

Supplementary information for: Cold water immersion: Exploring the effects on well-being – scoping review

Matthew Ono · Max Wahl · Robell Mekonen
Kevin Kemp-Smith · James Furness

Supplementary Material

Supplementary material 1. Full search strategy

Database	Search Strategy
PubMed	("cold water immersion"[tiab] OR "cold water swimming"[tiab] OR "cold immersion"[tiab] OR "ice bath"[tiab] OR "cold water swimming"[tiab] OR "cold water submersion"[tiab] OR "cold water therapy"[tiab] OR "ice water immersion"[tiab] OR "cold water exposure"[tiab] OR "winter swimming"[tiab] OR "whole-body cryotherapy"[tiab] OR "thermal sensation"[tiab]) AND ("Psychological Wellbeing"[tiab] OR "psychological wellness"[tiab] OR cognitive[tiab] OR Self-esteem[tiab] OR mood[tiab] OR "mental state"[tiab] OR "health promotion"[tiab] OR self-efficacy[tiab] OR "health effects"[tiab])
Embase	('cold water immersion':ti,ab OR 'cold water swimming':ti,ab OR 'cold immersion':ti,ab OR 'ice bath':ti,ab OR 'cold water swimming':ti,ab OR 'cold water submersion':ti,ab OR 'cold water therapy':ti,ab OR 'ice water immersion':ti,ab OR 'cold water exposure':ti,ab OR 'winter swimming':ti,ab OR 'whole-body cryotherapy':ti,ab OR 'thermal sensation':ti,ab) AND ('Psychological Wellbeing':ti,ab OR 'psychological wellness':ti,ab OR cognitive:ti,ab OR Self-esteem:ti,ab OR mood:ti,ab OR 'mental state':ti,ab OR 'health promotion':ti,ab OR self-efficacy:ti,ab OR 'health effects':ti,ab)
PsychInfo	("cold water immersion".ti,ab. OR "cold water swimming".ti,ab. OR "cold immersion".ti,ab. OR "ice bath".ti,ab. OR "cold water swimming".ti,ab. OR "cold water submersion".ti,ab. OR "cold water therapy".ti,ab. OR "ice water immersion".ti,ab. OR "cold water exposure".ti,ab. OR "winter swimming".ti,ab. OR "whole-body cryotherapy".ti,ab. OR "thermal sensation".ti,ab.) AND ("Psychological Wellbeing".ti,ab. OR "psychological wellness".ti,ab. OR cognitive.ti,ab. OR Self-esteem.ti,ab. OR mood.ti,ab. OR "mental state".ti,ab. OR "health promotion".ti,ab. OR self-efficacy.ti,ab. OR "health effects".ti,ab.)
SportDiscus	((TI "cold water immersion" OR AB "cold water immersion") OR (TI "cold water swimming" OR AB "cold water swimming") OR (TI "cold immersion" OR AB "cold immersion") OR (TI "ice bath" OR AB "ice bath") OR (TI "cold water swimming" OR AB "cold water swimming") OR (TI "cold water submersion" OR AB "cold water submersion") OR (TI "cold water therapy" OR AB "cold water therapy") OR (TI "ice water immersion" OR AB "ice water immersion") OR (TI "cold water exposure" OR AB "cold water exposure") OR (TI "winter swimming" OR AB "winter swimming") OR (TI "whole-body cryotherapy" OR AB "whole-body cryotherapy") OR (TI "thermal

