating pain.[6]

Different therapeutic exercise programs have showed effectiveness to improve disability [7,8] but the results are controversial.[9] The factors interact with physical measures of impairment in explaining disability, and the relative extents to which psychological and physical factors account for improvements in outcome following therapy for CLBP, have rarely been examined. Mannion et al.[10] established explicative models of changes in disability promote by therapeutic exercise, where changes in pain, psychological distress and fear-avoidance beliefs accounted for only 24% of the changes in disability following therapy. More precise and explicative models are needed to treat adequately this health problem.

Disability in back pain is highly influenced by pain, physical impairment, psychological and psychosocial factors. [2,11] Patients with CLBP usually report that pain is their main problem and the main cause of their disability.[2] In individuals with chronic disabilities, pain may induce serious psychological problems, negatively affecting quality of life,[12] where psychological distress has been identified as one potential pathway by which an episode of pain influences the development of persistent disabling symptoms.[13]

These factors explain only a portion of how CLBP affects disability, and other factors should be explored. There are evidences that exercise can decreased disability, pain, secondary physical deconditioning in patients with CLBP,[14,15] where physical treatments are based on the assumption that increased muscle strength, aerobic capacity and stretching are crucial for the resumption of activities, and hence for the reduction of disability.[16,17] Nevertheless, there is not information about influence of different physiological and psychological parameters in improvement of disability after aquatic exercise.

To the best of the authors' knowledge, no previous study has investigated the association of pain, QoL and health-related fitness with disability in patients with CLBP post-therapy. The aim of this study was to investigate the relationship of changes in pain, QoL and health-related fitness with improvement in disability in patients with CLBP treated with aquatic exercise.

METHODS

Patients

A total of 75 sedentary adults suffering CLBP (37 men and 38 women); age 49.46 ± 9.89 years; body mass index (BMI) 27.07 ± 5.03 kg/m^2 volunteered to participate in this study. A cross-sectional study was used. Participants were recruited in Massam Sport Center (Granada, Spain). In a first session, they received written and oral instructions about the intervention, test protocol and the possible risks and benefits of the study. Written informed consent was obtained before participation. The study was approved by the Ethical Committee of the University of Granada and was performed in accordance with the Helsinki Declaration, last modified in 2000. The inclusion and exclusion criteria for this study appear on Table 1.

We contacted the patients by phone or upon their hospital admission, and those meeting initial study criteria received an explanation of the research protocol at the beginning of the exercise program. Data were then gathered on the following demographic and clinical characteristics by using a previously prepared questionnaire and reviewing the patients' clinical records: age, sex, height, weight, comorbidity, socio-educational level, civil status and physical activity level.

Treatment

The eight weeks aquatic exercise program was carried out in an indoor pool sized 25 x 6 m, with 140 cm water depth, 30 ± 1ºC of water temperature. Each aquatic exercise session was conducted in reduced groups of 7 to 8 participants and lasted 55-60 minutes (10 minutes of warm-up, 20-25 minutes of aerobic exercise, 15-20 minutes of resistance exercise, and 10 minutes of cool-down). The resistance exercises included the following resistance exercises: hip flexion-extension, hip abduction-adduction, arms abduction-adduction at chest level, curl-ups, scissors leg, backstroke kick with water noodle under the waist. The aerobic exercises incorporated large muscle mass and consisted of lateral displacements, long-lever pendulum-like movements of the extremities, forward and backward jogging with arms pushing, pulling, and pressing, leaps, kicks, leg crossovers and hopping movements focusing on travelling in multiple directions, and bounding off the bottom of the pool. Lower-body stretching exercises (static stretching technique) were performed at the end of each session, as part of the cool-down. The muscle groups to stretch were gluteus, lumbar back and hamstrings.[20]

Outcome Measures

To assess the changes in different parameters after aquatic exercise, the measurements were taken at baseline and 24 hours after discharge the aquatic exercise program.

Questionnaires

Participants were evaluated for the following questionnaires: Oswestry low back pain disability questionnaire, visual analog scale (VAS) and Short-Form 36 Health Survey (SF-36).

