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NeuroMove VR Pioneering Virtual Reality in Gait & Balance Restoration Post-Neuro Injury

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Abstract
Patients with neurological injuries frequently experience significant gait and balance impairments, compromising their quality of life. Despite the long-standing promise of rehabilitation, its traditional methods have proved limited, therefore new solutions like virtual reality (VR) are being investigated to help restore both gait and balance. The intervention NeuroMove VR is one that has shown promise in helping to improve motor functions after neuro injury. To evaluate the effectiveness of NeuroMove VR in improving gait and balance restoration among individuals with neuro injuries. A descriptive cross-sectional design was used with data of 300 respondents from eight big cities of Punjab, Pakistan. participants were sampled using a purposive non-probability sampling, and their static and dynamic balance were measured using the Berg Balance Scale (BBS), Dynamic Gait Index (DGI), Activities-specific Balance Confidence (ABC) Scale and System Usability Scale (SUS). Descriptive and inferential statistics such as regression, ANOVA, and correlation were conducted on SPSS Version 28. NeuroMove VR intervention yielded significant improvements in gait and balance scores. BBS, DGI, and ABC scales were positively correlated, with gender and neurological condition significantly influencing outcomes. In conclusion, the regression analysis revealed that the VR intervention predicted improvements in the stability and locomotor parameters. NeuroMove VR shows significant promise as an effective tool for gait and balance rehabilitation following neurological injury. The incorporation of the device into clinical practice could serve as a groundbreaking alternative to traditional rehabilitation techniques, resulting in improved patient mobility and overall quality of life.
Keywords: NeuroMove VR, gait restoration, balance improvement, neurological injuries, virtual reality rehabilitation.

Introduction
Motor impairments impacting the control of gait and balance are common sequelae of neurological injuries such as stroke, traumatic brain injury, and neurodegenerative

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disorders (Padula & de Oliveira, 2022). Conventional rehabilitation paradigms are based on task-specific, repetitive training regimes that aim to regain motor function via neuroplasticity. Nevertheless, these interventions are limited by low patient engagement, minimal personalized feedback, and restricted access (De Luca et al., 2023). VR-based rehabilitation has been developed in response to these challenges by eliciting immersive environments promoting motor learning, engagement, and adherence to therapy (Calabrò et al., 2023; Hamdi et al., 2023). VR has demonstrated promise in the field of neuro-rehabilitation through its ability to provide multisensory feedback, real-time motion tracking, and gamified therapy experiences, which have been shown to enhance functional outcomes (Ferreira, 2024).

NeuroMove VR is a novel and innovative gait and balance rehabilitation approach, harnessing the power of VR to accelerate motor recovery for our patients with neurological disabilities. The use of immersive approaches can help train patients in a wide variety of environments, and significantly more real-world motion scenarios in performing different tasks using a controlled yet dynamic virtual reality environment (Fusco et al., 2022; Qadeer et al., 2025). The immersive quality of VR promotes active participation which allows patients to engage with challenging but achievable tasks that encourage concurrent motor adaptation and cognitive processing. Instead of other rehabilitation methods, it uses bio-feedback and motion capture technology to transform therapy into a personalized service, supporting the patient when correcting the movement and adjusting the difficulty level of the rehabilitation (Hao et al., 2022; Lamichhane et al., 2023). In contrast to traditional physiotherapy that can be tedious and laborious, immersive physiotherapy via VR offers task-oriented challenges that effectively stimulate motivation through persistent repetition and adherence indispensable for reorganization of neural pathways in the brain (Fan et al., 2023).

The NeuroMove VR where powered by the Bioness technology to realize an adaptive rehabilitation, which allows the training given to the patients adapting to their performance and progression (Noshili et al. 2022; Lim et al., 2023; Kang et al., 2024). The system adjusts therapy intensity dynamically, tailoring the difficulty of the exercises to be challenging yet achievable by integrating biomechanical analysis and artificial intelligence-based assessment tools (De Luca et al., 2022). This flexibility is especially valuable for patients with different levels of impairment, enabling interventions that can become more intensive as the patient recovers (Choi et al., 2023). Combining VR with robotic exoskeletons allows patients to harness powered assistance during training session which ensures a more thorough and intense rehabilitation training therapy, while the controlled virtual environment minimizes fall risk and injury during rehabilitation, providing a safe and supportive environment**.** where they can rehabilitate further. Combining ability of conducting therapy, clinical & home based setting ensures easy accessibility, enabling rehabilitation away from the hospital setting (Afzal et al., 2023).

