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Defining Pilates exercise: A systematic review

Cherie Wells*, Gregory S. Kolt, Andrea Bialocerkowski

School of Science and Health, University of Western Sydney, Locked Bag 1797, Penrith, NSW, 2751, Australia
 Available online 13 March 2012

KEYWORDS

Pilates;
 Low back pain;
 Exercise

Summary

Objectives: To describe Pilates exercise according to peer-reviewed literature, and compare definitions used in papers with healthy participants and those with low back pain.

Design: A systematic review of literature was conducted. A search for “pilates” within the maximal date ranges of the Cochrane Library, Medline, Cumulative Index to Nursing and Allied Health Literature, Physiotherapy Evidence Database, ProQuest: Nursing and Allied Health Source, Proquest: Medical and Health Complete, Scopus, Sport Discus, and Web of Science, was undertaken. To be included, papers needed to describe Pilates exercise, and be published in English within an academic, peer-reviewed journal. There were no restrictions on the methodological design or quality of papers. Content analysis was used to record qualitative definitions of Pilates. Frequencies were calculated for mention of content categories, equipment, and traditional Pilates principles. Frequencies were then compared statistically in papers with healthy participants and those with low back pain.

Results: 119 papers fulfilled inclusion criteria. Findings suggest that Pilates is a mind–body exercise that focuses on strength, core stability, flexibility, muscle control, posture and breathing. Exercises can be mat-based or involve use of specialised equipment. Posture was discussed statistically significantly more often in papers with participants with low back pain compared to papers with healthy participants. Traditional Pilates principles of centering, concentration, control, precision, flow, and breathing were discussed on average in 23% of papers. Apart from breathing, these principles were not mentioned in papers with low back pain participants.

Conclusions: There is a general consensus in the literature of the definition of Pilates exercise. A greater emphasis may be placed on posture in people with low back pain, whilst traditional principles, apart from breathing, may be less relevant.

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* Corresponding author. Tel.: +61 2 46203835; fax: +61 2 46203792.
 E-mail address: c.wells@uws.edu.au (C. Wells).

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Introduction

Chronic low back pain (CLBP) is a common and disabling condition, with costly implications for society.^{1,2} Several forms of exercise have been reported to reduce pain and disability in people with CLBP.^{3,4} One such exercise is Pilates, a mind–body exercise approach that can be considered a Complementary and Alternative Medicine (CAM) therapy.^{5,6} How Pilates exercise is defined, and applied in the treatment of people with CLBP, however, seems to vary in the literature.^{7,8} This makes it difficult to interpret research findings appropriately, and conduct valid research into its efficacy.

Pilates exercise was founded by Joseph Pilates during the 1920s.^{9,10} An emphasis is placed on control of body position and movement, as suggested by its original name ‘‘Contrology’’.¹¹ Exercises are floor-based, or involve the use of specialised equipment which provide adjustable spring resistance.^{10,11} Traditional principles of Pilates exercise include centering, concentration, control, precision, flow, and breathing.⁷ These principles are defined in Table 1.

Over the past decade, Pilates has changed from being exclusively used by dancers, to becoming popular in the mainstream exercise arena, and in injury rehabilitation.^{10,14} Pilates is frequently prescribed to people with low back pain due to its focus on activating stabilising muscles of the trunk and lower back.^{5,11} These muscles have been shown to be inhibited in people with low back pain.^{15–19} Pilates exercise, therefore, is theorised to assist in the re-activation of these muscles, and by so doing, increase the support of the lower back, and reduce pain and disability.⁵

Pilates exercise has diversified with the extension of its use in different contexts. Changes relate to the modification of exercises to suit different client needs and abilities, and updating of traditional techniques to align with evidence-based principles.^{7,8,11} The removal of trademark restrictions on the use of the term ‘‘Pilates’’ has also led to widespread variation.²⁰ Despite literature reporting variation of Pilates exercise, there is no published research that has investigated how Pilates exercise is defined in literature or clinical practice.

The aim of this systematic review is to identify peer-reviewed, published literature that describes Pilates exercise, and to synthesise definitions, use of specialised

equipment, and report of traditional principles. This will help determine if there is any difference between original descriptions provided by Joseph Pilates, and current understanding of Pilates exercise. The definition of Pilates exercise will be further explored in papers with low back pain participants, and compared to papers with healthy participants. This will provide a basis for understanding how definitions may vary in health promotion, versus rehabilitation contexts.

