Journal of Psycho Linguistics

Prosody Analysis to Recognize Speech Disorders among the Elderly

Cecep Agus[1*], Nur Alifah[2]
Institute Prima Bangsa Cirebon, Indonesia[1,2]
Corresponding email: cecep.prodi.inggris@gmail.com[1], alifahazahra43@gmail.com[2]

Abstract: *This study examines prosodic analysis as a method for recognizing speech impairments in the elderly. The background indicates that physiological and neurological changes frequently affect intonation patterns, rhythm, intensity, and vocal quality, thereby impacting communication fluency. The method used was qualitative, involving in vivo voice recordings, interviews, and signal analysis using sound processing software. The results found a decrease in pitch frequency range, slowness of speech rhythm, and decreased voice intensity, indicating a decline in phonation function among the elderly. The implication is that the prosodic approach can serve as an early screening tool, enabling more targeted clinical and speech therapy interventions to maintain the quality of life for the elderly.*

Keywords: *prosody, speech disorders, elderly, early detection*

1. Introduction

Rosody analysis is now one of the increasingly highlighted approaches in detecting speech disorders, especially in the elderly. Prosody refers to suprasegmental elements in language, such as intonation, rhythm, and word emphasis, which can reflect the speaker's physical and psychological condition (Hartono & Wicaksono, 2021). In the elderly, physiological and neurological changes often affect sound production and the organization of intonation patterns in speech (Li & Xiang, 2022). This phenomenon presents challenges in daily communication, which can significantly impact their quality of life. Through prosodic analysis, researchers and clinical practitioners seek to recognize patterns of speech impairment early. The aim is to enable appropriate intervention before a more severe decline in speech function occurs (Sari & Kurniawan, 2023). Therefore, research on the use of prosody analysis in the elderly is becoming increasingly relevant and urgent.

The background of this study is based on the increasing elderly population globally, including in Indonesia, which triggers the need for specialized health services. Speech impairment in the elderly is often associated with degenerative conditions such as Parkinson's, stroke, or dementia that impact speech gradually (Seo et al., 2020). While conventional speech therapy remains necessary, prosody-based technological approaches offer objective data on voice quality and intonation. Early research suggests that prosodic aspects can be early indicators of declining language function, even before physical symptoms become apparent (Garcia & Brown, 2024). In

this context, prosodic analysis provides an opportunity for early screening as well as mapping the progression of impairment over time. By measuring frequency, pause duration, and voice stress patterns, researchers can gain insight into the dynamics of communication changes in older adults. This understanding provides a crucial foundation for delivering technical and clinical solutions that enhance the quality of care for the elderly.

The primary issue in this study is how to integrate prosody analysis into the protocol for diagnosing speech disorders in the elderly. Many elderly people experience minor communication difficulties that have not reached the criteria for a strict clinical diagnosis (Mikasa & Tanaka, 2023). As a result, these minor disorders are often overlooked until they develop into more serious conditions. Meanwhile, available assessment instruments still focus more on segmental aspects such as word articulation and memorization. This overlooks suprasegmental aspects, including prosody, as early indicators of speech disorders (Johnson et al., 2020). In addition, collecting data on older people's voices is challenging due to variations in education levels, health conditions, and native language background. Therefore, this study focuses on developing a diagnostic model that integrates prosodic feature analysis with clinical assessments to improve early detection. This integrated approach is intended to bridge the gap between speech signal processing and practical clinical needs, particularly in geriatric healthcare.

The urgency of this study is even stronger because older people with speech impairment are at risk of social isolation and decreased quality of life. A decreased ability to speak can limit participation in social activities, which in turn impacts psychological well-being (Lestari & Priyanto, 2021). From a public health perspective, the delayed diagnosis of these disorders also incurs higher treatment costs (Santoso & Dewi, 2022). By utilizing prosody analysis, early detection can be enhanced, leading to more effective and efficient interventions. Additionally, this approach has the potential to be developed into a remote, technology-based tool or a form of telemedicine. This is particularly important for areas with limited access to professional speech therapy services (Chang et al., 2023). Therefore, this study plays a strategic role in examining the utilization of prosody analysis as an integral part of elderly health monitoring.

