

FROM CLINICAL CLUES TO PROGNOSTIC JUDGMENTS: HOW PHYSICAL THERAPISTS INTEGRATE AND PRIORITIZE PROGNOSTIC INFORMATION IN MUSCULOSKELETAL PRACTICE - A MIXED-METHODS STUDY

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Abstract

Background

Prognostic reasoning is an important component of physiotherapy clinical decision-making, yet limited evidence describes how physical therapists prioritize and integrate multiple prognostic indicators when formulating individualized prognoses. This study investigated the factors shaping prognostic reasoning among physical therapists and examined the association between initial prognostic judgments and subsequent patient outcomes.

Methods

A mixed-methods observational study was conducted among 48 physical therapists involved in musculoskeletal physiotherapy at Saidu Group of Teaching Hospitals, Swat, Khyber Pakhtunkhwa, Pakistan. All therapists participated in qualitative and quantitative components. Semi-structured interviews were analyzed using framework analysis to explore identification, prioritization, integration, conflicting indicators, within-session change, clinical experience, pattern recognition, and prognostic confidence. Quantitatively, therapists recorded considered prognostic factors, perceived direction of influence, influential factors, prognostic confidence, and an overall prognostic judgment on a 1–10 scale. Clinical-experience differences were examined using ≤5 and >5-year groups. Patient outcomes were assessed at baseline and follow-up. Multilevel regression

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examined associations between initial prognostic judgment and subsequent outcomes while accounting for clustering within therapists.

Results

Clinical and symptom-related factors were the most frequently identified domain (45, 91.7%), followed by psychological and behavioral factors (43, 87.5%) and patient expectations and motivation (41, 83.3%). Symptom severity (41, 85.4%), functional status (39, 81.3%), and motivation (39, 81.3%) were frequently considered. Clinical severity and functional status were among the most influential factors for 35 (72.9%) therapists. Within-session change influenced prognostic formulation for 31 (64.6%) therapists. The mean prognostic judgment was 6.6 ± 1.6 . Of 94 patients with baseline data, 86 completed follow-ups. Functional outcome improved from 47.9 ± 13.8 to 62.7 ± 14.9 , pain decreased from 6.3 ± 1.6 to 3.9 ± 1.7 , and global perceived recovery increased from 4.3 ± 1.4 to 6.6 ± 1.5 (all $p < 0.001$). Initial prognostic judgment was associated with functional improvement ($\beta = 1.92$, 95% CI: 0.71–3.13; $p = 0.002$) and remained significant after adjustment (adjusted $\beta = 1.58$, 95% CI: 0.39–2.77; $p = 0.010$).

Conclusion

Physical therapists used multidimensional prognostic reasoning involving clinical, functional, psychological, behavioral, contextual, and experiential information. Prioritization and integration of competing indicators were central to prognostic judgment. Initial prognostic judgments demonstrated a significant association with subsequent functional improvement, supporting further investigation of prognostic reasoning, accuracy, and calibration in physiotherapy practice.

INTRODUCTION

Musculoskeletal disorders (MSDs) are among the major causes of pain, disability, reduced participation, and healthcare utilization worldwide. The burden of MSDs has continued to increase globally, creating substantial demands on rehabilitation services and placing greater responsibility on physiotherapists to make individualized decisions about assessment, treatment, expected recovery, and long-term outcomes (1). Patients presenting with similar diagnoses can demonstrate substantially different clinical trajectories because recovery is influenced by interacting biological, psychological, behavioral, social, occupational, and environmental factors (2). Consequently, prognosis has become an important component of contemporary physiotherapy practice, particularly in musculoskeletal rehabilitation, where clinicians are expected to estimate the likely course of symptoms and function while communicating

realistic expectations and establishing appropriate treatment goals.

Prognosis refers to an estimate of the likely future course or outcome of a health condition based on available clinical information. In musculoskeletal physiotherapy, prognostic judgments may concern pain, disability, physical function, participation, return to work, treatment response, and overall recovery. Prognostic factors can operate across multiple levels. Evidence from low back pain research, for example, has identified symptom severity, symptom duration, occupational demands, physical workload, psychological distress, maladaptive coping, functional limitations, and other patient characteristics as factors associated with persistence or recovery (2). These findings demonstrate that prognosis cannot be adequately understood through diagnosis or tissue pathology alone. The clinician must interpret information from multiple domains and determine its relevance to the individual patient.

This multidimensional nature of prognosis creates a complex clinical reasoning problem. Physiotherapists frequently encounter patients in whom prognostic indicators point in different directions. A patient may be present with severe pain, chronic symptoms, or multiple comorbidities while simultaneously demonstrating strong motivation, favorable expectations, good social support, and rapid improvement during clinical assessment. Another patient may have relatively limited physical impairment but substantial fear avoidance, low confidence, poor adherence, or occupational barriers. Therefore, identifying prognostic factors represents only one component of prognostic practice. A more fundamental question concerns, that how physiotherapists interpret, prioritize, integrate, and reconcile these different sources of information when arriving at an overall prognostic judgment.

Clinical reasoning is central to this process. Physiotherapists use clinical reasoning to gather information, interpret findings, develop hypotheses, select interventions, evaluate responses, and modify decisions according to patient-specific circumstances. Contemporary physiotherapy education recognizes clinical reasoning as a complex professional competency that develops through interaction between theoretical knowledge, clinical experience, reflective practice, patient communication, and contextual understanding. Recent evidence indicates that educational interventions can support development of clinical reasoning among physical therapy learners, reinforcing the importance of reasoning as an explicit professional skill rather than an incidental consequence of clinical exposure (3).

The biopsychosocial model provides an important framework for understanding the information potentially incorporated into prognostic reasoning. Biological information may include diagnosis, symptom severity, duration, comorbidities, physical impairment, and functional status. Psychological information may include expectations, fear, motivation, self-efficacy, coping, pain-related beliefs, and

emotional distress. Social and contextual information may include occupation, family support, environmental demands, socioeconomic circumstances, access to healthcare, and opportunities for physical activity. Research examining physiotherapists' implementation of the biopsychosocial model has identified barriers related to knowledge, confidence, professional beliefs, communication, and clinical context (4). Thus, although biopsychosocial information is increasingly recognized as relevant to musculoskeletal care, its actual incorporation into clinical reasoning may vary between clinicians and practice environments.

Prognostic research has traditionally focused on identifying variables statistically associated with future outcomes and developing prediction models. A systematic review of prognostic models for musculoskeletal rehabilitation identified numerous models across spinal, upper-limb, lower-limb, injury, and musculoskeletal pain populations (5). However, substantial methodological limitations were identified, including risk of bias and inconsistent reporting of model performance. Only a small number of externally validated models demonstrated potential clinical value (5). These findings highlight an important distinction between prognostic evidence and clinical prognostic reasoning. Statistical models can identify variables associated with outcomes, while clinicians must determine how such information should be interpreted and applied to an individual patient.

The complexity of prognostic information is also evident in work-related musculoskeletal conditions. An overview of systematic reviews identified multiple prognostic factors spanning physical, psychological, occupational, and contextual domains (6). Such evidence supports individualized prognostic assessment because occupational exposure, functional requirements, psychological characteristics, and workplace circumstances may influence recovery independently of the underlying physical condition. Prognosis therefore requires clinicians to consider the relationship between the patient's

clinical presentation and the environment in which recovery is expected to occur.

Clinical reasoning research further suggests that physiotherapists do not simply apply isolated factors or guidelines in a linear manner. Qualitative research examining exercise prescription has demonstrated that physiotherapists construct individualized decisions through interaction between patient characteristics, clinical findings, professional knowledge, and contextual considerations (7). This process provides a useful conceptual basis for understanding prognosis because the same information may receive different levels of importance depending on the patient's goals, clinical presentation, and expected trajectory.

Direct investigation of physiotherapists' prognostic reasoning has emerged more recently. Smith et al. conducted a mixed-methods study involving 29 physical therapists and identified several domains used when formulating prognosis (8). Mood, motivation, cognition, and pain behaviors were identified across all interviews, while disease severity, health status, social and occupational factors, environmental factors, and biological characteristics were also incorporated into therapists' reasoning (8). The investigators additionally identified factors that did not fit neatly within the initial framework, including within-session response and clinician familiarity with the condition. Their quantitative analysis demonstrated associations between therapists' initial prognostic scores and several patient outcomes at discharge (8). This study established that physical therapists use information from multiple biopsychosocial domains when formulating prognosis and provided an important foundation for understanding the content of prognostic reasoning.

Subsequent research has examined how physiotherapists conceptualize prognosis itself. Mullen et al. explored the perceptions and knowledge of physiotherapists working in musculoskeletal practice and found that prognosis was understood in relation to outcomes such as pain, tissue health, and function (9). Participants also described the development of prognostic

knowledge through clinical experience and professional learning (9). These findings suggested that physiotherapists may conceptualize prognosis differently and that prognostic reasoning may develop partly through experiential learning rather than through a consistently structured educational framework.

More recent phenomenological research specifically examined prognostic reasoning practices among physiotherapists treating musculoskeletal disorders. Mullen et al. reported that prognostic reasoning involved consideration, determination, and discussion of prognosis (10). Biomedical information appeared to facilitate prognostic reasoning, whereas psychosocial factors were described as sources of complexity and uncertainty (10). The study therefore advanced the field beyond simple identification of prognostic factors by demonstrating that the process of formulating and communicating prognosis involves uncertainty, contextual interpretation, and clinical judgment.

At the same time, quantitative evidence indicates that clinician prognosis does not necessarily translate into accurate prediction of individual patient outcomes. A secondary analysis involving patients with patellofemoral pain examined physical therapists' prognosis following initial assessment and subsequent outcomes after exercise therapy (11). The findings did not demonstrate a meaningful relationship between the therapists' initial prognostic estimates and subsequent patient outcomes (11). This finding is important because it separates two concepts that are sometimes treated as equivalent: having a prognostic judgment and making an accurate prognostic prediction. A clinician may consider multiple relevant factors and still produce a prediction that does not correspond closely with the patient's eventual trajectory.

