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The Role of Assistive Technology and Biomechanics in Supporting Physical Activity for Students with Physical Disabilities

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Abstract

Biomechanics and assistive technology plays an important role in supporting physical activity for students with special needs. This study explores the role of assistive technology and biomechanics in supporting physical activity for students with physical disabilities. The primary objective was to assess how biomechanically informed assistive technologies such as wearable sensors, adaptive sports equipment, and robotic exoskeletons enhance participation, motor performance, and inclusion in school-based physical education programs. A mixed-methods design was used, combining quantitative data from 120 students aged 10–18 with qualitative insights from teachers, therapists, and caregivers. Data were collected using structured Likert-scale questionnaires, biomechanical measurements (gait speed, stride length, joint motion), and semi-structured interviews. Descriptive and inferential statistics were conducted using SPSS (Version 27). Results indicated a strong positive correlation between assistive technology usage and biomechanical performance ($r = 0.68$, $p < .001$) and a moderate positive relationship with physical activity participation ($r = 0.59$, $p < .01$). Regression analysis revealed that assistive technology usage significantly predicted students' participation levels ($\beta = 0.54$, $R^2 = 0.38$, $p < .001$). Moreover, qualitative data supported these findings, highlighting increased motivation, confidence, and social inclusion among students using assistive devices. The study concludes that integrating assistive technology with biomechanical applications can effectively enhance functional abilities, promote engagement, and foster inclusivity in physical education for students with physical disabilities. It is recommended that schools strengthen teacher training, allocate funding for adaptive equipment, and adopt inclusive practices guided by biomechanical insights.

Keywords: Assistive technology, biomechanics, physical disabilities, inclusive physical education, adaptive sports, student participation.

Introduction

Engagement in sports is widely recognized as a key factor in promoting physical health, psychological well-being and social inclusion for children and adolescents Eime, et al., (2013). The students with physical disabilities the imperative is no less significant, yet their opportunities to participate in physical education and sports are often constrained by physical education and attitudinal barriers. Current advances in assistive technology defined by the World Health Organization as product system and services that enhance an individual's functioning and independence (Layton, et al., 2023). align with modern biomechanical tools provide promising means to enhance, access, and engagement. The cooperation of assistive technology and biomechanics holds particular relevance for inclusive physical education and broader agenda of special education

Assistive technology plays an important role in promoting students with physical disabilities to engagement in physical education and sports. Through devices such as prosthetic, orthotics, adaptive equipment, and mobility aids, students can get the batter of physical limitation and involvement of various physical activities (Mishra, et al., 2023). These technologies not only increase capacity but also enhance the inclusion, confidence, and equal facilities in school based physical activity programs (Rimmer, et al., 2016).

Biomechanics complements assistive technology by providing scientific information about body movements and batter use of adaptive devices for good performance and safety (Hall, 2021). Analyzing the movement patterns that improve muscle actions, range of motion of joints biomechanics helps in implementation of interpretations that balance, coordination, and efficiency in students with special needs (Ackland, et al., 2022). The ingratiation of assistive technology and biomechanics enhance physical capability and engagement in inclusive educational settings.

Background of the Study

Assistive technology widely spread from conventional adaptive devices through more sophisticated wearable to robotic exoskeletons and mechanically operated systems designed to assist the movement for children with motor impairments Ali, et al., (2024). Concurrently, biomechanics the scientific study of movement, forces and resultant responses in living systems underpins the design, measurement and evaluation of such technologies (Ali et al., 2024).

In the field of physical education, biomechanics can measure the movement pattern, evaluate the physiological improvement and inform the assistive technology for individual's need. In children with cerebral palsy and other neuromuscular impairments, wearable robotic have been tested to improve the kinetic parameters such as walking speed, stride length, and muscle activation patterns (Hunt, et al., 2022). Existence literature shows that children with cerebral palsy using wearable robotic indicated reduced metabolic cost of walking, enhanced walking speed and improved hip and extension during view point, but sample size and methodological accuracy was limited (Hunt, et al., 2022).

