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REVIEW

Adverse events related to physiotherapy practice: a scoping review

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ABSTRACT

Introduction: While adverse events related to physiotherapy are possible, the type of adverse event and the area of physiotherapy practice in which they occur are not well understood. The purpose of this scoping review was to establish adverse events related to physiotherapy practice and understand the nature of these events and the circumstances in which they occurred.
Methods: Relevant literature from January 2014 to February 2024 was gathered from five electronic databases. Studies reporting adverse events within any physiotherapy practice (intervention or assessment) were eligible. Two reviewers independently assessed title and abstract, and full texts. Findings were synthesised by clinical streams.
Results: A total of 58 studies met the inclusion criteria. Common adverse events described in musculoskeletal physiotherapy involving manual therapy, exercise and electrotherapy were increased pain and stiffness. Cardiorespiratory physiotherapy interventions involving early mobilisation, exercise and airway clearance therapy reported desaturation and haemodynamic instability. Neurological physiotherapy studies reported falls and fatigue during gait and balance training and exercise. Oncology and aged care interventions involving exercise, balance training and lymphoedema management reported increased pain and muscle strain while studies including pelvic floor muscle training reported the adverse event of vaginal discomfort.
Conclusion: This review identified adverse events occurring during physiotherapy interventions or assessment procedures. Increased monitoring and proactive safety measures may be necessary to ensure patient safety during these treatments.

Keywords: Adverse events, Patient safety, Physiotherapy, Scoping review

What is already known about this topic:

- *Adverse events within clinical trials and observational studies across physiotherapy practice have been documented. However, the adverse events and the nature of physiotherapy practice during which these events have occurred are not well understood.*

What this study adds:

- *This review summarises adverse events attributable to physiotherapy across a range of clinical practice areas. The awareness of these events highlights the importance of clinicians adapting and monitoring their practice to maximise patient safety.*

Introduction

Patient safety is important in all healthcare settings. However, preventable adverse events do occur and are a significant challenge globally. Recent data generated by the World Health Organization indicate that within hospital settings, unsafe healthcare practices contribute to 134 million adverse events annually (1,2). An adverse event is defined as an incident in which harm resulted to a person receiving healthcare (3). A serious adverse event is defined as any undesirable experience occurring during intervention which requires further medical attention or extended hospital stays (4). The healthcare treatment may involve a procedure, medication or a specific intervention, and the type of adverse events can have a wide range of severity, including injury, specific signs or symptoms, psychological harm or trauma (5). Adverse events may be unintended or a side effect of treatment, with the potential for either no harm, rapid recovery, the possibility of an extended hospital stay or significant clinical deterioration requiring additional medical attention (6).

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While patient safety is the foundation of healthcare practice, procedures or interventions associated with unintended harm can arise as a result of medical, nursing and allied health management, including physiotherapy (7). Although physiotherapy procedures and treatments are commonly acknowledged for their safety, particularly when implemented by qualified professionals (8), adverse events do occur (4). Musculoskeletal physiotherapy has been associated with a range of risks, including those related to manual therapy (e.g. increases in pain beyond baseline following treatment) and electrotherapy (4,9). In the field of cardiac surgery, 20% of physiotherapy interventions within intensive care were associated with adverse events, with 10% of these linked to negative outcomes (10). Similarly, early mobilisation in critically ill patients has been linked to haemodynamic and respiratory changes which have raised potential safety concerns (11). In physiotherapy management of patients with Parkinson's disease, common adverse events reported include falls, pain or discomfort and hypotension (12).

Early awareness and recognition of potential risks are vital for the safety of physiotherapy interventions and are key strategies to reduce the occurrence of adverse events (13). The benefit of this practice extends to those of graduate-entry physiotherapy students to facilitate the reduction in risk of harm in clinical situations (14). Instruction for students regarding potential adverse events across a variety of clinical fields of physiotherapy may be instrumental in developing risk management skills and contribute to enhanced patient safety, a core professional expectation of clinicians (15). Given the diverse field of physiotherapy practice, it is of clinical value to identify adverse events directly attributed to physiotherapy interventions and the nature of those adverse events. The collation of this information can be used to improve the awareness of clinicians and physiotherapy students of potential adverse events related to clinical practice. This may further promote the implementation of mitigating strategies to minimise or eliminate their occurrence (16). Furthermore, the problems with adequate systems to capture adverse events and the poor quality of the data that are collected is well documented (17). Learning from the adverse events that are reported can assist us identify priorities for investing in improved systems or supplementary data collection for this process. This scoping review is a step towards achieving this.

A scoping review was chosen to enable a broad inclusion of studies regardless of study design or quality (18). The objective of this study was to: (i) establish the adverse events related to physiotherapy practice; and (ii) describe the nature of these events.

Methods

The scoping review methodology involved documentation of a structured protocol including: eligibility criteria, information sources, selection of sources of evidence, data charting process and synthesis of results. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) was used to guide the reporting (Appendix 1) (19).