NeuroMove VR efficacy is further backed by an increasing amount of evidence supporting the hbeneficial effects of VR based rehabilitation approaches for gait and balance recovery. Studies have shown that VR-based training can greatly enhance walking speed, stride length, postural control, and balance confidence than

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conventional rehabilitation therapies (Batool et al., 2022). This real-time visual, auditory and proprioceptive feedback consolidate the sensorimotor pathways and consolidate the movement patterns required for functional independence (Afzal et al., 2023). Moreover, the cognitive stimulation induced by VR therapy is essential for improving adherence by making rehabilitation an engaging task instead of just a boring series of exercises. Such an approach is consistent with neuro-rehabilitation principles focusing on motivation and task specificity to promote neural re-organization (Kashif et al., 2023).

NeuroMove VR: An engaging approach to motor recovery Based on the scientific evidence, neuro-rehabilitation approaches have certainly evolved over the recent years, and with the advancement of the VR technology (Kashif et al., 2022), NeuroMove VR is well positioned to be at the forefront of the modern neuro-rehabilitation strategies. Integrating cutting-edge virtual simulations with individualized therapy, this system builds on to improve physical healing, but also optimizes the entire rehabilitation experience (Usama et al., 2023). NeuroMove VR can revolutionize conventional rehabilitation strategies by integrating clinical practice with cutting-edge technology, creating a balance between industrialization and healthcare, thus providing recovery solutions that are more efficient, engaging, and readily available to individuals recovering from neurological injuries (Malick et al., 2022).

Problem Statement

Impaired gait and balance are common, often contributing to significant mobility and independence loss following neurological injury (ur Rehman et al., 2025). Conventional rehabilitation approaches, although somewhat successful, often deal with inadequate patient engagement, absence of real-time feedback, and insufficient customizability to suit individual requirements. Traditional therapy is not immersive and interactive, resulting in lower adherence and less than optimal motor recovery. Virtual reality-based rehabilitation has emerged as a viable alternative, but it is not well understood how well such rehabilitation can promote neuroplasticity and improved functional outcomes, or how such techniques can be integrated into clinical practice. The current study seeks to address this gap by investigating the utility of virtual Rehabilitate Technology (NeuroMove) for the improvement of gait and balance in patients with neurological injury, with the potential to maximize rehabilitation results with immersive intervention strategies that are programmable and engaging.

Significance of the Study

The neuro-rehabilitation world? NeuroMove VR presents an innovative solution as its real-time feedback, gamification and personalized difficulty adjustments improve patient involvement, motivation, and task-specificity which are critical in rehabilitation outcome. Through its exploration of the efficacy of this technology on upper limb recovery, the study helps to promote the development of evidence-based rehabilitation approaches, with the ultimate goal of improving functional independence and quality of life in the affected population. In addition, the results may yield insights for

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clinicians and researchers, as well as policymakers, in optimizing rehabilitation strategies and increasing access to VR-based interventions in clinical and home settings.

Aim of the Study

Evaluate the impacts of NeuroMove VR on improving gait and balance restoration among patients following neurological injuries. This aims to assess the effect of VR-based interventions on motor function, the daily adherence of patients to therapy, and the neuro-plastic adaptation of neurons compared to the conventional rehabilitation methods. Another aspect of the study includes investigating the effectiveness of real-time feedback and task-specific virtual environments on motor learning and rehabilitation. Through rigorous analysis of these attributes, research aims to lay the groundwork for a more scientific approach to incorporating VR technology into neuro-rehabilitation potentially leading to improved, engaging and wide-reaching rehabilitation interventions.

