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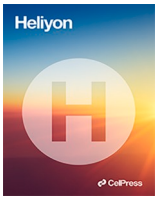

Research article

A systematic review of pathophysiological and psychosocial measures in adaptive sports and their implications for coaching practice

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ABSTRACT

Background: The pathophysiological and psychosocial factors influencing athletes with disabilities are crucial to their sports performance and well-being. This systematic review aims to provide evidence-based insights into how these factors should be adopted into coaching practice.
Methods: The systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. A comprehensive search of PubMed, Web of Science, SPORTDiscus, and Google Scholar was conducted, and studies were selected based on clear inclusion and exclusion criteria. Thirty-six studies met these criteria and were included in the thematic analysis.
Results: In the pathophysiological domain, effective coaching requires adaptive training programs tailored to address the specific physical and physiological challenges of athletes with disabilities. These strategies include injury prevention, performance optimization, and management of muscle imbalance and altered musculoskeletal biomechanics. The psychosocial domain emphasizes the importance of emotional support, resilience-building, and social inclusion, with coaches playing a key role in helping athletes navigate challenges such as social stigma, emotional stress, and reduced self-confidence.
Conclusion: This review underscores the necessity of a comprehensive coaching approach that integrates both pathophysiological and psychosocial considerations, enabling coaches to address the complex needs of athletes with disabilities. Synthesized findings provide actionable recommendations for individualized coaching strategies. These insights have significant implications for advancing coaching practices and promoting inclusivity in sports environments for all athletes.

1. Introduction

Adaptive sports have gained prominence in both research and practice due to increased awareness of the unique needs and challenges faced by athletes with disabilities [1]. These athletes encounter specific pathophysiological challenges, such as muscle

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imbalances resulting from spinal cord injuries, which require coaches to implement targeted training and injury prevention strategies to manage potential complications [2,3]. For example, wheelchair athletes often need adapted techniques that accommodate the unique demands of their sports, underscoring the importance of individualized coaching approaches that consider each athlete's physical condition.

In addition to these physiological challenges, athletes with disabilities face significant psychosocial barriers, including social stigma, emotional stress, and limited peer interaction, which can hinder their social participation, sports performance, and career development [4]. Effective coaching in this context must therefore go beyond physical training and address the psychological well-being of athletes by fostering resilience, providing mentorship, and encouraging social inclusion [5]. For instance, psychological support and social integration initiatives help athletes with disabilities build confidence and navigate societal expectations, reinforcing the need for a holistic approach in coaching.

Despite the expanding literature on adaptive sports, there remains a gap in systematically understanding how these physiological and psychosocial factors influence coaching practices. To bridge this gap, this review applies the International Classification of Functioning, Disability and Health (ICF), a framework developed by the World Health Organization, which emphasizes the complex interaction between an individual's health condition, environmental, and personal factors [2]. The ICF is particularly relevant in adaptive sports as it provides a structured approach to consider how health and contextual factors jointly influence an individual's functioning and participation [6]. As a vehicle to support coaching, the ICF highlights not only physical health but also broader environmental and personal contexts, enabling coaches to adopt holistic approaches that address diverse needs [3].

The ICF model categorizes disability across body structures, activity limitations, and participation restrictions, incorporating contextual elements to encourage adaptive coaching strategies tailored to the diverse needs of athletes with disabilities [4]. Furthermore, the ICF's application in contemporary settings underscores its adaptability across sports disciplines, offering coaches a structured means to address both the immediate physical challenges and the long-term development needs of athletes [7]. Acknowledging its limitations, such as the need for contextual adaptation in sports environments and challenges in measuring psychosocial factors, allows coaches to apply the ICF with an awareness of its constraints while still leveraging its strengths for inclusive coaching [4].

This systematic review consolidates evidence on the pathophysiological and psychosocial dimensions of adaptive sports and examines their implications for coaching practices within the ICF framework. By exploring how these factors intersect, we seek to identify coaching practices that address both the physical and psychosocial needs of athletes with disabilities—practices that enhance performance, foster mental resilience, and promote well-being.

Ultimately, this review provides guidance for developing holistic, inclusive coaching strategies that address the distinct challenges faced by athletes with disabilities and support their long-term growth in adaptive sports environments [12,13]. Through these insights, we aim to advance adaptive coaching practices that empower athletes with disabilities to reach their full potential.

2. Method

2.1. Registration and protocol

Our systematic review is registered with the International Prospective Register of Systematic Reviews (PROSPERO) under registration number CRD42024590442 for ensuring transparency and adherence to established guidelines.

2.2. Search strategy

This systematic review focuses on investigating the effect of pathophysiological and psychosocial factors of athletes with disabilities on adaptive sports and their relevance to coaching practice. A robust and transparent search method was employed, following the framework provided by the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, which ensured a systematic and accurate selection of pertinent studies [8]. The process followed PRISMA's four key phases: identifying relevant literature, screening for eligibility, assessing study qualifications, and ultimately including studies for analysis. Both qualitative and quantitative research were incorporated to deliver a broad and detailed examination of the topic.

2.3. Databases and search terms

The following electronic databases were thoroughly searched from the earliest record to September 2024 to identify relevant studies: PubMed/Medline, Web of Science, SPORTDiscus, and Google Scholar. The search terms were developed based on key concepts related to the pathophysiological and psychosocial bases of athletes with disabilities. Boolean operators (AND, OR) were applied to combine search terms, ensuring a comprehensive and systematic search. The specific search strategy used was: (disabled athletes [Title/Abstract] OR para-athletes[Title/Abstract] OR paralympic athletes[Title/Abstract] OR wheelchair athletes[Title/Abstract] OR special athletes[Title/Abstract] OR sportspeople with disabilities[Title/Abstract] OR parasport[Title/Abstract] OR athletes with impairments[Title/Abstract] OR disabled sports competitors[Title/Abstract]) AND (physiology[Title/Abstract] OR physical[Title/Abstract] OR physiological[Title/Abstract] OR pathophysiological[Title/Abstract] OR strength[Title/Abstract] OR endurance[Title/Abstract] OR mentality[Title/Abstract] OR cognitive[Title/Abstract] OR self-esteem[Title/Abstract] OR well-being[Title/Abstract] OR emotional[Title/Abstract] OR stress[Title/Abstract] OR anxiety[Title/Abstract] OR social inclusion[Title/Abstract] OR hrql [Title/Abstract] OR blood[Title/Abstract] OR nutrition[Title/Abstract] OR psychology[Title/Abstract] OR athletic performance

Table 1
Summary of included articles in the review.