Eligibility criteria

The review included studies that met the following criteria: (i) peer-reviewed literature; (ii) studies published from January 2014 to February 2024; (iii) studies conducted in physiotherapy settings; (iv) reporting of adverse events or serious adverse events (as defined within each study) during or after the physiotherapy intervention or assessment procedure and was deemed by the study to be attributable to the physiotherapist-prescribed intervention or assessment procedure; and (v) studies published in English. Exclusion criteria were: studies involving adverse events in physiotherapy students rather than patients.

Information sources

The process of identifying potentially relevant studies included searching the following bibliographic databases from January 2014 to February 2024: Scopus; Physiotherapy Evidence Database (PEDro); Excerpta Medica Database (Embase); Medical Literature Analysis and Retrieval System Online (MEDLINE); Psychological Information Database (PsycINFO); and Cumulative Index to Nursing and Allied Health Literature (CINAHL). The time frame of 2014 to 2024 was selected in order to focus on studies published in the last 10 years due to their relevance to recent or current physiotherapy practice. As physiotherapy practice continues to evolve, it is likely that some practice procedures and technology from more than 10 years ago are not consistently equivalent to current practice. For some practices, continuous quality improvement in healthcare would enable a proportion of adverse events to be minimised by controls in place. Adverse events which occurred more than 10 years during physiotherapy practice, if persistent, are likely to be captured in a search limited to the last 10 years. The search strategies were developed and further refined through team discussion. The search strategy applied in each of the databases is outlined in Appendix 2.

Selection of sources of evidence

Covidence (Covidence systematic review software, Veritas Health Innovation, Melbourne, Australia, 2024) and Endnote 20 were used for data screening and extraction. The retrieved references were imported into Endnote 20, where duplicates were identified and removed. These references were subsequently imported into Covidence for the screening process. Two reviewers (YW and ALL) independently conducted the initial title and abstract screening. These reviewers evaluated the eligibility criteria for each study; any disagreement was resolved through discussion. Following the title and abstract screening, the two reviewers independently evaluated the full text of the selected studies to make final decisions.

Data charting process

Data extraction was performed using Google Sheets and Microsoft Excel. Extracted data included study design, patient condition, number of participants, demographics (age and sex), nature of the physiotherapy interventions, the location of the physiotherapy assessment or intervention (e.g. hospital setting – inpatients or outpatients; primary care – private

practice, community, home) and related adverse or serious adverse event(s) reported during physiotherapy interventions. One reviewer (YW) extracted the relevant data from the selected studies and the team evaluated the data systematically. Any disagreements arising during this process were resolved via team discussion.

Synthesis of results

Findings were synthesised in tables, grouped by physiotherapy clinical stream: musculoskeletal; cardiorespiratory; neurological; oncology, aged care and pelvic health (20).

Results

Selection of sources of evidence

After 261 duplicates were removed, 1,104 studies were identified from searches of electronic databases and review article references. Based on the title and abstract, 1,015 studies were excluded, with 89 full-text articles to be retrieved and assessed for eligibility. Of these, 31 were excluded for reasons outlined in Figure 1. The remaining 58 studies were considered eligible for this scoping review.

Characteristics of sources of evidence

The included studies were published from 2014 to 2024. Study designs included 36 randomised controlled trials; one randomised cross-over study; 20 non-randomised interventional, cross-sectional, cohort or feasibility studies; and one case study. Sample sizes ranged from one to 1,208 participants. Across the studies, the age of participants ranged from a median of eight months to a mean of 80 years. Regarding areas of physiotherapy practice, 22 studies reported on adverse events on musculoskeletal physiotherapy (21-42), 20 in cardiorespiratory (43-62), eight in neurological physiotherapy (63-70), five in oncology (71-75), one in aged care (76) and two in pelvic health (77,78).

Synthesis of findings

In musculoskeletal physiotherapy, all adverse events were reported by patient participants. The majority of included studies involved pain management for chronic conditions such as osteoarthritis (21,25-28), impingement syndrome (22), meniscal injury (29), buttock pain (31), tendinopathy or foot fractures (32,33), post-orthopaedic procedure rehabilitation following total hip or total knee arthroplasty or hip surgery (23,24,30), neck or back pain (34-36), shoulder conditions (37-40) or non-specific regions (41,42) (Tab. 1 and Supplementary Table 1). For management of a range of lower limb conditions (including following surgery) or back or neck pain, interventions provided included manual therapy, heat therapy, strength exercises, functional training, gait retraining and education. Findings indicated that commonly reported adverse events during or after these interventions were increased pain, stiffness, swelling, headaches and worsening of symptoms (Tab. 1 and Supplementary Table 1) with other serious or non-serious adverse events consisting of musculoskeletal tissue disorders and falls. For those with shoulder conditions receiving exercise, pain, muscle soreness and tendon complications were apparent.

