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Research Article

Mean length of utterance in words (MLUw) and lexical diversity among Urdu speaking children between 3 to 3.11 years of age

Sidra Shabbir1*, Rabia Zubair[2] , Sajeela Aatif[3], Amina Iqbal[4], Mahnoor Javed[5]

ABSTRACT

Background: Language is an excellent and convenient means of communication. Mean Length of Utterance (MLU) measures linguistic productivity in children.

Objectives: to find the mean length of utterance in words and lexical diversity among children aged 3-3.11 years typically developing Urdu-speaking.

Methods: The data of n=100 children of both genders of age between (3 to 3.11 years) who performed on blank levels 1 and 2 was collected through a cross-sectional survey. The data was collected from day-care centres and schools in Rawalpindi and Islamabad from November 2022 to June 2023. MLU calculation procedure was carried out through activities from ICW and Blank Level. For the calculation of MLU, the formula was used.

Results: The Mean Length of Utterance at word level (MLUw) of children aged between 3 to 3.11 years was 3.43. In lexical diversity (LD) children have used Nouns (NN) most abundantly as 55% of Verbs (VB) with 35% Tense Auxiliaries (TA)30%.

Conclusion: It is found that children's MLUw of 3.43 between the ages of 3 and 4 indicates an increase in speech complexity. Nouns, verbs, and tense auxiliaries have been recognized as the main elements via lexical analysis.

Keywords: diversity; language disorders; lexical marker; speech pathology.

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INTRODUCTION

Language facilitates social interaction and environmental adaptation and can be in the expressive or receptive form [1, 2]. The mean length of utterance (MLU) is used to assess expressive language as well as recognize the language deficiencies among children, individual differences in language development, and therapeutic efficacy[3-5].

The mean language of utterance at the word level is already measured in Spanish, Irish, Russian, English Southern Banto, etc. Lexical development can be evaluated by the MLUw and ranges from 3 to 5 words in 3-4-year-olds. [6-10]. MLUw typically rises as the skill of languages advances, indicating their capacity to construct increasingly difficult sentences and articulate themselves in more detail[11, 12].

Lexical diversity is a measure of how many different words a child learns and uses. Children's vocabulary develops rapidly by the age of three to four, and they may already know several hundred to more than a thousand words[13]. They may still have a somewhat narrow vocabulary, nevertheless, when compared to older children as well as adults. To communicate, they frequently rely on a core lexicon and basic phrase structures[14]. Acquisition of lexical diversity in children depends on the language and is impacted by individual input, language structure, and cultural norms as well as age. Usually, common terminology from the surrounding area is learned first[15].

A significant literature gap exists since the research on Mean Length of Utterance (MLU) and lexical variety that has been conducted so far has not specifically focused on preschoolers who speak Urdu and are between the ages of three and four. Furthermore, it has practical application for speech-language pathologists (SLPs) in evaluating language proficiency and identifying possible delays or abnormalities. Compiling normative data for MLUW and lexical variation in children speaking Urdu facilitates clinical evaluations by enabling comparisons with age-appropriate reference points.

METHODOLOGY

Cross Sectional study was conducted on n=100 typically developing children from schools and day-care centres after the approval from the research ethical committee of Riphah International University (Ref # RIPHAH/RCRS/REC Letter 01457). The sampling technique used for this research was convenient Sampling. The data was collected from day-care centres and schools in Rawalpindi and Islamabad from November 2022 to June 2023.

A total of 109 children were screened for language impairments utilizing blank levels 1 and 2 to gather data. Children, ages 3 to 3.11 years, who demonstrated satisfactory performance on blank levels 1 and 2, regardless of gender, were included in the study. The n=9 children with documented language disorders were not included in the study.

MLU calculation procedure was carried out through activities from information carrying words (ICW) and Blank Level. Demographics and utterances of the research participants were documented using age-appropriate Blank Level 1 and 2 activities. These activities were designed through noun cards, verb cards, picture description cards, object toy animals, and pretend play toys.

After obtaining consent from the site and parents of the children, audio recordings were used for recording the data. Speech sample was collected by using age-appropriate designed activities. A total of 100 utterances were collected for analysis across 2 to 3 sittings. The recorded data was transcribed for the calculation of MLU. The formula for the calculation was the Total number of words/100 utterances[16, 17]. The rule book was established through an extensive literature review between 2009 and 2023 to determine the inclusion and exclusion of utterances at the word level in Urdu. The rule book was formulated after an extensive literature review[16-20].

Data was documented and analysed in Excel software. For the mean length of utterance mean standard deviation was calculated. While for identified lexical markers frequency and percentages were mentioned.

RESULTS

The mean age of Urdu-speaking children is 3.52±0.27 years. The percentage of males is n=28 and that of females is n=72. The mean length of utterance among the participants was 3.47.0.45, which means that on average, the participants' sentences contained approximately 3.47 words.

Moreover, n=40 diverse lexical markers were used with a total frequency of 17183 from 100 utterances. The frequently used lexical markers, more than 1000 frequency, were Noun (30.41%), Verb (20.39%), Tense Auxiliaries (18.01%), Personal Demonstratives (8.90%) Personal Pronouns (8.27%), and Aspectual Auxiliaries (7.72%). All other lexical markers were not frequently used as their frequency was >1000. (Figure 1)

DISCUSSION

The present study investigated children's conversational language abilities. In a group of typically developing Urdu-speaking children in Pakistan, the mean length of utterance (MLU) and lexical diversity (D) were initially determined.

In terms of language development for children between the ages of 3 and 3.11 year, Children with this age are usually still in the early phases of learning a language[21]. With an MLU of 3.47, children in this age range develop utterances that are, on average, just slightly longer than three words[3]. So children at this age develop from single words to longer and more complicated monologues. There can be possibilities of exhibiting longer and shorter utterances than the mean due to individual differences [21]. On the other hand, an MLU of 3.47 for children aged 3-3.11 years who speak Urdu often shows a trend towards more advanced speech patterns in language development.

Research has shown that children's MLUW tends to improve as they learn more words, suggesting a developmental progression in their language abilities[22]. The increased MLU could be explained by the children's language abilities' maturation stage in addition to the linguistic richness and complexity of Urdu. To make definitive decisions about MLU variances among children of this age range across languages, more comparative studies across various language groups would be required. Scholars have observed that there is an important relationship between the breadth and diversity of a child's vocabulary and the growth in MLUW, in addition to chronological age[22-24].

Certain lexical indicators stand out as extremely common and essential for the linguistic evolution of 3- to 3.11-year-old Urdu-speaking children. For appropriate assessment and intervention in speech-language pathology/therapy, it is essential to comprehend the usual acquisition and development of lexical markers in Urdu-speaking children[25] between the ages of 3 and 4 years. Nouns are among the most easily learned words; they are used in speech regularly and describe tangible objects. By regularly categorizing objects, caregivers reinforce the child's comprehension and play a key role. Next in terms of speed of acquisition are verbs, which are important for communicating experiences and actions. Like nouns, verbs are learned through caregiver modeling and the development of storytelling abilities [26, 27].

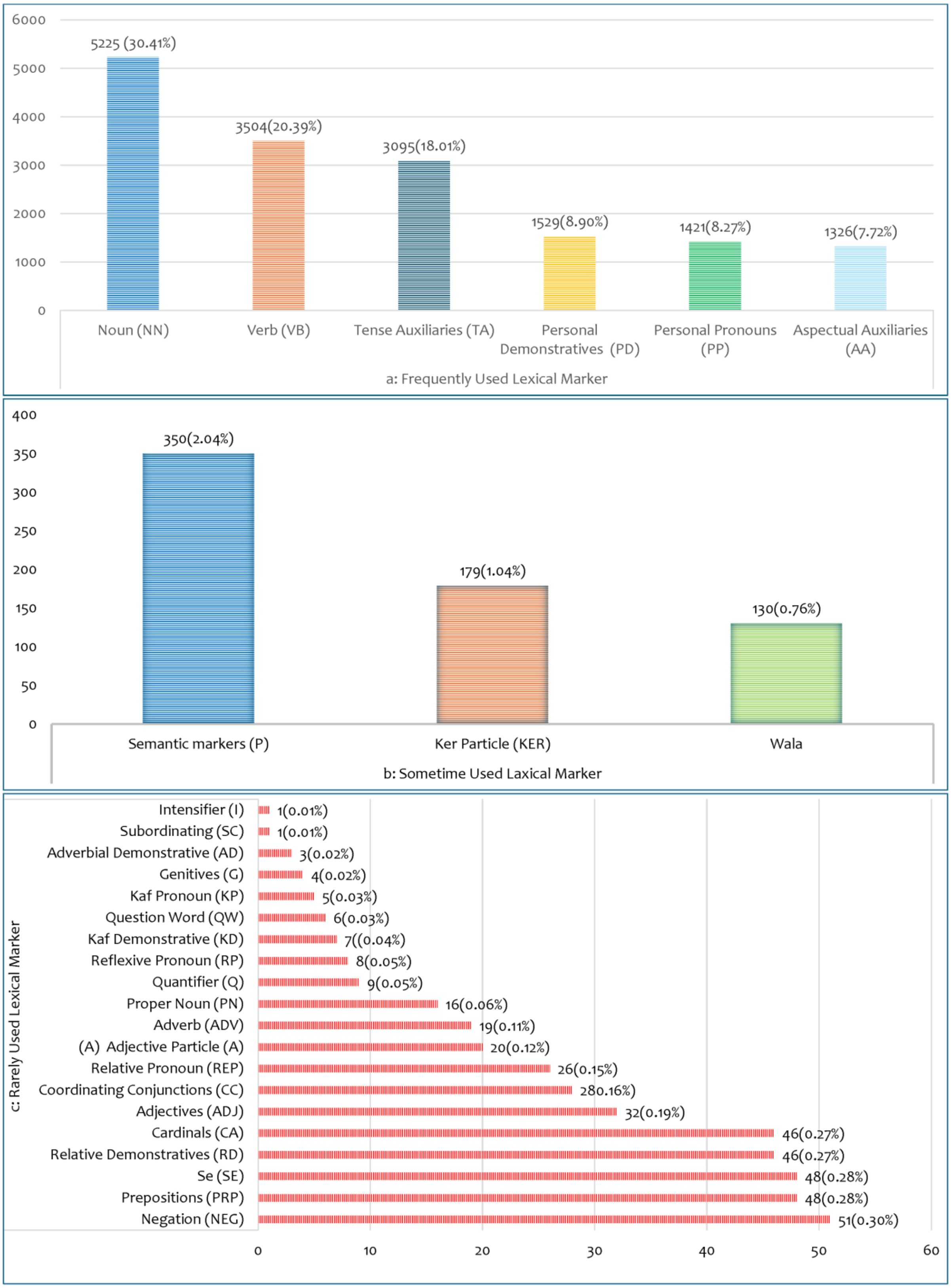

Figure 1: Lexical diversity among 3-3.11 years old children

Next, acquired tense and aspectual auxiliaries facilitate the expression of temporal linkages and are impacted by cultural storytelling traditions and cognitive development[28, 29]. Alongside other markers, personal pronouns, which are intimately associated with social interactions and personal identity, emerge, underscoring the complex process of language development[30].

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This understanding is used by speech-language pathologists (SLPs) to evaluate language competence, identify areas of strength and weakness, and create specialized intervention strategies. Understanding how social norms affect language development necessitates cultural sensitivity. Including caregivers encourages interaction and the generalization of skills. To address speech and language impairments, improve the potential for language development, and minimize long-term communication difficulties, early intervention is essential. In general, an evidence-based approach that supports language development and communication skills in early Urdu-speaking children is driven by an understanding of lexical marker development.

Grey literature was not included in the rule book. Gender differences were not calculated for the mean length of utterances at the word level. The sample size is low and from an urban setting.

CONCLUSION

The mean length of utterance among the participants was approximately 3.47 words, which showed higher language skills in 3-to 3.11-year-old old children. The study also emphasizes how crucial lexical markers such as verbs, nouns, tense and aspectual auxiliaries, and personal pronouns were to the linguistic development of 3-to 3.11-year-old Urdu-speaking children. Effective evaluation and intervention in speech-language pathology and treatment depend on an understanding of the normal acquisition and development of these markers.

DECLARATIONS & STATEMENTS

Author's Contribution

SS and RZ: substantial contributions to the conception and design of the study.
SS: acquisition of data for the study.
SS: analysis of the data for the study.
SS and RZ: interpretation of data for the study.
SS: drafted the work.
SS and RZ: revised it critically for important intellectual content.
SS and RZ: final approval of the version to be published and agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All authors contributed to the article and approved the submitted version.

Ethical Statement

The study was conducted in schools and daycare centers after the approval from the research ethical committee of Riphah International University (Ref # RIPHAH/RCRS/REC Letter 01457)

Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Conflicts of Interest

The authors declare no conflict of interest.

