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Exercise Prescription for Patients With Persistent Low Back Pain Who Present With Impaired Lateral Abdominal Muscle Activation: A Delphi Survey

Caitlin Lauren Siobhan Prentice[1] | Carol Ann Flavell[2] | Nicola Massy-Westropp[1] | Steve Milanese[3]

[1]Allied Health and Human Performance, University of South Australia, Adelaide, Australia | [2]College of Healthcare Sciences, James Cook University, Townsville, Australia | [3]Department of Allied Health, School of Health Sciences, Swinburne University of Technology, Hawthorn, Australia

Correspondence: Caitlin Lauren Siobhan Prentice (precl004@mymail.unisa.edu.au)

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ABSTRACT

Background and Purpose: Exercise is commonly prescribed for patients with low back pain (LBP) and maladaptive changes in lateral abdominal muscle (LAM) activation. The literature has considered various exercise programs, but the evidence has not consistently identified exercise parameters associated with superior outcomes. The aim of this study was to determine how physiotherapists should prescribe exercise for patients with persistent LBP who present with maladaptive LAM activation.

Methods: This was a three round Delphi survey. The international expert panel comprised physiotherapy clinicians with postgraduate orthopaedic manipulative physiotherapy training. Round 1 included open ended questions. Responses were collated and coded using content analysis. In Rounds 2 and 3, participants were provided with the collated responses and rated their agreement with or chose their preferred options regarding exercise prescription for patients with maladaptive LAM activation. Items were defined as meeting consensus when ≥ 70% of participants agreed/disagreed or chose the same option.

Results: Twenty-three physiotherapists consented to participate. Seventeen, 20 and 15 participants completed Rounds 1, 2 and 3, respectively. The exercise prescription suggestions consisted of 46 items reaching consensus across the domains of exercise: goals, considerations, agreement on prescribing exercise for the LAM and other muscles, muscle activation during exercise, the exercise prescription and its focus.

Discussion: This study provides clinically informed recommendations for physiotherapists prescribing exercise for patients with persistent LBP and maladaptive LAM activation. Findings align with motor control exercise approaches outlined in the literature. Participants emphasised the consideration of patient preferences and balancing motor control exercise with moderate/vigorous physical activity.

1 | Introduction

Motor control in the context of low back pain (LBP) is defined as the consideration of how an individual's posture, movement and muscle activation influences the loading of lumbopelvic structures (Hodges et al. 2013). Although not all patients with persistent LBP (PLBP) present with motor control changes, there is substantial evidence that changes in muscle activation can be present in people with PLBP (Van Dieen et al. 2019a). Observations in such patients are highly variable with evidence for increased and/or inhibited muscle activity. Additionally, muscle activation changes can be context dependent and have adaptive or maladaptive consequences (Van Dieen et al. 2019a). For example, patients may present with (1) 'tight control' involving increased muscle activity and therefore tissue loading but decreased lumbar movement or (2) 'loose control' involving decreased muscle activity and therefore tissue loading but increased lumbar movement (Van Dieen et al. 2019a). Three muscles commonly investigated in the PLBP literature for activation changes include the lateral abdominal muscles (LAM: transversus abdominus [TrA, internal [IO] and external oblique [EO]).

Where muscle activation changes are maladaptive, and hypothesised to be contributing to abnormal tissue loading and LBP symptoms, motor control exercise may be used as a treatment (Hodges et al. 2019). As per the definition of motor control, these interventions target improving posture, muscle activation and/or movement patterns (Van Dieen et al. 2019b). Some motor control exercise approaches include Motor Control Training (Richardson et al. 1999), the Integrated Systems Approach (Lee et al. 2011), The McGill Method (McGill 2007) and the Movement Systems Impairment Syndromes approach (Sahrmann 2002).

Systematic reviews and meta-analyses have demonstrated inconsistent evidence regarding whether motor control exercise approaches are superior to other exercise programs for improving pain, disability and function (Owen et al. 2020; Saragiotto et al. 2016;jan; Bystrom et al. 2013; Smith et al. 2014; Hayden et al. 2021; Fernández-Rodríguez et al. 2022). Similarly, a systematic review concluded that various types of interventions may improve TrA activity as measured by ultrasound imaging (Shanbehzadeh et al. 2022). However, another systematic review found that specific muscle activation exercise (SMA) interventions were superior to other exercise programs for activity limitations in the short and intermediate term and pain in the long term (Ford et al. 2020). Thus, there is emerging evidence for components of some motor control exercise approaches compared with other exercise interventions. Possible causes for contrasting research findings include the following: (1) It is unlikely that motor control impairments are a main contributor to pain in all non-specific LBP samples and (2) the standardised protocols used in many studies are not relevant to all patients with motor control impairments (Van Dieen et al. 2019a; Reeves et al. 2019).

Even within approaches that target motor control, there is some divergence regarding exercise prescription (Hides et al. 2019). For example, where some approaches recommend beginning with SMA (Richardson et al. 1999), others address maladaptive muscle activation by correcting movement patterns (Sahrmann 2002). Similarly, the incorporation of recommendations regarding strengthening and cardiovascular exercise is variable between approaches (Hides et al. 2019).