In cardiorespiratory physiotherapy, the patient conditions, physiotherapy interventions and types of adverse events are outlined in Tab. 2 and Supplementary Table 2. The majority of adverse events were collated from patient

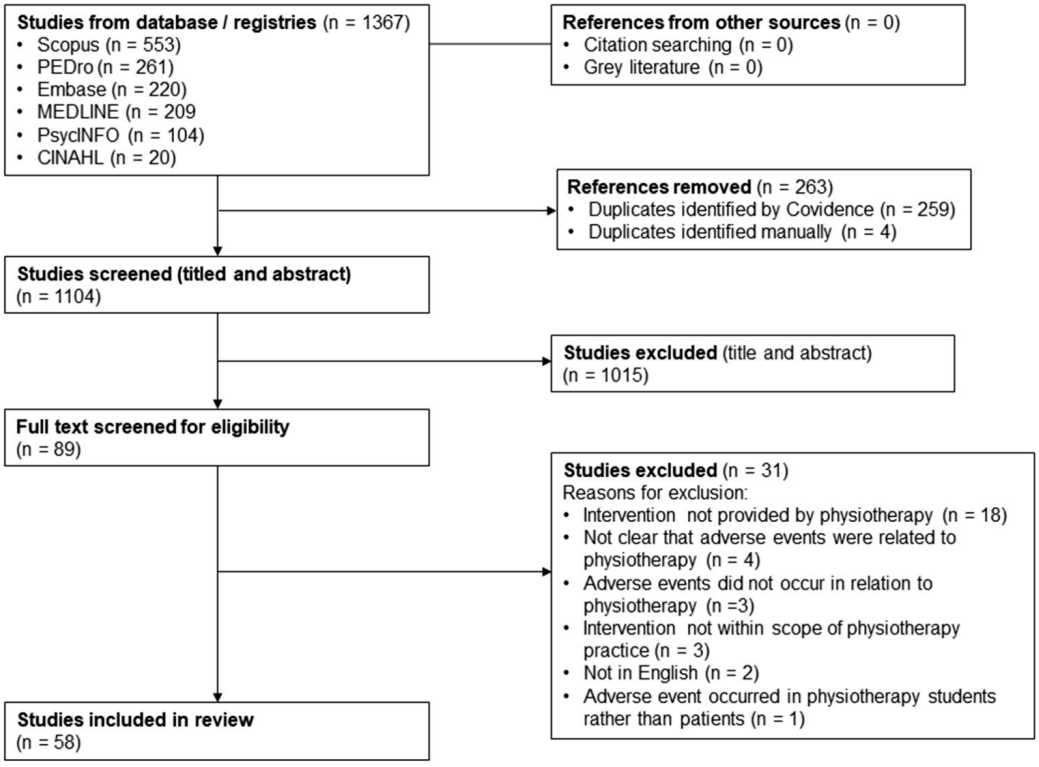

FIGURE 1 - Flow chart of included studies.

TABLE 1 - Musculoskeletal physiotherapy interventions for lower limb conditions and associated adverse events

Condition	Study design	No., age (mean±SD) years	Physiotherapy interventions			Adverse events and method of reporting			Setting and supervision provision
			ROM exercises	Strength exercises	Other interventions	Pain/muscle soreness	Stiffness	Other non-serious or serious adverse events	
Lower limb joint conditions									
Hip osteoarthritis (21)	RCT	102, 65±9	✓	✓	Manual therapy, functional balance, and gait drills	✓, ↑ post-Rx	✓	–	PP (S) and home (US)
						Collated from logbook during Rx and via questionnaires during follow-up			
Femoroacetabular impingement syndrome (22)	RCT	177, 35±9	–	–	Personalised hip therapy: physiotherapist-led rehabilitation	✓, change from baseline NR	–	–	Hospital – outpatients (S)
						Collated from questionnaires			
Hip fracture with surgical repair (23)	RCT	210, 80±8	✓	✓	Endurance, balance, function training Sensory-level TENS	–	–	Falls, femur/hip fracture, dehydration, dyspnoea	Home (visits by therapist) (S)
						Collated from telephone interviews			
Hip arthroplasty for osteoarthritis (24)	RCT	34, 65±8	–	✓	–	✓, ↑ post-Rx	–	Wound oozing, hypotension	Home (visits by therapist) (S)
						Collated from scoring on VAS and observations			
Knee osteoarthritis (25)	RCT	32, 63±8	–	–	Extracorporeal shockwave therapy	–	–	Reddening of skin, burning sensation, swelling	Hospital – outpatient (S)
						Collated from VAS and questionnaires			
Knee osteoarthritis (26)	RCT	102, 70±8	–	–	Neuromuscular exercises	–	–	Musculoskeletal disorders, connective tissue disorders	Outpatient clinic (S)
						Collated from questionnaire pain subscale			
Knee pain (27)	RCT	128, ≥50	–	✓	–	✓, ↑ post-Rx	–	Swelling	PP (S) and home (US)
						Collated from questionnaire			
Antero- or retro-patella pain (28)	RCT	16, 32±10	–	–	Gait retraining	✓, ↑ post-Rx	–	–	PP (S) and home (US)
						Collated from physiotherapy Rx notes			
Knee pain and meniscal tear (29)	RCT	161, 57±7	–	✓	Cardiovascular, coordination/balance exercise	–	–	Repeat knee surgery, acute myocardial infarction, sudden death	Outpatient (S) and home (US)
						Collated from follow-up Ax and reports			

