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Variability of physiological attributes among athletes with different disabilities

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ABSTRACT

Understanding physiological diversity among athletes with disabilities is vital for designing effective training methods and ensuring equitable participation in sports. The present study examined the differences in physiological attributes among athletes with varying types of disabilities. A purposive sampling technique was used to recruit 300 participants, consisting of 75 athletes each with visual impairment (VI), hearing impairment (HI), intellectual disability (ID), and limb deficiency (LD). The research employed a static group comparison design to evaluate variations in physiological outcomes across the groups. To assess the distribution of the data, the Shapiro-Wilk test was applied, which indicated non-normality, thereby justifying the use of the Kruskal-Wallis test for statistical analysis. Results showed significant disparities in physiological measures among the four disability categories. Further pairwise comparisons using the Dunn-Bonferroni post hoc test confirmed specific group differences. These findings demonstrate that athletes with disabilities present distinct physiological patterns, underscoring the importance of customized training strategies and inclusive practices to enhance athletic performance.

Keywords: *Disability, Athlete, Physiology*

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1. INTRODUCTION

Disability is a multifaceted condition that encompasses a wide array of physical, cognitive, and sensory impairments. Each influences the way an individual engages with the world. It is an inherent aspect of human existence, with approximately 1.3 billion people, or roughly 16% of the global population, experiencing some form of disability. This number is on the rise, influenced by factors such as an aging population and the growing prevalence of non-communicable diseases (WHO, 2011). As the world's population ages and chronic health conditions become more common, the number of individuals living with disabilities is expected to continue increasing. In essence, engaging in regular physical activity can help prevent illness, encourage a more active lifestyle, reduce health risks, and enhance physical work capacity (Carmeli et al, 2005; Chanias et al, 1998; Fernhall, 1993; Fragala-Pinkham et al, 2005; Frey et al, 2008). However, numerous studies have found that individuals with disabilities often perform below average on typical fitness assessments (Franciosi et al, 2010). Due to reduced physical activity, individuals with disabilities often face a decline in their physiological functions (Kim et al, 2024; Lopes et al, 2021). Moreover, the physiological variable of hypertension is one of several cardiovascular risk factors that can contribute to the onset of functional disability also (Hubert, H. B., & Fries, J. F. 1994; Pinsky et al, 1985).

In the realm of sports, disabilities are grouped according to the nature of their impairment, including categories such as visual impairment (VI), hearing impairment (HI), intellectual disabilities (ID), limb deficiency (LD), and so on. Each category presents its own set of challenges, requiring specialized training methods and performance strategies. As these athletes participate in sports, their physiological reactions, particularly their systolic blood pressure (SBP), diastolic blood pressure (DBP), and pulse rate (PR) differ from those observed in non-disabled athletes, making it crucial to examine how these variables manifest in each group. The cardiovascular system, which includes the heart, blood vessels, and blood, plays a central role in physical performance by supplying oxygen and nutrients to tissues during exercise. However, the functioning of this system can be altered in individuals with disabilities. The physiological response to physical activity may be influenced by the specific nature of the impairment, impacting how effectively the body handles exertion. For instance, athletes with limb deficiency often experience disruptions in autonomic regulation, leading to significant differences in their cardiovascular responses, such as changes in heart rate during both rest and physical activity. On the other hand, athletes with sensory disabilities like visual or hearing impairments tend to exhibit cardiovascular responses that are more similar to those of able-bodied athletes, as their disability does not typically affect the cardiovascular system directly but rather influences sensory processing (Soto-Rey et al., 2024). Blood pressure (BP) in individuals with intellectual disabilities may vary from that observed in the general population (Axmon et al, 2017).

The average PR observed in individuals with visual impairments during gameplay were generally comparable to or higher than those of individuals without visual impairments (Tsurui, T., & Kakizawa, T., 2020). Individuals with various disabilities generally exhibit a higher pulse rate than those without disabilities. This increase is often linked to the specific physiological changes caused by their conditions. Recognizing these differences is essential for developing individualized training programs that not only optimize athletic performance but also prioritize the safety and health of athletes with disabilities. Monitoring cardiovascular markers such as SBP, DBP, and PR provides valuable insight into how the body adapts to physical activity in individuals with disabilities, helping to improve training strategies, prevent cardiovascular issues, and enhance overall performance (Soto-Rey et al., 2024).