Thus, there remain conflicts and gaps in the literature regarding the use of exercise for patients with PLBP and maladaptive LAM activation. To the best of the authors knowledge, one avenue of evidence yet to be explored in this field is clinical expertise. Therefore, the aim of this study was to establish consensus amongst 'expert' physiotherapists regarding the optimal exercise prescription for patients with PLBP presenting with maladaptive LAM activation.

2 | Methods

2.1 | Study Design

Between May and July 2022, a three-round Delphi survey was conducted. This survey followed published methodologic criteria for Delphi surveys (Diamond et al. 2014; Avella 2016) (see Supporting Information S1: Appendix A) and ethical approval was obtained from the University of South Australia Human Research Ethics Committee application number: 204299. The study process is represented in Figure 1.

2.2 | Participants

The researchers defined 'experts' (in exercise prescription for patients with maladaptive changes in LAM activation) as physiotherapists/physical therapists who have completed a postgraduate training program accredited by the International Federation of Orthopaedic Manipulative Physical Therapists (IFOMPT). This is because orthopaedic manual therapy has been defined as a 'specialised area of physiotherapy/physical therapy for the management of neuromusculoskeletal conditions…using highly specific treatment approaches including… *therapeutic exercises*' (International Federation of Orthopaedic Manipulative Physical Therapists 2016). Requiring postgraduate training by IFOMPT enabled this survey to be distributed internationally whilst maintaining an equivalent level of relevant education across participants. Additionally, participants were required to be fluent in English (the language used in the survey), able to access a computer and internet to complete the electronic surveys, have the time needed to complete the surveys and sign a consent form prior to commencing the surveys.

From the IFOMPT website, a list of the IFOMPT member organisations was generated. The study information sheet was then emailed to each member organisation and/or the organisation members depending on the availability of contact information. Contacts were encouraged to invite colleagues whom they believed would be interested and eligible. Only people who agreed to meet all study criteria were eligible to participate. A subset of participants initially recruited were given the opportunity to participate in the pilot study if interested. Written informed consent was obtained from all participants.

Whilst the literature has not reached consensus regarding the optimal sample size in a Delphi survey (Avella 2016), 15–20 participants are generally considered acceptable (Hsu and Sandford 2007). Attrition has been noted as a common issue in Delphi surveys (Keeney et al. 2011). While larger expert panels are believed to be more susceptible to attrition, having too small a panel has also been criticised for potentially being unrepresentative (Keeney et al. 2011). To account for potential attrition and maintain an 'acceptable' sample size, we aimed to recruit 20 to 30 participants. First responders were included until the target sample size was reached.