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The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

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Research Article

Comparative effects of backward walking training and standing balance training on balance and risk of fall among Parkinson's patients

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ABSTRACT

Background: balance and risk of falls are common problems among People with Parkinson's disease (PD) which compromise their functional independence and quality of life. Various rehabilitation protocols are being used for these patients.

Objective: To determine the effectiveness of backward walking training (BWT) and standing balance training (SBT) on balance, and risk of falls among Parkinson's patients.

Methodology: A randomized controlled trial was conducted at General Hospital Lahore from June 2020 to March 2021. The Parkinson's Patients of stage 3 or 4 of lower extremity on Brunnstrom motor recovery and the ability to walk 14 m with or without a walking aid or orthosis were included in the study. The Berg Balance Scale was used to evaluate the balance and fall risk. Group A (n=15) received backward walking training and Group B (n=15), standing balance training. The participants were assessed at the baseline, after the 6th week, and after 12 weeks of intervention.

Results: The mean age of participants was 50.03+8.36 years. A total of n=17 participants were male while 13 were female. The result showed that group A received backward walking training (BWT) had a significantly large mean difference (22.13+-2.35 vs. 18.20.3.58, 95%CI (1.64,6.22) in BSS score as compared to group B received standing balance training (SBT).

Conclusion: The study concluded that standing balance training and backward walking training both are effective, but backward walking training is more effective in improving balance and the risk of falls in Parkinson's patients.

Keywords: balance; Berg balance scale; backward walking; Parkinson's disease.

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Citation

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INTRODUCTION

Parkinson's disease is a neurodegenerative disorder, that presents with bradykinesia consisting of generalized slowing of movement[1]. Later, further progression symptoms such as resting tremor and rigidity are seen. Other symptoms include sleep problems, mood swings, increased salivation, loss of smell, and constipation. After Alzheimer's, it is the second most common neurodegenerative condition[2]. Falls are a significant issue for those with Parkinson's disease (PD). Every year, up to 68% of those with PD experience falls, with 50% experiencing several falls. Falls can result in accidents, the fear of falling, inactivity, and a lower quality of life [3].

In Parkinson's disease, gait dysfunction can be used to evaluate quality of life, fall risk, and even death. In PD, deficits in both forward and backward walking can be evaluated individually. Walking backward is a better way to spot elderly fallers than walking forwards[4]. Gait analysis in PD should incorporate extra walking tasks beyond forward walking due to the additional information offered by backward walking[5]. The first quantitative gait parameter changes during backward walking in people with PD are linked to shorter strides, lower swing percentages, and higher stance percentages[6]. Reporting the variations in certain gait metrics, such as step length or gait speed, falls short of capturing the complete complexity of gait mechanics. To clarify the relationship between different gait characteristics and walking situations, numerous factor analyses can be utilized[7].

Traditional physical therapy, which includes some balance exercises, may help PD patients with their postural control. To increase the autonomy, independence, and quality of life of these people, rehabilitation programs that demand sensorimotor dexterity and functionality with a focus on exercises involving coordination, proprioception, difficult balance tasks, gait training with speed variation, and cognitive tasks may also be most effective[8].

A randomized controlled trial reported that In comparison to controls, the standing balance training group demonstrated improved balance and decreased fall risk [9]. Another study found that walking backward improved balance more than forward walking did and that it also lowered the risk of falling. Standing balance training and backward walking both significantly improved balance and decreased the risk of falling in Parkinson's disease.[10] There was little to no difference between the therapies. The ability to walk backward suggests that gait and balance issues in PD may be addressed[11]. According to a study it has been observed that backward walking has potential benefits as a practical training alternative to enhance gait in people suffering from Parkinson's disease.). BW engages different muscle groups and sensory inputs compared to forward walking, potentially leading to improvements in gait parameters such as stride length, walking speed, and cadence [12].

Balance impairments and an increased risk of falling are common challenges faced by individuals with PD. It was hypothesized that backward walking may offer a more effective training approach than standing to address balance issues, as it requires enhanced proprioceptive awareness and balance control. By engaging in BW exercises, individuals with PD may improve their postural stability and decrease the risk of falls during challenging, multidirectional everyday tasks. So current study was conducted to compare the backward walking training and standing balance training on balance and risk of falls among Parkinson's patients.

METHODOLOGY

A randomized controlled trial was conducted at Lahore General Hospital after the approval from the Medical Superintendent and Ethical Committee (UIPT/202/487/2022) of the University Institute of Physical Therapy, The University of Lahore from June 2020 to March 2021. The approval of The Parkinson’s Patients of stage 3 or 4 of lower extremity on Brunnstrom motor recovery and the ability to walk 14 m with or without a walking aid or orthosis were included in the study. The patients with cerebellar disease, vestibular lesions, and a previous history of neurological disorder, gait disorders, or unilateral neglect were excluded from the study.

To determine the sample size moderate effect size of 0.5, a significance level of 0.05, and a power of 0.80 for our analysis. a sample size of n=28 participants was obtained in the priori analysis. The researcher recruited n=34 participants to account for potential dropouts. All participants were randomly allocated into the backward walking training group (n=17) and the standing balance training group (n=17). After the randomization process, n=34 participants, and n=15 participants in each group completed the intervention period. There was n=2 dropouts in the follow-up in each group due to deterioration in health in PD patients. A total of n=30 participants were included in the data analysis resulting in a final analyzed sample size of n=30 participants.

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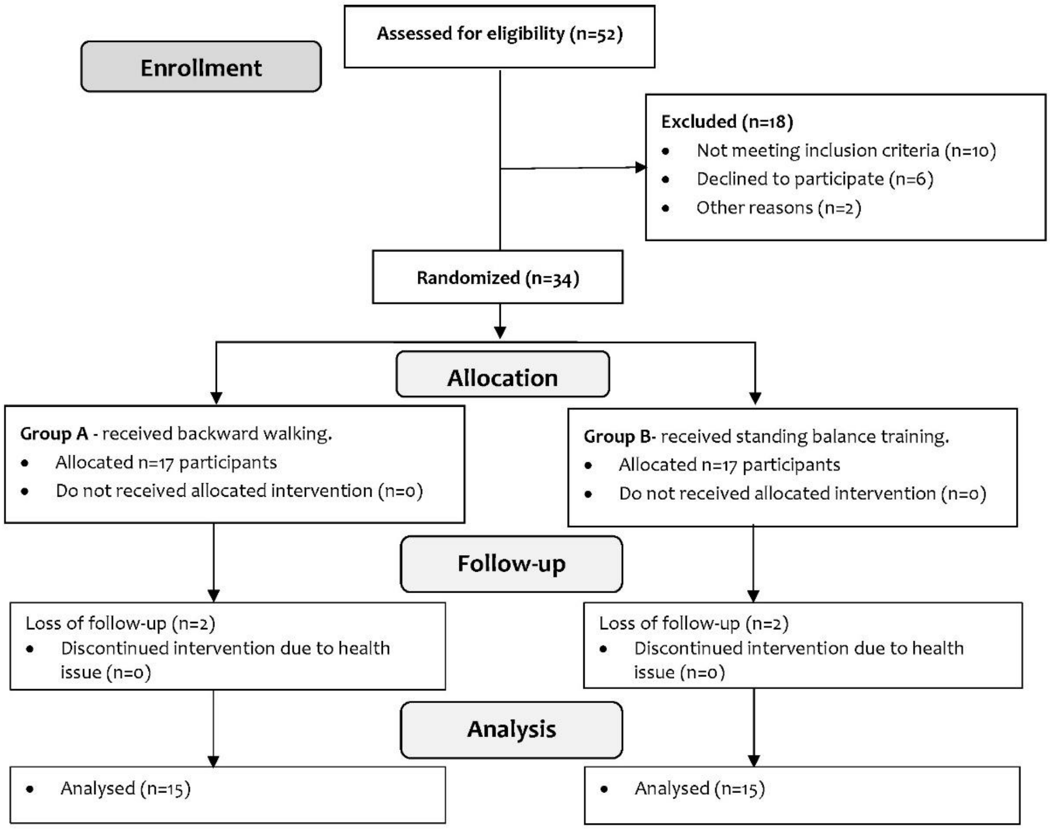

Figure 1: CONSORT diagram

A sample was selected through the non-probability purposive sampling technique. The 14 tasks Berg Balance Scale is a reliable and valid tool for balance and risk of fall assessment in neurological conditions, used to assess various aspects of postural stability, including sitting, standing, transferring, and dynamic movements. Each task is scored on a 5-point Likert scale, ranging from 0 (unable to perform) to 4 (normal performance). The total score ranges from 0 to 56, with higher scores indicating better balance and lower fall risk. A higher BBS score indicates better balance performance and reduced risk of falls. Scores below 45 are associated with an increased risk of falling, while scores between 45 and 56 indicate moderate to good balance control. [13]. It also exhibits good construct validity, as it effectively differentiates between individuals with and without balance impairments.

The randomization process was performed using a computer-generated randomization table and concealed allocation envelopes. As the study was single-blinded, participants were unaware of groups about received interventions.

The routine physical therapy given to both groups included TENS and a hot pack with task-oriented training of lower extremities to address to initiate cutaneous afferent fibres and inhibit tremors of rehabilitation and functional improvement in individuals with Parkinson's disease. In this session, TENS with the frequency of 100 Hz and intensity of 200µs and hot pack were given for 15 minutes respectively. The task-oriented training for the lower extremity included walking training on the ground for 10 minutes, equal weight-bearing sit-to-stand exercises (10 repetitions, 2 sets), resistance exercises e.g., leg press, leg extension, and leg curl (10 rep, 2 sets) and reaching tasks for improving balance. There was a rest period of 5 minutes between each set of training.

In addition, group A received backward walking training (BWT) which involved walking over the ground without the aid of any assistive aids. The intervention therapist assisted the patient as needed with shifting their weight, controlling their paretic lower extremity, and maintaining their balance while walking. If necessary, a therapy assistant assisted with posture. As physical resistance decreased and gait speed and distance increased, intensity increased. Participants were asked to continuously walk backward while maintaining balance, increasing their cadence and/or step length as well as their overall distance. This was done for 4 days per week for 12 weeks for 30 minutes.

The Group B received the standing balance training (SBT). participants were advised to stand with their eyes open on their right leg for one minute, then their left leg for another minute, for a total of two minutes, three times per day. If a participant needed multiple breaks to be able to stand on one leg for one minute, they were told to stand on one leg until they were able to stand on one leg for one minute in total. Standing on the right leg for one minute and the left leg for one minute each made up a single set of this one-leg standing balance exercise. This protocol was done for 4 days per week for 12 weeks for 30 minutes.

the data was collected at the baseline, after the 6th week and 12th week by using the Berg balance scale. The data was entered and analyzed using SPSS Version 24. The data was presented as mean ±SD, n(%), median(IQR), and mean ranks. As the assumption of the normality was violated and baseline differences also existed, the Friedman test was used to compare the changes in balance from the baseline to the 12th week, while for pairwise comparison, the Wilcoxon sign rank test was used for each level of assessment. As baseline differences exist, the mean differences of both groups were also compared with an independent t-test. The level of significance was set at $p<0.05$ and SPSS Ver 23 was used for data analysis.

RESULTS

The Mean age for the participants was 50.03+8.36 years. Among n=30 participants, 17 (56.7%) were male while 13 (43.3%) were female. Out of the participants were 28 (93.3%) married and 2 (6.7%) participants were unmarried.

The Freidman test showed significant with-in-group improvement ($p<0.001$) in both groups from baseline to the 12th week in the Berg balance scale. The pairwise comparison with the Wilcoxon sign rank test showed that each group was significantly improved ($p<0.001$) in the first month, and in the second month no significant change ($p\geq0.05$) was observed in the balance score.