Materials and methods

Study design

A systematic review was undertaken to define Pilates exercise according to the literature. This review adheres to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.²¹ Nine databases were used to conduct the search: Cochrane Library, Medline, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Physiotherapy Evidence Database (PEDro), ProQuest: Medical and Health Complete, Proquest: Nursing and Allied Health Source, Scopus, Sport Discus and Web of

Table 1 Traditional Pilates principles.

Traditional principle	Definition
1. Centering	Tightening of the muscular centre of the body or ‘‘powerhouse’’, located between the pelvic floor and the ribcage during exercises ^{12,13}
2. Concentration	Cognitive attention required to perform exercise ⁷
3. Control	Close management of posture and movement during exercise ⁷
4. Precision	Accuracy of exercise technique ⁷
5. Flow	Smooth transition of movements within the exercise sequence ⁷
6. Breathing	Moving air into and out of lungs in coordination with exercise ⁷

Science. Both medical and exercise science databases were chosen to access as many relevant articles as possible.

Search strategy

Development of the search strategy was conducted using the Scopus database. A search for the word 'pilates' within the title, abstract, or keyword field was undertaken from the date of database inception until April 13, 2011. Expanding the search to include 'exercise', 'motor control', and 'core stability' did not increase the number of relevant papers sourced. A similar protocol was repeated in the other databases (Table 2). Limits were applied to database searching to identify papers published in English in peer-reviewed journals. The title, abstract, and as required, the full text of papers was examined to determine suitability of inclusion against selection criteria. Once papers were included, their reference lists were searched for relevant papers that had not been previously been identified.

Selection criteria

To be included in this systematic review, papers needed to describe Pilates exercise, and be published in the English language in a peer-reviewed journal. A peer-reviewed journal was defined as a scholarly, academic, and refereed journal indexed within Ulrich's periodical directory.²² The Ulrich's periodical directory is commonly used to categorise types of journals, and provides a conservative estimate of peer-review status.²³ Using the Ulrich's directory to identify journals that were peer-reviewed helped to ensure papers were not overlooked.

Types of papers that could be included in this systematic review were systematic and narrative reviews, randomised and case control trials, case series and case reports, cross-sectional descriptive studies, abstracts and opinion articles. Papers were not critically analysed for their methodological quality as the aim of this systematic review was to collate and synthesise information on the definition of Pilates exercise. Opinion articles, then, were considered to be valid sources of information in exploring different interpretations and perspectives.

Data extraction

The following information was extracted:

- Author and year of publication
- Methodological design
- Definition of Pilates exercise
- Study sample, where applicable
- Use of mat and/or specialised Pilates equipment
- Which, if any, traditional Pilates principles were discussed, or used

Data analyses

Content analysis^{24,25} was used to identify and record definitions of Pilates exercise in the literature. Content categories were identified based on recurring themes related to

the description of Pilates exercise in included papers. If greater than 25% of papers mentioned a feature of Pilates exercise, it was included as a content category. Content categories were then further defined, and alternative key words or phrases identified, to enable consistent recognition in the literature (Table 3). Papers were reviewed twice within two weeks by one reviewer to cross-check categorisation of information, and ensure appropriate thematic analysis.

Whilst some content categories were relatively easy to define, such as breathing, flexibility, and posture, others required more explanation. To identify the content category of 'core stability', papers needed to mention the activation of deep, stabilising trunk muscles to support the lumbar spine and pelvis.^{27,28} For 'strength', papers needed to mention this term specifically, rather than endurance. This is because different muscle fibres are recruited with strength training, that is, fast twitch, fatiguing fibres as opposed to slow, twitch enduring fibres.^{32–34} The category of 'muscle control' was identified if papers commented on the need for segmental control of spinal motion with or without combination with limb movement.^{29,30} This helped differentiate this category from 'mind–body connection' by explicitly detailing the type of control required. The 'mind–body connection' category was identified if authors of papers proposed Pilates exercise involved the mind controlling the body's movement and position.¹⁰

In addition to content analysis of the definition of Pilates in the literature, frequency of mention of specialised Pilates equipment and traditional Pilates principles was recorded. Specialised Pilates equipment included any, or several of the following: the Reformer, Trapeze Table or Cadillac, Ladder Barrel, and Wunda Chair.¹⁰ Common therapeutic and gym equipment, such as medicine balls or resistive tubing, were not considered to be specialised Pilates equipment. Traditional Pilates principles included centering, concentration, control, precision, flow, or breathing.⁷ Papers needed to specifically list these principles for this to be noted (Table 1).