This distinction raises an important question concerning the cognitive mechanisms underlying prognostic judgment. If physiotherapists consider multiple factors, how do they determine which factors deserve greater weight? How do they respond when clinical, psychological, and contextual factors provide contradictory

information? How does a rapid within-session improvement influence a prognosis when chronicity suggests poor recovery? How does strong patient motivation influence prognosis when severe symptoms or multiple comorbidities are present? Such questions concern the integration and prioritization of prognostic information, rather than the simple identification of prognostic factors.

The role of clinical experience adds another dimension to this problem. Recent evidence regarding clinical prediction rules has demonstrated that physiotherapists' knowledge and use of prediction rules may vary and that clinical experience can influence their application (12). This suggests that professional experience may modify how clinicians interpret and use prognostic information. However, it remains unclear what specifically changes with experience. Experienced clinicians may recognize clinical patterns more rapidly, integrate contextual information more efficiently, tolerate uncertainty differently, or rely more heavily on clinical gestalt. Alternatively, experience may reinforce biomedical assumptions or cognitive biases. Understanding these possibilities is important because prognostic reasoning is expected to develop throughout professional practice.

The educational relevance of prognosis has also recently received greater attention. A 2026 Australian and New Zealand consensus framework identified prognosis as a complex but essential component of entry-level physiotherapy education and recommended explicit teaching and assessment of prognostic knowledge and reasoning (13). The framework recognized prognostic reasoning as an important educational skill and emphasized the need for physiotherapy curricula to prepare graduates to manage uncertainty and apply prognostic concepts in musculoskeletal practice (13). This development demonstrates increasing international recognition that prognostic reasoning should be deliberately developed and assessed rather than left entirely to informal clinical experience.

The Pakistani context provides an important and underexplored setting for investigating prognostic

reasoning. Healthcare delivery, physiotherapy education, professional roles, patient expectations, referral pathways, access to diagnostic services, and socioeconomic circumstances may differ from those in the high-income settings in which much of the current prognostic reasoning literature has been developed. Consequently, findings derived from Western healthcare systems cannot automatically be assumed to represent how physiotherapists formulate prognosis within Pakistan.

Recent Pakistani evidence has demonstrated that professional beliefs and attitudes can influence musculoskeletal clinical decision-making. Khan et al. conducted a cross-sectional study of 343 healthcare professionals in Pakistan, including 124 physiotherapists, and examined attitudes, beliefs, confidence, and clinical decision-making related to low back pain (14). The study found that biomedical orientations remained important within clinical practice and examined how professional beliefs were associated with treatment-related decisions (14). These findings are highly relevant to prognostic reasoning because they demonstrate that the beliefs held by Pakistani clinicians may influence how clinical information is interpreted and translated into decisions. Importantly, however, the study investigated attitudes, beliefs, and broader clinical decision-making rather than the specific cognitive process through which physiotherapists formulate a patient-specific prognosis (14).

Patient-level evidence from Pakistan also supports the relevance of psychosocial and functional information in musculoskeletal presentations. Nazir et al. investigated 136 Pakistani patients with chronic low back pain and found relationships among fear-avoidance beliefs, disability, pain, symptom duration, physical capacity, strength, endurance, and flexibility (15). Their findings demonstrated that psychological and functional characteristics were closely related to disability and fear-avoidance beliefs within the Pakistani population (15). Such evidence is relevant to prognostic reasoning because it demonstrates the presence of interacting physical and psychosocial

characteristics that clinicians may need to interpret when estimating future recovery.

Earlier Pakistani research has also examined clinical decision-making among physiotherapists. Umar et al. reported an association between clinical decision-making ability and professional characteristics, including clinical experience and postgraduate education, among physiotherapists in Pakistan (16). Although this work provides useful contextual evidence regarding clinician-level influences on decision-making, it examined general clinical decision-making rather than the specific process of prognostic formulation (16). Moreover, its publication as a conference abstract and its earlier date limit the extent to which it can address contemporary prognostic practice.

Collectively, Pakistani research therefore provides evidence that professional beliefs, clinical experience, postgraduate education, psychosocial characteristics, and physical factors can influence musculoskeletal clinical decision-making, but it has not adequately examined how these information sources are synthesized into a prognostic judgment (14-16). The distinction is important. Knowing that Pakistani physiotherapists may hold beliefs or consider specific clinical characteristics does not explain how they decide which information is most influential when estimating a patient's likely recovery. It also remains unclear whether Pakistani physiotherapists prioritize prognostic information in ways like those described in international research.

The international and Pakistani literature demonstrates that prognosis is a multidimensional component of musculoskeletal physiotherapy and that clinicians consider biological, psychological, behavioral, social, occupational, environmental, and experiential information when estimating expected outcomes (8, 9, 13). However, a critical gap remains between identifying prognostic factors and understanding the cognitive process through which those factors are transformed into a final prognostic judgment.

Previous research has established important prognostic domains, but the relative weighting of these domains remains insufficiently understood.

Smith et al. identified multiple factors used by physiotherapists and demonstrated associations between overall prognosis scores and patient outcomes, but the study did not establish how therapists prioritized individual factors or reconciled conflicting prognostic information during the final judgment (8). Mullen et al. subsequently provided a deeper description of prognostic reasoning practices, but their phenomenological study primarily explored clinicians' experiences and perceptions rather than quantitatively examining how specific reasoning patterns related to subsequent patient outcomes (10). Evidence from patient-outcome research has additionally demonstrated that clinician prognostic estimates may not consistently correspond with actual recovery (11).

A particularly important unresolved issue is therefore information integration. Existing research has identified what physiotherapists consider, but limited evidence explains how they decide which information should carry greater prognostic weight when different indicators conflict. The influence of within-session response, patient expectations, motivation, psychosocial barriers, clinical examination findings, contextual circumstances, professional experience, and clinical intuition on the final prognostic estimate remains insufficiently characterized. Similarly, the extent to which clinical experience changes the structure of prognostic reasoning remains unclear. The Pakistani evidence adds an important contextual dimension. Existing Pakistani studies have examined professional beliefs and broader clinical decision-making, as well as patient-level psychosocial and functional factors (14-16). However, no sufficiently detailed evidence has established how Pakistani physiotherapists identify, prioritize, integrate, and reconcile competing prognostic information when formulating a patient-specific prognosis, or whether their prognostic reasoning is associated with subsequent patient outcomes. This represents an important gap because professional beliefs, healthcare context, patient expectations, clinical resources, and educational pathways may

influence how prognostic information is interpreted within Pakistan.

Therefore, the central unresolved problem is not simply which factors physiotherapists consider, but how those factors are weighted and integrated into clinical prediction and whether the resulting judgment corresponds with patient outcomes. Addressing this problem requires a methodology capable of capturing both the depth of clinicians' reasoning and measurable relationships between prognostic judgments and patient outcomes. A mixed-methods approach is consequently appropriate because qualitative inquiry can reveal the cognitive and contextual processes underlying prognostic judgments, while quantitative analysis can examine the distribution, prioritization, and outcome relevance of those judgments.

The present study was therefore designed to investigate how physical therapists integrate and prioritize clinical, psychological, behavioral, social, occupational, environmental, and therapist-related information when formulating patient prognosis. The study further examined how therapists reconciled favorable and unfavorable prognostic indicators, how clinical experience influenced prognostic reasoning, and how therapists' prognostic judgments related to subsequent patient outcomes. By integrating qualitative exploration of clinical reasoning with quantitative assessment of prognostic judgments and patient outcomes, the study sought to move beyond the identification of prognostic factors toward a more comprehensive understanding of the clinical reasoning pathway from information acquisition to prognostic judgment and eventual patient outcome.

OBJECTIVES

The primary objective of this study was to explore how physical therapists integrated and prioritized clinical, psychological, behavioral, social, occupational, environmental, and therapist-related information when formulating patient prognosis in musculoskeletal physiotherapy practice in Pakistan.

METHODS

Study Design

This study used a mixed-methods design comprising a qualitative therapist-level component and a quantitative patient-level prognostic component. The qualitative component explored the factors, reasoning processes, and contextual considerations underlying physical therapists' clinical prognostic judgments. The quantitative component examined patient-specific prognostic judgments, prognostic factors recorded by treating therapists, and their associations with subsequent patient outcomes.

The qualitative and quantitative components were conducted as complementary components of the study. The qualitative component provided an in-depth description of therapists' prognostic reasoning processes, whereas the quantitative component characterized patient-specific prognostic judgments and examined their relationship with subsequent clinical outcomes.

Study Setting

The study was conducted within the physiotherapy services of Saidu Group of Teaching Hospital, Swat, Khyber Pakhtunkhwa, Pakistan. The setting provided access to physical therapists involved in musculoskeletal physiotherapy and patients receiving routine physiotherapy care. Patient management remained part of routine clinical practice. Treatment decisions were made by the treating physical therapist according to the patient's clinical presentation and usual clinical judgment. The study did not prescribe or modify the physiotherapy treatment provided.

Participants and Study Structure

The study comprised two interconnected components: a qualitative therapist-level component and a quantitative patient-level prognostic component. A total of 48 physical therapists were recruited and participated in the study. Each therapist contributed to the qualitative component through a semi-structured interview exploring the factors, reasoning processes, and contextual considerations underlying clinical prognostic judgments. For the

quantitative component, the participating physical therapists assessed eligible patients receiving physiotherapy for musculoskeletal conditions. A total of 94 patients were enrolled and completed the baseline assessment. For each enrolled patient, the treating physical therapist completed a patient-specific Prognostic Reasoning Assessment Form (PRAF) and recorded an initial prognostic judgment before subsequent patient outcomes were available. Thus, the prognostic assessment was linked to the individual patient rather than representing a single prognostic judgment for the therapist. The therapist identification code was retained to permit identification of the clustering of patients managed by the same therapist. Patients subsequently received routine physiotherapy according to the clinical judgment of their treating therapists and were reassessed at follow-up. Of the 94 patients who contributed baseline data, 86 completed the follow-up assessment, while 8 had no available follow-up outcome data. Baseline observations from all eligible patients were retained for analyses that did not require follow-up measurements, whereas analyses involving change from baseline to follow-up were restricted to patients with available follow-up data. The quantitative dataset therefore consisted of 94 patient-level prognostic assessments linked to 48 treating physical therapists, allowing patients to be treated as the observational unit while accounting for the clustering of patients within therapists. Multilevel regression models were subsequently used to examine the association between the initial patient-specific prognostic judgment and subsequent patient outcomes.