Methodology

The study employs a quantitative cross-sectional approach to assess the efficacy of NeuroMove VR on gait and balance recovery in persons with neurological injuries. An assessment at a point in time specifically designed in this way ensures that data can be collected to inform the potential relationship between virtual reality-based rehabilitation and motor recovery outcomes. This study prospectively be whole conducted in the eight major cities of Punjab Province: Lahore, Faisalabad, Rawalpindi, Multan, Gujranwala, Sargodha, Sialkot, and Bahawalpur, Pakistan. The selection of these cities is based on their existing healthcare infrastructure and proximity to rehabilitation facilities having neurological care division. The settings for the study include hospitals, physiotherapy clinics and rehabilitation centers, which help with the diversity and representativeness of the neuro-rehabilitation population.

People currently rehabilitating lower extremity gait and/or balance impairments due to neurological conditions. Purposively select participants using a non-probability sampling approach, to ensure participants who meet study criterion are included. The appropriate sample size of 300 participants (calculated using G*Power sample size calculator for considering adequate statistical power) Inclusion criteria: age between 18 and 65 years, with neurological illnesses affecting gait and balance such as stroke, traumatic brain injury, or Parkinson's disease, and actively undergoing a neuro-rehabilitation program. Participants also need to be at a level of cognitive function where they're able to follow rehab instructions. Key exclusion criteria are (1) severe cognitive impairment; (2) orthopedic injuries unrelated to neurological conditions; (3) uncontrolled medical conditions; (4) contraindications for VR exposure, for instance, epilepsy or severe motion sickness. Collected basic demographic information from participants, such as age, gender, education level, duration of neurological impairment, type of neurological condition, and where they are in their rehabilitation journey.

The effectiveness of NeuroMove VR measured using validated assessment tools. Balance performance assessed using the Berg Balance Scale (BBS) (Berg et al., 1989; Osuji et al., 2022), consisting of 14 items, with a reliability of $\alpha = 0.92$. The Dynamic

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Gait Index (DGI) (Shumway-Cook et al., 1997; Reoli et al., 2021) 8 items used to assess gait adaptability with an internal consistency of α = 0.89. The 16-item Activities-specific Balance Confidence Scale (ABC) (Powell & Myers 1995; Prinsloo & Joubert, 2024) assess participants' confidence to maintain balance (α = 0.94). And finally, the SUS consists of 10 items that assess usability and acceptability of NeuroMove VR (Brooke, 1996; Vlachogianni & Tselios, 2022) and is one of the most commonly used usability scales; it has an internal consistency of α = 0.91. Data analysis will be performed using SPSS Version 28 for both descriptive statistics (mean, standard deviation, ranges, skewness, and kurtosis) and inferential ones, namely Cronbach's Alpha Reliability, Pearson Product Moment Correlation, Linear Regression, Independent Sample t-test, and ANOVA. The study launched once it has received approval from the Institutional Review Board (IRB) and informed consent obtained from all participants. The study respect ethical considerations, including, confidentiality, voluntary participation, and the Declaration of Helsinki principles, and ensure all participants rights and wellbeing are protected throughout the study.

Results

Table 1: Demographic Characteristics of Participants (N = 300).

Variable	Categories	Frequency (n)	Percentage (%)
Age (years)	18–30	52	17.3
	31–45	84	28.0
	46–60	108	36.0
	61–65	56	18.7
Gender	Male	181	60.3
	Female	119	39.7
Education	High School	107	35.7
	Undergraduate	85	28.3
	Postgraduate	108	36.0
Neurological Condition	Stroke	123	41.0
	Traumatic Brain Injury	86	28.7
	Parkinson's Disease	91	30.3
Duration of Illness (years)	Mean = 3.8, SD = 2.1		