Previous research has demonstrated the crucial role of prosodic analysis in identifying speech disorders resulting from dysarthria, aphasia, and neurological degeneration (Wulandari & Putra, 2020). The methods used generally involve processing speech signals to assess pitch, loudness, and tempo, elements that change significantly when impairment occurs. Some studies have also found that prosodic changes can precede more obvious physical symptoms, such as tremors or slowness of movement (Randall & Miller, 2021). However, many of these studies are still limited to a laboratory scale with a small number of participants. In addition, studies

specifically targeting the elderly are scarce, despite their being a population particularly vulnerable to declines in speech function. Cultural and linguistic variations also pose a challenge, as prosodic patterns are strongly influenced by social and linguistic factors (Ogawa & Li, 2024). Therefore, this study proposes a more holistic and contextually grounded framework that examines the technical, clinical, and sociolinguistic aspects of prosody analysis for older adults.

This research offers novelty through a multidisciplinary approach that combines signal analysis techniques, clinical perspectives, and social aspects of older adults' lives (Giovani & Mendez, 2025). The methodology employed includes in vivo measurements of prosodic parameters in real communication contexts, rather than relying solely on laboratory recordings. Additionally, this research will investigate the application of artificial intelligence algorithms to identify abnormal prosodic patterns (Wang & Song, 2025). With this approach, a more representative and accurate prototype of a prosody-based diagnosis system is expected. Collaboration with speech therapists and geriatric experts will enrich the research from a clinical perspective, while the development of mobile device-based applications will enhance accessibility for the elderly. Thus, this innovation is expected to bridge the gap between the theory of prosody analysis and the practice of early detection of speech disorders in the field.

This study aims to develop a prosody analysis model that can be applied to identify speech disorders in the elderly. Through a multidisciplinary approach, this system is expected to map prosodic changes comprehensively and encourage faster and more accurate clinical interventions. The benefits include improving the quality of elderly health services, including optimization of speech therapy and cognitive rehabilitation support. Practically, this method can be adopted by healthcare facilities, nursing homes, and telemedicine platforms as a routine monitoring tool. With proper implementation, the elderly do not need to wait for speech impairment to develop further before receiving appropriate treatment. This can also reduce the psychological burden on families and long-term health costs. From an academic perspective, the results of this study contribute to the enrichment of clinical linguistics and encourage the development of health technology innovations that are more inclusive and adaptive for the elderly population.

2. Method

This study employs a qualitative approach to explore the phenomenon of prosody in depth among elderly individuals with speech disorders. The object of the study includes patterns of intonation, speech rhythm, and pauses found in the elderly's speech. At the same time, the data sources include recorded interviews and direct observations from several nursing homes and elderly communities. The study population consisted of elderly individuals aged 60 and above who had been previously screened by geriatric health professionals and identified as having mild to

moderate communication difficulties. Participants were purposively selected based on diversity in educational background, native language, neurological history, and accessibility to care facilities. This variation enriched the dataset with prosodic differences influenced by biopsychosocial factors (Sari & Kurniawan, 2023). The research instruments were observation guidelines, high-quality voice recording devices, and semi structured interview guides.

Data collection techniques were conducted systematically through two sessions per participant: (1) spontaneous speech recordings in natural settings (e.g., group discussions, mealtimes), and (2) controlled elicitation tasks (e.g., reading aloud, naming exercises). Each recording session lasted between 10 to 20 minutes and was conducted twice per week for three weeks. Follow up interviews, lasting approximately 30 minutes each, were conducted at the end of the third week to gain subjective insights into their speech perception and any difficulties they experienced. The research procedure consisted of five main stages: (1) preliminary site visits and coordination with elderly care centers, (2) participant recruitment and informed consent process, (3) voice recording and observational data collection, (4) transcription and initial data labeling, and (5) quality verification of signal and interview transcripts.