Oswestry low back pain disability questionnaire

The Spanish version of the Oswestry low back pain disability questionnaire [21] was used to measure back-related disability of activities of daily living. The Oswestry low back pain disability questionnaire is comprised of 10 questions about pain and pain-related disability in activities of daily life and social participation. The sum of the response scores was calculated and presented as a percentage, where 0 % represents no pain or disability and 100 % represents the worst possible pain and disability. The reliability and validity of the Spanish version of the Oswestry low back pain disability questionnaire has been found to be acceptable, [21] and the minimal clinical important change is considered 10 % in patients with low back pain. [22]

Visual analog scale

Back pain was assessed at rest and during movement (flexion and extension) using a VAS, ranging from 0 to 10 cm (0 means no pain, 10 means highest level of pain). The reliability and validity of VAS has previously been found to be acceptable, [23] and the minimal clinical important change has been estimated to be 15 mm in patients with low back pain. [22]

Short-Form 36 Health Survey

The Quality Short-Form Health Survey 36 is a generic instrument assessing health related QoL. In this study we used the Spanish version of SF-36. [24] It contains 36 items and yields 8 domains (parameters): physical functioning, physical role, bodily pain, general health, vitality, social functioning, emotional role and mental health. These 8 parameters can be used to derive 2 composite scoring summaries: physical composite summary (PCS SF-36: physical functioning, physical role, bodily pain and general health perceptions) and mental composite summary (MCS SF-36: vitality, social functioning, mental health and emotional role).The SF-36 is a sensitive measure of treatment success in patients with low back pain. [25] Each domain is scored on a scale from 0 (worst possible health) to 100 (best possible health). [26]

Health-related fitness outcomes

Participants were evaluated in health-related fitness for curl-up test, handgrip strength, sit and reach test and resting heart rate. Body mass index (BMI) was also measured. All testing sessions were conducted by the same experimented researcher and testing took place in laboratory conditions at 24º C temperature.

Curl up Test

Abdominal muscular endurance was measured using the curl-up test.[20] The cadence for the test was 40 beats/min, paced by a metronome. The test was terminated when the subject was unable to maintain the required cadence or unable to maintain the proper curl-up technique for 2 consecutive repetitions despite feedback from the researcher. A maximum of 3 corrections were allowed by the appraiser before termination of the test. The highest number of repetitions completed while maintaining proper form was recorded.

Handgrip strength Test

Upper body isometric strength was assessed by using handgrip strength test. A hand dynamometer with adjustable grip was used (TKK 5101 Grip D; Takey, Tokio Japan) was used. The patients squeezed gradually and continuously for at least two seconds, performing the test with the right and left hands in turn, with the elbow in full extension. The test was performed twice and the maximum score for each hand was recorded in kilograms. Optimal grip was noted for each participant in the pre-test, and repeated in the post-test. The sum of the scores achieved by left and right hands was used in the analysis. [27]

Sit and reach Test

Trunk flexion and hamstring tone were determined via the sit and reach test, as described by the American College of Sport Medicine´s (ACSM) protocol.[20] The test was performed twice, and the best result in centimetres was recorded. If the ruler was somewhere between two centimetres, the lower one was scored.

Resting heart rate

Participants were instructed in the procedure of measuring their pulse, and then were asked to register resting heart rate manually at home, from the carotid artery using a stopwatch. They registered resting heart rate in four non-consecutive days during pre- and post-test weeks: in the morning before getting up or after staying in prone position for at least 30 min. The average heart rate among the four measurements was used as resting heart rate before and after the intervention.

Body mass index

Weight (kg) was measured using Octapolar bioimpedance analyses (Biospace Inbody 720; Biospace Company, Ltd., Seoul, Korea). Biospace Inbody analyse has been found in the literature to be reliable in the calculation of body composition. [28] Height (m) was measured in the Frankfurt plane with a telescopic height measuring instrument (Type SECA 225; range, 60 to 200 cm; precision, 1 mm). BMI was calculated (kg/m^2).