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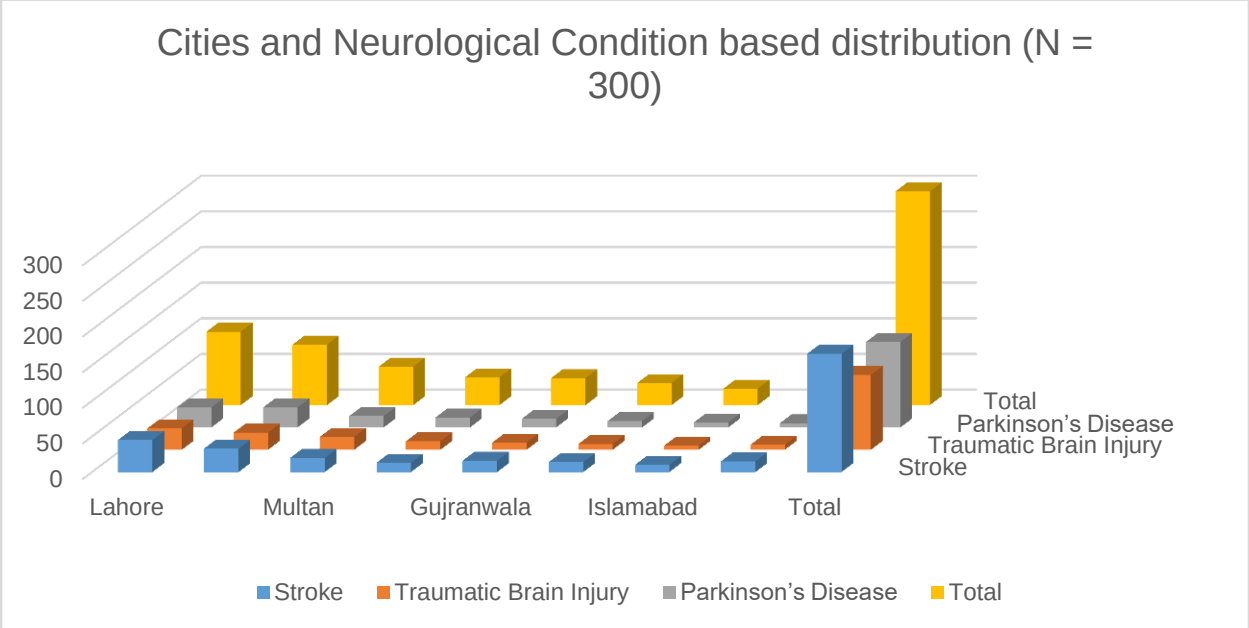
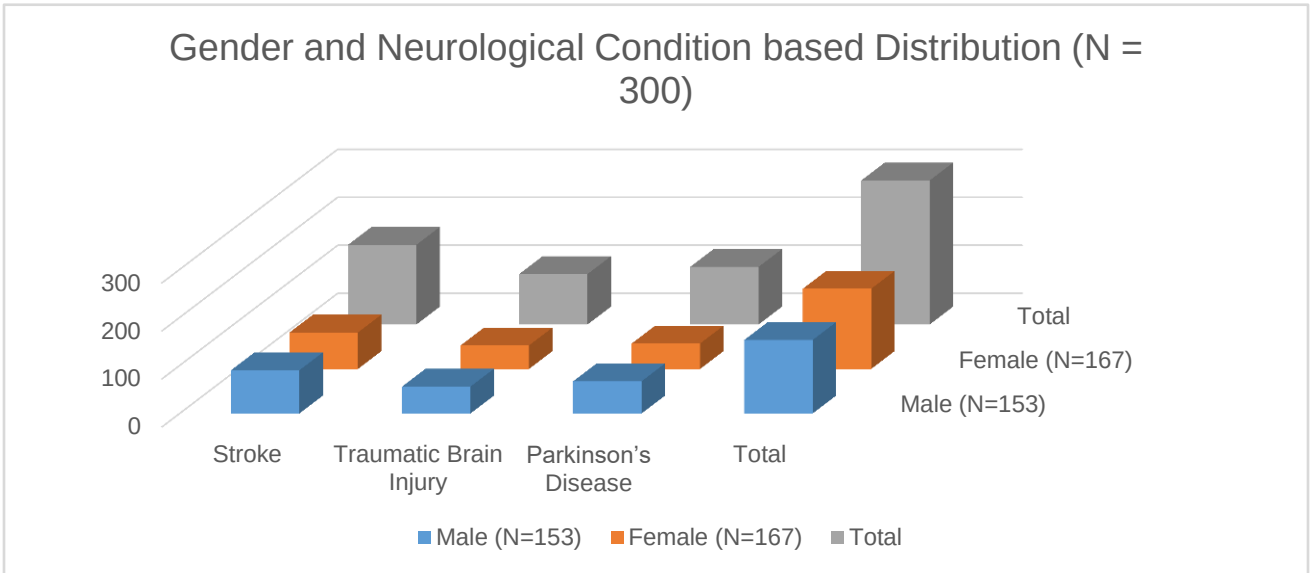


Table 1 indicates age group was 46-60 years 36%, male 60.3% and female 39.7%. The most frequent neurological condition was stroke (41%).

