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Personalized Technological Interventions: The Potential of Wearable Technologies in the Education of Individuals with Autism Spectrum Disorder[1]

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Abstract

Purpose: Wearable technologies have recently gained increasing attention as innovative tools for supporting the education and functional development of individuals with Autism Spectrum Disorder (ASD).

Methodology: This review synthesizes current findings and discusses the potential of wearable devices—such as smart glasses, biofeedback wristbands, smartwatches, and augmented-reality-enabled tools—to enhance social communication, emotion regulation, sensory integration, and daily living skills. Drawing on international research, the paper examines how wearable technologies enable real-time monitoring, personalized interventions, and context-sensitive feedback while addressing challenges related to data privacy, sensory sensitivities, cost, and accessibility.

Findings: Wearable technologies can enhance independence and educational participation when integrated with evidence-based strategies and Individualized Education Plans (IEPs). However, the field is still in its early stages and requires rigorous research, including large-scale randomized controlled trials and longitudinal studies, to evaluate long-term outcomes and generalizability.

Implications & Suggestions: Practical recommendations for interventionists and directions for future research are provided to support the ethical and inclusive use of wearable technologies in ASD education.

Keywords: Autism spectrum disorder, Wearable technologies, Special education, Social communication, Emotional regulation, Self-regulation

1 The study's preliminary findings were presented orally at the 1st Interdisciplinary Special Education Congress.

INTRODUCTION

Autism Spectrum Disorder (ASD) is a lifelong neurodevelopmental disorder characterized by limitations in social communication, restricted and repetitive behaviors, and sensory sensitivities (American Psychiatric Association, 2013). It is frequently emphasized that meeting the educational needs of individuals with ASD requires individualized, accessible, and inclusive strategies that go beyond academic support to address communication, emotional regulation, and adaptive functioning (Koo et al., 2018). Among the new tools supporting these multidimensional needs are wearable technologies, which improve educational outcomes and support independence (Black et al., 2020).

Autism Spectrum Disorder (ASD) is classified in the DSM-5 as Level 1, Level 2, and Level 3 based on the level of support the individual requires, and these levels show significant differences in terms of social communication skills, cognitive flexibility, sensory sensitivities, and adaptive behavior profiles. This heterogeneous structure indicates that the applicability and effectiveness of wearable technologies are not equal across the entire spectrum. For example, wearable applications that require complex user interactions, self-monitoring, or multi-step responses tend to yield more functional outcomes in Level 1 individuals, who generally have higher verbal skills and greater cognitive self-regulation capacity. In contrast, physiological monitoring, sensory feedback, and automatic alert-based systems become more appropriate for Level 2 and Level 3 individuals with more intensive support needs when used in conjunction with intermediary support (teacher/parent guidance), structured instruction, and stimulus simplification. Therefore, when interpreting findings related to wearable technologies, clearly specifying the targeted ASD support level, communication profile (verbal/minimal verbal), cognitive comorbidities, and sensory tolerance characteristics is critical for the generalizability of the results.

Recent technological advancements enable wearable devices to provide real-time behavioral and physiological data, facilitating the identification, assessment, and support of interventions for individuals with ASD (Gao et al., 2024). Initially developed for health monitoring purposes, these innovations have evolved into tools that provide customized educational support tailored to individual needs and limitations (Newbutt et al., 2017). Current applications range from identifying anxiety and internal states in individuals with ASD (Nguyen et al., 2021; Taj-Eidin et al., 2018) to identifying precursors of problem behaviors and planning behavioral interventions to optimize their frequency and intensity (Voss et al., 2019; Zwilling et al., 2022).

Broadly defined, wearable technologies are electronic devices worn on the body that collect data in real time or respond to it. These devices include smart glasses, biological and tactile feedback devices, and sensor-equipped clothing (Wu & Luo, 2019). Unlike traditional assistive technologies, wearable devices provide continuous, unobtrusive, and context-aware support, making them highly suitable for individuals and increasing their social acceptance in both educational settings and social life (Almusawi et al., 2021).