Prognostic Reasoning Assessment Form

The Prognostic Reasoning Assessment Form (PRAF) was completed by the treating physical therapist for each enrolled patient following the patient's baseline clinical assessment and formulation of the initial prognosis. The PRAF captured the prognostic factors considered by the therapist, the perceived direction of their influence, the relative importance assigned to selected factors, and the overall initial prognostic

judgment. The overall prognostic judgment was recorded on a 1–10 numerical scale, with higher scores representing a more favorable expected clinical outcome. Because the PRAF was completed for each patient, prognostic judgments were treated as patient-specific observations, while therapist identification was retained to account for clustering of patients within therapists. The prognostic factors recorded through the PRAF were summarized according to their frequency and perceived direction of influence. Factors identified as influential were also summarized according to their relative importance in the therapist's overall prognostic judgment.

Eligibility Criteria

Physical Therapist Inclusion Criteria

Physical therapists were eligible for participation if they:

- were licensed or registered and actively engaged in clinical practice;
- were involved in musculoskeletal physiotherapy;
- had direct responsibility for patient assessment and clinical prognostic judgment;
- were willing to participate in the study; and
- provided informed consent.

Physical Therapist Exclusion Criteria

Physical therapists were excluded if they:

- were not actively involved in musculoskeletal clinical practice;
- did not have direct clinical responsibility for patient assessment;
- were unable to complete the required prognostic assessment or interview; or
- declined or withdrew informed consent.

Patient Inclusion Criteria

Patients were eligible if they:

- were receiving routine outpatient physiotherapy for a musculoskeletal condition;
- were eligible for physiotherapy assessment by a participating physical therapist;

- were able to complete the required baseline assessment and outcome measures; and
- provided informed consent.

Patient Exclusion Criteria

Patients were excluded if they:

- required urgent medical or surgical management;
- had a condition for which routine outpatient physiotherapy was inappropriate;
- had substantial cognitive or communication impairment that prevented completion of the required assessments or outcome measures; or
- declined or withdrew informed consent.

Patients who completed the baseline assessment but did not complete the follow-up assessment were retained in the baseline dataset and excluded only from analyses requiring follow-up measurements.

Sampling and Recruitment

Physical therapists were recruited using a maximum-variation sampling approach to obtain variation in clinical experience, postgraduate education, musculoskeletal experience, and other relevant professional characteristics. A total of 48 eligible physical therapists participated in the study. Patients were recruited from the clinical caseloads of participating physical therapists. Eligible patients underwent a baseline clinical assessment by the participating therapist. Following the assessment, the treating therapist completed the patient-specific PRAF and recorded the initial prognostic judgment before subsequent patient outcomes were available. A total of 94 patients contributed baseline data. Each patient was linked to the treating physical therapist through a study identification code. This linkage allowed patient-level prognostic assessments to be analyzed while accounting for the clustering of patients within therapists.

Sample Size

The final study sample comprised 48 physical therapists and 94 patients. The physical therapist sample was determined through the planned recruitment strategy, with maximum-variation sampling used to capture variation in clinical experience and professional characteristics. The patient sample consisted of eligible patients recruited from the clinical caseloads of participating therapists.

Qualitative Data Collection

Semi-structured interviews were conducted with all 48 participating physical therapists. The interviews explored the factors considered during prognostic reasoning, the processes used to prioritize prognostic information, integration of multiple prognostic domains, management of conflicting prognostic indicators and uncertainty, and the influence of clinical experience on prognostic judgment. The interview guide was aligned with the study objectives and the domains addressed through the PRAF. Interviews were conducted after the therapists had completed their clinical assessment and formulated the initial prognosis, allowing them to describe the reasoning underlying their clinical judgment.

Qualitative Data Analysis

Semi-structured interviews with the 48 participating physical therapists were analyzed using framework analysis. The analysis involved familiarization with the interview material, identification of relevant concepts, development of an analytical framework, coding and indexing of the data, charting of coded material, and interpretation of relationships among categories. The analysis focused on the factors considered during prognostic reasoning, prioritization of prognostic information, integration of multiple prognostic domains, management of conflicting prognostic indicators and uncertainty, clinical experience, pattern recognition, prognostic confidence, and formulation of the final prognosis. The qualitative findings were summarized according to the major domains and

reasoning processes identified across the interviews

Patient Outcome Assessment

Patient outcomes were assessed at baseline and follow-up. The study examined functional outcome, pain intensity, and global perceived recovery. The primary functional outcome was used to evaluate change in patient function over the follow-up period. Pain intensity and global perceived recovery were examined as additional clinical outcomes. The baseline evaluation was completed before the subsequent patient results were available to the treating therapist. Follow-up was performed after a routine period of physiotherapy.

Follow-up and Patient Retention

All 94 enrolled patients contributed baseline data. Follow-up data were available for 86 patients, while 8 patients had no available follow-up outcome data. Patients with both baseline and follow-up measurements were included in analyses examining longitudinal change. Patients with baseline data but without follow-up data remained available for analyses that did not require follow-up measurements. The patient-level prognostic assessment and subsequent outcome data were linked through the study identification system. Therapist identification was retained to permit identification of patients managed by the same therapist.

Missing Data Management

The primary documented missingness occurred at follow-up. Of the 94 patients who contributed baseline data, 86 completed follow-ups, resulting in 8 patients without available follow-up outcome data. Patients with missing follow-up outcomes were excluded from analyses requiring paired baseline and follow-up measurements. Their available baseline observations were retained for analyses that did not require follow-up data. The number of observations contributing to each analysis was reported according to data availability. No imputation procedure was applied to missing

follow-up outcomes unless otherwise specified in the original statistical analysis plan.

Missing Data Management

All 94 patients contributed baseline data. Follow-up data were available for 86 patients, while 8 patients had no available follow-up outcome data. Patients without follow-up data were excluded from analyses requiring paired baseline and follow-up measurements. Their available baseline observations were retained for analyses that did not require follow-up measurements. The number of observations contributing to each analysis was reported according to data availability. No imputation was performed for missing follow-up outcomes.

Quantitative Data Analysis

Quantitative data was analyzed using IBM SPSS Statistics version 27. Continuous variables were summarized using means and standard deviations or medians and interquartile ranges, as appropriate, while categorical variables were summarized using frequencies and percentages. The distribution of continuous variables was assessed before selection of the appropriate statistical procedure. Prognostic factors were summarized according to their frequency and perceived direction of influence. The overall initial prognostic judgment and prognostic confidence were summarized using appropriate descriptive statistics. Patient outcomes were summarized at baseline and follow-up. Analyses examining longitudinal change were restricted to patients with available measurements at both time points.

Multilevel Regression Analysis

Multilevel regression analysis was used to examine the association between the patient-specific initial prognostic judgment and subsequent patient outcomes while accounting for the clustering of patients within treating physical therapists. The patient constituted the level 1 observational unit, and the treating physical therapist constituted the clustering level. The initial prognostic judgment recorded for each individual patient was entered

as the principal predictor. Thus, the predictor was a patient-level prognostic observation generated by the treating therapist, rather than a single therapist-level prognostic score. An unadjusted multilevel model was first fitted to examine the association between initial prognostic judgment and the subsequent outcome. An adjusted model was then fitted for the primary functional outcome, incorporating age, baseline clinical status, symptom duration, and baseline functional status as prespecified patient-level covariates. Regression coefficients (β), 95% confidence intervals (CI), and p-values were reported. Statistical significance was assessed using a two-sided alpha level of 0.05.

Integration of Qualitative and Quantitative Findings

The qualitative and quantitative findings were integrated during interpretation. The qualitative component provided an in-depth description of how physical therapists identified, interpreted, prioritized, and integrated prognostic information. The quantitative component characterized the frequency and perceived direction of prognostic factors, patient-specific initial prognostic judgments, and their associations with subsequent patient outcomes. Integration focused on areas of convergence and complementarity between the qualitative descriptions of prognostic reasoning and the quantitative PRAF findings. The integrated interpretation was used to provide a comprehensive account of clinical prognostic reasoning and its relationship with patient outcomes.

Analysis According to Clinical Experience

Physical therapists were categorized according to clinical experience into two groups: ≤ 5 years and > 5 years of clinical experience. The groups were examined with respect to prognostic domains considered, influential prognostic factors, pattern recognition, consideration of within-session clinical change, prognostic confidence, and overall prognostic judgment. Clinical experience was also considered as a continuous characteristic where

appropriate. Continuous variables were summarized using means and standard deviations or medians and interquartile ranges, while categorical variables were summarized using frequencies and percentages.

Integration of Qualitative and Quantitative Findings

The qualitative interviews with the 48 participating therapists were analyzed separately to identify broader domains and reasoning processes underlying prognostic judgment. The quantitative PRAF findings were subsequently integrated with the qualitative findings to provide complementary information regarding the factors considered during prognostic reasoning. The qualitative component provided information about how therapists reasoned about prognosis, whereas the quantitative component characterized which factors were recorded, how they were prioritized, and whether the initial patient-specific prognostic judgment was associated with subsequent patient outcomes. Integration was performed during interpretation by examining areas of convergence between therapists' reported reasoning processes and the quantitative prognostic assessments. This approach allowed the study to provide a combined description of clinical prognostic reasoning and its relationship with patient outcomes.