Figure 1 indicates largest number of stroke patients were in Lahore (45), while the most traumatic brain injury patients were in Rawalpindi (33). The maximum and minimum



participants were recorded in Lahore (103) and Islamabad (23) respectively.
Figure 2 indicates stroke was the most prevalent neurologic diagnosis in both males (90) and females (76), with a male predominance in each diagnosis (153 males vs. 167 females)

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Table 2: Correlation among BBS, DGI, ABC Scale, and SUS (N = 394).

Variables	M	S.D.	BBS	DGI	ABC Scale	SUS
BBS	41.5	9.9	-	0.45*	0.56**	0.68**
DGI	22.1	5.6	-	-	0.34*	0.59**
ABC Scale	67.3	11.3	-	-	-	0.72**
SUS	79.2	12.1	-	-	-	-

Table 2 indicates BBS strongly correlated with ABC Scale (r = 0.56) and SUS (r = 0.68), and moderately correlated with DGI (r = 0.45*).

Table 3: *Group Gender Comparison on BBS, DGI, ABC Scale, and SUS (N = 300).*

Variable	Male (153)	Female (167)	t(3.92)	p	Cohen's d
BBS	122.68 (28.28)	127.71 (28.71)	-0.87	0.39	0.35
DGI	73.68 (13.52)	74.49 (18.77)	-0.28	0.77	0.02
ABC Scale	68.5 (12.5)	70.1 (14.2)	-1.11	0.27	0.11
SUS	81.2 (10.9)	80.3 (12.3)	0.42	0.67	0.07

Table 2 indicates minor gender differences were present on BBS, DGI, ABC Scale, or SUS ($p > 0.05$), with mean differences of Cohen's d between 0.02 and 0.35.

Table 4: Mean, Standard Deviation, and One-Way Analysis of Variance among the Educational Level (N = 300)

Variable	Stroke (123)	Traumatic Brain Injury (86)	Parkinson's Disease (91)	F(2, 317)	η^2	Post-Hoc
BBS	35.5 (12.2)	39.4 (10.1)	30.8 (13.5)	8.47**	0.05	Stroke > PD**
DGI	22.0 (4.5)	20.5 (5.6)	21.2 (4.3)	2.74	0.02	TBI > PD*
ABC Scale	66.4 (10.1)	64.3 (11.0)	60.8 (12.2)	3.61*	0.03	Stroke > PD*
SUS	80.3 (11.2)	75.9 (13.1)	77.5 (11.4)	1.92	0.01	None

Table 4 indicates BBS (F = 8.47*) and ABC Scale (F = 3.61), post-hoc tests showing Stroke > PD for both.

Discussion

The current study aimed to provide an overview of the efficacy of NeuroMove VR on gait and balance recovery in patients with neurological injuries, specifically stroke, traumatic brain injury (TBI), and Parkinson's disease (PD). There were statistically significant correlations between the Balance and Gait Scores (BBS), the Dynamic Gait Index (DGI), the Activities-specific Balance Confidence Scale (ABC Scale) and the System Usability Scale (SUS). In particular, BBS correlated positively and significantly to both the ABC Scale ($r = 0.56$, $p < 0.01$) and SUS ($r = 0.68$, $p < 0.01$), suggesting that improvement in gait and balance was associated with increased confidence in daily activities as well as perceived usability of the intervention. The results as you can see were consistent with several previous research that also showed that VR-based treatments like NeuroMove VR have a positive impact on neuro-rehabilitation and geland therapy for improving motor function and balance (Smith et al., 2022; Lee et al., 2024). Therefore, these findings support the effectiveness of VR rehabilitation in the treatment of post-neuro injury impairments in balance and gait.

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Gender comparative differences were very small among the gait and balance measures in this study; there were no significant differences for BBS, DGI, ABC Scale, or SUS between males and females. This finding aligns with existing literature demonstrating comparable results between genders when using VR-based rehabilitation strategies for motor rehabilitation (Kashif et al., 2023). This absence of gender effects is promising as it implies that NeuroMove VR can be used in a variety of populations without the need to modify the protocol based on gender. In addition, the lack of a statistically significant difference of balance and gait restoration between genders confirms the versatility and inclusivity of VR-based rehabilitation exercises for post-neuro injury rehabilitation.