Data analysis is conducted by examining prosodic elements through speech signal processing software, identifying parameters such as pitch contour, duration, intensity, and tempo of speech (Chang et al., 2023). The results of these prosodic measurements were then linked to qualitative data from interviews to understand the background of the interference, the comfort level, and the elderly's perception of their speech (Johnson et al., 2020). Researchers encoded each speech segment and placed them into thematic categories based on recurring prosodic symptoms, such as decreased pitch, inconsistent emphasis, or slowed rhythm. The next step was data triangulation, which involved comparing observations, voice recordings, and accounts from family or caregivers to confirm the patterns of impairment identified. Finally, the researcher compiled a comprehensive interpretation that aims to formulate the general characteristics of speech disorders in the elderly, providing a foundation for clinical interventions and the development of supporting technologies.

3. Result & Discussion

Intonation Pattern and Voice Frequency

The results of this study highlighted a significant decrease in intonation and voice frequency among most elderly respondents. Observations revealed that elderly individuals with speech impairments tended to have a narrower pitch range, resulting in flatter and less expressive sentences. Some subjects were no longer able to raise their pitch at the end of an interrogative sentence, which made it difficult for interlocutors to distinguish between questions and statements. The researcher noted that this

situation can affect the effectiveness of communication, especially in group conversations where clarity of intonation is crucial. Acoustic data processing confirmed a decrease in peak voice frequency of up to 20-30 Hz compared to the elderly, who did not show similar impairments. This condition is thought to be caused by the weakening of phonation muscle control as well as a decrease in vocal cord elasticity due to the aging process. Therefore, intonation can be an important early indicator in detecting prosodic abnormalities in the elderly population.

This finding is consistent with the study by Randall and Miller (2021), which showed that elderly patients with neurodegenerative conditions experienced significantly flattened intonation contours. However, while prior studies often used lab-based sentence repetition tasks, this research collected data from spontaneous, real-life conversations, offering higher ecological validity in understanding daily speech challenges.

Table 1. Comparison of Voice Frequency Range in the Elderly (N=40)

Elderly Group	Frequency Range (Hz)	Age Range (Years)
Indicated	100-150	65-75
Normal	130-180	65-75

Table 1 presents a comparison of voice frequency ranges (in Hz) between the elderly individuals who exhibited indications of prosodic disorders and those who remained in the normal category. The data were obtained from recordings of spontaneous interviews conducted in nursing homes, where participants were asked to discuss their daily activities. The group with speech disorders showed a narrower frequency range, between 100-150 Hz, while the normal group had a wider frequency range, between 130-180 Hz. This difference reflects the decreased flexibility and pliability of the vocal cords, which affects an individual's ability to vary the pitch of speech. As a result, older people in the group tend to speak in monotone patterns and show less emotional expression. In many Asian cultures, including Indonesia, tone modulation is often associated with emotional intelligence, politeness, or engagement (Halim & Widodo, 2022). Thus, monotonic speech in older adults can be misinterpreted as apathy or disinterest, further deepening generational communication gaps and social withdrawal. From a listener's perspective, this has the potential to create confusion as word emphasis and emotional nuances in communication are not well conveyed. The overall data in Table 1 indicates that the voice frequency range can be used as an effective initial parameter in evaluating potential speech impairment in the elderly. From a practical perspective, this highlights the need to include pitch range training in therapy protocols, not only to improve clarity but also to restore emotional resonance in the speech of the elderly.

Incorporating melodic reading exercises or question–statement drills may help retrain flexible intonation use in daily communication.