	sensation" OR AB "thermal sensation")) AND ((TI "Psychological Wellbeing" OR AB "Psychological Wellbeing") OR (TI "psychological wellness" OR AB "psychological wellness") OR (TI "cognitive" OR AB "cognitive") OR (TI "Self-esteem" OR AB "Self-esteem") OR (TI "mood" OR AB "mood") OR (TI "mental state" OR AB "mental state") OR (TI "health promotion" OR AB "health promotion") OR (TI "self-efficacy" OR AB "self-efficacy") OR (TI "health effects" OR AB "health effects"))
Proquest Dissertations & Theses Global	(TI,AB("cold water immersion") OR TI,AB("cold water swimming") OR TI,AB("cold immersion") OR TI,AB("ice bath") OR TI,AB("cold water swimming") OR TI,AB("cold water submersion") OR TI,AB("cold water therapy") OR TI,AB("ice water immersion") OR TI,AB("cold water exposure") OR TI,AB("winter swimming") OR TI,AB("whole-body cryotherapy") OR TI,AB("thermal sensation")) AND (TI,AB("Psychological Wellbeing") OR TI,AB("psychological wellness") OR TI,AB(cognitive) OR TI,AB(Self-esteem) OR TI,AB(mood) OR TI,AB("mental state") OR TI,AB("health promotion") OR TI,AB(self-efficacy) OR TI,AB("health effects"))
Proquest Health & Medical	(TI,AB("cold water immersion") OR TI,AB("cold water swimming") OR TI,AB("cold immersion") OR TI,AB("ice bath") OR TI,AB("cold water swimming") OR TI,AB("cold water submersion") OR TI,AB("cold water therapy") OR TI,AB("ice water immersion") OR TI,AB("cold water exposure") OR TI,AB("winter swimming") OR TI,AB("whole-body cryotherapy") OR TI,AB("thermal sensation")) AND (TI,AB("Psychological Wellbeing") OR TI,AB("psychological wellness") OR TI,AB(cognitive) OR TI,AB(Self-esteem) OR TI,AB(mood) OR TI,AB("mental state") OR TI,AB("health promotion") OR TI,AB(self-efficacy) OR TI,AB("health effects"))
CINAHL	((TI "cold water immersion" OR AB "cold water immersion") OR (TI "cold water swimming" OR AB "cold water swimming") OR (TI "cold immersion" OR AB "cold immersion") OR (TI "ice bath" OR AB "ice bath") OR (TI "cold water swimming" OR AB "cold water swimming") OR (TI "cold water submersion" OR AB "cold water submersion") OR (TI "cold water therapy" OR AB "cold water therapy") OR (TI "ice water immersion" OR AB "ice water immersion") OR (TI "cold water exposure" OR AB "cold water exposure") OR (TI "winter swimming" OR AB "winter swimming") OR (TI "whole-body cryotherapy" OR AB "whole-body cryotherapy") OR (TI "thermal sensation" OR AB "thermal sensation")) AND ((TI "Psychological Wellbeing" OR AB "Psychological Wellbeing") OR (TI "psychological wellness" OR AB "psychological wellness") OR (TI cognitive OR AB cognitive) OR (TI Self-esteem OR AB Self-esteem) OR (TI mood OR AB mood) OR (TI "mental state" OR AB "mental state") OR (TI "health promotion" OR AB "health promotion") OR (TI self-efficacy OR AB self-efficacy) OR (TI "health effects" OR AB "health effects"))

Supplementary material 2. Complete codebook

Code	Definition	Inclusion	Exclusion	Example
Interacting with nature	Engaging in activities or experiences that involve direct contact or connection with natural environments, such as parks, forests, gardens, bodies of water, or wilderness areas	Interaction must involve individual going/immersing oneself into water	Blue space areas like beaches	"One of the things I love is to me this is real water because it has got life and movement to it and you can feel that there is this lovely swell coming through and the ripples over the top from the wind. And it is proper water, it is not all tamed." (Denton & Aranda, 2020, p. 658)
Escape	The ability or act of freeing one's mind from constraints, worries, or limitations that might be holding it captive	Must involve the act of an individual being able to mentally escape in their mind	Physical form of escaping an aspect, situation or area	"I don't get the headspace in a pool that I do out here. I don't get out of the pool and get that feeling of 'ahhh, that was nice' and the headspace. When I'm in open water, and it probably sounds awful, but I don't have a phone, I don't have emails, I'm not a mum, I'm not a wife, I'm not running a business, I'm just on 'time out' - I don't get that in a pool, a lot of people approach me in a pool, because they know what I do, and my daughter might be over there, and my phone's in my locker, buzzing... you forget everything when in open water." (Christie & Elliott, 2023, p. 14)
Sense of purpose	Having a clear reason for doing something. Gives one's life meaning and direction			"I always sleep better after an OWS...it's very positive for me...I miss it if I can't get for a swim, I like to think when I retire full time, I'll find more time to swim, so that's my aim, to up the distances." (Christie & Elliott, 2023, p. 14)
Self-esteem	Refers to a person's overall subjective evaluation or perception of their own worth, value and capabilities			"People appear relaxed about their bodies, whether lean or carrying excess body fat, which suggests they feel comfortable in their surroundings, and that the lake offers something of a supportive place to be." (Christie & Elliott, 2023, p. 17)
Exhilarating	Causing you to feel very excited and happy	Discussion of excitement	Solely happiness-	"I think I know, once I get in it will be really nice, and I love that rush when you kind of,

