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Original Article

The Adaption and Validation of a Body Mass Management Questionnaire for Olympic Weightlifters

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Abstract

This study aimed to adapt and validate a pre-existing weight loss questionnaire specific for Olympic weightlifting (OWL) athletes, given their pre-competition body mass (BM) management practices are unknown. A structured four-phase validity process was employed, focusing on content, face validity, and internal reliability. The Delphi technique was applied utilising experts (n = 7) over three anonymous rounds to achieve consensus. Questions were reviewed to determine whether to keep, modify, or delete, then rate the relevance of each (content validity index (CVI)). Online interviews were conducted with a pilot group of OWL athletes (n = 6) to assess readability and item difficulty. A test-retest process was undertaken with a second pilot group (n = 9) to verify questionnaire reliability using Pearson's correlation. All items in the first round achieved consensus with an item-CVI of 0.93, scale-CVI average of 0.98, and no items were recommended for deletion. The average difficulty rating was 4.8/5. Internal reliability was high for weight history (r = 0.93) and weight loss methods (r = 0.83), and moderate for influences (r = 0.65). The adapted questionnaire was shown to be a valid tool for content and face validity to assess the BM management practices of OWL athletes..

Keywords: Body Mass Management; Olympic Weightlifters; Athletes

Introduction

Weight categories have been established in a number of sports to facilitate fairness and equity by limiting size and strength disparity between competitors [1-3]. Athletes in weight-category sports use both chronic and acute body mass (BM) management practices to compete in categories below their day-to-day training BM (i.e., making weight) [4-10]. This is to achieve a potential size or strength advantage over their opponents [11-14]. Due to increased participation rates in combat sports, there has been growing concern about the health and/or performance implications of these BM management practices [4-10,15]. However, little is known about the BM management practices of Olympic weightlifting (OWL) athletes, a sport included in the summer Olympic Games for the past 100 years.

Anonymous questionnaires have served as a primary research instrument in identifying the BM management practices of athletes in weight-category sports. A rapid weight loss questionnaire (RWLQ) designed and validated by Artioli et al., [4], for judo athletes, has subsequently been used to assess the BM management practices of athletes in other weight category sports [Table 1]. However, many have failed to validate the instrument for their population [1,5-8,16-20]. Failing to validate a questionnaire prior to administration, draws into question the sensitivity and reliability of the data captured [21,22]. Even minor alterations to a questionnaire can influence user response, confirming validation should be undertaken, even with the slightest of adjustments [23].

A valid questionnaire should possess attributes of clarity, relevance, reliability, and the ability to precisely capture the intended construct [21,23,24]. A critically appraised content validation ensures that each item (question) is not only easily understood, but also holds relevance to the subject in focus [21,24]. The Delphi technique has been particularly encouraged in healthcare settings as an important means of facilitating content validity [25]. This technique plays a significant role in determining the relevance of the items, guiding decisions on their inclusion or exclusion, and ensuring the clarity of each item [25]. Despite its clear application, the Delphi technique remains underutilised in the validation of BM management questionnaires.

The aim of this study was to adapt a previously validated BM management questionnaire [26], and undertake content and face validity of the modified tool by following recommended methodologies [21,22,27], for an OWL population. It was hypothesised the questionnaire could achieve adequate content and face validity and reliability testing to enable the delivery of a tool for future research, addressing the BM management practices of OWL athletes prior to competition.

Methods

To adapt and validate the RWLQ, a mixed methods approach was undertaken over four phases. Participants in phases 2, 3 and 4 were provided with specific research participation information sheets and signed an online written consent form.

The four phases involved [Figure 1]

Phase 1: Initial item (question) adaption from a previously validated questionnaire

Phase 2: Content validity (subject matter experts (SMEs), including the Delphi technique)

Phase 3: Face validity (OWL athletes)

Phase 4: Reliability processes (OWL athletes, test-retest)

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Table 1: Questionnaires identifying the body mass management practices used by weight-category athletes