Statistical Analyses

Mean and 95% confidence interval were reported for continuous variables with a normal distribution. Pearson's and Spearman's correlation analyses were applied whenever appropriate. The correlation analyses were carried out between the change (Λ), post – pre differences at baseline (pre-test) and follow-up (post-test), in the disability (ODI), back pain (VAS at rest), PCS SF-36 and MCS SF-36 (Short-Form 36 Health Survey), abdominal muscular endurance (curl up), upper body isometric strength (handgrip), trunk flexion and hamstring tone (sit and reach), resting heart rate and BMI, after physical therapy program. The assumptions of normality, linearity, and homoscedasticity were investigated by the residual scatterplots. Stepwise multiple regression analysis was used to explore which variables could explain the variation in disability (dependent variable). The change in back pain, health related QoL, abdominal muscular endurance, upper body isometric strength, trunk flexion and hamstring tone, resting heart rate and BMI were considered independent variables. The requirement of an independent variable to be included in the multiple regression analysis was: 1) the correlation coefficient between the dependent variable and the independent variables was ≥0.25; and 2) the correlation coefficient between the independent variables was ≤0.7. [29] In addition, only variables with a significant correlation with the dependent variable were included in the multiple regression analysis. *p*-values <0.05 were considered significant. Finally, the final model was validated using bootstrapping.

Specifically, the bootstrapping method was carried out with repeated samples of the same size as the original samples in replacement. Two thousand replications were produced to estimate bootstrap bias-corrected and accelerated confidence intervals (bca CI). For statistical analyses, significance level was set at $p < 0.05$. All analyses were performed using R software (2.9.3).

RESULTS

Participants had an educational status of unfinished studies and primary school of 41%, secondary school and university degree of 59%; civil status was married of 75%; occupational status was housewife 23%, working 42%, retired 22% and unemployed 13%. Caucasian from Granada metropolitan area (Table 2). Participants showed moderate disability (mean ± SD: 29.3 ± 13.4), [30] pain was from moderate to intensity (mean ± SD: 6.2 ± 2.2), [31] MCS SF-36 (mean ± SD: 50.2 ± 11.4) was borderline to poor mental health, [26] and curl up was low (mean ± SD: 12.4 ± 5.4),[20] handgrip test from low to moderate (mean ± SD: 69.4 ± 20.2),[20] sit and reach test very low (mean ± SD: 9.1 ± 9.8),[20] resting heart rate (mean ± SD: 69.4 ± 8.9), PCS SF-36 was low (mean ± SD: 35.9 ± 9.9). [26]

Correlational analyses

Significant positive correlations between disability and VAS at rest ($r = 0.582$, $p < 0.01$) were also found: the greater the disability, the higher back pain. In addition, significant negative correlations between disability and MCS SF-36 ($r = -0.270$; $p < 0.05$); disability and curl up ($r = - 0.35$, $p < 0.01$), disability and handgrip ($r = -0.431$; $p < 0.01$), were found: the greater the self-reported disability, the lower MCS SF-36, abdominal muscular endurance and upper body isometric strength.

In addition, significant correlations existed among the independent variables ($r = - 0.27 < r < 0.58$; **Table 3**), but none was considered to be multi-collinear (defined as $r > 0.70$); therefore, each one was included in regression analyses.

Regression analyses

Stepwise regression analyses revealed that changes in back pain intensity, abdominal muscular endurance, and MCS SF-36 were independent and significant predictors of change in disability related CLBP after aquatic exercise, and when combined, they explained 51.1 % of the variance in disability scores (**see Table 4**).

DISCUSSION

Results from this study showed that changes in back pain intensity, abdominal muscular endurance and MCS SF-36 were significant predictors of changes in CLBP-related disability after aquatic exercise program. Current findings suggest that changes in back pain intensity, abdominal muscular endurance and emotional symptoms have a relevant contribution to changes in CLBP-related disability.

Disability related to CLBP may be caused by pain, physical impairment, psychological distress and psychosocial factors. [2,32] Our study is the first to specifically examining disability determinants related to pain intensity, abdominal muscular endurance and MCS SF-36, after a treatment based on aquatic exercise program, resulting from CLBP. Since rehabilitation strategies are focussed in reducing pain and clinical repercussions from CLBP, particularly disability, understanding potential determinants for improves disability may assist in the rehabilitation process in these patients.