Studies	Country	Subjects			Sports	Disability	Method	Key Findings		
		Gender	Age	Occupation				Pathophysiological Factors	Psychosocial Factors	Implications for Coaching Practices
Michael Horvat et al. (1986) [55]	United States	Male and Female	Male aged 18–35, female aged 19-37	Wheelchair athletes, able-bodied athletes	Track and field, basketball, gymnastics, rowing, wrestling, marathon	Lower limb impairments	Psychological assessment with the "Profile of Mood States" (POMS), a self-report instrument for mood states	None	Relaxation techniques as psychological preparation are key for athletes' performance, helping disabled athletes manage stress and emotions, optimizing performance under pressure	None
Keith Henschen et al. (1984) [6]	United States	Male	18–35 years old	Wheelchair athletes	Track and field	Spinal cord injuries, polio, amputations	Psychological assessment with the "Profile of Mood States" (POMS) and the State-Trait Anxiety Inventory (STAI)	None	Relaxation and biofeedback as mental training are vital for success, with coaches tailoring these for disabled athletes to address emotions like anger, enhancing performance	None
Maria Kavussanu et al. (2015) [3]	United Kingdom	Male athletes	Disabled athletes: 18–56 years; Able-bodied athletes: 17–54 years	Wheelchair athletes, able-bodied athletes	Disabled athletes: Wheelchair rugby and wheelchair basketball players Able-bodied athletes: Rugby union players	Spinal cord injuries: cervical, 62 % complete lesions	Assessment of antisocial behavior, moral disengagement, empathy, and emotions among wheelchair and rugby athletes using validated scales	None	Disabled athletes showed lower antisocial behavior and moral disengagement compared to able-bodied athletes, with empathy and negative emotions similar in both groups	None
Francesco Borea et al. (2021) [14]	Italy	Male	28 years (average)	Regional-level tennis players; wheelchair tennis players	Tennis	Various physical impairments	Evaluation of an 8-week strength training program on wheelchair tennis players, measuring serve ball speed and points won pre- and post-program	Strength disparities' impact on serving speed and power in wheelchair vs. able-bodied tennis players; strength-hypertrophy training's role in enhancing performance	None	Strength-hypertrophy training for wheelchair athletes; improved tennis performance, especially serving strength; inclusive and competitive play

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Table 1 (*continued*)

Studies	Country	Subjects			Sports	Disability	Method	Key Findings		
		Gender	Age	Occupation				Pathophysiological Factors	Psychosocial Factors	Implications for Coaching Practices
E. K. Skordilis et al. (2002) [11]	United States	Not specified	18–45 years	Wheelchair athletes; Able-bodied athletes: basketball players	Recreational basketball players	Spinal cord injuries, spina bifida, post-polio syndrome, or amputation	Comparison of competitiveness and goal orientation between wheelchair and able-bodied athletes using the Sport Orientation Questionnaire, analyzed via MANOVA	None	Wheelchair basketball athletes score higher in competitiveness and goal orientation than able-bodied athletes, focusing more on personal growth and competition than on winning	Coaching emphasis on personal goal setting; fostering competitive spirit; developing competitive mindset and personal milestones
Ljubica Bačanac et al. (2014) [18]	Serbia	2 females, 10 males	Athletes with disabilities: 28.58 ± 5.71 years; Athletes without disabilities: 26.21 ± 6.36 years	Top athletes competing in Olympic and Paralympic games	Athletics, shooting, table tennis, chess, and cycling (for both groups)	Various disabilities: sight impairment, wheelchair use, auditory impairment, impaired arm movement	Comparison of self-esteem, sport confidence, and coping skills between athletes with and without disabilities, showing similar profiles but lower pressure-handling in disabled athletes	None	Disabled and able-bodied athletes share similar psychological traits, though disabled athletes struggle more with pressure due to less competitive experience	Training and psychological support for all athletes; focus on stress management and competitive experience for athletes with disabilities
Manuele Taleb et al. (2021) [20]	Italy	Male athletes	23–25 years	Non-disabled athletes; Athletes with functional classification KL3	Canoe and Paracanoe athletes	Functional classification KL3 (partial lower limb function)	Improvement of trunk stability, strength, and sprint performance in KL3 canoe athletes following a 6-week core training program, measured by a 200-m sprint	Core training's effect on trunk stability in KL3 canoe athletes; reducing performance gap with able-bodied athletes	None	Core training for KL3 athletes; enhancing trunk stability and power; stabilizing devices for balance
Stephan Turbanski et al. (2010) [12]	Germany	Male athletes	Wheelchair athletes: 33.2 ± 10.6 years; Control subjects: 25.4 ± 1.8 years	Wheelchair athletes: involved in wheelchair basketball and rugby; Healthy physical education students	wheelchair basketball and rugby	Spinal cord injury	Enhancement of upper body strength in wheelchair athletes following an 8-week resistance training program, with significant gains in strength and power	Heavy resistance training's benefits for upper body strength in wheelchair athletes; significant strength gains despite spinal cord injuries	None	Heavy resistance training for wheelchair athletes; enhancing upper body strength; proper supervision to prevent injuries
Phoebe Runciman et al. (2015) [15]	South Africa	Male athletes	CP group: 22.7 ± 3.6 years; Able-bodied group: 26.1 ± 3.7 years	Paralympic athletes; Able-bodied athletes: well-trained field hockey players	Sprint; field hockey	Hemiplegic CP	Comparison of performance and neuromuscular traits in athletes with CP and able-bodied athletes pre- and post-fatigue, measuring sprint and jump performance	CP athletes' fatigue levels compared to able-bodied athletes; greater performance declines in sprinting and jumping; potential of high-level training to mitigate deficits	None	Fatigue management for CP athletes; addressing limb asymmetry; optimizing sprinting and jumping

