

1. Literature list related to PNF teaching content

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Philosophy

Positive approach

1. Lindström B, Eriksson M. Salutogenesis. J Epidemiol Community Health. 2005 Jun;59(6):440-2.
2. Kim SI. Neuroscientific model of motivational process. Front Psychol. 2013 Mar 4;4:98
3. Michael Higgins, Carolyn Greer Proprioceptive Neuromuscular Facilitation for the Upper Extremity and Scapula: Review and Update on Rehabilitation of Shoulder Pathology: Int J Sports Phys Ther. 2025 Sep 2;20(9):1407–1419. doi: 10.26603/001c.143176

Functional approach

1. Steiner WA, Ryser L, Huber E, et al. Use of the ICF model as a clinical problem solving tool in physical therapy and rehabilitation medicine. Phys Ther. 2002;82:1098-1107
2. Smedes F, Functioneel oefenen, de betekenis van het functioneel oefenen binnen het PNF concept. FysioPraxis 2002 (11) 9-11 (functional exercise, the meaning for PNF)
3. Smedes F, Heidmann M, Schäfer C, Fischer N, Stepien A. The proprioceptive neuromuscular facilitation-concept; the state of the evidence, a narrative review. Physical Therapy Reviews 2016; 21(1):17-31
4. Smedes F. The essential elements of the PNF-concept; an educational narrative. Journal of Physical Medicine and Rehabilitation 2022;4(2):37-48

Mobilize of reserves

1. Sanes JN, Donoghue JP. Plasticity and Primary Motor Cortex. Annu. Rev. Neurosci. 2000. 23:393–415 (I moved this here from Motor Learning)
2. Cauraugh J H, Kim S B. Stroke motor recovery: active neuromuscular stimulation and repetitive practice schedules. J Neurol Neurosurg Psychiatry 2003;74:1562–1566 (I moved this here from Motor Learning)
3. Li S. Spasticity, Motor Recovery, and Neural Plasticity after Stroke. Front. Neurol. 2017;8:120. doi: 10.3389/fneur.2017.00120

4. Georgios Kakavas, Nikolaos Malliaropoulos, Florian Forelli, Anterior Cruciate Ligament Reconstruction Rehabilitation as a Complex Adaptive Process: From Control–Chaos to Actionable Return-to-Sport Decisions, *Bioengineering* (Basel). 2025 Nov 10;12(11):1229. doi: 10.3390/bioengineering12111229, PMID: PMC12649574 PMID: 41301184

Treating the total human being

1. Smedes F, PNF beter (be)grijpen. *FysioPraxis* 2001 (12) 42-46. (Better understanding of PNF)
2. Burke RE. Sir Charles Sherrington's the integrative action of the nervous system: A centenary appreciation. *Brain* 2007;130:887–94.
3. Westwater-Wood S, Adams N, Kerry R. The use of proprioceptive neuromuscular facilitation in physiotherapy practice *Physical Therapy Reviews* 2010 vol 15. (1) 23-28
4. Functional multidisciplinary rehabilitation versus outpatient physiotherapy for non-specific low back pain: randomised controlled trial Yves Henchoz, Pierre de Goumoëns, Alexander Kai Lik So, Roland Paillex *Swiss Med Wkly.*2010;140:w13133
5. Røijezon, Clark, Treleaven. Proprioception in musculoskeletal rehabilitation. Part 1 Basic science and principles of assessment and clinical interventions. *Manuel Therapy* 2015(20) 368-377
6. Clark, Treleaven, Røijezon, Proprioception in musculoskeletal rehabilitation. Part 2 Basic science and principles of assessment and clinical Interventions. *Manuel Therapy* 2015(20) 378- 387
7. Landelle C, Chancel M, Blanchard C, Guerraz M, Kavounoudias A. Contribution of muscle proprioception to limb movement perception and proprioceptive decline with ageing. *Curr Opin Physiol* [Internet]. 2021;20:180–5.
8. Prochazka A. Proprioception: clinical relevance and neurophysiology. *Curr Opin Physiol* 2021;23:100440.

Use of motor learning and motor control principles

1. Frank JS, Earl M, Coördination of posture and movement. *Physical Therapy* 1990 (12) 109-117
2. Winstein CJ, Knowledge of results and motor learning - Implications for physical therapy. *Physical Therapy* 1991 (71) 140-149.
3. Mulder T, A process- oriented model of human motor behaviour: toward a theory-based rehabilitation approach. *Physical Therapy* 1991 (2) 82-89.
4. Lee TD, Swanson LR, Hall AL, What is repeated in a repetition? Effects of practice conditions on motor skill acquisition. *Physical Therapy* 1991 (71) 150-156
5. Corcos DM, Strategies underlying the control of disordered movement. *Physical Therapy* 1991 (71) 25-38
6. Vereijken B, Whiting HTA, Newell KM. Free(z)ing Degrees of Freedom in Skill Acquisition. *Journal of Motor Behavior* 1992 (24) 1, 133-142
7. Charlton JL, Motor control issues and clinical applications. *Physiotherapie theory and practice* 1994 (10) 185-190
8. Taub E, et al. An operant approach to rehab medicine, overcoming learned nonuse by shaping. *Journal of experimental analysis of behaviour.* 1994 (61) 281-293

9. Marks R, Peripheral mechanisms underlying the signaling of joint position. *NZ Journal of Physiotherapy* 1997 April
10. Vereijken et al. Changing coordinative structures in complex skill acquisition. *Human Movement Science* 1997 (16) 823-844
11. Vereijken B, Van Emmerik REA, Bongardt R, Beek WJ , K.M. Newell. Changing coordinative structures in complex skill Acquisition. *Human Movement Science* 1997 (16) 823-844
12. Wulf G, Höss M, Prinz W. instructions for motor learning differential effect for internal versus external focus of attention. *Journal of motor behavior* 1998 (30) 2
13. Hecht H, Prinz W, Vogt S. Motor Learning enhances perceptual judgment. a case for action-perception transfer. *Psychological research* 2001(65) 3-14
14. Newell KM, Vaillancourt DE. Dimensional change in motor learning. *Human Movement Science* 2001 (20) 695-715
15. Grafton ST, Salidis J, Willingham DB. Motor Learning of Compatible and Incompatible Visuomotor Maps *Journal of Cognitive Neuroscience* 2001 13:2, 217–231
16. Celnik P, Stefan K et al. Encoding a motor memory in the older adult by action observation. *NeuroImage* 2006 (29) 677 – 684
17. Halsband U, Lange RK. Motor learning in man: A review of functional and clinical studies. *Journal of PhysiologyParis* 2006 (99) 414-424
18. Krakauer JW. Motor learning: its relevance to stroke recovery and neurorehabilitation. *Current Opinion in Neurology* 2006, 19:84–90
19. Vliet van PM, Wulf G. Extrinsic feedback for motor learning after stroke what is the evidence. *Disability and Rehabilitation* 2006 (28) 831 – 840
20. Filimon F, et al. Human cortical representations for reaching mirror neurons for execution, observation and imagery. *Neuroimage*. 2007 37(4): 1315–1328
21. Rokni U et al. Motor Learning with Unstable Neural Representations *Neuron* 2007 (54) 653–666
22. Stefan K, Classen J, CelnikP, Cohen LG. Concurrent action observation modulates practice-induces motor memory formation. *European Journal of Neuroscience* 2008 (27) 730–738
23. Zwicker JG, Harris SR. A reflection on motor learning theory in pediatric occupational therapy practice. *Canadian journal of Occupational Therapy* 2009 (76) 1 29-37
24. Latash ML, Levin MF, Scholz JP, Schöner G. Motor control theories and their applications. *Medicina (Kaunas)* 2010;46(6):382-92
25. Wulf G, Shea C, Lewthwaite R. Motor Learning and Performance: A Review of Influential Factors. *Medical Education* 2010;44:75–84
26. Frey SH, Fogassi L, Grafton S, Picard N, Rothwell JC, Schweighofer N, Corbetta M, Fitzpatrick SM. Neurological Principles and Rehabilitation of Action Disorders : Computation, Anatomy, and Physiology (CAP) Model Neurorehabil Neural Repair 2011; 25: 6-20
27. Taylor JA, Ivry RB. The role of strategies in motor learning *Ann. N.Y. Acad. Sci.* 2012 doi: 10.1111/j.1749-6632.2011.06430.x
28. Stanley J, Krakauer JW. Motor skill depends on knowledge of facts. *Frontiers in Human Neuroscience* 2013 (8) 01-11
29. Malouin F, Jackson PL, Richards CL. Towards the integration of mental practice in rehab programs. a critical review. *Frontiers in Human Neuroscience* 2013 (9) 01-20
30. Luft CDB. Learning from FB. The neural mechanisms of fb processing facilitating beter performance. *Behavioural Brain Research* 2014(261) 356– 368

31. Kesar TM, Sauer MJ, Binder-Macleod SA et al. Motor learning during post stroke gait rehabilitation: A case study. *J Neurological PT* 2014; 38:183-189
32. Wulf G, Lewthwaite R. Optimizing performance through intrinsic motivation and attention for learning: The OPTIMAL theory of motor learning. *Psychon Bull Rev* 2016; 23:1382–1414
33. Waddell KJ, Strube MJ, Bailey RR et al. Does task-specific training improve upper limb performance in daily life post stroke? *Neurorehabilitation and Neural Repair* 2017, Vol. 31(3) 290-300, doi: 10.1177/1545968316680493
34. Kleyen M, Beurskens A, Olijve H, Kamphuis J, Braun S. Application of motor learning in neurorehabilitation, a framework for health-care professionals *Physiotherapie theory and practice* 2018
35. Atun-Einy O, Kafri M. Implementation of motor learning principles in physical therapy practice, survey of PT's perceptions and reported implementation. *Phys Theory and Practice* 2019;34(7):633-44
36. Jie L-J, Kleynen M, Meijer K, Beurskens A, Braun S. Implicit and explicit motor learning interventions have similar effects on walking speed in people after stroke: a randomized controlled single blind trial. *MedRxiv* 2019:19008797. <https://doi.org/10.1101/19008797>.
37. Yoshida N, Suzuki T, Ogahara K, Higashi T, Sugawara K. Somatosensory temporal discrimination threshold changes during motor learning. *Somatosens Mot Res* 2020;37:313–9.
38. Sugawara K. Change in motor cortex activation for muscle release by motor learning. *Phys Ther Res* 2020;23:106–12.
39. Spampinato D, Celnik P. Multiple Motor Learning Processes in Humans: Defining Their Neurophysiological Bases. *Neuroscientist* 2021;27:246–67

Basic principles

1. Higgins M, Greer C. Proprioceptive Neuromuscular Facilitation for the Upper Extremity and Scapula: Review and Update on Rehabilitation of Shoulder Pathology. *Int J Sports Phys Ther.* 2025 Sep 2;20(9):1407-1419. doi: 10.26603/001c.143176. PMID: 40904708; PMCID: PMC12404573.

Tactile stimulus

1. Jeka JJ, Lackner JR. Fingertip contact influences human postural control 1994. *Exp Brain Res* 1994 (100) 495-502
2. Fallon JB et al. Evidence for Strong Synaptic Coupling Between Single Tactile Afferents From the Sole of the Foot and Motoneurons Supplying Leg Muscles. *J Neurophysiol* 2005 (94) 3795–3804
3. Saradjian AH, Tremblay L, Perrier J, Blouin J, Mouchnino L. Cortical facilitation of proprioceptive inputs related to gravitational balance constraints during step preparation. *J Neurophysiol* 2013;110: 397–407
4. Ryan, J. L., Wright, F. V., & Levac, D. E. (2020 jan 1.). Exploring physiotherapists' use of motor learning strategies in gait-based interventions for children with cerebral palsy. *Physical & Occupational Therapy in Pediatrics*, 40(1), 79–92, doi: 10.1080/01942638.2019.1622623, PMCID: PMC6864228 NIHMSID: NIHMS1050434 PMID: 31154883
5. Brudzynski S, Silkstone M, Mulvihill K. Ascending Activating Systems of the Brain for Emotional Arousal. *Handbook of Behavioral Neuroscience* 2018 , chapter 23

6. Viseux FJF. The sensory role of the sole of the foot: Review and update on clinical perspectives. *Neurophysiol Clin.* 2020;50(1):55–68
7. Watanabe H, Kojima S, Otsuru N, Onishi H. The Repetitive Mechanical Tactile Stimulus Intervention Effects Depend on Input Methods. *Front Neurosci.* 2020 Apr 28;14:393

Verbal stimulus

1. Sadowski J, Mastalerz A, Niznikowski, Wisniowski W, Biegajlo M, Kulik M. The effects of different types of verbal feedback on learning a complex movement task. *Polish Journal of Sports and Tourism.* 2011;18:308-310
2. Snyder, B. J., & Fry, W. R. (2012). Effect of Verbal Instruction on Muscle Activity During the Bench Press Exercise. *Journal of Strength and Conditioning Research,* 26(9), 2394–2400. DOI: 10.1519/JSC.0b013e31823f8d11
3. Marianne Storberget, Linn Helen J Grødahl, Suzanne Snodgrass, Paulette van Vliet, Nicola Heneghan Verbal augmented feedback in the rehabilitation of lower extremity musculoskeletal dysfunctions: a systematic review, *BMJ Open Sport Exerc Med.* 2017 Sep 21;3(1):e000256. doi: 10.1136/bmjsem-2017-000256, PMID: PMC5623330 PMID: 29018544
4. Rendos, N. K., Zajac-Cox, L., Thomas, R., Sato, S., Eicholtz, S., & Kesar, T. M. (2020). Verbal feedback enhances motor learning during post-stroke gait retraining. *Topics in Stroke Rehabilitation,* 28(5), 362–377. <https://doi.org/10.1080/10749357.2020.1818480>