Despite growing international interest, the use of wearable technologies in special education, particularly in the education of individuals with autism spectrum disorder (ASD), remains underdeveloped. Most research has focused on tablet or computer-based interventions, with limited studies on wearable technologies. This leaves a significant gap in understanding how wearable technologies can be adapted to the educational needs and individual differences of individuals with ASD. Given the growing importance of inclusive and technology-supported education in recent years and the limitations experienced by individuals with ASD, this review aims to synthesize existing knowledge on wearable technologies in the education of these individuals, investigate the types, functions, benefits, and limitations of wearable devices, and critically examine their potential in special education.

Table 1: Differential Applicability of Wearable Technologies Across ASD Support Levels

Technology Type	Level 1	Level 2	Level 3	Note
Smart glasses social cue systems	High suitability	Medium (with support)	Limited	Cognitive load is high
Physiological sensor/stress monitoring	Medium	High	High	Advantage of passive data collection
Self-monitoring watch applications	High	Medium (with cue)	Low	Self-regulation is required
Sensory feedback devices	Medium	Medium-high	Medium-high	Depends on sensory profile

Note: Synthesized by the authors based on the reviewed studies on wearable technologies and ASD severity characteristics.

Types and Functions of Wearable Technologies

Wearable technologies used in the education of individuals with ASD encompass a wide range of tools that incorporate sensors, data collection mechanisms, and interactive feedback systems (Newbutt et al., 2017). These devices are not limited to monitoring individuals; they also actively support users' learning and behavioral needs in real time (Benssassi et al., 2018). The main categories of wearable technologies, their basic functions, and their relevance to education are explained in the following sections.

Eye tracking systems

Eye tracking systems are among the oldest and most studied wearable technologies in ASD research (Yaneva et al., 2020). These tools provide detailed information about an individual's attention span and focus by tracking eye movements and pupil responses (Keehn et al., 2024). Eye tracking can identify ASD symptoms in early stages and help educators design interventions that increase eye contact, joint attention, and social participation (Jones et al., 2023). In addition, it can increase teaching efficiency by adapting instructional materials to the objects, people, or situations to which the individual is visually attending (Ahmad & Jadhav, 2020).

Wearable biofeedback devices

Wearable devices that provide biological feedback, such as smart wristbands, vests, and gloves, collect physiological data, including heart rate, skin conductance, and respiration, to detect anxiety, stress, or emotional arousal in real time (Torrado et al., 2024). These devices are typically used to prompt practitioners to intervene by enabling users to employ self-regulation strategies or by providing tactile or vibrational feedback to remind the individual of their own actions (Gao et al., 2024). Research findings emphasize the importance of these devices in emotion regulation training (Goodman et al., 2018). For example, a smart wristband can support behavior management and self-awareness by reminding a student to take deep breaths or to stay within social boundaries. Another example is a bright vest that provides a child with ASD with the sensory stimulation they need to relax. The following sections describe wearable feedback devices.

Smartwatches and smart bracelets

Smartwatches are multifunctional tools that support both educational and behavioral goals (Moraiti & Drigas, 2024). They can be programmed to provide reminders for daily routines, such as medication, hygiene, and class transitions, and to monitor an individual's physical activity (Torrado et al., 2016). Some advanced models can measure biometric data and, with the support of artificial intelligence, detect immediate sensory issues and provide alerts for real-time interventions. These features make smartwatches powerful tools for promoting independence among individuals with ASD (Wright et al., 2022). Smartwatches also facilitate communication through text or voice functions, supporting individuals who are unable to communicate verbally or have limited verbal communication skills (O'Brien et al., 2020).

Smart glasses

Smart glasses equipped with augmented reality and artificial intelligence features are described in the literature as powerful tools that provide contextual cues during real-time social interactions (Rajkumar et al., 2019). These devices analyze others' facial expressions and tone of voice and provide feedback to the user, such as "the person is smiling," thereby helping individuals with ASD communicate in complex social environments (Keshav et al., 2017). Their discreet and mobile formats enable their use in unstructured settings such as break times or group work, thereby supporting the generalization of social skills across different contexts. Additionally, they include applications with gradually increasing difficulty levels that support learning and provide users with direct feedback on their performance (Vahapzadeh et al., 2017).