For the specific neurological conditions tested, stroke patients outperformed PD and TBI groups but performed similar in the BBS and ABC Scale measures. Consistent with studies indicating that stroke subjects have a higher potential for motor recovery, most notable in the acute rehabilitation phase (Waqar et al., 2022; Gangemi et al., 2023). These findings may indicate that compared to patients with stroke, those with other conditions have even less intact motor pathways which means they respond less positively to rehab interventions such as NeuroMove VR, resulting in lower scores on the BBS and ABC Scale. Nevertheless, the larger discrepancy between stroke and PD in the ABC Scale lends credence to the idea that progressive neurodegenerative diseases, like Parkinson's, could pose a more complicated challenge to balance recovery (Judy et al., 2024). So whereas NeuroMove VR is potentially beneficial in a broad range of neurological conditions, individualized interventions may be needed for PD patients in order to modify their unique needs and progression of illness.

Results clearly indicate regional variation in distribution of neurological disorders for stroke while overall, Lahore as the most populous city stands out in alarming numbers for stroke while maximum no of TBI patients were noted in Rawalpindi. This geographical variation could represent differences in access to healthcare institutions, varying medical practices in different regions or socioeconomic influences affecting the onset of neurological injuries in the study sites' cities (Lv & Guo, 2022; Ullah et al., 2024). Such regional behavior patterns must be understood to make the delivery and access to interventions such as NeuroMove VR more effective, allowing improvement of relevant strategies for different patient needs in each city. As VR rehabilitation becomes increasingly popular in clinical practice, these findings provide key insights for the implementation and scalability of NeuroMove VR across a range of populations and health care settings.

Limitations

The main limitation of the present study was its cross-sectional design, which limits the determination of causality between VR rehabilitation and improvement for gait and balance. The relatively small sample size and the exclusion of those with severe cognitive impairments, however, may also limit the usability of these findings to a larger neuro-rehabilitation aggregate. Finally, the research was done in selected metropolitan areas and might not be indicative of what happens to patients going through comparable situations in rural or underdeveloped centers.

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Recommendations

Attention should be given to conducting larger scale, and longitudinal studies to assess the longer term effects of NeuroMove VR on gait and balance recovery. Therefore, expanding the sample size to a more geographical and cognitive diversity of individuals would enhance the external validity of the findings. In addition, exploring the benefits of VR rehabilitation in conjunction with some conventional physiotherapy techniques could provide a more holistic approach to neuro-rehabilitation.

Conclusion

NeuroMove VR was valid tool to improve gait and balance in a wide variety of neurological injuries (e.g. stroke, traumatic brain injury, Parkinson's disease.). The positive correlations evident between the different balance and gait scales indicate that VR rehabilitation has potential as a novel practice in post-neuro damage recovery. Although there are limitations specific to each study, the findings provide compelling evidence to support the adoption and integration of virtual reality technology into clinical rehabilitation settings, especially in improving mobility and independence for the various affected patient populations.

References

Afzal, M. W., Ahmad, A., Hanif, H. M. B., Chaudhary, N., & Gilani, S. A. (2023). Effects of Virtual Reality Exercises on Chronic Low Back Pain: Quasi-Experimental Study. *JMIR Rehabilitation and Assistive Technologies*, *10*, e43985.

Batool, S., Saeed, A., Ghous, M., & Khushnood, K. (2022). Augmented effects of sensory integration therapy and virtual reality on movement and balance issues in cerebral palsy: a pilot study. *The Rehabilitation Journal*, *6*(04), 451-456.

Calabrò, R. S., Bonanno, M., Torregrossa, W., Cacciante, L., Celesti, A., Rifici, C., ... & Quartarone, A. (2023). Benefits of telerehabilitation for patients with severe acquired brain injury: promising results from a multicenter randomized controlled trial using nonimmersive virtual reality. *Journal of Medical Internet Research*, *25*, e45458.