			based statement	you know, you're all cold and your body goes all tingly, and it's exciting and thrilling, and you kind of find a new comfort inside, in the water. And I know it's there because I've done it a million times before, but also I feel very reluctant. But I kind of know it's going to sort me out as well." (Bates & Moles, 2023, p. 74)
Sense of pride	One's belief that their existence has a specific reason or a larger, overarching goal that provides direction, motivation and fulfilment			"I think it's probably part of me, and equally my family. I think we just...it's very difficult... I suppose it's something so basic and its ingrained and it's there from nearly birth and becomes part of what you are as well." (Foley, 2015, p. 223)
Resilience	One's ability to effectively cope with challenges, setbacks, stress, and adversity			"The sea definitely strengthened me personally. And I would tend to be quite an empathetic person. I could walk into a room and feel everybody's feelings. Whereas I think going in and out of the sea helps me to be stronger about that. So it's protecting yourself in a strange way." (Murray & Fox, 2021, p. 92)
Sense of adventure	When doing unusual, exciting, and possibly dangerous activities	Must be within CWI	Any type of mention of adventure that's related to other blue space/nature that doesn't require cold water	"It was always something that you want to explore but you know that it is dangerous and scary and then overtime, I guess, it is that experience and knowledge you kind of, that completely changes and you end up going from something that you kind of really fear and don't want to go in to something you want to explore and have a look around." (Denton & Aranda, 2020, p. 653)
Self-Confidence	belief in one's own abilities, judgment, and self-worth. It involves feeling sure of oneself and being able to tackle challenges and make			"The cold water quiets the mind, washes away the "butterflies" and leads to a sense of achievement, of overcoming something—and of surviving [. . .] it will make you

	decisions with a sense of self-assuredness.			feel invincible." (Oliver, 2021, p. 105)
Perceived health & well-being	An individual's subjective assessment or evaluation of their own physical and mental health, as well as their overall quality of life	Any mention of health and well-being either during or post CWI	Any mention of health and well-being pre or not related to CWI	"When cold water swimming is practiced by people with good general health in a regular, graded (go with the season) and adjusted mode, it appears to bring some health benefit" (Knechtle et al., 2020, p. 5)
Self-Actualisation	Realisation or fulfilment of one's potential and the pursuit of personal growth and self-improvement			"Personal agency elements relating to self-actualization appear to be important influences." (Christie & Elliott, 2023, p. 15)
Mindfulness	a mental state and practice that involves paying deliberate and non-judgmental attention to the present moment.			"You have to be present. Like it's like the most mindful experience ever . . . you don't have time to think about how you feel before you don't have time to think about what's going to come after. It's like you're so present." (McDougall et al., 2022, p. 7)
Achievement	The realization or attainment of something significant or noteworthy, often requiring effort, skill, or determination	Any mention of the sense of achievement sustained during CWI or post CWI		"Furthermore, there is something about going for a swim—with others—in very cold water, in the winter, that seems to bring the community of swimmers even closer together. There is a sense of group achievement and camaraderie and always, after a cold water swim, lots and lots of laughter." (Oliver, 2021, p. 107)
Feeling good	Euphoric, pleasurable, and positive sensations when engaging in certain activities that may alter their mental state			"It just makes me smile, I can't tell you how (why). It makes me so much happier through the day." (McDougall et al., 2022, p. 7)
Fun	The enjoyment, amusement, and entertainment that one experiences while engaging in CWI			"It is commonly described as a joyful and positively experienced leisure activity by experienced individuals." (Espeland et al., 2022, p. 11)
Self-efficacy	An individual's belief in their own ability to successfully perform specific tasks, achieve goals or overcome challenges			"Taking up open water swimming offered me a challenge, a purpose and something to focus on when grief threatened to overwhelm me. I discovered that the sea, with its vastness, its majesty