(*Continued*)

TABLE 1 - (*Continued*)

Condition	Study design	No., age (mean±SD) years	Physiotherapy interventions			Adverse events and method of reporting			Setting and supervision provision
			ROM exercises	Strength exercises	Other interventions	Pain/muscle soreness	Stiffness	Other non-serious or serious adverse events	
Post-knee arthroplasty (30)	RCT	621, 70±8	–	–	Personalised home-based rehabilitation and standard post-operative physiotherapy	–	–	Musculoskeletal disorders, connective tissue disorders	Outpatient (S) and home (US)
						Collated from patient reports			
Pain between the buttock band and the rib arch (31)	RCT	113, 31±12	–	–	Hydrotherapy, TENS, and infrared thermal therapy	✓, ↑ from baseline	–	–	Outpatient (S)
						Collated from self-report			
Achilles tendinopathy (32)	Feasibility study	15, 38±9		✓	Double leg jump progression Single leg hops and running	–	–	Muscle tears	PP (S)
						Collated from daily diary			
Calcaneal or talar fracture (33)	RCT	50, 18-70	✓	–	Manual therapy	–	–	Wound complications, deep vein thrombosis	Outpatient (S)
						Collation from self-reported questionnaires, chart review			

✓ = applied; – = not applied; No. = number; NR = not reported; PP = private practice; RCT = randomised controlled trial; ROM = range of motion; Rx = treatment; S = supervised; SD = standard deviation; TENS = transcutaneous electrical nerve stimulation; US = unsupervised; VAS = visual analogue scale.

TABLE 2 - Cardiorespiratory physiotherapy interventions for the critically unwell and associated adverse events

Condition	Study design	No., age (mean±SD) years	Physiotherapy interventions			Adverse events			Setting and supervision provision
			Early mobilisation	Airway clearance therapy	Breathing exercises/ oxygen therapy	Cardiac issues	Oxygen-related issues	Other non-serious or serious adverse events	
Critically unwell patients undergoing MV									
Adults requiring MV (43)	RCT	371, 61±15	✓	–	–	Altered blood pressure, cardiac arrhythmia	Oxygen desaturation, tachypnoea	Pain or agitation, removal of invasive line	Hospital – inpatient (S)
						AEs reported by clinicians and patients Collated from PRO and case analyses			
Adults requiring MV (44)	RCT	115, 65±15	Endurance and resistance training	–	Respiratory therapy	Haemodynamic instability	Desaturation	–	Hospital – inpatient (S)
						AEs reported by researchers (clinicians and nurses) Collated from chart review (standard monitoring)			
Adults requiring MV >48 hours (45)	Process evaluation	36, 56±18	Bilateral lower limb in-bed cycling	–	–	–	Desaturation, increased RR	–	Hospital – inpatient (S)
						AEs reported by principal investigators Collated from pre-defined safety criteria			
Adults requiring MV <48 hours (46)	RCT	200, 65 (46-74)#	Early, goal-directed mobilisation	–	–	Hypotension	Desaturation	Dislodgement of arterial line Dislodgement of nasogastric tube	Hospital – inpatient (S)
						AEs summarised by treating clinicians Collated from chart review, patient record, bedside exam			
Children requiring MV (47)	RXT	34, 1 (0-15)		Postural changes, endotracheal instillation of saline or mucolytics, endotracheal suction, manual techniques	Manual or ventilator lung inflation	Haemodynamic instability	Transient alterations in oxygen saturation	Acute haemodynamic instability, pneumothorax, cardiac arrest 30 minutes post-PT	Hospital – inpatient (S)
						AEs reported by physiotherapists Collated from case analyses			
Adults requiring MV for 120 hours (48)	RCT	99, 58 (42-67)#	Progressive mobilisation as tolerated	–	–	Tachycardia, hypotension	Tachypnoea, desaturation	Arterial catheter removal, rectal tube removal	Hospital – inpatient (S)
						AEs reported by treating PT and OT Collated from chart review of therapy notes			

(*Continued*)

TABLE 2 - (*Continued*)