Sport	Questionnaire was derived from	Calibre of athlete[a]	Form of validation	Methods used at a specific competition or in general practice
Wrestling(41)	IS	Tier 2	Test-retest reliability	General Practices
Wrestling (51)	IS	Tier 2	Nil	General Practices
Jockey (17)	IS	Tier 2, 3, 4	Nil	General Practices
Rowing (48)	IS	Tier 2, 3	Informal readability – a pilot study	Specific Competition
Judo (4)	Artioli[b]	Tier 1, 2, 3, 4	Content, discriminant test-retest reliability	Specific Competition
Judo(43)	Artioli	Tier 2,3,4	Content, discriminant, test-retest reliability	General Practices
Judo (13)	IS	Tier 4, 5	Nil	General Practices
MMA (1)	IS	Unsure	Nil	General Practices
Taekwondo (8)	Artioli	Tier 3	Nil	General Practices
MMA (19)	Artioli	Tier 3	Nil	Specified competition
MMA (42)	Artioli	Tier 3,4,5	Content; test-retest reliability	General Practices
MMA (5)	IS	Tier 3	Nil	General Practices
Judo (6)	Artioli	Tier 2	Nil	General Practices
MMA (44)	Artioli	Tier 3, 4	Informal readability – pilot study	General Practices
MMA (7)	Artioli	Tier 4:	Nil	General Practices
MMA (10)	IS	Tier 2, 3, 4	Informal readability – pilot study	General Practices
Powerlifting (20)	Artioli	Tier 2,3,4	Nil	General Practices

MMA: mixed martial arts. RWLQ: rapid weight loss questionnaire. IS: independent source
[a](McKay et al(52)) Tier 0: Sedentary. Tier 1: Recreationally Active. Tier 2: Trained/Developmental. Tier 3: Highly Trained/National Level. Tier 4: Elite/International Level. Tier 5: World Class. [b] Questionnaire has been adapted from Artioli et al (26)

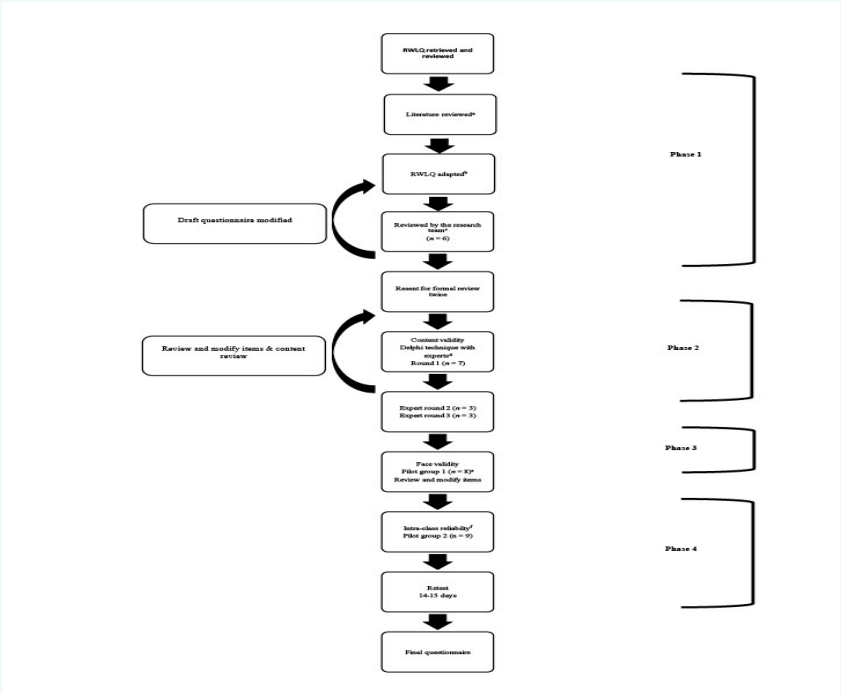

Figure 1 Methodological framework outlining the development and validation process of adapting and validating a rapid weight loss questionnaire (RWLQ).
[a]Review of previous athlete questionnaires (Table 1). [b]Artioli et al(4) RWLQ. [c]Research team: Amie Cox, Gary Slater, Rachel Scrivin, Fiona Pelly, David Jenkins, Reid Reale, Carl Langan-Evans. [d]Accredited, Advanced Sports Dietitians and Fellow with Sports Dietitians Australia. [e]Pilot group 1, Olympic weightlifting (OWL) athletes from Cougars Weightlifting Club (Brisbane Australia). [f]Pilot group 2, OWL athletes from the researchers known contacts.

Phase 1

Phase 1 of the study was to adapt a previously validated RWLQ, initially designed for judo athletes [26], for an OWL population. The questionnaire was adapted by the primary researcher and formally reviewed twice by the research team, which consisted of four experienced sports dietitians and two experienced sports scientists.