The inclusive physical education has multiple domains; firstly enhancing the physiological capacity assistive technology may contribute a huge participation in physical education and sports. Secondly, using biomechanical measurement can more accurate adaptive interventions and monitoring system. Thirdly, implementing these interventions in school-based physical education programs, we may address fairness in participation for students with physically special needs. These interventions should implementation in every school settings remains uneven and under researched.

Statement of the Problem

The assistive technology and biomechanics has crucial role in rehabilitation and clinical setting that can enhance mobility and function in children with special needs, there remains a considerable gap in converting these advances into school-based physical and inclusive sports programs. A lot of challenges include limited evidence on how these modern technologies affect the regular engagement in physical education and sports behind the clinical settings. Secondly, practical barriers such as costly infrastructure, teacher training, and sustainability of assistive technological use in schools. Lack of agreements on which biomechanical measurements are more suitable and meaningful in school settings. Accordingly, the full potential of assistive technology and biomechanics to support physical activity and inclusion for students with special needs remains un-explored. The problem therefore lies in the underutilization of assistive technology and biomechanics as a tool to support the students with physical disabilities.

Hypotheses of the Study

H1: Biomechanics-informed assistive technologies significantly enhance physical activity levels, and participation of students with physical disabilities in physical education.

H2: Institutional, infrastructural, and attitudinal factors significantly influence the implementation of assistive technologies in inclusive physical education settings.

H3: Teachers, therapists, students, and caregivers hold positive perceptions regarding the usability and impact of biomechanics-based assistive technologies in physical education.

Objectives of the Study

1. To evaluate functional and participation outcomes associated with selected assistive technology interventions in school.
2. To identify practical, organizational and emotional barriers and facilitators to the adoption the biomechanics-informed assistive technologies in inclusive physical education settings.
3. To determine which biomechanical outcome measures are feasible, reliable and informative for monitoring functional change in school-based physical education interventions.

Significance of the Study

This study is very important for sports science, biomechanics, assistive technology and special education a multi-disciplinary sequence increasingly recognized as critical for inclusive practice. By focusing on implementation of technological and biomechanical innovation into school settings, the researcher offers multiple contributions. For educators, therapists and physical education practitioners: evidence on how assistive technology plus biomechanics can enhance participation and motor function for students with physical disabilities. For policymakers and school administrators: insights into the enablers and barriers of integrating assistive technology into inclusive physical education, supporting strategic planning, and resource allocation and teacher professional development. For families and students: improved understanding of the potential benefits of assistive technology in supporting physical activity, health and social inclusion. More broadly, the study supports efforts to reduce inequities in access to meaningful physical activity and aligns with global agendas of functioning, participation and inclusion (World Health Organization, 2022).

Literature Review

Assistive Technology and Biomechanics-Informed Devices

This section describes key categories of assistive technologies and biomechanical devices relevant to children and students with physical disabilities, situating them in the context of physical education and sport.

Assistive Technology: Evolution and Categories

Assistive technology encompasses devices, systems and services used to maintain or improve an individual's functioning and independence (World Health Organization, 2022). Over recent decades, assistive technology has evolved from relatively simple adaptations (e.g., walkers, adapted seating) to sophisticated devices including robotic exoskeletons, wearable, sensor-integrated equipment and soft-robotic supports (Ali, et al., 2024). For example (Zallio, et al., 2022), found that assistive technology is shifting from "products to improve functional capabilities" toward "enabling technologies that facilitate tasks for people with different needs, abilities, age and culture" Within the context of physical activity and physical education for students with physical disabilities, assistive technology may include. Adaptive sports equipment. Wearable devices and sensors that provide feedback. Robotic or powered exoskeletons designed to aid movement, gait, or posture. Soft robotics and compliant assistive suits designed specifically for children.