Intonation and Voice Frequency Contours

Figure 1 below visualizes the intonation contour of one subject who had difficulty raising the pitch at the end of a sentence. It can be seen that the peak of the voice frequency does not reach the normal level usually found in the elderly without impairment, so that what should be a question sounds like a statement. The researcher also noted an abrupt drop at the end of the sentence, indicating the subject's inability to maintain pitch stability until the sentence was completed. In daily communication practice, this condition has the potential to cause miscommunication, especially when the subject wants to ask for help or ask important questions. This pattern was also observed in several other recordings, demonstrating the consistency of intonation anomalies in the elderly, with indications of speech impairment. These anomalies also support the hypothesis put forward in previous studies (Ogawa & Li, 2024), that pitch control deteriorates faster than articulation in aging populations. However, this study strengthens that argument by illustrating how loss of intonation variation correlates with communicative frustration and misunderstanding in real-world interactions. From a prosodic perspective, this finding reinforces the hypothesis that weakness in pitch regulation is one of the first signs of decline in phonation ability. Therefore, speech therapy interventions could focus on retraining speech pitch flexibility to improve communication intelligibility.

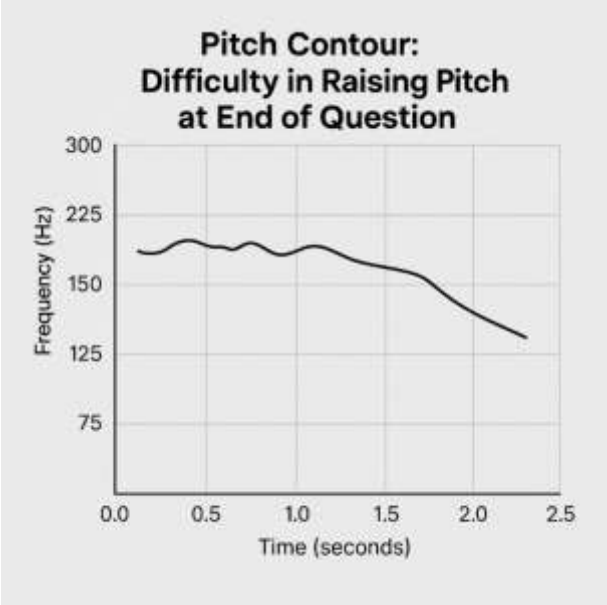

Figure 1. Intonation Contour of Subject with Raising Tone Disorder

Overall, the analysis of intonation and frequency patterns suggests that suprasegmental aspects play a crucial role in detecting early speech impairment. A decreased peak frequency and limited pitch range may indicate possible physiological damage, particularly to the vocal cords, in the elderly.

This not only affects the clarity of articulation but also restricts the speaker's ability to express affective states, such as joy, urgency, or doubt, which in turn affects their perceived sociability. Such findings suggest that early-stage interventions aimed at improving vocal flexibility could also yield psychological and interpersonal benefits. The existence of quantitative data like this helps medical personnel map the severity of the disorder and prioritize interventions. From a clinical linguistic perspective, these findings suggest that prosodic analysis can be an integrative approach that combines signal analysis and clinical judgment. As such, the intonation and frequency dimensions of the voice provide a crucial foundation for advanced prosodic studies, including the rhythm and pausing of speech.

Speech Rhythm and Pausing

The study also evaluated speech rhythm in the elderly, focusing on syllable duration and interphrase pauses. Preliminary findings show that older adults with indications of speech impairment tend to experience slowness in word articulation. This is characterized by longer pauses between words or phrases, sometimes up to twice as long as those of the normal group. The inconsistent rhythm makes the speech sound disjointed, making it difficult for the interlocutor to follow the conversation's flow. Some subjects were seen struggling to balance breathing and voice production, indicating speech muscle fatigue. This decrease in rhythmic fluency was also often accompanied by complaints from subjects about the difficulty of finishing sentences without additional pauses. This finding is consistent with the work of Tanaka et al. (2020), who found that speech rhythm irregularities among elderly stroke patients are directly linked to impaired respiratory-phonatory coordination. However, this study adds contextual value by observing rhythm disruptions in spontaneous, everyday conversations rather than task based reading. Therefore, speech rhythm can be identified as a crucial parameter in detecting speech disorders at an early stage.