Ethical Considerations

Ethical approval was obtained from the Institutional Review Board (IRB) of Saidu Group of Teaching Hospital, Swat, Khyber Pakhtunkhwa, Pakistan, before commencement of data collection. The study was conducted in accordance with applicable ethical principles governing research involving human participants. Written informed consent was obtained from all participating physical therapists and patients before enrollment. Participants were informed about the study purpose and procedures, voluntary participation, their right to withdraw at any stage without consequences, confidentiality, data handling procedures, and the intended use of study findings. Participation did not affect the clinical care provided to patients. Participant

confidentiality was maintained throughout the study.

RESULTS

Participant Recruitment and Characteristics

A total of 48 physical therapists participated in the qualitative component of the study. Each therapist completed one semi-structured interview, resulting in 48 therapist-level qualitative records. For the quantitative component, 94 patients were enrolled and completed baseline assessment. Each patient received a patient-specific prognostic assessment from the treating physical therapist,

including completion of the PRAF and recording of the initial prognostic judgment. Therefore, the quantitative prognostic dataset comprised 94 patient-level assessments linked to the 48 participating therapists. Of the 94 patients assessed at baseline, 86 completed the follow-up assessment and 8 did not have available follow-up outcome data. Analyses involving baseline-to-follow-up change were therefore conducted using the available follow-up observations. Patient observations were clustered according to treating therapist for multilevel analyses (Figure 1).

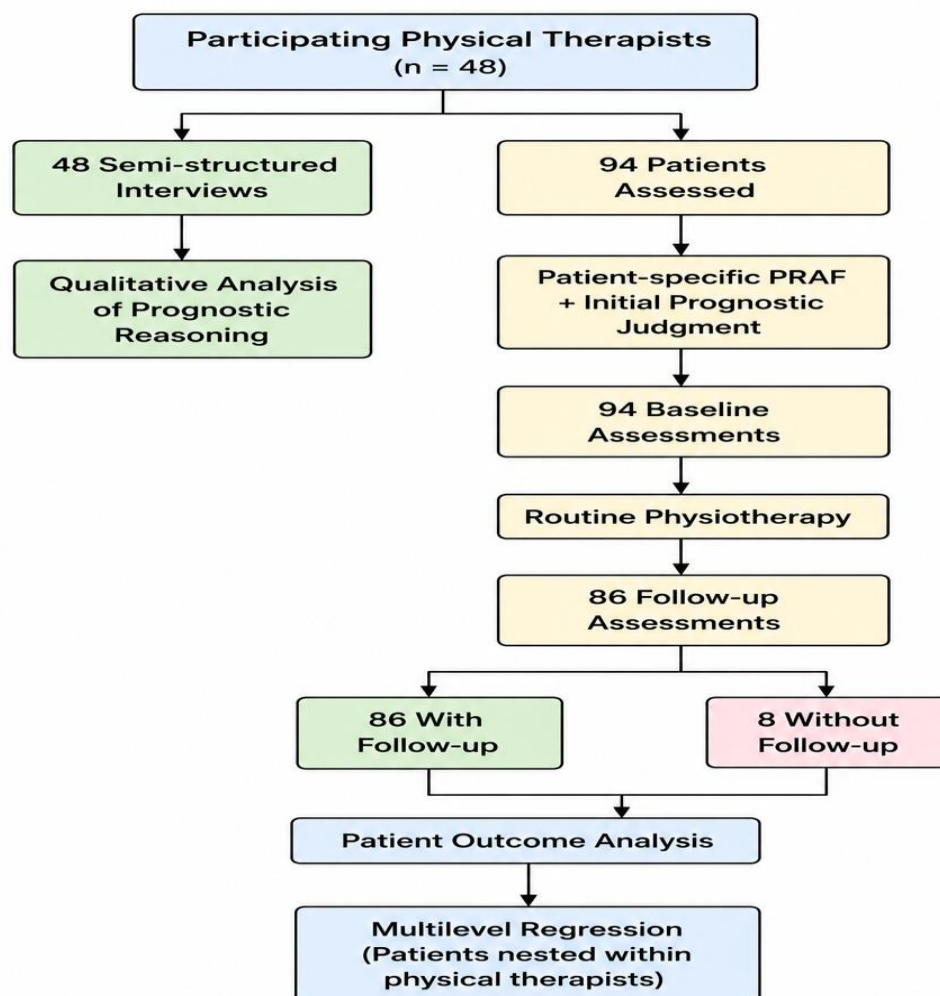


Figure 1. Participant flow and integration of the qualitative and quantitative components of the study.

The mean age of the participating physical therapists was 32.4 ± 6.1 years, with an age range of 24–49 years. Twenty-eight therapists (58.3%) were male and 20 (41.7%) were female. Twenty-eight therapists (58.3%) held a postgraduate qualification, while 20 (41.7%) had an

undergraduate qualification as their highest qualification. Mean total clinical experience was 7.6 ± 5.0 years, and mean musculoskeletal clinical experience was 6.1 ± 4.2 years. Additional musculoskeletal-related professional training was reported by 23 therapists (47.9%).

Table 1. Demographic and professional characteristics of participating physical therapists

Characteristic	Value
Physical therapists, n	48
Age, mean $\pm$ SD (years)	32.4 ± 6.1
Age range (years)	24–49
Male, n (%)	28 (58.3)
Female, n (%)	20 (41.7)
Undergraduate qualification, n (%)	20 (41.7)
Postgraduate qualification, n (%)	28 (58.3)
Clinical experience, mean $\pm$ SD (years)	7.6 ± 5.0
Musculoskeletal experience, mean $\pm$ SD (years)	6.1 ± 4.2
Additional musculoskeletal training, n (%)	23 (47.9)
No additional training, n (%)	25 (52.1)

Qualitative Findings

Framework analysis of interviews with all 48 physical therapists identified six major domains involved in prognostic reasoning: clinical and symptom-related factors; psychological and behavioral factors; patient expectations and motivation; health status and comorbidities; social and occupational factors; and therapist-related factors. Therapists described obtaining prognostic information from patient history, physical

examination, patient interaction, contextual circumstances, and previous clinical experience.

Clinical and symptom-related factors were identified by 45 therapists (93.8%). Psychological and behavioral factors were identified by 43 (89.6%), patient expectations and motivation by 41 (85.4%), health status and comorbidities by 38 (79.2%), therapist-related factors by 36 (75.0%), and social and occupational factors by 35 (72.9%).

Table 2. Major prognostic domains identified during qualitative analysis.

Prognostic domain	Therapists, n (%)
Clinical and symptom-related factors	45 (93.8)
Psychological and behavioral factors	43 (89.6)
Patient expectations and motivation	41 (85.4)
Health status and comorbidities	38 (79.2)
Therapist-related factors	36 (75.0)
Social and occupational factors	35 (72.9)

Clinical and Symptom-Related Prognostic Factors

Clinical and symptom-related characteristics were frequently incorporated into therapists' prognostic judgments. Symptom severity was considered by 41 therapists (85.4%), functional status by 39

(81.3%), symptom duration by 37 (77.1%), and response to clinical examination by 34 (70.8%). Shorter symptom duration, lower symptom severity, lower irritability, and favorable responses during the initial clinical assessment were generally interpreted as favorable prognostic

indicators. Greater symptom severity and longer symptom duration were more frequently interpreted as unfavorable indicators.

Psychological, Behavioral, and Patient-Related Factors

Psychological, behavioral, and patient-related characteristics were also incorporated into prognostic reasoning. Motivation was considered by 39 therapists (81.3%), patient expectations of 38 (79.2%), adherence expectations of 35 (72.9%), and fear-avoidance behavior by 30 (62.5%). Greater motivation, realistic expectations, and active engagement were predominantly perceived as favorable prognostic characteristics. Poor motivation, substantial fear-avoidance behavior, and unrealistic expectations were more frequently classified as unfavorable prognostic characteristics.

Social, Occupational, and Contextual Factors

Social and occupational circumstances were incorporated into prognostic judgments by 35 therapists (72.9%). Occupational demands were considered by 30 therapists (62.5%), family or social support by 28 (58.3%), and work-related physical demands by 26 (54.2%). Adequate social support was generally perceived as facilitating treatment participation and adherence, whereas greater occupational physical demands and limited opportunities for rehabilitation participation were more frequently considered unfavorable prognostic circumstances.

Health Status and Comorbidities

General health status and comorbidities were considered by 38 therapists (79.2%). Factors within this domain included diabetes, hypertension, obesity, coexisting musculoskeletal conditions, and reduced physical activity. Therapists described multiple comorbidities as potentially influencing the expected rate of functional recovery. Baseline physical activity and functional requirements associated with patients' recovery goals were also incorporated into prognostic judgments.

Therapist-Related Factors

Therapist-related characteristics were identified by 36 therapists (75.0%). Clinical experience and familiarity with similar clinical presentations were commonly described as influential components of prognostic reasoning. Previous clinical experience supported recognition of familiar clinical patterns and interpretation of findings encountered during patient assessment.

Prioritization and Integration of Prognostic Information

Therapists considered multiple prognostic indicators when formulating an overall prognosis. Among the 48 therapists, 35 (72.9%) identified clinical severity and functional status among the most influential prognostic considerations, while 32 (66.7%) considered psychological or motivational factors particularly influential. Within-session change was identified as an important factor in modifying the initial prognosis by 31 therapists (64.6%). These findings indicate that therapists assigned different levels of importance to prognostic information during formulation of the final prognosis. The qualitative findings further demonstrated that therapists integrated several indicators when determining the overall clinical trajectory.

Conflicting Prognostic Indicators

Therapists described clinical situations in which prognostic indicators provided competing signals. Favorable characteristics, including motivation, preserved function, positive expectations, social support, and favorable clinical responses, could occur alongside unfavorable characteristics such as greater symptom severity, longer symptom duration, health-related burden, and occupational demands. When competing indicators were present, therapists described integrating the information within the overall clinical presentation and determining which indicators should receive greater influence in the final prognostic judgment. The qualitative findings therefore demonstrated a process involving interpretation and reconciliation of competing prognostic information.