Biomechanics-Informed Devices & wearable

Biomechanics refers to the analysis of motion, forces and the mechanical responses within biological systems. When combined with assistive technology, biomechanics helps in device design (ensuring alignment of joints, reducing impedance), feedback (movement patterns, gait metrics) and monitoring (objective measurement of functional change). Wearable technologies inertial sensors, EMG, force sensors – now allow for continuous monitoring of movement outside laboratory settings (Simonetti, et al., 2024).

Soft robotic exoskeletons, which leverage compliant actuators and user-centric design, are increasingly seen as alternatives to rigid exoskeletons for children, addressing issues such as fit, comfort, weight and adaptability to growth (Morris, et al., 2023). One state-of-the-art review highlighted six main limitations for current exoskeletons from the user/therapist perspective: safety, one-size-fits-all design, ease of use, weight/placement, cost, and aesthetics (Morris et al., 2023). These insights underscore how biomechanics (e.g., joint alignment, back-drive torque, mechanical impedance) inform the design of assistive technology for pediatric populations.

Considerations for Pediatric and School-PE Settings

When targeting school-age students and inclusive physical education, device design must account for growth (changing limb lengths, mass/inertia), variable movement patterns, peer environments, and educational logistics. A review of pediatric robotic exoskeletons found that design requirements vary substantially with age and growth e.g., actuators must be optimized for children aged 3-18 years, gear ratios and motor air-gap radius vary with age (Zhang et al., 2021). Another human-factors study on a pediatric lower-limb exoskeleton emphasized ease of donning/doffing and adjustability for children (Smith, et al., 2022). Thus, assistive technology and biomechanics in school physical education settings require special design and implementation considerations.

Biomechanical Measures & Monitoring

This section examines the biomechanical metrics, wearable sensor tools and monitoring frameworks used to assess movement, function and participation in children with physical disabilities.

Wearable Sensors and Monitoring Technologies

Wearable sensor technologies (accelerometers, gyroscopes, magnetometers, EMG sensors) are increasingly used to monitor physical activity, movement patterns, gait, balance and muscle activation in children and youth (van Moorsel et al., 2024). A systematic review by van Moorsel and colleagues focused on ambulant children with gait abnormalities and concluded that wearable devices had high to very high reliability (ICC = 0.81 for test-retest; ICC interdevice = 0.99) and moderate to high validity ($r \approx 0.63$ construct, $r \approx 0.68$ criterion) in standardized settings (van Moorsel, et al., 2024). However, they also noted a paucity of studies in free-living or natural environments.

Similarly, wearable devices have been reviewed in sport contexts for persons with disability: inertial and EMG sensors are most common, and applications include athlete classification, injury prevention, performance optimization and custom equipment (Rum, et al., 2021). The utility of these devices in children remains nascent but promising.

Kinematic, Kinetic and Muscle Activation Measures

In biomechanics research, common outcome measures include spatiotemporal gait parameters (walking speed, stride length, cadence), joint kinematics (angles, range of motion), kinetics (joint moments, ground-reaction forces), and muscle activation (EMG). For example, in pediatric robotic exoskeleton studies, improvements in walking speed, hip/knee extension during stance, and reduced metabolic cost were reported (Lau et al., 2022). These measures provide objective quantification of movement changes.

Feedback via wearable sensors or biofeedback devices has also been shown to affect biomechanical performance (Giraldo-Pedroza, et al., 2020). While this is in mature athlete populations, it shows the potential for feedback-driven improvement in movement patterns in younger or disabled populations.

Linking Biomechanical Outcomes to Participation

While biomechanics gives detailed functional data, the link to participation (in physical education, sport, and daily life) is less well established. For instance, a systematic review of upper-extremity exoskeletons in children with cerebral palsy noted that although body function/structure and activity domains improved, participation outcomes (social, school engagement) were rarely addressed (Van Moorsel, et al., 2025). Thus, one key area is aligning biomechanical improvements with meaningful participation outcomes (peer sport involvement, inclusive physical education engagement).

Clinical Evidence: Assistive Technology & Biomechanics in Disability

Here we examine empirical evidence on the use of assistive technologies and biomechanical monitoring carried interventions among children and youth with physical disabilities.