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Studies	Country	Subjects			Sports	Disability	Method	Key Findings		
		Gender	Age	Occupation				Pathophysiological Factors	Psychosocial Factors	Implications for Coaching Practices
Selda Uzun et al. (2012) [17]	United States	Male athletes	Wheelchair basketball players: 29.6 ± 6.4 years; Able-bodied basketball players: 23.8 ± 3.8 years; Sedentary subjects: 28.1 ± 7.3 years	Wheelchair basketball players; Able-bodied basketball players; Sedentary subjects	Wheelchair basketball	Spinal cord injuries	SEMG analysis of muscle fatigue and endurance during sustained isometric elbow flexion, focusing on motor unit synchronization and fatigue patterns	Muscle strength similarities in wheelchair basketball players with spinal cord injuries; need for specific endurance training; SEMG analysis revealing better fatigue resistance than sedentary individuals	None	Targeted endurance and strength training for wheelchair basketball players; preventing fatigue-related performance issues
László Dorogi et al. (2008) [23]	Hungary	59 athletes with disabilities: 46 men and 13 women 58 able-bodied athletes: 23 men and 35 women	Athletes with disabilities: Mean age 32.9 years (±8.7) Able-bodied athletes: Mean age 22.4 years (±2.30)	Athletes with disabilities; Able-bodied athletes	Athletes with disabilities: Individual Sports: Athletics, fencing, swimming Team Sports: Wheelchair basketball, goalball, volleyball Able-bodied athletes: Individual Sports: Athletics, fencing Team Sports: Basketball, volleyball	Physical impairments: spinal cord injuries, amputations, visual disabilities; 26 individual sport athletes, 33 team sport athletes	Assessment of task and ego orientation, and motivational climates via questionnaires, with task and performance orientations analyzed through MANOVA	None	Athletes with disabilities perceived a mastery-oriented climate focused on self-improvement, while women preferred performance-oriented climates, regardless of disability	Mastery-oriented climates for athletes with disabilities; encouraging personal growth; recognizing gender differences in motivation
Barbara Hall et al. (2022) [16]	United Kingdom	Male	Handcyclists: Average age 36.6 years Powerlifters: Average age 22.4 years Control Group: Average age 23.6 years	Handcyclists; Powerlifters; Physically active; Non-athletes	Handcyclists: Trained in handcycling, athletes with spinal cord injuries Powerlifters: Athletes trained in powerlifting Control Group: Physically active, non-athletes	Handcyclists: men with SCI (C5-C7, Th6-12, L1-L2)	Measurement of pathophysiological responses like VO_{2max} and lactate threshold in handcyclists, powerlifters, and a control group using a graded arm ergometer test	Handcycling-trained athletes with spinal cord injuries; higher aerobic capacity and improved cardiovascular adaptation compared to powerlifters and non-athletes	None	Aerobic training like handcycling for athletes with SCI; improving endurance and cardiovascular health; incorporating resistance training
Artur Gołaś et al. (2017) [25]	Poland	Both	Able-bodied athlete: Age 34 years; Disabled	International Powerlifting Federation (IPF) regulations	flat bench press	Lower limb disability	Recording of muscle activity during the bench press at various loads using EMG,	Neuromuscular control comparison during bench pressing between disabled and	None	Upper-body muscle isolation in bench press training;

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Table 1 (*continued*)

Studies	Country	Subjects			Sports	Disability	Method	Key Findings		
		Gender	Age	Occupation				Pathophysiological Factors	Psychosocial Factors	Implications for Coaching Practices
			athlete: Age 31 years				analyzing peak activity during lifting and lowering phases	able-bodied athletes; greater upper-body activation in disabled athlete		enhancing muscle engagement and synchronization
Mark Vermillion and Richard A. Dodder (2007) [24]	United States	Male (83.8 %), female athletes (16.2 %)	Mean age of 22.5 years	Collegiate wheelchair basketball student athletes	Wheelchair basketball	Participants had either acquired disabilities (56.8 %) or congenital disabilities (43.3 %)	Validation of the Rosenberg Self-Esteem Scale for 68 wheelchair basketball athletes, confirming accuracy in measuring self-esteem	None	Validation of the RSES for disabled athletes; positive self-esteem in wheelchair basketball players; sports participation fostering self-image and confidence	Inclusive environments for enhancing self-esteem; using RSES for monitoring psychological well-being
Deborah R. Shapiro et al. (2010) [28]	United States	27 males and 9 females	Mean age 16	Youth athletes with physical disabilities	Participants competed in adapted sports through the American Association of Adapted Sports Programs (AAASP)	CP (18), spina bifida (9), traumatic brain injury (3), muscular dystrophy (2), other conditions	Surveys measuring athletic identity, affect, and peer relations in 36 youth athletes with disabilities using PPAIS, PANAS, and the Peer Relations Scale	None	Strong private athletic identities in youth athletes with disabilities; positive emotions and good peer relations; friendships enhancing emotional experiences	Nurturing athletic identity and peer relationships in youth athletes with disabilities; boosting emotional well-being and engagement
Pasquale Imparato et al. (2021) [29]	Italy	Not specified	Average age 23 years	Athletes with and without disabilities	Swimming	S2 category athletes: lower limb disabilities, amputations, paralysis; 6 non-disabled athletes	8-week program: HIIT, Tabata, Pilates, physiotherapy for disabled athletes; measures: pool times, VO_{2max}, joint ROM	8-week training program's effect on disabled vs. non-disabled swimmers; gains in ROM for disabled athletes, but lagging in stroke efficiency	Social and psychological benefits of inclusive swimming training; motivation and engagement of disabled athletes training with non-disabled peers	Inclusive programs focusing on stroke efficiency and ROM; supportive environments to enhance motivation
Andrew G et al. (2017) [13]	United Kingdom	5 males and 3 females	Mean age 40.12	Elite Paralympic athletes	Participants were from the same sport, though the specific sport was not disclosed due to confidentiality requirements.	Elite athletes with disabilities, Paralympic experience: 1 month to 17 years	REBT with Paralympic athletes; measures: psychological, pathophysiological, performance outcomes; includes: anxiety, competitive scores	REBT's impact on reducing irrational beliefs and systolic blood pressure in Paralympic athletes; stress management intervention benefits	Improved emotional regulation and focus through REBT; reduced avoidance goals; enhanced interpersonal relationships and emotional control	Incorporating REBT into training; managing stress; improving psychological resilience
Anna Carin Aho et al. (2022) [30]	Sweden	18 males and 3 females	Mean age 19	Volt hockey players with various physical disabilities	Volt hockey	Duchenne muscular dystrophy, limb-girdle muscular dystrophy, CP	Qualitative study: PERMA model; explores well-being in Volt Hockey players; highlights: emotions, relationships, external	None	Well-being of Volt Hockey players through positive emotions, social engagement, meaningful	Promoting teamwork and skill development in Volt Hockey; fostering