Quantitative Prognostic Assessment

The overall prognostic judgment was recorded on a 1–10 numerical scale, with higher scores

representing a more favorable expected clinical outcome. The mean initial prognostic judgment was 6.6 ± 1.6 , with a median of 7 (IQR 6–8) and a range of 2–10.

Table 3. Distribution of initial prognostic judgments

Statistic	Value
Mean $\pm$ SD	6.6 ± 1.6
Median (IQR)	7 (6–8)
Minimum	2
Maximum	10

The most frequently considered individual prognostic factors were symptom severity, functional status, motivation, patient expectations, health status, and symptom duration.

Table 4. Prognostic factors considered by physical therapists

Prognostic factor	Considered, n (%)	Favorable	Unfavorable	Neutral/uncertain
Symptom severity	41 (85.4)	7	31	3
Functional status	39 (81.3)	29	8	2
Motivation	39 (81.3)	33	5	1
Patient expectations	38 (79.2)	29	6	3
Health status	38 (79.2)	9	25	4
Symptom duration	37 (77.1)	12	23	2
Clinical examination response	34 (70.8)	27	5	2
Adherence	35 (72.9)	29	5	1
Social support	28 (58.3)	24	3	1
Occupational demands	30 (62.5)	8	20	2

The perceived direction of prognostic influence varied across factors. Motivation, functional status, patient expectations, adherence, social support, and favorable clinical examination responses were predominantly classified as favorable, whereas symptom severity, symptom duration, health-related burden, and occupational

demands were more frequently classified as unfavorable. Symptom severity, functional status, motivation, patient expectations, and health status were among the most frequently considered prognostic factors, with their perceived direction of influence varying across factors (Figure 2).

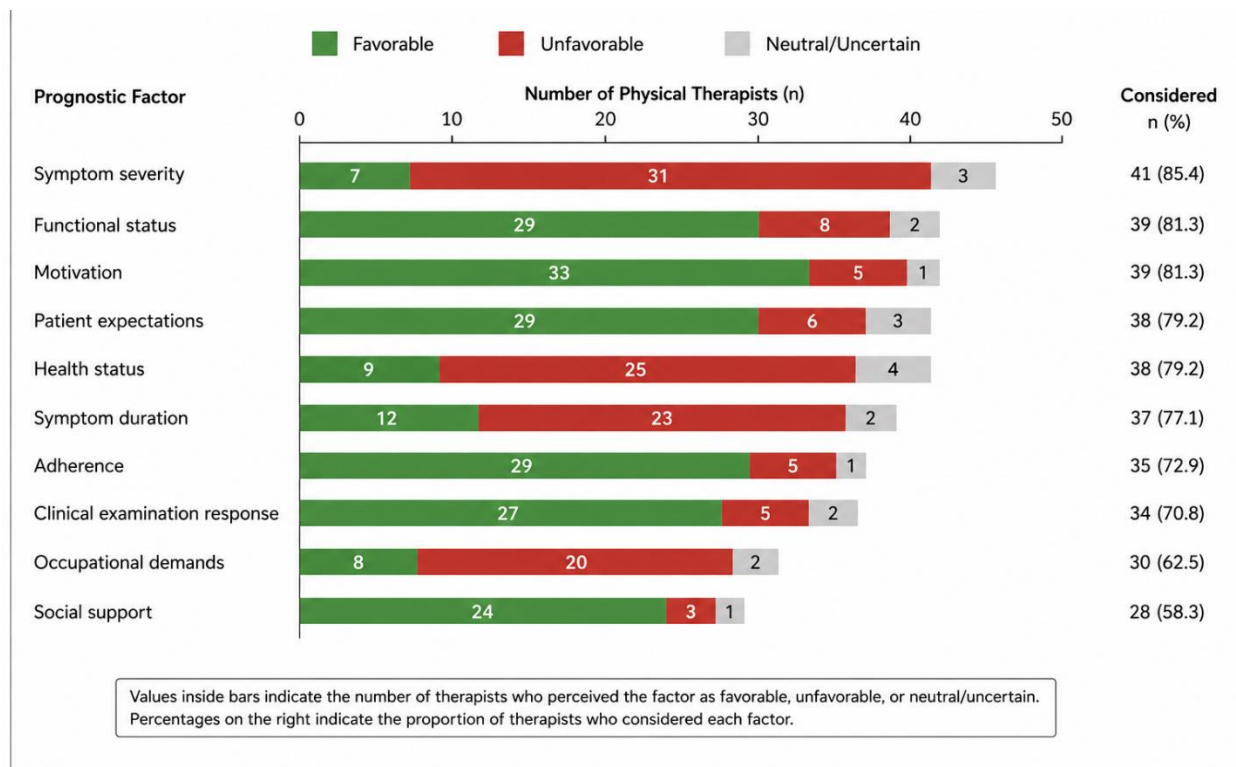


Figure 3. Frequency and perceived direction of considered prognostic factors among physical therapists.

Prognostic Confidence

Prognostic confidence was assessed using a 10-point scale, with higher scores indicating greater confidence in the recorded prognostic judgment. Therapists with ≤ 5 years of clinical experience had a mean confidence score of 6.3 ± 1.3 , compared with 7.2 ± 1.2 among therapists with >5 years of experience. The difference was statistically significant ($p=0.012$).

Patient Recruitment and Follow-up

A total of 94 patients contributed baseline data, and 86 completed the follow-up assessment, resulting in 8 patients without available follow-up outcome data. Patients without follow-up data were excluded from analyses requiring paired baseline and follow-up measurements, while their available baseline observations remained available for analyses that did not require follow-up measurements. The patient pathway consisted of:

Eligibility assessment → enrollment → baseline assessment → initial prognostic judgment → routine physiotherapy → follow-up assessment → outcome analysis.

The patient-level outcome dataset was linked to the participating therapists through study identification codes.

Patient Outcomes

Outcome data were available for 94 patients at baseline and 86 patients at follow-up. The primary functional outcome increased from 47.9 ± 13.8 at baseline to 62.7 ± 14.9 at follow-up, representing a mean increase of 14.8 points. Mean pain intensity decreased from 6.3 ± 1.6 to 3.9 ± 1.7 , representing a mean change of -2.4 points. Global perceived recovery increased from 4.3 ± 1.4 to 6.6 ± 1.5 , representing a mean increase of 2.3 points. All three outcome domains demonstrated statistically significant baseline-to-follow-up changes ($p<0.001$).

Table 5. Patient outcomes at baseline and follow-up

Outcome	Baseline	Follow-up	Mean change	p-value
Primary functional outcome	47.9 ± 13.8	62.7 ± 14.9	+14.8	<0.001
Pain intensity	6.3 ± 1.6	3.9 ± 1.7	−2.4	<0.001
Global perceived recovery	4.3 ± 1.4	6.6 ± 1.5	+2.3	<0.001

Association Between Initial Patient-Specific Prognostic Judgment and Patient Outcomes

Multilevel regression analysis was used to account for clustering of patient observations within treating physical therapists. The patient-specific initial prognostic judgment was entered as the principal predictor, and subsequent patient outcomes were examined as dependent variables.

Unadjusted Associations

In the unadjusted multilevel model, each one-point increase in the initial patient-specific prognostic judgment was associated with a 1.92-point greater improvement in the primary functional outcome ($\beta=1.92$, 95% CI 0.71–3.13; $p=0.002$). Initial prognostic judgment was also statistically associated with the modeled change in pain intensity ($\beta=0.18$, 95% CI 0.06–0.30; $p=0.004$) and global perceived recovery ($\beta=0.24$, 95% CI 0.09–0.39; $p=0.002$).

Table 6. Unadjusted associations between initial prognostic judgment and patient outcomes

Outcome	β	95% CI	p-value
Primary functional outcome	1.92	0.71–3.13	0.002
Pain intensity	0.18	0.06–0.30	0.004
Global perceived recovery	0.24	0.09–0.39	0.002

Adjusted Association Between Prognostic Judgment and Primary Functional Outcome

After adjustment for age, baseline clinical status, symptom duration, and functional status, the association between initial prognostic judgment and improvement in the primary functional

outcome remained statistically significant. The adjusted effect estimate was $\beta=1.58$ (95% CI 0.39–2.77; $p=0.010$). The coefficient was lower than the unadjusted estimate of 1.92, while the direction and statistical significance of the association remained consistent

Table 7. Adjusted Association Between Initial Prognostic Judgment and Primary Functional Outcome.

Model	β	95% CI	p-value	Covariates
Unadjusted	1.92	0.71–3.13	0.002	None
Adjusted	1.58	0.39–2.77	0.010	Age, baseline clinical status, symptom duration, functional status

After adjustment for age, baseline clinical status, symptom duration, and baseline functional status, the association between the initial patient-specific prognostic judgment and improvement in the primary functional outcome remained statistically significant. The adjusted effect estimate was $\beta=1.58$ (95% CI 0.39–2.77; $p=0.010$), compared

with $\beta=1.92$ (95% CI 0.71–3.13; $p=0.002$) in the unadjusted model. The adjusted model therefore demonstrated a persistent association between the initial patient-specific prognostic judgment and subsequent improvement in the primary functional outcome after accounting for the prespecified patient-level covariates (Figure 3).