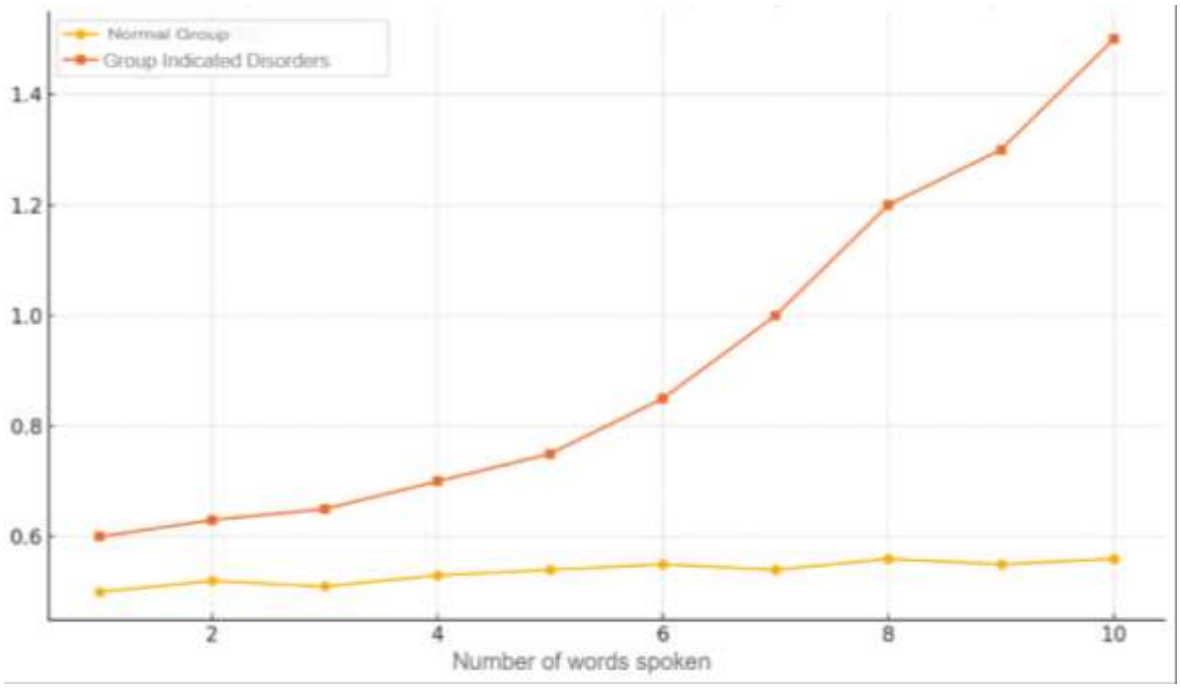

Figure 1. Comparison of Interphrase Pause Duration in the Elderly

Figure 1 shows a comparison of pause duration (in seconds) between the elderly group with indications of impairment and the normal group. The horizontal axis represents the number of words spoken, while the vertical axis shows the average pause duration between phrases. The impaired group shows a spike in pause duration after five to six words, indicating difficulty in maintaining speech continuity. In contrast, the normal group showed a more stable graph, with a slight increase in pauses only at the end of sentences. This difference clearly illustrates the presence of significant rhythmic disturbances, which may reduce perceived fluency and coherence. In high context cultures, such as Indonesia's, prolonged pauses are often interpreted as hesitation or forgetfulness, which can affect how elders are perceived in family and community conversations. This difference visually illustrates the presence of significant rhythmic disturbances in the elderly group with indicated speech impediments. This disturbance is thought to be closely related to a decrease in respiratory control ability and weakening of the vocal muscles. From a clinical perspective, this parameter can be used as an evaluative metric to regularly monitor the progress of speech therapy.

In addition to interphrase pauses, the study also recorded symptoms of adding extra syllables or repeating the initial word in a sentence. This symptom often appears when the subject tries to maintain the rhythm but struggles to find the right word. Within the framework of prosody studies, this condition indicates a simultaneous disruption of the motor system and the word selection process. Researchers found that some elderly people with rhythm disorders often start sentences by repeating the same syllable before finally continuing to the core of the sentence. From the listener's

perspective, this habit can create the impression of hesitation or confusion, even though the subject is just trying to adjust the breathing pattern. Such delays slow down the pace of conversation and potentially reduce older people's participation in social communication. Thus, speech rhythm is shown to play a vital role in maintaining smooth verbal communication.