Descriptive statistics were then used to summarise the frequency of:

- Different methodological study designs.
- Content categories used in the definition of Pilates exercise, that is, breathing, core stability, flexibility, muscle control, mind–body connection, posture and strength (Table 3).
- Report of specialised Pilates equipment, such as the Reformer, Trapeze Table or Cadillac, Ladder Barrel, and Wunda Chair.¹⁰
- Mention of traditional Pilates principles including centering, concentration, control, precision, flow, or breathing.⁷

The proportion of papers with healthy participants versus papers with low back pain was also calculated. Healthy participants were defined as people of any age, gender or sporting ability but without a diagnosed medical condition or injury. Participants with low back pain needed to be part of the research study in the paper, or else a major focus of discussion in the opinion paper.

Frequencies of mention of content categories, traditional Pilates principles, and specialised equipment were then compared across papers with healthy versus low back pain

Table 2 Search strategy: database, date range, fields using search term ‘‘Pilates’’.

Database	Date range	Fields
Cumulative Index to Nursing and Allied Health Literature (CINAHL)	1970–2011	Title or abstract or word in subject heading
Cochrane Library	1800–2011	Full text
Medline	1928–2011	Title or abstract or keyword
Physiotherapy Evidence Database (PEDro)	1928–2011	Abstract and title
Proquest (Health and Medical Complete)	1928–2011	Citation and abstract
Proquest (Nursing and Allied Health Source)	1928–2011	Citation and abstract
Scopus	1960–2011	Title, abstract, or keywords
Sport Discus	1975–2011	Title or abstract or keywords
Web of Science	1977–2011	Topic or title

participants. A Pearson’s Chi-Square test was used to calculate statistical differences in frequencies. When frequencies were less than 5, a Fisher’s exact test was used. The level of significance was set at 0.05.

Results

Search results

A total of 2182 papers were identified using the search strategy. Of these, 119 papers fulfilled the selection criteria. Most papers were excluded due to not being published in peer-reviewed journals (Fig. 1).

Different methodological designs of included papers

The majority of the included papers were opinion pieces ($n = 54$),^{7,8,10–14,34–80} The remainder of the papers were case series ($n = 17$)^{81–97}, randomised controlled trials ($n = 13$),^{98–110} case controlled trials ($n = 12$),^{111–122}

cross-sectional descriptive studies ($n = 11$),^{123–133} case studies ($n = 7$)^{134–140}, and systematic reviews ($n = 5$).^{5,141–144}

Content categories in the definition of Pilates exercise

Content categories frequently identified in the definition of Pilates exercise included breathing, core stability, flexibility, muscle control, mind–body connection, posture and strength. These have been defined in Table 3.

Content category frequency

The most frequently mentioned content categories in descending order were strength (76%), core stability (69%), flexibility (62%), posture (60%), muscle control (49%), breathing (49%), and mind–body connection (46%). Examples of other components mentioned in the definition of Pilates exercise, but less frequently, included balance, proprioception, endurance and coordination. For references of papers that identified these content categories, please see Appendix A.

Table 3 Definition and associated words/phrases of content categories.

Content category	Associated words/phrases	Definition
Breathing	Breath, breathing, respiration	Process of moving air into and out of lungs ²⁶
Core stability	Core stability, core control, core strength	Activation of deep trunk muscles that stabilise lumbar spine and pelvis ^{27,28}
Flexibility	Stretching, full range of movement	Ability of joints to move through full range of movement ²⁶
Muscle control	Muscle control, movement control, motor control, segmental control	Isolated, segmental movement of the spine and coordination with limb movement ^{29,30}
Mind–body connection	Mind–body exercise, contrology ^a	Control of the physical body by the mind ¹⁰
Posture	Posture, alignment, positioning	Relative positioning of body parts at a given time ³¹
Strength	Strength, strengthening (not endurance)	Ability of muscle to produce or resist a physical force ²⁶