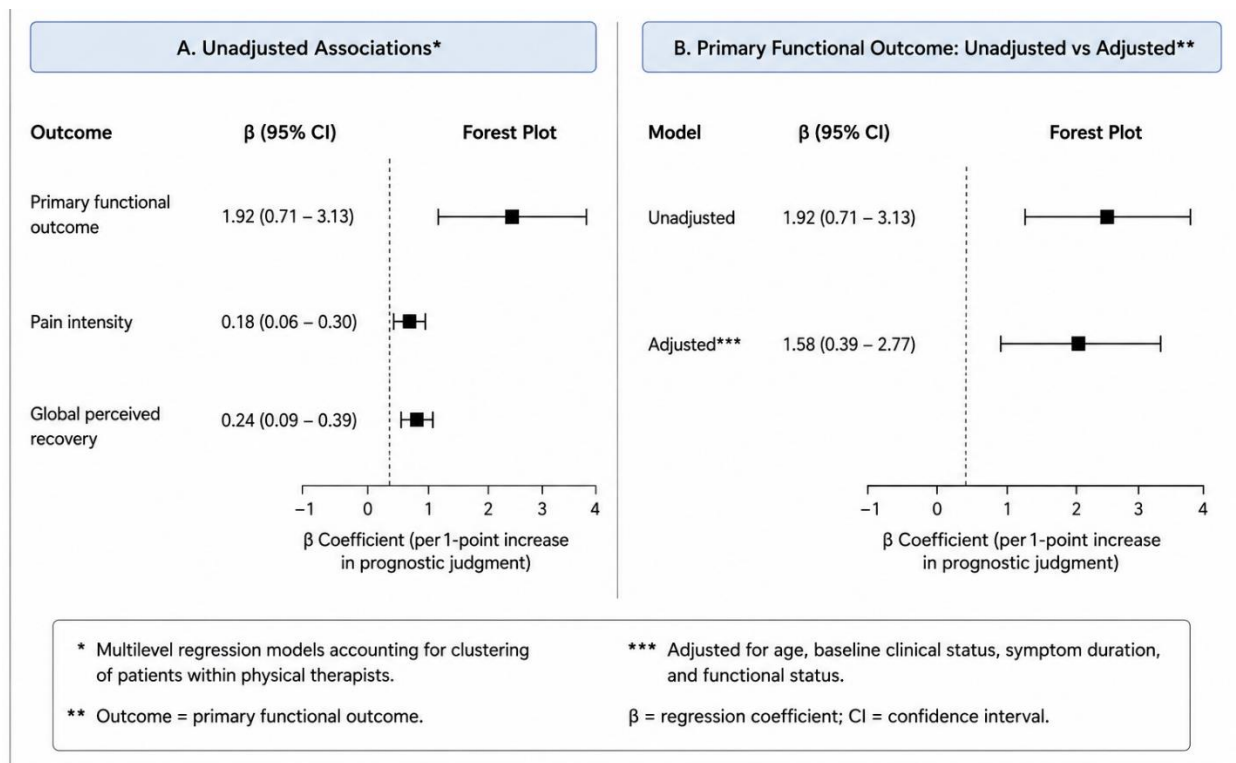


Figure 4. Association between initial prognostic judgment and subsequent patient outcomes.

Influence of Clinical Experience on Prognostic Reasoning

Therapists were categorized according to clinical experience as ≤ 5 years ($n=22$) and >5 years ($n=26$). Therapists with >5 years of experience considered a greater number of prognostic domains than those with ≤ 5 years of experience. The mean number of domains considered was 5.0 ± 1.1 in the >5 -year group and 4.0 ± 1.2 in the ≤ 5 -year group ($p=0.004$). Prognostic confidence was

higher among therapists with >5 years of experience, with mean scores of 7.2 ± 1.2 compared with 6.3 ± 1.3 among therapists with ≤ 5 years of experience ($p=0.012$). Pattern recognition was reported by 22 (84.6%) therapists in the >5 -year group compared with 13 (59.1%) in the ≤ 5 -year group ($p=0.046$). Within-session change was considered by 20 (76.9%) therapists with >5 years of experience compared with 12 (54.5%) therapists with ≤ 5 years of experience ($p=0.048$).

Table 8. Prognostic reasoning according to clinical experience

Variable	≤ 5 years ($n=22$)	>5 years ($n=26$)	p-value
Prognostic domains considered, mean $\pm$ SD	4.0 ± 1.2	5.0 ± 1.1	0.004
Prognostic confidence, mean $\pm$ SD	6.3 ± 1.3	7.2 ± 1.2	0.012
Pattern recognition, n (%)	13 (59.1)	22 (84.6)	0.046
Within-session change, n (%)	12 (54.5)	20 (76.9)	0.048

The findings indicated that greater clinical experience was associated with consideration of a broader range of prognostic domains, greater reported prognostic confidence, more frequent pattern recognition, and greater consideration of within-session clinical responses. Therapists with

greater clinical experience considered more prognostic domains and demonstrated higher reported prognostic confidence, more frequent pattern recognition, and greater consideration of within-session change (Figure 4).

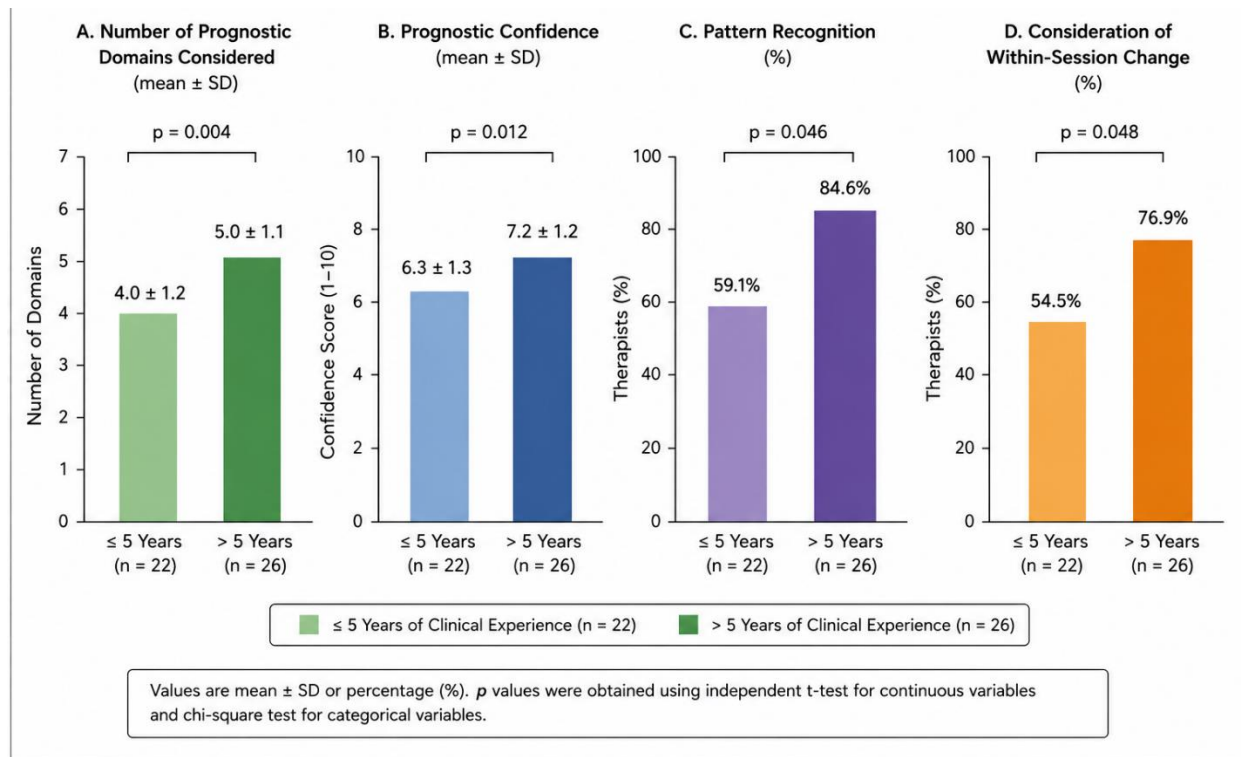


Figure 5. *Clinical experience and dimensions of prognostic reasoning.*

Integrated Mixed-Methods Findings

Integration of the qualitative and quantitative findings demonstrated convergence across the two components. Clinical severity, functional status, motivation, patient expectations, health status, and symptom duration were consistently identified as important prognostic considerations. The qualitative findings demonstrated that therapists interpreted these factors alongside contextual and therapist-related information rather than relying on individual characteristics in isolation. The quantitative findings complemented this interpretation by demonstrating measurable patterns in factor prioritization, overall prognostic judgments, clinical-experience-related differences, and associations between initial prognostic judgments and subsequent patient outcomes. The integrated findings characterized prognostic reasoning as a process involving identification of prognostic information, interpretation of its clinical meaning, prioritization of influential factors,

integration of competing indicators, and formulation of an overall prognostic judgment.

Summary of Principal Findings

Among the 48 participating physical therapists, prognostic reasoning incorporated clinical, functional, psychological, behavioral, social, occupational, health-related, and therapist-related information. Clinical and symptom-related factors represented the most frequently identified domain, followed by psychological and behavioral factors and patient expectations and motivation. At the individual-factor level, symptom severity was considered by 41 therapists (85.4%), functional status by 39 (81.3%), motivation by 39 (81.3%), patient expectations by 38 (79.2%), health status by 38 (79.2%), and symptom duration by 37 (77.1%). Clinical severity and functional status were among the most influential considerations for 35 therapists (72.9%), psychological or motivational factors for 32 (66.7%), and within-session change for 31

(64.6%). The mean initial prognostic judgment was 6.6 ± 1.6 on the 1–10 scale. At the patient level, 94 patients contributed baseline data and 86 completed follow-ups. The primary functional outcome increased by 14.8 points, pain intensity decreased by 2.4 points, and global perceived recovery increased by 2.3 points; all baseline-to-follow-up comparisons were statistically significant at $p < 0.001$. The multilevel analysis demonstrated significant associations between the initial prognostic judgment and subsequent patient outcomes. For the primary functional outcome, each one-point increase in initial prognostic judgment was associated with a 1.92-point greater improvement in the unadjusted model (95% CI 0.71–3.13; $p = 0.002$). After adjustment for age, baseline clinical status, symptom duration, and functional status, the association remained statistically significant ($\beta = 1.58$, 95% CI 0.39–2.77; $p = 0.010$).