Smart clothing

These devices include sensors embedded in clothing, such as vests, belts, or shoes, that monitor an individual's physiological data while appearing to be everyday clothing from the outside (Koo, 2014). Some of these devices are designed to detect risky situations, such as stepping outside a designated area or sudden increases in anxiety, and send alerts to practitioners or caregivers (Nadeem, 2023). Some devices have features such as changing color or emitting audible/vibrating alerts based on the wearer's emotional state. Such technologies are particularly preferred for continuous health and behavior monitoring in situations outside the classroom, such as school trips or transition periods (Koo et al., 2018).

Wearable communication aids

Wearable communication devices designed for individuals with communication, language, and speech impairments provide alternative and augmentative communication (wAAC) support (Zhao et al., 2023). These devices typically feature touch-sensitive surfaces, voice output functions, and integration with mobile applications. Used as small panels worn on wristbands or clothing, these devices enable users to express their needs, emotions, and requests without relying on verbal speech (Washington et al., 2016). When integrated with goals outlined in Individualized Education Plans (IEPs), such tools support communication independence (Koumpouros, 2021). When appropriately selected and implemented, these wearable technologies can significantly enhance the educational experience of individuals with ASD. Their educational functions span a range of areas, from attention and communication to emotional regulation and safety, providing a comprehensive support framework that adapts to the student's evolving needs (Motti, 2019).

The Use of Wearable Devices in the Education of Individuals with ASD

Wearable technologies offer multifaceted and individualized support to individuals with ASD, particularly in educational settings. The integration of these technologies into classroom environments, daily life, and instructional routines opens new avenues for inclusive, data-driven, and student-centered learning (Black et al., 2020). These technologies, which offer solutions to fundamental challenges such as limited social communication, executive function impairments, sensory sensitivities, and limited adaptive skills, are also consistent with the fundamental principles of individualized instruction and universal learning design (Banes & Behnke, 2019). The following sections provide information on the areas in which wearable technologies are used in the education of individuals with ASD.

Real-time social skills training

One of the most interesting applications of wearable technologies in educational settings is their ability to facilitate real-time social skills training. Devices such as smart glasses provide dynamic cues during social interactions, helping students interpret facial expressions, emotional tones, and perspectives (Özcan et al., 2016). For example, augmented reality-based glasses can enhance social reciprocity and empathy by providing visual cues such as "Your friend looks sad" or "It is your turn to speak," thereby helping individuals overcome communication limitations. Research shows that such feedback significantly increases social participation and joint attention in students with ASD (Washington et al., 2016).

Emotional self-regulation

Individuals with ASD have difficulty identifying and managing their emotional states and regulating themselves during daily life. Wearable biological feedback devices help fill this gap by detecting physiological signals indicative of emotional arousal, such as increases in heart rate or skin conductance (Ahuja et al., 2022; Torrado et al., 2017). For example, when stress is detected in an individual, the device can provide calming cues such as a gentle vibration or alert the educator, enabling the implementation of behavioral support strategies before the situation escalates. Integrating these devices into behavioral intervention plans facilitates the use of coping mechanisms, such as deep breathing, seeking help, or using a break card, when an individual encounters a negative situation. These tools support the development of internal awareness, which is critical for emotional self-regulation, and reduce the occurrence of behavioral outbursts in academic settings (Goodwin et al., 2019).