To the best of the authors' knowledge, only one study has investigated predictor's variables in disability post-therapy in patients with CLBP. [10] Mannion et al., (2001)[10] reported a model where pain, phychological distress and fear-avoidance belief account for only 24% of variance in disability after treatement. Our model was able to explain in total 51% of the variability in disability post-therapy in patients with CLBP, where a reduction of pain intensity combined with an improvement in abdominal muscular endurance and emotional symptoms, could contribute to reducing disability.

Patients with CLBP usually report that pain is their main problem and the main cause of their disability. [2] In the present study, change in pain is the variable with the largest contribution (33%) to the total explained variance, this was reflected by higher back pain intensity in patients with CLBP reporting greater disability. These results are in accordance with previous studies that have used multivariated analysis to predict disability, and have shown that pain normally explains the greatest or second greatest proportion of the variance. [10,11,33,34] The relationship between disability and pain is bidirectional and a complex process, as disability is a symptom of pain, resulting in loss of function. Back pain may lead to disability through its effects on physical impairment [35] and psychological distress. [13] It is often assumed that patients who feel more disabled and thus report more daily life restrictions due to pain intensity [36] will be those who are less physically active in CLBP. [37] This is reflected in treatments recommended for CLBP, which typically promote increased physical activity to aid recovery and reduce pain intensity and disability.

Abdominal muscle endurance was a significant and relative new determinant of disability in the present study (11% to the total explained variance in disability post-therapy), and was one of the few physical factors that retained its importance when considered in combination with the pain and MCS SF-36. One important risk factor for low back pain is weakness of abdominal muscles [38,39] and strengthening of these is often associated with significant improvements of CLBP, as well as, with decreased functional disability. [40-42] We speculate that increased abdominal muscular endurance could be one of the most substantial effects of the aquatic exercise in physical condition of patients suffering CLBP in our study.

Changes in muscle activity have been observed in experimental [43] and clinical studies [44] induced by pain, where reflex inhibition is suggested to play a role. [45] The role of muscular strength in the performance of activities of daily living (sitting, standing, lifting, or rolling over in bed), as well as in the prevention of chronic disease, is increasingly being recognized. [46,47] There is an association between abdominal muscle endurance and disability, where qualitative changes in posture [48] and movement can occur dramatically and spontaneously as a result of gradual changes in parameters of abdominal muscular endurance, resulting in some degree of disability hindering the patient to perform activities of daily living. [49]

Finally, data from the current study suggest that MCS SF-36 is also related to disability. MCS SF-36 is characterised by four parameters: vitality, social functioning, mental health and emotional role, which can be summed to represent a composite measure of positive emotional symptoms affecting disability. In the present study, MCS SF-36 explained 6% to the total variance in disability post-therapy. Previous studies have used psychological [10] and psychosocial factors [50] analysis to predict disability, which are potentially influential in the development of pain-related disability, [51] and assessment of these factors has been recommended to help predict long-term outcome. [1] according to Mannion et al.,[10] disability was explained for measure of negative emotional symptoms; where psychological distress such as depression, stress, somatic anxiety and fear-avoidance beliefs accounted for 8% of variance in disability after treatment. In our study disability was explained for positive emotional symptoms, where was used a wider variable (MCS SF-36) of the psychological and psychosocial factors post-therapy.

We should recognize some limitations of the study. First, we included a relative small sample size (*n*= 60) and used a cross-sectional design. However, because of the small sample size, the number of independent variables entered in the regression analysis was limited to reduce the likelihood of a type II error. Second, other relevant outcomes such as lumbar musculature endurance levels should be examined in future research to provide more global information about relationship between physical condition and disability. Additionally, due to the cross-sectional study design, a cause and effect relationship between those variables associated with disability cannot be truly confirmed.

CONCLUSSION

The current study described significant associations between disability, back pain intensity, QoL and health-related fitness in patients with CLBP treated with aquatic exercise. Changes in pain intensity, abdominal muscular endurance and positive symptoms were significant predictors of change in disability in patients with CLBP post-therapy. Therapists working with patients with CLBP should take in account these relationships to improve the management of CLBP-related disability. Multidimensional programmes with pain-control strategies and strength exercise could help patients to cope with CLBP-related disability.

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Table 1. Inclusion and exclusion criteria.