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Studies	Country	Subjects			Sports	Disability	Method	Key Findings		
		Gender	Age	Occupation				Pathophysiological Factors	Psychosocial Factors	Implications for Coaching Practices
							resources for participation		participation, and personal achievement; overall sense of accomplishment	belonging and achievement
T. N. Kirk et al. (2021) [26]	USA	3 males and 1 female	22–29 years old	Elite Paralympic athletes	Wheelchair basketball, Paralympic 7-a-side football (soccer)	Phocomelia, hemiplegic CP, spinal cord injuries	Interviews: four elite athletes with disabilities; explores experiences in Paralympic sport awareness program; focuses on dignity, self-worth	None	Respect and value felt by elite athletes with disabilities in a disability awareness program; empowerment through advocacy; recognition of skills over disabilities	Highlighting athletes' abilities; providing advocacy opportunities; respecting dignity and empowerment
Ana Margarida Martins Domingues et al. (2022) [27]	Portugal	71.3 % male and 28.7 % female.	Mean age 32.61 years	Adapted sports athletes with intellectual and developmental difficulties (IDD), specifically participants in the Special Olympics of Portugal	Both individual and team sports	Intellectual and developmental difficulties	Quantitative study: validated scales; analyzes gender differences in motivation, psychological needs, well-being	None	Satisfaction of basic psychological needs and self-determined motivation predicting well-being in athletes with intellectual and developmental disabilities; gender differences in life satisfaction	Focusing on autonomy, competence, and social relationships; enhancing motivation for athletes with intellectual disabilities
Erdem Ayyildiz et al. (2024) [31]	Turkey	150 males and 103 females	18–47 years old.	Physically and hearing-impaired athletes	Various	Participants had physical disabilities or hearing impairments	Exploration of sports motivation: individuals with physical, hearing disabilities; analyzes data by gender, education, welfare levels	None	Higher motivation scores in physically disabled individuals compared to hearing-impaired; socioeconomic and gender differences affecting motivation in sports participation	Tailoring motivational strategies; considering disability type, gender, and socioeconomic factors
Olatz Zabala-Dominguez et al. (2023) [32]	Spain	86.1 % male and 13.9 % female.	Mean age 39.94 years	Federated athletes with physical disabilities	Various	Spinal cord injuries, amputations, CP, muscular dystrophy, polio, spastic paraparesis	Questionnaire: measures life satisfaction, psychological capital (PsyCap) in athletes with physical disabilities; analyzes demographic relationships	None	Positive correlation of psychological capital, especially self-efficacy, hope, and resilience, with life satisfaction; differences based on gender, dependence, and competition level	Enhancing psychological strengths like self-efficacy; addressing gender and dependence differences

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Table 1 (*continued*)

Studies	Country	Subjects			Sports	Disability	Method	Key Findings		
		Gender	Age	Occupation				Pathophysiological Factors	Psychosocial Factors	Implications for Coaching Practices
Deborah R. Shapiro and Jeffrey J. Martin (2010) [33]	United States	9 females and 27 males	12–21 years	Athletes	wheelchair basketball and wheelchair football	CP, spina bifida, traumatic brain injury, muscular dystrophy, heart, hip	Physical Self-Description Questionnaire (PSDQ); assesses physical self-perceptions: strength, endurance, sport competence, body fat, self-esteem	Self-perceptions of physical attributes in athletes with disabilities; positive influence on physical activity and self-esteem; lower activity levels and higher body fat ratings	Psychosocial benefits of sport for athletes with disabilities; competence and endurance perceptions boosting physical activity and self-esteem; physical competence crucial for mental health	Improving perceptions of physical competence; addressing body image concerns for psychological well-being
Hannah Macdougall et al. (2016) [34]	Australia	10 females, 13 males	16–53	Athletes.	both individual sports (e.g., athletics, boccia, cycling, swimming, etc.) and team sports (e.g., wheelchair basketball, wheelchair rugby)	Congenital impairments; limb loss, spinal cord injury, CP	Qualitative methods: interviews, focus groups with Paralympic Committee staff and athletes; analyzed through thematic analysis	Health challenges faced by Australian para-athletes; pain, injuries, and impairments affecting well-being and quality of life compared to able-bodied athletes	Psychological and social well-being of para-athletes; struggles with self-acceptance and emotional challenges in those with acquired impairments; strong social support and resilience aiding coping amidst societal stigmatization	Supporting para-athletes with physical and emotional challenges; fostering resilience and strong support networks
Julius Jooste et al. (2018) [35]	South Africa	16 male	Mean age 32.13 years	National-level wheelchair basketball players	Wheelchair basketball	Acquired disabilities; congenital disabilities	Leadership Scale for Sport, Subjective Vitality Scale, Ryff's Psychological Well-Being Scale; assess coach leadership, vitality, well-being	None	Positive coaching styles (feedback and support) linked to higher psychological well-being and personal growth in South African wheelchair basketball players; autocratic behavior negatively affecting team dynamics	Positive feedback and individualized instruction in wheelchair basketball; improving psychological well-being and team cohesion
Samir Qasim et al. (2019) [56]	Jordan, Palestine, and Oman	male	Mean age 31 years	Wheelchair basketball players competing in the West Asian Wheelchair Basketball Championship	Wheelchair basketball	CP, spina bifida, leg length difference, unspecified	Physical Self-Description Questionnaire (PSDQ); assesses physical self-perception in wheelchair basketball players; analyzed with descriptive statistics, regression	High physical self-esteem in wheelchair basketball players; strength and coordination linked to better physical activity and well-being	Connection between physical self-esteem and global self-esteem in wheelchair basketball players; physical activity enhancing self-confidence and	Enhancing physical competence; fostering positive body image and resilience through competition