Table 2: With-in group changes in BBS

	Control group				Experimental group			
	Media(IQR)	**MR**	**Z/X^2(df)**	**p-value**	**Media(IQR)**	**MR**	**Z/X^2(df)**	**p-value**
Baseline	37 (5)	21.13	-3.540	**0.00***a**	**32(3)**	**9.87**	**-3.54**	**0.00***a**
6th Week	**48(3)**	**14.03**	**-0.92**	**0.35b**	**49(6)**	**16.97**	**-0.92**	**0.35b**
12th Week	**54(3)**	**15.80**	**30(2)**	**0.00***c**	**54(1)**	**15.20**	**30(2)**	**0.00***c**

[a]Baseline to 6th week, [b]6th week to 12th week & [c]Baseline to 12th week
Level of significance: p<0.05, p<0.01** & p<0.001****

The independent t-test was applied to the mean differences (BBS) of both groups as baseline differences existed. The result showed that group (A) received backward walking training (BWT) had a significantly large mean difference (22.13+-2.35 vs. 18.20.3.58, 95%CI (1.64,6.22) in BSS score as compared to group (B) received standing balance training (SBT). (Figure 2)

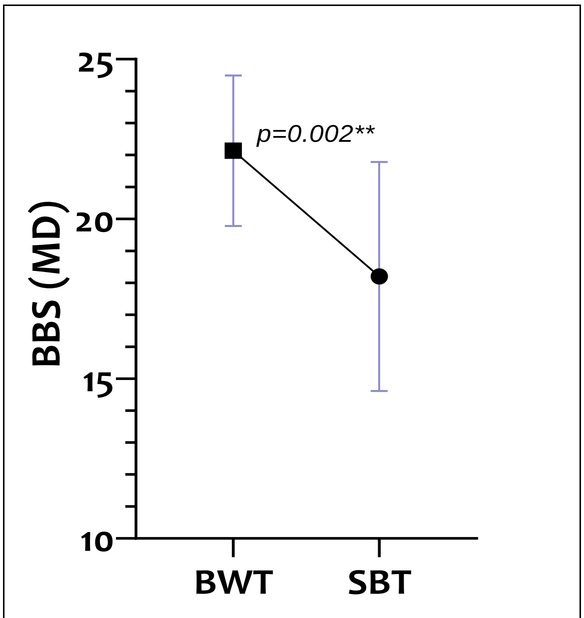

Figure 2: Comparison of MD (BBS)

DISCUSSION

The results of this study provide valuable insights into the comparative effectiveness of backward walking training and standing balance training as gait strategies for balance training in individuals with Parkinson's disease. The positive outcomes observed in both intervention groups indicate the potential benefits of incorporating these exercises into rehabilitation programs for Parkinson's patients. However, backward walk training (BWT) showed a more significant improvement in BBS score than standing balance training (SBT).

Soke et al reported that in addition to conventional walking training (CWT), backward walking training more significantly Improves balance functional mobility[14]. In the current study, backward walk training has a significant positive impact on improving balance and reducing the risk of falls. With its distinct emphasis on activating various muscle groups and sensory inputs, backward walking training might have had an impact on the observed improvements in balance control. BW reduces the risk of falling during multidirectional daily activities and helps in neurological recovery[15]. Backward walking training is an effective rehabilitation method for Parkinson's patients that reduces the risk of falls and improves balance through a variety of mechanisms [16, 17].

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BWT stimulates the neuroplastic changes in the brain by challenging the neuromuscular system in a novel way, leading to improved sensory integration and coordination. This process is essential for maintaining the good balance control [18, 19]. BWT also increases the demand for vestibular input and proprioception, which also improves postural stability and enhanced sensory integration [18, 20]. BWT also improved muscle strength and control of movement by activation of hip extensors and ankle dorsiflexors[21]. Dynamic stability and spatial awareness may also improve with BWT, as neurological patients practice around obstacles and change direction in real time[22]. The ability to move around obstacles helps the patients to feel confident and increases their participation in rehabilitation programs [23].

In the current study standing balance training program also improved the balance in Parkinson's patients. Standing balance training is essential to improve balance and reduce the risk of falls among neurological patients. SBTs have a crucial role in improving postural stability and balance control among PD activating core muscles and improving proprioception[24, 25]. SBT also improves neuroplasticity by increasing repetitive motor responses and sensory inputs. helps in reorganizing the brain networks responsible for balance control. Standing balance exercises improve visual, proprioceptive, and vestibular signal integration by challenging different sensory systems.[26, 27] It also helps in improving dynamic stability and functional abilities by incorporating dynamic movements and task-specific training necessary for daily activities[28].

When comparing the backward walking training and standing balance training on balance and risk of fall, backward walking training showed promising results over standing balance training. BWT training among PD provides a comprehensive approach for improvement in balance, lowering fall risk, and promoting overall quality of life by addressing muscle strength, sensory integration, dynamic stability, neuroplasticity, and psychological variables[29]. BWT provides better postural control and stability by strengthening key postural muscles including the ankle dorsiflexors and hip extensors. BWT also more actively engages Proprioceptive feedback, sensory integration, and spatial awareness, as compared to standing balance training, which is lacking in Parkinson's disease sufferers. [21, 30]. As the BWT challenges the dynamic balance the patients adjust to shifting environmental demands, enhancing reaction time and balance in routine activities[31]. Moreover, backward walking training lessons the abnormal gait pattern and increases postural stability among the PDs, by inducing novel motor patterns that trigger neuroplastic changes in the brain[32].

In the current study, the small sample size and duration of the study might have limited the more significant effects of the interventions.

CONCLUSION

The study concluded that to improve balance and reduce the risk of falls in Parkinson's disease, both backward walking training and standing balance training are effective. But backward walking training proved to be more effective. Practical implications of these findings involve the development of more individualized and focused rehabilitation programs to improve the functional outcomes of Parkinson's patients with balance problems.

DECLARATIONS & STATEMENTS

Author's Contribution

MU, AL and SaS: substantial contributions to the conception and design of the study.
MU: acquisition of data for the study.
ShS and SN: analysis of the data for the study.
Sas, ShS, and SN: interpretation of data for the study.
MU: drafted the work.
MU, AL, SaS, ShS and SN: revised it critically for important intellectual content.
MU, AL, SaS, ShS and SN: final approval of the version to be published and agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All authors contributed to the article and approved the submitted version.

Ethical Statement

The study was conducted at Lahore General hospital after the approval from Medical Superintendent and Ethical committee (UIPT/202/487/2022) of university Institute of Physical Therapy, The University of Lahore

Consent Statement

Written Informed consent was obtained from all subjects involved in the study prior to the study.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Acknowledgments

The authors declare no acknowledgment.

Conflicts of Interest

The authors declare no conflict of interest.

Funding

The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

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Research Article

Effects of action observation therapy with Otago exercises on balance and quality of life in older adults

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ABSTRACT

Background: Balance problems and falls are prevalent issues, especially among older adults. Otago exercise is one of the interventions applied to the geriatric population to prevent falls and balance problems, The Action observation therapy with the Otago exercise program can be a more beneficial intervention method to decrease the prevalence of falls and balance issues among older people.

Objective: to evaluate the effectiveness of Otago exercise in combination with action observation training (AOT) on balance and quality of life among the elderly.

Methods: A randomized clinical trial was conducted on n=54 elderly between 60-80 years and moderate risk of fall Berge balance scale from May 2022 to July 2023. The participants were included in the study after fulfilling the selection criteria. Then the participants were randomly assigned into two AOT plus Otago (n= 27) groups and Otago exercise alone group (n= 27). The static and dynamic balance were assessed with the Berg Balance Scale (BBS), Timed Up and Go (TUG) test, and Functional Reach Test (FRT) respectively. Additionally, quality of life was measured with the SF-36 questionnaire among older adults. The data was collected at baseline, 6th week, and 12th week.

Results: Significant improvements ($p<0.05$) were observed in balance and quality of life as measured by the Berg Balance Scale and SF-36 respectively in both intervention groups but did not reveal any significant difference ($p\geq0.05$) between the groups.

Conclusion: the current study showed no additional effects of action Observation training (AOT) with Otago exercises among the elderly. However, the addition of AOT may improve the balance, physical functioning, and ultimately quality of life among the elderly, if incorporated into routine rehabilitation of this population.

Keywords: Action observation training; balance; elderly; fall risk; geriatric population; fall risk; otago exercise; old people; quality of life.

Clinical trial #: NCT06008665

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INTRODUCTION

Automatic activities like standing and walking require active control of balance, which prevents the risk of falls. However, aging has a serious detrimental effect on balance ultimately leading to an increased risk of falls. The history of falls among those over 65 years is at least once per year or even more[1]. Balance declining with age is a complex sensory-motor process that requires the coordinated work of the visual, vestibular, and musculoskeletal system to maintain postural stability and decrease the risk of falls. Poor balance leads to musculoskeletal injury, fractures, poor quality of life, and disability[2]. Interventions include balance and postural control that can help older people to avoid falling, through tai chi methods, gait training, strengthening exercises, and balance training programs[3, 4].

The Otago Exercise Program was developed by the New Zealand's Otago University. It can be done at home it consists of strengthening and balance exercises, gait exercises, and aerobic activities. These all exercises are individualized depending on individual tolerance and are easily added to the home exercise plan[5]. Jahanpeyma P reported that significantly reduced fall frequency among 65-year-old participants[6]. A meta-analysis reported that Otago exercises decreased the mortality rate and risk of falls among community-dwelling older adults[7].

Action Observation Therapy (AOT) is a novel approach used to improve brain motor learning through performance observation[8, 9]. The literature suggests that AOT improves functional ability by motivating and providing appropriate pathways to recovery may include the mirror neuron system, and is beneficial for different neurological along with conventional rehabilitation strategies [10]. Watching recordings of everyday activities and hand movements significantly improved upper extremity function in chronic stroke patients [11].

To improve treatment outcomes beyond what either approach could do alone, the study integrates Action Observation Therapy (AOT) with Otago exercises. Although Otago exercises are useful and easily accessed, AOT offers a distinctive way to acquire motor skills through action observation, which may increase motor relearning and cognitive engagement. For those with specific neurological problems, this dual approach may be extremely helpful, improving functional abilities or facilitating a better recovery. As part of the efforts to validate and innovate present procedures, the study intends to ascertain whether the extra complexity and monitoring of AOT can considerably improve rehabilitation.

METHODS

Study Design & Setting: a single-blinded, randomized clinical trial (NCT06008665) was conducted for 1 year from May 2022-June 2023 at the Baghbaan Old Age Home (Baghbaan-19102023) and Najjat Old Age Home (Ref/NT/5-6-2023), Rawalpindi Pakistan. The research and ethical committee (REC) of the Faculty of Rehabilitation and Allied Health Sciences (with Ref# Riphah/RCRS/REC/01345) at Riphah International University approved the study.

Participants: The Participants between the ages of 60 to 80 years both genders participated in this study, having Berg balance score of falls between 20 to 40 (moderate risk of fall) were included through non-probability purposive sampling technique. Participants who experienced fall more than one time in the last 6 months were included in this study. Participants having abnormalities in the vestibular, hearing, or visual systems, any limb defects, history of recent fractures, and Participants with Cardiovascular, Cerebrovascular disease or traumatic brain injury and Epilepsy were excluded from the study.

Sample Size: The G Power was used for sample size calculation while keeping the effect size small (0.24), α error=0.05. To avoid β error the power (1-β) was set at 0.95%. A total of n=54 sample size was determined. A total of n=75 participants were assessed for eligibility and n=65 fulfilled the inclusion criteria, 11 elderly declined to participate. Then n=54 participants were randomly allocated to group A (n=27), which Otago Exercise, and group B (n=27) which received Otago with action observation. A total of n=54 participants were analysed at the end of the study. (Figure 1)

Randomization: The enveloped sealed method used combined with computerized random number generator software was used for randomization. The allocation at random was done by a person who had no direct involvement in the research. Before the trial began, the numbers that were chosen at random were then inscribed on the list of cards and put within a substantial, opaque sealed envelope. The respective intervention has been provided by the Physical therapist, after written informed consent from the participants. The study was single blinded in which assessing physical therapist was blinded.

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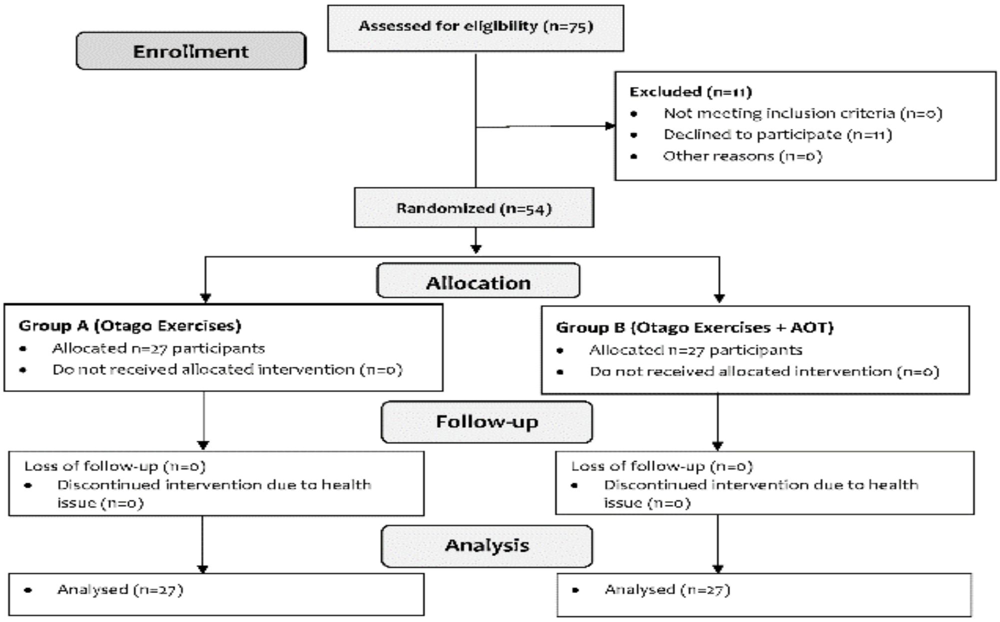


