The influence of hearing impairment level and gender on learning comprehension in badminton: differences in understanding badminton learning

La influencia del nivel de discapacidad auditiva y el género en la comprensión del aprendizaje en bádminton: diferencias en la comprensión del aprendizaje del bádminton

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Abstract

Introduction: This study examined the influence of deafness and gender on deaf students' understanding of short-serve badminton techniques through interactive learning videos.
Methods: Using a descriptive quantitative approach, this study involved 40 deaf students from two Special Schools (SLBs) in Padang, who were grouped by level of deafness (mild and severe) and sex (male and female). Data were collected using a 25-item multiple-choice test that measured the conceptual and technical understanding of short-serve badminton following an intervention using interactive learning videos.
Results: The results of the multiple linear regression analysis indicated that the regression model significantly predicted badminton learning comprehension ($F(2.37) = 19.061$, $p < 0.001$), with a contribution of 50.7% ($R^2 = 0.507$). Deafness rates had a greater negative influence ($\beta = -0.633$, $t = -5.486$, $p < 0.001$) than sex ($\beta = -0.327$, $t = -2.833$, $p = 0.007$). The regression coefficient showed that a one-unit increase in the rate of deafness (from mild to severe) resulted in a 4,550-unit decrease in learning comprehension scores, while a change in gender from male to female resulted in a decrease of 2,350 units.
Discuss: Students with mild deafness showed a much better understanding than students with severe deafness, and male students performed better than female students. These findings highlight the importance of considering each student's unique traits when creating flexible learning methods for physical education, and they also show what teachers need to think about when planning effective learning strategies for deaf students.

Keywords

Multiple linear regression, deaf children, gender, badminton learning.

Resumen

Introducción: Este estudio examinó la influencia de la sordera y el género en la comprensión de los estudiantes sordos de las técnicas de bádminton de servicio corto a través de videos de aprendizaje interactivos.
Métodos: Utilizando un enfoque cuantitativo descriptivo, este estudio involucró a 40 estudiantes sordos de dos Escuelas Especiales (SLB) en Padang, quienes fueron agrupados por nivel de sordera (leve y grave) y sexo (hombre y mujer). Los datos se recopilaron mediante una prueba de opción múltiple de 25 ítems que midió la comprensión conceptual y técnica del bádminton de servicio corto después de una intervención con videos de aprendizaje interactivos.
Resultados: El análisis de regresión lineal múltiple mostró que el modelo de regresión predijo de manera significativa la comprensión del aprendizaje del bádminton ($F(2,37) = 19,061$, $p < 0,001$), con una contribución del 50,7% ($R^2 = 0,507$). Las tasas de sordera tuvieron una mayor influencia negativa ($\beta = -0,633$, $t = -5,486$, $p < 0,001$) que el sexo ($\beta = -0,327$, $t = -2,833$, $p = 0,007$). El coeficiente de regresión mostró que un aumento de una unidad en la tasa de sordera (de leve a grave) dio como resultado una disminución de 4.550 unidades en los puntajes de comprensión del aprendizaje, mientras que un cambio en el género de hombre a mujer dio como resultado una disminución de 2.350 unidades.
Analizar: Los estudiantes con sordera leve mostraron una comprensión mucho mejor que los estudiantes con sordera severa, y los estudiantes varones obtuvieron mejores resultados que las mujeres. Estos hallazgos resaltan la importancia de considerar las características únicas de cada estudiante al crear métodos de aprendizaje flexibles para la educación física, y también muestran lo que los maestros deben tener en cuenta al planificar estrategias de aprendizaje efectivas para estudiantes sordos.

Palabras clave

Regresión lineal múltiple, niños sordos, género, aprendizaje de bádminton.

Introduction

Learning physical education and sports skills for deaf students requires a specific approach that considers their perceptual characteristics and learning styles. Ochoa-Martínez (2020) identified significant differences in motor skills and sports participation between deaf and hearing students Soori et al. (2019) also found that deaf children exhibited deficits in dynamic balance, coordination, and reaction speed compared to children with normal hearing. Kandemir and Kose (2019) showed that deaf students have different patterns of visuomotor coordination development, which require adaptation in teaching. These differences are further emphasized by variations in the degree of deafness that can affect their ability to perceive instructions and translate them into appropriate movements (Smirnova, 2025). Hence, specially designed structured physical activity-based interventions are needed, such as those developed by Kamel et al. (2024), because they have shown significant improvements in gross and fine motor skills in children with hearing loss.