^a Original name for Pilates exercise.¹¹

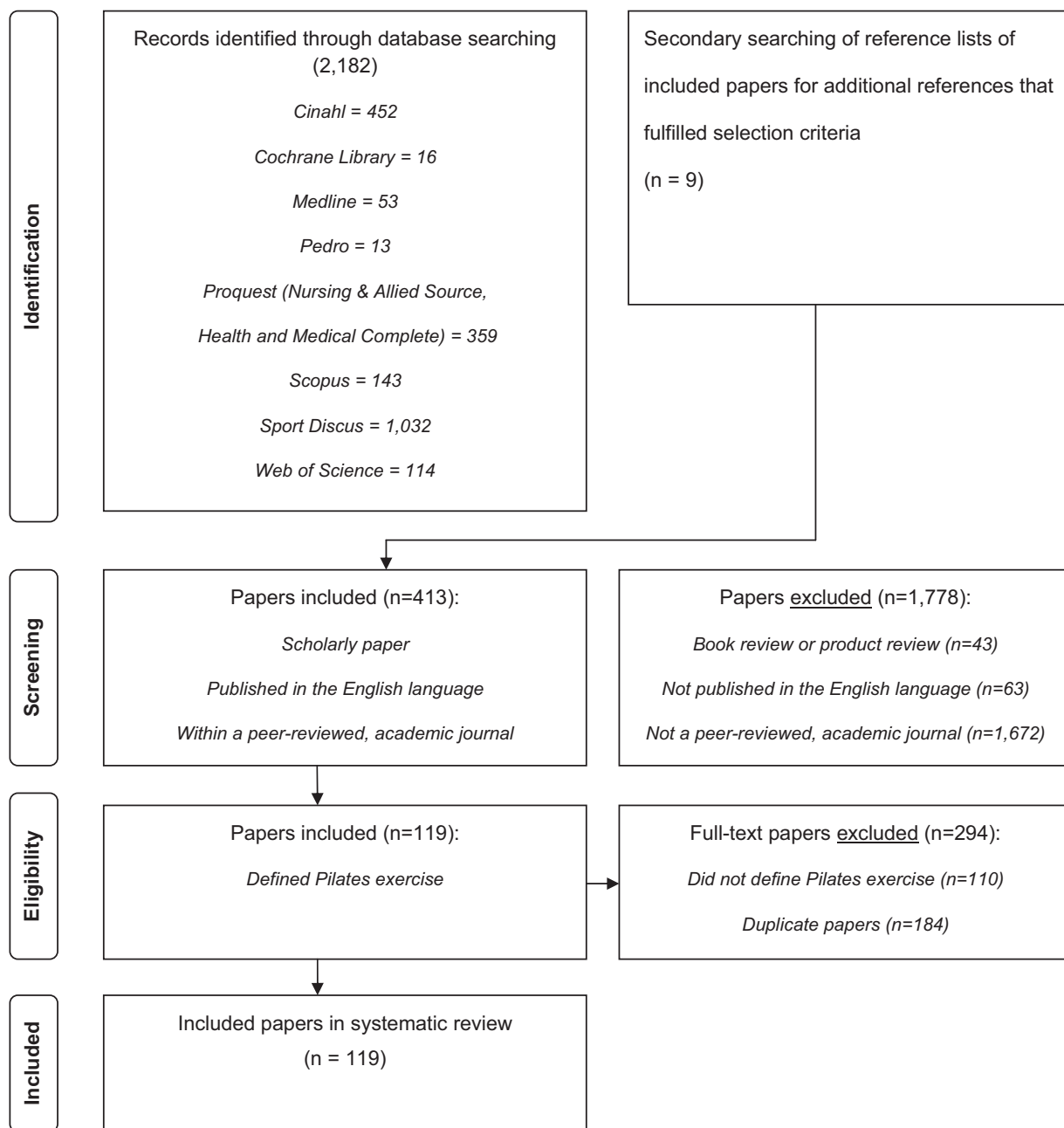


Figure 1 Results of literature search.

Supplementary Appendix A related to this article found, in the online version, at [doi:10.1016/j.ctim.2012.02.005](https://doi.org/10.1016/j.ctim.2012.02.005).