				and power, its rhythm and flow, has the ability to heal and to soothe me." (Oliver, 2021, p. 105)
Peaceful	Refers to a mental and emotional state characterized by a sense of calm, tranquillity and inner harmony			"One hundred per cent, I'd say I'm most at peace and most with myself in cold water." (Murray & Fox, 2021, p. 93)
Freedom	A state of mental liberation, autonomy, and the absence of mental constraints or limitations that might otherwise restrict one's thoughts, beliefs, and actions		Any type of physical form of freedom	"It is nice to do something that is totally unconnected. to your day to day bills and people to speak to and family obligations and that kind of stuff, it is nice to do something that is completely unrelated to all of that. And is pretty much a totally different environment. It gives you a bit of space to kind of collect your thoughts. And, yeah, to get back to where you kind of like to be." (Denton & Aranda, 2020, p. 653)
Pleasure	The positive and enjoyable feelings or experiences that result from engaging in CWI			"It is commonly described as a joyful and positively experienced leisure activity by experienced individuals." (Espeland et al., 2022, p. 11)
Friendship	A sense of companionship, understanding, and willingness to provide emotional support, encouragement, and assistance to one another through shared experiences around CWI			"The social connections sometimes led to close friendships being forged, or more informal, but nonetheless valued, connections." (Christie & Elliott, 2023, p. 17)
Calming	Reduced or alleviated feelings of anxiety, stress, or emotional agitation, leading to a state of greater tranquillity and relaxation			"I like to be alone . . . it's kind of a meditative experience for me, like I need it to be just me in the water. So yeah, I try to go with people who don't speak too much when they're in the water." (McDougall et al., 2022, p. 9)
Happiness	The positive emotional and psychological state experienced while engaging in CWI that signifies a sense of joy, contentment and fulfilment			"Whereas I think the buoyancy and the weightlessness of the water lends itself to a certain feeling of freedom, which I think is the ultimate happiness." (Murray & Fox, 2021, p. 93)

Mood improvement	The positive change or enhancement in a person's emotional state or overall mood			"It's some indefinable thing especially if you swim all the year round. It just has some kind of effect. I couldn't even begin to describe it to be honest with you, but it has got an effect on you which...it's hard to explain, it just makes you feel better about the day ahead. That you can sort of deal with stuff in a sense." (Foley, 2015, p. 222)
Flow state	A mental state of heightened focus and absorption in an activity where the individual becomes fully immersed in what they are doing			"I think I am more connected and more in the present. I think the cold water" is refreshing. More in the present and I think it's good for me when I think a lot. I go there and it's more clear." (Murray & Fox, 2021, p. 92)
Courage	One's willingness and determination to face challenges, risks or difficult situations despite their feelings of fear, uncertainty or discomfort			"It was always something that you want to explore but you know that it is dangerous and scary and then overtime, I guess, it is that experience and knowledge you kind of, that completely changes and you end up going from something that you kind of really fear and don't want to go in to something you want to explore and have a look around." (Denton & Aranda, 2020, p. 653)
Togetherness	State of being physically or emotionally close to others		Exclude anything that involves the pre/post immersion	"... felt that swimming at the study lake offered a very supportive, encouraging, and friendly milieu." (Christie & Elliott, 2023, p. 17)
Social connection	The feeling that you belong to a group and generally feel close to other people Relationships/bonds people have within social context	This concept must be from taking part in CWI	Anything pre/post CWI	"Many swimmers attest to having found a new community, a new "tribe", a new group of friends, all of whom share the love of outdoor swimming." (Oliver, 2021, p. 107)
Shared experience	Seeing, hearing, or doing the same thing as someone else (activity that brings people together)		Exclude anything that involves the pre/post immersion	"It is a fantastic feeling of camaraderie there were three of us in a row together, the whole time looking out for each other, but aware of each

				other there, a bit like a shoal of dolphins or whatever they are, pack of dolphins, swimming together, all totally aware and you know just remember the buzz of that particular day, and you do get similar buzzes all the time but you know, the text messages, emails." (Denton & Aranda, 2020, p. 655)
Positive Recollection	The act of remembering or recalling past events, experiences, or memories that are associated with positive emotions, feelings, or outcomes			"... also provided an example of how immersion in water can promote fun and playful behaviours, which may be explained by immersion in water evoking childhood memories and childlike behaviours." (McDougall et al., 2022, p. 9)
Vitality	State of being strong, active and having energy			"The sea definitely strengthened me personally. And I would tend to be... quite an empathetic person. I could walk into a room and feel everybody's feelings. Whereas I think going in and out of the sea helps me to be stronger about that. So, it's protecting yourself in a strange way." (Murray & Fox, 2021, p. 92)
Restorative	Having the ability to restore health, strength and well-being			"I had a car accident eight years ago and I've had back issues ever since . . . when I first started, it initially it increased my use of painkillers, but after about six months, I completely stopped taking them basically and it was mainly because it just strengthened my core muscles." (McDougall et al., 2022, p. 6)
De-stress	Something that helps individuals reduce or alleviate stress, tension, or anxiety and promotes relaxation, emotional wellbeing, and a sense of calmness			"I couldn't swim much I was going through a rough patch because my father just died and I really missed getting in the water because that's my form of exercise to deal with stresses of daily life . . . I found it really tough to miss the water. If I don't swim three times a week,