The majority of items were kept, answers were adapted for a more appropriate online presence and the item language was modified for an OWL population. Time frames increased from one year to two years due to COVID-19 and the lack of competitions athletes were able to compete in. Two questions were removed including, 'at what age did you begin to cut weight for competitions' and 'how much did you weigh in the last off-season?' Athlete calibre was changed to identify the highest total the OWL athlete had ever lifted within their normal body weight category rather than by identifying their medal tally from competitions.

A question was added, asking athletes to identify the reasons behind why they competed in a different weight category. Additional options were included for sources/people of influence which included journal articles, social media, and the internet. Water loading, hot baths, low carbohydrate diet, low fibre diet, low weight high calorie food options, low salt were all added to the weight loss methods section and the 'how often' scale was changed to time domains (e.g., <24 hours, last week, last 4 weeks etc).

Phase 2

Phase 2 of the questionnaire development included an expert content review using the Delphi technique. The Delphi technique is a process where items are reviewed anonymously in a series of rounds by SMEs until consensus is obtained, or until the items for review decrease [25]. An electronic questionnaire review template was created with Qualtrics Core XM survey software and this platform was used this throughout all validation phases (Qualtrics LLC, Provo, Utah).

Researchers determined that SMEs were Sports Dietitians with greater than five years of experience in supporting athletes competing in weight-category sports [25]. SMEs (n = 7) were contacted individually via email through the research teams sports dietitians' contacts. Seven SMEs (Fellow, Accredited Sports Dietitians, and Advanced Accredited Sports Dietitians) volunteered to participate in the review process.

During the first review round, 17 content-related items (excluding yes, no, or skip logic questions) were presented. The SMEs (n = 7) were then tasked with rating each item's relevance on a Likert scale from 1 to 4 (1 = Not relevant, 2 =Somewhat relevant, 3 = Quite relevant, 4 = Highly relevant). The content validity index (CVI) was calculated for each item to gauge item consensus, as well as the scale-CVI average (S-CVI/Ave). An individual item was deemed to have achieved unanimous agreement if its item-CVI (I-CVI) was greater than 0.78. For the overall content to be considered valid, the S-CVI/Ave needed to exceed 0.80 [21,28].

In addition to the rating, SMEs were also asked to determine whether each item should be kept, modified, or deleted, and to provide any additional comments, as advocated in previous questionnaire validation processes [29]. Agreement scores for keep, modify, or delete responses were calculated, and items that scored ≥70% to keep were reviewed in subsequent rounds.

After each Delphi round, a content review was conducted categorising feedback based on item content specifics, presentation style and language changes [25]. General feedback that did not result in changes was also documented. A member of the research team cross-verified these categories to ensure accuracy. After each round, an anonymous report was compiled for the SMEs to review, detailing group outcomes with corresponding researchers' feedback.

Phase 3

Phase 3 included a face validity process undertaken with a pilot group of OWL athletes (Pilot group 1, PG1) (n = 6, four males and two females, mean age 29 ± 5.8 years) who were recruited through Cougars Weightlifting Club in Brisbane, Australia. Individual athletes and the main researcher conducted online interviews via Zoom (Zoom Video Communications Inc., San Jose, California) over a three day period to review the questionnaire for readability [30, 31]. Athletes reviewed each item on a 5-point Likert scale rating the item difficulty from 1 (very difficult to understand) to 5 (very easy to understand) and provided any comments on each question. At the completion of the questionnaire, athletes were required to respond to the questionnaire's overall ease of use (feasibility). A content review was conducted on all comments to determine categories (content, language, general - clarification, other). Based on athlete feedback, the questionnaire was modified and confirmed by the research team for the final phase (Supplementary File 1: Body mass management questionnaire).

Phase 4

In phase 4, reliability testing was conducted using a test-retest procedure on a cohort of independent OWL athletes. The second pilot group (PG2), consisting of 9 participants (4 males and 5 females, with a mean age of 31 ± 8.5 years), was instructed to complete the questionnaire. Fourteen days later, the same group was asked to complete the questionnaire once more. The selected time frame was intentionally set to avoid any competitions, ensuring the standardisation of results.

Statistical Analysis

This research project was approved by the Human Research Ethics Committee (University of the Sunshine Coast, Australia); ethics approval number S221696. All data was analysed with IBM SPSS Statistics 26.0 (IBM Corporation, Armonk, New York). I-CVI scores were calculated by the total item score divided by the number of experts answering that item. S-CVI is the average of each items I-CVI score. Frequency statistics were used to describe categorical variables, and descriptive statistics were used to describe continuous variables. To determine internal consistency between test-retest scores, Cronbach alpha was measured (α >0.90 is considered excellent reliability; α = 0.80-0.89 is good reliability; α = 0.70-0.79 is acceptable). For internal reliability, Pearson's correlation was measured (r >0.90 is a considered very high correlation; r = 0.70-0.90 is a high correlation r = 0.50-0.70 is a moderate correlation) [32], and P-values <0.05 were considered statistically significant.