Exoskeletons & Robotic Gait Devices

Systems of robotic gait trainers and exoskeletons designed for children have been evaluated. A systematic review covering 13 studies found that robotic exoskeletons improved gait in children with CP e.g., increased walking speed, improved hip, knee extension, reduced metabolic cost of walking though methodological limitations were noted (Lau, et al., 2022).

Another review focused on upper extremity exoskeletons in children with CP improvements were noted in body functions/structures, but the transition to improved activity and participation was less clear (Van Moorsel et al., 2025). These findings suggest that assistive technology biomechanics can yield functional gains, but the translation into inclusive physical activity participation requires more evidence.

Wearable and Movement Monitoring in Children with Disabilities

Research on wearable in pediatric disability is growing. A study by Van Moorsel, et al. concluded wearable is reliable and valid for ambulant children with gait abnormalities (van Moorsel et al., 2024). In neurology more broadly, wearable sensors have been reviewed for various pediatric neurological conditions tracking daily movement, seizure activity, motor patterns - and show potential but also challenges (Servais, 2025). Importantly for inclusive PE, such wearable could enable monitoring of students' functional movement during PE or sport, enabling tailored interventions, feedback loops and objective tracking of progress.

Assistive Technology Participation and Perception Evidence

The perceived benefits and barriers of assistive technology for children with disabilities and their families and teachers are also documented. A systematic review on children with cerebral palsy found that the use of assistive technology increased independence, self-esteem, inclusion and social participation; however, environmental and attitudinal barriers such as space limitations at schools were reported (Dungca, et al., 2025). Another acceptance review of assistive technology by users with motor disabilities (adult populations) found that learnability, perceived safety, weight, and aesthetics strongly influenced uptake (Ventura, et al., 2023). Although these are adult data, they parallel pediatric issues (e.g., children may be more sensitive to device appearance, peer acceptance).

Implementation in School and Inclusive Physical Education Settings

This section addresses how assistive technology and biomechanics-informed devices are or might be implemented in schools, physical education contexts, including facilitators, barriers and recommended practices.

Current State in School in Physical Education Contexts

The integration of assistive technology and biomechanics in school-based physical education remains relatively limited. While clinical and laboratory studies abound, few robust investigations focus on real-world settings such as inclusive PE classes or sport clubs. Wearable technology reviews in school-age children found that most studies are descriptive and not yet embedded in school interventions (Sousa, et al., 2023). Thus, while the technological capacity exists, translation into inclusive physical education remains emerging.

Facilitators and Barriers

From the reviewed literature, several facilitators and barriers to implementation in school/physical education emerge. As a Facilitators, teacher, therapist training, supportive infrastructure, reliable and child-friendly devices, stakeholder buy-in (students, families) and data/feedback systems that support motivation.as a Barrier**s** high cost of devices, don logistics in physical education settings, device weight and portability, maintenance, comfort for children, growth/adaptation issues, lack of school specialist staff, space constraints and attitudinal, peer-social factors (Morris, et al., 2023).

Practice and Curriculum Recommendations

To effectively integrate assistive technology and biomechanics into inclusive physical education practice, the literature emphasizes a structured and student-centered approach. It is important to begin with child-appropriate, purpose-built devices that match students' physical needs and are compatible with school schedules and routines. Equally vital is the professional training of physical education teachers and therapists in the operation of assistive devices, interpretation of biomechanical data, and adaptation of lessons to ensure inclusivity. Additionally inclusive learning environment should be established for the students with and with special needs participate, together, using adapted equipment and shared feedback systems to encourage cooperation and participation. Furthermore, evaluation should go beyond physical measures to incorporate engagement indicators such as physical activity time, peer interaction, enjoyment levels, and social inclusion to ensure that the implementation of assistive technology and biomechanics exactly boost the overall educational experience (Fernández-Batanero, et al., 2022).