Visual stimulus

1. Ramachandran VS, Altschuler EL. The use of visual feedback, in particular mirror visual feedback, in restoring brain function. *Brain* 2009; 132; 1693–1710
2. Prodoehl J, Vaillancourt DE. Effects of visual gain on force control at the elbow and ankle *Exp Brain Res.* 2010; 200(1): 67–79.
3. Mohapatra S, Krishnan V, and Aruin AS. The effect of decreased visual acuity on control of posture *Clin Neurophysiol.* 2012 January ; 123(1): 173–182
4. Castro-Medina, K. G. (2023). Effects of visual feedback on walking speed for stroke patients: Single-case design. *Revista de Investigación e Innovación en Ciencias de la Salud,* 5(1), 127–142 <https://doi.org/10.46634/riics.153>
5. Niering M, Seifert J. The effects of visual skills training on cognitive and executive functions in stroke patients: a systematic review with meta-analysis. *J Neuroeng Rehabil.* 2024 Mar 26;21(1):41. doi: 10.1186/s12984-024-01338-5. PMID: 38532485; PMID: PMC10967170
6. Wang, C. q. s., Wang, K., Sun, L., Liu, S. q., & Luo, J. (2025). The effect of visual feedback on balance rehabilitation in people with impaired ankle instability: A systematic review and meta-analysis. *BMC Sports Science, Medicine and Rehabilitation,* 17, 77

Vestibular stimulus

1. Kim, B., Lohman, E., & Yim, J. (2022). Effects of stabilizing reversal technique and vestibular rehabilitation exercise on dizziness and balance ability in patients with vestibular neuritis. *Medicine (Baltimore),* 101(4), e28740. doi: 10.1097/MD.00000000000028740

2. Marco Tramontano,Valeria Belluscio,Elena Bergamini,Giulia Allevi,Sara De Angelis,Giorgia Verdecchia,Rita Formisano,Giuseppe Vannozzi andMaria Gabriella Buzzi: Vestibular Rehabilitation Improves Gait Quality and Activities of Daily Living in People with Severe Traumatic Brain Injury: A Randomized Clinical Trial, *Sensors* 2022, 22(21), 8553; <https://doi.org/10.3390/s22218553>, Submission received: 16 August 2022 / Revised: 3 November 2022 / Accepted: 3 November 2022 / Published: 6 November 2022
3. Li, Z., Zhang, Y., Wang, J., Chen, X., & Liu, H. (2023). Vestibular rehabilitation therapy on balance and gait in patients after stroke: A systematic review and meta-analysis. *BMC Medicine*, 21, 375.
4. do Amaral CMS, de Almeida SB, de Almeida RP. Effectiveness of vestibular rehabilitation on postural balance in Parkinson's disease: a systematic review and meta-analysis of randomized controlled trials. *BMC Neurol.* 2024 May 14;24(1):161. doi: 10.1186/s12883-024-03649-5. PMID: 38745275; PMCID: PMC11092171.

Resistance

1. KofotolisN, Vrabas IS, Vamvakoudis E, Papanikolaou A, Mandroukas K: Proprioceptive neuromuscular facilitation training induced alterations in muscle fiber type and cross sectional area. *British Journal of Sports Medicine* 2005 (3):e11.
2. Gabriel DA, Kamen G, Frost G: Neural adaptations to resistive exercise, mechanisms and recommendations for training practices. *Sports Med* 2006 (2) 183-189
3. Youdas JW, Adams KE, Bertucci JE, Brooks KJ, Steiner MM, Hollman JH. Magnitudes of gluteus medius muscle activation during standing hip joint movements in spiral-diagonal patterns using elastic tubing resistance. *Physiother. Theory Pract..* 2015;31(6):410-7.
4. Franchi MV, Reeves ND, Narici MV. Skeletal Muscle Remodeling in Response to Eccentric vs. Concentric Loading: Morphological, Molecular, and Metabolic Adaptations. *Front Physiol.* 2017 Jul 4;8:447.
5. Bishop BN, Greenstein J, Etnoyer-Slaski JL, Sterling H, Topp R. Electromyographic Analysis of Gluteus Maximus, Gluteus Medius, and Tensor Fascia Latae During Therapeutic Exercises With and Without Elastic Resistance. *Int J Sports Phys Ther.* 2018 Aug;13(4):668-675.

Stretch / Elongation

1. Avela J, Finni T, Liikavainio T, Niemelä E, Komi PV. Neural and mechanical responses of the triceps surae muscle group after 1 h of repeated fast passive stretches *J Appl Physiol* 2004;96(6):2325-2332
2. Hornberger TA, Armstrong DD, Koh TJ, Burkholder TJ, Esser KA. Intracellular signaling specificity in response to uniaxial vs. multi-axial stretch: implications for mechanotransduction. *Am J Physiol Cell Physiol.* 2005 Jan;288(1):C185-94
3. Weiler J, Gribble PL, Pruszynski JA. Spinal stretch reflexes support efficient control of reaching. *J Neurophysiol.* 2021 Apr 1;125(4):1339-1347.
4. Schoenfeld BJ, Wackerhage H, De Souza E. Inter-set stretch: A potential time-efficient strategy for enhancing skeletal muscle adaptations. *Front Sports Act Living.* 2022 Nov 15;4:1035190

Traction

1. Vaarbakken K, Ljunggren AE. Superior effect of forceful compared with standard traction mobilizations in hip disability? *Adv Physiother.* 2007 Sep;9(3):117-128
2. Camy Bhagat, Paras Bhura Effect of Joint Traction and Approximation on H-Reflex in Normal Subjects, 2014, *Indian journal of Physiotherapy & Occupational Therapy* vol8 No3, DOI: 10.5958/0973-5674.2014.00349.9
3. Comrie WA, Burkhardt JK. Action and Traction: Cytoskeletal Control of Receptor Triggering at the Immunological Synapse. *Front Immunol.* 2016 Mar 7;7:68
4. Min Sun Choi, Dong Kyu Lee. The Effect of Knee Joint Traction Therapy on Pain, Physical Function, and Depression in Patients with Degenerative Arthritis. *J Kor Phys Ther* 2019;31(5):317-321

Approximation

1. Ratliffe KT, Alba BM, Hallum A, Jewell MJ. Effects of approximation on postural sway in healthy subjects. *Phys Ther.* 1987;67(4):502-6.
2. Fitts RH1, Riley DR, Widrick JJ. Functional and structural adaptations of skeletal muscle to microgravity. *J Exp Biol.* 2001 Sep;204(Pt 18):3201-8.
3. Mahani MK, Karimloo M, Amirsalari S. Effects of Modified Adeli Suit Therapy on Improvement of Gross Motor Function in Children With Cerebral Palsy. *Cerebral Palsy Hong Kong Journal of Occupational Therapy*, 2010 (21),1:9-14
4. Shin WS, Lee SW, Effect of gait training with additional weight on balance and gait in stroke patients. *Phys Ther Rehab Sci.*2014(3);1:55-62
5. Sylos-Labini F, Lacquaniti F, and Ivanenko YP. Human Locomotion under Reduced Gravity Conditions: Biomechanical and Neurophysiological Considerations. *BioMed Research International* 2014 DOI:10.1155/2014/547242
6. Camy Bhagat, Paras Bhura Effect of Joint Traction and Approximation on H-Reflex in Normal Subjects, 2014, *Indian journal of Physiotherapy & Occupational Therapy* vol8 No3, DOI: 10.5958/0973-5674.2014.00349.9

Basic procedures

Pattern

Scapula, upper-limb

1. Myers JB, Lephart SM: The role of the sensorimotor system in the athletic shoulder *Journal of athletic training* 2000;35(3):351-363
2. Mc Mullen J, Uhl TL: A kinetic chain approach for shoulder rehabilitation. *Journal of athletic training* 2000;35(3):329-337
3. Shimura K, Kasai T: Effects of proprioceptive neuromuscular facilitation on the initiation of voluntary movement and motor evoked potentials in upper limb muscles. *Human movement science* 2002;21(1):101-113
4. Witt D, Talbott N, Kotowski S: Electromyographic activity of scapular muscles during diagonal patterns using elastic resistance and free weights. *International Journal of Sports Physical Therapy* 2011;6(4):322- 332

5. Youdas JW, Arend DB, Extrom JM, Helmus TJ, Rozeboom JD, Hollman JH. Comparison of muscle activation levels during arm abd. in the plane of the scapula vs PNF upper extr. Patterns. *Journal of Strength and Conditioning Research* 2012 (26) 4, 1058-1065
6. Lial L, Moreira R, Correia L. Proprioceptive neuromuscular facilitation increases alpha absolute power in the dorsolateral prefrontal cortex and superior parietal cortex. *Somatosensory & motor research*, 2017; 34(3): 204–212, doi.org/10.1080/08990220.2017.1392298
7. Moreira et al. Diagonal movement of the upper limb produces greater adaptive plasticity than sagittal plane flexion in the shoulder. *Neuroscience Letters* 2017,643:8–15
8. Cellatoğlu H, Belgen Kaygısız B. Effect of proprioceptive neuromuscular facilitation (PNF) technique on posture, balance and gait characteristics of older adults with scapular dyskinesis: a randomized controlled trial. *PeerJ*. 2025 Aug 14;13:e19718. doi: 10.7717/peerj.19718. PMID: 40827206; PMCID: PMC12358108.

Pelvic lower-limb

1. G. Bosco, R. E. Poppele. Proprioception From a Spinocerebellar Perspective. *Department of Neuroscience, University of Minnesota, Minneapolis, Minnesota Physiological Reviews* Vol. 81, No. 2, April 2001, Printed in U.S.A.
2. Park BS, Verdisco J, Kimball M, Zuhair A, Edeer AO. Effectiveness of proprioceptive neuromuscular facilitation exercise with virtual reality motion capture gaming system and concurrent feedback on early shoulder muscle activation in healthy individuals. *J Exerc Rehabil*. 2025 Feb 28;21(1):16-24.
3. Moté Barboza P J, Mansueto Gomes Neto, Bruno Corrente Tanaca, Maycon Douglas Alves de Oliveira, Robson Cassefo, Daniella A. de Oliveira, Carsten Schaefer, Paulo Roberto Garcia Lucareli, Acute contralateral lower-limb muscle activation induced by PNF patterns: an sEMG comparison of contraction modes, *Journal of Bodywork and Movement Therapies*, Volume 48,2026:847-857, ISSN 1360-8592, <https://doi.org/10.1016/j.jbmt.2026.07.050>.

Trunk

Irradiation

1. Arai M, ea: Effects of the use of cross-education to the affected side through various resistive exercises of the sound side and settings of the length of the affected muscles. *Hiroshima journal of medical science* 2001 (3):65-73
2. Shima N et al. Cross education of muscular strength during unilateral resistance training and detraining. *Eur JAppl Physiol* 2002 (86): 287–294
3. Zhou S. Cross education and neuromuscular adaptations during early stage of strength training. *Journal of exercise science and Fitness* 2003 (1) 54-60
4. Munn J, Herbert RD, Gandevia SC. Contralateral effects of unilateral resistance training a meta analysis. *JAppl Physiol* 2004 (96):1861-1866
5. Carroll GTJ, Herbert RD, Munn J, Lee M. Gandavia SC. Contralateral effects of unilateral strength training. Evidence and possible mechanisms. *J Appl Physiol* 2006;101(5):1514-1522

6. Kofotolis ND, Kellis E: Cross-training effects of a Proprioceptive neuromuscular facilitation exercise programme on knee musculature. *Physical Therapy in Sport* 2007;8(3):109–116
7. Lee M, Carroll TJ. Cross Education Possible Mechanisms for the Contralateral Effects of Unilateral Resistance Training. *Sports medicine* 2007; 37 (1) 1-14
8. Lee M, Gandevia SC, Carroll TJ. Unilateral strength training increases voluntary activation of the opposite untrained limb. *Clinical Neurophysiology* 2009 (120) 802-808
9. Sato H, Maruyama H: The effects of indirect treatment of PNF. *J. Physical therapy science* 2009, 21, 189-193
10. Mastalerz A, Wozniak A, Urbaniak C, Lutoslawska G. Contralateral effects after McBiomechanics 2010, 12,(2) 1-7
11. Gontijo LB, Pererla PD, Neves CDC, Santos AP, Castro Dutra Machado D, Vale Bastos, VH. Evaluation of Strength and Irradiated Movement Pattern Resulting from Trunk Motions of the Proprioceptive Neuromuscular Facilitation. *Rehabilitation Research and Practice* Volume 2012, Article ID 281937, 6 pages doi:10.1155/2012/281937
12. Hendy AM; Spittle M; Kidgell DJ Cross education and immobilisation: mechanisms and implication for injury rehabilitation. *Journal of Science and Medicine in Sport* 2012(15) 94–101
13. Gupta S, Hamdani N and Sachdev HS, Effect of Irradiation by Proprioceptive Neuromuscular Facilitation on Lower Limb Extensor Muscle Force in Adults, *Research Article - (2015) Volume 5, Issue 4 Gupta et al., J Yoga Phys Ther* 2014, 5:2 DOI: 10.4172/2157-7595.1000192
14. Abreu R, Lopes AA, Sousa AS, Pereira S, Castro MP. Force irradiation effects during upper limb diagonal exercises on contralateral muscle activation. *J Electromyogr Kinesiology*. 2015; 25 (2):292-297
15. Reznik JE, Biros E, Bartur G. An electromyographic investigation of the pattern of overflow facilitated by manual resistive proprioceptive neuromuscular facilitation in young healthy individuals: a preliminary study. 2015 Nov;31(8):582-6
16. Barss TS, Pearcey GEB, Zehr EP. Cross-education of strength and skill: an old idea with applications in the aging nervous system *Yale Journal of Biology and Medicine* 2016;89:81-86.
17. Chiou SY, Wang RY, Liao KK, Yang YR: Facilitation of the lesioned motor cortex during tonic contraction of the unaffected limb corresponds to motor status after stroke. *JNPT*. 2016; 40: 15-21
18. Hwang YI, Park DJ. Comparison of abdominal muscle activity during abdominal drawing-in maneuver combined with irradiation variations. *J Exerc Rehabil*. 2017 Jun 30;13(3):335-339
19. Shiratani T, Arai M, Kuruma H, Masumoto K. The effects of opposite-directional static contraction of the muscles of the right upper extremity on the ipsilateral right soleus H-reflex. *J Bodyw Mov Ther*. 2017;21(3):528-533.
20. Dionisio VC, Baptista CRdJA, de Sales Rodrigues A, Sande de Souza LAP. Is it possible to stabilize the trunk using rhythmic stabilization in the upper limb? A cross-sectional study of asymptomatic individuals, *Journal of Manual & Manipulative Therapy*, 2018; 26:4, 212-217, DOI:10.1080/10669817.2018.1467994