Sensory processing differences are common in individuals with ASD. In these individuals, the condition can manifest as hypersensitivity or hyposensitivity to sensory stimuli, including sound, light, touch, or movement. These differences can significantly affect individuals' ability to regulate their emotions, focus and sustain attention, and participate in social environments, thereby affecting their overall quality of life in educational settings (Reis et al., 2021). Wearable technologies offer targeted and personalized strategies to support sensory regulation and facilitate the acquisition of daily living skills (Black et al., 2020). Some wearable devices are designed to provide calming sensory input in real time. For example, vibrating belts, pressure vests, or sensor-equipped garments can help regulate the sensory system by applying light vibration, deep pressure, or thermal feedback (Cano et al., 2024). The effect of such sensory inputs is mediated by the regulatory influence of proprioceptive and deep-pressure stimulation on the central nervous system. According to Sensory Integration Theory, controlled and rhythmic sensory inputs balance arousal levels by modulating excessive or insufficient sensory response patterns and support the individual's behavioral organization. Deep pressure and vibration stimuli have been reported to increase physiological calmness by reducing autonomic nervous system responses, thereby indirectly enhancing attention, engagement, and self-regulation. Therefore, wearable sensory feedback technologies are considered effective tools not only for symptom reduction but also through neurophysiological regulatory mechanisms. These technologies may contribute to balancing arousal levels and regulating anxiety in individuals who benefit from deep pressure stimulation or rhythmic movement. This effect is explained by modulation of the autonomic nervous system response by proprioceptive and vestibular inputs, as well as by physiological calming. However, the effectiveness of the intervention is closely related to the level of ASD support and the individual's sensory profile. While deep-pressure- and tactile-feedback-based wearable systems can support self-regulation in Level 1 and some Level 2 profiles, in individuals with Level 3 support needs and pronounced tactile hypersensitivity, such stimuli may lead to overload, avoidance, or behavioral dysregulation. Therefore, the use of tactile and pressure-based wearable technologies should not be standard practice; rather, it should be planned based on individual sensory assessments and under expert guidance. When integrated into the student's Individualized Education Program (IEP), it can provide sensory regulation support throughout the day for suitable candidate profiles (Pergantis et al., 2025).

Wearable biofeedback devices equipped with sensors that monitor physiological signals, such as heart rate variability, electrodermal activity, and skin temperature, can detect early signs of sensory overload or emotional dysregulation (Newbut et al., 2017). For example, when a student's arousal level increases in response to bright lights or noisy environments, a wearable device can send a tactile alert, prompting the individual to implement a coping strategy such as taking a break or using noise-canceling headphones (Kalantari et al., 2021). Teachers can also receive real-time notifications, enabling them to intervene before a crisis or problem behavior arises (Goodwin et al., 2019).

Task management and transition support

Limitations in executive functions, such as initiating tasks or transitioning between activities, are commonly observed in individuals with ASD. Wearable devices such as smartwatches and vibrating timers provide structured alerts to initiate, sustain, and complete academic and daily living tasks (Di Palma et al., 2017). For example, a student may receive a tactile alert prompting them to begin a writing task, followed by intermittent reminders from the device to maintain focus on the task. When used in conjunction with visual schedules or video models, these wearable alerts enhance the individual's adherence to assigned tasks and reduce dependence on adult instructions. Research shows that these wearable systems increase the individual's independence and reduce anxiety during transitions (Bhat et al., 2016).

Increased academic participation and attention

Wearable devices can also support cognitive engagement by providing real-time feedback and reinforcement during instruction. Eye-tracking devices measure where students look, enabling practitioners to assess whether visual attention aligns with instructional materials (Koo et al., 2018; Siko, 2018). In interactive learning environments, brightly colored garments equipped with tactile sensors provide feedback when a student focuses on a task, thereby reinforcing sustained attention. In game-based learning scenarios, biometric data collected from wearable devices are used to adapt difficulty levels in real time to ensure optimal challenge and engagement (DeLeyer-Tiarks et al., 2023).