2. REVIEW OF LITERATURE

Sedentary behavior increases the risk of hypertension and cardiovascular diseases, particularly among visually impaired individuals (Eelke & Folmer, 2015). Engaging in physical activities, such as competitive sports, can mitigate the negative cardiovascular effects associated with visual impairment (Kakiyama, 1999). During stressful situations, visually impaired individuals often exhibit heightened heart rate variability, which may impair their ability to cope with everyday tasks (Moreno et al., 2019). Visually impaired individuals generally exhibit lower levels of physical activity, leading to potential cardiovascular issues. Moreover, visual impairment has been associated with reduced aortic distensibility, suggesting potential blood pressure problems (Kakiyama, 1999). Elevated systolic blood pressure was linked to a greater likelihood of hearing impairment at 1 kHz (Miyata et al, 2022). The study demonstrated that the foam rolling recovery method following submaximal exercise led to a notable improvement in heart rate variability in deaf basketball players compared to passive rest. However, it showed no significant differences in HRV or blood pressure compared to dynamic stretching (Güngör et al, 2022). The study found that a significantly high prevalence of hypertension in individuals with intellectual disabilities was linked to elevated BMI, body fat percentage, and poor performance on the 3-minute step test (Jeoung, B., & Pyun, D. Y, 2024). People with intellectual disabilities who walked more did not show a significant reduction in blood pressure (Stanish, H. I., & Draheim, C. C., 2007). Rates of high blood pressure (HBP) were significantly elevated among individuals with more severe disabilities (Kim et al, 2024).

3. NEED OF THE STUDY

Research suggests that athletes with various disabilities may show unique autonomic and cardiovascular responses due to the specific nature of their impairments. For instance, athletes with VI may experience elevated blood pressure, which is linked to altered autonomic control. This is often due to the lack of visual cues, which are crucial for spatial awareness and regulating physiological processes. On the other hand, athletes with HI, who depend heavily on visual and tactile feedback for communication, may face increased mental stress during physical activities, which could lead to higher pulse rates and blood pressure levels.

Athletes with ID often exhibit distinct cardiovascular responses due to the combination of cognitive and emotional stressors, which can affect heart rate variability and the stability of blood pressure during exercise. Likewise, individuals with LD may show varied cardiovascular responses depending on the nature and severity of their condition. This variability can influence key measurements such as blood pressure and pulse rate, with different types of physical impairments affecting energy expenditure and autonomic functions. Gaining a deeper understanding of these physiological variations is essential for creating individualized training and health programs that cater to the distinct needs of athletes with disabilities. The distinctive value of this study lies in its comparative approach, which contrasts physiological responses among athletes with different disabilities, rather than focusing on a single category. This cross-comparative analysis helps identify specific cardiovascular challenges and physiological performance capabilities tied to each impairment. As inclusive sports gain more emphasis, it becomes critical for coaches, sports scientists, and healthcare professionals to have access to empirical evidence to guide their practices. This ensures that athletes with disabilities are properly monitored, receive appropriate training, and are managed effectively to mitigate cardiovascular risks. By better understanding these physiological differences, the study will contribute to reducing injury risks, optimizing athletic performance, and enhancing the overall health and quality of life for athletes with disabilities. Moreover, the findings can help create more inclusive and supportive sports environments, fostering equal opportunities for all athletes, regardless of impairment type.

Goal of The Study
This study seeks to investigate the physiological variables, specifically blood pressure and pulse rate, among athletes with visual VI, HI, ID, and LD. And also the study seeks to identify potential differences in physiological responses across these groups.

Objectives
- To find athletes with VI, HI, ID, and LD
- Acquire relevant data on the key physiological attributes
- To reveal the contrast in identified parameters across athletes with different impairments

Hypotheses
There is a marked difference in SBP, DBP, and PR levels between athletes with diverse impairments

4. METHODOLOGY

Sample
A purposive sampling method was utilized to recruit 300 athletes with disabilities from Tamil Nadu. Of these, 75 athletes had VI, 75 had HI, 75 had ID, and 75 had LD.

TABLE-1

Parameter choosing

S.no	Parameter	Gauzed by	Gauzed in
1	PR	Pulse oximeter	Beats per minute (BPM)
2	SBP	Sphygmomanometer	Millimeters of mercury (mmHg)
3	DBP		

Research design
For this exploration, a static group comparison design was applied. Potential differences were assessed by comparing the test results from four separate participant groups.

Assessing the pattern of data distribution
It is essential to assess the normality of the collected data before conducting any statistical analysis. Understanding the dispersion of the dependent variable's values is key to this step. In this study, the Shapiro-Wilk test was applied to check for normality.