In the context of the sport of badminton, a mastery of basic techniques is important for developing advanced skills. Wang et al. (2025) revealed that perceptual-cognitive skills play an important role in open skill sports such as badminton. These skills are particularly relevant for deaf students, who often experience challenges in information processing and sensorimotor coordination. Alder et al. (2019), in a meta-analysis of perceptual-cognitive skills in sports, found that well-designed video-based learning strategies can significantly improve anticipatory and decision-making abilities in sports, including badminton. Such findings reinforce the need for effective learning media to support skill acquisition in this community.

Recent studies highlight the potential of technology-enhanced learning for deaf students, with innovations such as wearable feedback systems, technology-based balance training, and video-based instruction shown to improve performance in racket sports including badminton (Malwanage et al., 2022; Lin et al., 2023; Dimitrova & Mitrovic, 2022; de Matos et al., 2021). For deaf students, learning media serves as a communication bridge that facilitates the understanding of academic materials and practical skills (Kurniawan et al., 2024). One of the examples of the learning media is an interactive video. Scholars have shown significant potential in improving motor and cognitive skills in students with disability through a multisensory approach that compensates for auditory limitations (Antonietti et al., 2021). Van et al. (2023) further showed that video simulations and virtual reality can improve decision-making skills in sport. They support the potential for adaptation in special education contexts.

Strikingly, gender differences also play a role in adaptive physical education. For instance, Duncan et al. (2021) observed boys outperforming girls in movement quality in the BWF's Shuttle Time program. Similar findings were also reported by Panoutsakopoulos et al. (2024) who identified gender differences in vertical jump performance and other performance metrics. These differences are also evident among students with disabilities. Alhroub et al. (2024) reported that deaf adolescents differ in activity preferences and perceived barriers based on gender, while Zhao et al. (2021) noted that gender-specific methods can lead to better results in training female badminton players. According to Sandbakk et al. (2018) these gender differences might be influenced by complex interactions between biological and sociocultural factors.

Although various studies have examined badminton learning and deaf students, they are typically conducted separately. There remains a significant gap regarding the interaction between deafness and gender levels, in the understanding of badminton short serve techniques through interactive video media. Francisco and Padilla (2024) identified the need for a multimodal approach which considers individual student characteristics, while Shemshack et al. (2021) highlighted the importance of personalizing learning interventions for students with hearing loss based on their sensory and cognitive profiles.

This study aims to answer the following research question: "How do deafness and gender levels affect the understanding of badminton short serve techniques through interactive videos in deaf students?" It aims to contribute to the development of adaptive learning methods that incorporate individual variations among deaf students.

Method

This study used a quantitative approach with a comparative quasi-experimental design to analyze the influence of the level of deafness and gender on the understanding of badminton learning. The researcher measured participants' understanding of basic short serve techniques and rules of the game of badminton after they were given learning media.

Participants

The population in this study consisted of students from SLB 1 and SLB 2 in Padang City who participated in badminton sports learning, with variations in both gender and levels of deafness (mild and severe). The research sample was selected using the purposive sampling technique, which is sampling based on certain criteria that are relevant to the research objectives. Prior to their participation, they were given a consent form stating their volunteering participation and the flexibility to withdraw at any stage of the research via their parents or guardians. Initially, the study involved 73 participants. Then, 40 were purposively selected to become the sample in this study. These participants were divided into four groups: mildly deaf men, severely deaf men, mildly deaf women, and severely deaf women. Each group consisted of 10 people, as illustrated in Table 1. The selection of participants was carried out to ensure that each group met the desired criteria, namely gender and level of deafness, which will be used to measure the influence of these two variables on the understanding of badminton learning.

Table 1. Participants' demographic profile

No	Items	N
1	School origins	
	SLB 1	20
	SLB 2	20
2	Groups	
	Mildly deaf men	10
	Severely deaf men	10
	Mildly deaf women	10
	Severely deaf women	10

Ethical Approval

This study received ethical approval from the Research Ethics Committee of the Directorate of Research and Community Service, Yogyakarta State University (No. T/7.1/UN34.9/PT.01.04/2025), in accordance with the 7 WHO 2011 Standards and CIOMS 2016 Guidelines. All procedures followed ethical principles, including informed consent from parents/guardians, confidentiality, and voluntary participation with the right to withdraw at any time.

Instrumentation and Procedure

Participants' understanding was measured using a validated 25-item multiple-choice test after they watched a 10-minute interactive video demonstrating badminton short-serve techniques. The video included visual adaptations for deaf learners, such as slow-motion replays and sign language inserts. Testing was conducted under supervised conditions immediately following the video intervention.

Data analysis

The analysis technique used is multiple linear regression analysis. This test is intended to find out whether the model to be used in this study is stated to have an independent variable influence on the bound variable, namely the hypothesis to be tested as follows.