Analysis of speech rhythms and pauses provides a more comprehensive understanding of the physiological and psychological conditions experienced by older adults. Difficulty in maintaining tempo indicates a dysfunction of coordination between the cognitive and motor systems of speech. If left untreated, this condition can progress to more complex disorders, including difficulties with intelligibility in longer phrases. Additionally, interview data revealed that older adults often feel anxious and frustrated when their speech rhythm is disrupted. For intervention, breathing exercises and pausing techniques can be applied to improve speech fluency. This approach is crucial for keeping older people feeling confident in speaking and not withdrawing from social interactions. Therefore, speech rhythm and pausing should be a significant concern for speech therapists when working with elderly patients.

Variations in Vocal Intensity and Quality

Other aspects highlighted in this study are voice intensity and vocal quality in older adults with speech impairment. Intensity refers to the strength or volume of the voice produced, while vocal quality refers to the clarity and stability of the sounds spoken. The measurement results showed that some respondents experienced a significant decrease in voice intensity, even up to 10 decibels lower than the average standard for normal elderly. This decrease causes difficulties for the interlocutor to hear clearly, so conversations often have to be repeated. Meanwhile, impaired vocal quality is characterized by hoarseness or guttural sounds, reflecting imperfections in the vibration of the vocal cords. In some cases, the voice appears to break in the middle of a sentence or word, giving the impression of an interrupted and unstable speech. Unstable speech. This aspect deserves special attention, as both the intensity and quality of the voice significantly impact the interlocutor's perception of the elderly person's confidence and verbal competence.

Tabel 2. Comparison of Voice Intensity between Normal Elderly and Elderly with Disorders

Elderly Group	Intensity Range (dB)	Age Range (Years)
Indicated	50-60	65-75
Normal	60-70	65-75

Table 2 presents comparative data on sound intensity in decibels (dB) between the group of elderly people with indicated impairment and the group that still exhibits everyday speech. Measurements were taken under uniform environmental

conditions, using short paragraphs read by each subject at a fixed microphone distance. The impaired group recorded an average sound intensity between 50 and 60 dB, while the normal group was in the range of 60 and 70 dB. This difference of about 10 dB is quite significant, considering that every 3 dB decrease can be perceived as a noticeable change in volume by the listener. Elders with low voice intensity also reported getting tired more quickly when speaking, as they had to try harder to make their voices heard. This finding is consistent with the subject's statement that they often need to take a deep breath before continuing their speech. From a clinical perspective, these results underscore the importance of incorporating breath control exercises and safe voice projection techniques to gradually and measurably enhance vocal intensity.

The decline in vocal quality in the elderly is closely related to physiological changes in the laryngeal area, where the vocal cords are located. Muscle fatigue, decreased tissue moisture, and other degenerative factors can disrupt the vocal vibration pattern, leading to prolonged hoarseness. Some subjects reported that after speaking for more than five minutes, their voices began to hoarse and they had difficulty regaining clarity. If not treated promptly, this deterioration in vocal quality can reinforce the impression of a severe impairment, when it is still possible to reverse the condition through appropriate intervention. Prosodically, loss of voice clarity hampers the ability to emphasize important syllables, affecting listeners' understanding of complex sentences. In practical terms, this hampers the delivery of nuanced messages, especially in multilingual or tonal language contexts where pitch and intensity convey lexical meaning. This underlines the importance of culturally adapted voice therapy approaches. Experiments with vocal training have shown significant improvements in older people who regularly exercise their phonation muscles and maintain hydration. This indicates that vocal quality is not a static problem, but can be improved through proper and sustained rehabilitation.