TABLE-2

Overview of Shapiro-Wilk Test Statistic for Normality

Parameter	Group	Statistic	df	Significant
PR	VI	0.938	75	0.001
	HI	0.951	75	0.006
	ID	0.963	75	0.029
	LD	0.955	75	0.009
SBP	VI	0.943	75	0.002
	HI	0.932	75	0.001
	ID	0.952	75	0.006
	LD	0.896	75	<0.001
DBP	VI	0.960	75	0.019
	HI	0.959	75	0.015
	ID	0.948	75	0.004
	LD	0.947	75	0.004

The data for all group parameters were assessed for each characteristic using the Shapiro-Wilk test, as indicated by the results in Table - 2. Notably, the obtained values were below 0.05, indicating that the data distribution was abnormal.

Statistical technique

To scrutinize and contrast the physiological profiles of visually impaired, hearing impaired, intellectually disabled, and limb-deficient participants, the following statistical techniques were adopted. A Kruskal-Wallis test was performed to determine if there were any statistically significant variations between the four distinct disabled groups. This test identifies whether there is a meaningful variation in the means of the groups. When the Kruskal-Wallis test yielded significant results, the Dunn-Bonferroni post hoc test was conducted to explore the pairwise comparisons. Hypotheses were tested using a significance level of 0.05 in all cases.

5. RESULT

TABLE-3

Kruskal-Wallis test for scrutinizing the variations across different impairments

Parameter	Group	Mean	SD	N	Mean rank	Chi-square	df	P value
PR	VI	85.853	15.749	75	130.14	31.577	3	<0.001* (0.000)
	HI	83.533	16.308	75	116.06			
	ID	94.066	13.575	75	172.22			
	LD	96.693	16.911	75	183.58			
SBP	VI	122.320	14.399	75	155.82	61.599	3	<0.001* (0.000)
	HI	124.160	10.829	75	179.39			
	ID	110.813	12.586	75	84.79			
	LD	123.760	12.479	75	182.01			
DBP	VI	79.653	11.876	75	167.35	34.939	3	<0.001* (0.000)
	HI	75.546	13.103	75	150.21			
	ID	67.346	14.584	75	102.97			
	LD	80.480	10.257	75	181.47			

For PR, the descriptive statistics for each group reveal that the average value for athletes with VI is 85.853 (SD = 15.759), for those with HI is 83.533 (SD = 16.308), for those with ID is 94.066 (SD = 13.575), and for those with LD is 96.693 (SD = 16.911). The mean ranks show that the VI (130.14), HI (116.06), ID (172.22), and LD (183.58). The Kruskal-Wallis test for PR yielded a Chi-square value of 31.577 with 3 degrees of freedom and a p-value of <0.001 (0.000), indicating that there are statistically significant differences in PR across the four groups. Since the p-value is much lower than the 0.05 threshold, the researcher rejects the null hypothesis.

For SBP, the descriptive statistics for each group reveal that the average value for athletes with VI is 122.320 (SD = 14.399), for those with HI is 124.160 (SD = 10.829), for those with ID is 110.813 (SD = 12.586), and for those with LD is 123.760

(SD = 12.479). The mean ranks show that the VI (155.82), HI (179.39), ID (84.79), and LD (182.01). The Kruskal-Wallis test for SBP yielded a Chi-square value of 61.599 with 3 degrees of freedom and a p-value of <0.001 (0.000), indicating that there are statistically significant differences in SBP across the four groups. Since the p-value is much lower than the 0.05 threshold, the researcher rejects the null hypothesis.

For DBP, the descriptive statistics for each group reveal that the average value for athletes with VI is 79.653 (SD = 11.876), for those with HI is 75.546 (SD = 13.103), for those with ID is 67.346 (SD = 14.584), and for those with LD is 80.480 (SD = 10.257). The mean ranks show that the VI (167.35), HI (150.21), ID (102.97), and LD (181.47). The Kruskal-Wallis test for SBP yielded a Chi-square value of 34.939 with 3 degrees of freedom and a p-value of <0.001 (0.000), indicating that there are statistically significant differences in DBP across the four groups. Since the p-value is much lower than the 0.05 threshold, the researcher rejects the null hypothesis.