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Studies	Country	Subjects			Sports	Disability	Method	Key Findings		
		Gender	Age	Occupation				Pathophysiological Factors	Psychosocial Factors	Implications for Coaching Practices
									overall self-esteem through perceptions of strength and coordination	
Luca Puce et al. (2017) [36]	Italy	Both	12–23 years	Young Paralympic athletes and a reference group of disabled individuals not engaged in competitive sports	Paralympic athletes	Various	Psychological General Well-Being Index (PGWBI), SF-12 Health Survey; assess well-being in athletes; analyzed through t-tests, regression	None	Investigation of psychological well-being in young Paralympic athletes; focus on competition's impact on self-perception; comparison of athletes' well-being with non-athletes using tools like the PGWBI	Enhancing emotional support; promoting self-motivation and social interaction for psychological well-being
Paul M. Valliant et al. (1985) [37]	Canada	Not specified	Not specified	161 physically disabled individuals	Various	Amputees, blind, CP, control	Coopersmith Self-Esteem Inventory, Rotter's Locus of Control Scale, Social History Questionnaire; compare self-esteem, locus of control between disabled athletes, non-athletes	Physical benefits of sports for disabled athletes; improvements in endurance, strength, and balance enhancing confidence	Psychological benefits for disabled athletes, including increased self-esteem and life satisfaction; sport participation linked to improved self-concept and social integration, especially for those with congenital impairments	Emphasizing physical and psychological training; fostering self-esteem and physical fitness in inclusive environments
Deborah R. Shapiro and Laurie A. Malone (2016) [38]	United States	47 males, 23 females	Mean age 15 years	children and youth athletes with physical disabilities	Swimming: 3 participants Wheelchair basketball: 23 participants Wheelchair handball: 32 participants Multisport	CP, spina bifida, spinal cord injury	Pediatric Quality of Life Inventory (PedsQL), Subjective Exercise Experience Scale (SEES); assess HRQoL, emotional well-being in athletes; analyzed with t-tests, ANOVA	Health and quality of life in young disabled athletes; participation in adapted sports improves fitness, but parents rate physical health lower	Psychological benefits of sports for young disabled athletes; higher emotional and social well-being compared to parental assessments, with parents	Fostering physical and emotional well-being through sports; engaging parents to bridge athlete-parent perception gaps

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Studies	Country	Subjects			Sports	Disability	Method	Key Findings		
		Gender	Age	Occupation				Pathophysiological Factors	Psychosocial Factors	Implications for Coaching Practices
					program: 12 participants				underestimating these improvements	
Deborah R. Shapiro and Jeffery J. Martin (2014) [39]	United States	35 males, 11 females	Mean age 15.37 years	46 athletes with physical disabilities	Participants were recruited from five wheelchair basketball and wheelchair football teams	CP, spina bifida, traumatic brain injury, spinal cord injury, muscular dystrophy	Sport Friendship Quality Scale, Loneliness Rating Scale, Self-Perception Profile for Adolescents; examine relationship: friendship quality, loneliness, self-perception in athletes	None	Higher athletic competence and self-worth in youth athletes with disabilities linked to stronger social well-being and less loneliness; minimal effect of friendship quality in sports	Building confidence and self-worth; enhancing social well-being through team-building activities
Jeffrey J. Martin, and Laurel Whalen et al. (2012) [21]	United States	26 males, 24 females	Mean age 26.5 years	50 athletes with physical disabilities	Various	CP, spina bifida, muscular dystrophy, spinal cord injury	Physical Self-Description Questionnaire Short Form (PSDQ-S); assesses physical self-concept, relationship with physical activity, global self-concept; analyzed with regression	Strength as a key predictor of physical activity for disabled athletes; training programs enhancing strength and overall health	Positive physical self-concept (strength and endurance) significantly influencing self-esteem and physical activity; reinforcement of mental and social benefits from a strong self-image	Focusing on strength training; enhancing perceptions of abilities for improved self-esteem and motivation
Marco Batista et al. (2019) [43]	Portugal	42 males, 12 females	Mean age 29.57 years	54 athletes with intellectual and developmental difficulties	Various	Intellectual and developmental difficulties	Basic Psychological Needs in Exercise Scale, Behavioural Regulation in Sport Questionnaire, Satisfaction with Life Scale; assess motivation, well-being in athletes	None	High autonomous motivation in athletes with intellectual and developmental disabilities in the Special Olympics; close link to greater life satisfaction and emotional well-being	Promoting autonomous motivation; encouraging self-direction while avoiding controlling techniques
Giovanni Fiorilli et al. (2021) [46]	Italy	104 males, 42 females	Mean age 41.17 years	146 athletes	Various	52 % blind, 34 % mobility impairments, 14 % deaf	Impact of Event Scale—Revised (IES-R); measures psychological distress during COVID-19	None	Less stress and more resilience in disabled athletes during COVID-19 sports restrictions	Recognizing resilience in disabled athletes; providing support during