Figure 1: CONSORT flow diagram

Intervention: Action observation and Otago were performed by the participants. Both groups received intervention for 12 weeks. The assessment was done at the baseline, after 6 weeks and 12 weeks. Otago Exercise Program (Group A) includes specific exercises for strength and balance improvement. (Table 1) These exercises were conducted three times a week with the guidance of a therapist. Each training session lasted for 35-40 minutes, preceded by a 5-minute warm-up and followed by a 5-minute cool-down. Exercises were demonstrated to each participant and were given individualized load and progression. Each exercise has been started with 10 repetitions initially. In Group B Otago exercise program was performed with action observation training (AOT). Participants were instructed to watch a video on a 22-inch screen positioned 1 meter away from them, while comfortably seated in a chair with armrests. They were not allowed to follow along or engage in any movement while watching the video. The video featured a model who was 70 years old or older, like the participants. The duration of the video viewing was 17 minutes (1 minute for each video), followed by a 35-minute (2 minutes maximum per session) Session physical training session conducted by a therapist, based on the content of the video. To ensure the effectiveness of the action observation training, the video viewing took place at a designated time in a quiet environment, supervised by the same investigator throughout the entire study. The activities done during the physical education workshops and pieces of training were featured in the videos played during the actual observation training sessions. (Table 1)

Table 1: Detail Intervention Protocol

	Group A (Otago Exercises)	Group B (Otago Exercises + AOT)
Otago Exercise	Strength exercise: Knee flexor, Knee extensor, Hip adductors, Ankle Plantar flexors and Ankle dorsi flexors	
	Balance exercise: Walking backward, Walking in a figure of eight, Tandem walking, Tandem stance, Standing on one leg, Walking on heels, Walking on toes, Heel-toe walking backward, Sit to stand, Stair walking, Sideways walking, Exercise: Start at 10 repetitions	
Action Observation Training	-	Action Observation Therapy: Each component of the Otago exercises video watching time will be 1 minute. The participant will not be allowed to follow or move around while watching the video After watching each video, 1-2 min of following Otago exercises training was conducted under the supervision of a Physical therapist.

AOT-Action Observation Therapy

Assessment: After approval from the research ethics committee, participants were selected based on inclusion criteria. The subjects were provided informed consent before participation. The Balance was Assessed through tools like the Berg Balance scale (BBS), Time up and go test (TUG test), and functional reach test (FRT). For Quality of Life, the SF36 questionnaire was filled out by participants before and after the intervention. The BBS is used to objectively determine a patient's ability to safely balance during a series of predetermined tasks. The BBS scoring is as follows: 0-20 (high risk of fall), 21-40 (moderate risk of fall), 41-56 (low risk of fall). In the TUG test, An older adult who takes ≥12 seconds to complete the TUG is at risk for falling. Functional Reach Test (FRT) is a clinical outcome measure and assessment tool for ascertaining dynamic balance in one simple task. Participants whose scores were 6 inches or less indicate a significantly increased risk for falls. A score between 6-10 inches indicates a moderate risk for falls.

Data Analysis Procedure: Data analyzed by SPSS version 21. The mixed ANOVA was applied to see the interaction effect between intervention and assessment level of BBS. The interaction effects were significant so for the main effects Repeated measure ANOVA with pairwise comparison was applied and for between the group comparison Way ANOVA was applied along with their effect sizes. Univariate ANCOVA was applied to determine the individual domains of Quality of Life. A significance level of $p<0.05$ was considered statistically significant.

RESULTS

The mean age of individuals in the Otago group is 70.15±2.22 years and the Action Observation with the Otago group is 68.61±2.28 years. A total of n=36 was male and the remaining n=18 was female in the study. (Figure 2)

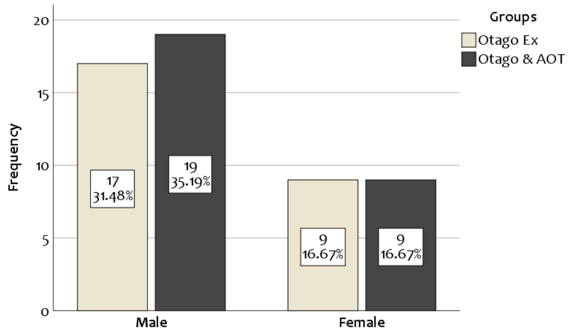
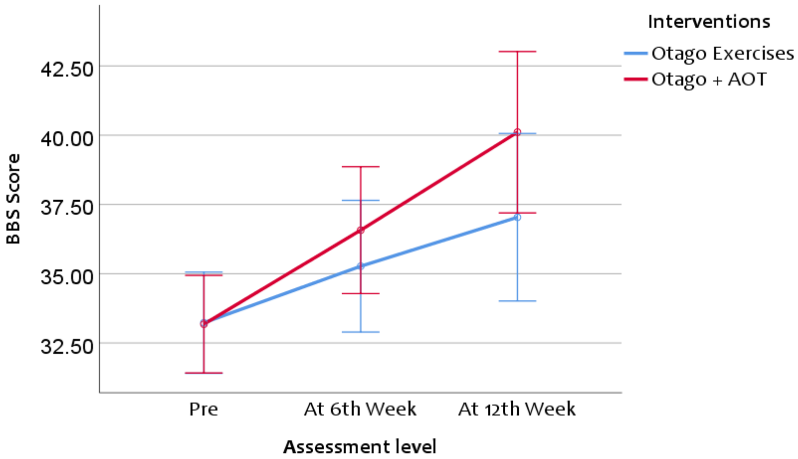


Figure 2: Gender frequency



Figures: 3 Interaction effect between intervention and level of assessment (BBS)

Mixed ANOVA result showed that there is significant interaction effect $\{F_{(1.10,57.56)}=4.21$, $p=0.041$, $\eta_p^2=0.07\}$ observed between Interventions and balance's assessment level . (Figure 3)

For in-group changes, RM ANOVA was applied and shows within-group changes in the BBS scores for the two groups: Group B, who underwent additional training (AOT) in addition to the Otago exercise, and Group A, which adhered to the Otago exercise program. At baseline, 6th week, and 12th week, assessments were given to both groups. The result showed significant improvement in BBS score from the baseline to the end of intervention with moderate effect size in Group A ($p<0.001$, $\eta p^2=0.296$), while in Group B ($p<0.001$, $\eta p^2=0.647$) large effect size respectively. Pair-wise comparison showed that in both groups, The BBS scores significantly increased ($p<0.05$) with time, from baseline to the end of the 6th week and then 7th week to the 12th Week. (Table 2)

Table 2: With-in group (Main effects) changes in both groups (Berg Balance Scale Score)

		Group A (Otago) (n=27)				Group B (Otago + AOT) (n=27)			
		Mean±SD	MD/f(df)	p-value	ηp2	Mean±SD	MD/f(df)	p-value	ηp2
Berge Balance Scale	Baseline	33.23±4.82	-2.038	0.010*a	.296	33.17±4.49	-3.393	0.00***a	.647
	6th Week	35.26±6.44	-1.769	0.019*b		36.57±5.67	-3.546	0.00***b	
	12th Week	37.03±8.39	10.523(2,50)	0.00***c		40.10±7.00	49.429(2,54)	0.00***c	

[a]baseline to 6th week, [b]6th week to 12th week & [c]baseline to 12th week; Significance level- p<0.05, p<0.01** & p<0.001***; SD-standard deviation; MD-mean difference; df-degree of freedom*

Table 3: Between Group Comparison (Balance)

		Group A (Otago) (n=27)	Group B (Otago + AOT) (n=27)	F(df)	p-value
		Mean±SD	Mean±SD		
Berge Balance Scale	Baseline	33.23±4.82	33.17±4.49	.002	.967
	6th Week	35.26±6.44	36.57±5.67	.622	.434
	12th Week	37.03±8.39	40.10±7.00	2.137	.150

Significance level- p<0.05, p<0.01** &p<0.001****

The result of One way ANOVA on each level of assessment no significant difference (p≥0.05) was observed between groups. (Table 3)

The within-group changes of quality of life among participants showed that in group A, no significant changes p≥0.05) were observed in physical functioning, role limitation due to physical and mental, pain, and energy/vitality, except social functions, mental health and over general health was significantly improved (p<0.05) after 12-week intervention. Group B where AOT performed in addition to Otago exercises showed improvement in all domains of quality of life (SF-36), except pain (p=0.059). (table 4)

Table 4: With-in Group changes in quality of life (SF-36)

		Group A (Otago) (n=27)			Group B (Otago + AOT) (n=27)		
		Mean±SD	MD	p-value	Mean±SD	MD	p-value
Physical Functioning	Baseline	54.80±8.84	-4.28	0.284	53.16±7.60	-9.98	0.001**
	12th Week	59.09±21.80			63.14±15.01		
Role Limitation-Physical Health	Baseline	29.80±31.63	5.76	0.136	41.96±34.05	15.178	0.00***
	12th Week	24.03±26.90			26.78±27.15		
Role Limitation-Mental Health	Baseline	32.05±29.02	7.69	0.265	29.76±31.86	17.85	0.005**
	12th Week	24.35±37.18			11.90±24.36		
Social Function	Baseline	57.21±11.81	-9.61	0.002**	48.21±13.90	-16.51	0.00***
	12th Week	66.82±10.57			64.73±10.78		
Pain	Baseline	72.98±14.56	-1.53	0.541	69.55±19.44	-6.78	0.059
	12th Week	74.51±13.24			76.33±11.49		
Mental Health	Baseline	49.53±5.06	-8.15	0.00***	49.00±4.16	-12.57	0.00***
	12th Week	57.69±7.85			61.57±7.80		
Energy/Vitality	Baseline	53.84±7.52	-3.07	0.203	51.07±7.24	-7.85	0.003**
	12th Week	56.92±7.08			58.92±7.11		
General Health	Baseline	52.30±4.29	-8.26	0.003**	52.50±4.19	-9.82	0.00***
	12th Week	60.57±12.43			62.32±9.66		

Significance level- p<0.05, p<0.01** & p<0.001****

Table 5: Between Group Comparison of SF-36

		Mean±SD	Mean±SD	F(df)	p-value	np2
Physical Functioning	Baseline	54.80±8.84	53.16±7.60	-	-	-
	12th Week	59.09±21.80	63.14±15.01	0.016	0.9	0
Role Limitation-Physical Health	Baseline	29.80±31.63	41.96±34.05	-	-	-
	12th Week	24.03±26.90	26.78±27.15	0.588	0.447	0.013
Role Limitation-Mental Health	Baseline	32.05±29.02	29.76±31.86	-	-	-
	12th Week	24.35±37.18	11.90±24.36	0.563	0.457	0.013
Social Function	Baseline	57.21±11.81	48.21±13.90	-	-	-
	12th Week	66.82±10.57	64.73±10.78	0.696	0.409	0.016
Pain	Baseline	72.98±14.56	69.55±19.44	-	-	-
	12th Week	74.51±13.24	76.33±11.49	0.072	0.789	0.002
Mental Health	Baseline	49.53±5.06	49.00±4.16	-	-	-
	12th Week	57.69±7.85	61.57±7.80	0.982	0.327	0.022
Energy/Vitality	Baseline	53.84±7.52	51.07±7.24	-	-	-
	12th Week	56.92±7.08	58.92±7.11	0.318	0.576	0.007
General Health	Baseline	52.30±4.29	52.50±4.19	-	-	-
	12th Week	60.57±12.43	62.32±9.66	0.121	0.73	0.003

Significance level- p<0.05, p<0.01** & p<0.001****

There is no statistically significant difference between the Otago and action observation with the Otago group on the Quality of life in all domains while controlling the baseline. Wilks' Λ= 0.835 p≧0.05. partial η2 = 0.153. Univariate ANCOVA was applied to determine the individual domains of quality of life and the value shows there are no significant differences (p≧0.05) in all domains of quality of life. (Table 5)

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DISCUSSION

The purpose of the current study was to assess the additional effects of Action observation training with the Otago group, on balance, and quality of life in a population of individuals with impaired balance. The result reveals that the effect of intervention on balance differs across the levels of balance assessment. Both individual groups showed improvement in quality of life, but the AOT plus Otago group showed improvement in all domains as compared to Otago alone. While comparing for the main effect. there is no difference relating to the intervention on quality of life among the participants at the end of the study.

Research has demonstrated that the Otago exercise program enhances various aspects of older persons' lives, including health-related quality of life, functional mobility, balance, physical performance, functional capacity, muscle strength in the lower limbs, and the likelihood of falling[12, 13] These results align with the current study's findings, which indicated that Group A had a modest impact size and considerable improvement. There is a noticeable decrease in falls with the Otago Exercise Program[6, 7, 14, 15]. This is probably the result of these important areas' combined effects of improved physical function[14]. Furthermore, as individuals experience increased strength and stability, they might also feel more self-assured in their movements, which could result in higher activity levels and additional health benefits. Improved strength and balance also increase functional mobility and physical performance[6, 14], so the advantages go beyond just preventing falls. In turn, this leads to an improvement in life quality as daily tasks become easier. A person's ability to function as they age can also be preserved by maintaining their muscle strength and flexibility[12].