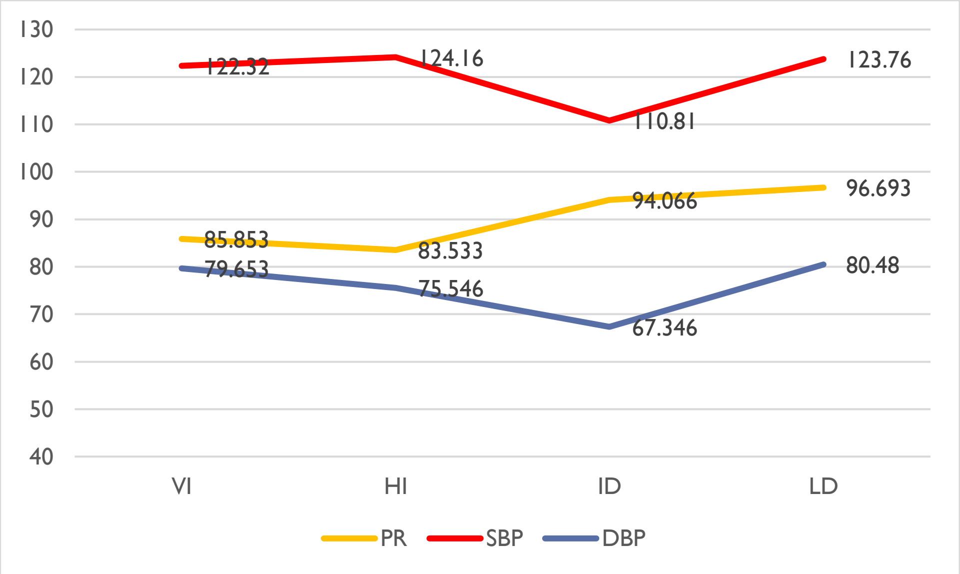

Figure 1: Graphical representation of the average value of PR, SBP, and DBP on various impairment groups

TABLE-4

Dunn-Bonferroni Post hoc test for PR, SBP, and DBP

Parameter	Groups	Mean difference	Test statistic	Std. error	Std. test statistic	Sig	Adjusted sig
PR	VI and HI	2.320	14.080	14.162	0.994	0.320	1.000
	HI and ID	10.533	56.160	14.162	3.965	<0.001	<0.001*
	ID and LD	2.626	11.360	14.162	0.802	0.422	1.000
	LD and VI	10.840	53.440	14.162	3.773	<0.001	0.001*
	VI and ID	8.213	42.080	14.162	2.971	0.003	0.018*
	HI and LD	13.160	67.520	14.162	4.768	<0.001	<0.001*
SBP	VI and HI	1.840	23.567	14.158	1.665	0.096	0.576
	HI and ID	13.346	94.600	14.158	6.682	<0.001	<0.001*
	ID and LD	12.946	97.220	14.158	6.867	<0.001	<0.001*
	LD and VI	1.440	26.187	14.158	1.850	0.064	0.386
	VI and ID	11.506	71.033	14.158	5.017	<0.001	<0.001*

	HI and LD	0.400	2.620	14.158	0.185	0.853	1.000
DBP	VI and HI	4.106	17.140	14.159	1.211	0.226	1.000
	HI and ID	8.200	47.247	14.159	3.337	0.001	0.005*
	ID and LD	13.133	78.500	14.159	5.544	<0.001	<0.001*
	LD and VI	0.826	14.113	14.159	0.997	0.319	1.000
	VI and ID	12.306	64.387	14.159	4.547	<0.001	<0.001*
	HI and LD	4.933	31.523	14.159	2.207	0.027	0.164

For PR, the mean differences between the pairs of groups VI and HI, HI and ID, ID and LD, LD and VI, VI and ID, and HI and LD were 2.320, 10.533, 2.626, 10.840, 8.213, and 13.160, respectively. The adjusted p-values for these comparisons were 1.000 for VI and HI, <0.001 (0.000) for HI and ID, 1.000 for ID and LD, 0.001 for LD and VI, 0.018 for VI and ID, and <0.001 (0.000) for HI and LD. The adjusted significance values for the comparisons between HI and ID, LD and VI, VI and ID, and HI and LD were below 0.05, indicating statistical significance at the 0.05 confidence level. Among the significant pairs, the largest pairwise difference was found between HI and LD, followed by LD and VI, HI and ID, and finally, VI and ID.

For SBP, the mean differences between the pairs of groups VI and HI, HI and ID, ID and LD, LD and VI, VI and ID, and HI and LD were 1.840, 13.346, 12.946, 1.440, 11.506, and 0.400, respectively. The adjusted p-values for these comparisons were 0.576 for VI and HI, <0.001 (0.000) for HI and ID, <0.001 (0.000) for ID and LD, 0.386 for LD and VI, <0.001 (0.000) for VI and ID, and 1.000 for HI and LD. The adjusted significance values for the comparisons between HI and ID, ID and LD, and VI and ID were below 0.05, indicating statistical significance at the 0.05 confidence level. Among the significant pairs, the largest pairwise difference was found between HI and ID, followed by ID and LD, and finally, VI and ID.