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Studies	Country	Subjects			Sports	Disability	Method	Key Findings		
		Gender	Age	Occupation				Pathophysiological Factors	Psychosocial Factors	Implications for Coaching Practices
							lockdown; analyzed with descriptive statistics, MANOVA		compared to non-disabled athletes; benefit from experience in overcoming adversity	uncertainty to enhance social interaction
Lei Zheng (2023) [19]	China	60 males, 53 females	24–34 years	113 athletes with disabilities who participated in the 11th National Games for People with Disabilities in China	Various	54 with hearing impairments and 59 with physical limitations	Physical Self-Perception Profile Scale, Satisfaction with Life Scale, WHOQOL; examine relationship: physical activity, self-esteem, life satisfaction, quality of life	Regular physical activity's role in boosting quality of life for disabled athletes; improving physical self-esteem, confidence, and well-being	Physical activity enhancing life satisfaction (SWL) and well-being in disabled athletes through social inclusion, self-efficacy, and physical self-esteem	Promoting physical activity; improving self-esteem and life satisfaction in inclusive environments
Deborah R. Shapiro and Jeffery J. Martin et al. (2014) [39]	United States	35 males, 11 females	Mean age 15.37 years	46 athletes with physical disabilities	Various	CP, spina bifida, traumatic brain injury, spinal cord injury, muscular dystrophy	Sport Friendship Quality Scale, Loneliness Rating Scale, Self-Perception Profile for Adolescents; assess social interactions, loneliness in wheelchair athletes	None	Higher athletic competence and self-worth in youth athletes with disabilities leading to stronger friendships, social acceptance, and reduced loneliness	Building athletes' confidence and creating social interaction opportunities for enhanced well-being and reduced loneliness
Luca Puce et al. (2023) [49]	various European countries	58.4 % male and 41.6 % female.	Mean age 17.39 years	1208 people with disabilities, including 849 para-athletes and 359 non-competitive disabled individuals	Para-athletes participated in various sports, including para-swimming, para-athletics, wheelchair basketball, boccia, and wheelchair rugby	Not specific	Psychological General Well-Being Index (PGWBI); assesses hedonic well-being in para-athletes; data analyzed using univariate, multivariate models	None	Para-athletes exhibiting higher well-being than non-athletes; sports participation boosting self-esteem, social interaction, and emotional resilience	Fostering social connections and emotional support for improved life satisfaction and well-being, particularly for athletes with acquired disabilities

[Title/Abstract] OR depression[Title/Abstract] OR quality of life[Title/Abstract] OR QoL[Title/Abstract] OR musculoskeletal adaptation[Title/Abstract] OR cardiorespiratory fitness[Title/Abstract] OR physical resilience[Title/Abstract] OR motor function[Title/Abstract]).

2.4. Inclusion and exclusion criteria

The inclusion criteria for this systematic review were designed to select studies that specifically addressed the pathophysiological and psychosocial bases of disabilities in athletes and their impact on coaching practice. Eligible studies included quantitative, qualitative, and case study designs that explored the influence of these factors on coaching strategies and athlete performance. The target population encompassed athletes with disabilities, coaches, and relevant support personnel, as all these groups are critical to understanding the coaching dynamics. To ensure academic rigor, only peer-reviewed journal articles published in English were included. No limitations were placed on the publication date, allowing for a comprehensive analysis of both historical and current perspectives on the pathophysiological and psychosocial aspects of disabled athletes.

The exclusion criteria omitted non-academic sources such as news articles or opinion pieces, as they lacked the necessary scholarly foundation. Studies that did not directly examine the pathophysiological or psychosocial factors in relation to coaching practice were excluded to maintain focus. Additionally, duplicate studies and those with significant overlap in content were removed. Articles without accessible full texts or those lacking clear methodological rigor, such as solid research design or robust analytical methods, were also excluded to preserve the quality of the review.

2.5. Data extraction

Data from the selected studies were extracted using a customized form (Table 1) specifically adapted for this systematic review. The form included key details such as study title, authors, publication year, research methodology, participant characteristics (e.g., disability types, sport participation), and main findings regarding pathophysiological and psychosocial factors influencing coaching practice. To maintain accuracy and consistency, two reviewers independently screened titles and abstracts, followed by a full-text assessment. Discrepancies were resolved through discussion or, if necessary, by involving a third reviewer.

Data synthesis involved an iterative thematic approach. Instead of reporting each study's results individually, common themes and trends across the 36 selected studies were identified and organized into key pathophysiological and psychosocial categories. Open and