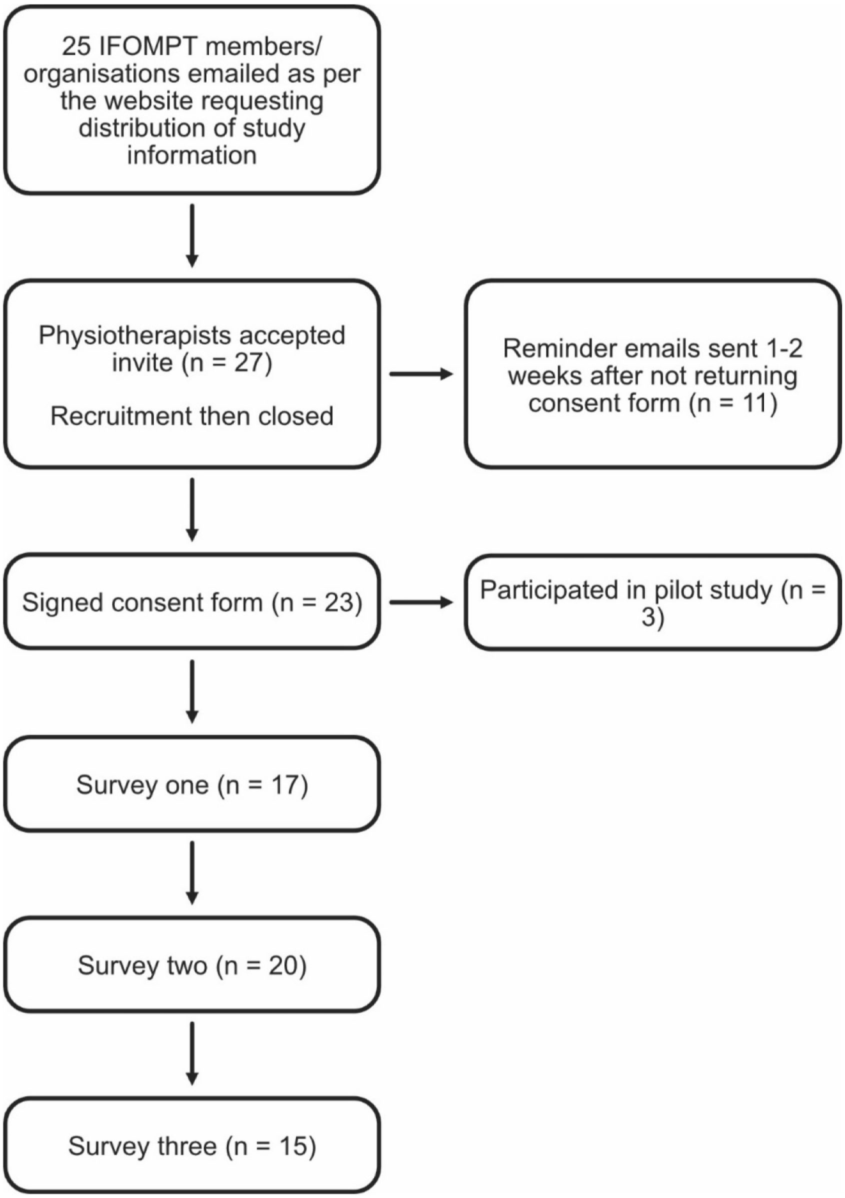

FIGURE 1 | Recruitment and flow of participants through the Delphi survey. IFOMPT, International Federation of Orthopaedics and Manipulative Physical Therapists.

2.3 | Survey Process

A list of the components of exercise prescription was generated (Table 1). Exercise prescription parameters were based on previously published exercise prescription guidelines (Thompson et al. 2010). Program duration was added to understand what clinicians believe is reasonable in practice considering programs in the literature can vary between one session (Tsao and Hodges 2007) and 8 weeks (Costa et al. 2009) or more. The authors added several topics to determine the level of clinician agreement with principles previously discussed in motor control exercise approaches (Hodges et al. 2013; Hides et al. 2019). This literature base considered both scientifically tested interventions and concepts based on clinical observation. From Table 1, a list of open-ended questions was generated to enable participants to describe and justify their preferred option (e.g., what is your preferred duration of the exercise program? Please provide a reason for your decision). This provided the basis for the pilot/round one surveys. Topics/questions were purposively left broad and did not specifically name or discuss motor control exercise approaches to reduce potential response bias.

The electronic surveys were developed using REDCap electronic data capture tools (Vanderbilt) hosted at the University of South Australia. The surveys consisted of one pilot survey and then three rounds. The link to the pilot and each subsequent survey was emailed to participants and each survey was open for 2 weeks. A reminder email to encourage completion of the survey was sent at the end of the first week and again the day before the survey closed. There was a 2-week break between the pilot survey closing and round one starting to enable data analysis and modifications to the round one survey. Subsequent surveys had a 1-week break between the closing of one survey and release of the next to enable time for data analysis and

TABLE 1 | Generic exercise prescription components and topics described in the motor control literature used to inform Delphi study questions.

Exercise prescription	
Prescription parameters	Underlying literature
Frequency (of sessions)	American College of Sports Medicine 2018
Intensity (adapted to level of muscle activity during exercise)	
Time (session and program duration)	
Type (of exercise including recommended individual exercises)	
Volume (if applicable)	
Repetitions per exercise	
Sets per exercise	
Time holding isometric exercises if applicable (addition by the authors)	
Pattern	
Rest times between sets	
Progression methods	
Topic	Principles in motor control exercise approaches
Importance of prescribing exercise for specific muscles	Conducted in Richardson et al. approach (Richardson et al. 1999), seen as automatically managed by correction of movement patterns in McGill (McGill 2007) and Sahrmann approaches (Hodges et al. 2013)
Aim i.e. strength, endurance, power, control	Across approaches, it is generally recommended to correct control and mobility prior to enhancing strength and endurance (Hodges et al. 2013)
Goals for the intervention	Goals consistent across multiple motor control approaches:
	Improve lumbopelvic loading, respiration, pelvic floor control and coordination, trunk muscle endurance, correct motor impairments in progressively more challenging and patient specific functional situations
	Non motor control specific goals:
	Pain education, decreased catastrophising and kinesiophobia, improved self-management, dissociation of movement at adjacent segments, balance control, sensory function, improve trunk muscle strength/endurance deficits, improve trunk muscle control during strength/endurance exercises for the limbs, develop stiffness to reduce pain, develop functional fitness
	Hodges et al. 2013

generation of the next survey. Participants completed the survey anonymously to encourage freedom of expression, but were asked to only complete each survey once. Participants were asked to create an ID consisting of memorable letters/numbers. By including this in each survey, responses could be linked across surveys without being able to identify individuals.

The pilot survey presented the round 1 survey to a sample of participants. Participants were asked to complete the survey, describe their interpretation of the questions and provide feedback on whether any questions were confusing/ambiguous, issues with the questions/design of the survey or any other feedback.

Round 1: Based on feedback from the pilot survey, modifications were made to improve the coherence of questions. In this survey, participants provided demographic information and answered questions regarding their preferred exercise prescription for patients with PLBP and maladaptive LAM activation. Participants were given a text box to write any other comments or feedback at the conclusion of the survey.