Results

Phase 1

The questionnaire adapted by the primary researcher and research team consisted of 17 items with five areas of investigation. These include demographics, training and competition, weight history, source of influence, and weight loss methods.

Phase 2

From the initial email invitation to seven SMEs, all experts agreed to volunteer to participate in the content review process. In the first review round a 100% (n = 7) response rate was achieved, while in rounds two and three, responses were received from three SMEs. The first-round expert group (n = 7) had 18.6 ± 12.0 years of sports nutrition experience. All items in the first round obtained consensus with an I-CVI of 0.93 and a S-CVI average of 0.98 [Table 2]. The item agreement rating from the SMEs indicated that nine items were to be kept, seven items were suggested to be modified, there were no recommendations to delete any items, and one item was suggested to be added (i.e., Have you ever missed competing in an Olympic weightlifting competition as a result of not making weight?) [Table 3]. One question was missed due to an input error with Qualtrics. As a result, the item was removed from the round one review process and was sent to the SMEs in the second round to review.

In round one, the most frequent comments were related to content (n = 6, 35%) and language changes (n = 6, 35%). Eight items were returned to SMEs for review (seven original items and one additional item) and during round two, recommendations for a language change (n = 1, 33%) and comments surrounding item clarification (n = 2, 50%) were provided. Only three items were returned for a third and final round as they scored less than 70% in the second round. The most frequent comments provided by the experts were to "modify the item" (n = 6, 35%) or to "change the question/answer wording" (n = 6, 35%), which has been summarised in Table 4. All returned items had a total of 15 comments (average = 2.1

Table 2: Item relevance (I-CVI) and keep, modify, or delete responses from subject matter experts (Delphi round 1) (n = 7)

Item	Item Type	1[a]	2[b]	3[c]	4[d]	Total = 3 + 4	I-CVI[e]	Delete %	Modify %	Keep%
Item 1	Demographics			2	3	5	1	0		100.00%
Item 2[f]	Demographics			1	4	5	1	0	16.7%	83.3%
Item 3	Demographics		1	2	2	4	0.8	0		100
Item 4	Demographics			2	3	5	1	0		100
Item 5[f]	Training + Competition			3	2	5	1	0	16.7	83.3
Item 6	Training + Competition			3	2	5	1	0		100
Item 7	Training + Competition			2	2	4	1	0		100
Item 8[f]	Training + Competition			1	3	4	1	0	16.7	83.3
Item 9[f]	Weight History		1	3	1	4	0.8	0	16.7	83.3
Item 10	Weight History			1	2	3	1	0		100
Item 11[f]	Weight History			1	4	5	1	0	16.7	83.3
Item 12[f]	Weight history									
Item 13	Weight History				4	4	1	0		100
Item 14	Weight History			1	4	5	1	0		100
Item 15	Weight History				5	5	1	0		100
Item 16	Influence			2	2	4	1	0	20	80
Item 17[f]	Weight loss Methods			1	4	5	1	0	16.7	83.3
Mean			1	1.8	2.9	4.5	0.98[g]	0	17.2	92.5
SD[h]			0	0.8	1.1	0.6	0.07	0	1.4	8.8
SE[i]			0	0.2	0.3	0.2	0.02	0	0.6	2.2
Lower (95% CI)[j]			1	1.3	2.3	4.2	0.9	0	15.8	87.8
Upper (95% CI)			1	2.2	3.5	4.6	1	0	18.7	97.2

[a]not relevant. [b]Somewhat relevant. [c]Quite relevant. [d]Highly relevant. [e]Item-level content validity index. [f]items returned for round 2. [g]Scale content validity index/average, [h]standard deviation. [i]standard error. [j]confidence interval.

Table 3: Content validity subject matter expert's results generated over three rounds.

Item	Experts	Total Items Reviewed	Delete	Modify	Keep	Added	Total comment	Content	Format	Language	Comments not requiring a change
Round 1 (totals)	7	17	0	7	10	1	17	6	0	6	5
Returned items (*n*=8)							13	6	0	5	2
Round 2 (totals)	3	8	0	3	5	0	6	1	0	2	3
Returned items (*n*=3)							3	1	0	2	0
Round 3 (total)	3	3	0	0	3	0	0	0	0	0	0

comments per returned item). The adapted questionnaire contained five sections which included 18 questions prior to being subjected to face validity.