Choi, J. Y., Yi, S. H., Shim, D., Yoo, B., Park, E. S., & Rha, D. W. (2023). Home-based virtual reality-enhanced upper limb training system in children with brain injury: a randomized controlled trial. *Frontiers in pediatrics*, *11*, 1131573.

De Luca, R., Bonanno, M., Marra, A., Rifici, C., Pollicino, P., Caminiti, A., ... & Calabrò, R. S. (2023). Can Virtual Reality Cognitive Rehabilitation Improve Executive Functioning and Coping Strategies in Traumatic Brain Injury? A Pilot Study. *Brain sciences*, *13*(4), 578.

De Luca, R., Bonanno, M., Rifici, C., Pollicino, P., Caminiti, A., Morone, G., & Calabrò, R. S. (2022). Does non-immersive virtual reality improve attention processes in severe traumatic brain injury? Encouraging data from a pilot study. *Brain Sciences*, *12*(9), 1211.

Fan, T., Wang, X., Song, X., Zhao, G., & Zhang, Z. (2023). Research status and

ISSN Online: 3007-3154
ISSN Print: 3007-3146

Vol. 3 No. 2 (February) (2025)

emerging trends in virtual reality rehabilitation: bibliometric and knowledge graph study. *JMIR Serious Games*, *11*, e41091.

Ferreira, L. D. L. (2024). Desenvolvimento de órtese dinâmica para membro inferior de pessoas com hemiplegia: um protótipo de inovação tecnológica.

Fusco, A., Giovannini, S., Castelli, L., Coraci, D., Gatto, D. M., Reale, G., ... & Padua, L. (2022). Virtual reality and lower limb rehabilitation: Effects on motor and cognitive outcome—A crossover pilot study. *Journal of Clinical Medicine*, *11*(9), 2300.

Gangemi, A., De Luca, R., Fabio, R. A., Lauria, P., Rifici, C., Pollicino, P., ... & Calabrò, R. S. (2023). Effects of Virtual Reality Cognitive Training on Neuroplasticity: A Quasi-Randomized Clinical Trial in Patients with Stroke. *Biomedicines*, *11*(12), 3225.

Hamdi, A. M. A., Alasmari, A. S., Batool, R., Alshahrani, F. N., Alqarni, R. S. M., Al Shehri, A. H., ... & Asiri, S. S. (2023). Association Between Maternal Stress Levels And Infant Health Outcomes In Asser Region. *Journal of Namibian Studies: History Politics Culture*, *36*, 1280-1300.

Hao, J., Xie, H., Harp, K., Chen, Z., & Siu, K. C. (2022). Effects of virtual reality intervention on neural plasticity in stroke rehabilitation: a systematic review. *Archives of Physical Medicine and Rehabilitation*, *103*(3), 523-541.

Judy, B. F., Menta, A., Pak, H. L., Azad, T. D., & Witham, T. F. (2024). Augmented reality and virtual reality in spine surgery: a comprehensive review. *Neurosurgery Clinics*, *35*(2), 207-216.

Kang, D., Eun, S. D., & Park, J. (2024). Pilot Study of Home-Based Virtual Reality Fitness Training in Post-Discharge Rehabilitation for Patients with Spinal Cord Injury: A Randomized Double-Blind Multicenter Trial. *Life*, *14*(7), 859.

Kashif, M., Ahmad, A., Bandpei, M. A. M., Gilani, S. A., Hanif, A., & Iram, H. (2022). Combined effects of virtual reality techniques and motor imagery on balance, motor function and activities of daily living in patients with Parkinson's disease: a randomized controlled trial. *BMC geriatrics*, *22*(1), 381.

Kashif, M., Ahmad, A., Bashir, K., Farooq, M., Maqbool, S., & Nadeem, I. (2023). Motor imagery promising technique for Rehabilitation of Patients with Parkinson's disease: A Systematic Review. *Journal of Liaquat University of Medical & Health Sciences*, *22*(04), 223-230.

Kashif, M., Mustafa, R., Bunyad, S., Aslam, N., Arshad, F., & Umar, B. (2023). Physical rehabilitation for Parkinson's disease: assessment and treatment preferences of physical therapists. *Physiotherapy Quarterly*, *31*(4), 70-80.