Rounds 2 and 3: Each subsequent questionnaire was developed from the analysis of the responses to the previous surveys. Participants were asked to either rate their agreement with statements using a six-point Likert scale or to select their preferred options for multiple choice questions. A six-point scale was chosen so that participants could not select an ambivalent answer such as unsure or neither agree nor disagree. Several open-ended questions were incorporated to ensure that participants could communicate further comments, for example, on the results of previous surveys (surveys in Supporting Information S1: Appendix B).

2.4 | Data Analysis

Participant demographics were analysed using means and standard deviations.

Using content analysis (Hsieh and Shannon 2005), three authors independently identified the themes/concepts from the open-ended survey responses of three participants. Themes/concepts aimed to summarise responses, or use in vivo coding, to capture the various responses to open ended questions. For example, a question considered what goal participants may have for the treatment program. In response, participants may discuss decreasing pain and increasing functional capacity. The authors met to discuss the consistency of their coding for each question. Once agreement was reached between the authors, they independently reviewed another two participants' responses. Coding was compared and determined to be consistent. The remaining participant responses were coded by one author. Questions in which participants provided numbers (e.g. number of repetitions) or listed options (e.g. exercises they might prescribe) were collated into ranges (e.g. 8–15 repetitions) or lists (e.g. list of exercises).

The codes were then fed back to the participants in the subsequent round to determine their agreement. For example, in round two, participants were asked to rate their agreement with all codes on potential treatment goals identified in round one.

Prior to the study, consensus was defined as ≥ 70% of participant agreement (Avella 2016). For Likert scale questions, this included where ≥ 70% of participants agreed (inclusive of somewhat, agree or strongly agree), or where ≥ 70% of participants disagreed (inclusive of somewhat, disagree or strongly disagree) with the codes. Once questions met this definition of consensus, they were removed from further rounds. Some authors have considered 60% agreement to be sufficient for consensus (Ferguson et al. 2008). Therefore, items with 60%–69% agreement/disagreement were defined as nearing consensus. Items with less than 60% agreement/disagreement were defined as not having met consensus. Items not achieving consensus were fed back into the next round/s with modification of coding according to participant feedback. Alternatively, if consensus was not gained at round three, this was reported as such. The median score and interquartile range were calculated for each item. The median was chosen instead of the mean because of the likelihood of convergence of opinion (Hsu and Sandford 2007).

3 | Results

3.1 | Flow of Participants Through the Study

The flow of participants through the study is presented in Figure 1. Table 2 describes the participant characteristics. Twenty-three physiotherapists agreed to participate. In Round 1, there were 17 participants from five countries and in Round 2, three additional participants completed the survey. Fifteen participants were retained for Round 3, representing 65% retention of individuals agreeing to participate. Those who did not complete the surveys did not provide a reason.

Over 65% of participants in all rounds ($n = 12$ in Round 1, 14 in Round 2, 10 in Round 3) were registered physiotherapists of 20 years or more. Participants estimated that over a third of their patients presented with PLBP. Of these patients, participants estimated that at least 60% had maladaptive LAM activation. Over 85% of participants prescribed exercise as part of treatment for patients hypothesised or assessed as having maladaptive LAM activation.

Most feedback from the pilot survey was regarding question interpretation/clarification. One comment was made about the consideration of other muscles and one comment suggested that exercise repetitions/sets should not be standardised for all patients. No comments were related to the survey design or flow.

The results from the surveys were grouped under the following thematic headings: goals, considerations, agreement on prescribing exercise for the LAM and other muscles, muscle activation during exercise, the exercise prescription and its focus. The specific items achieving, or nearing consensus and percentage of agreement can be found in Tables 3 and 4. Key findings indicated that the exercise program needed to be individualised to the patient presentation, considered in the context of physical activity required for good health, and should improve patient functional capacity, motor control and symptoms. To achieve this, it was identified that exercise programs should be evidence based, initially consisting of motor control exercises of most days of the week. Specific details, such as repetitions, were considered to be dependent on the exercises, patient symptoms and amount of resistance. To progress the program, participants recommended changing the focus from control to endurance and then to strength, following the exercise prescription guidelines. Examples of exercises to include the endurance and strength components were agreed upon.

Concepts not achieving consensus included what exercises should be prescribed in the initial phase of the program and which muscles should be considered in the program. Disagreement regarding the former stemmed from the concept of whether SMA exercises are relevant. While all participants agreed that SMA exercises may not be required for every patient, many participants reported that they would begin the program with SMA exercises before transitioning to more dynamic and functional exercises. Other participants suggested dissociation exercises, exercises requiring maintenance of neutral spine posture against resistance, and instability or a combination of trunk strengthening and flexibility exercises. Despite this, participants reached a high level of agreement that the program must progress to patient centred global strengthening and have relevance for their functional capacity. Consensus could not be achieved for any other muscles to consider in the program. Posterior superficial and deep trunk muscles, as well as flexors, extensors, rotators and abductors of the hip, were some of the other muscles cited as being commonly targeted by clinicians.