H1: $\beta i = 0$. This result means that the variables of gender and deafness level have a significant influence on the understanding of badminton teaching.

H2: $\beta i = 0$. This value means that the gender variable has a significant influence on the understanding of badminton teaching.

H3: $\beta i = 0$. This result means that varying degrees of deafness have a significant effect on the understanding of badminton teaching.

Therefore, to determine the influence of variables in this study, the formula is used:

$$Y = \beta 0 + \beta 1X1 + \beta 2X2 + \varepsilon$$

Information:

Y: Dependent Variables (Badminton Learning Comprehension)

β0, β1, β2: Coeficin

X1: 1st Independent Variable (Gender)

X2: 2nd Independent Variable (Deaf Level)

ε: Error

Results

Instrument Eligibility

Before presenting the results, the questions in the test instrument must pass the feasibility test stage. The results of the feasibility test from instrument experts for student comprehension test questions for badminton learning are provided in Table 2. It can be seen that all test items were classified as very valid. Hence, they can be distributed to the participants.

Table 2. Instrument Validation Results

No	Indicator	Percentage	Information
1	Clarity of each question item	100%	Very valid
2	Clarity of the instructions for filling in the questions	100%	Very valid
3	Question items according to the indicators of assessment of badminton learning comprehension	80%	Very valid
4	The item of the statement about using good and correct Indonesian rules.	100%	Very valid
5	Use simple word choices that are easy for validators and learners to understand.	100%	Very valid
	Average	96 %	Very valid

A total of 40 participants from four groups were given a test after viewing the interactive video. Based on the research objectives, the researcher conducted a descriptive analysis of gender variables and deafness level in understanding badminton learning. The results of the test are presented in Table 3.

Table 3. Gender and level of deafness in understanding badminton learning

	Descriptive Statistics of Gender and level of deafness in understanding badminton learning		
	N	Mean (± SD)	Confidence Interval (CI)
Mildly deaf men	10	84.100 (3.071)	81.90-86.30
Severely deaf men	10	78.100 (2.378)	76.40-79.80
Mildly deaf women	10	80.300 (1.567)	79.18-81.42
Severely deaf women	10	77.200 (2.898)	75.13-79.27

Source: SPSS 2025 Data Processing

Table 3 shows that deaf male participants have higher average scores than deaf female participants. This suggests that in this sample, gender may influence class achievement. In terms of the deafness level, participants with mild deafness showed higher average scores than those with severe deafness. This shows that the level of deafness affects the participant's performance; the lighter the level of damage, the higher the average score.

Assumption Tests

Table 4. Assumption Test Results

Test	Value	Criteria	Conclusion
Normality	P= 0.200	P > 0.05	Data normally distributed
Multicollinearity	Tolerance = 1.000; VIF = 1.000	Tolerance > 0.10; VIF < 10	No multicollinearity
Heteroscedasticity	$p(X_1) = 0.931$; $p(X_2) = 0.270$	P > 0.05	No heteroscedasticity

Source: SPSS 2025 Data Processing

After obtaining differences in gender and deafness level, a normality test was performed to examine whether the variables were normally distributed. Table 4 above demonstrates a normal distribution of two variables: the level of deafness (X1) and gender (X2). This can be seen by the significant value of 0.200 (> 0.05), meaning the data is eligible for multiple regression analyses. In addition to that, a multicollinearity test was conducted. As shown in Table 4, the Tolerance value of the Blind Level (X1) and Gender (X2) variables is 1,000, while the VIF value is 1,000. It can be concluded that the regression model does not have a multicollinearity problem because the VIF value of a variable is less than 5. Another important test to perform is heteroscedasticity. Table 4 presents that the values of Sig X1 (0.931) > 0.05 and Sig X2 (0.270) < 0, so the regression model can be concluded to have no heteroscedasticity problem. Another important test to perform is heteroscedasticity. Based on Table 4, it can be seen that the values of Sig X1 (0.931) > 0.05 and Sig X2 (0.270) < 0, so the regression model can be concluded to have no heteroscedasticity problem.