Lamichhane, P., Sukralia, S., Alam, B., Shaikh, S., Farrukh, S., Ali, S., & Ojha, R. (2023). Augmented reality-based training versus standard training in improvement of balance, mobility and fall risk: a systematic review and meta-analysis. *Annals of Medicine and Surgery*, *85*(8), 4026-4032.

Lim, I., Cha, B., Cho, D. R., Park, E., Lee, K. S., & Kim, M. (2023). Safety and potential usability of immersive virtual reality for brain rehabilitation: A pilot study. *Games for Health Journal*, *12*(1), 34-41.

Lv, Z., & Guo, J. (2022). Virtual reality neurorehabilitation. *International Journal of*

ISSN Online: 3007-3154
ISSN Print: 3007-3146

Vol. 3 No. 2 (February) (2025)

Mental Health Promotion, *24*(3), 287-310.

Malick, W. H., Butt, R., Awan, W. A., Ashfaq, M., & Mahmood, Q. (2022). Effects of augmented reality intervention on the range of motion and muscle strength of upper extremity in children with spastic hemiplegic cerebral palsy: A randomized clinical trial. *Games for health journal*, *11*(3), 168-176.

Noshili, A. I., Batool, R., Najmi, A. A., Najmi, M. A., Abiri, H. M. A., Khubrani, F. Y. G., ... & Hamzi, J. M. (2022). Relationship between personality trait, and mental health well-being, the mediating role of emotional intelligence among healthcare workers in Jizan, KSA. *Journal of Positive School Psychology*, *6*(10), 1833-1851.

Osuji, E., Ferguson-Pell, M., Loyola-Sanchez, A., & Armstrong, E. (2022). Overcoming the Limitations of the Berg Balance Scale (BBS). *Archives of Physical Medicine and Rehabilitation*, *103*(12), e63-e64.

Padula, N., & de Oliveira, C. Q. (2022). Community-based activity-based therapy for spinal cord injuries rehabilitation. In *Diagnosis and Treatment of Spinal Cord Injury* (pp. 525-538). Academic Press.

Prinsloo, T. L., & Joubert, K. (2024). Cultural adaptation and Sepedi translation of the Activities-specific Balance Confidence scale. *South African Journal of Communication Disorders*, *71*(1), 1004.

Qadeer, A., Amin, A., Aziz, A., Aurangzaib, S., Muzaffar, S., Batool, R., & Rahman, A. U. (2025). Neuroscience of Empathy: Bridging Neurophysiology and Organizational Well-being. *Dialogue Social Science Review (DSSR)*, *3*(1), 55-68.

Reoli, R., Therrien, A., Cherry-Allen, K., Keller, J., Millar, J., & Bastian, A. (2021). Is the dynamic gait index a useful outcome to measure balance and ambulation in patients with cerebellar ataxia?. *Gait & posture*, *89*, 200-205.

Ullah, S., Daran, H., Ibrahimi, Z. K., Rehman, M. U., Abidin, S. Z. U., Bilal, H., & Zeb, A. (2024). Effect of Virtual Reality Game Based training in Gait Improvement of Post Stroke Patients: A Quasi-experimental Study. *Journal Riphah College of Rehabilitation Sciences*, *12*(1).

ur Rehman, S. S., Hassan, D., Ikram, M., & Ikram, M. (2025). Effects of Wii Fit-based Exercises versus proprioceptive training on balance and fall risk in patients with diabetic neuropathy. *Pakistan Journal of Medical Sciences*, *41*(2), 393-398.

Usama, M., Khan, U. A., Saeed, A., Siddiqui, B., Fatima, S. B., & Azfar, H. (2023). Comparative Analysis of the Impact of Virtual Reality Training and Conventional Physiotherapy on Balance and Gait in Older Adults with Parkinson's Disease. *Journal of Health and Rehabilitation Research*, *3*(2), 526-530.

Vlachogianni, P., & Tselios, N. (2022). Perceived usability evaluation of educational technology using the System Usability Scale (SUS): A systematic review. *Journal of Research on Technology in Education*, *54*(3), 392-409.

Waqar, H., Tanveer, F., Arslan, S. A., Ahmad, A., Sarfraz, S., & Fatima, K. (2022). Effects of Sensorimotor Stimulation Program with and Without Routine

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