				four times a week, I notice the adverse impact that has on me." (McDougall et al., 2022, p. 9)
Mental stability	Sense of being in control of their personal thoughts and actions			"It (wild swimming) keeps me on a level pegging and maintains my balance sort of thing mentally as well. And because we've been through quite a lot over the last couple years, so it has given me a bit of stability." (McDougall et al., 2022, p. 8)
Self-Transcendence	An individual's ability to go beyond their immediate concerns and self-interest to connect with broader aspects of life, including other people, the natural world, or spiritual or transcendent experiences.			"I think it puts any concerns or worries that I have into perspective because "you're this tiny person in this vastness that is connected to everything and I think that's very soothing and calming." (Murray & Fox, 2021, p. 93)

Supplementary material 3. Study characteristics of included articles

<u>AUTHOR</u>	<u>COUNTRY OF PUBLICATION</u>	<u>YEAR</u>	<u>SAMPLE SIZE</u>	<u>AGE (RANGE, YEARS)</u>	<u>AGE (MEAN)</u>	<u>GENDER</u>	<u>STUDY DESIGN</u>	<u>METHODOLOGY</u>
CHRISTIE & ELLIOTT (2023)	United Kingdom	2023	17	29-68	52.7	M = 6 (35%) F = 11 (65%)	Qualitative	Rapid ethnographic
OLIVER (2021)	United Kingdom	2021	N/A	N/A	N/A	N/A	Qualitative	N/A
DENTON & ARANDA (2020)	United Kingdom	2019	6	38-73	N/A	M = 3 (50%) F = 3 (50%)	Qualitative	Lifeworld phenomenological framework
MCDUGALL ET AL. (2022)	Switzerland	2022	12	18-59	N/A	M = 5 (42%) F = 7 (58%)	Qualitative	Phenomenology
FOLEY (2015)	United Kingdom	2015	N/A	N/A	N/A	N/A	Qualitative	Ethnographic & phenomenological
MURRAY & FOX (2021)	United Kingdom	2021	5	N/A	N/A	M = 1 (20%) F = 4 (80%)	Qualitative	Interpretive phenomenological
BATES & MOLES (2023)	United Kingdom	2023	3	N/A	N/A	M = 0 (0%) F = 3 (100%)	Qualitative	Phenomenology
OLIVER ET AL. (2023)	United States	2023	717	18 - 65+	N/A	M = 58 (8%) F = 657 (92%)	Cross-sectional study	N/A
DEMORI ET AL. (2021)	Italy	2020	228	19 - 88	67	M = 125 (55%) F = 103 (45%)	Cross-sectional study	N/A

KELLY & BIRD (2022)	United Kingdom	2021	64	N/A	23 +/- 6	N/A	RCT	N/A
LINDEMAN ET AL. (2002)	United States	2002	25	47 - 65	55.1	M = 7 (28%) F = 18 (72%)	Prospective cohort study	N/A
YANKOUSKAYA ET AL. (2023)	Switzerland	2023	33	20 -45	28.4	M = 17 (52%) F = 16 (48%)	Experimental - One group design	N/A
TRYLINSKA-TEKIELSA ET AL. (2022)	Romania	2022	916	<20 - 51+	N/A	M = 394 (43%) F = 522 (57%)	Mixed methods	N/A

Supplementary material 4. CWI characteristics

<u>AUTHOR</u>	<u>LOCATION</u>	<u>EXPERIENCE WITH CWI (YEARS)</u>	<u>TEMPERATURE (AVERAGE/CELS IUS)</u>	<u>FREQUENCY</u>	<u>DURATION OF EXPOSURE</u>
CHRISTIE & ELLIOTT (2023)	Lake	6m-35y+	11.8 (7.5 to 16)	N/A	N/A
OLIVER (2021)	Sea	N/A	N/A	N/A	N/A
DENTON & ARANDA (2020)	Sea	>1y	N/A	N/A	N/A
MCDUGALL ET AL. (2022)	Lake Sea	>5y (N = 6) <2y (N = 6)	N/A	8.5 days/ month	N/A
FOLEY (2015)	Sea	N/A	13.5 (Guilleme)* 12.7 (40 foot)**	N/A	N/A
MURRAY & FOX (2021)	N/A	N/A	N/A	N/A	N/A
BATES & MOLES (2023)	Sea	N/A	N/A	N/A	N/A
OLIVER ET AL. (2023)	Sea	N/A	N/A	N/A	N/A
DEMORI ET AL. (2021)	Sea	9.6y +/- 8y	11	2.5 days/month	20'
KELLY & BIRD (2022)	Sea	N/A	13.6	1 time exposure	18'36" +/- 1'48"
LINDEMAN ET AL. (2002)	N/A	N/A	N/A	N/A	N/A
YANKOUSKAYA ET AL. (2023)	Cold Bath	Nil within previous 12-18 months	19.9	1 time exposure	5'
TRYLINSKA-TEKIELSA ET AL. (2022)	N/A	N/A	N/A	N/A	N/A