TABLE 2 | Characteristics of the Delphi study participants.

Participants	Round 1	Round 2	Round 3
N	17	20	15
Country			
Australia	10	12	10
Canada	4	4	4
England	1	1	0
Ireland	1	1	0
United States	1	1	1
Qualifications			
Bachelor's degree	10	10	9
Honours degree	1	0	0
Master's degree	12	14	11
PhD	3	3	2
Doctor of physical therapy	1	1	1
Post-graduate degree/registration accredited by IFOMPT	17	20	15
Years registered as a physiotherapist			
0–5 years	0	0	0
6–10 years	0	1	1
11–20 years	5	4	4
21–30 years	5	6	5
30+ years	7	8	5
Participation in exercise training courses			
Yes	13	15	13
No	4	4	2
Average percentage of patients with PLBP per week	39%	37%	34%
Average percentage of PLBP patients with hypothesised maladaptive LAM activation	67%	63%	67%
Average percentage of PLBP patients assessed as having maladaptive LAM activation	65%	60%	63%
Use of exercise for patients hypothesised/assessed as having maladaptive LAM activation	96%	88%	93%
Use of assessment tools			
USI	5	5	3
PBU	4	5	5
EMG	0	0	0
None of the above	9	10	8

Abbreviations: EMG, electromyography; IFOMPT, International Federation of Orthopaedic Manipulative Physical Therapists; LAM, lateral abdominal muscles; PBU, pressure biofeedback; PLBP, persistent lower back pain; USI, ultrasound imaging.

4 | Discussion

The aim of this study was to gain consensus regarding the optimal exercise prescription for patients with PLBP who present with maladaptive LAM activation using clinical opinion. The main themes emerging from the Delphi study included that the program should improve patients' pain, motor control, strength/hypertrophy, endurance, functional capacity and psychosocial factors. To achieve this, participants recommended education and individualised exercise incorporating motor control and general exercise.

4.1 | Exercise Prescription

Participants agreed that the program should be of 4–12 weeks duration. While programs in the literature generally fall within this timeframe, a single session of voluntary TrA activation has immediately improved feedforward TrA recruitment in an unrelated activity (Tsao and Hodges 2007). For improving muscle strength and hypertrophy, programs from 4 to at least 8 weeks, respectively, are generally recommended (Kenney et al. 2015). Similarly, a meta-analysis noted a trend towards Pilates and

TABLE 3 | Items achieving (> 70% agreement) or nearing consensus (60%–69%): Exercise program goals, considerations and agreement on prescribing exercise for the lateral abdominal muscles.

Exercise program goals/desired outcomes	Percentage of agreement	Median (Q1, Q3)	Strength of agreement
Decrease pain	95%	5 (4, 5)	Agree
Improve functional capacity, that is ability to perform daily activities (self-care, work, physical activity etc.)	100%	5.5 (5, 6)	Agree
Improve patient education (regarding the role of the lateral abdominal muscles, why exercise is important) and psychosocial factors (fear of movement, confidence in their spine, self-efficacy, anxiety and wellbeing)	90%	5 (4, 6)	Agree
Prevention of symptoms	100%	5 (5, 5.25)	Agree
Exercise program considerations			
Individualised: Form in collaboration with patient considering level of difficulty and engagement based on patient preferences, lifestyle, impairments and symptoms	100%	6 (5, 6)	Strongly agree
Following theory/convention	79%	4 (4, 5)	Somewhat agree
Evidence based	100%	5 (4, 5)	Agree
Based on clinical experience	100%	5 (4, 5)	Agree
Have no or minimal low-cost equipment	74%	5 (3.5, 5)	Agree
We should be careful with our language, so patients do not become fixated on impairments	100%	6 (6, 6)	Strongly agree
There is not one right approach to assessment of muscle endurance, activation and function	93%	5 (4, 6)	Agree
Agreement for prescribing exercise for the lateral abdominal muscles			
Transversus abdominis	82%	5 (4, 5)	Agree
Internal oblique	82%	5 (4, 5)	Agree
External oblique	82%	5 (4, 5)	Agree
Depends on individual presentation	100%	6 (6, 6)	Strongly agree
Rationales/considerations			
All the lateral abdominal muscles are 'important' as they increase the stiffness of the trunk. It is the balance between the muscles that is more important	79%	4 (4, 5)	Somewhat agree
Transversus abdominis is the most important muscle to consider based on the research literature	68%	3 (2.5, 4)	Somewhat disagree
Specific muscle exercises can be important, but we need to progress towards patient centred global strengthening	87%	5 (4, 5)	Agree
Specific muscle activation exercises may not be required as automatic correct motor control/activation can sometimes be achieved with the correct spinal alignment/technique of the exercise	100%	5 (4, 5.5)	Agree
Targeting these impairments should not be to the detriment of patients' ability to participate in moderate/vigorous physical activity for good health	93%	6 (5, 6)	Strongly agree
It is important that key muscles are not weak, but they do not have to be overly strong	80%	4 (4, 5)	Somewhat agree

Note: Strength of agreement refers to median; 6 strongly agree, 5 agree, 4 somewhat agree, 3 somewhat disagree, 2 disagree, 1 strongly disagree.