DISCUSSION

Principal Findings

This mixed-methods study investigated how physical therapists formulate prognosis by identifying, interpreting, prioritizing, and integrating clinical, psychological, behavioral, contextual, and therapist-related information. The findings demonstrate that prognostic reasoning was a multidimensional clinical process rather than a judgment based on a single clinical characteristic. Among the 48 participating physical therapists, clinical and symptom-related information was the most frequently represented domain, followed by psychological and behavioral factors, patient expectations and motivation, health status and comorbidities, therapist-related factors, and social and occupational circumstances. Symptom severity, functional status, motivation, patient expectations, health status, and symptom duration were among the most frequently considered individual factors. An important contribution of the study was the explicit examination of prioritization. Clinical severity and functional status were identified among the most influential considerations by 35 (72.9%) therapists, psychological or motivational

factors were particularly influential for 32 (66.7%), and within-session change influenced prognostic formulation for 31 (64.6%). These findings indicate that therapists did not simply collect prognostic information; they assigned differential importance to information during the formulation of the final prognosis. The qualitative findings further demonstrated that therapists encountered combinations of favorable and unfavorable indicators and attempted to reconcile these competing signals within the overall clinical presentation.

The quantitative component provided an additional dimension to these findings. The mean initial prognostic judgment was 6.6 ± 1.6 on the 1–10 scale. Among patients linked to the participating therapists, 94 contributed baseline data and 86 completed follow-ups. Functional outcome, pain intensity, and global perceived recovery demonstrated statistically significant changes over follow-up. Importantly, higher initial prognostic judgments were associated with greater subsequent improvement in the primary functional outcome. The unadjusted association was $\beta = 1.92$ (95% CI 0.71–3.13; $p = 0.002$), while the association remained statistically significant after adjustment for age, baseline clinical status, symptom duration, and functional status (adjusted $\beta = 1.58$, 95% CI 0.39–2.77; $p = 0.010$). These findings provide evidence that the synthesized prognostic judgment recorded at the initial assessment contained measurable information regarding subsequent patient trajectory.

Prognostic Reasoning as a Multidimensional Clinical Process

The prominence of multiple prognostic domains in the present study is consistent with contemporary understanding of musculoskeletal recovery. Recovery from musculoskeletal disorders is influenced by interacting physical, psychological, behavioral, occupational, and contextual characteristics, making individualized prognosis inherently complex (1, 2). Prognostic research has identified symptom severity, duration, disability, occupational factors, psychological characteristics, and other patient-

level variables as relevant to recovery trajectories (2, 6).

The current findings extend this evidence by examining these factors from the perspective of the clinician making the prognostic judgment. Therapists considered symptom severity, functional status, symptom duration, psychological characteristics, expectations, motivation, health status, social circumstances, occupational demands, and therapist-related factors. This pattern is consistent with evidence concerning biopsychosocial physiotherapy practice, where clinicians are expected to integrate biological, psychological, and social information within patient-specific clinical decisions (4).

The findings also correspond with broader research on physiotherapy clinical reasoning. Grimus et al. demonstrated that physiotherapists develop individualized exercise decisions through interactions between patient characteristics, clinical findings, professional knowledge, and contextual considerations (7). The present study indicates that a similar multidimensional reasoning process operates when clinicians estimate future outcomes. Prognosis therefore appears to emerge from interpretation of the patient's overall presentation rather than from mechanical application of an isolated prognostic variable.

This distinction is particularly important when considering prognostic models. A systematic review of prognostic models in musculoskeletal rehabilitation identified numerous prediction models, while also highlighting limitations in methodological quality, validation, and clinical applicability (5). Statistical prediction models can identify associations between variables and outcomes. Clinical prognosis requires the clinician to interpret those variables within an individual clinical presentation. The present findings provide empirical support for this clinician-level integration process.

Clinical Severity and Functional Status as Central Prognostic Information

Clinical severity and functional status emerged as particularly influential components of prognostic

reasoning. Symptom severity was considered by 41 (85.4%) therapists, functional status by 39 (81.3%), and symptom duration by 37 (77.1%). These findings are consistent with established prognostic literature demonstrating relationships between symptom characteristics, disability, physical capacity, and recovery in musculoskeletal conditions (2, 6).

Functional status may have particular importance because it provides information about the patient's current ability to perform meaningful activities and establishes a clinically relevant reference point for subsequent recovery. Therapists predominantly interpreted better functional status as favorable, whereas greater symptom severity was more frequently interpreted as unfavorable. This suggests that clinicians may use current functional capacity and symptom burden as complementary indicators when estimating future recovery.

The Pakistani context provides additional support for the importance of integrating physical and psychosocial characteristics. Nazir et al. demonstrated relationships among pain, disability, fear-avoidance beliefs, symptom duration, physical capacity, strength, endurance, and flexibility among Pakistani patients with chronic low back pain (15). The current findings complement this patient-level evidence by demonstrating that Pakistani physical therapists actively incorporate similar clinical and psychosocial characteristics into prognostic judgments.

The Importance of Within-Session Clinical Response

A notable finding was the importance assigned to within-session response. Thirty-one therapists (64.6%) reported that within-session change could modify their prognosis. This finding is particularly relevant because prognostic reasoning frequently occurs dynamically during clinical assessment. The information available to the therapist can change as the patient describes symptoms, undergoes physical examination, performs functional tasks, or responds to an initial intervention.

The finding corresponds closely with Smith et al., who identified within-session response among the factors considered by physical therapists when

determining prognosis (8). The present study adds greater emphasis to this finding by examining within-session response specifically as part of prioritization and prognostic modification.

Within-session response may provide therapists with patient-specific information that is difficult to obtain from baseline characteristics alone. For example, a patient with substantial symptom severity may demonstrate a favorable response during examination or initial therapeutic activity. Such a response can modify the clinician's interpretation of the likely trajectory. Conversely, limited response despite appropriate clinical management may reinforce concerns generated by other unfavorable indicators.

This dynamic process supports the interpretation of prognosis as an evolving judgment. Information obtained during history-taking may establish an initial expectation, physical examination can modify that expectation, and the patient's response during the clinical encounter can provide additional evidence. Prognostic reasoning therefore appears to involve continuous updating of the clinician's working judgment.

Psychological, Behavioral, and Patient-Expectation Factors

Psychological and behavioral information formed a substantial component of prognostic reasoning. Motivation was considered by 39 (81.3%) therapists, patient expectations of 38 (79.2%), adherence of 35 (72.9%), and fear-avoidance behavior of 30 (62.5%). These findings reinforce the importance of psychological and behavioral characteristics within contemporary musculoskeletal rehabilitation.

The incorporation of these factors is consistent with the biopsychosocial model, although implementation of biopsychosocial practice can be influenced by clinician knowledge, confidence, beliefs, communication, and clinical context (4). The present findings suggest that therapists were actively interpreting motivation, expectations, adherence, and fear avoidance as information relevant to expected recovery.

The Pakistani literature is particularly relevant here. Nazir et al. identified relationships between

fear-avoidance beliefs, disability, pain, and physical capacity among Pakistani patients with chronic low back pain (15). Such findings establish the clinical relevance of psychosocial characteristics within the local patient population. The present study demonstrates the corresponding clinician-level process: these characteristics were considered when therapists constructed their prognostic judgments.

Patient expectations and motivation may also influence prognosis indirectly through engagement with rehabilitation. Therapists frequently classify realistic expectations, motivation, and adherence as favorable characteristics. This suggests that clinicians may perceive these factors as indicators of the patient's capacity to participate in rehabilitation and implement recommended management strategies.

Prioritization: Moving Beyond the Identification of Prognostic Factors

The central conceptual contribution of this study concerns prioritization. Existing research has established that physical therapists consider multiple prognostic factors. Smith et al. identified mood, motivation, cognition, pain behaviors, disease severity, health status, social and occupational factors, environmental factors, and biological characteristics within therapists' prognostic reasoning (8). Mullen et al. subsequently demonstrated that physiotherapists' prognostic reasoning involves consideration, determination, and discussion of prognosis, with psychosocial information contributing to complexity and uncertainty (10).

The present study advances this literature by explicitly distinguishing between information that is considered and information that is regarded as influential. This distinction is clinically important. A therapist may consider ten factors during an assessment, while only two or three may substantially determine the final prognosis. Understanding this prioritization process provides a more realistic representation of clinical reasoning than simply counting the factors considered.

The findings indicate that clinical severity and functional status frequently occupied a high position within this hierarchy, followed by psychological and motivational information. Within-session response also played an important role. These findings suggest that therapists may combine relatively stable baseline characteristics with dynamic information generated during the clinical encounter.

The presence of conflicting indicators further emphasizes the importance of prioritization. Prognostic reasoning in clinical practice frequently involves competing signals. A patient can demonstrate severe symptoms and chronicity while simultaneously showing strong motivation, favorable expectations, good social support, and an encouraging response during assessment. The therapist must determine how these signals should collectively influence the final judgment.

The findings therefore support a conceptual pathway:

Information acquisition → interpretation → prioritization → integration → prognostic judgment → subsequent outcome.

This pathway provides a useful framework for understanding the clinical reasoning process underlying prognosis.

Conflicting Indicators and Clinical Integration

The qualitative findings demonstrated that therapists encountered favorable and unfavorable prognostic indicators simultaneously. Their reasoning involved determining which indicators deserved greater influence within the specific patient context. This finding is important because prognostic factors rarely operate independently in actual clinical practice.

A factor classified as unfavorable in one patient may carry different significance in another patient depending on the surrounding clinical circumstances. For example, greater symptom severity may be interpreted differently when accompanied by rapid within-session improvement, strong motivation, and preserved functional capacity. Similarly, relatively mild symptoms may coexist with substantial fear

avoidance, poor adherence expectations, or significant occupational barriers.

This contextual interpretation is consistent with the broader literature on physiotherapy clinical reasoning, which emphasizes interaction between patient characteristics, professional knowledge, clinical findings, and context (7). It also complements phenomenological research demonstrating that physiotherapists experience prognostic reasoning as a process involving uncertainty and interpretation of complex information (10).