Healthy versus low back pain participants

In 41% of papers ($n = 49$), participants were healthy, whilst in 14% of papers ($n = 17$), participants had low back pain. The remainder of the included papers ($n = 53$) focused on people with other pathologies, or did not consider the application of Pilates exercise to any particular group of people. When comparing frequencies of mention of content categories in papers with healthy versus low back pain participants, there was no statistically significance difference for strength,

core stability, flexibility, muscle control, breathing, and mind–body connection. There was, however, a statistically significant difference related to posture ($\chi^2 = 5.051$, $p = 0.047$). A higher proportion (76%) of papers with low back pain participants suggested posture was important in Pilates exercise compared to papers with healthy participants (45%) (Table 4).

Equipment recommendation for Pilates exercise

Thirty-eight percent of all papers included in this study ($n = 45$) reported floor-based Pilates exercise and the use of specialised equipment. Twenty-five percent of papers

Table 4 Frequency of content categories in papers with healthy participants and participants with low back pain.

Content category	Frequency of papers with healthy participants [%]	Frequency of papers with participants with low back pain [%]	Pearson Chi-Square [χ^2 (<i>p</i> value)]
Mind–body connection	29	35	$\chi^2 = 0.270$ (<i>p</i> = 0.603)
Breathing	45	47	$\chi^2 = 0.024$ (<i>p</i> = 0.877)
Muscle control	41	59	$\chi^2 = 1.651$ (<i>p</i> = 0.199)
Posture ^a	45	76	$\chi^2 = 5.051$ (<i>p</i> = 0.047)
Flexibility	64	60	$\chi^2 = 0.229$ (<i>p</i> = 0.632)
Core stability	71	88	$\chi^2 = 1.941$ (<i>p</i> = 0.205)
Strength	76	59	$\chi^2 = 1.714$ (<i>p</i> = 0.190)

^a Statistically significant difference between papers with healthy participants and those with low back pain at the 0.05 level.

(*n* = 30) did not specify equipment or exercises. The remainder of the papers suggested the use of either floor-based exercise (28%, *n* = 33), or the use of specialised equipment (9%, *n* = 11) (Appendix B). There was no significant difference in the frequency of recommendations of use of mat ($\chi^2 = 0.309$, *p* = 0.759) or specialised equipment ($\chi^2 = 0.015$, *p* = 0.904) in papers with healthy versus low back pain participants.

Supplementary Appendix B related to this article found, in the online version, at doi:10.1016/j.ctim.2012.02.005.

Traditional Pilates principles used in definition of Pilates exercise

The most frequently reported traditional principles of Pilates exercise across all papers were breathing (49%), centering (19%), control (19%), precision (18%), flow (18%), and concentration (18%) (Appendix C). Breathing was also classified as a content category. Apart from breathing, none of the papers investigating Pilates exercise with low back pain participants quoted, or reported using, traditional principles.

Supplementary Appendix C related to this article found, in the online version, at doi:10.1016/j.ctim.2012.02.005.

Discussion

According to this review, Pilates is a mind–body exercise that requires core stability, strength, and flexibility, and attention to muscle control, posture, and breathing. Exercises can be mat-based, or involve the use of specialised equipment. Traditional Pilates principles of centering, concentration, control, precision, flow, and breathing may be relevant to contemporary Pilates exercise. In people with low back pain, posture may be a critical component of Pilates exercise, but traditional principles, apart from breathing, may be less important.

This systematic review is the first of its kind to describe Pilates exercise according to peer-reviewed literature, and compare definitions used in papers with healthy versus low back pain participants. The design of this review helped ensure relevant, but detailed information on Pilates was obtained from a variety of sources. A systematic review methodology limited bias in the selection of evidence.^{145–147} Comprehensive searching of papers indexed in both medical and sport databases meant that relevant papers were unlikely to have been overlooked. Inclusion of papers with

different methodologies contributed to a broad understanding of Pilates as described in the literature.

Content analysis was used to systematically identify and synthesise recurring themes within definitions of Pilates.^{24,25} Though only one reviewer extracted and synthesised information, categorisation of information was checked twice to ensure appropriate analysis. A limitation of this systematic review is the assumption that frequency of mention of content categories, equipment use, and traditional principles equated to their importance in defining Pilates exercise.