'core based exercises' programs from 3 to 9 weeks duration being more beneficial than programs of other durations for improving pain and disability in participants with PLBP (Fernández-Rodríguez et al. 2022). Therefore, considering the outcomes participants identified for the program, a duration of 4–12 weeks appears justified. As this is a wide duration, in practice, clinicians may need to reflect on the patient's chronicity and goals to more precisely estimate the likely required duration of the program. For example, if patients need to improve motor control, strength and endurance for their functional goals, then a longer duration program may be warranted. However, for all patients, it was recommended that the program

TABLE 4 | Items achieving (> 70% agreement) or nearing consensus (60%–69%): Exercise program aims, prescription, progression and other muscles.

Focus of exercise program: Strength, endurance, power and/or control	Percentage of agreement		
Strength		71%	
Endurance		76%	
Control		100%	
Power		63%	
Rationale: Target commensurate with patient lifestyle, fitness, physical assessment, preferences			
Order of exercise program focus	**Percentage of agreement**	**Median (Q1, Q3)**	**Strength of agreement**
Starting aim: Control	95%		
Rationale: Improve movement and motor control (alter maladaptive/improve motor patterns and muscle activation)	100%	5.5 (5, 6)	Agree
Second aim: Endurance	79%		
Rationale: Aim to improve muscle endurance as the LAM work at a low percentage of maximal voluntary contraction to stabilise and contain more slow twitch fibres	95%	5 (5, 6)	Agree
Third aim: Strength	79%		
Rationale: Aim to improve muscle strength and hypertrophy and then power if required according to functional needs and assessed deficits	80%	5 (4, 5)	Agree
Initial exercise prescription			
Frequency of exercise sessions per week: Daily (most days)		82%	
Rationale: Regular repetition for motor learning/developing automatic control			
Exercise type: Motor control, depends on clinical presentation		84%	
Rationale for motor control: Improve movement and motor control (as per focus of program)			
Rationale for depends on clinical presentation: Consider patient preferences/compliance; needs identified by the physical assessment and whether building self-efficacy and lowering anxiety are required			
Time to hold isometric exercise: Individualise		79%	
Number of repetitions: Individualise		84%	
Number of sets: individualise		74%	
Rest time between sets (seconds): Individualise		74%	
Rationale: Depends on exercise, patient form, fatigue and load			
Session duration: Individualise		84%	
Rationale: Depends on what is achievable, irritability, functional goals			
Program duration: 4–12 weeks			
Rationales:			
Time required to develop neuromuscular control/automatic activation			
Time required for muscular hypertrophy			
Chronic patients will require most of this time to control pain, reverse longstanding maladaptive motor patterns ± develop endurance/hypertrophy.		68%	
Progression methods			
Functional positions and tasks		95%	
Paced progression based on patient responses		68%	

(Continues)

TABLE 4 | (Continued)

Progression methods	
Alter repetitions	63%
Addition of limb movement	68%
Alter resistance	68%
Alter stability	68%
Rationale to guide choice of progression method:	
Clinical experience, patient centred/functional biased rehab, keep interesting to ensure compliance	
Activation level of lateral abdominal muscles during exercise	
Depends on the individual presentation	88%
Rationales: Higher levels of activation if required for functional activities. Start with obtaining a controlled, mild contraction that can be repeated for typical ADLs	
Patients may present with inhibition or hypertonicity of abdominal ± other muscles. Therefore, the goal may be to increase or decrease activation as required	
Some patients do not require specific muscle activation training	
Progression from control to endurance	
Increase time holding positions	80%
Increase sets or reps (aim for exercise guidelines of 2–3 sets of 15–25 reps)	87%
Increase resistance/more challenging positions	60%
Progression based on patient improvement/lack of improvement in both symptoms and control of exercise	60%
Progression from endurance to strength	
Changing repetitions and sets to strength (4x 5–8 reps) or hypertrophy (3x 8–12 reps) guidelines	87%
Increase resistance	80%
Exercises for endurance and strength	
Bridge and variations e.g. one leg, with ball	73%
4-Point leg extensions or contralateral arm and leg lifts (bird dog)	73%
Side bridges	80%
Shirley Sahrmann progression of toe tap/leg lift exercises in crook lying	67%
Other muscles to target in the exercise program	
Glutaeus medius and minimus	R2: 68%
	R3: 67%
Depends if assessed as having impairment	68%
Erector spinae	60%
Multifidus	60%
Glutaeus maximus	60%

begin by addressing motor control impairments. This aligns with protocols of various motor control based exercise approaches outlined in the literature (Hides et al. 2019).