Inclusion criteria
- Age between 25 and 64 years - Presence of self-reported low back pain for more than 12 weeks. [18]
Exclusion criteria
• Symptoms or signs that might suggest serious medical illness • Pregnancy or recent childbirth • Major rheumatologic, neurologic, neoplastic, or other conditions that may prevent full participation in the intervention • Previous spinal surgery, inflammatory, infectious, or malignant diseases of the vertebra • Presence of any psychiatric disorder which might affect the compliance and the assessment of symptoms • Presence of severe cardiovascular disease • Sedentary people (participants were also excluded if they were engaged in physically active ≥ 60 minutes per week during the last 12 months). [19]

Table 2. Sociodemographic characteristics of participants by group, percentages are given in brackets.

Variable	Usual care Group (n=15)	Experimental Group (n=60)	p Value
Gender, n (%)			0.817
Men	7 (46.7)	30 (50.0)	
Women	8 (53.3)	30 (50.0)	
Age, years ± SD	44.93 ± 9.70	50.60 ± 9.69	0.047*
Civil status, n (%)			0.114
Married	9 (60.0)	45 (75.0)	
Unmarried	5 (33.3)	7 (11.7)	
Separated/Divorced/Widowed	1 (6.7)	8 (13.3)	
Educational status, n (%)			0.033*
Unfinished studies	0 (0.0)	3 (5.0)	
Primary school	3 (20.0)	22 (36.7)	
Secondary school	10 (66.7)	16 (26.7)	
University degree	2 (13.3)	19 (31.7)	
Occupational status, n (%)			0.306
Housewife	2 (13.3)	14 (23.3)	
Student	0 (0.0)	0 (0.0)	
Working	10 (66.7)	25 (41.7)	
Unemployed	2 (13.3)	8 (13.3)	
Retired	1 (6.7)	13 (21.7)	

*p <0.05

Table 3. Pearson product–moment correlation matrix for study variable

	Λ ODI	Λ PCS SF-36	Λ MCS SF-36	Λ BMI	Λ HS	Λ SR	Λ VAS rest	Λ HRR	Λ CURL
Λ ODI	1.00	-	-	-	-	-	-	-	-
Λ PCS SF-36	-0.009	1.00	-	-	-	-	-	-	-
Λ MCS SF-36	-0.270(*)	-0.063	1.00	-	-	-	-	-	-
Λ BMI	-0.081	-0.034	0.011	1.00	-	-	-	-	-
Λ HS	-0.431(**)	0.314(*)	0.130	0.002	1.00	-	-	-	-
Λ SR	-0.193	0.215	-0.141	-0.249	0.348(**)	1.00	-	-	-
Λ VAS rest	0.582(**)	-0.164	-0.084	-0.084	-0.355(**)	-0.241	1.00	-	-
Λ HRR	0.242	-0.018	0.085	0.148	-0.481(**)	-0.176	0.223	1.00	-
Λ CURL	-0.353(**)	0.023	-0.042	-0.303(*)	0.288(*)	0.206	0.039	-0.349(**)	1.00

* p <0.05; ** p<0.01

Λ, change between post – pre differences at baseline (pre-test) and follow-up (post-test); ODI, Oswestry Disability Index; PCS SF-36, Physical Composite Summary of SF-36; MCS SF-36, Mental Composite Summary of SF-36; BMI, Body Mass Index; HS, Handgrip strength; VAS rest, Visual Analog Scale at rest; HRR, Heart Rate at Rest; SR, Sit and Reach.

Table 4. Summary of stepwise regression analyses to determine predictors of improvement in disability (r^2 = 51.1%)

Independent Variables	*Unstandardized Coefficients β*	*95 % CI for β*	*Bootstrap Bca 95 % CI*	*Bootstrap β*	*Standardized Coefficients β*	*t*	*p Value*	*r^2 (%)*
Interceptil	3.264	(-1.571 /8.100)	-1.155 /7.621	3.213		1.352	0.182	
Λ VAS rest	2.189	(1.494/2.883)	1.512-2.883	2.182	0.577	6.312	<0.001	32.7 %
Λ CURL	-0.960	(-1.415 /-0.505)	-1.344/-0.574	-0.959	-0.386	-4.231	<0.001	11.0 %
Λ MCS SF-36	-0.244	(-0.433/-0.056)	-0.459/-0.086	-0.254	-0.238	-2.599	0.012	5.70 %

β = regression coefficient; r^2 = Variability of disability explained by the respective models in percent; Λ, change between post – pre differences at baseline (pre-test) and follow-up (post-test); MCS SF-36, Mental Composite Summary of SF-36; VAS rest, Visual Analog Scale at rest.