21. Nakada CS, Meningroni PC, Ferreira ACS, Hata L, Fuzaro AC, Júnior WM, de Araujo JE. Ipsilateral proprioceptive neuromuscular facilitation patterns improve overflow and reduce foot drop in patients with demyelinating polyneuropathy. *J Exerc Rehabil.* 2018 Jun 30;14(3):503-508. doi: 10.12965/jer.1836178.089. eCollection 2018 Jun. PMID: 30018940
22. Oliveira KCR et al. Overflow using proprioceptive neuromuscular facilitation in post-stroke hemiplegics: A preliminary study. *Journal of Bodywork & Movement Therapies* 2019 (23):399-404
23. Oliveira Ferro de JK, Martins JVP, Cunha Melo Ribeiro BR, et al. oblique muscles during the execution of pelvic patterns of proprioceptive neuromuscular facilitation 2021. *Avanços em Medicina* 2021, Published online e-ISSN 2676-0347 ADOI: 10.52329/AvanMed.6
24. Marchese RR, Severo do Pinho A, Mazutti C, Rech KD, Grzebellus M, Schäfer C, et al. Proprioceptive neuromuscular facilitation induces muscle irradiation to the lower limbs – A cross-sectional study with healthy individuals. *J Bodyw Mov Ther.* 2021;27:440–6.
25. Sevgi ÖZDİNÇ1A , Halit SELÇUK1B, Demonstrating the Irridation and Reinforcement Effects of Proprioceptive Neuromusculer Facilitation Technics, *Journal of Sport and Exercise / Türk Spor ve Egzersiz Dergisi*, <http://dergipark.gov.tr/tsed>, 2022 - Volume: 24 – Issue 3 - Pages: 233-237, DOI: 10.15314/tsed.107885
26. Oliveira, Maria Carolina Isaías, et al. "Surface electromyography analysis of contralateral muscle irradiation in proprioceptive neuromuscular facilitation." *Fisioter. Mov.* 12. February 2025: e38108-e38108., DOI: 10.1590/fm.2025.38108
27. Yoon B, Park S, Oh S, You JSH. Augmented Effect of Combined Robotic Assisted Gait Training and Proprioceptive Neuromuscular Facilitation-irradiation Technique on Muscle Activation and Ankle Kinematics in Hemiparetic Gait: A Preliminary Study. *NeuroRehabilitation.* 2025 Mar;56(2):196-206. doi: 10.1177/10538135241296733. Epub 2024 Dec 19. PMID: 40260718
28. Carlos Henrique Ramos Horsczaruk, Thiago Lemos, Laura Alice Santos de Oliveira, José Vicente Martins, Electromyographic activation during motor irradiation of proprioceptive neuromuscular facilitation: a scoping review, *Rev. Bras. Neurol.* 61 (3): 32 - 39, Nov. 2025, DOI: <https://doi.org/10.46979/rbn.v61i3.67794>

Body mechanics

Timing

Summation of stimuli

1. Urbenjaphol P, Jitpanya C, Khaoropthum S. Effects of the Sensory Stimulation Program on Recovery in Unconscious Patients With Traumatic Brain Injury. *Journal of Neuroscience Nursing* 2009;41(3):10-16.
2. Da Silva LG, Lummertz CA, Lopes Pedralli M, Rigon F. Visual and verh summation enhance muscle output in young female subjects. *CEP ULBRA* 2011 436H.
3. Mahoney JR, Clara Li PC, Park MO, Verghese J, Holtzer R, Multisensory integration across the senses in young and old adults. *Brainresearch* 2011;1426; 43–53

4. Silva et al.: Verbal and visual stimulation effects on rectus femoris and biceps femoris muscles during isometric and concentric. *International Archives of Medicine* 2013 6:38.
5. Lucchesi M, Maya-Vetencourt JF, Rusciano D. Multisensory integration, brain plasticity and optogenetics in visual rehabilitation. *Front Neurol.* 2025 Jul 10;16:1590305. doi: 10.3389/fneur.2025.1590305. PMID: 40708952; PMCID: PMC12288684.

Techniques

Rhythmic Initiation

Replication

1. Magarey ME, Jones MA. Dynamic evaluation and early management of altered motor control around the shoulder complex. *Manual Therapy* 2003;8(4):195-206
2. Takasaki H, Okubo Y, Okuyama S. The Effect of Proprioceptive Neuromuscular Facilitation on Joint Position Sense: A Systematic Review. *J Sport Rehabil.* 2019 Oct 18;29(4):488-497

Combination of Isotonics

1. Lepley LK, Lepley AS, Onate JA, Grooms DR. Eccentric Exercise to Enhance Neuromuscular Control. *Sports Health.* 2017 Jul/Aug;9(4):333-340
2. Guruhan S, Kafa N, Ecemis ZB, Guzel NA. Muscle Activation Differences During Eccentric Hamstring Exercises. *Sports Health.* 2021 Mar;13(2):181-186.
3. Harper SA, Thompson BJ. Potential Benefits of a Minimal Dose Eccentric Resistance Training Paradigm to Combat Sarcopenia and Age-Related Muscle and Physical Function Deficits in Older Adults. *Front Physiol.* 2021 Nov 30;12:790034
4. Lattouf NA, Tomb R, Assi A, Maynard L, Mesure S. Eccentric training effects for patients with post-stroke hemiparesis on strength and speed gait: A randomized controlled trial. *NeuroRehabilitation.* 2021;48(4):513-522
5. Lim JY. Therapeutic potential of eccentric exercises for age-related muscle atrophy. *Integr Med Res.* 2016 Sep;5(3):176-181.
6. Harris-Love MO, Gollie JM, Keogh JWL. Eccentric Exercise: Adaptations and Applications for Health and Performance. *J Funct Morphol Kinesiol.* 2021 Nov 24;6(4):96.

Stretch through range / Stretch at beginning of range

1. Shimamoto Y, Suzuki M, Mikhailenko SV, Yasuda K, Ishiwata S. Inter-sarcomere coordination in muscle revealed through individual sarcomere response to quick stretch. *PNAS* 2009 106(29) 11954-11959
2. Reschechtko S, Pruszyński JA. Stretch reflex. *Current Biology, Elsevier* 2020; 30: R1009–R1035

Dynamic reversals

1. Gabriel DA, Basford J, An K-N. The reversal of antagonists facilitates the peak rate of tension development. *Arch Phys Med Rehab* 2001
2. Kamimura, T., Yoshikioka, K., Ito, S., & Kusakabe, T. Increased rate of force development of elbow flexors by antagonist conditioning contraction. *Human Movement Science* 2009;28(4): 407-414.

Stabilizing reversals / Rhythmic stabilization

1. Kim JJ, Park SY Immediate effects of the trunk stabilizing exercise on static balance parameters in double-leg and one-leg stances. *J. Phys. Ther. Sci.* 2016;28:1673–75
2. Desai RR, Steven VJ, Joshi RM, et al. Proprioceptive Neuromuscular Facilitation Techniques versus Closed Kinematic Chain Exercises in Scapular Dyskinesia among Hospital Housekeeping Staff: An Experimental Study. *Journal of clinical and diagnostic research*, 2021, 15(11)
3. Kim B, Lohman E, Yim J. Effects of stabilizing reversal technique and vestibular rehabilitation exercise on dizziness and balance ability in patients with vestibular neuritis: An observational study. *Medicine* 2022;101:4
4. Lamp JDS, Beraldo LM, Vieira Dos Santos W, Giacometti da Silva L, Cadore EL, Pietta-Dias C. Acute effects of different proprioceptive neuromuscular facilitation on the balance of elderly women. *J Bodyw Mov Ther.* 2023 Jul;35:342-347
5. Muthusamy, R. Physiotherapy Intervention Following Excision of Brainstem Cavernoma. *Indian Journal of Natural Sciences* 2025, June, Vol.16, Issue 90

Hold – Relax / Contract – Relax

1. Moore MA, Kulkulka CG: Depression of Hoffmann reflexes following voluntary contraction and implications for proprioceptive neuromuscular facilitation therapy. *Physical Therapy* 1991;71(4):321-329; discussion 329-33.
2. Surburg PR, Schrader JW. Proprioceptive Neuromuscular Facilitation techniques in Sports Medicine. A re assessment. *Journal of Athletic Training* 1997;32 (1) 34-39
3. Carter AM, Kinzey SJ, Chitwood LF, Cole JL: PNF decreases muscle activity during the stretch reflex in selected posterior thigh muscles. *Journal of sport rehabilitation* 2000 (9) 269-278
4. Church JB, Wiggins MS, Moode FM, Crist R: Effect of warm-up and flexibility treatments on vertical jump performance *Jo. Strenght cond. Research* 2001;15(3):332-336
5. Ferber R, Gravelle DC, Osternig LR. Effect of PNF stretch techniques on trained and untrained older adults. *Journal of aging and physical activity* 2002;10(2) 132-142
6. Ferber R, Osternig LR, Gravelle DC: Effect of PNF stretch techniques on knee flexor muscle EMG activity in older adults. *Journal of electromyography and kinesiology* 2002;12(5):391-397
7. Funk DC, Swank AM, Mikla BM, Fagan TA, Farr BK: Impact of prior exercise on hamstring flexibility: a comparison of proprioceptive neuromuscular facilitation and static stretching. *Journal of strength and conditioning research* 2003;17(3):489-492
8. Godges JJ, Matsen-Bell M, Thorpe D, Shah D: The immediate effects of soft tissue mobilization with proprioceptive neuromuscular facilitation on glenohumeral external rotation and overhead reach. *Journal of orthopedics sports and Physical Therapy* 2003;33(12):713-718

9. Rowlands AV, Marginson VF, Lee J: Chronic flexibility gains: effect of isometric contraction duration during proprioceptive neuromuscular facilitation stretching techniques. *Research Quarterly Exercise and sports* 2003;74(1):47-51.
10. Youdas JW, Haefflinger KM, Kreun MK, Holloway AM, Kramer CM, Hollman JH: The efficacy of two modified PNF stretching techniques in subjects with reduced hamstring muscle length. *Physiotherapy Theory and Practice* 2010; 26(4): 240-250
11. Bonnar BP, Deivert RG, Gould TE: The relationship between isometric contraction durations during hold-relax stretching and improvement of hamstring flexibility. *Journal sports medicine and physical fitness* 2004 (3) 258-261
12. Chalmers G: Re-examination of the possible role of Golgi tendon organ and muscle spindle reflexes in proprioceptive neuromuscular facilitation muscle stretching. *Sports biomechanics* 2004;3(1):159-183
13. Weerapong P, Hume PA, Kolt GS: Stretching: mechanisms and benefits for sport performance and injury prevention. *Physical Therapy Reviews* 2004;9(4):189-206
14. Wenos DL, Konin JG: Controlled warm-up intensity enhances hip range of motion. *Journal of strength and conditioning research* 2004;18(3):529-533
15. Feland JB, Marin HN: Effect of sub maximal contraction intensity in contract-relax proprioceptive neuromuscular facilitation stretching. *British journal of sports medicine* 2004;38(4)e18
16. Schuback B, Hooper J, Salisbury L: A comparison of a self stretch incorporating PNF components and a therapist applied PNF technique on hamstring flexibility. *Physiotherapy* 2004;90(3):151-157
17. Davis DS, Ashby PE, Mc Cale KL, Mc Quain JA, Wine JM: The effectiveness of 3 stretching techniques on hamstring flexibility using consistent stretching parameters. *Journal of strength and conditioning research* 2005;19(1):27-32
18. Marek SM et al: Acute effects of static and PNF stretching on muscle strength and power output. *Journal of athletic training* 2005;40(2):94-103
19. Deccicco PV, Fisher FM: The effects of proprioceptive neuromuscular facilitation stretching on shoulder range of motion in overhand athletes. *Journal of sports medicine and physical fitness* 2005;45(2):183-187.
20. Olivo SA, Magee DJ: Electromyographic assessment of the activity of the masticatory using the agonist contract – antagonist relax technique (AC) and contract – relax technique (CR). *Manual therapy* 2006;11(2):136-145
21. Sharman MJ, Cresswell AG, Riek S: Proprioceptive Neuromuscular Facilitation Stretching, mechanisms and clinical implications. *Sports Med* 2006;36(11):929-939
22. Bradley PS, Olsen PD, Portas MD: The effect of static, ballistic and PNF stretching on vertical jump performance *Journal of strength and conditioning research* 2007;21(1): 223-226
23. Mahieu NN, Cools A, De Wilde , Boon M, Witvrouw E: Effect of PNF stretching on the plantar flexor muscle-tendon tissue properties. *Scandinavian journal of medicine & science in sports* 2009 (19) 4,553-560
24. Youdas JW, Haefflinger KM, Kreun MK, Holloway AM, Kramer CM, Hollman JH: The efficacy of two modified PNF stretching techniques in subjects with reduced hamstring muscle length. *Physiotherapy Theory and Practice* 2010; 26(4): 240-250
25. Azevedo DC, Melo RM, Alves Corea RV, Chalmers G. Uninvolved versus target muscle contraction during contract-relax proprioceptive neuromuscular facilitation stretching. *Physical Therapy in Sport* 2011;12:117- 121
26. O'Hora J, Cartwright A, Wade CD, Hough AD, Shum GLK: Efficacy of static stretching and PNF stretch on hamstrings length after a single session. *Journal of Strength and Conditioning Research* 2011;25 (6) 1586-91