Facilitating communication and language development

For students who cannot communicate verbally or have very limited verbal communication skills, wearable alternative and augmentative communication (AAC) devices can be an important tool in supporting expressive and receptive language skills; however, the effectiveness of these technologies varies depending on the level of ASD support and accompanying cognitive-sensory characteristics. For individuals at Levels 2 and 3 according to the DSM-5 who require more intensive communication support, such devices can function as the primary communication channel; however, effective use often requires simplified interface design, systematic teaching, prompting, and adult facilitation. In contrast, for individuals at Level 1, wearable AAC systems are generally more functional as supportive, situational tools rather than as replacements for basic communication. Therefore, the contribution of wearable AAC technologies should be evaluated considering the individual's support level, symbolic representation skills, and tolerance for interacting with technology (Zhao et al., 2023). These tools enable individuals to initiate communication independently and participate in classroom dialogues. Teachers can support academic participation by programming individual vocabulary and sentence structures appropriate to the curriculum. Additionally, wearable devices integrated with mobile speech generation apps or cloud-based language journals help educators track communication development over time (Curtis et al., 2023).

Advanced wearable systems that incorporate machine learning and augmented reality can simulate complex social situations, helping students understand conversations and perspectives within a given environment and thereby reducing anxiety (Ahuja et al., 2022). For example, a student wearing smart glasses can participate in a role-playing application that requires them to understand whether the person they are interacting with is joking or being serious. Thus, these simulations help develop pragmatic language use and contextual interpretation skills, which are often challenging for individuals with ASD. Such augmented reality and smart-glasses applications are generally more applicable to Level 1 profiles but may be less usable for Level 3 individuals and those with pronounced sensory sensitivity due to device contact and visual load. Furthermore, as these systems require specific cognitive prerequisites, they should not be considered a universal solution across the spectrum.

Data-driven instruction and individualized support

Wearable technologies provide educators with a continuous stream of behavioral and physiological data that informs instructional planning and intervention (Ahuja et al., 2022). For example, trends in arousal levels throughout the day can help identify environmental stressors or optimal learning periods. Teachers can use this information to adjust the timing of instruction, seating arrangements, or sensory supports. When integrated with IEPs or response-to-intervention applications, wearable technologies provide a responsive and evidence-based approach to instruction (Van Laarhoven et al., 2021).

In summary, wearable technologies enhance the individualization, inclusivity, and sensitivity of special education by adapting educational interventions in real time to each student's profile. Their multifaceted use, from facilitating communication to guiding behavior, makes wearable technologies powerful tools for meeting the diverse and changing needs of individuals with ASD in educational settings (Benssassi et al., 2018).

Social interaction and emotion recognition

Limitations in social communication and difficulties in emotion recognition create persistent barriers to meaningful participation in both academic and social environments for individuals with ASD. Wearable technologies equipped with augmented reality, artificial intelligence, and bio-sensing features offer innovative, context-sensitive methods to support these fundamental skills in real time (Fazana et al., 2017). For example, smart glasses integrated with such systems provide real-time visual and auditory cues to help students identify and interpret others' emotional states. These systems analyze facial expressions, tone of voice, and gaze direction to provide subtle cues such as "This person is smiling" or "They look confused," helping users associate observable characteristics with specific emotional states. (Koo et al., 2018). This real-time biofeedback supports the development of the theory of mind and empathetic responses, which are often impaired in individuals with ASD (Black et al., 2020).

Current studies indicate that consistent use of such devices is associate improvements in eye contact duration, turn-taking, and joint attention—critical prerequisites for collaboration and peer interaction in the classroom (Kinsella et al., 2017). These positive developments are sustainable not only in structured application environments but also in natural educational settings such as free play, group work, or mealtime conversations (Gao et al., 2024).

Wearable devices that detect physiological markers of stress or arousal also play an important role in enhancing successful social interactions (Washington et al., 2016). For example, a biological feedback wristband can detect increased anxiety during a group activity and suggest calming strategies (e.g., "Take a deep breath" or "Take a step back and observe first") to help the user maintain participation. These interventions may help individuals with ASD manage the emotional burden that arises in social situations and reduce withdrawal behaviors; however, this effect is most often expected to occur directly and independently in individuals at Level 1 support. At Levels 2 and 3, similar outcomes are generally achieved through structured instruction, mediated practice, and technology-supported cues.

Wearable devices can also function as digital social coaches. Through scenarios, reminders, or cues delivered via smartwatches or vibrating signals, students can be supported in greeting others, asking questions, and responding appropriately (Black et al., 2020; Liu et al., 2017). For example, a tactile vibration can signal a student to make eye contact when addressed, thereby reinforcing important but often complex social behaviors.