Condition	Study design	No., age (mean±SD) years	Physiotherapy interventions			Adverse events			Setting and supervision provision
			Early mobilisation	Airway clearance therapy	Breathing exercises/ oxygen therapy	Cardiac issues	Oxygen-related issues	Other non-serious or serious adverse events	
Critically unwell patients									
Patients considered functionally independent before hospitalisation (49)	Prospective observational study	142, 51 (43-64)[#]	Five times Sit-to-Stand Test	–	–	–	Dyspnoea	Muscle pain/ fatigue, chest pain	Hospital – inpatient (S)
						AEs reported by physiotherapists			
						Collated from checklist and physiological monitoring			
Uncomplicated AMI (50)	Cross-sectional study	152, 56±10	6-Minute Walk Test	–	–	Tachycardia, angina, hypotension	Dyspnoea, desaturation	Dizziness, palpitation	Hospital – inpatient (S)
						AEs reported by physiotherapists and medical staff			
						Collated from physiological responses			
Acute respiratory infection (51)	Case study	1, 59	–	Mechanical insufflation-exsufflation, expiratory vibrations, manual assisted cough, suction with saline		–	Desaturation	–	Hospital – inpatient (S)
						AEs reported by physiotherapists			
						Collated from observation during Rx			
Post-extubation (52)	Observational study	258, ≥18	Ambulation	–	NIV	Alteration in blood pressure	–	Vertigo	Hospital – inpatient (S)
						AEs reported by physiotherapists			
						Collated from observation of treatment			
Admitted to the medical ICU (53)	Retrospective analysis	99, 65 (52-72)[#]	Electrical muscle stimulation, passive or active range of motion, and mobility	–	–	Bradycardia	Respiratory distress, desaturation	Intolerance, tracheostomy removal	Hospital – inpatient (S)
						AEs reported by clinicians			
						Collated from observation during mobility Rx			
Covid-19 (54)	Feasibility	93; N/R	Prone positioning and supine turning	–	–	–	–	Endotracheal tube leak, one airway obstruction secondary to the body habitus	Hospital – inpatient (S)
						AEs reported by clinicians			
						Collated from observations and chart review			
Covid-19 (55)	Observational	84; 56±11	Active mobilisation in bed and activities of daily living training	✓	Assist invasive mechanical ventilation, lung expansion techniques	Tachycardia, hypotension, hypertension	Desaturation	Falls	Hospital – inpatient (S)
						AEs reported by physiotherapists			
						Collated from observation of Rx and chart review			

[#]Data are median (interquartile range).
✓ = applied; – = not applied; AE = adverse events; AMI = acute myocardial infarction; Covid-19 = coronavirus-19; MV = mechanical ventilation; NIV = non-invasive ventilation; No. = number; N/R = not reported; OT = occupational therapy; PRO = patient-reported outcomes; PT = physiotherapy; RCT = randomised controlled trial; RR = respiratory rate; Rx = treatment; RXT = randomised cross-over trial; S = supervised; SD = standard deviation.

reports or physiotherapists, via a mix of monitoring and chart review. Of those individuals who were critically ill who may or may not have required mechanical ventilation (43-55), physiotherapy interventions provided in the intensive care setting included early mobilisation, endurance and resistance training, strength and functional exercise testing, electrical muscle stimulation and respiratory therapy. Findings from 10 studies indicated that adverse events during these treatments were haemodynamic instability, episodes of angina, oxygen desaturation, elevated respiratory rate, vertigo and falls, line or tube dislodgement and airway obstruction during prone positioning (Tab. 2). For individuals following cardiac or abdominal surgery (56-59), interventions included exercises for breathing and upper and lower limbs, passive mobilisation, oxygen therapy, non-invasive ventilation and suction. Similar adverse events with haemodynamic instability, desaturation, dyspnoea and pain were reported (Supplementary Table 2). For those deconditioned due to COVID-19 following an acute hospital stay or related to stay-at-home orders, resistance training was linked to falls (60). Physiotherapy for managing acute respiratory infections or asthma consisted of breathing exercises and airway clearance therapy (61,62). Asthma exacerbations or episodes of desaturation were reported with these therapies (Supplementary Table 1).

In neurological physiotherapy, the patient population, interventions and adverse events are outlined in Tab. 3. Most adverse events were reported by patients or clinicians, from self-reports, observations or chart review. For patients diagnosed with stroke or an acute brain haemorrhage (63-65), the interventions consisted of treadmill or gait training. Common adverse events reported during or after these interventions were increased pain, falls and symptoms of intolerance of the activity. For those with Parkinson's disease or multiple sclerosis, physiotherapy management consisted of gait and balance training and exercise prescription (66-68). Adverse events reported in relation to these interventions were pain, falls and haemodynamic intolerance. For patients with sport-related concussion, interventions included submaximal aerobic training, sport-specific exercises and imagery techniques and were linked to headaches, dizziness and exacerbation of symptoms during exercise (69). For patients with peripheral nervous system disorders who underwent supervised aerobic exercises, pain and fatigue were the most commonly reported adverse events (70).

In oncological physiotherapy, key interventions for those with breast or other types of cancer (71-74) were resistance and aerobic exercise training, balance training and whole-body vibration (Tab. 4). These treatments were linked to increased pain, falls, haemodynamic instability, muscle strain and fatigue as adverse events. In lymphoedema physiotherapy, manual lymphatic drainage led to discomfort, lymphangitis attacks and oedema displacement (75), as reported from both patients and clinicians via self-report or monitoring. In aged care, active mobilisation exercises, lower limb strengthening, walking and balance for those with dementia were linked to increased pain from baseline measures (76). Pelvic floor muscle training resulted in vaginal discomfort, spotting and greater pain (77,78).