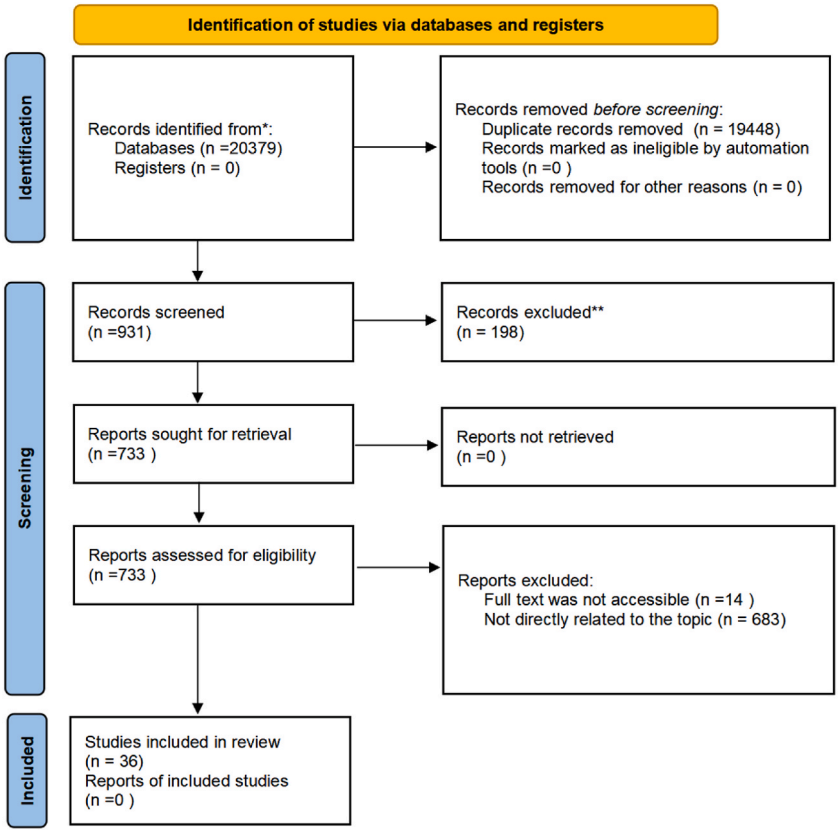

Fig. 1. PRISMA flow diagram.

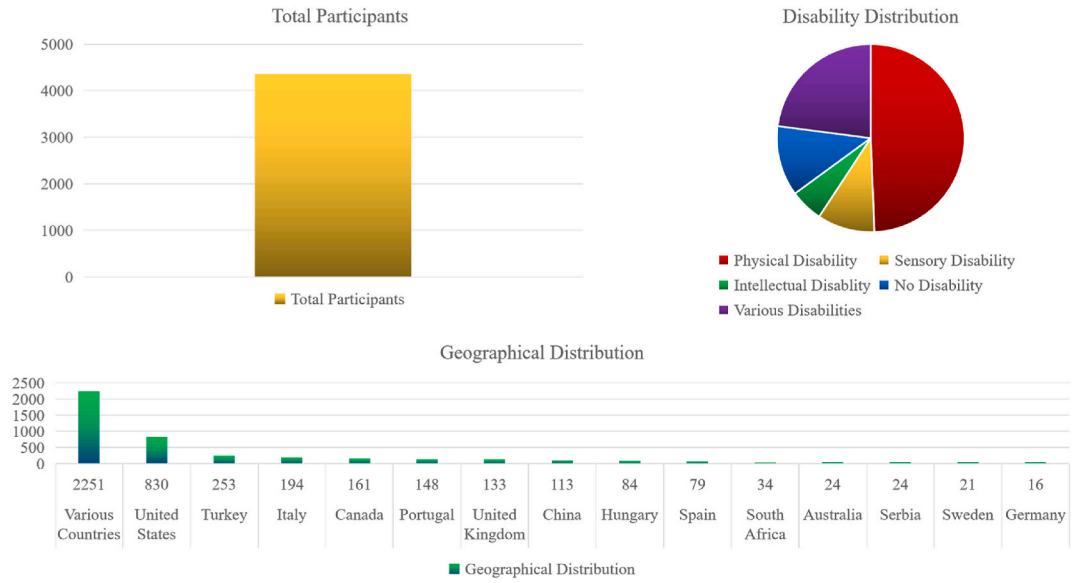

Fig. 2. Participant demographics and disability distribution by geographical location.

axial coding cycles were conducted to further refine these categories, ensuring that the synthesis captured the most significant factors affecting coaching practice. This method provided a thorough and structured analysis, emphasizing the influence of these factors on coaching athletes with disabilities.

2.6. Quality assessment

The methodological quality of the selected studies was evaluated utilizing the Mixed Methods Appraisal Tool (MMAT) [9], selected for its suitability in appraising studies employing qualitative, quantitative, and mixed methods. The MMAT focuses on critical elements of research design, such as the precision of research questions, alignment of methodologies, reliability of data collection tools, clarity in participant selection, and thoroughness in data analysis, emphasizing the role of triangulation to strengthen validity.

Each study was carefully reviewed using the MMAT's 5-point rating system. Studies that received a score of 5 exhibited superior research designs, consistent data collection, clear participant selection procedures, and thorough data analysis, applying triangulation to support the validity of their results. Studies with scores of 3 or 4 generally met many of the MMAT's criteria, yet showed some weaknesses, like reduced transparency in participant selection or a limited application of triangulation, potentially impacting the strength of their findings. These shortcomings were taken into account during synthesis to ensure a balanced interpretation.

This comprehensive quality evaluation contributes to the inclusion of methodologically robust studies, thereby increasing the reliability and validity of the review's findings while transparently presenting the strengths and weaknesses of each study.

2.7. Data synthesis

A thematic synthesis was performed to consolidate the findings from studies examining both pathophysiological and psychosocial factors affecting athletes with disabilities, with a focus on their implications for coaching practice. Two independent reviewers conducted an iterative coding process, utilizing both open and axial coding to identify and categorize key themes into two primary domains: pathophysiological challenges and psychosocial barriers. Open coding allowed for the identification of initial themes directly from the data, while axial coding helped in refining these themes by exploring the relationships between them [10]. The synthesis aimed to provide a comprehensive understanding of how these factors influence coaching strategies.

Key themes emerging from this synthesis highlight the necessity for disability-specific training programs, as well as the expanded role of coaches in addressing both physical and psychological demands. An integrated approach that considers both domains is essential for supporting athletes with disabilities.

3. Results

3.1. Descriptive analysis

This systematic review includes 36 studies that met the inclusion criteria. These studies examine the pathophysiological and psychosocial factors underlying disabilities in athletes and their implications for coaching practice. The peer-reviewed research utilized a variety of methodologies, including quantitative descriptive studies, qualitative research, mixed-methods approaches, and

Table 2
Quality Assessment Results for Quantitative descriptive study.