Phase 3

Six OWL athletes (PG1) were recruited for the face validity process. The average difficulty rating was 4.8 ± 0.2 out of 5 on the Likert scale (1 = Extremely difficult to answer to 5 = Extremely easy to answer), with an overall questionnaire difficulty rating of 4.8 ± 0.4 out of 5. The OWL athletes comments consisted of format changes (n = 9, 75%) and general comments not requiring change (n = 3, 25%) as identified in Table 5. Revisions to the layout were made by the research team for items 14 and 15. Item 14 was segregated into three items, asking the same question but more directly. To assist with interpretation, an example of how to answer item 15 was provided.

Phase 4

The average time between the test-retest rounds for PG2 was 14.1 ± 0.3 days. For the first test, athletes took an average 8.6 ± 3.2 minutes and the second was 6.2 ± 2 minutes. Internal consistency was identified as excellent using Cronbach's alpha for demographics (α = 0.99), training and competition (α = 0.96), weight history (α = 0.97), and weight loss

Table 4: Examples of summarised subject matter expert's comments with identifying categories from round one, two and three

Item	Comment	Category
2	What (weight) range do you normally sit in / how much above your weight class do you tend to train at (either by percentage or kg)?	Language
2	What is your most recent weight? (If they don't regularly weigh themselves)	Language
5	Is this referring to when they became a professional weightlifter with the Olympics in sight?	General – Clarification
7	Follow on with a question identifying whether any competitions were missed due to making weight reasons.	Content
8	Which weight class have you competed in most in the past two years?	Language
9	Total what? Do you mean what is the heaviest you have been or what is the most weight you have lost?	Language
9	Do you mean the highest total weight lifted? The question could be clearer.	Language
11	Coming off injury could be a useful sub-category here.	Content
11	Lack of understanding of how to make a lighter-weight class.	Content
11	You have only included an option that suggests an increase in lean mass was the only reason to change the weight category. What about a decrease in body fat/lean mass?	Content
17	Would intermittent fasting be worth including also (in isolation or with the 'fasting' question?)?	Content
17	Perhaps add an extra row for 'other' and allow space for comments.	Content

Table 5: Face validity: examples of the Olympic weightlifting athlete comments summarised into identifying category

Category	*n*	Comments from Athletes
Content Change	2	Add in increased cardio with increased exercise. Tracking calories.
Format Change	5	Move water loading to the top around the restriction of fluid. Do I answer 'other'? How it reads, I didn't realise I had to select each row.
Language Change	3	Is that in the last year or the last 12 months? Specifically, is that apart from doing resistance training in other sports?
Comments not requiring a change	2	CrossFit training versus Olympic lifting? It's a long question.

methods (α = 0.94). The internal consistency of the influences section was determined to be acceptable (α = 0.75). An intraclass correlation applied between test-retest rounds using Pearson's correlation identified excellent agreement for demographics (r = 0.99, p = 0.01), training and competition (r = 0.96, p = 0.02) and weight history (r = 0.93, p = 0.02). There was good agreement for weight loss methods (r = 0.83, p = 0.10) and a moderate agreement for influences (r = 0.65, p = 0.20).

Discussion

The aim of this study was to adapt a previously validated BM management questionnaire and establish content and face validity, and reliability for use in an OWL population. Utilising current best practice guidance for content and face validity of a questionnaire [22], the results show the BM management questionnaire developed for an OWL population is valid. The final questionnaire was comprised of 20 items, (depending upon skip logic responses) presented over five sections including, demographics, training and competition, weight history, influences, and weight loss methods.

In the realm of sport-specific research, the necessity to adapt scales to accommodate the nuances of specific athletic populations is recognised. For an OWL demographic, utilising an adapted scale rather than Artioli's et al. [4], questionnaire validated amongst judo athletes offer distinct advantages. OWL and judo have different competition regulations, including differences in weight categories, timeframe between weigh-in and competition, plus limits on weight restoration following weigh-in [33], training paradigms, and physiological demands [34]. Furthermore, the bespoke nature of the adapted scale enables the implementation of familiar sport specific terminology, likely making it more comprehensible for OWL athletes. This tailored approach also better discerns the distinct cultural and social influences within OWL, thereby enhancing the scale's construct validity and reliability. Ultimately, an OWL-adapted questionnaire not only provides a more accurate representation of current weight management practices within the sport but also allows for a more coherent comparison with other weightlifting-centric studies [20,35-37].