Discussion

This scoping review identifies adverse events related to a range of physiotherapy interventions across a mix of clinical fields. In musculoskeletal physiotherapy, increased muscle pain or soreness and to a lesser extent joint stiffness were the most commonly reported adverse events. Within cardiorespiratory physiotherapy interventions, the adverse events most commonly reported were haemodynamic or respiratory instability, while in neurological, oncological physiotherapy and aged care management, increased pain, fatigue, falls and cardiovascular intolerance were the most commonly reported adverse events. In pelvic health physiotherapy, the predominant adverse event during pelvic floor muscle training was discomfort.

For musculoskeletal physiotherapy, experiencing a certain level of pain or muscle soreness during exercise or manual therapy is not unusual, as specific exercise training and manual therapy techniques including joint mobilisation can lead to temporary muscle soreness due to the mechanical stress applied to the muscles and connective tissues (79). However, the level of pain is expected to remain within a tolerable range and be temporary in nature. Excessive or prolonged pain is considered an adverse response (80); this is the type of pain which has been reported in the included studies. The identification of these adverse events suggests that symptom monitoring during these interventions would be important to regulate the adjustment of treatment intensity to minimise pain or soreness (81). Range-of-motion exercises performed too aggressively or with excessive force have the potential to cause temporary stiffness in the area being treated (82). To minimise this effect, gradual progressions and individualised approaches may be necessary to improve the safety of this type of intervention (82). Experienced clinicians may be more likely to notice subtle signs and consistently tailor interventions, but physiotherapy students may benefit from targeted education about potential adverse events that may occur during physiotherapy treatment. 'Clinical noticing' is arguably a skill to be emphasised as practical skills are developed and refined (83). This may be key to minimising the occurrence of adverse events during these interventions when delivered by students in clinical care (84).

For cardiorespiratory physiotherapy, the adverse events described related to haemodynamic and respiratory intolerance during selected interventions. This is not an unexpected outcome given the nature of patients being critically unwell (85). The occurrence of these adverse events reinforces the importance of regular monitoring of these responses in patients undergoing treatments including exercise, early mobilisation and airway clearance techniques, in order to detect possible intolerance and enable adjustment to interventions to accommodate these clinical responses (86). Furthermore, changes in heart rate, blood pressure and patient reports of dyspnoea or dizziness during interventions highlight the necessity of monitoring clinical signs and subjective symptoms on an individual patient basis (87). This knowledge is critical for physiotherapy students to be aware of, as they gain clinical experience in the management of

TABLE 3 - Neurological physiotherapy interventions for acute and chronic conditions and associated adverse events

Condition	Study design	No., age (mean±SD) years	Physiotherapy interventions			Adverse events			Setting and supervision provision
			Strength and endurance training	Balance and coordination exercises	Other intervention types	Pain	Falls	Other non-serious and serious adverse events	
Stroke									
Subacute phase of ischaemic or haemorrhagic stroke (63)	RCT	200, 69±12	Treadmill-based, bodyweight supported training	–	–	–	✓	Fatigue, dizziness	Hospital – inpatient (S)
						AEs reported by patients Collated from self-reports			
Stroke (64)	RCT	38, 71±13	Treadmill training	–	Gait training	–	✓	Chest pain, syncope, nausea and SOB	Hospital – inpatient (S)
						AEs reported by physiotherapists and patients Collated from patient report and observations			
Acute condition									
Subarachnoid haemorrhage or subdural hematoma (65)	Observational pilot study	50, 61±14	Mobilisation as tolerated	–	–	–	–	Symptoms of light headedness, hypotension, feeling unwell	Hospital – inpatient (S)
						AEs reported by physiotherapists and patients Collated from self-report and physiotherapy monitoring during Rx			
Chronic conditions									
Parkinson's disease (66)	Exploratory clinical study	100, 75±9	✓	✓	Movement strategy training, gait training, and progressive resistance training	✓, ↑ from baseline	✓	Hypotension or hypertension, cardiorespiratory arrest, hip fracture attributed to a fall	Hospital – inpatient (S) and home (US)
						AEs reported by physiotherapists and patients Collated from self-report or witnessed by physiotherapists			
Mild to moderate Parkinson's disease (67)	Interventional study	5; 72 (69-80)	–	Balance training regime emphasising specific and highly challenging exercises	–	–	✓	Dizziness related to low blood pressure	Hospital – outpatient (S)
						AEs reported by physiotherapists and patients Collated from patient experience and physiotherapy monitoring			
Multiple sclerosis (68)	Feasibility study	17, 54 (18-70)	✓	✓	Stretching exercise	–	–	Fatigue	Home (S) – virtual group exercise
						AEs reported by patients Collated from self-report			