Limitations of Using Wearable Devices in the Education of Individuals with ASD

The integration of wearable technologies into educational programs for individuals with ASD raises various ethical, sensory, and logistical issues. While these tools hold significant promise for promoting independence, learning, and inclusion, their use must be ensured in a manner that does not infringe upon users' rights, dignity, and well-being. This section summarizes the key ethical and practical dimensions of the application of wearable technologies in education.

Wearable technologies typically collect sensitive physiological, behavioral, and location-based data. While this data can provide valuable insights for personalized education, it also raises critical issues related to privacy, consent, and data security (Roos & Slavich, 2023). Educational institutions must establish clear protocols for data collection, storage, and access. Informed consent should be obtained not only from parents or guardians but also from individuals themselves when developmentally appropriate (Tobin et al., 2021). Transparency regarding what data is collected, how it is used, and who has access to it is essential for ethical practice.

In this context, compliance with national and international standards such as the Personal Data Protection Act is required (Cardinale & Varney, 2017). Many individuals with ASD have a high level of sensitivity to tactile, auditory, or visual inputs, which can affect their ability to tolerate wearable devices.

For some users, even slight vibrations or loose straps can be uncomfortable (Roos & Slavich, 2023). In the context of ASD, this is not merely a physical comfort issue but often a clinical manifestation of sensory processing disorder (SPD). Especially in individuals with Level 2 and Level 3 support needs and pronounced sensory hypersensitivity, tactile contact, pressure, or vibration stimuli can trigger intense physiological stress responses and emotional dysregulation. Therefore, beyond comfort, sensory tolerance, and neurophysiological excitability should be considered in the physical design of wearable technologies. Although vibration feedback is offered as a customizable option, it can be a high-intensity aversive stimulus for many individuals on the autism spectrum and may increase anxiety rather than have a regulatory effect. Therefore, customization options should be approached not as universal solutions but as adaptable design components based on individual sensory profile assessments. Lightweight, breathable, and hypoallergenic materials, adjustable contact surfaces, and alternative feedback types (e.g., visual or silent alert systems) are critical design requirements, especially for profiles with high sensory sensitivity. Active user participation in device selection and adaptation processes increases the likelihood of acceptance and sustainable use (Wohofsky et al., 2023).

While wearable technologies can enhance individuals' independence, these devices are not equally accessible to everyone. Cost remains a significant barrier, particularly in schools with limited resources or low-income communities. Additionally, inequalities in teacher training, infrastructure, and technical support capabilities can impact the successful integration of these tools into classrooms (Gerhardson & Laike, 2023). Efforts should be made to ensure that access to wearable technologies is not limited by socioeconomic status.

Accessibility also includes the availability of culturally and linguistically appropriate devices and content (Moon et al., 2019). While wearable technologies can promote independence, there is also a risk of excessive dependence on these devices, at the expense of interpersonal interaction or internal skill development. For example, if a student becomes dependent on wearable devices to initiate every task, long-term goals such as internal regulation may be compromised (Black et al., 2020). Additionally, visible devices may label users as unusual or intrusive to peers. It is important to integrate the use of wearable devices into a broader instructional framework that includes decreasing cues, peer-mediated strategies, and skill generalization. Devices should be as unobtrusive as possible and normalized through inclusive classroom practices (Ezenwoke et al., 2016).

The successful use of wearable technologies in the education of individuals with ASD depends primarily on practitioners' preparedness. Practitioners should be trained in the technical use of wearable devices, in interpreting data, in integrating wearable devices into lesson plans, and in applying ethical guidelines (Roos & Slavich, 2023). Professional development should be achieved through practical application, problem-solving, and alignment with evidence-based practices. implementation fidelity, i.e., the consistent and accurate use of interventions as intended, is crucial for achieving desired outcomes (Koorts et al., 2020).