The present findings consequently support a model in which prognostic information is not treated as a simple additive list. Therapists appear to interpret the meaning and relative importance of each indicator in relation to the entire clinical presentation.

Clinical Experience, Pattern Recognition, and Prognostic Confidence

Clinical experience was associated with measurable differences in prognostic reasoning. Therapists with more than five years of experience considered a greater number of prognostic domains than those with five years or less of experience (5.0 ± 1.1 versus 4.0 ± 1.2 ; $p=0.004$). More experienced therapists also reported greater prognostic confidence, greater use of pattern recognition, and greater consideration of within-session change.

These findings are consistent with Mullen et al., who reported that physiotherapists developed prognostic knowledge through clinical experience and professional learning (9). Research concerning clinical prediction rules has also demonstrated variation in physiotherapists' knowledge and application, highlighting the role of clinician characteristics in clinical decision-making (12).

Pattern recognition may represent one mechanism through which experience influences prognostic reasoning. Repeated exposure to similar clinical presentations allows experienced therapists to develop a repertoire of previously encountered patterns. This accumulated experience may

facilitate rapid recognition of clinically meaningful combinations of findings.

Greater confidence, however, requires careful interpretation. The present study measured self-reported prognostic confidence. It did not establish that therapists with greater confidence were more accurate. Jørgensen et al. demonstrated that physical therapists' prognostic estimates may have limited correspondence with subsequent outcomes in patients with patellofemoral pain (11). Therefore, confidence and prognostic accuracy should be treated as distinct constructs. This distinction has direct educational relevance. Experienced clinicians may benefit from structured reflection that requires them to articulate the evidence supporting their intuitive judgments. Such an approach could help transform tacit pattern recognition into transparent and teachable reasoning.

Prognostic Judgment and Subsequent Patient Outcomes

The association between initial prognostic judgment and patient outcomes represents one of the most important quantitative findings of the study. The unadjusted analysis demonstrated that each one-point increase in the initial prognostic score was associated with a 1.92-point greater improvement in the primary functional outcome (95% CI 0.71–3.13; $p=0.002$). After adjustment for age, baseline clinical status, symptom duration, and functional status, the association remained statistically significant, with an adjusted β of 1.58 (95% CI 0.39–2.77; $p=0.010$).

The attenuation of the coefficient following adjustment indicates that some of the crude association was related to patient-level characteristics included in the adjusted model. The persistence of the association suggests that the therapist's synthesized initial judgment retained outcome-related information after accounting for these characteristics.

The findings are consistent with Smith et al., who reported associations between physical therapists' initial prognostic scores and subsequent patient outcomes (8). The present study therefore provides additional evidence that clinicians'

overall prognostic judgments can contain measurable information about future patient trajectories.

At the same time, these findings should not be interpreted as evidence that therapist prognosis causes better or poorer patient outcomes. The study was observational, and the analysis examined associations rather than causal effects. Prognostic judgment may reflect information that was incompletely captured by the measured covariates. The results also do not establish individual-level prognostic accuracy, calibration, or prediction error.

This distinction is particularly important given evidence from Jørgensen et al., where physical therapists' initial prognosis did not demonstrate a meaningful relationship with subsequent outcomes in another musculoskeletal population (11). The differing findings across studies suggest that the relationship between clinician prognosis and patient outcome may depend on the population, clinical condition, outcome measures, treatment context, and characteristics of the prognostic judgment itself.

Relevance to the Pakistani Physiotherapy Context

The study provides an important Pakistani perspective because much of the literature examining physiotherapists' prognostic reasoning has originated from high-income healthcare systems. The present findings demonstrate that physical therapists practicing within a Pakistani hospital environment incorporated multidimensional clinical, psychological, behavioral, contextual, and experiential information into prognosis.

The findings complement recent Pakistani evidence regarding professional beliefs and clinical decision-making. Khan et al. reported that attitudes and beliefs were associated with musculoskeletal clinical decision-making among Pakistani healthcare professionals, including physiotherapists (14). The present study extends this literature into a more specific domain by examining how therapists formulate prognosis and prioritize information.

Patient-level evidence from Pakistan also demonstrates the relevance of psychosocial and functional characteristics to musculoskeletal disability and recovery-related constructs (15). Thus, the present findings connect two previously separated areas of evidence: characteristics observed among Pakistani patients and the clinical reasoning processes used by Pakistani physiotherapists to interpret those characteristics. Earlier work by Umar et al. also reported relationships between clinical decision-making and professional characteristics among physiotherapists in Pakistan (16). Although that study addressed broader clinical decision-making rather than prognosis specifically, it provides contextual support for examining experience and professional development as potential influences on clinician reasoning.

The present study consequently addresses a specific gap in Pakistani physiotherapy research by moving from the question of which factors clinicians consider toward how those factors are prioritized and integrated into an overall prognostic judgment.

Implications for Physiotherapy Education and Clinical Practice

The findings have important implications for physiotherapy education. Prognostic reasoning should be taught as an explicit clinical competency involving identification, interpretation, prioritization, and integration of prognostic information. This approach is consistent with the recent Australian and New Zealand framework that identifies prognosis as an important component of entry-level physiotherapy education and recommends explicit development of prognostic knowledge and reasoning (13). Case-based education could require students to identify prognostic factors, classify their perceived direction of influence, select the most influential factors, and justify their final prognostic judgment. Cases involving conflicting prognostic indicators would be particularly valuable because they would require students to explain how and why one source of information receives greater weight. Clinical educators could also ask learners

to document the reasoning behind prognostic judgments rather than recording only an expected outcome. Such documentation could include the principal favorable indicators, principal unfavorable indicators, factors given the greatest weight, sources of uncertainty, and information that could modify the prognosis during subsequent assessment. For experienced clinicians, structured reflection may provide a mechanism for examining pattern recognition and clinical intuition. The objective would be to make tacit reasoning more transparent, facilitate peer discussion, and identify situations in which intuitive judgments require additional verification.

Strengths and Limitations

A major strength of this study was its mixed-methods design. Qualitative interviews provided detailed information regarding how therapists interpreted and integrated prognostic information, while the quantitative component operationalized prognostic-factor consideration, perceived direction, prioritization, prognostic judgment, clinical experience, and patient outcomes. The participation of all 48 therapists in both components enabled direct linkage between their reported reasoning and quantitative prognostic assessments. Another strength was the linkage between therapist-level prognostic judgments and patient-level outcomes. The analysis accounted for clustering of patients within therapists through multilevel regression, thereby recognizing the hierarchical structure of the data. The study also has limitations. First, participants were recruited from a single hospital setting in Swat, which limits transferability to other Pakistani regions and healthcare systems. Differences in professional education, caseload, healthcare resources, referral systems, and clinical practice may influence prognostic reasoning. Second, the study included self-reported descriptions of clinical reasoning. Interview responses may be influenced by recall, social desirability, or retrospective reconstruction of reasoning. The qualitative findings therefore represent therapists' articulated accounts of their

reasoning and should not be interpreted as direct observation of every cognitive process occurring during clinical practice. Third, the 1-10 prognostic judgment was developed for the study and should undergo further psychometric evaluation before being considered a standardized clinical instrument. The same consideration applies to the structured assessment of prognostic reasoning and prioritization. Fourth, eight patients lacked follow-up outcome data. Although baseline information was retained for analyses that did not require follow-up, attrition may have introduced bias into outcome analyses. Fifth, observational design permits assessment of associations between prognostic judgments and outcomes while providing limited evidence regarding causal mechanisms. The statistically significant association between prognostic judgment and functional improvement should therefore be interpreted as an outcome-related association rather than evidence of causal predictive accuracy. Finally, the study did not establish formal prognostic accuracy, calibration, discrimination, or prediction error. Future studies should compare therapist predictions with observed outcomes using validated accuracy metrics and should examine whether specific reasoning strategies improve individual-level prognostic performance.

CONCLUSION

This mixed-methods study demonstrated that prognostic reasoning among physical therapists was a multidimensional clinical reasoning process involving identification, interpretation, prioritization, and integration of clinical, functional, psychological, contextual, and therapist-related information. Clinical severity and functional status were among the most influential considerations, while motivation, patient expectations, health status, adherence, social circumstances, occupational demands, and within-session clinical response also contributed to the final prognostic judgment. The study's central contribution lies in demonstrating that prognostic reasoning extends beyond identifying relevant prognostic factors. Physical therapists actively

determined which information deserved greater influence when multiple favorable and unfavorable indicators were present. This prioritization process provides an important conceptual bridge between established prognostic-factor research and the actual clinical reasoning used to formulate an individualized prognosis. Initial prognostic judgments were significantly associated with subsequent patient outcomes. The association with the primary functional outcome remained statistically significant after adjustment for age, baseline clinical status, symptom duration, and functional status. These findings indicate that the therapist's synthesized initial judgment contained clinically relevant outcome information, while the observational design and absence of formal accuracy measures require cautious interpretation. Greater clinical experience was associated with consideration of a broader range of prognostic domains, greater self-reported prognostic confidence, more frequent pattern recognition, and greater attention to within-session responses. These findings support the importance of developing prognostic reasoning as an explicit professional competency throughout physiotherapy education and continuing clinical practice. Within the Pakistani context, the study provides initial empirical evidence describing how physical therapists integrate clinical and psychosocial information when formulating prognosis. It extends existing Pakistani research on clinical decision-making and musculoskeletal patient characteristics by focusing specifically on the reasoning pathway through which information is transformed into a prognostic judgment (14, 15). Future research should validate structured measures of prognostic reasoning and prioritization, recruit therapists and patients across multiple Pakistani healthcare settings, examine prognostic calibration and individual-level accuracy, and investigate whether structured educational interventions can improve transparent, evidence-informed prognostic reasoning. Such work could establish a stronger evidence base for integrating prognostic reasoning into physiotherapy curricula, clinical supervision, and routine musculoskeletal practice.

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