The highly significant effect size of Group B implies that AOT and Otago exercises could work in combination. This may be because the effects of Otago exercises alone are enhanced by additional cognitive and motor stimulation that AOT offers. This enhancement's possible mechanism is mirroring neurons, which fire when a person performs an action and when they observe someone else perform the same action. The motor circuits in the brain may be stimulated by this observation, which could enhance learning and motor function[16, 17]. After a 12-week intervention, Group B improved in every category except pain, which is interesting to note in terms of quality-of-life improvements. In contrast, Group A demonstrated considerable gains in some categories. This is consistent with research indicating that moderate gains in physical and mental health composites can result from exercise programs[18, 19]. A four-month video-supported Otago exercise program significantly enhanced lower extremity strength, functional balance, and mobility. Improvements in walking speed, stride length, and sitting time have been verified in older individuals with AOT, including standing, sitting, and walking training[20].

Both interventions appear to be effective, however, their effects on quality of life may be similar when baseline levels are taken into consideration, as seen by the lack of significant differences between the groups in quality-of-life areas when correcting for baseline. Environmental, social, psychological, and physical factors all have an impact on quality of life (QoL), which is a multifaceted concept [12,15,21]. Because of their complexity, short study duration, and inherent aging processes, interventions like Otago exercises and AOT may improve physical function but not always other QoL aspects

Limitation of the study: the absence of a screening test to assess cognitive impairment and drug usage along with the small sample size is another limitation, which may affect the results

CONCLUSION

The current study showed no additional effects of action Observation training (AOT) with Otago exercises among the elderly. However, the addition of AOT may improve the balance, physical functioning, and ultimately quality of life among the elderly if incorporated into routine rehabilitation of this population. Future research is recommended, while considering the confounders among the Pakistani population, to ensure external validity.

DECLARATIONS & STATEMENTS

Author's Contribution

SA and AQA: substantial contributions to the conception and design of the study.
SA, AQA: acquisition of data for the study.
SA: analysis of the data for the study.
SA and AQA: interpretation of data for the study.
SA, FM and HN: drafted the work.
SA, FM, HN and AQA: revised it critically for important intellectual content.
SA, FM, HN and AQA: final approval of the version to be published and agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All authors contributed to the article and approved the submitted version.

Ethical Statement

The study was conducted at the Baghbaan Old Age Homes (Baghbaan-19102023) and Najjat Old Age Home (Ref/NT/5-6-2023), Rawalpindi Pakistan. The research and ethical committee (REC) of the Faculty of Rehabilitation and Allied Health Sciences (with Ref# Riphah/RCRS/REC/01345) at Riphah International University approved the study.

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Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Conflicts of Interest

The authors declare no conflict of interest.

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The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

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Research Article

Factors affecting the speech intelligibility of children with hearing impairment

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ABSTRACT

Background: Children with hearing impairment have difficulties affecting their ability to understand speech and general communication development. It is essential to understand the background of the factors affecting young children's speech intelligibility in the Pakistani setting.

Objective: To explore the factors affecting speech intelligibility among children with hearing impairment.

Methods: A total of n=107 individuals were selected for the 6-month study at GMT clinic, Siemens Hearing Clinic, Hearing and Speech Care Clinic, and RHS in Islamabad using non-probability convenience sampling. Children between the ages of 6 and 12 who had mild to profound sensorineural hearing loss and could express themselves at the phrase level met the inclusion criteria. Speech-impairing conditions and progressive or conductive hearing loss were included in the exclusion criteria. Using the Assessing Intelligibility Worksheet, data was collected, in which 17 utterances with 57 words spoken by the therapist participants were repeated and the responses were noted by the therapist. Multiple linear regression, descriptive statistics, and percentage distribution were all analyzed using SPSS 21.

Results: A multiple regression model was run to predict intelligibility utterance from age, gender, type of hearing aid, technology of hearing aid, degrees of hearing loss, and talkativeness. This model significantly predicted speech intelligibility of hearing aid users {F (8, 98) = 42.905, $p<0.001$}. All variables cause 77.8% (Adj. $R2=.778$) variance in speech intelligibility of hearing aid users.

Conclusion: The study concludes that there is a considerable impact of gender, the technology of hearing aids, degree of hearing loss, and talkativeness level on speech intelligibility while no significant impact of types of hearing aids concerning Behind the ear and receiver in the canal on children's speech intelligibility.

Keywords: hearing aids; hearing impairment; speech intelligibility

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INTRODUCTION

Hearing loss (HL) in infancy and early childhood is a well-established factor contributing to suboptimal speech and language development. By impeding a child's access to speech and language input, varying from minimal in cases of mild HL to nearly complete in severe to profound HL, it adversely affects speech and language development [1]. Speech intelligibility is the capacity of a person to comprehend speech [2, 3]. Affecting Speech Intelligibility is articulation, childhood apraxia of speech, dysarthria, speech sound disorders, stuttering, background noise, and hearing [4].

There is a well-established relationship between speech intelligibility and hearing impairment. Hearing impairment can affect an individual's ability to perceive sounds, particularly high-frequency sounds, which are important for speech perception. As a result, individuals with hearing impairment may have trouble understanding speech, particularly in noisy or reverberant environments [5,6]. Additionally, as hearing impairment severity increased, speech intelligibility scores decreased further. The relationship between hearing impairment and speech intelligibility is also influenced by other factors, such as age, cognitive abilities, and language proficiency [7,8]. Therefore, early identification and intervention for hearing impairment are crucial to improving speech intelligibility and overall communication ability even in profound hearing loss [9-11].

The impact of HL on their communication abilities, primarily in spoken language, can lead to heightened difficulties in establishing positive relationships with hearing peers [12]. A prevalent consequence of hearing loss, affecting approximately 10% of the population, is a diminished ability to comprehend speech in the presence of background noise, particularly nonstationary noises [13]. Speech intelligibility in people with hearing impairments is affected by several variables, including talkativeness, auditory training, emotional state, environmental context, hearing aid type and technology, and degree of hearing loss [14, 15]. While digital and Receiver-In-Canal (RIC) aids improve clarity, severe hearing loss impairs speech perception [16]. Speech comprehension is enhanced through social engagement and auditory rehabilitation. Important roles are also played by cognitive abilities and environmental elements like background noise [17]. Better outcomes are correlated with positive emotional states [18, 19].

There is a dearth of thorough research on the complex factors influencing the speech intelligibility of children with hearing impairment among children in Pakistan. Prior research frequently concentrates on discrete elements, like the effectiveness of assistive technology or the accessibility of speech therapy, failing to provide a comprehensive understanding of the interplay between multiple variables. Furthermore, little is known about the prevalence of early detection and the influence of socioeconomic status on the availability and caliber of services related to hearing rehabilitation for children. Targeted interventions can be developed with an understanding of how factors such as talkativeness, age, gender, type of aid, technology, and degree of hearing loss affect speech intelligibility. So, the objective of the studies is to explore the factors affecting speech intelligibility among children with hearing impairment.

MATERIALS AND METHODS

Study Design: The Cross-sectional analytical study was conducted after permission from competent authorities of Siemens Hearing Clinic (SHC/Ref-2023/10-1) Islamabad, Hearing and Speech Care Clinic (R. No-HSCC/1206) Rawalpindi and RHS (No: RHS/EC/02-06-2023-01) in Islamabad. The duration of the study was 6 months from July 2023 to December 2023, after the ethical approval.

Selection Criteria: The participants were clinically diagnosed with sensorineural hearing loss as shown by their Pure Tone Audiometry from mild to profound degree of hearing loss, their age ranging from 6 to 12 years of both genders, and they were using hearing aids and having phrase level Expression. The participants with Progressive hearing loss, Conductive hearing loss, Children with otitis media, any other disability affecting the speech, and Unilateral hearing loss.

Sample Size: The required sample size (n=107) was calculated through priori analysis for multiple linear regression. In which effect size was kept at 0.15, the probability of the alpha error was 0,05, power 80%, and total number of predictors was 12.

Outcome Measure: Assessing Intelligibility Worksheet was used to assess and test the degree of intelligibility or understandability of spoken language The worksheet's methodical design evaluates various facets of intelligibility, assisting professionals in learning more about a person's or a group's capacity for efficient speech communication. The worksheet was designed for the children to assess their speech intelligibility having 17 utterances with 57 words. After that, the formula was applied to the acquired data (intelligible words/ total words X 100) same as well, for the utterance's intelligibility (intelligible utterances/ total utterances X 100). If a child scores <70% intelligibility he or she might pass. It means that his device working accurately according to the need.

Data Collection Procedure: The study used non-probability Convenience sampling to collect children

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with hearing impairment after obtaining written informed consent from their parents. The data was collected from the participants using an Assessing Intelligibility worksheet, the examiner was seated at a one-armed distance in front of the participants with covered faces and the responses were noted on phrase level expression by 17 utterances with 57 words spoken by the therapist and participants were listening and were repeating the listen utterances and the responses were written by the therapist.

Data Analysis: Data was analyzed descriptively by mean and standard deviation and graphically presented using a bar chart showing frequencies and percentages. The Multiple Linear regression test was applied to determine the impact of different factors on the speech intelligibility of children. For multiple linear regression, categorical variables were converted to dummy variables with a regression algorithm requiring numerical input to process the variables. The test was applied through SPSS version 22, and the level of significance was set at α=0.05

RESULTS

The mean age of the n=107 study participants was 10.1308±1.83176 years. A total of n=59 (55.14%) was male and the remaining n=48 (44.86%) were females. Other demographic characteristics have been reported in Table 1.

Table 1: Demographic Distribution

		n	%
Gender	Male	59	55.1
	Female	48	44.9
Degree of Hearing loss	Moderate HL (41-55 dB)	12	11.2
	Moderately Severe HL (56-70 dB)	32	29.9
	Severe HL (71-90 dB)	41	38.3
	Profound HL (90 dB above)	22	20.6
Type of Hearing Aid	BTE	92	86.0
	RIC	15	14.0
Hearing Aid Technology	Digital	68	63.6
	Analog	39	36.4
Talkativeness	Talkative	67	62.6
	Not-Talkative	40	37.4

BTE-Behind the ear; RIC- Receiver in Canal; n-Frequency

A multiple regression model was run to predict intelligibility means from age, gender, type of hearing aid, technology of hearing aid, degrees of hearing loss, and talkativeness. This model significantly predicted speech intelligibility of hearing aid users {$F(8, 98) = 45.788$, $p<0.001$}. All variables cause 77.2% (Adj. R^2=.772) variance in speech intelligibility of hearing aid users. Individually, Speech intelligibility mean was not significantly impacted by age, type of hearing aid, and moderate and severe hearing loss. While gender, talkativeness level, and technology of hearing aid showed significant results, on the other hand, degree of hearing loss shows important results in moderately severe hearing loss and profound hearing loss as compared to different types of hearing loss (Moderate and Severe HL) which showed no significance. (Table 2)

A multiple regression model was run to predict intelligibility words from age, gender, type of hearing aid, technology of hearing aid, degrees of hearing loss, and talkativeness. This model significantly predicted speech intelligibility of hearing aid users {$F(8, 98) = 32.961$, $p<0.001$}. All variables cause 70.7% (Adj. R^2=.707) variance in speech intelligibility of hearing aid users. Individually, Speech intelligibility of words was not significantly impacted by age or type of hearing aid ($p<0.05$). While gender, talkativeness level, and technology of hearing aid showed significant results, on the other hand, the degree of hearing loss showed consequences resulting in moderately severe hearing loss as compared to different types of hearing loss (Moderate, Severe, and Profound HL) which showed no significance. (Table 3)

A multiple regression model was run to predict intelligibility utterance from age, gender, type of hearing aid, technology of hearing aid, degrees of hearing loss, and talkativeness. This model significantly predicted speech intelligibility of hearing aid users {$F(8, 98) = 42.905$, $p<0.001$}. All variables cause 77.8% (Adj. R2=.778) variance in speech intelligibility of hearing aid users.