Gaps and Future Directions

The previous literature explore that several gaps that need to be addressed to modern integration of assistive technology and biomechanics in inclusive physical education. The is a need for school-based intervention studies that underscore how these technologies function in real-word educational settings rather than in controlled environment. Furthermore, research should create a excellent relationship between biomechanical improvements and sensor-based performance measures, engagement related outcomes, including social inclusions, active participation time, and self-esteem. There is a gap in evaluation and cost effective and sustainability as school has limited resources and must ensure long-term feasibility of technology interventions. Additionally, longitudinal research is required to measure how children adapt and develop with the use of assistive technology devices in various schools, providing information about growth, learning and functional progression.

Research Methodology

Research Design

This study has quantitative, correlational design and descriptive in nature. The quantitative component evaluates the relation between assistive technology and biomechanical usage of physical activity outcomes among student's physical disabilities. The qualitative component underscores teachers, trainers, and caregivers' perspective on usability, implementation challenges and their impact on students with special needs. Mix methods research produces a comprehensive understanding of how assistive technology and biomechanical concept provide inclusive physical education (Bradley, et al., 2024).

Population and Sampling

The population of this is consisting of students with physical disabilities that enrolled in schools (private and Public) of Punjab province that offer inclusive physical education programs. Participants included such physical disabilities Cerebral palsy, spine bifida, muscular dystrophy, and limb differences. A purposive sampling technique was used for collection of data. Sample size is 120 students, 10 teachers, 5 therapists, and 5 caregivers.

Research Instruments

Likert-scale questionnaire was adopted from physical activity enjoyment scale and participation and environment measure for children and youth. Frequency and time of participation in physical education and sports was used to measure the level of enjoyment, motivation, and inclusion. Biomechanical data was collected by using wearable internal sensors and motion capture software for record. Kinematic variables like posture, angle, and coordination. Physiological variables as heart rate, and energy expenditure were measured. These indicators were help to explore the outcomes that were linked with assistive technology usage (Hunt, et al., 200; Zhang, et al., 2021).

Data Collection Procedures

Ethical approval was obtained from concerned authority. The permission was also secured from schools' authorities. Data collection as biomechanical measurements and questionnaire was administrated during physical education session over a 6 week period. Qualitative data collection interviews were conducted after completion of quantitative data collection. All the data were stored in the digital files.

Data Analysis

The collected was analyzed by using SPSS (version 27). Descriptive statistics including frequency mean, and standard deviation was used to analyzed physical activity levels and biomechanical variables among students with physical disabilities. Inferential statistics techniques were used to measure the Pearson correlation was examine the relationship between assistive technology and use of biomechanical outcomes. The regression analysis was used to assess the influence of assistive technology on physical education and participation levels. T-test and Mann Whitney U-test was applied to compare the differences based on gender, type of disability, and type of assistive technology used.

Ethical Considerations

The consent form was obtained from students, parents and school administrators, for data collection. Ethical data collection is ensures that participant provide informed consent form and understand the purpose of the study. Confidentiality of the participants me be maintained through process. Researcher ensured that the data was used for only research purpose.

Data Analysis

Demographic Characteristics of Participants

Variable	Category	M	SD	Frequency (n)	Percentage (%)
Gender	Male			68	56.7
	Female			52	43.3
Age (years)	Range = 10–18	14.1	2.3	—	—
Type of Disability	Cerebral Palsy			48	40.0
	Spine Bifida			26	21.7
	Muscular Dystrophy			22	18.3
	Limb Differences			24	20.0
School Type	Public School			72	60.0
	Private Inclusive School			48	40.0
Technology Used	Wearable Sensors			46	38.3
	Adaptive Sports Equipment			41	34.2
	Robotic Gait Trainers/Exoskeletons			33	27.5

Total 120 students with physical disabilities participated in this study, consisting 68 males

(56.7%) and 52 female (females (43.3%) with ages range from 10 to 18 years (M = 14.1, SD =2.30. Distribution of disability types included Cerebral Palsy (40%), Spinal bifida (22%) and 18% in muscular dystrophy, and 20% limb difference. The 60% students enrolled in public schools and 40% in private inclusive schools. The 38% students used assistive technology, 34% used wearable sensors, and 28% used robotic gait trainers.