27. Hindle KB, Whitcomb TJ, Briggs WO, Hong J. Proprioceptive Neuromuscular Facilitation (PNF): Its Mechanisms and Effects on Range of Motion and Muscular Function. *Journal of Human Kinetics* 2012;31(1):105-113
28. Kwak DH, Ryu YU. Applying proprioceptive neuromuscular facilitation stretching: optimal contraction intensity to attain the maximum increase in range of motion in young males. *J Phys Ther Sci.* 2015;27(7):2129-32
29. Akbulut, T and Agopyan, A. Effects of an Eight-Week Proprioceptive Neuromuscular Facilitation Stretching Program on Kicking Speed and Range of Motion in Young Male Soccer Players. *J Strength Cond Res* 2015; 29(12):3412–23.
30. Behm DG, et al. Acute effects of muscle stretching on physical performance, range of motion, and injury incidence in healthy active individuals: a systematic review. *Appl Physiol Nutr Metab.* 2016;41(1):1-11
31. Konrad A, Stafilidis S, Tilp M. Effects of acute static, ballistic, and PNF stretching exercise on the muscle and tendon tissue properties. *Scand J Med Sci Sports* 2016 doi: 10.1111/sms.12725
32. Kay AD, Dods S, Blazeovich AJ. Acute effects of contract-relax (CR) stretch versus a modified CR technique. *Eur J Appl Physiol.* 2016 Mar;116(3):611-21.
33. Medeiros DM, Martini TF. Chronic effect of different types of stretching on ankle dorsiflexion range of motion: Systematic review and meta-analysis. *Foot (Edinb).* 2017;34:28-35.
34. Borges MO, Medeiros DM, Minoto BB: Comparison between static stretching and proprioceptive neuromuscular facilitation on hamstring flexibility: systematic review and meta-analysis. *European journal of physiotherapy* 2018; 20(1): 12-19, doi.org/10.1080/21679169.2017.1347708
35. Lempke L, Wilkinson R, Murray C, Stanek J. The Effectiveness of PNF Versus Static Stretching on Increasing Hip-Flexion Range of Motion. *Journal of Sport Rehabilitation*, 2018; 27:289-294
36. Lim W. Optimal intensity of PNF stretching: maintaining the efficacy of stretching while ensuring its safety. *J. Phys. Ther. Sci.* 2018; 30: 1108–1111
37. Wanderley D, Lemos E, Moretti E et al. Efficacy of proprioceptive neuromuscular facilitation compared to other stretching modalities in range of motion gain in young healthy adults: A systematic review, *Physiotherapy Theory and Practice* 2018;35(2):109-129
38. Cayco CS, Labro AV, Gorgon EJR. Hold-relax and contract-relax stretching for hamstrings flexibility, a systematic review with meta-analysis. *Physical Therapy in Sport* 2019;35:42-55
39. Humberto Miranda, Fabio H. de Freitas, Aline A. de Oliveira. Effect of Different Numbers of Interset Antagonist Proprioceptive Neuromuscular Facilitation Stretching on the Total Number of Repetitions for the Agonists. *Int J Exerc Sci* 15(4): 498-506, 2022
40. Pérez-Bellmunt A, Casasayas-Cos O, Ragazzi P, Rodríguez-Sanz J, Hidalgo-García C, Canet-Vintró M, Caballero-Martínez I, Pacheco L, López-de-Celis C. Foam Rolling vs. Proprioceptive Neuromuscular Facilitation Stretching in the Hamstring Flexibility of Amateur Athletes: Control Trials. *Int J Environ Res Public Health.* 2023 Jan 12;20(2):1439, doi: 10.3390/ijerph20021439
41. Zaidi S, Ahamad A, Fatima A, Ahmad I, Malhotra D, Al Muslem WH, Abdulaziz S, Nuhmani S. Immediate and Long-Term Effectiveness of Proprioceptive Neuromuscular Facilitation and Static Stretching on Joint Range of Motion, Flexibility, and Electromyographic Activity of Knee Muscles in Older Adults. *J Clin Med.* 2023 Mar 30;12(7):2610

42. Konrad A, Alizadeh S, Daneshjoo A et al. Chronic effects of stretching on range of motion with consideration of potential moderating variables: A systematic review with meta-analysis. *J Sport Health Sci.* 2023 Jun 8:S2095-2546(23)00057-1.
43. George, J., Maqsood, M., Ahmed, H. S., & Muhammad, A. S. The Efficacy of Proprioceptive Neuromuscular Facilitation Techniques in Improving Range of Motion and Strength: A Systematic Review. *EEJPH*, 2025, 26, 996-1002.
44. Carolina Jiménez-Sánchez, Rocío Fortún-Rabadán, Beatriz Carpallo-Porcar, Paula Cordova-Alegre, Luis Espejo-Antúnez, María Ortiz-Lucas, Effectiveness of Electrical Muscle Elongation and Proprioceptive Neuromuscular Facilitation Programs on Muscle Flexibility and Stiffness in Young Adults with Functional Hamstring Disorder: A Randomized Clinical Trial with 4-Week Follow-Up *Life* 22. March 2025, 15(4), 523; <https://doi.org/10.3390/life15040523>
45. P. Shanmukha Priya, N. Siva Harish, M.N. Magesh, To find the effectiveness of foamrolling along with dynamic Stretching vs Hold and relax PNF technique on tight hamstring muscle in young adults, July 2025 *International Journal of Physical Education & Sports Sciences* 20(2):5-16 DOI:10.29070/83trwm98
46. Andrés Forján-Barcia, Pablo Hernandez-Lucas, Lorenzo A Justo-Cousiño, Immediate Effects of Abdominal Hypopressive Technique Versus PNF Stretching in Shortened Hamstring Syndrome: A Pilot Randomized Controlled Trial, *Physiother Res Int.* 2025 Dec 22;31(1):e70155. doi: 10.1002/pri.70155, PMID: PMC12723337 PMID: 41431280
47. Tai WH, Chen YR, Li PA, Lin JZ, Lai BK, Yu HB. Acute neuromechanical effects of static and PNF hamstring stretching on explosive power and balance. *Front Physiol.* 2026 Mar 10;17:1751808. doi: 10.3389/fphys.2026.1751808. PMID: 41884266; PMID: PMC13008731

Mat Activities

Transfers and mat progression: General

1. Klein DA, Stone WJ, ea. PNF training and physical function in assisted living older adults. *Journal of aging and physical activity* 2002 (10) 476-488
2. Ekstrom RA, Donatelli RA, Carp KC. Electromyographic analysis of core trunk, hip, and thigh muscles during 9 rehabilitation exercises. *J Orthop Sports Phys Ther.* 2007 Dec;37(12):754-62
3. Okubo Y, Kaneoka K, Imai A, Shiina I, Tatsumura M, Izumi S, Miyakawa S. Electromyographic analysis of transversus abdominis and lumbar multifidus using wire electrodes during lumbar stabilization exercises. *J Orthop Sports Phys Ther.* 2010 Nov;40(11):743-50
4. Wong YH, Cheung KW, KoYC, Tse HC, Law YL, Hwang SS, Ngai PC. Effect of a 4-week Theraband Exercise with PNF Pattern on Improving Mobility, Balance and Fear of Fall in Community-Dwelling Elderly. *J Korean Soc Phys Med*, 2017; 12(4): 73-82
5. Szafranec R, Chromik K, Poborska A, Kawczyński A. Acute effects of contract-relax proprioceptive neuromuscular facilitation stretching of hip abductors and adductors on dynamic balance. *PeerJ*;2018:1–12

Transfers and mat progression: Rolling

1. Richter RR, VanSant AF, Newton RA: Description of Adult Rolling Movements and Hypothesis of Developmental Sequences Physical Therapy 1989; 69:63-71
2. Santos de Britto VL, Correa R, Vincent MB: Proprioceptive neuromuscular facilitation in HTLV – I – associated myelopathy/tropical spastic paraparesis. Rev Soc Bras Med Trop. 2014; 47(1): 24-29
3. Hoogenboom BJ, Voight ML. Rolling revisited: using rolling to assess and treat neuromuscular control and coordination of the core and extremities of athletes. Int J Sports Phys Ther. 2015 Nov;10(6):787-802.
4. Baik SM, Cynn HS, Shim JH, Lee JH, Shin AR, Lee KE. Effects of Log-Rolling Position on Hip-Abductor Muscle Activation During Side-Lying Hip-Abduction Exercise in Participants With Gluteus Medius Weakness. J Athl Train. 2021 Sep 1;56(9):945-951

Transfers and mat progression: Bridging

1. Kang H, Jung J, Yu J. Comparison of trunk muscle activity during bridging exercises using a sling in patients with low back pain. J Sports Sci Med. 2012 Sep 1;11(3):510-52.
2. Teixeira de Carvalho F, de Andrade Mesquita LS, Pereira R, et al. Pilates and Proprioceptive Neuromuscular Facilitation Methods Induce Similar Strength Gains but Different Neuromuscular Adaptations in Elderly Women. Exp Aging Res. 2017 Oct-Dec;43(5):440-452

Transfers and mat progression: Quadruped

1. Maenhout A, Van Praet K, Pizzi L, et al Electromyographic analysis of knee push up plus variations: what is the influence of the kinetic chain on scapular muscle activity? British Journal of Sports Medicine 2010;44:1010-1015.
2. Du -J in P ark, H yun -O k L ee. The Intramuscular Activation of Scapular Stabilizing Muscles during Push-up plus and PNF Exercises in a Quadruped Position. J. Phys. Ther. Sci. Vol. 25, No. 4, 2013

Transfers and mat progression: Sit to stand

1. Barros Ribeiro Cilento M: Evaluation of the efficacy of train protocols of the sit to stand movement. Fisioterapia Brasil 2006 (6)

Gait Facilitation

Gait related with PNF facilitation

1. Reichel HS PNF: Gangschulung. Sportverletzung, sportschaden 1996 (10) A11-A20
2. Yigiter K, Sener G, Erbahceci F, BayarK, Ülger ÖG, Akodogan S: A comparison of traditional prosthetic training versus PNF resistive gait training with trans-femoral amputees. Prosthetics and orthotics international 2002 (26) 213-217

3. Mirek e, ea. Przydatnosc trójwymiarowej analizy lokomocji dla usprawniania ruchowego metoda PNF chorych na chorobe Parkinsona. *Neurol. Neurochir Pol.* 2003;37 suppl (5) 89-102
4. Caplan N, Rogers R, Parr MK, Hayes PR: The effect of PNF and static stretch training on running mechanics. *Journal of Strength and Conditioning Research* 2009;23 (4) 1175-1180
5. Lacquaniti F, Ivanenko YP, Zago M: Patterned control of human locomotion. *J Physiol.* 2012;590(10);2189–2199
6. Sahay P, et al., Efficacy of proprioceptive neuromuscular facilitation techniques versus traditional prosthetic training for improving ambulatory function in transtibial amputees, *Hong Kong Physiotherapy Journal*, 2013
7. Mirek E, et al. The effects of physiotherapy with PNF concept on gait and balance of patients with Huntington's disease - pilot study. *Neurol Neurochir Pol.* 2015;49(6):354-7
8. Anjum H, Amjad I, Malik AN. Effectiveness of PNF techniques as compared to traditional strength training in gait training among transtibial amputees. *Journal of the College of Physicians and Surgeons Pakistan* 2016, Vol. 26 (6): 503-506
9. Choughley A, Soomro N, Yamin F et al. Efficacy of Cryotherapy v/s Thermotherapy with PNF Technique in Improving Hemiplegic Gait. *Indian Journal of Physiotherapy and Occupational Therapy.* 2016;10(1):114-119
10. Jaczewska-Bogacka J, Stolarczyk A. Improvement in Gait Pattern After Knee Arthroplasty Followed by Proprioceptive Neuromuscular Facilitation Physiotherapy *Clinical and Experimental Biomedicine; Rehabilitation Science in Context* 2018: 1-9
11. Alexandre de Assis IS, Luvizutto GJ, Bruno ACM, Sande de Souza LAP. The Proprioceptive Neuromuscular Facilitation Concept in Parkinson Disease: A Systematic Review and Meta-Analysis. *J Chiropr Med* 2020;19:181–7
12. Gong W. The effects of rhythmic exercise using PNF patterns on gait variables in normal adults. *Technol Health Care.* 2024;32(S1):415-422
13. Gabada R, Jawade S, Tikhile P. Proprioceptive Neuromuscular Facilitation (PNF)-Integrated Gait Rehabilitation Following Total Hip Arthroplasty. *Cureus.* 2024 Apr 8;16(4):e57854.