Individually, Speech intelligibility of utterance was not significantly impacted by age or type of hearing aid ($p<0.05$). While gender, talkativeness level, and technology of hearing aid showed significant results, however the degree of hearing loss showed no significant result in moderate hearing loss as compared to other types of hearing loss (Moderately Severe, Severe, and Profound HL) which showed significant results. (Table 4)

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Table 2: Factors Predicting The Total Intelligibility Score

		Mean ± SD	β	95% CI	Sig.
	Age	10.13±1.831	-.51	-1.14,.11	.10
Gender	Male[a]	85.87± 10.64	-	-	
	Female	97.26 ± 5.88	6.00	3.48,8.53	.000***
Type of Hearing Aid	Behind The Ear[a]	89.54±10.62	-	-	-
	Receiver In Canal	99.82 ±.36	-.26	-4.47,3.93	.900
Hearing Aid Technology	Digital HA	94.90 ± 7.06			
	Analogue HA	84.14 ± 11.94	-6.68	-8.77 ,-4.59	.000***
Degree of Hearing loss	Mild HL	NA			
	Moderate HL	99.63± .45	.19	-4.29,4.67	.933
	Moderately Severe HL[a]	92.96 ± 9.88	-	-	-
	Severe HL	90.80 ± 7.06	1.16	-1.52,3.85	.394
	Profound HL	83.72 ± 14.51	-5.33	-8.50, -2.16	.001**
Talkativeness	Not Talkative[a]	80.81 ± 9.46	-	-	-
	Talkative	97.05 ± 4.83	11.80	9.30,14.30	.00***

[a]Reference variables; p<0.05, p<0.01**, p<0.001***; SD-Standard deviation; CI-Confidence Interval; HL- Hearing Loss*

Table 3: Factors Predicting The Word Intelligibility

		Mean±SD	β	95% CI	Sig.
	Age	10.13± 1.83	-.98	-1.63,-.09	.081
Gender	Male[a]	80.52± 11.74	-	-	-
	Female	96.12 ± 7.58	9.07	5.60,12.4	000***
Type of Hearing Aid	Behind The Ear[a]	85.54 ± 12.65	-	-	-
	Receiver In Canal	99.64 ± .72	.91	-4.87,6.69	.756
Hearing Aid Technology	Digital HA[a]	92.67 ± 8.55	-	-	-
	Analogue HA	78.54 ± 13.85	-9.05	-11.92,-6.17	000***
Degree of Hearing loss	Mild HL	NA			
	Moderate HL	99.26± .90	.42	-5.74,6.58	.893
	Moderately Severe HL[a]	89.96 ± 12.87	-	-	-
	Severe HL	84.76 ± 10.62	-1.17	-4.87,2.52	.529
	Profound HL	82.69 ± 15.13	-3.30	-7.66,1.04	.135
Talkativeness	Not Talkative[a]	76.49± 9.07	-	-	-
	Talkative	94.10± 9.66	11.15	7.71,14.59	000***

[a]Reference variables; p<0.05, p<0.01**, p<0.001***; SD-Standard deviation; CI-Confidence Interval; HL- Hearing Loss*

Table 4: Factors Predicting The Intelligibility Utterances

		Mean ± SD	β	95% CI	Sig.
	Age	10.13 ± 1.83	-.26	-.86,.33	.384
Gender	Male[a]	91.22± 11.31	-	-	-
	Female	98.40 ± 4.96	2.94	.54,5.33	.017*
Type of Hearing Aid	Behind The Ear[a]	93.54 ± 10.17	-	-	-
	Receiver In Canal	100.00 ± .00	-1.44	-5.43,2.54	.474
Hearing Aid Technology	Digital HA[a]	97.14 ± 6.30	-	-	-
	Analogue HA	89.74 ± 12.49	-4.31	-6.29,-2.33	.000***
Degree of Hearing loss	Mild HL	NA			
	Moderate HL	100.00 ± .00	-.04	-4.29,4.21	.985
	Moderately Severe HL[a]	95.95 ± 7.82	-	-	-
	Severe HL	96.84 ± 5.43	3.50	.94,6.05	.008**
	Profound HL	84.75 ± 14.02	-7.36	-10.36, -4.36	.000***
Talkativeness	Not Talkative[a]	85.14 ± 10.65	-	-	-
	Talkative	100.00 ± .00	-7.36	10.07-14.82	.000***

[a]Reference variables; p<0.05, p<0.01**, p<0.001***; SD-Standard deviation; CI-Confidence Interval; HL- Hearing Loss*

DISCUSSION

The study's results, which sought to predict speech intelligibility among varied users of hearing aids, show a complex link between several variables and speech comprehension. The study shows that speech intelligibility would be greatly impacted by talkativeness, age, gender, kind of hearing aid, and technology. The results show that some characteristics are quite important in predicting speech intelligibility, but other ones might not have a big impact [20].

According to various hearing aid users' speech intelligibility may not be significantly predicted by age. This result defies some of the material that has been published thus far, which suggests that age plays a significant role in speech perception. It is intriguing and deserves more investigation. The absence of a statistically significant impact of age may be due to a few factors, including the study's particular techniques, sample size, and participant inclusion requirements. Developmental, cognitive, and environmental factors play a complex role in the relationship between age and speech intelligibility in children wearing hearing aids. Speech perception is impacted by the development of the auditory system, which is modified by early exposure and skill acquisition. Variations are influenced by linguistic exposure, vocabulary growth, and levels of cognitive and linguistic maturity. The efficacy of hearing aids is affected by age-related changes in adaptation. Speech understanding is impacted by age-related changes in social interactions and communication abilities. Understanding individual variances is essential to comprehending speech intelligibility in this heterogeneous population, including the degree of hearing loss and the effectiveness of the intervention [21].

Second, the study highlights that the type of hearing aid worn may not have a major impact on speech intelligibility. This result contradicts some earlier studies that emphasize how important it is to select the appropriate hearing aid to improve communication outcomes. It raises questions about the effectiveness of different assistive listening technologies and the need for therapies specific to a person's characteristics. Choosing between Behind-the-Ear (BTE) and Receiver-in-Canal (RIC) hearing aids has a significant impact on children's comprehension of speech [22]. BTE devices' larger size and more potent components make them useful for those with severe to profound hearing loss.

On the other hand, smaller, inside-the-ear devices called RIC aids offer natural sound quality for mild to moderate hearing loss. To BTE aids, which could be more sensitive to feedback and pain, thus impairing intelligibility, RIC aids reduce feedback challenges and are simpler to maintain. Children may find certain RIC aids are more aesthetically beautiful and handy, so it's crucial to take their needs and tastes into account when selecting the appropriate kind of hearing aid [23].

It's also remarkable that some degrees of hearing loss did not significantly predict speech intelligibility. This contradicts the widely held belief that a higher degree of hearing loss is correlated with a lower ability to perceive speech. The subtle differences in how speech intelligibility and hearing loss relate to each other highlight how intricate auditory processing is and how much more research is needed to fully comprehend individuals with variances[24]

Positively, talkativeness, gender, and hearing aid technology are all important predictors of speech intelligibility across various hearing aid users, according to the study. These results concur with previous research indicating that these variables are critical to the communication outcomes experienced by those having hearing loss [25].

According to research showing the benefits of digital technology, children who use digital hearing aids have greater anticipated speech intelligibility than those who use analogue devices. Signal processing is where digital aids shine; they can successfully separate speech from background noise. Their programmability and adaptability allow customized amplification for different hearing profiles, improving voice recognition. Digital aids work better than analogues under listening settings because they incorporate sophisticated noise reduction, feedback management, dynamic range compression, and speech processing algorithms. Many audiology investigations have confirmed this trend, representing a major progress in meeting the auditory demands of people with hearing loss and improving speech intelligibility [26].

According to the current study, children with profound and moderately severe hearing loss can perceive speech better when their hearing aids are adjusted properly. Conventional hearing aids and advanced features like cochlear implants' direct auditory nerve stimulation enhance speech comprehension. Sophisticated speech coding techniques maximize the transmission of important speech cues in hearing aids. Children with significant hearing loss benefit from early exposure to language-rich environments and access to communication therapies showing language development. Notwithstanding general trends, individual variability influenced by things like early intervention and cognitive processing highlights the significance of tailored strategies for achieving the best results in speech intelligibility [27].

According to a recent study, talkative children get greater auditory stimulation from verbal conversations, which may improve their auditory processing and speech intelligibility. Their engaged involvement in discussions offers regular language exposure and speech practice chances, which build up understanding and output. Improved speech intelligibility may also be influenced by engaging children's strong social engagement and communication skills. An active motivation to wear hearing aids improves optimal auditory input. Parental and educational support for advanced language development expands vocabulary and improves language structures, which enhances total speech intelligibility [28].

Age-related influences on word and utterance intelligibility in children wearing hearing aids include auditory development, vocabulary growth, language acquisition, experience, cognitive processing, hearing aid adaption, and intervention services. While older kids benefit from more developed cognitive skills and linguistic repertoires, younger kids could still be in the early phases of auditory and language development. Improved intelligibility can be attributed to hearing aid adaption and rich language exposure over time. The outcomes are further influenced by individual differences, the quality of the intervention, and the features of the hearing aids. This highlights the need for ongoing research in pediatric audiology to improve therapies for children at different developmental stages [1].

Gender and word/utterance intelligibility in children wearing hearing aids have a complicated and poorly understood relationship. Variations in language development, social and communication styles, cultural influences, educational approaches, socioemotional factors, hearing aid usage habits, and biological factors are a few possible causes. These factors influenced by individual variances within genders, probably work together to produce the observed discrepancies. To improve outcomes for both boys and girls with hearing impairment, further research is necessary to identify the precise mechanisms underlying gender-related disparities in speech intelligibility and to inform customized therapies [29].

The lack of statistically significant results in predicting word and utterance intelligibility among children based on hearing aid types (BTE and RIC) could be attributed to shared technological characteristics, the focus on customized fittings, different adaptation strategies, and possible differences in regular use. The nuanced findings are influenced by various factors, including technological developments, limited sample sizes, outcome measurements, and testing settings. Differences between each type of hearing aid may potentially be masked by heterogeneity. Future studies should examine characteristics and personal preferences to have a deeper understanding of how the type of hearing aid affects speaking outcomes in children who wear them [30].

The substantial influence that digital aids have on children's word and utterance intelligibility can be attributed to their advanced signal processing, flexibility, noise reduction, feedback control, dynamic range compression, and speech processing algorithms that are prioritized. Personalized fits, which guarantee a customized strategy based on lifestyle and hearing impairment considerations, enhance intelligibility. Digital hearing aids are more successful than analogue ones according to aiding children's speech understanding because of their consistent sound quality and continuous technical developments [31].

Children with moderately severe hearing loss, using hearing aids, exhibit superior word intelligibility compared to those with moderate, severe, and profound hearing loss. This aligns with literature-supported factors: enhanced audibility, advanced signal processing, communication interventions, individual variability, developmental advantages, and the influence of social and educational support. The complexity of hearing loss, coupled with technological advancements and contextual nuances in intervention, underscores the need for a comprehensive understanding of factors contributing to divergent word intelligibility outcomes in children with varying degrees of hearing loss [32].

Children with extensive to moderately severe hearing loss who wear hearing aids had better speech intelligibility than children with mild hearing loss. Better auditory development, effective management of speech perception problems, advanced speech coding techniques, individual variances, improved communication accessibility, targeted intervention, and potential contributions from social and educational dynamics are all consistent. The realization of the intricate interactions between these components emphasizes the need for individualized knowledge and interventions to maximize utterance intelligibility in children with varying hearing profiles. This complexity of hearing loss outcomes in using hearing aids is reinforced [33].

Compared to their less talkative counterparts, children who wear hearing aids and are talkative have greater word and utterance intelligibility. Contributing factors include increased motivation and engagement, advanced language development, parental and educational support, improved social interaction and communication skills, increased auditory stimulation, language exposure, and practice. Even if these factors contribute to the observed differences, it's also important to consider individual distinctive features and contextual factors. To have a more complex picture of these dynamics, more study is required to examine the precise processes behind the relationship between talkativeness and speech intelligibility in kids wearing hearing aids[34].

Limitation of the study: The study's limitations were a small sample size for the generalization and the need for attention in the digital hearing aid which should include additional channels or quality.

CONCLUSION

There is a considerable impact of gender, technology of hearing aids, degree of hearing loss, and talkativeness level on speech intelligibility. The optimization of hearing aid technology and support, customized interventions based on the severity of hearing loss, and the promotion of frequent verbal interactions to improve talkativeness and speech practice are all important considerations for interventions aimed at improving speech intelligibility.

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It is recommended that we investigate hearing technology more, with a particular focus on the digital hearing aids' channels and other improving features. To enhance generalizability, suggesting repeating the study with a bigger, more varied population.

DECLARATIONS & STATEMENTS

Author's Contribution

SA and AQA: substantial contributions to the conception and design of the study.
SA, AQA: acquisition of data for the study.
SA: analysis of the data for the study.
SA and AQA: interpretation of data for the study.
SA, FM and HN: drafted the work.
SA, FM, HN and AQA: revised it critically for important intellectual content.
SA, FM, HN and AQA: final approval of the version to be published and agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All authors contributed to the article and approved the submitted version.

Ethical Statement

The study was conducted with permission from competent authorities of Siemens Hearing Clinic (SHC/Ref-2023/10-1) Islamabad, Hearing and Speech Care Clinic (R. No-HSCC/1206) Rawalpindi and RHS (No:RHS/EC/02-06-2023-01) in Islamabad.

Consent Statement

Informed consent was obtained from parents/guardians of all children involved in the study.

Data Availability Statement

Due to privacy the data presented in this study are available upon request from the corresponding author, as they are not publicly accessible.

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Conflicts of Interest

The authors declare no conflict of interest.