Historically, the Delphi technique has been used in health survey validation studies [29], and more recently in sports nutrition questionnaire design [27,38,39]. Recent studies have used the Delphi technique in the development of a questionnaire to align the tool with the target population [27,38,39]. The CVI rating method and agreement rating were used to determine the item relevance and seek agreement. This methodology was adapted from Scrivin et al. [40], and Tam et al. [27], which included not only the CVI rating method but also an additional agreement rating, asking SMEs whether each item should be kept, modified, or deleted. The experts' additional comments required a content review of each category. As there is no general agreed cut-off, researchers determined a <70% agreement to return items for further review [40]. The items that required modifications had the greatest amount of feedback or comments. Although the I-CVI was appropriate for all items, the additional agreement method allowed for additional content and language changes that would not have occurred otherwise. This agreement method also provided the possibility for additional items

to be included to ensure the questionnaire asks what it is intended to do. As a result, the second agreement rating has been deemed an integral part of the content validation process, and the researchers would recommend utilising both agreement methods in the development of future sports nutrition questionnaires.

A small proportion of studies that used the original questionnaire undertook an additional validation process prior to administration using either formal or informal methods of validation for their population [4,17,41-44]. However, many researchers modified the Artioli et al. [4], questionnaire with minor adjustments without any further validation [Table 1] [6-9,19,23]. Consequently, given differences in target populations between investigations, it is unclear if the outcomes of these investigations are reliable.

Face validity identified problems with the presentation of two questions (items 14 and 15). For item 15, an example was provided to show how to answer the question appropriately, however, for item 14 ("What is the maximum amount of weight loss you have lost for an OWL competition and in what time frame? Please answer each row.") was modified into three questions. The aim was to understand the maximum amount of weight an athlete lost in the week before an OWL competition and the maximum weight loss achieved in an athlete's competition career. Due to the online format of the questionnaire, it was identified that athletes struggled to answer the question in full detail. As a result, three specific questions were asked instead, "What was the maximum amount of weight you have had to lose for an Olympic weightlifting competition?", "In what time frame was this achieved?", and "What is the maximum amount of weight you have had to lose in the last week?". It is recognised that the current questionnaire scored a moderate association for internal reliability in the 'influences' section, however as the SMEs rated this question highly relevant and did not require any modifications, the item was kept. History effects (internal validity) refer to events that can happen in the environment that may change the conditions of the study [45]. The level of influence a person/source may have over an athlete can change as they may have had an unpleasant experience with a doctor, teammate, social media, or a dietitian in that time frame. This may adjust the level of influence that the athlete may perceive the person/option to have [45]. Items which discuss personal beliefs can be prone to bias, as there are no acceptable measures for these type of constructs [46]. The suggested interval between test-retest processes is between two to six weeks [24,46,47].

Establishing construct validity is necessary for a questionnaire to be deemed valid. The restraint scale was used to determine construct validity in the original RWL questionnaire [26]. However, its emphasis on chronic dieting renders it less suitable here, failing to address acute dietary and training adjustments associated with sport specific populations. An alternative approach could be facilitated via concomitant administration of the newly validated questionnaire with relevant biochemical indices (assessing hydration and energy status), as has been undertaken previously [48]. The Delphi method, while intricate and often lengthy, may lead to a significant drop-out rate due to its requirement for participants to engage in multiple rounds [49]. It is also recognised that a small population of athletes was used to identify the internal reliability and consistency of the questionnaire [50].

In summary, the adapted BM management questionnaire has been validated in accordance with current guidance for content validity, face validity, and test-retest reliability. These validation measures have been an integral part of the questionnaire's modification for OWL athletes. This adaption enables an opportunity for future research to identify the BM management practices OWL athletes use prior to competition.

Authorship

The authors' responsibilities were as follows; AC, GS, RS, FP, DJ, RR, and CLE helped in the study concept and design; AC and GS in the acquisition of data; AC, GS and RS assisted in analysis and interpretation of data; GS helped in drafting the manuscript; AC, GS, RS, FP, DJ, RR, and CLE assisted in the critical revision of the manuscript for important intellectual content; RS helped in statistical analysis; and GS in study supervision. AC had full access to all the data in the investigation and takes responsibility for the integrity and the accuracy of the data analysis.

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