Multiple Regression Analysis Test

Table 5. Multiple Regression Analysis Results

Coefficientsa						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	90.275	1.808		49.941	.000
	Deaf Rate	-4.550	.829	-.633	-5.486	.000
	Gender	-2.350	.829	-.327	-2.833	.007
a. Dependent Variable: Badminton Learning Outcomes						

Source: SPSS 2025 Data Processing

From Table 5, some regression models can be formulated as follows:

$Y = a + \beta 1X1 + \beta 2X2$

$Y = 90{,}275 - 4{,}550\ X1 - 2{,}350\ X2$

1. The regression equation was known to have a constant value of 90,275, meaning that without the variables of the level of deafness and gender, the learning outcomes of badminton are 90,275 units. The influence of each variable does not depend on the level of deafness and gender. The learning outcomes of badminton are
2. The regression coefficient of the level of deafness (X1) was –4,550, which means that for every 1 unit of increase in X_1, Y will decrease by 4,550 units, assuming X_2 is fixed. This value indicates a negative relationship between X_1 and Y. In short, the more severe the hearing loss, the lower the Y score.
3. The sex regression coefficient (X2) was – 2,350, meaning that for every increase of 1 gender category (from male = 1 to female = 2), the Y value decreases by 2,350 points.

This means that, according to this model, women have lower Y scores than men (since the rise to category 2 leads to a decrease in scores).

Simultaneous Test (F Test)

Table 6. F Test

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	262.250	2	131.125	19.061	.000b
	Residual	254.525	37	6.879		
	Total	516.775	39			

Source: SPSS 2025 Data Processing

As shown in Table 6, it can be concluded that there is a joint influence between the level of deafness (X1) and the type of game (X2) on the understanding of badminton learning (Y). This effect can be seen from the results of data processing, where the significance value is 0.000 < 0.05.

Determination Test

Table 7. Determination Test

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.712a	.507	.481	2.62280

Source: SPSS 2025 Data Processing

Finally, Table 7 demonstrates the R-squared value of 0.507 or 50.7%. This value means that the contribution of deaf (X1) and gender (X2) levels to the understanding of badminton learning (Y) is 50.7%, while 49.3% is determined by other factors that were not present in this study.

The results of multiple regression analysis comprehensively show that the rate of deafness and gender are significant predictors of badminton learning outcomes. The influence of these two variables was proven to be significant when tested together (simultaneously), which was proven by the results of the F test with a significance value of 0.000, well below the threshold of 0.05. This evidence confirms that the regression model used is feasible and able to explain the relationship between variables convincingly.

Furthermore, the power of this model in explaining the phenomenon studied is substantial. The value of R Square (R^2) obtained is 0.507. This figure indicates that 50.7% of variations or changes in scores in badminton learning outcomes can be explained by a combination of deafness and gender variables in the field. Other factors outside the scope of this study influenced the remaining 49.3%.

Analyzed individually, both variables also showed a significant partial influence. The variable rate of deafness has a significant negative influence (B = -4.550; p = 0.000), which means that the more severe the deafness rate of a student, the more likely his learning outcomes are to decrease. Similarly, the sex variable showed a significant negative influence (B = -2.350; p = 0.007). In the context of this study, it implies that female students tend to have lower learning outcome scores than male students.

Discussion

This study aims to analyze the influence of the level of deafness and gender on the understanding of learning badminton in deaf students. The results of statistical analysis show that these two variables significantly function as predictors of learning outcomes. In this section, these key findings will be elaborated in depth, critically linked to previous theoretical and research frameworks, as well as their practical implications for the world of education and future research directions.

The Effect of Deafness Rate on Learning Outcomes

The main finding of this study is that there is a significant negative relationship between the rate of deafness and the understanding of learning badminton. Specifically, the results of the analysis indicated that the heavier the deafness rate (X_1), the lower the learning comprehension score (Y) achieved by students. These findings confirm an initial hypothesis and are in line with various previous studies that highlight the unique challenges faced by deaf individuals in the context of physical education.

The fundamental explanation for this phenomenon lies in communication and sensory barriers. The process of learning badminton relies heavily on verbal instructions from the coach, auditory cues such as the sound of the shuttlecock when hit, and nonverbal communication between players, which is often accompanied by voice cues. Students with severe deafness lose access to this auditory information, so they have difficulty understanding the techniques, strategies, and rules of the game in their entirety. This argument is reinforced by Nur et al. (2019), who assert that the challenges in understanding verbal instruction and auditory cues have a direct impact on students' levels of involvement and understanding in sports activities.

Furthermore, this difficulty extends beyond just communication. Research by Muḥammad & Yahya (2022) notes that deaf children also tend to experience obstacles in basic biomotor skills. These limitations, coupled with difficulties in understanding instructions, create dual challenges that can hinder mastery of techniques and strategies in complex sports such as badminton. However, it does not mean that accomplishments are impossible to achieve. A study by Farida (2020) in the context of physics, which is also relevant in principle, emphasizes that the application of appropriate and adaptive learning methods has been proven to improve the learning achievement of deaf students. This suggests that we can mitigate these barriers with the appropriate approach.