Condition	Study design	No., age (mean±SD) years	Physiotherapy interventions			Adverse events			Setting and supervision provision
			Strength and endurance training	Balance and coordination exercises	Other intervention types	Pain	Falls	Other non-serious and serious adverse events	
Traumatic injury									
Sport-related concussion (69)	RCT	10, 16±2	Submaximal aerobic training	Light coordination and sport-specific exercises	Visualisation and imagery techniques, home exercise programme	–	–	Worsening of symptoms, headache, dizziness	Hospital – outpatient (S) and home (US)
						AEs reported by physiotherapists and patients Collated from PRO, measurement and observation by treating physiotherapist			
Peripheral nervous system disorders									
Neuromuscular diseases (70)	Prospective pilot study	31, 58 (20-76)[#]	Supervised aerobic exercises	–	–	✓, ↑ from baseline	–	Fatigue	Home (S)
						AEs reported by physiotherapists and patients Collated from self-report, log books and patient records			

[#]Data are median (interquartile range).
✓ = applied; – = not applied; AEs = adverse events; No = number; PRO = patient-reported outcomes; RCT = randomised controlled trial; Rx = treatment; S = supervised; SD = standard deviation; SOB = shortness of breath; US = unsupervised.

TABLE 4 - Oncology, aged care and pelvic health interventions and associated adverse events

Condition	Study design	No., age (mean±SD) years	Physiotherapy interventions			Adverse events			Setting and supervision provision
			Musculoskeletal	Neurological	Other intervention types	Pain	Falls	Other non-serious or serious adverse events	
Oncology (adults and paediatrics)									
Curable breast, prostate or colorectal cancer (71)	RCT	577, 59±12	Supervised, group-based and home-based resistance training	–	–	✓, ↑ from baseline	–	Muscle strains Dizziness Injured finger	Public gym (S) and home (US)
						AEs reported by physiotherapists and patients Collated from self-report and monitoring			
Non-metastatic or metastatic breast cancer (72)	Experimental study	20, 61±10	Resistance Training	–	–	✓, ↑ from baseline	–	–	Hospital – outpatient (S)
						AEs reported by patients Collated from self-report			
Non-central nervous system cancer (73)	Retrospective chart review	147, 9±4	Strengthening and endurance exercise, jumping	Balance training	Stretching	–	✓	Tachycardia Headaches Fatigue	Hospital – inpatient (S) and outpatient (US)
						AEs reported by patients, physiotherapists and oncology doctors Collated from chart review and patient report			
Paediatric cancer (74)	Exploratory feasibility study	11, 12 (7-17)	–	–	Whole-body vibration	–	–	Bleeding observed in patients with bleeding tendencies and low platelets	Hospital – inpatient (S)
						AEs reported by physiotherapists and patients Collated from self-report and observation			
Lymphoedema									
Primary or secondary lymphedema (75)	RCT	194, 58±12	–	–	Manual lymphatic drainage	–	–	Discomfort Lymphangitis attacks Oedema displacement	Hospital – outpatient (S)
						AEs reported by physiotherapists and patients Collated from patient experience and monitoring			

Condition	Study design	No., age (mean±SD) years	Physiotherapy interventions			Adverse events			Setting and supervision provision
			Musculoskeletal	Neurological	Other intervention types	Pain	Falls	Other non-serious or serious adverse events	
Aged care									
Community-dwelling individuals with dementia (76)	RCT	54, 80±6	Active limb mobilisation exercises, lower limb strengthening exercises, and walking	Balance exercises	Whole-body vibration	✓, ↑ from baseline	–	–	Community – outpatient (S)
						AEs reported by patients			
						Collated from self-report			
Pelvic health									
Symptoms of stress or mixed urinary incontinence (77)	RCT	362, 68±6	–	–	Pelvic floor muscle training	–	–	Vaginal discomfort during intravaginal biofeedback	PP (S) and home (US)
								Vaginal spotting	
						AEs reported by participants			
						Collated from self-report			
Vaginal prolapse (78)	RCT	414, 46±5	–	–	Individual home pelvic floor muscle training programme	✓, ↑ from baseline	–	Shortness of breath and chest pain during pelvic floor muscle training	PP (S) and home (US)
						AEs reported by patients			
						Collated from self-report			

AE = adverse events; No. = number; RCT = randomised controlled trial; S = supervised; SD = standard deviation; US = unsupervised; ✓ = applied; – = not applied.

acutely unwell patients. While less frequent, dislodgement of tubes or lines remains an area requiring careful management, which likely involves multiple healthcare team members to ensure patient safety (88). The reported occurrence of falls in those who were deconditioned illustrates the need for a heightened level of awareness of this potential adverse event in this patient population to enable risk mitigation (89).