In summary, the use of wearable technologies in the education of individuals with ASD should be based on ethical principles and sensitive to the practical realities of students, families, and educators. Respect for autonomy, attention to sensory and cultural diversity, equal access, and careful education are necessary for these promising tools to benefit the individuals for whom they are designed truly.

DISCUSSION

This review aimed to identify current trends, application areas, and effects of wearable technologies on the education of individuals with ASD.

The findings indicate that wearable technologies are used functionally for communication, daily living skills, behavior monitoring, safety tracking, and self-regulation. This result is consistent with other reviews that highlight the potential of wearable technologies to support independent living skills among individuals with ASD (e.g., Ahuja et al., 2022).

The reviewed literature emphasizes the usability of tools such as smartwatches, sensor-equipped wristbands, and glasses-based augmented reality devices (e.g., Google Glass) in educational interventions. These technologies provide significant benefits to teachers and caregivers by providing instructional cues, supporting task analysis, monitoring behavioral indicators, and sending alerts when necessary. However, the findings also indicate that it is not possible to draw a general conclusion about the effectiveness and applicability of wearable technologies for individuals with ASD across all situations. The small sample sizes in many studies, the use of short-term evaluations, and the pilot-level use of technologies limit the generalizability of findings on the effectiveness of wearable technologies (Black et al., 2020). In addition, some studies emphasize that wearable devices may cause discomfort, especially in individuals with sensory sensitivity, and that device use should be adapted to individual characteristics. A structured overview of the methodological characteristics of the reviewed wearable technology studies is presented in Table 2.

Table 2: Methodological Overview of Wearable Technology Studies in ASD

References	Device Type	Target Skill / Goal	Participants (Age & ASD Level)	Sample Size	Duration
Keehn 2024	Eye-tracking wearable biomarker system	Early ASD diagnosis	Children aged 14–48 months, ASD-referred sample (severity level not reported)	146	Short-term
Keshav 2017	AR smartglasses (BPAS)	Social communication coaching – tolerability	Children and adults with ASD, mixed severity levels (not separately reported)	21	Short-term
Kinsella et al., 2017	Google Glass	Social skills	Mean age 13 years (severity level not reported)	15	Short-term
Koumpouros 2021	Multi-functional wearable system	Daily living and independence support	High-functioning children with ASD + parents	20 children/25 parents	Long-term
Liu 2017	AR smartglasses	Social communication and self-regulation	Children with ASD (severity level not reported)	2	Short-term
Moraiti & Drigas 2024	IoT smartwatch	Anxiety/stress measurement	Adults with ASD (severity level not reported)	10	Short-term
Washington 2016	Social wearable device	Social interaction	Children with ASD (severity level not reported)	13	Short-term
Wright 2022	Smartwatch	Executive functioning	ASD + ID (severity level not reported)	6	Long-term

Table 2 summarizes the methodological characteristics of selected studies on wearable technologies in ASD. Upon reviewing the studies, it is observed that the vast majority were conducted using pilot feasibility or short-term evaluation designs, sample sizes were generally limited, and intervention periods were mostly based on short-term applications. The types of devices used include smart glasses, smartwatches, eye-tracking systems, and multifunctional wearable solutions. The targeted outcomes focus on early diagnosis, social communication, emotional self-regulation, stress measurement, and support for independent living. However, many studies do not explicitly report the ASD support level (Level 1–3). This limits the generalizability of the findings across the spectrum and highlights the need for more detailed characterization of participant profiles in future research.

It is also noteworthy that there are only a limited number of studies on teachers', families', and individuals' views on the use of wearable technologies in education. This makes it challenging to develop application-oriented policies. For example, teachers' competence in integrating technology into the classroom environment is a critical factor in the effectiveness of wearable technologies (Almusawi et al., 2021). However, existing studies indicate that teachers require technological support and that professional development opportunities should be expanded.