Balance / postural control

1. Byeong Jin Park, Byeong Min An, Sook Kyeong Yu. The Effects of PNF Rhythmic Dance on the Change of Static Balance Ability in Young Adults. *J Int Acad Phys Ther Res* 2010; 1: 176-184
2. Muhammad Hanif , Asifa Riaz , Iqra Ikram. Effects of Core Strengthening Versus Lower Limb Proprioceptive Neuromuscular Facilitation Techniques on Trunk Function and Stability. *Riphah International University, Lahore, Pakistan*, 2023
3. Dhillon SK, Venkataraman S, Chanu AR, Handa G, Wadhwa S. A cross-sectional study to assess dual-task interference in postural control in people with lower limb amputation. *Gait Posture.* 2024 Jun 20;113:204-208.
4. Kumar S, C.M. George. Effects of Head and Neck pattern of PNF combined with conventional balance training in older adults with balance impairment–A Randomized control Trial. *Journal of Bodywork and Movement Therapies* Vol 40, Oct 2024, Pages 552-556
5. Gabriel A, Fuchs K, Haller B, Sulowska-Daszyk I. A four-week minimalist shoe walking intervention influences foot posture and balance in young adults-a randomized controlled trial. *PLoS One.* 2024 Jun 20;19(6):e0304640

6. Harjpal P, Qureshi MI, Kovala RK, Jain M. Efficacy of Bilateral Lower-Limb Training Over Unilateral Lower-Limb Training To Reeducate Balance and Walking in Post-Stroke Survivors: A Randomized Clinical Trial. *Cureus*. 2022 Oct 27;14(10):e30748
7. Dinesh M, Thenmozhi P, KalaBarathi S. Proprioceptive Neuromuscular Facilitation Neck Pattern and Trunk Specific Exercise on Trunk Control and Balance-an Experimental Study. *Int J Ther Massage Bodywork*. 2022 Dec 1;15(4):9-17.
8. Rimsha Sadiq, Sajjad Khaliq, Haider Ali, et al. The Effects of Proprioceptive Neuromuscular Facilitation in Improving Balance and Gait in Patients with Knee Osteoarthritis. *JHWCR*, 2025, 8:6

Vital functions

Respiration / Breathing

1. Nitz J, Burke B. A study of the facilitation of respiration in myotonic dystrophy. *Physiotherapy research international* 2002;7(4):228-238
2. Areas GPT, Silva AB, Lobato AN, Silva AA, Friere jr RC, Areas FZS. Effect of upper extremity proprioceptive neuromuscular facilitation combined with elastic resistance bands on respiratory muscle strength: a randomized control trial. *Braz J Phys Ther*. 2013; 17(6):541-546
3. Bujar- Misztal M, Chcialowski A. Influence of PNF on lung function in patients after coronary artery bypass graft surgery. *Adv Exp Med Biol*. 2018;3: 11–17 https://doi.org/10.1007/5584_2018_243
4. Slupska L, Halski T, Zytkeiwicz M et al. Proprioceptive Neuromuscular Facilitation for Accessory Respiratory Muscles Training in Patients After Ischemic Stroke. *Adv Exp. Medicine, Biology - Neuroscience and Respiration* 2019, PP 81-91
5. De Souza RJP, Brandão DC, Martins JV, Fernandes J, Dornelas De Andrade A. Addition of proprioceptive neuromuscular facilitation to cardiorespiratory training in patients poststroke: Study protocol for a randomized controlled trial. *Trials* 2020;21:1-9.
6. Mohamed RA, Mohamed ESH, Habshy SM, Aly SM. Impact of two different pulmonary rehabilitation methods in children with down syndrome. *J Bodyw Mov Ther* 2021;27:512–21.
7. Liu K, Yu X, Cui X, Su Y, Sun L, Yang J, et al. Effects of proprioceptive neuromuscular facilitation stretching combined with aerobic training on pulmonary function in copd patients: A randomized controlled trial. *Int J COPD* 2021;16:969–77.
8. Komal D Thorat, et al. Effectiveness of Respiratory Proprioceptive
9. Neuromuscular Facilitation Techniques on Pulmonary Functions in Patients with Spinal Cord Injury - A Pilot Study. *International Journal of Science and Healthcare Research*, Vol.6; Issue: 4; Oct.-Dec. 2021
10. Zwoliński T, Wujtewicz M, Szamotulska J, Sinoracki T, Wąż P, Hansdorfer-Korzon R, et al. Feasibility of Chest Wall and Diaphragm Proprioceptive Neuromuscular Facilitation (PNF) Techniques in Mechanically Ventilated Patients. *Int J Environ Res Public Health*. 2022;19(2).
11. Bhakaney PR, Walke RR, Kulkarni CA, Vardhan V. Immediate Effectiveness of Chest Proprioceptive Neuromuscular Facilitation (PNF) Technique on Hemodynamic Status in COVID-19 Patients: An Original Research. *Cureus*. 2022 Sep 22;14(9):e29477.

12. Naik, V., & Vernekar, S. . Effect of Respiratory Proprioceptive Neuromuscular Facilitation in Phase One Cardiac Rehabilitation – A Randomized Controlled Trial. *Nepalese Heart Journal* 2024; 21(1), 3-9
13. Zhou Q, Zhang Y, Yao W, Liang S, Feng H, Pan H. Effects of proprioceptive neuromuscular facilitation combined with threshold inspiratory muscle training on respiratory function in neurocritical patients with weaning failure: a randomized controlled trial. *Int J Rehabil Res.* 2024 Sep 1;47(3):164-168.
14. Dsilva R, Kanase S. Effect of Chest Proprioceptive Neuromuscular Facilitation on the Respiratory Status of Post-stroke Survivor: A Systematic Review. *Cureus.* 2024 Oct 16;16(10):e71594.
15. Zakaria, I., Serry, Z. M. H., Soliman, Y. M. A., Aziz, M. M., Mohamed, M. I., & Guirguis, S. A. (2025). Chest mobility exercises versus proprioceptive neuromuscular facilitation in patients with chronic obstructive pulmonary disease: A randomized trial. *Journal of Bodywork and Movement Therapies* 2025 , 44, 400-408.
16. Aktar, Burcin, et al. "Acute Effects of Proprioceptive Neuromuscular Facilitation Compared to Active Range of Motion Exercises on Respiratory and Hemodynamic Responses in Critically Ill Patients: A Pilot Study." *Journal of Basic and Clinical Health Sciences* 9.2 (2025): 327-334.
17. Sakshi Tiwari, Sumedha Rabra, Impact of neurophysiological facilitation (PNF stretch) of pectoralis major and minor muscle:a noval approach to improve pulmonary function in copd patients, April 2025 *International Journal For Multidisciplinary Research* Volume 7(Issue 2):7, IJFMR250238496, E-ISSN: 2582-2160
18. Themistocleous IC, Andreou A, Plaiti C, Hadjisavvas S, Papamichael E, Michailidou C, Efsthathiou MA, Stefanakis M. Effectiveness of respiratory proprioceptive neuromuscular facilitation techniques on pulmonary function and other health-related parameters in chronic obstructive pulmonary disease: A systematic review. *J Bodyw Mov Ther.* 2025 Dec;45:83-92. doi: 10.1016/j.jbmt.2025.08.001. Epub 2025 Aug 8. PMID: 41316657

Face and head

1. Olivo SA, Magee DJ: Electromyographic assessment of the activity of the masticatory using the agonist contract – antagonist relax technique (AC) and contract – relax technique (CR). *Manual therapy* 2006;11(2):136-145
2. Olivo SA, Magee DJ: Electromyographic activity of the masticatory and cervical muscles during resisted jaw opening movement. *Journal of oral rehabilitation* 2007;34(3):184-194
3. Namura M, Motoyoshi M, Namura Y, Shimizu N: The effect of PNF training on the facial profile. *Journal of oral science* 2008;50(1):45-51
4. Barbara M, Antonini G, Vestri A, Volpini L, Monini S. Role of Kabat physical rehabilitation in Bell's palsy: A randomized trial. *Acta Oto-Laryngologica*, 2010; 130: 167_172
5. Sardaru D, Pendefunda L. Neuro Muscular Facilitation in the re-education of functional problems in facialis paralysis. a practical approach. *Rev. Med. Chir. Soc. Med. Nat.* 2013; 117(1) 1-6
6. Kumar S, Tiwari SP, Effect Of Neuromuscular Reeducation In Bilateral Facial Palsy On Patient With GBS. *Int J Physiother Res* 2014; 2(2):449-52.

7. Kumar C, Kaur Bagga T. Comparison between Proprioceptive Neuromuscular Facilitation and Neuromuscular Re-Education for Reducing Facial Disability and Synkinesis in Patients with Bell's palsy: A Randomized Clinical Trial. *Int J Phys Med Rehabil* 2015;3:4
8. Monini S, Iacolucci CM, Di Traglia M, Lazzarino AJ, Barbara M. Role of Kabat rehabilitation in facial nerve palsy: a randomised study on severe cases of Bell's palsy *Acta Otorhinolaryngol Ital* 2016;36:282-288
9. Aranha VP, Samuel AJ, Narkeesh K. Correct the smile of a child by neuromuscular facilitation technique: An interesting case report. *Int J Health Sci (Qassim)*. 2017 Apr-Jun;11(2):83-84.
10. Kurt A, Turhan B. Physiotherapy Management of Migraine Pain: Facial Proprioceptive Neuromuscular Facilitation Technique Versus Connective Tissue Massage. *J Craniofac Surg*. 2022 Nov-Dec 01;33(8):2328-2332
11. Dominguez-Defez N, Lopez-Barreiro J, Hernandez-Lucas P, González-Castro A. Proprioceptive Neuromuscular Facilitation and/or Electrical Stimulation in Patients with Peripheral Facial Paralysis: A Systematic Review. *Neurol Int*. 2025 Jan 23;17(2):17.

Swallowing

1. Sayaca C, Serel-Arslan S, Sayaca N, Demir N, Somay G, Kaya D, et al. Is the proprioceptive neuromuscular facilitation technique superior to Shaker exercises in swallowing rehabilitation? *Eur Arch Oto-Rhino-Laryngology* 2020;277:497–504.
2. Ni B, Jin H, Wu W. Therapeutic effect of proprioceptive neuromuscular facilitation combined with muscle energy technique on post-stroke dysphagia. *Technol Health Care*. 2024;32(6):4331-4342.
3. E. N. Özcan, N. Ö. Ünlüer, M. Öztürk, and Ö. Erdur, “ Does Proprioceptive Neuromuscular Facilitation Approach Have an Effect on Swallowing Function, Muscle Morphology and Quality of Life in Dysphagic Stroke Patients? A Randomised Controlled Trial,” *Journal of Oral Rehabilitation* (2025): 1–15
4. Park JS, Kim H, Han N. Effects of Multidirectional Head Lift Exercise Based on Proprioceptive Neuromuscular Facilitation Techniques on Oropharyngeal Swallowing Muscles in Community-Dwelling Older Adults With Oral Frailty. *J Oral Rehabil*. 2025 Dec;52(12):2282-2290. doi: 10.1111/joor.70031. Epub 2025 Aug 6. PMID: 40767365; PMCID: PMC12624186.

Temporomandibular joints

1. Saleh MS, Mohamed WM, Elsayed WH, Abdelatif EEM. Proprioceptive neuromuscular facilitation stretching exercises for treatment of temporomandibular dysfunction in patients with forward head posture: A double-blinded, randomized, controlled trial. *Journal of Back and Musculoskeletal Rehabilitation*. 2024;37(5):1259-1268.
2. Yamini Umasankar, Vignesh Srinivasan, Prathap Suganthirababu, et al. Efficacy of Proprioceptive Neuromuscular Facilitation on Jaw Function in Bruxism Among Post Stroke Survivor: A Case Study. *Int Journal of Experimental Research and Review* 2024, 42, 292-297.

3. Ergezen Sahin G, Ergezen E, Akmansoy SC, Meran Caglar M, Ozkan Y. The efficacy of adding proprioceptive neuromuscular facilitation to conventional treatments for myogenous temporomandibular disorders: a randomized controlled trial. *Physiother Theory Pract.* 2026 Feb 5;1-12. doi: 10.1080/09593985.2026.2624517. Epub ahead of print. PMID: 41641718

2. Literature list directly related to PNF clinical application in specific problems

Orthopeadics related

Cervical spine

1. Epifanov VA, Shuliakovskii V V: The rehabilitative therapy of patients with osteochondrosis of the cervical spine and manifestations of hyper mobility by means of therapeutic physical exercise. *Vopr Kurortol Fizioter Lech Fiz Kult* 2000 (1):8-11.(Russian)
2. Maicki T, Trabka R, Szwarczyk W, Wilk Franzczuk M, Figura B. Analysis of therapy results in patients with cervical spine pain according to PNF concept and elements of manual therapy. *MEDSPORTPRESS*, 2012; 3(4);12, 263-273
3. Maicki T, Bilski J, Szczygiel E, Trabka R. PNF and manual therapy treatment results of patients with cervical spine osteoarthritis. *J Back Musculoskelet Rehabil.* 2017;30(5):1-7
4. Vaishnavi S, Suruliraj K, Venkatesan P. Proprioceptive Neuromuscular Facilitation in Chronic Low Back and Neck Pain and Disability: A Systematic Review and Meta-analysis. *Phys Prac and Res.* 2022; Pre press:1-16
5. Ashfaq M, Babur MN, Malick WH, Hussain MA, Awan WA. Comparative effectiveness of proprioceptive neuromuscular facilitation and passive vertebral mobilization for neck disability in patients with mechanical neck pain: A randomized controlled trial. *J Bodyw Mov Ther.* 2022 Jul;31:16-21
6. Chen Q, Wang Z, Zhang S. Exploring the latest advancements in physical therapy techniques for treating cervical spondylosis patients: A narrative review. *Biomol Biomed.* 2023 Sep 4;23(5):752-759
7. Ibrahimaj Gashi A, Kovačić T, Gashi F. The effect of proprioceptive neuromuscular facilitation technique on treating cervical radiculopathy. *Journal of Physical Education and Sport* 2023 Vol. 23 (issue 3), Art 89, pp. 722 – 729
8. Suresh V, Venkatesan P, Babu K. Effect of proprioceptive neuromuscular facilitation and cranio-cervical flexor training on pain and function in chronic mechanical neck pain: A randomized clinical trial. *Physiother Res Int.* 2024 Jan;29(1):e2058
9. Maicki T, Trąbka R, Wilk-Frańczuk M, Krzepkowska W. Proprioceptive neuromuscular facilitation therapy versus manual therapy in patients with neck pain: a randomised controlled trial. *J Rehabil Med.* 2024 Sep 5;56:jrm40002.