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Research Article

Effectiveness of progressive muscle relaxation on sleep disturbance in athletes

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Abstract

Background: Athletes have general complaints about sleep disturbance which is important for body recovery, healthy brain and body functions, tissue wear and tear, and the body's immune system.

Objective: To determine the effectiveness of Progressive Muscle Relaxation (PMR) on sleep disturbance in athletes.

Methodology: N=24 athletes aged 18 to 36 years participating in a competition were included in a randomized controlled trial. Athletes who were training for a competition, aged between 18 -and 36 years, and athletes with sleep disturbance score (SDS) falling above 4 on the Athletic Sleep Screening Questionnaire were included. Athlete sleep screening questionnaire (ASSQ) was used to assess sleep disturbance score (SDS). Athletes were randomly assigned to the experimental (n=12) and control (n=12) groups. The experimental group was given progressive muscle relaxation and re-assessed the next day for SDS.

Results: The pre-post analysis showed that progressive muscle relaxation reduced the athletes' sleep disturbance score significantly one day after the intervention with a large effect size (p=0.006 Cohen's d= 1.44) in the experimental group. The mean of the mean differences of SDS of both groups were compared which showed a group had a significantly improved sleep disturbance score compared to a control group with a large effect size. (Mean= 1.41 ±1.44 v/s 0.00±1.85, p≤ 0.01, Cohen's d= 1.66).

Conclusion: Progressive Muscle Relaxation exercises can be a non-pharmacological method to help athletes sleep by simple head-to-toe muscles contract and relax technique.

Keywords: athletes sleep quality; athlete sleep screening questionnaire; progressive muscle relaxation; sleep disturbance.

Clinical Trail No: *NCT05695092*

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INTRODUCTION

Sleep is an important recovery process, and an athlete's health arguably includes healthy cognition, emotional state, metabolism, tissue regeneration, immune system, and other normal body functions [1]. Sleep deprivation affects a person's learning ability, cognition, learning, and psycho-social well-being, as well as short-term and long-term memory [2]. Additionally, it hinders the capacity to respond to vaccination and respiratory infections as cellular wear and tear, glucose metabolism, and other factors [3, 4].

Less or compromised sleep is a typical complaint reported by athletes and it negatively affects the sports performance of a player[5]. The exact reason behind athlete sleep disturbance is unknown, however general anxiety disorders, idealism, energy deprivation, and any previous history of head injury can be the contributing factor [6] The sleep deprivation before contests is mainly competitive ideas" and thoughts about performance, whereas sleep disorders and stress were considered to be due to negative perfectionism image which leads to cerebral arousal and preconceived ideas[7] (7). However, not everyone has the impact of these factors, psychological traits such as generalized anxiety disorders, and negative idealism can make some people more inclined towards sleep disorders[8].

Intervention strategies to improve sleep quality and duration and are being used internationally are GABA agonists and benzodiazepines, cognitive behavior therapy, power naps, sleep education charts, light treatment, sleep extension, and relaxation methods[9, 10]. Progressive muscle relaxation (PMR) is one of the most extensively researched relaxation strategies supported by the American Psychological Association as a potential treatment for insomnia[1]. It is a mental and body calming technique invented by Jacobson in 1938 that works on the mechanism of tensing the muscle and then a relaxation period to relieve mental and physical fatigues and improve the concentration ability by activating the peripheral nervous system and decreasing cortisol levels and pulse rate[1, 11, 12].

PMR has a variety of physiological benefits such as regulating blood pressure, reducing fatigue, tachycardia, and pain, improving body equilibrium, better sleep, and body's energy availability along with psychological benefits including reducing stress and anxiety as well as increasing perceived alertness [13]. The mechanism of its efficacy is thought to be linked to stress and sleep problems [14]. PMR has shown promising results in improving sleep in clinical populations however athletes who used it as a treatment of anxiety found mixed results[7].

Knowing all the benefits of good quality sleep and potential risk factors of sleep deprivation in athletes, sleep education is not a common practice in Pakistan. Considering sleeping aids such as hypnotics and drug use have side effects such as withdrawal symptoms, drug resistance, and compromised performance non-pharmacological methods are considered safe however each method has its impact. PMR has been considered one of the cost-effective and simple methods for easing sleep with no side effects. However, its use and effective dose were not evaluated during any competition/tournament where athletes experience more sleep challenges which can affect their performance as well. So the study objective was to determine the effectiveness of progressive muscle relaxation on sleep disturbance in athletes. The study hypothesis was that PMR would be effective in improving athletes' sleep.

METHODOLOGY

Study Design: a single-blinded, randomized clinical trial was conducted (NCT05695092) after approval (No.F.81-2/2022-PSB(R&T) from the competent authority at Pakistan Sports Complex Islamabad and Midfield Football Club and Academy (Mid-F-AL-2022/0905). The duration of the study was six months from January 2022 to August 2022. The purpose of the study was explained, and written informed consent was obtained before the start of the study from study participants by the Declaration of Helsinki.

Participants: Athletes who were training for a competition, aged between 18 -and 36 years, and athletes sleep disturbance score (SDS) falling above 4 on the Athletic Sleep Screening Questionnaire were included. On the other hand, the participants who did not perform in sports for more than a year, history of metabolic diseases, were on sleeping aids i.e. sleeping pills or having an acute injury were excluded from the study.

*Sample Size: For sample size determination g*power was used. The power was kept at 80%, the alpha error probability was set at 0.05 and the effect size was considered large (0.8), So the n=26 sample size was determined. A total of* n=65 participants were initially assessed and n=41 were excluded due to not meeting the inclusion criteria (n=34) and declined (n=7) to participate in the study. So, n=26 athletes were randomly allocated to both groups. There was a loss of follow-up in experimental (n=1) and control (n=1) groups due to an unwillingness to participate further, So at the end n=24 participants were analyzed (Figure 1)

Randomization: The sealed envelope method was used for randomization through a computerized random number generator. After obtaining written informed consent from the participants, experimental and control group allocation was done through a sealed opaque envelope allocated by a person not directly involved in the study. It was single blinded study as participants were blinded to the type of group they were allocated.

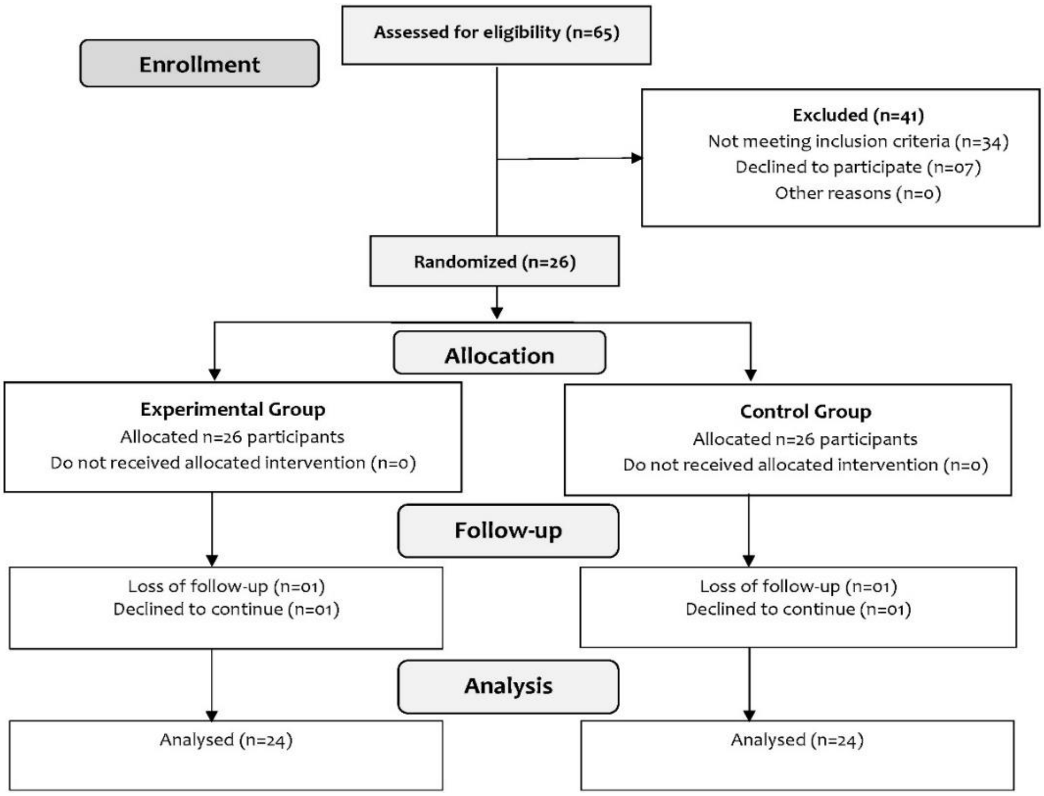

Figure 1: CONSORT diagram

Intervention: Prior to intervention athletes were asked to complete the athlete sleep screening questionnaire which was then scored according to the scoring protocol. The experimental group was given a demonstration about how to contract and relax groups of body muscles using a progressive muscle relaxation protocol. The guidance was kept basic and was effectively comprehended by athletes exposed to Jacobson's progressive muscle relaxation strategy and provides them with a clear image of how to cooperate during the activity. When the researcher was ascertaining about athlete understanding of the protocol. The athletes were asked to sit and relax by keeping their whole body free and light then close the eyes, be agreeable and quiet, stay away from stray contemplations, and avoid unnecessary movements. Contract a group of muscles without repetition, hold that tension for 5 seconds and then relax for 10 seconds, and then contract the next group of muscles. (table 1)

Table 1: Key Muscle Actions To Perform

Wrinkles on brow (try to touch hairline with the brow)
Forceful eye closure
Jaw contraction by teeth clenching forcefully
Pressing the tongue against the palate
The head extension (pushing the headrest backward)
Head flexion (try to touch the chest with jaw)
Tense shoulder-in-shoulder shrugging position
Clenching the hands (right and left separately
Arm flexion
Arm extension
Inflate and deflate the chest by deep inhalation and exhalation
Stomach contraction
Back extension as a whole (make an arch with the back)
Then tense the thighs and glutes (squeeze the buttocks) together
Point toes towards head
Then towards the floor (Toe curling)
Flexing the digits (make fist with feet)

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While performing this from head to toe notice the sensation of tensing and then relaxing the muscles and try to keep other muscles relaxed. Before jumping to the next group of muscles take three deep breaths by inhaling through the nose, and exhaling through the mouth. After this, completely relax the whole body by silently breathing in and out for two minutes, and then enjoy the energy and calmness afterward. The whole protocol takes 20 minutes to complete [14]

The control group was given active range of motion exercises within the range without any stretch on the shoulder (flexion, extension, abduction, and adduction) elbow (flexion, extension), hip (flexion, extension, adduction, abduction), and knee (flexion, extension). 5 repetitions of each activity were performed at a minimum dose with no proven effect on sleep and relaxation. It was used in this study as the placebo effect.

Outcome measures: Sleep disturbance score (SDS) was calculated using the Athlete Sleep Screening Questionnaire (ASSQ) for the pre-SDS score prior to the PMR session and post-SDS score after 24 hours of assessment of the athlete's sleep during the study. Which has internal consistency (Cronbach's alpha = 0.74), test-retest reliability (r = 0.86), specificity of 93%, and an acceptable sensitivity of 81% (15). It included 5 items about total hours spent in bed, perceived satisfaction with the quantity of sleep, time taken to fall asleep, trouble staying asleep and sleeping pills use. SDS was calculated as a scoring protocol described by Bender et al. by adding five questions from ASSQ and used to categorize athletes into four groups according to the severity: none (SDS 0-4), mild (SDS 5-7), moderate (SDS 8-10), severe (SDS 11-17). The mean score was then compared between both pre and post-PMR and among experimental and control groups.

Statistics: To describe the categorical variables, frequency and percentage were calculated. Means and standard deviations were used to summarize height, weight, BMI, and Sleep Disturbance Score (SDS) as well as individual item scores. For pre and post-sleep disturbance score analysis paired sample t-test was applied to determine the changes in both groups. The comparison independent sample t-test was used to compare the means of Items of both groups as well as the mean of the differences in sleep disturbance score (SDS) of both groups. The level of significance was set at alpha (α) <0.05.

RESULTS

A total of n=24 participants were enrolled in this study, among them n=13 were football and n=11 were taekwondo players. The mean age of study participants was 23.92 ±2.96 years and mean BMI was found 20.818 ± 2.72. A total of n=20 (83.33%) were males and n=4 (16.67%) were females.