The potential of wearable technologies in the education of individuals with ASD offers innovative solutions to the field, but it also raises new ethical and privacy-based responsibilities. Functions such as location tracking, audio recording, and video recording raise important ethical questions about individual privacy (Hayes et al., 2020). Therefore, future studies should examine not only technological effectiveness but also ethical appropriateness, user satisfaction, and data security, using clear, ASD-sensitive evaluation frameworks. Ethically, accessible informed consent and approval processes tailored to the characteristics of individuals with ASD should be developed. In this context, the device's operation and data collection processes should be made understandable through visual aids, simplified language, and social-story-based explanations. In user satisfaction and usability evaluations, participatory design approaches should be prioritized; that is, individuals on the spectrum and caregivers should be involved in the process not only as end users but also as active stakeholders in the design and development. This approach supports the development of technologies that are more appropriate, particularly in terms of sensory compatibility and cognitive accessibility. In terms of data security, enhanced privacy, data minimization, and explicit consent-based protection protocols must be implemented for highly sensitive data collected in educational environments, such as biometric data and location information.

In studies conducted in the international literature involving individuals with ASD, tablet and computer-based interventions have been disproportionately emphasized (e.g., Rezayi et al., 2023). Smart glasses, biofeedback belts, or AAC-supported wearable technologies still receive very little attention in academia. Research highlights a potential synergy between artificial intelligence and wearable systems in interventions for individuals with ASD, particularly for social-cognitive and behavioral support (Çakır & Karaaziz, 2024). However, the number of concrete applications in Turkey remains limited.

Although practitioners in special education are interested in integrating new technologies, they face challenges due to limited access to wearable devices, limited knowledge of their use, and limited institutional support (Demir & Sezgin, 2021). The high cost of acquiring such devices continues to make them inaccessible for many schools, especially in resource-constrained regions. There is no national subsidy mechanism for assistive devices in education. In Turkey, there are no comprehensive national guidelines on data privacy, informed consent, and the ethical use of physiological data in educational settings. Furthermore, specific provisions of the personal data protection law may prevent the use of these devices in educational settings. Finally, there are still very few Turkish wearable devices or applications that take into account the cultural norms, user feedback preferences, and language characteristics specific to individuals with ASD.

Recommendations

Technologies (e.g., smart bands, smart glasses) in schools, and their usability and results should be evaluated in a national context.

The following action points are critical to bridge the gap between international developments and local applications:

Recommendations for implementation

•National standards specific to the use of wearable technologies in educational settings should be developed.

•Integrate wearable technology modules into the training and professional development programs of special education teachers.

• To develop culturally and sensorially appropriate devices, interdisciplinary collaborative design processes should be encouraged among Turkish technology developers, special educators, occupational therapists, and families; thus, sensorial appropriateness can be based not only on user preferences but also on clinical expertise in the field of sensorial integration.

Grant programs, European Union funds, the Ministry of National Education, or private sector-supported projects are recommended to increase access to wearable devices in low-income schools; however, these projects must prioritize not only hardware provision but also long-term sustainability, device maintenance, technical support, and continuous software updates. This is because, especially in schools with limited resources, the fundamental obstacles to the continuity of implementation are often maintenance and update requirements rather than hardware acquisition.

Recommendations for further research

- It is believed that there is a need for more applied research evaluating the effectiveness of wearable technologies in the education of individuals with ASD.
- If not integrated into policies and educators' practices, new technologies risk remaining in the innovation phase in our country rather than bringing about systemic change.
- The necessity of adapting technologies to cultural norms and language should be addressed through more concrete technical components. In this context, the availability of Turkish text-to-speech (TTS) support in wearable systems is critical for the accessibility of applications that include voice feedback and guidance.
- Similarly, visual symbols used in AAC (Augmentative and Alternative Communication)-based wearable devices must be localized, culturally appropriate, and compatible with the Turkish language structure. Currently, many global wearable technology solutions only support English or a limited number of European languages. Therefore, if language and symbol localization is not performed, the effective use of these systems in educational settings can be significantly limited.

CONCLUSION

The use of wearable technologies in the education of individuals with ASD is still a new development in the special education literature. Although new applications have begun to emerge, increasing applied research, updating policies, and restructuring professional development opportunities are necessary for these technologies to realize their transformative potential in educational settings.

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