Lumbar spine

1. Johnson GS, Johnson VS. The application of the principles and procedures of PNF for the care of lumbar spinal instabilities. *The Journal of manual and Manipulative therapy* 2002;10(2):83-105
2. Kofotolis N, Eleftherios K: Effects of two 4-week PNF programs on muscle endurance, flexibility, and functional performance in women with CLBP. *Physical Therapy* 2006;86(7) 1001-1012
3. Franklin CVJ et al. Effectiveness of PNF Training for Chronic Low Back Pain. *Journal of Nursing and Health Science* 2013;2(4):41-52
4. Dhaliwal MK, Amandeep, Jagmohan, Manjeet. To compare the effect of PNF and core stabilizing exercises for Decreasing Pain And Improving Functions In Patients With Low Back Pain. *Journal of Sports and Physical Education* 2014;1(5): 29-35
5. Jadeja T, Vyas N, Sheth M. Effect of PNF on back muscle strength and pain and quality of life in subjects with CLBP *Int J Physiother.* 2015; 2(5): 778-785
6. Mavromoustakos S, Beneka A, Malliou V, Adamidis A, Kellis E, Kagiaoglou A. Effects of a 6-week Proprioceptive Neuromuscular Facilitation Intervention on pain and disability in individuals with chronic low back pain. *Journal of Physical Activity, Nutrition and Rehabilitation*, 2015;1(1):1-13
7. Hosseinifar M, Akbari A, Ghiasi F, Shamsoaldini N, Shahraki R. The Effects of Proprioceptive Neuromuscular Facilitation Exercises on Pain , Function , Lumbar Mobility , and Lumbar Lordosis in Patients with Non-Specific. *J Pharm Res Allied Sci* 2016;5:250–61.
8. Kim BR, Lee HJ. Effects of proprioceptive neuromuscular facilitation-based abdominal muscle strengthening training on pulmonary function, pain, and functional disability index in chronic low back pain patients. *J Exerc Rehabil.* 2017 Aug 29;13(4):486-490
9. Anggiat L, Hon WHC, Sokran SNBBM. Comparative effect of PNF and McKenzie method on pain in NSLBP among university population. *IJMAES* 2018;4(3): 475-485,
10. Areeudomwong P ,Buttagat V. Proprioceptive neuromuscular facilitation training improves pain-related and balance outcomes in working-age patients with chronic low back pain: a randomized controlled trial *Braz. J Phys Ther.* 2018
11. Smedes F, Shin S, Giacometti da Silva L Incorrect use of proprioceptive neuromuscular facilitation-techniques and principles, a response to: Proprioceptive neuromuscular facilitation training improves pain-related and balance outcomes in working-age patients with chronic low back pain: a randomized controlled trial *Braz. J Phys Ther* 2019; 23 (3):273-274
12. Areeudomwong P, Buttagat V. Comparison of core stabilisation exercise and proprioceptive neuromuscular facilitation training on pain-related and neuromuscular response outcomes for chronic low back pain: a randomized controlled trial. *Malays J Med Sci.* 2019; 26(6): 77–89.
13. Pourahmadi M, Sahebalam M, Bagheri R. Effectiveness of proprioceptive neuromuscular facilitation on pain intensity and functional disability in patients with low back pain: A systematic review and meta-analysis. *Arch Bone Jt Surg* 2020;8:479–501.
14. Zaworski K, Latosiewicz R. The effectiveness of manual therapy and proprioceptive neuromuscular facilitation compared to kinesiotherapy: a four-arm randomized controlled trial. *Eur J Phys Rehabil Med.* 2021 Apr;57(2):280-287.

15. Sipko T, Glibowski E, Kuczyński M. Acute effects of proprioceptive neuromuscular facilitation exercises on the postural strategy in patients with chronic low back pain. *Complement Ther Clin Pract* 2021;44.
16. Jeanbart K, Tanner-Bräm C. Mobilization of the neurodynamic system using proprioceptive neuromuscular facilitation decreases pain and increases mobility in lower extremities and Spine-A case report. *J Bodyw Mov Ther* 2021;27:682–91.
17. Anggiat L, Susy N, Manurung A, Wilson J, Manik H. Proprioceptive neuromuscular facilitation approach for low back pain : A review study. *International journal of sport, exercise and health research*. 2022;6(2):81–7
18. Vaishnavi S, Suruliraj K, Venkatesan P. Proprioceptive Neuromuscular Facilitation in Chronic Low Back and Neck Pain and Disability: A Systematic Review and Meta-analysis. *Phys Prac and Res*. 2022; Pre press:1-16
19. Arcanjo FL, Martins JVP, Moté P, Leporace G, Oliveira DA de, Sousa CS de, et al. Proprioceptive neuromuscular facilitation training reduces pain and disability in individuals with chronic low back pain: A systematic review and meta-analysis. *Complement Ther Clin Pract*. 2022;46 (November 2021)
20. Gao P, Tang F, Liu W, Mo Y. The effects of proprioceptive neuromuscular facilitation in treating chronic low back pain: A systematic review and meta-analysis. *J Back Musculoskelet Rehabil*. 2022;35(1):21-33
21. Rakesh Ranjan, Smriti Singh, Kumari Sandhya. Comparison of Proprioceptive Neuromuscular Facilitation with other exercises on Pain and Disability in patients with Non-specific Chronic Low Back Pain: A Meta Analysis. *Indian Journal of Physiotherapy and Occupational Therapy* Vol 17 No. 1, January-March 2023
22. Sriramulu P, Kameswaran R, Ramalingam V. Effectiveness of Proprioceptive Neuromuscular Facilitation in Gluteus Medius Activation for Low Back Pain among Tailors. *Universal Journal of Public Health* 2023, 11(5): 621-626
23. C M Pérez Castro, P G Ortiz Villalba, et al. Proprioceptive neuromuscular facilitation applied to dairy factory workers with low back pain. *Ibero-American Journal of Health Science Research*, 2024: 4(2): 2764-6165
24. Tikhile P, Patil DS, Jaiswal PR. An Integrated Approach to Chronic Low Back Pain: Evaluating the Impact of Consecutive Loop TheraBand Training Combined With Proprioceptive Neuromuscular Facilitation and Conventional Physiotherapy. *Cureus*. 2024 Apr 20;16(4):e58632.
25. Jurak I, Grabar S, Žura N, Jakuš L. Evaluating the Efficacy of Capacitive Resistive Monopolar Radiofrequency Combined With Proprioceptive Neuromuscular Facilitation in Managing Chronic Low Back Pain: A Randomised Controlled Trial. *Physiother Res Int*. 2025 Jan;30(1):e70009.

Pelvis and pelvic floor

1. Ferro JK de O, de Moura Filho AG, de Amorim KCS, Lima CRO d. P, Martins JVP, Barboza PJM, et al. Electromyographic analysis of pelvic floor muscles during the execution of pelvic patterns of proprioceptive neuromuscular facilitation-concept: An observational study. *Neurourol Urodyn*. 2022;(May):1–10

Scoliosis

1. Lee BK. Influence of the proprioceptive neuromuscular facilitation exercise programs on idiopathic scoliosis patient in the early 20s in terms of curves and balancing abilities: single case study. *Journal of exercise rehabilitation*. 2016;12(6):567-574

2. Stepien A, Fabian K, Graff K, Podgurniak M, Wit A. An immediate effect of PNF specific mobilization on the angle of trunk rotation and the TPHA range of motion in adolescent girls with double idiopathic scoliosis - a pilot study, *Scoliosis and Spinal Disorders* 2017;12:29
3. Zhang Y, Chai T, Weng H, Liu Y. Pelvic rotation correction combined with Schroth exercises for pelvic and spinal deformities in mild adolescent idiopathic scoliosis: A randomized controlled trial. *PLoS One*. 2024 Jul 30;19(7):e0307955.
4. Kaya MH, Büyükturan Ö, Büyükturan B, Alkan H, Erbahçeci F. Effects of proprioceptive neuromuscular facilitation and core stabilization on physical and functional parameters in adolescents with idiopathic scoliosis: a randomized controlled trial. *Eur Spine J*. 2026 Mar 17. doi: 10.1007/s00586-026-09868-3. Epub ahead of print. PMID: 41843057

Shoulder and scapula

1. Smedes F, Oefentherapie met het PNF concept: een zinvolle behandelstrategie. *Fysiopraxis* 2006 (6) 22-27+ internet (Exercise therapy with the PNF concept a useful therapy strategy)
2. Carlson M, Hadlock T: Physical Therapist Management following rotator cuff repair for a patient with postpolio syndrome, Case Report. *Physical Therapy* 2007;87(2):179-192
3. Nellutla M, Giri P. Comparative Study between Efficacy of PNF Movement Patterns Versus Conventional Free Exercises on Functional Activities Among Patients with Chronic Peri-Arthritis of Shoulder. *Indian Journal of Physiotherapy and Occupational Therapy*. 2011;.5(3):62-67
4. Nakra N, Quddus N, Khan S, Kumar S, Meena R. Efficacy of proprioceptive neuromuscular facilitation on shoulder function in secondary shoulder impingement. *International Journal of Therapy and Rehabilitation*. 2013;20(9):450-458
5. Kim JJ, Lee SY, Ha K. The effects of exercise using PNF in patients with a supra spinatus muscle tear. *J. Phys. Ther. Sci.* 2015;27(8):2443–6
6. Lee BK. Effects of the combined PNF and deep breathing exercises on the ROM and the VAS score of a frozen shoulder patient: Single case study. *J Exerc Rehabil*. 2015 Oct 30;11(5):276-81.
7. Balci NC, Yuruk ZO, Zeybek A, Gulsen M, Tekindal MA. Acute effect of scapular proprioceptive neuromuscular facilitation (PNF) techniques and classic exercises in adhesive capsulitis: a randomized controlled trial. *J. Phys. Ther. Sci*. 2016;28(4):1219–1227
8. Olędzka M, Jaczewska-Bogacka J. Effectiveness of Proprioceptive Neuromuscular Facilitation (PNF) in Improving Shoulder Range of Motion. A Pilot Study. *Ortop Traumatol Rehabil*. 2017;19(3):285-292
9. Oh DG, Yoo KT. The effects of therapeutic exercise using PNF on the size of calcium deposits, pain self-awareness, and shoulder joint function in a calcific tendinitis patient: a case study. *J Phys Ther Sci*. 2017 Jan;29(1):163-167
10. Jain AS, Anandh S, Pawar A. Effectiveness of proprioceptive neuromuscular facilitation as an adjunct to eccentric exercises in subacromial impingement. *Indian Journal of Physiotherapy and Occupational Therapy* 2017;11(2): 141 - 146.
11. Comel JC, Nery RM, Garcia EL, Bueno C, Silveira E, Zarantonello MM, Stefani MA. A comparative study on the recruitment of shoulder stabilizing muscles and types of exercises. *Journal of Exercise Rehabilitation* 2018;14(2):219-225

12. Tedla JS, Sangadala DR. Proprioceptive neuromuscular facilitation techniques in adhesive capsulitis: a systematic review and meta-analysis. *J Musculoskelet Neuronal Interact* 2019; 19(4):482-491
13. Peteraitis T, Smedes F. Scapula motor control training with proprioceptive neuromuscular facilitation in chronic subacromial impingement syndrome: A case report. *Journal of Bodywork & Movement Therapies* 2020;24:1–7
14. Fader L, Nyland J, Li H, Pyle B, Yoshida K, Fader L, et al. Radial nerve palsy following humeral shaft fracture : a theoretical PNF rehabilitation approach for tendon and nerve transfers. *Physiother Theory Pract* 2021;00(00):1–11
15. Hwang M, Lee S, Lim C. Effects of the proprioceptive neuromuscular facilitation technique on scapula function in office workers with scapula dyskinesis. *Med* 2021;57
16. Çelik MS, Sönmezer E, Acar M. Effectiveness of proprioceptive neuromuscular facilitation and myofascial release techniques in patients with subacromial impingement syndrome. *Somatosens Mot Res* [Internet]. 2022;0(0):1–9.
17. de Sire, A.; Moggio, L.; Marotta, N.; Fortunato, F.; Spalek, R.; Inzitari, M.T.; Paolucci, T.; Ammendolia, A. Ultrasound-Guided Injections and Proprioceptive Neuromuscular Facilitation as Shoulder Rehabilitation for Multiple Sclerosis and Neuropathic Pain. *Healthcare* 2022, 10, 1869
18. Iğrek S, Çolak TK. Comparison of the effectiveness of proprioceptive neuromuscular facilitation exercises and shoulder mobilization patients with Subacromial Impingement Syndrome: A randomized clinical trial. *J Bodyw Mov Ther.* 2022 Apr;30:42-52
19. Ping Lin, Moudan Yang, Deqing Huang. Effect of proprioceptive neuromuscular facilitation technique on the treatment of frozen shoulder: a pilot randomized controlled trial. *BMC Musculoskelet Disord.* 2022 Apr 20;23(1):367.
20. Xu ZH, An N, Wang ZR. Exercise-Induced Hypoalgesia Following Proprioceptive Neuromuscular Facilitation and Resistance Training Among Individuals With Shoulder Myofascial Pain: Randomized Controlled Trial. *JMIRx Med.* 2022 Dec 27;3(4):e40747
21. Chengyu Zhu, Xueyan Huang, Jiaying Yu, Ying Feng , Haifang Zhou. The clinical efficacy of proprioceptive neuromuscular facilitation technique in the treatment of scapulohumeral periarthritis: a systematic review and meta-analysis. *BMC Musculoskelet Disord.* 2025 Mar 24;26:288
22. Higgins M, Greer C. Proprioceptive Neuromuscular Facilitation for the Upper Extremity and Scapula: Review and Update on Rehabilitation of Shoulder Pathology. *IJSPT.* 2025;20(9):1407-1419. doi:10.26603/001c.143176

Elbow

1. Birinici T, Ozdincler AR, AltunS, Kural C. A structured exercise programme combined with proprioceptive neuromuscular facilitation stretching or static stretching in posttraumatic stiffness of the elbow: a randomized controlled trial. *Clinical Rehabilitation* 2019;33(2):241-252

Wrist and hand

1. Orsini M et al. Physical Therapy Improved Hand Function in a Patient with Traumatic Peripheral Lesion: A Case Study. *American Medical Journal* 2012;3(2): 161-168.