Notes. *Temperature recorded from <https://www.surf-forecast.com/breaks/Tramore/seatemp#:~:text=Tramore%20sea%20water%20temperatures%20peak,46%20to%2050%C2%B0F>

**Temperature recorded from <https://seatemperatures.net/europe/ireland/forty-foot/>

Supplementary material 5. 34 codes grouped into categories and themes

<u>Theme</u>	<u>Category</u>	<u>Definition</u>	<u># of Codes</u>	<u>Codes</u>	<u>Code Frequency</u>
Sense of Connectedness	Social relationships	The feeling that one belongs and has the support and care needed to live a quality life. It also encompasses the bonds formed between family, friends, the community, and society	4	Friendship	4
				Social connection	15
	Shared experiences			Shared experience	4
				Togetherness	9
Exposure to Nature	Blue Space	Involves the experience one gets when exposed to the natural environment	3	Interacting with nature	29
				Sense of adventure	9
				Exhilarating	7
Physical and Psychological Health	Headspace	Signifies an overall quality of life and functioning of the body and mind. Both physical and mental health contribute to one's holistic health and capacity to lead a fulfilling and balanced life	15	Flow state	10
				Escape	18
				Mindfulness	20
				Peaceful	5
				Freedom	21
	Positive emotional experiences			Fun	4
				Feeling good	17
				Pleasure	11
				Happiness	7
				Positive recollection	8
	Physical and Mental health			Mood improvement	11
				Perceived health & well-being	30
				Restorative	10
Personal Growth	Coping with adversity	The process of developing and progressing one's skills, knowledge, attitudes, and self-awareness	13	Resilience	17
				De-stress	8
				Mental stability	1
				Courage	3
				Calming	21
				Self-efficacy	10
				Self-transcendence	5
	Personal fulfilment			Self-actualisation	4
				Self-confidence	7
				Self-esteem	4
				Sense of purpose	13
				Sense of pride	2
				Achievement	8

Authors

Matthew Ono

Bond Institute of Health and Sport, Bond University, Australia

<https://orcid.org/0009-0007-6437-3251>

matthew.ono@student.bond.edu.au

Max Wahl

Bond Institute of Health and Sport, Bond University, Australia

<https://orcid.org/0009-0006-1374-8036>

Robell Mekonen

Bond Institute of Health and Sport, Bond University, Australia

Kevin Kemp-Smith

Bond Institute of Health and Sport and Water Based Research Unit, Bond University, Australia

<https://orcid.org/0000-0002-0504-3275>

James Furness

Bond Institute of Health and Sport and Water Based Research Unit, Bond University, Australia

<https://orcid.org/0000-0001-7773-0253>

Funding

The author(s) reported there is no funding associated with the work featured in this article.

Conflict of interest statement

The authors report no conflicts of interest.

Author contributions statement

Matthew Ono: Conceptualization, Methodology, Formal analysis, Investigation, Writing – Original Draft, Writing – Review & Editing, Visualization. Max Wahl: Conceptualization, Formal analysis, Investigation, Writing – Original Draft, Writing – Review & Editing. Robell Mekonen: Conceptualization, Formal analysis, Investigation, Writing – Original Draft, Writing – Review & Editing. Kevin Kemp-Smith: Conceptualization, Supervision. James Furness: Conceptualization, Supervision.

Data availability statement

The data utilized in this study can be accessed on request from the corresponding author.

Acknowledgements

The authors would like to acknowledge the Bond University Doctor of Physiotherapy program and staff members and the Department of Health Sciences and Medicine for their support in conducting this research. We also thank the reviewers and the editor for their valuable comments and suggestions, which greatly improved the manuscript.

Publishing Timeline

Received 15 April 2024

Revised version received 31 October 2024

Accepted 1 November 2024

Published 31 January 2025