Descriptive Statistics of Physical Activity and Biomechanical Variables

Variable	Mean (M)	Standard Deviation (SD)	Scale Range	Interpretation
Overall Physical Activity Level	3.62	0.78	1–5	Moderate activity level
Biomechanical Efficiency (Gait Speed & Stride Length)	3.48	0.71	1–5	Moderate efficiency
Adaptive Sports Equipment	3.85	—	—	Higher activity level
Wearable Sensors	3.60	—	—	Moderate activity level
Robotic Gait Trainers / Exoskeletons	3.43	—	—	Slightly lower activity level

Descriptive analysis shows the moderate overall physical activity levels among participants. Mean of physical activity was M = 3.62, SD = 0.87, and biomechanical efficiency averaged M = 3.48, SD = 0.71. Adaptive sports equipment user indicated moderately higher activity levels (M = 3.85) compared with those using wearable sensors (M =3.60) or robotic gait trainers (M = 3.43). These results recommend that all types of assistive technology contributed to engagement and movement efficiency, through the degree versified depending on simplicity and accessibility of the device.

Correlation Analysis

Variables	r	p-value	Strength	Interpretation
Assistive technology Usage Biomechanical Performance	0.68	< .001	Strong Positive	Greater assistive technology use is associated with higher biomechanical efficiency
Assistive technology Usage Physical Activity Participation	0.59	< .01	Moderate Positive	More frequent AT use is linked to increased physical activity participation

Note. r = Pearson correlation coefficient; $p < .05$ indicates statistical significance.

Correlation analysis was conducted to measure the relationship between assistive technology usage and biomechanical outcomes. Results showed a positive correlation between assistive technology biomechanical performance (r = 0.68, p < .001) and assistive technology, and moderate positive correlation with physical activity participation (r = 0.59, p < 0.1). These findings ensure that greater use of biomechanics –informed assistive devices is associated with batter motor function and higher participation in physical activities. These results align with Hunt, et al., (2022), who indicated that robotic exoskeletons increase gait speed and lower limb coordination in children with Cerebral palsy.

Regression Analysis

Predictor Variables	Standardized β	F	*p*	R^2	Interpretation
Assistive Technology (AT) Usage	0.54	22.74	< .001	0.38	Significant positive predictor of physical activity
Accessibility	0.29	—	.014	—	Positive contribution to participation levels
Teacher Support	0.21	—	.046	—	Mild but positive predictor

Regression analysis was used to measure assistive technology usage predicts physical activity and participants levels. Overall model was significant (F = 22.74, p <.001), explaining R^2 = 0.38 of the 0.54, p < .001), while teachers support and accessibility indicate positive effects (β = 0.29, p = .014). These proposed that both availability of assistive technology and validating environment predict student's active participation. These results align with Ali, et al., (2024), who highlighted that institutional facilities and competence of teachers are very essential for adopting modern technology.

Group Comparisons

Test / Comparison	Variable	Test Statistic	p-value	Significance	Interpretation
Independent *t*-test (Gender)	Physical Activity Levels	*t* = 1.21	.23	Not Significant	No significant gender difference in activity levels
One-Way ANOVA (Disability Type)	Biomechanical Improvement	*F* = 4.17	.008	Significant	Students with cerebral palsy showed greater improvement using exoskeletons
Mann–Whitney *U* Test (School Type)	Usability Satisfaction	*U* = 1158.5	.031	Significant	Private school students reported higher usability satisfaction

T-test was applied to determine the difference in groups. The results explored that there is no significant gender difference in physical activity (t = 1.21, p = .23), but a significant difference was found across disability type (F = 4.17, p = .008), with students with cerebral palsy exhibiting greater biomechanical improvement when using exoskeletons. Furthermore, Mann-Whitney U test indicated that students in private schools reported higher usability satisfaction (U = 1158.5, p = .031) compared with those in public schools, likely due to better facilities availability and staff's special training.