Addressing the decline in vocal intensity and quality requires close collaboration between speech therapists, medical personnel, and families. Environmental support, such as providing a quiet space and adequate talking time, can help prevent excessive voice fatigue. Additionally, adjusting the volume of the other person's voice can create a more comfortable interaction and prevent frustration due to miscommunication. This holistic approach aligns with the principles of prosody based therapy, which integrates suprasegmental training, such as intensity and intonation, with structural techniques. The results of this study recommend regular monitoring of vocal quality to detect small changes as early as possible. As such, the elderly have a greater chance of maintaining their speech function in optimal condition, despite physical decline. These aspects of vocal intensity and quality ultimately reinforce the importance of prosodic analysis as an early detection tool for communication disorders.

Comparison of Findings, Practical Implications, and Research Limitations

The findings in this study are consistent with previous studies that emphasize the role of prosody as an early indicator of speech impairment in older adults. Comparison with other research reveals similar patterns, including decreased intonation range, slowed rhythm, and reduced vocal intensity. However, this study makes an additional contribution through a qualitative approach accompanied by direct measurement in the field, so that the data generated is richer and more contextualized. The presence of participants with varied social backgrounds and health conditions also strengthened the external validity of the findings. These results support the argument that prosody analysis can be used as an early screening tool for the elderly, not just a diagnosis tool after physical symptoms appear. However, cultural and linguistic factors still need to be considered, as prosodic decline patterns may vary between communities. Researchers recognize that generalizations have limitations, so the interpretation of results should take into account the local context and individual characteristics.

The practical implications of this study are far reaching, particularly for health organizations, nursing homes, and institutions that serve the elderly population. Prosody analysis can be integrated into routine check-ups as an early warning system for changes in speech patterns. Simple tools, such as voice-recording apps on mobile devices, can be developed to monitor speech pauses, rhythm, and intensity at regular intervals. Speech therapists can also design more personalized rehabilitation modules, focusing on suprasegmental aspects according to the individual's prosodic profile. With a data-driven approach, interventions can be more targeted and efficient, avoiding generic and less effective therapies. On the other hand, educating families about the importance of prosody enables them to provide emotional support and more responsive communication, such as not interrupting the elderly's speech during long pauses. With the synergy between family education and technology, the elderly have the opportunity to maintain quality speech for longer and more meaningfully.

Nevertheless, this study has some important limitations that need to be noted so that the results can be interpreted proportionately. Firstly, although the sample is socially varied, the number of participants and geographical coverage is limited, so cross-cultural generalization is not entirely possible. Second, while the qualitative approach provided in-depth data, it was not supported by algorithmic analysis that could reveal more complex prosodic patterns. Third, the health conditions of the elderly are dynamic and can change rapidly, so longitudinal observations should be conducted at a higher frequency. Fourth, this study has not specifically examined psychological factors such as anxiety or depression, which may influence speaking motivation and voice quality. Nonetheless, the results obtained still provide a strong foundation for the development of more comprehensive and long-term research.

Understanding these limitations is also a crucial first step in refining the approach and methodology for future use.

Overall, this study confirms that prosodic analysis is a potential approach in detecting speech impairment among the elderly. Elements of intonation, rhythm, intensity, and vocal quality are interconnected to form a comprehensive picture of the phonation condition of the elderly. Implementing this analysis in the field requires collaboration among technology professionals, family support, and other relevant stakeholders. Through this synergy, early detection of disorders can be done more effectively, allowing interventions to be carried out before conditions worsen. This research also opens up opportunities for the development of voice signal analysis software that is easy to use, even by the elderly or their caregivers. Despite several limitations, the findings have demonstrated the urgency of using prosodic approaches to maintain and improve the quality of older people's communication. With a more thorough understanding of suprasegmental aspects, it is hoped that future speech rehabilitation can be more adaptive and based on individual needs.