Consensus indicated that such motor control exercises should be practiced daily or most days of the week to develop automaticity. This parallels with motor learning theory which indicates considerable practice is required for movement patterns to become habitual (Hodges 2003). Despite this, a systematic review with meta-regression noted a trend towards motor control exercise sessions conducted 3–5 times per week yielding larger effect sizes than training more frequently for pain and disability (Mueller and Niederer 2020). Potentially, the systematic review did not find improved outcomes from greater frequency of practice because the sample was not limited to those with maladaptive motor control changes, and the authors indicated this finding was based on low quality evidence (Mueller and Niederer 2020). Greater frequency of exercise is also recommended from the pain literature more broadly which indicates that consistent exercise is associated with pain inhibition (Sluka et al. 2018). Future research should examine whether there is an optimal frequency of practicing motor control exercise for people with maladaptive LAM activation.

Once patients' motor control impairments had been addressed, the Delphi study participants recommended developing muscle endurance and strength. The rationale for prescribing endurance-focussed exercises was related to the concepts of muscle fibre type and spinal stability. The LAM are considered to contain an equal proportion of type I and II fibres (Häggmark and Thorstensson 1979). Endurance training may be relevant as it can induce a change to type I fibres (Plotkin et al. 2021) which has been identified as important for sustaining minimal trunk muscle activation during normal daily activities (Cholewicki et al. 1997). However, to the best of the authors' knowledge, maladaptive changes in LAM fibre type in people with PLBP has not been researched, despite being demonstrated in paraspinal muscles (Mannion 1999). There is some evidence for the ratio of LAM to extensor muscle endurance being significantly decreased in people with history of LBP compared to asymptomatic participants (McGill et al. 2003). As poor muscle endurance is one factor that may decrease spinal stability in combination with others such as neural inhibition and joint laxity (Reeves et al. 2019), an endurance exercise prescription appears logical.

Strength training for muscle hypertrophy as recommended by this Delphi study may be applicable as some patients have reduced LAM thickness (Rahmani et al. 2018). Study participants agreed that whilst it is important that muscles are not weak, they do not have to be overly strong. This appears to relate to participants' emphasis on improving impairments (e.g., motor control, atrophy) relevant to achieving functional capacity and reduced pain.

Participants proposed specific repetition and set ranges, progression methods and exercises for endurance and strengthening. These dosage and progression methods correspond to the general guidelines for exercise prescription from the American College of Sports Medicine (Thompson et al. 2010). The exercises agreed on by participants for improving LAM endurance and strength included: four-point leg extensions or contralateral arm and leg lifts (bird dog), bridges and variations (e.g. one leg and with a ball) and side bridges. Such exercises are consistent with McGill's exercise recommendations (McGill 2007). Additionally, a systematic review found that the bird dog exercise and bridging exercises result in moderate level activation of the LAM, suggesting that these exercises would be effective for recruiting the LAM (Oliva-Lozano and Muyor 2020). There were many other exercises proposed that clinicians did not agree on. One could argue that the above exercises are 'abdominal specific'. In accordance with this principle, a review of the literature indicated that abdominal muscle specific strengthening exercises are required to improve abdominal muscle strength (Hubley-Kozey et al. 2003).

However, only one meta-analysis found low quality evidence that 'stabilisation' and resistance exercises may be effective for improving trunk strength and endurance and this was not significant when compared to a no intervention control group (Owen et al. 2020). The argument against a progression from motor control exercises to a specific endurance and strengthening protocol is that general exercise programs may address muscular fatiguability, and there is lack of significant differences between these programs in the literature (Reeves et al. 2019). As the superiority of exercise programs remains unclear and potential LAM fibre changes are yet to be examined, it seems reasonable to incorporate a combination of general resistance exercises in with motor control exercises as recommended by Delphi study participants.

Another benefit of incorporating general aerobic and resistance exercises is that they are most likely to improve mental health outcomes when compared with other exercise types (Owen et al. 2020). This is consistent with participants' goal of improving psychosocial factors such as fear of movement and anxiety from the exercise program.

Participants recommended that psychosocial factors also be addressed through education in this program. Previous research has found that patients with LBP believe exercise programs should be accompanied by individualised biomedical explanations for how the exercise program will be effective for them (Ayre et al. 2022). Similarly, this Delphi study identified that explaining the LAM and rationale for exercise was important; however, cautiously so patients do not fixate on impairments. The literature also highlights the need for caution, suggesting that individuals can respond to terminology including 'spinal instability' with feelings of fragility/vulnerability. This may lead to abnormally high levels of muscle co-activation, thereby detracting from attempts to normalise LAM activation and potentially increasing pain (Reeves et al. 2019). This supports Delphi study participants desire to provide education in a manner which increases patients' movement abilities and confidence in their spine.