2. Mowafy ZME, Sharkawy AGE, Fouda BM. Proprioceptive neuromuscular facilitation and irtual reality for improving hand functions post reconstructive surgeries. Bioscience Research, 2019;16(2):1085-1093
3. Campos-Villegas C, S. Pérez-Alenda, J.J. Carrasco et al., Effectiveness of proprioceptive neuromuscular facilitation therapy and strength training among post-menopausal women with thumb carpometacarpal osteoarthritis. A randomized trial, Journal of Hand Therapy. 2022;7:26
4. Tang H, Yang P, Wang X, Zhao B, Ling K. The influence of early exercise (Proprioceptive Neuromuscular Facilitation-based muscle activation) on functional prognosis in patients with distal radius fracture: A retrospective observational study. J Hand Ther. 2026 Apr-Jun;39(2):435-443. doi: 10.1016/j.jht.2026.02.002. Epub 2026 Apr 14. PMID: 41982025
5. Eapen C, Aggarwal V, Thomas DT, Fondekar AP, Godia R. Effectiveness of proprioceptive training in patients with thumb carpometacarpal osteoarthritis: A systematic review. J Hand Ther. 2026 Apr-Jun;39(2):459-468. doi: 10.1016/j.jht.2026.02.015. Epub 2026 Apr 9. PMID: 41963167.

Hip

1. Smedes F, Komt een vrouw bij de fysiotherapeut. Case report. Fysiopraxis 2009 (1) 42-46+ internet (Comes a woman to the physiotherapist. Case report - hip replacement)
2. Morley J J, Perrault T. Chiropractic Management of Myositis Ossificans Traumatica: A Case Report Journal of the American Chiropractic Association 2012, 4, 16-24
3. Smedes F, Heidmann M, Keogh J. PNF- based Gait Rehabilitation-training after a Total Hip Arthroplasty in congenital pelvic malformation; A case report. Physiother Theory Pract 2021;00:1–10.
4. de Sire A, Marotta N, Spanó R, Fasano S, Sgro M, Lippi L, Invernizzi M, Ammendolia A. Efficacy of proprioceptive neuromuscular facilitation on functioning in patients with bilateral hip osteoarthritis: A pilot randomized controlled trial. J Back Musculoskelet Rehabil. 2024;37(2):445-457.

Knee

1. Schneider F, Laps K, Wagner S: Chronic patello femoral pain syndrome: alternatives for cases of therapy resistance. Knee surgery sports traumatology arthroscopy 2001 Sep;9(5):290-295
2. Chow TPY, Ng GYF. Active, passive and proprioceptive neuromuscular facilitation stretching are comparable in improving the knee flexion range in people with total knee replacement: a randomized controlled trial. Clinical Rehabilitation 2010; 24: 911–918
3. Moyano FR, Valenza MC, Martin L M, Caballero YC, Jimenez EG, Demet GV Effectiveness of different exercises and stretching physiotherapy on pain and movement in patellofemoral pain syndrome: a randomized controlled trial. Clinical Rehabilitation 2012 27(5):409– 417
4. Alaca N, et al. Comparison of the long-term effectiveness of progressive neuromuscular facilitation and continuous passive motion therapies after total knee arthroplasty. 2015 Nov;27(11):3377-80

5. Fetlis A, Alectoridou C, Iakovidis P, et al. Effectiveness of A PNF Based Rehabilitation Program on Balance Parameters after Total Knee Replacement. *J Phys. Educ.* 2019;6:84-90.
6. Song, Q, Shen, P, Mao, M, Sun, W, Zhang, C, Li, L. Proprioceptive neuromuscular facilitation improves pain and descending mechanics among elderly with knee osteoarthritis. *Scand J Med Sci Sports.* 2020; 30: 1655– 1663.
7. Shen P, Li L, Song Q, Sun W, Zhang C, Fong DTP, Mao D. Proprioceptive Neuromuscular Facilitation Improves Symptoms Among Older Adults With Knee Osteoarthritis During Stair Ascending: A Randomized Controlled Trial. *Am J Phys Med Rehabil.* 2022 Aug 1;101(8):753-760.
8. Maia TFLD, Tenório A da S, Martins JVP, Barros PT de, Oliveira FB de, Barboza PJM, Wanderley D, Oliveira DA de. Proprioceptive Neuromuscular Facilitation compared to usual resistance exercise therapy in individuals with knee osteoarthritis: a randomized clinical trial protocol. *RSD [Internet].* 2022;11(10):1-20.
9. Yu S, Lin L, Liang H, Lin M, Deng W, Zhan X, Fu X and Liu C (2022), Gender difference in effects of proprioceptive neuromuscular facilitation stretching on flexibility and stiffness of hamstring muscle. *Front. Physiol.* 13:918176. doi: 10.3389/fphys.2022.918176
10. Gao B, Li L, Shen P. Effects of proprioceptive neuromuscular facilitation stretching in relieving pain and balancing knee loading during stepping over obstacles among older adults with knee osteoarthritis: A randomized controlled trial. *PLoS One.* 2023 Feb 13;18(2):e0280941
11. Nafees K, Baig AAM, Ali SS, Ishaque F. Dynamic soft tissue mobilization versus proprioceptive neuromuscular facilitation in reducing hamstring muscle tightness in patients with knee osteoarthritis: a randomized control trial. *BMC Musculoskelet Disord.* 2023 Jun 2;24(1):447
12. Haijiao Wang, Hong Qian, Buqi Zhu. Clinical study on the effect of proprioceptive neuromuscular facilitation technique on postoperative proprioception and neuromuscular control in patients with anterior cruciate ligament mucoid degeneration. *Research Square* 2023. doi.org/10.21203/rs.3.rs-3318512/v1
13. Komalasari, D.R., Gazella, R.A.Z.Z. 2023. The effect of proprioceptive neuromuscular facilitation stretching exercises on pain and postural balance in patients with knee osteoarthritis. *Physical Therapy Journal of Indonesia* 4(2): 138-143.
14. Markopoulos N, Apostolou T, Kallistratos I, Lytras D, Iakovidis P. The effectiveness of proprioceptive neuromuscular facilitation in the rehabilitation of patients following total knee arthroplasty: A narrative review. *International Journal of Oncology Research.* 2024; 10(1): 192-195.
15. Nikolaos Markopoulos, Thomas Apostolou, Ilias Kallistratos, Dimitrios Lytras, Paris Iakovidis Effect of proprioceptive neuromuscular facilitation and focal vibration in older adults with osteoarthritis after total knee arthroplasty: A randomized clinical trial study PMID: 39973275, *J Back Musculoskelet Rehabil.* 2025 May;38(3):550-566. doi: 10.1177/10538127241304932. Epub 2025 Feb 12.
16. Zhang W, Zhang D, Liu J. The effect of Proprioceptive Neuromuscular Facilitation (PNF) therapy on functional recovery in patients with knee joint injury: a systematic review and meta-analysis. *BMC Musculoskelet Disord.* 2025 Dec 17;27(1):47. doi: 10.1186/s12891-025-09407-z. PMID: 41408617; PMCID: PMC12821984.

17. Hu Z, Dong J, Zeng Y, He Z, Wang Q, Luo Q. Effect of proprioceptive neuromuscular facilitation on pain and joint mobility in knee osteoarthritis: a systematic review and meta-analysis of randomized controlled trials. *PeerJ*. 2026 Jan 16;14:e20581. doi: 10.7717/peerj.20581. PMID: 41561818; PMCID: PMC12814904.

Ankle and foot

1. Rees SS, Murphy AJ, Watsford ML, McLachlan KA, Coutts AJ: Effects of PNF stretching on stiffness and force producing characteristics of the ankle in active women. *Journal of strength and conditioning research* 2007;21(2):572-577
2. Lazarou L, et al. Effects of two proprioceptive training programs on ankle range of motion, pain, functional and balance performance in individuals with ankle sprain. *J Back Musculoskelet Rehabil*. 2018;31(3):437-446.
3. Khalid A Alahmari, Paul Silvian, Irshad Ahmad, Ravi Shankar Reddy, Jaya Shanker Tedla, Venkata Nagaraj Kakaraparthi, Kanagaraj Rengaramanujam , Effectiveness of Low-Frequency Stimulation in Proprioceptive Neuromuscular Facilitation Techniques for Post Ankle Sprain Balance and Proprioception in Adults: A Randomized Controlled Trial, *Biomed Res Int*. 2020 Sep 23;2020:9012930. doi: 10.1155/2020/9012930. eCollection 2020. PMCID: PMC7532422 PMID: 33029528
4. Sasun AR, Babar T, Dadgal R. Effectiveness of Ankle Proprioceptive Neuromuscular Facilitation Techniques in Restoring the Biomechanical Integrity of the Ankle Following Plantar Fasciitis: An Experimental Study. *Cureus*. 2024 Jul 11;16(7):e64371.
5. Yin Y, Wang J, Lin Q, Luo Y, Liu Y, Sun J. Effect of proprioceptive neuromuscular facilitation on patients with chronic ankle instability: A systematic review and meta-analysis. *PLoS One*. 2025 Jan 9;20(1):e0311355.
6. Park JM, Lee KW, Yoon SY, Kim YW, Lee SC. Flexibility-enhancing Interventions for Ankle Range of Motion: A Network Meta-analysis. *Int J Sports Med*. 2026 Jun 10. doi: 10.1055/a-2876-9237. Epub ahead of print. PMID: 42134336

Amputation

Neurology related

Hemiplegia / Stroke

1. Kraft GH, Fitts SS, Hammond MC: Techniques to improve function of the arm and hand in chronic hemiplegia. *Arch. Phys. Med. Rehabilitation* 1992;73(3):220-227
2. Wang RY. The effect of proprioceptive neuromuscular facilitation in case of patients with hemiplegia of long and short duration. *Physical Therapy* 1994;74(12):25-32
3. Pasiut SA, Banach M, Longawa K, Windak F: Stroke rehabilitation conducted by PNF method, with and without the application of botulinum toxin– case reports. *Medical rehabilitation* 2005 (9) 1, 15-24

4. Wolny T, Saulicz E, Gnat R, Kokosz M. Butler's neuromobilizations combined with proprioceptive neuromuscular facilitation are effective in reducing of upper limb sensory in late-stage stroke subjects: a three-group randomized trial. *Clinical Rehabilitation* 2010;24(9):810–821
5. Brzuszkiewicz-Kuźmicka G, Kuźmicki S, Domaniecki J. Relationships between kinesiotherapy methods used in rehabilitation and the course of lost function recovery following surgical treatment of cranio-cerebral trauma. *Brain Inj.* 2012;26(12):1431-8
6. Kumar, S, Kumar A. Kaur J. Effect of PNF Technique on Gait Parameters and Functional Mobility in Hemiparetic Patients. *Journal of Exercise Science and Physiotherapy*, 2012;8(2): 67-73
7. Choi YK, Nam CW, Lee JH, Park YH. The Effects of Taping Prior to PNF Treatment on Lower Extremity Proprioception of hemiplegic Patients *J. Phys. Ther. Sci.* 2013;25(9):1119–1122
8. Khanal D, Singaravelan M, Khatri KM. Effectiveness of Pelvic Proprioceptive Neuromuscular Facilitation Technique on Facilitation of Trunk Movement in Hemiparetic Stroke Patients. *Journal of Dental and Medical Sciences* 2013;3(6):29-37
9. Ribeiro T, Britto H, Oliveira D, Silva E, Galvao E, Lindquist A. Effects of treadmill training with partial body weight support and the proprioceptive neuromuscular facilitation method on hemiparetic gait: a comparative study. *European Journal of Physical and Rehabilitation Medicine* 2013;49(4):451-61
10. Ribeiro TS, et al. Effects of training program based on the PNF method on post stroke motor recovery- a preliminary study. *Journal of Bodywork & Movement Therapies.* 2014;18(4):526-532.
11. Stephenson JB, Maitland ME, Beckstead JW, Anemeat WK. Locomotor training on a treadmill compared with PNF in chronic stroke. *Technology and Innovation*, 2014;15:325–332
12. Zhou Z, Zhou Y, Wang N, Gao F, Wei K, Wang Q. A PNF integrated robotic ankle-foot system for post stroke rehab. *Robotics and Autonomous Systems* 2015;73:111–122
13. Almeida De PM. et al. Hands-on physiotherapy interventions and stroke and ICF outcomes, a systematic review 2015 *European Journal of Physiotherapy*, 2015; 17: 100–115
14. Bhalerao G, Shah H, Bedekar N et al. Perspective of Neuro Therapeutic Approaches Preferred for Stroke Rehabilitation by Physiotherapists *Indian Journal of Physiotherapy and Occupational Therapy*.2016;10 (1):47-50
15. Hwangbo PN, Kim KD. Effects of proprioceptive neuromuscular facilitation neck pattern exercise on the ability to control the trunk and maintain balance in chronic stroke patients. *J. Phys. Ther. Sci.* 2016;28(3):850–853
16. Park Se, Oh DS, Moon SH. Effects of oculo-motor exercise, functional electrical stimulation and proprioceptive neuromuscular stimulation on visual perception of spatial neglect patients. *J. Phys. Ther. Sci.* 2016;28(4):1111–15
17. Zhou Z, Sun Y, Wang N, Gao F, Wei K, Wang Q. Robot-assisted rehabilitation of ankle plantar flexors spasticity: A 3month study with proprioceptive neuromuscular facilitation. *Front Neurorobot* 2016;10:1–14.
18. Park SI, Moon SH. Effects of trunk stability exercises using PNF with change in chair height on the gait of patients who had a stroke *J. Phys. Ther. Sci.* 2016;28(7):2014–18
19. Guia-Tula FX et al. The efficacy of the PNF approach in stroke rehab. study protocol *BMJ Open* 2017;7:1-5