Increased pain and risk of falls during gait retraining after stroke are likely to be attributed to impairments in balance or postural instability (90), while their occurrence as part of Parkinson's disease management is associated with freezing of gait or difficulty dual tasking (91). It is not unforeseen that patients with neurological pathology such as stroke are at greater risk of falls during treatment, given impairments such as weakness, sensory deficits and poor balance. In addition, these patient populations may have a heightened fear of falling, which can lead to hesitation and guarding, all factors which increase the risk of falls (92,93). To minimise the risk of falls, optimal therapist body mechanics and safe patient handling techniques are required (94), and an awareness of the appropriate level of assistance and decluttered environments is also important in ensuring safety for patients engaged in gait retraining and walking practice (95). For those with Parkinson's disease, clinician-directed education regarding safe mobility and cueing strategies, together with healthcare team collaboration to ensure optimal symptom management prior to physiotherapy interventions are potential approaches to minimise the risk of these adverse events (96). This may be further supported by interdisciplinary communication and sharing knowledge regarding an individual patient's clinical status to assist in reducing risk. Fatigue is a common side effect in multiple sclerosis and conditions affecting the peripheral nervous system (97). Education on pacing and energy conservation techniques including breaking down activities and incorporating rest periods (98) can reduce the occurrence of this type of adverse event. Adjusting the intensity and intervention duration according to a patient's tolerance is also crucial to reduce the risk of exacerbating fatigue (99).

Within oncology and aged care physiotherapy, the commonly reported adverse event of increased pain during exercises and walking may be caused by muscle wasting or reduced bone density secondary to specific cancer treatments or age-related deconditioning (100,101). The nature of these diagnoses indicates these undesirable outcomes are not unexpected. Collaborating with other healthcare professionals, such as dietitians and pharmacists, to improve the nutrition intake and provide medication for slowing muscle atrophy is important for these patient populations. A multidisciplinary approach, together with proactive education for patients and caregivers, may enhance muscle function and exercise performance and minimise discomfort during physiotherapy interventions (102). Within paediatric oncology, early recognition of changes in clinical signs and symptoms secondary to cancer and its related treatment (103) may be supported by the adoption of a proactive approach. This enables children's caregivers in monitoring individual responses and providing education to enable adjustments to be made in a timely manner (104).

In pelvic health physiotherapy, discomfort during pelvic floor muscle training can be attributed to muscle overwork or irritation (105). Conducting an individualised training programme may be necessary to provide instructions on correct techniques and minimise the discomfort from improper contractions (106).

Identifying adverse events across a range of clinical areas in physiotherapy provides valuable information for optimising patient-centred care. This information has direct applications for the practice of physiotherapy clinicians and physiotherapy students. Awareness of adverse events associated with physiotherapy in different practice contexts can inform adjustments to interventions based on early awareness, close monitoring of patient responses, and education of patients and caregivers of the potential risks to enhance safety. In addition, this information may be used to develop physiotherapy students' knowledge and understanding of situational awareness in a mix of clinical areas of practice, having the potential to inform and implement timely mitigating strategies to reduce the risk of adverse events (107).

The mean age range included across the studies is vast. For musculoskeletal physiotherapy, the mean age of participants was 18 to 80 years; for cardiorespiratory physiotherapy, the mean age was 1 to 65 years; for neurological physiotherapy, age ranged from 16 to 73 years. A wide range was also apparent for oncology physiotherapy and pelvic health. Although the common comorbidities in each study have not been reported in this review, for some participants, the presence of co-existing conditions may have influenced the occurrence of adverse events during physiotherapy assessment or intervention practices and therefore contributed to an undesirable outcome.

Many challenges related to identifying and tracking adverse events in hospital and healthcare settings have been reported (108), and it is recommended that more than one method be used to identify adverse events comprehensively (109). There is potential for using routinely collected data in electronic health records implemented in hospitals and primary care to develop automated adverse event recording systems (110), but confidence in data quality is needed. One factor affecting data quality is variability in the terminology used when reporting adverse events (111,112). In this scoping review, we sought to identify what is known about adverse events in physiotherapy and have identified how adverse events have been reported in a range of physiotherapy practice areas across hospital and community-based settings, and the terminology used to describe adverse events in the physiotherapy context.

There are limitations to this scoping review. This scoping review only included the adverse events or serious adverse events that occurred during physiotherapy interventions and assessments and that were defined by the study authors as adverse events attributable to interactions with physiotherapy. It is likely that there is a variation between studies regarding the definition and threshold for adverse events and criteria for attributing these events to physiotherapy. The search strategy focused on selected terms (adverse events); this terminology may not be consistently used within studies to describe events which are considered undesirable

outcomes. For this reason, it is possible that some relevant studies which identified the occurrence of adverse events were not included. We did not choose to include systematic reviews of all types of physiotherapy interventions, as not all reviews are guaranteed to incorporate mention of adverse events as part of their data extraction. Nor did we include systematic reviews of adverse events related to interventions which are within the scope of physiotherapy practice, as studies greater than 10 years contributed to the collated data and this may not be reflective of current practice. It is possible that some adverse events related to physiotherapy interventions occurred after the intervention had been delivered. Therefore, there is a small possibility that this review has potentially missed important adverse events associated with physiotherapy.

This review highlighted adverse events related to physiotherapy interventions across various clinical settings. Increased awareness of adverse events reported in studies of physiotherapy interventions provides an opportunity to focus on clinical awareness when tailoring interventions to individuals, implementation of preventive strategies and designing curriculum related to patient safety in physiotherapy education programmes.

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