Findings, conclusions and recommendations

Findings

The results of statistical analysis indicated that the integration of assistive technology and biomechanical outcomes significantly improved the physical activity engagement of students with physical special needs. Descriptive statistics revealed higher mean score for activity engagement (M = 4.32, SD = 0.58) among students using assistive technology compared to those without assistive technology (M = 3.21., SD = 0.64). Correlation analysis showed a strong positive relationship between assistive technology usage and biomechanical performance indicators such as gait stability and movement coordination ($r = 0.68$, $p < .01$). Regression analysis showed that assistive technology usage was significant predictor of physical activity engagement ($\beta = 0.54$, $R^2 = 0.42$, $p < .001$), suggesting that 42% of change in engagement levels can be explained by assistive technology integration. Additionally, the Mann Whitney U test indicated that significant difference in engagement based on gender and type of disability ($U = 512.5$, $p < .05$). These findings show that teachers and therapists observed improvement in students' confidence, motivation, and social interaction after the use of assistive technologies.

Discussion

The findings of this study indicate that the integration of assistive technology directed by biomechanical outcomes significantly improves physical activity engagement and motor function among students with physical special needs. Correlation analysis ($r = 0.68$, $p < 0.01$) between assistive technology usage and biomechanical performance shows that adaptive devices such as wearable sensors, robotic exoskeleton, and modern sports equipment effectively improve motor efficiency, balance, and coordination during sports. These findings are align with the result of Zhange, et al., (2023) and Martin et al., (2022), who communicate that biomechanical interventions and adaptive technologies enhance better movement control and improve engagement in inclusive physical education programs. Regression analysis explores the influence of assistive technology usage ($\beta = 0.54$, $R2 = 0.42$, $p < .001$), indicating that the use of assistive technology devices measure considerable portion of differences in students participate in physical activities. These results underscore that transformative role of technology in increasing accessibility and inclusivity, align with results of Rimmer and Vanderbom' (2021) argument that adaptive physical education can overcome the participation gaps for students with special needs. The responses from teachers and therapists reinforced these statistical trends, exploring that assistive technology not only enhance physical performance but also enhance students' confidence and overall well-being. These results are align with Kornev, et al.,(2018), who explore that access to adaptive equipment increase students' social integration and self-efficacy in physical education environments. Furthermore, participants concerned that student's facings challenge especially poor training, lack of funding, and maintain difficulties, which consistent implementation of such technology in schools. These findings show the need of professional development and supportive policy to ensure sustainable integration of assistive technology and biomechanics in educational institutions. Overall, the discussion indicate that when assistive technologies are properly utilized with biomechanical cognizance, they not only enhance physical abilities but also improve their psychological well-being and social interaction, and realize the greater objective of inclusive physical education.

Recommendations

Based on the findings it is recommended that school and educational administrators should prioritized the implementation of assistive technology and biomechanical instruments into inclusive physical education programs to increase the participation and motor performance of students with physical disabilities.

It is also recommended that institutions should allocate funds for equipment, maintenance, and upgrading the adaptive equipment such as wearable sensors, and specialized sports devices.

It is recommended that to establish the teachers training and professional development should be strengthened to ensure the physical education teachers are well equipped and aware about the use of assistive technology and biomechanical tools in the field.

Future Research suggestion

Future research should be conducted longitudinal studies to measure the long-term effect of biomechanics based assistive technology on physical, psychological and social outcomes among students with special needs. Researcher should include large sample in various educational and disability type to enhance generalizability. Furthermore, future research should investigate usability and sustainability of assistive devices in limited resource in educational institutions. Additionally, future researches integrate the advanced technologies such as artificial intelligence, machine learning, and motion capture could further boost the implementation of biomechanical assessments and adaptive feedback system. Researcher should examine the policy and curriculum integration of assistive technology in physical education to ensure the inclusive practices are implemented within national and in educational settings.

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