20. Sharma V, Kaur J. Effect of core strengthening with pelvic proprioceptive neuromuscular facilitation on trunk, balance, gait, and function in chronic stroke. *Journal of Exercise Rehabilitation* 2017;13(2):200-205.
21. Sharma V, Kaur J. Effect of core strengthening with pelvic proprioceptive neuromuscular facilitation on trunk, balance, gait, and function in chronic stroke. *J Exerc Rehabil.* 2017 Apr 30;13(2):200-205
22. Cayco CS, Gorgon EJR, Lazaro RT. Effects of PNF facilitation on balance, strength, and mobility of an older adult with chronic stroke, a case report *Journal of Bodywork & Movement Therapies* 2017;21(4):767-774
23. Chaturvedi P, Singh AK, Kulshreshtha D, Maurya PK, Thacker AK. Proprioceptive neuromuscular facilitation (PNF) vs. task specific training in acute stroke: the effects on neuroplasticity. *MOJ Anat Physiol.* 2018;5(2):154–8
24. Cayco CS, Gorgon EJR, Lazaro RT. Proprioceptive neuromuscular facilitation to improve motor outcomes in older adults with chronic stroke. *Neurosciences* 2019;24(1):53-60
25. Smedes F, Giacometti da Silva L. Motor learning with the PNF-concept, an alternative to CIMT in a patient after stroke; a case report. *JBMT* 2019;23:622-627.
26. Apeksha Hemant Shirsath, Bhawani Rana, Kalyani Nagulkar. Effect of Proprioceptive Neuromuscular Facilitation [PNF] Technique for Knee & Ankle Muscles on Lower Limb Performance in Subacute Stroke. *International Journal of Science and Research (IJSR)* 2019: 7.583
27. Gunning E Uszynski MK. Effectiveness of the PNF method on gait parameters in patients with stroke. *Arch of Phys Med and Reh* 2019;100(5):980–986
28. de Oliveira, K.C.R., et al., Overflow using proprioceptive neuromuscular facilitation in post-stroke hemiplegics: A preliminary study, *Journal of Bodywork & Movement Therapies* 2019;23(2)399-404, <https://doi.org/10.1016/j.jbmt.2018.02.011>
29. Shim J et al. Effects of EMG-triggered FES during trunk pattern in PNF on balance and gait performance in persons with stroke. *Restorative Neurology and Neuroscience* 2020; x–xx, doi 10.3233/RNN-190944
30. Chaturvedi P et al. Post-stroke BDNF concentration changes following proprioceptive neuromuscular facilitation (PNF) exercises. *J Family Med Prim Care.* 2020 Jul; 9(7): 3361–3369
31. Alashram AR, Alghwiri AA, Padua E, Annino G. Efficacy of proprioceptive neuromuscular facilitation on spasticity in patients with stroke: a systematic review. *Phys Ther Rev [Internet].* 2021;26(3):168–76.
32. Kuciel M, Rutkowski S, Szary P, Kiper P, Rutkowska A. Effect of PNF and NDT Bobath concepts in improving trunk motor control in ischemic stroke patients – a randomized pilot study. *Rehabil Med.* 2021;25(2):4–8.
33. Li YF. Effectiveness of proprioceptive neuromuscular facilitation techniques in improving balance in post- stroke patients: a systematic review. *Brain Netw Modul* 2022; 1(1):9-12.
34. Manali A. Boob , Rakesh K. Kovala. Effectiveness of Pelvic Proprioceptive Neuromuscular Facilitation Techniques on Balance and Gait Parameters in Chronic Stroke Patients: A Randomized Clinical Trial. *Cureus.* 2022 Oct; 14(10): e30630
35. Priya1 A, Thomas A. Review of Literature on the Effect of Constraint Induced Movement Therapy along with Proprioceptive Neuromuscular Facilitation in Upper Limb Fine Motor Skills in Chronic Stroke Patients. *IJSR* (2022): 7.942

36. Tedla JS, Rodrigues E, Ferreira AS, Vicente J, Reddy RS, Gular K, Sangadala DR, Kakaraparthi VN, Asiri F, Midde AK, Dixit S. Transcranial direct current stimulation combined with trunk-targeted, proprioceptive neuromuscular facilitation in subacute stroke: a randomized controlled trial. *PeerJ*. 2022 Apr 28;10:e13329.
37. Phan The Nguyen, Li-Wei Chou, Yueh-Ling, Proprioceptive Neuromuscular Facilitation-Based Physical Therapy on the Improvement of Balance and Gait in Patients with Chronic Stroke: A Systematic Review and Meta-Analysis Hsieh Life (Basel). 2022 Jun 13;12(6):882. doi: 10.3390/life12060882, PMCID: PMC9225353 PMID: 35743913
38. Borowicz W, Ptaszkowski K, Ptaszkowska L, Rosińczuk J, Murawska-Ciałowicz E. Association Between Serum Vitamin D Levels and Physical Outcomes of Patients Who Underwent Rehabilitation Following Ischemic Stroke. *Med Sci Monit*. 2023 May 30;29:e940115
39. Zwoliński T, Gworys K, Licznarski M, Zorena K. Home Physiotherapy Using the Proprioceptive Neuromuscular Facilitation Concept in a Patient with Chronic Hemiplegia in a Rural Area: A Case Report. *J Clin Med*. 2025 Dec 17;14(24):8913. doi: 10.3390/jcm14248913

Multiple Sclerosis

1. Yucekaya, Bircan, et al. "The effect of proprioceptive neuromuscular facilitation techniques on pain, motor functions, fatigue and health related quality of life in individuals with multiple sclerosis: a randomized, single-blind study." *Neurological Research* (2025): 1-13.
2. Katirci Kirmaci Zİ, Özsoy SD, Inanç Y, Kirmaci YŞ, Adigüzel Tat H, Tuncel Berktaş D. Effects of pelvic proprioceptive neuromuscular facilitation on strength, balance and gait in patients with multiple sclerosis: A randomized controlled study. *Mult Scler Relat Disord*. 2025 Dec;104:106764. doi: 10.1016/j.msard.2025.106764. Epub 2025 Sep 18. PMID: 41038140
3. Ögüt M, Polat H, Firat YE, Ergun N. Effects of lower extremity proprioceptive neuromuscular facilitation exercises versus resistance training on gait, balance, and fatigue in patients with multiple sclerosis: A randomized controlled study. *Mult Scler Relat Disord*. 2026 May;109:107099. doi: 10.1016/j.msard.2026.107099. Epub 2026 Feb 27. PMID: 41795503

Ataxia

1. Gardas G, Mahajan A. Impact of structured physical therapy intervention on functional recovery in a patient with CAPOS syndrome: a case report. *Bulletin of Faculty of Physical Therapy* (2021) 26:8.

Parkinson

1. Mazhar T, Jameel A, Sharif F, Asghar M. Effects of conventional physical therapy with and without proprioceptive neuromuscular facilitation on balance, gait, and function in patients with Parkinson's disease. *J Pak Med Assoc*. 2023 Jun;73(6):1280-1283.

2. Jung Ho Lee. Effects of proprioceptive neuromuscular facilitation on components of functional physical activity in patients with Parkinson's disease. *Journal of medical pharmaceutical and allied sciences*, 2023, V12-I2, Pages:5768 –5774.
3. Kumar S, Mujtaba, Faruqui Z, Muhammad YA. The Role of Proprioceptive Neuromuscular Facilitation in Improving Balance in Parkinson's Disease. *Allied Med Res J*. 2024;2(2):268-276

Cerebral Palsy

1. Hatice Adiguzel, Zekiye Ipek Katirci Kirmaci, Mehmet Gogremis et al. The effect of proprioceptive neuromuscular facilitation on functional skills, muscle strength, and trunk control in children with cerebral palsy: A randomized controlled trial, *Early Human Development*, Volume 192, 2024, 106010.

Spinal Cord Injury

1. Sharma A, Saxena A. Combined effect of pelvic proprioceptive neuromuscular facilitation with core strengthening on trunk control, balance, and gait in paraplegia. *Int J App Basic Med Res* 2023;13:263-5.

Brachial plexus

1. Chagas AC de S, Wanderley D, Barboza PJM, Martins JVP, de Moraes AA, de Souza FHM, et al. Proprioceptive neuromuscular facilitation compared to conventional physiotherapy for adults with traumatic upper brachial plexus injury: A protocol for a randomized clinical trial. *Physiother Res Int* 2021;26:1–9
2. Deodhe NP, Dhage P, Harjpal P. Functional Electrical Stimulation in Conjunction With Proprioceptive Neuromuscular Facilitation (PNF) Technique to Improve Upper Limb Function in Traumatic Brachial Plexus Injury: A Case Report. *Cureus*. 2023 Oct 2;15(10):e46386

Oncology

1. Hwang WT, Chung SH, Chung MS, Lee KH, Kim T. Effect of proprioceptive neuromuscular facilitation D2 flexion and breathing exercises on lymphedema without a short stretch compression bandage. *J Phys Ther Sci*. 2015 Oct;27(10):3341-3.
2. Ha KJ, Lee SY, Lee H, Choi SJ. Synergistic Effects of Proprioceptive Neuromuscular Facilitation and Manual Lymphatic Drainage in Patients with Mastectomy-Related Lymphedema. *Front Physiol*. 2017 Nov 28;8:959.
3. Pyszora A, Budzinsky J, Wojcik A, Prokop A, Krajnik M. Physiotherapy programme (PNF) reduces fatigue in patients with advanced cancer receiving palliative care RCT. *Support Care Cancer* 2017;25:2899–2908
4. Da Silveira DSP, Dos Santos MJ, da Silva ET, Sarri AJ, das Neves LMS, Guirro ECO. Proprioceptive neuromuscular facilitation in the functionality and lymphatic circulation of the upper limb of women undergoing breast cancer treatment. *Clin Biomech (Bristol, Avon)*. 2020 Dec;80:105158.

5. Guloglu S, Basim P, Algun ZC. Efficacy of proprioceptive neuromuscular facilitation in improving shoulder biomechanical parameters, functionality, and pain after axillary lymph node dissection for breast cancer: A randomized controlled study. *Complement Ther Clin Pract*. 2023 Feb;50:101692
6. Aherrao S, Lalwani L. Integral Role of Chest Physiotherapy and Proprioceptive Neuromuscular Facilitation in Improving the Oxygenation Index and Quality of Life of Patients With Squamous Cell Carcinoma: A Case Report. *Cureus*. 2025 Jan 26;17(1):e78009.

Cardiology

1. Cornelius WL, Jensen RL, Odell ME: Effects of PNF stretching phases on acute arterial blood pressure. *Can. Jo. Appl Physiology* 1995;20(2):222-229

Haemofilia

1. Luterek M, Baranowski M, Zakiewicz W, Biel A, Pedizisz P: PNF based rehabilitation in patients with severe haemophilic arthropathy-case study. *Ortopedia traumatologia rehabilitacja* 2009 (11) 3, (6) 280-289

Rheumatology

1. Torres-Quiles, José-María, Rubén Cuesta-Barriuso, et al. "Efficacy of Myofascial Techniques and Proprioceptive Neuromuscular Facilitation in the Treatment of Patients with Systemic Lupus Erythematosus—Randomized Crossover Clinical Study." *Healthcare*. Vol. 13. No. 13. MDPI, 2025.

Sport

1. Sos-Tirado M, Campo-Manzanares A, Aguado-Oregui L, Cerdá-Calatayud C, Guardiola-Ruiz JC, García-Lucas C, Montañez-Aguilera FJ, Lisón JF, Amer-Cuenca JJ. Short Term Effects of Proprioceptive Neuromuscular Facilitation Combined with Neuromuscular Electrical Stimulation in Youth Basketball Players: A Randomized Controlled Trial. *J Funct Morphol Kinesiol*. 2024 Dec 20;9(4):280.