Athletes' main sleep problem was difficulty falling asleep n=16 (66.7%), with the main reasons for poor sleep being competition-related thoughts and nervousness n=12(50%). N=3 (12.5%) athletes used relaxation methods as strategies to overcome poor sleep, while n=13 (54.2%) of team sport athletes had no strategy. (Figure 2)

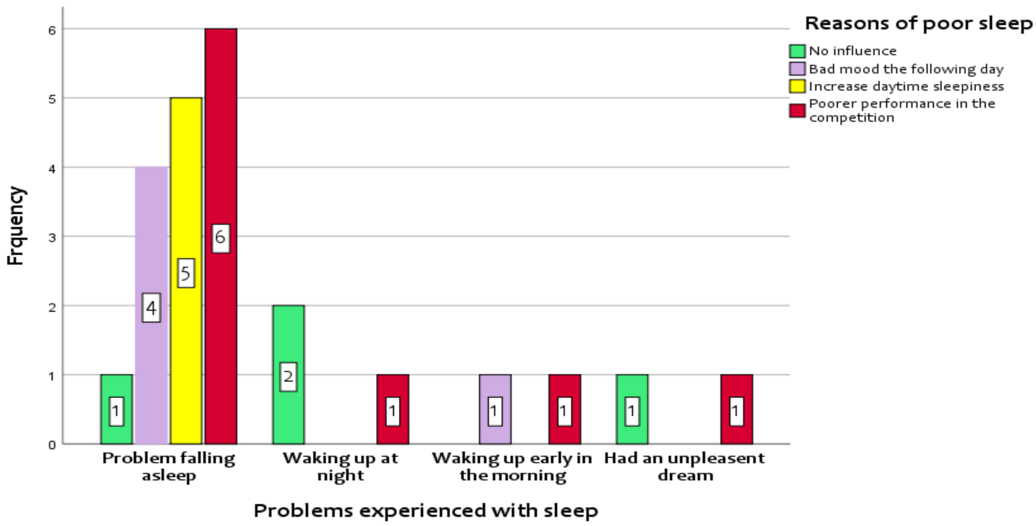

Figure 2: Sleep Disturbances and Their Reasons

The pre-post analysis showed that progressive muscle relaxation reduced the athletes' sleep disturbance score significantly one day after the intervention with a large effect size (p=0.006 Cohen's d= 1.44) in the experimental group. However individual item score was not significantly different (i.e. p ≥ 0.05), only perceived quality of sleep in athletes showed significant improvement post-progressive muscle relaxation (p = 0.02, Cohen's d = 0.67), whereas the mean difference of pre and post-sleeping pill use was found to be unaffected. When looking for the changes in the control group, no significant (p ≥0.05) reduction in sleep disturbance score (SDS) as well as individual item score was observed. (Table 2)

Table 2: Pre-Post Analysis of Sleep Disturbance Score in Both Groups

		Pre		Post		MD	CI 95%	p-value	Cohen's d
	Group	Mean	SD	Mean	SD				
Actual sleep hours	Experimental	3.50	0.67	3.00	0.73	0.50	-0.01,1.01	0.05	0.79
	Control	3.25	.96	3.08	.90	0.167	-0.28, 0.62	0.43	0.71
Perceived quality of sleep	Experimental	1.58	1.16	1.08	0.99	0.50	0.07,0.93	0.02*	0.67
	Control	1.58	1.08	1.50	1.00	0.08	-0.42, 0.58	0.72	0.79
Time taken to fall asleep	Experimental	1.67	1.15	1.42	1.16	0.25	-0.36,0.53	0.38	0.96
	Control	1.33	0.88	1.42	1.24	0.08	-0.58, 0.42	0.72	0.79
Trouble staying asleep	Experimental	1.25	1.13	1.08	1.16	0.167	0.16, -0.20	0.33	0.57
	Control	1.25	.62	1.08	.66	0.167	-0.08, 0.41	0.16	0.38
Sleeping Pill use	Experimental	.92	1.16	.92	1.16	N/A	N/A	N/A	N/A
	Control	.08	.28	.42	.90	0.333	-0.89, 0.23	0.22	0.88
SDS	Experimental	8.91	3.31	7.50	3.08	1.416	0.49,2.33	0.006**	1.44
	Control	7.50	2.11	7.50	2.57	0.000	-1.18, 1.18	1.00	1.85

Significance level-p<0.05, p<0.01** & p<0.001***; SD-Standard Deviation; MD-Mean Difference; CI-Confidence Interval;-SDS-Sleep Disturbance Score.*

There is no statistically significant difference between groups regarding items of SDS-ASSQ. Moreover, the score of sleeping pill use was not comparable at the baseline, so the MD of both group was compared, which showed a non-significant difference (p=0.22) between groups. (Table 3)

The mean of the mean differences of SDS of both groups were compared which showed experimental group had a significantly improved sleep disturbance score as compared to control group with large effect size. (Mean= 1.41 ±1.44 v/s 0.00±1.85, p≤ 0.01, Cohen's d= 1.66). (Figure 3)

Table 3: Comparison between groups

		Experimental		Control		MD	CI 95%	p-value	Cohen's d
		Mean	SD	Mean	SD				
Actual sleep hours	Pre	3.50	.67	3.25	.96	0.25	-0.45,0.95	0.47	0.83
	Post	3.00	.73	3.08	.90	-0.83	-0.78,0.61	0.80	0.82
Perceived quality of sleep	Pre	1.58	1.16	1.58	1.08	0.00	-0.95,0.95	1.00	1.12
	Post	1.08	.99	1.50	1.00	-0.41	-1.26,0.42	0.31	0.99
Time taken to fall asleep	Pre	1.67	1.15	1.33	.88	0.33	-0.53,1.20	0.43	1.03
	Post	1.42	1.16	1.42	1.24	0.00	-1.01,1.01	1.00	1.20
Trouble staying asleep	Pre	1.25	1.13	1.25	.62	0.00	-0.77,0.77	1.00	0.91
	Post	1.08	1.16	1.08	.66	0.00	-0.80,0.8	1.00	0.94
Sleeping Pill use	Pre	.92[a]	1.16	0.08	.28	0.83	0.11,0.15	0.02*	0.84
	Post	.92[a]	1.16	0.42	.90	0.50	-0.38,1.38	0.25	1.04
SDS	Pre	8.91	3.31	7.50	2.11	1.41	-0.93,3.76	0.22	2.77
	Post	7.50	3.08	7.50	2.57	0.00	-2.4-,2.40	1.00	2.84

Significance level-p<0.05, p<0.01** & p<0.001***; SD-Standard Deviation; MD-Mean Difference; CI-Confidence Interval; SDS-Sleep Disturbance Score.*

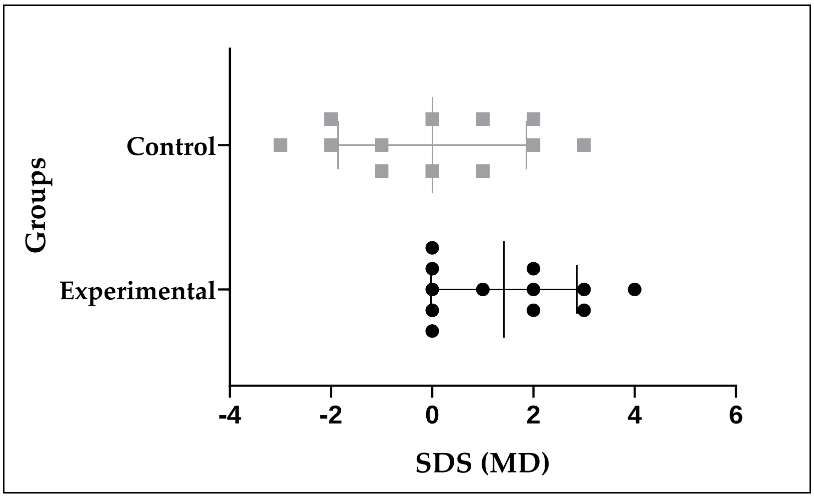

Figure 3: Comparison between the groups (Mean of Mean differences) SDS-ASSQ

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DISCUSSION

This study sought to assess the efficacy of progressive muscle relaxation as a natural sleep aid and recovery strategy for athletes to aid their sleep disturbance. The research hypothesis of this study was accepted, that progressive muscle relaxation is effective in improving athlete sleep.

The results suggested that study participants in experimental groups showed significant improvement in sleep. Furthermore, no significant improvement was found in the control group. The results of pre and post-mean sleep disturbance scores showed a significant reduction in sleep disturbance scores in the experimental group.

The PMR applications in rehabilitation have shown improvements in the sleep previously too but with different populations or different doses or for different purposes such as trait anxiety, and pain [15]. Progressive muscle relaxation (PMR) which is a well-known strategy for insomnia is known to induce sleep [16]. In the current study, the mean pre-PMR actual sleep hours reported by athletes were 5 to 6 hours, and in the post-PMR session it improved to somewhere between 6 to 7 hours however this improvement was not significant statistically, however, perceived quality of sleep was improved significantly from neither satisfied nor dissatisfied to "somewhat satisfied" level, keeping in mind that the study only included athletes with disturbed sleep.

The mechanism behind the effectiveness of PMR on sleep improvement is that muscle tension is a physiological response of the human body to irritating/disturbing thoughts. A person's stress level can be decreased by the dorsal and ventral hypothalamic nuclei equilibrium by reducing sympathetic nervous system activity, it induces physical and mental relaxation thus improving a person's sleep [17]. Keeping in mind the statistics of this research PMR mainly affects the satisfactory level of sleep as it induces relaxation in the body [18]. Athletes in this study achieved relaxation by learning how to tighten and relax muscles and identify stress symptoms. PMR itself has been used previously in athletes in comparison with other strategies as a non-pharmacological way to treat anxiety and a study used PMR to improve sleep in dancers and found a positive association [19]. No previous study was found that using any relaxation method during any competition, therefore the idea of this study came to being.

In the current study, the main reason for poor sleep during a competition reported by athletes was competition-related thoughts, poor performance the following day, and nervousness, which can be due to internal and external fear and can cause somatic responses such as tachycardia, blood pressure, and hormone level[19, 20] The PMR work on the mechanism of conscious activation of the autonomic nervous system's homeostasis-restoring parasympathetic nervous system (PNS) branch down-regulates the overactive HPA axis, as evidenced by a post-PMR decrease in salivary cortisol[14]. A growing body of research has established a link between trait anxiety and sleep problems [21]. Sports have significant aesthetic and social identity components, which could explain why the current study's sample reported higher trait social evaluation anxiety than physical danger or ambiguous anxiety.

Competitive stress in literature has identified socio-evaluative threat, implying that athletes with high trait social evaluation anxiety may benefit from PMR recovery interventions [22]. The current study results were found positive by addressing the same component behind sleep disturbance i.e. nervousness or thoughts about competition.

The mean time taken to fall asleep after going to bed at nighttime was more than half an hour and most of athletes reported that it usually takes somewhere between half an hour to more than an hour duration to fall asleep. Only slight changes (but not significant) were observed post PMR, results are justified by demographic data where 67 percent of athletes reported problems falling asleep as their main sleep problem. The lack of awareness about screen time and its negative consequences as well as not being aware of healthy methods that can help calm the human mind and assist in better sleep can be the reason for the main problem [23]. Although the athletic population is more prone to sleep and anxiety disorder, only a few athletes reported sleeping pill use among them and those who were using them were not more than once or twice per week as a sleeping aid. As this was a short-term study, we did not find pre and post-PMR changes regarding sleeping pill use.

The limitation of this study is that sleep was not correlated with performance because it was a short-term trial. We could not conduct it in any National or International tournament which usually continue for days or weeks so we could evaluate the effects of multiple sessions for multiple days. Furthermore, sleep problems can differ depending on the type of sport, so a large sample study focusing on each sport discipline may address this better. The sample size was small, and we used convenient sampling which usually compromises the generalizability of results.

CONCLUSION

The study showed that Progressive muscle relaxation a non-pharmacological method can improve sleep quality among the athletes ready to participate in the competition by simple head-to-toe muscle contract and relaxation technique. Progressive muscle relaxation is easy to learn, does not require specific equipment, can be done anytime, does not have any potential side effect, and does not require special technology as it is effective for improving athlete's sleep. So, Progressive muscle relaxation can be given by experts or practiced by athletes themselves during a tournament or competition for better sleep.

In the future, long-duration studies can be conducted with multiple sessions of PMR to observe the long-term effects on sleep. The effectiveness of progressive muscle relaxation on sleep and its impact on performance can be correlated.

DECLARATIONS & STATEMENTS

Author's Contribution

SK, AT and NJM: substantial contributions to the conception and design of the study.
SK: acquisition of data for the study.
SK and AT: analysis of the data for the study.
SK, FZ and UA: interpretation of data for the study.
SK and AP: drafted the work.
SK, AT, NJM, FUZ, UA and AP: revised it critically for important intellectual content.
SK, AT, NJM, FUZ, UA and AP: final approval of the version to be published and agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All authors contributed to the article and approved the submitted version.

Ethical Statement

The study was conducted (NCT05695092) after approval (No.F.81-2/2022-PSB(R&T) from the competent authority at Pakistan Sports complex Islamabad and Midfield Football Club and Academy (Mid-F-AL-2022/0905).

Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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None to declare.

Conflicts of Interest

The authors declare no conflict of interest.

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