LIMITACIONES Y FUTURAS INVESTIGACIONES

Aunque planificado, diseñado y ejecutado con el mayor rigor posible, el presente trabajo de Tesis Doctoral presenta algunas limitaciones que conviene considerar. Por cuestiones éticas y logísticas, no fue posible llevar a cabo una randomización completa de la muestra objeto de estudio a la hora de confeccionar los grupos experimentales y control. Además, para la estimación del volumen máximo de oxígeno, se empleó una prueba indirecta y no un analizador de gases capaz de medir directamente el intercambio gaseoso entre el sujeto y el ambiente. Otra limitación de este y otros estudios experimentales radica en el uso de una escala subjetiva del esfuerzo (RPE) como medio de cuantificación de la intensidad del ejercicio aeróbico. Y por último, y no menos importante, No se realizó un control de los hábitos nutricionales ni del uso de medicación durante el periodo de intervención, lo cual pudo influir sobre el grado en que la tratamiento tuvo efecto sobre las variables de estudio.

Para futuras investigaciones será necesario tener en cuenta las limitaciones de la presente memoria de Tesis, e incluir en sus objetivos y metodología experimental las siguientes consideraciones: a) un mayor número de participantes y tiempo de tratamiento, así como la realización de una tercera medida (re-test) para poder comprobar la evolución de las mejoras obtenidas por el programa una vez finalizado el mismo; b) evaluar el control y coordinación neuromuscular de la musculatura implicada en el control postural de la zona lumbar, así como el uso de herramientas de diagnóstico más potentes para la evaluación del estado muscular (Electromiografía, Resonancia Magnética Nuclear, Ecografía, Isocinética); c) comprobar si la metodología utilizada en el tratamiento referente a la planificación de los ejercicios es eficaz también fuera del medio acuático; d) e incluir nuevas herramientas para la evaluación del estado psicólogico del paciente.

CONCLUSIONES

- Es posible sugerir la idoneidad del ejercicio físico acuático como terapia física apropiada para personas con dolor lumbar crónico que genera discapacidad e incide en su CVRS.
- Un programa de ejercicio físico acuático de 5 días a la semana durante dos meses, disminuye la intensidad de dolor y la discapacidad, mejora la CVRS, la composición corporal y los parámetros de condición física en sujetos adultos sedentarios con DLC.
- Un programa de ejercicio físico acuático de 3 días/semana durante dos meses induce mayores beneficios en dolor, discapacidad, fuerza-resistencia abdominal y frecuencia cardiaca en reposo y post-esfuerzo que un programa con 2 días/semana en sujetos adultos sedentarios con DLC.
- La mejora de la discapacidad provocada por el DLC experimentada en los pacientes tras la práctica de ejercicio físico acuático se debe principalmente a la reducción del dolor, el incremento de la fuerza abdominal y la mejora del estado mental.

Conclusión general:

Los resultados de la presente memoria de Tesis ponen de manifiesto la utilidad de un programa de ejercicio físico acuático en el tratamiento de personas adultas sedentarias con DLC.

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Becas y Contratos de Investigación

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Publicaciones Científicas

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- Artero EG, España-Romero V, Castro-Piñero J, Ruiz JR, Jiménez-Pavón D, Aparicio VA, Gatto-Cardia MC, **Baena PA,** Vicente-Rodriguez G, Castillo MJ, Ortega FB. Criterion-related validity of field-based muscular fitness tests in youth. J Sports Med Phys Fitness. Aceptado.
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“El destino no es cuestión de suerte. Es fruto de una elección”.

“Lo que importa realmente no es si sigues o no sigues, sino si vas a disfrutar de tu camino”

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"Las fuerzas naturales que hay en nuestro interior son las verdaderas sanadoras de la enfermedad"

"La risa es la mejor medicina"

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