To provide effective exercise and education, Delphi participants repeatedly recommended that the program be individualised. Participants strongly agreed to collaborate with patients to create a program appropriate to their individual symptoms, impairments, exercise preferences and abilities. Consistent with this, a systematic review has found individualised exercise programs to significantly reduce disability and pain compared with active control groups at short but not long-term time points (Fleckenstein et al. 2022). A trial not included in that study compared individualised functional motor control training (involving posture/movement correction, no SMA) to strength and flexibility exercises. The motor control training group demonstrated greater clinically important changes in disability post intervention and at 6- and 12-month follow ups (van Dillen et al. 2021). This provides evidence for the potential superiority of individualised functionally based motor control exercise as recommended by Delphi participants compared to general exercise alone.

Despite this, there is some discrepancy between standardised application of motor control exercise protocols in research versus the clinical belief that individualisation of treatments results in greater treatment effects (Van Dieen et al. 2019b). Individualisation would seem to be important, as research indicates variability in motor control in both people with and without PLBP (Van Dieen et al. 2019a). Similarly, participants in this Delphi study mentioned the need to consider whether under and/or over activity of different muscles is present for each patient. The concept of prescribing exercise differently between patients with under and/or overactivity of different muscles was only agreed on in the final round. Future research should ask clinicians how exercise programs would differ for those characteristics.

The second component to individualisation identified in this study was patient preferences and lifestyle, which is strongly supported by people with PLBP (Ayre et al. 2022). Additionally, patients with PLBP value maintaining general fitness for wellbeing (Ayre et al. 2022). Delphi participants also highlighted the importance of the program including moderate to vigorous general exercise. However, to the best of our knowledge, the integration of patient preferred general exercise activities from the beginning of the program has only been explored in one trial.

In this trial, a motor control exercise program has been undertaken whilst elite cricketers continue with cardiovascular exercise and other sport specific activities (Hides et al. 2010). It was recommended that participants ceased heavy resistance training in the early stages of motor control while independent muscle activation was taught (Hides et al. 2010). Those participants with LBP demonstrated improvements in motor control by the end of the program (Hides et al. 2010). This suggests that incorporation of the program into individuals' current exercise regimes is possible in an athletic sample. It remains unclear whether similar changes in motor control could be achieved if non-athletic participants undertook a motor control program while continuing with potentially modified general exercise or preferred sporting activities.

As people with PLBP want their exercise preferences identified and are motivated by progress in their activity goals (Ayre et al. 2022), incorporation of exercise rehabilitation into participants' preferred physical activity from the outset may increase compliance and/or satisfaction with the program. Supporting this, patients demonstrated significantly greater adherence and function when training functional activities compared with a program of general strengthening and flexibility exercise (Van Dillen et al. 2016).

4.2 | Strengths and Limitations

A strength of this Delphi study includes the recruitment of experienced clinicians whose patients were relevant to our topic. While the sample size of the present study was within the targeted range, there was an inconsistent number of participants in each round and the attrition of eight participants by the third round must be acknowledged (65% retention). Seventy percent retention is recommended to maintain rigour (Keeney et al. 2011). Reminder emails were sent out each round; however, due to anonymity, the authors were unable to follow up on non-responders. Non-responders did not provide a reason as to why they were unable to continue. This may have biased consensus findings towards the opinions of those who completed all rounds. The findings may have limited generalisability to countries with different healthcare contexts to Australia as only seven participants were from countries outside Australia. Few IFOMPT member organisations outside Australia responded, indicating they would distribute the study information. It is therefore likely that recruitment to international physiotherapists was limited. Despite this, the physiotherapy training is likely to be similar across different countries as all participants were required to have completed postgraduate programs that were IFOMPT accredited.

4.3 | Implications for Physiotherapy Practice

This Delphi study outlines a general structure for prescribing exercise for patients with maladaptive LAM activation. Participants suggested that the key goals of exercise prescription for such patients include reducing symptoms while increasing patients' functional capacity and education about exercise and the LAM. To achieve such goals, participants recommended a 4–12 weeks program, beginning with motor control exercises. Motor control exercises should be relevant to the individual's impairment (i.e. over or underactivity of the muscle/s) and therefore may include muscle activation, posture or movement exercises. Such exercises should be practiced daily to improve motor learning. After motor control, exercises should be progressed to improve muscle endurance and strength as required. Exercises that may be prescribed in this phase include bird dogs and bridge variations. Use of resistance, increased time holding positions and specific repetition and set prescriptions may assist in achieving this. Individualisation was identified as a key principle to ensure that the program aligns with the patients' lifestyle, abilities, preferences and goals. The program principles and recommendations are supported by the literature. The emphasis on balancing motor control exercise with general physical activity differs from most previously examined programs. Future research should trial the proposed recommendations to determine the effect on LAM activation and patient satisfaction. Additionally, determining the feasibility of implementation in clinical practice. For example, potential challenges may include whether such recommendations are specific enough and if practitioners can develop and deliver such a multifaceted program within the time constraints of clinical practice.

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Ethics Statement

The University of South Australia Human Research Ethics Committee (s) approved this study Application ID: 204299. All participants gave written informed consent before data collection began.

Consent

The authors have nothing to report.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Permission to Reproduce Material From Other Sources

The authors have nothing to report.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.