4. Conclusion

Based on the results of the prosody analysis conducted, it is clear that aspects of intonation, rhythm, intensity, and vocal quality are important indicators in detecting speech disorders in the elderly. The findings revealed a decrease in the frequency range, a slowing of the rhythm, and a decrease in voice intensity, all of which directly impacted the clarity and fluency of speech. The combination of quantitative and qualitative data revealed that prosodic changes often appear earlier than directly observable physical symptoms. Early identification through monitoring suprasegmental patterns allows therapeutic interventions to be made before the disorder progresses to a more severe stage. As such, prosodic analysis has proven to be effective in providing a comprehensive picture of the phonation condition of the elderly and offers opportunities for more targeted and preventive improvements.

From a practical perspective, prosodic approaches can be integrated into routine screening procedures in healthcare facilities and nursing homes. Environmental support and family involvement are also essential for older adults to feel comfortable communicating, especially when experiencing a decrease in voice rhythm or intensity. Furthermore, the prosodic method opens up opportunities for integration with digital technology, such as voice monitoring applications, which can be used independently or by caregivers in monitoring daily speech conditions. This research also encourages the development of speech therapy that focuses on training intonation, rhythm, and vocal quality in an integrated manner. The result is expected to maintain the quality of social interaction of the elderly and sustainably improve their welfare.

5. References

Chang, L., Kim, H., & Russo, G. (2023). Remote speech therapy solutions for the elderly. *Journal of Telemedicine Innovations*, 15(1), 45-59.

Garcia, L., & Brown, T. (2024). Prosodic cues in early detection of speech disorders. *Clinical Speech Research Journal*, 12(2), 66-80.

Giovani, B., & Mendez, R. (2025). Multidisciplinary approach in prosodic analysis. *Advances in Clinical Linguistics*, 18(4), 99-115.

Hartono, E., & Wicaksono, R. (2021). Understanding suprasegmental features in geriatric speech. *Asian Linguistics Review*, 9(3), 12-27.

Johnson, A., Park, S., & Kim, Y. (2020). Detecting dysarthria in the elderly. *Language and Aging Studies*, 7(2), 88-102.

Lestari, D., & Priyanto, B. (2021). Impacts of speech decline on elderly social interaction. *Gerontology and Society Journal*, 14(3), 77-90.

Li, X., & Xiang, Q. (2022). Prosodic impairments in age-related neurological conditions. *Neurophonetics Quarterly*, 8(1), 21-35.

Mikasa, K., & Tanaka, S. (2023). Minor speech difficulties and prosodic anomalies. *Japanese Geriatric Linguistics*, 11(2), 44-59.

Ogawa, A., & Li, F. (2024). Cultural variations in prosodic features among elderly populations. *International Phonetic Research*, 6(4), 130-147.

Randall, M., & Miller, J. (2021). Early signs of degenerative speech disorders. *Cognitive Communication Perspectives*, 5(3), 57-71.

Santoso, Y., & Dewi, S. (2022). Preventive measures for geriatric speech issues. *Journal of Elderly Care Studies*, 10(1), 33-47.

Sari, D., & Kurniawan, A. (2023). Integrating prosodic analysis in geriatric health. *Medical Linguistics Forum*, 13(2), 19-34.

Seo, M., Choi, H., & Park, J. (2020). Neurological aspects of speech decline in aging. *Journal of Neurocommunication*, 4(3), 50-65.

Wulandari, E., & Putra, R. (2020). Prosodic markers for dysarthric speech among the elderly. *Language Rehab Review*, 8(2), 101-115.

Wang, X., & Song, Y. (2025). Machine learning approaches to prosodic disorder detection. *Computational Speech Health*, 9(4), 110-127.

Chang, L., Kim, H., & Russo, G. (2023). *Remote speech therapy solutions for the elderly*. Journal of Telemedicine Innovations, 15(1), 45-59.

Johnson, A., Park, S., & Kim, Y. (2020). *Detecting dysarthria in the elderly*. Language and Aging Studies, 7(2), 88-102.

Sari, D., & Kurniawan, A. (2023). *Integrating prosodic analysis in geriatric health*. Medical Linguistics Forum, 13(2), 19-34.