For DBP, the mean differences between the pairs of groups VI and HI, HI and ID, ID and LD, LD and VI, VI and ID, and HI and LD were 4.106, 8.200, 13.133, 0.826, 12.306, and 4.933, respectively. The adjusted p-values for these comparisons were 1.000 for VI and HI, 0.005 for HI and ID, <0.001 (0.000) for ID and LD, 1.000 for LD and VI, <0.001 (0.000) for VI and ID, and 0.614 for HI and LD. The adjusted significance values for the comparisons between HI and ID, ID and LD, and VI and ID were below 0.05, indicating statistical significance at the 0.05 confidence level. Among the significant pairs, the largest pairwise difference was found between ID and LD, followed by VI and ID, and finally, HI and ID.

6. DISCUSSION

The physiological characteristics of athletes with various disabilities, such as VI, HI, ID, and LD, exhibit distinct patterns. Differences in PR, SBP, and DBP are evident across these groups. The Kruskal-Wallis tests revealed statistically significant differences for all parameters, providing robust evidence to reject the null hypothesis.

Athletes with VI, HI, ID, and LD recorded higher average PR compared to normal pulse rate levels. The higher pulse rates could result from changes in cardiovascular function related to their impairments or tailored training programs. Variations in physical demands and compensatory strategies might also play a role in elevated PR. Consistent evaluation is essential to better understand these differences and enhance training approaches.

Significant differences in SBP were also observed. Athletes with ID displayed the lowest average SBP, while those with VI, HI, and LD exhibited relatively higher values. Pairwise analyses showed pronounced disparities between HI and ID, as well as ID and LD & VI and ID. The lower SBP in athletes with ID may point to unique cardiovascular dynamics, such as decreased arterial resistance. These differences suggest that individualized cardiovascular conditioning programs are crucial for optimizing performance and maintaining cardiovascular health.

Similarly, DBP showed substantial variability. Athletes with ID had the lowest average value compared to normal DBP. The balance groups' DBPs were almost normal. The largest differences were noted between ID and LD, VI and ID, & HI and ID. This pattern suggests that neurovascular factors or vascular elasticity might influence the lower DBP in athletes with ID. Such variability underscores the importance of tailored approaches to monitor and manage blood pressure in these athletes.

The significant differences in PR, SBP, and DBP among athletes with disabilities highlight the diverse physiological profiles within these groups. Various factors, including metabolic demands, physical activity patterns, vascular dynamics, and the type of disability, contribute to these differences. For example, athletes with ID may require interventions focused on improving cardiovascular function, while those with LD might benefit from strategies that address circulatory challenges.

These findings demonstrate the importance of individualized care in the training and health management of athletes with disabilities. Customized interventions can help enhance athletic performance, prevent potential health risks, and ensure overall well-being. Coaches, trainers, and healthcare professionals must consider these physiological distinctions to develop effective training and health management strategies that cater to the specific needs of each group. Such targeted approaches can foster a safe and supportive environment for all athletes, maximizing their potential while prioritizing their health.

7. CONCLUSION

Athletes with ID consistently exhibited lower values in both systolic blood pressure and diastolic blood pressure compared to their counterparts with other impairments. This pattern suggests that individuals with ID may experience unique cardiovascular adaptations, possibly linked to differences in vascular tone or autonomic nervous system regulation. In contrast, athletes with LD and those with VI and HI displayed SBP and DBP values that were closer to normal ranges. These findings may indicate that individuals with LD, VI, and HI may have cardiovascular responses more aligned with the general population, possibly due to less pronounced neurovascular differences.

However, PR across all disability groups was consistently higher than the normal range, with the most pronounced elevations observed in athletes with ID and LD. The elevated PR in these groups could be a result of increased metabolic demands, differences in cardiovascular efficiency, or adaptive responses to physical activity and training. Higher PRs may also reflect compensatory mechanisms due to mobility challenges in LD athletes or potential neurophysiological differences in ID athletes. These findings underscore the complexity of physiological responses in athletes with disabilities, where each disability type may present specific neurovascular and metabolic dynamics that influence cardiovascular health. Understanding these differences is essential for developing tailored health and training interventions that optimize safety and performance for athletes with diverse needs.

CONFLICT OF INTEREST
Nil

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