The findings of this systematic review also must be viewed in light of the fact that none of the included papers aimed to define Pilates, and the majority of included papers were opinion articles (45%). Definitions of Pilates given in the literature, then, may have been over-simplified, or biased. This is particularly true in relation to opinion articles, as publication in peer-reviewed journals does not guarantee peer-revision for these types of papers. Despite this, papers that did not aim to define Pilates, or were opinion articles, were included in this review due to limited availability of relevant research.

Furthermore, it should be recognised that there was only a small number of papers that focused on Pilates in relation to participants with low back pain (*n* = 17) compared to papers with healthy participants (*n* = 49). This may have influenced the comparative analyses of the definition of Pilates exercise in these papers, however, statistical analyses using a Fisher's exact test assisted in minimising bias. The definition of Pilates provided by this review may be used by clinicians and policy-makers to identify and evaluate Pilates exercise programmes. This review also has highlighted the potential importance of different features of Pilates exercise, particularly in relation to people with low back pain. Posture was mentioned more frequently as part of Pilates exercise in papers with low back pain participants, versus papers with healthy participants. This could mean that posture is more important for people with low back pain when performing Pilates exercise than in people without low back pain. Recent studies have reported that lumbo-pelvic posture can affect the activation of deep, stabilising trunk muscles such as transverses abdominis and multifidus.^{148,149} These muscles are inhibited in people with low back pain, and therefore may require additional postural facilitation to be recruited with Pilates exercise.^{15–19}

This review has been unable to provide detail on the interpretation of features of Pilates exercise across different contexts due to lack of relevant research. Different

interpretations of the components of Pilates, however, may result in variable exercise techniques. For example, the principle of ‘‘centering’’ requires the ‘imprint’ action or pulling of the navel towards the spine. Traditionally in Pilates, this ‘imprint’ action involves co-contraction of all the abdominal and buttock muscles, and tilting of the pelvis in a posterior direction to ‘straighten’ the spine.⁸ When Pilates is used to treat people with low back pain, however, emphasis may be placed on holding a ‘neutral’ spine position, where the natural curves of the spine are maintained.⁸ Focus also may be placed on primary activation of deep abdominal and back muscles, such as transverses abdominis and multifidus, over superficial trunk musculature.^{8,29}

A greater proportion of papers in this review suggested Pilates exercise is floor-based, rather than involving the use of specialised equipment. This finding, however, could relate to the expense, or size, of specialised Pilates equipment, and the relative ease of conducting floor-based exercise. In people with low back pain, specialised equipment has been reported to be beneficial as spring resistance can be adjusted to individual ability, and provide greater proprioceptive feedback during Pilates exercise.⁷ Further investigation then, on the benefits and barriers of using specialised Pilates equipment is required.

Traditional Pilates principles of centering, concentration, control, precision, and flow were reported in 18–21% of all papers. This may indicate these principles are less important in defining Pilates, compared to content categories that were mentioned in 46–69% of papers. Only breathing, which was a traditional Pilates principle, and content category, was mentioned in papers with low back pain participants. This may suggest that traditional principles, apart from breathing, are less critical than previously reported, particularly in people with low back pain.

Prior to this systematic review, no research has been undertaken to specifically examine the definition or application of Pilates exercise. Whilst this review has provided a definition of Pilates exercise according to current literature, these findings need to be validated with clinical research. The relative importance and interpretation of features of Pilates identified in this review also need to be explored in clinical practice with both healthy and low back pain participants. This may provide further direction regarding Pilates exercise technique and prescription in health promotion versus rehabilitation contexts. Finally, the benefits, and barriers, of using specialised equipment with Pilates exercise should be investigated, along with the relevance of traditional principles in contemporary Pilates exercise across different contexts.

Conclusion

The findings of this systematic review indicate that Pilates is a mind–body exercise approach requiring core stability, strength, and flexibility, and attention to muscle control, posture, and breathing. Exercises may be floor-based, but also include use of specialised equipment. In papers with low back pain participants, posture was mentioned more frequently than in papers with healthy participants. Traditional principles, apart from breathing, were not mentioned in papers with low back pain participants. This may imply

that posture is an important feature of Pilates for people with chronic low back pain, whilst traditional principles may be less relevant. The clinical validity of these findings needs to be confirmed with further research exploring the principles and techniques used in both healthy participants, and in people with low back pain.

Acknowledgement

Dr Paul Marshall is to be acknowledged for advice and review of draft article.

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