The Influence of Gender on Learning Outcomes

The study also found that gender (X_2) had a significant influence, with female participants in this sample tending to have lower comprehension scores than male participants. It is important to interpret these findings carefully, as these differences are most likely not due to innate ability factors but rather to social constructs, motivations, and different learning style preferences.

Support for this explanation is also provided by Al Salim (2024), who examined the motives underlying male and female college students' participation in physical activity and the types of activities they prefer. The study highlights that differences in participation motives are closely linked to the kinds of physical activities chosen by each gender.

Furthermore, Fatmawati et al. (2020) found that there are differences in learning styles between male and female students. Male students are more dominant in having a visual learning style, while dominant female students have a kinesthetic learning style. This difference in learning style can affect the way students understand and practice badminton techniques. Research by Nugroho et al. (2024) shows that, in the context of badminton, which relies heavily on technical (visual) demonstrations, students with visual preferences may have an early advantage. On the other hand, students with kinesthetic preferences need more opportunities to "feel" movement directly, which demands a different teaching approach from the teacher.

Statistically, the regression model in this study proved to be significant, where the rate of deafness and gender together were able to explain 50.7% of the variation in badminton learning outcomes. These figures demonstrate that both factors are crucial variables that demand attention. These findings have urgent practical implications for stakeholders in the education sector. There is a real need for teachers and trainers to move from a "one for all" approach to the development of adaptive learning strategies. For deaf students, this means maximizing visual demonstrations, tactile feedback (touch), and the use of assistive technology, in line with the idea of (Mahdiyah & Kasih, 2023) regarding the importance of modeling learning styles to design effective learning interactions.

Furthermore, it is necessary to implement gender-responsive pedagogy, where teachers consciously identify and respond to differences in motivation and learning styles. This can be realized by providing a variety of activities (competitive and recreational) and applying a balanced teaching method between visual and kinesthetic. As suggested by Pratama (2024), support tailored to individual needs is key to improving learning outcomes evenly. Ultimately, these strategies should be supported by inclusive physical education curriculum reforms, which are explicitly designed to equip teachers with guidance and resources in teaching technical sports to students with diverse needs.

While it provides valuable insights, this study has some limitations that need to be acknowledged for a balanced interpretation. First, relatively small sample sizes and limited geographic scope may limit the ability to generalize results to a broader population of deaf students. Second, the study focused only on two independent variables. Although significant, these two variables only explain about half of the variability of learning outcomes, leaving 49.3% of the variance influenced by other factors not measured in this model. As highlighted by Lomboan et al. (2023), factors such as playing experience, social support, and intrinsic motivation can also significantly affect learning outcomes.

Therefore, to build on the foundation of this research, it is strongly recommended that future studies overcome these limitations. Further research efforts can be directed to expand the scope of the sample by involving participants from various geographical backgrounds to improve external validity. In addition, it is important to add research variables by including psychological and environmental factors, such as intrinsic motivation, family support, previous sports experience, and the effectiveness of specific

teaching methods. Finally, to gain a more profound and holistic understanding, it is recommended to use a mixed-methods design.

Conclusions

Based on the results of data analysis obtained through multiple regression tests, F tests, and determination tests, it can be concluded that the level of deafness and gender have a significant influence on the understanding of badminton learning in deaf students. The regression model shows that the two independent variables together explain 50.7% of the variation in students' understanding of badminton learning materials. In particular, the rate of deafness has a significant negative influence, where an increase in the rate of deafness of students leads to a decrease in comprehension scores by 4,550 points. The study indicates that the more severe the hearing loss experienced by students, the lower their ability to understand sports learning materials. Meanwhile, gender also exerts a significant negative influence, with female students tending to have lower comprehension scores than male students. Differences in learning styles, levels of participation in physical activities, and learning motivation between male and female students contribute to this factor. Thus, students' understanding of badminton learning is not only influenced by individual abilities, but also by the accompanying biological and social conditions.

Looking at these findings, it is recommended that physical education teachers in special schools pay more attention to the differences in students' abilities based on the level of deafness and gender. Adaptive and inclusive learning approaches need to be developed, such as the use of visual media, hands-on demonstrations, and simple and clear instruction to support deaf students in understanding sports learning materials. In addition, it is important for teachers to encourage the active involvement of female students in sports activities by providing equal opportunities and paying attention to their learning styles that tend to differ from male students. Educational institutions are also expected to provide special training to educators so that they are better prepared to face the challenges of teaching in inclusive classrooms or in special schools. For further research, it is recommended to include additional variables such as learning motivation, interests, playing experience, and teachers' teaching strategies in order to obtain a more comprehensive understanding of the factors that affect the success of badminton learning in deaf students.

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