Studies	Types	Evaluation Result							Overall MMAT Score
		S1[a]	S2[b]	1.1[c]	1.2[d]	1.3[e]	1.4[f]	1,5[g]	
Michael Horvat et al. (1986)	Quantitative descriptive study	Yes	Yes	No	Yes	Yes	No	Yes	3***
Keith Henschen et al. (1984)		Yes	Yes	No	Yes	Yes	No	Yes	3***
Maria Kavussanu et al. (2015)		Yes	Yes	Yes	Yes	Yes	No	Yes	4****
Francesco Borea et al. (2021)		Yes	Yes	No	Yes	Yes	No	Yes	3***
E. K. Skordilis et al. (2002)		Yes	Yes	No	Yes	Yes	No	Yes	3***
Ljubica Bačanac et al. (2014)		Yes	Yes	Yes	Yes	Yes	Yes	Yes	5*****
Phoebe Runciman et al. (2015)		Yes	Yes	Yes	Yes	Yes	Yes	Yes	5*****
Selda Uzun et al. (2012)		Yes	Yes	Yes	Yes	Yes	Yes	Yes	5*****
László Dorogi et al. (2008)		Yes	Yes	Yes	Yes	Yes	Yes	Yes	5*****
Barbara Hall et al. (2022)		Yes	Yes	Yes	Yes	Yes	Yes	Yes	5*****
Artur Gołaś et al. (2017)		Yes	Yes	Yes	Yes	Yes	Yes	Yes	5*****
Mark Vermillion and Richard A. Dodder (2007)		Yes	Yes	Yes	Yes	Yes	Yes	Yes	5*****
Deborah R. Shapiro et al. (2010)		Yes	Yes	Yes	Yes	Yes	Yes	Yes	5*****
Pasquale Imparato et al. (2021)		Yes	Yes	Yes	Yes	Yes	Yes	Yes	5*****
Ana Margarida Martins Domingues et al. (2022)		Yes	Yes	Yes	Yes	Yes	No	Yes	4****
Erdem Ayyildiz et al. (2024)		Yes	Yes	Yes	Yes	Yes	No	Yes	4****
Olatz Zabala-Dominguez et al. (2023)		Yes	Yes	Yes	Yes	Yes	No	Yes	4****
Deborah R. Shapiro and Jeffrey J. Martin (2010)		Yes	Yes	Yes	Yes	Yes	No	Yes	4****
Julius Jooste et al. (2018)		Yes	Yes	Yes	Yes	Yes	Yes	Yes	5*****
Samir Qasim et al. (2019)		Yes	Yes	Yes	Yes	Yes	Yes	Yes	5*****
Luca Puce et al. (2017)		Yes	Yes	Yes	Yes	Yes	No	Yes	4****
Paul M. Valliant et al. (1985)		Yes	Yes	Yes	Yes	Yes	Yes	Yes	5*****
Deborah R. Shapiro and Laurie A. Malone (2016)		Yes	Yes	Yes	Yes	Yes	Yes	Yes	5*****
Deborah R. Shapiro and Jeffery J. Martin (2014)		Yes	Yes	Yes	Yes	Yes	Yes	Yes	5*****
Jeffrey J. Martin, and Laurel Whalen et al. (2012)		Yes	Yes	Yes	Yes	Yes	Yes	Yes	5*****
Marco Batista et al. (2019)		Yes	Yes	Yes	Yes	Yes	Yes	Yes	5*****
Giovanni Fiorilli et al. (2021)		Yes	Yes	Yes	Yes	Yes	Yes	Yes	5*****
Lei Zheng (2023)		Yes	Yes	Yes	Yes	Yes	Yes	Yes	5*****
Deborah R. Shapiro and Jeffery J. Martin et al. (2014)		Yes	Yes	Yes	Yes	Yes	Yes	Yes	5*****
Luca Puce et al. (2023)		Yes	Yes	Yes	Yes	Yes	Yes	Yes	5*****

Note.
[a] Are there clear research questions?.
[b] Do the collected data address the research questions?.
[c] Is the sampling strategy relevant to address the quantitative research question?.
[d] Is the sample representative of the target population?.
[e] Are the measurements appropriate?.
[f] Is the risk of nonresponse bias low?.
[g] Is the statistical analysis appropriate to answer the research question?.

Table 3
Quality Assessment Results for Quantitative nonrandomized study.

Studies	Types	Evaluation Result							Overall MMAT Score
		S1[a]	S2[b]	1.1[c]	1.2[d]	1.3[e]	1.4[f]	1,5[g]	
Manuele Taleb et al. (2021)	Quantitative nonrandomized study	Yes	Yes	No	Yes	Yes	No	Yes	3***
Stephan Turbanski et al. (2010)		Yes	Yes	No	Yes	Yes	No	Yes	3***

Note.
[a] Are there clear research questions?.
[b] Do the collected data address the research questions?.
[c] Are the participants representative of the target population?.
[d] Are measurements appropriate regarding both the outcome and intervention (or exposure)?.
[e] Are there complete outcome data?.
[f] Are the confounders accounted for in the design and analysis?.
[g] During the study period, is the intervention administered (or exposure occurred) as intended?.

quantitative nonrandomized designs, facilitating a comprehensive investigation of the topic (Fig. 1).

The geographical distribution of the studies contributes to a culturally diverse understanding of the issues (Fig. 2). Studies were predominantly conducted in the United States (n = 11), followed by Italy (n = 5), and the United Kingdom (n = 3). Additional contributions came from South Africa (n = 2), Portugal (n = 2), and various countries such as Turkey, China, Canada, Australia, Spain, Sweden, Poland, Hungary, Germany, Serbia, and several European countries (n = 1 for each country). This wide representation

Table 4
Quality assessment results for mixed methods study.

Studies	Types	Evaluation Result							Overall MMAT Score
		S1[a]	S2[b]	1.1[c]	1.2[d]	1.3[e]	1.4[f]	1,5[g]	
Andrew G et al. (2017)	Mixed methods study	Yes	Yes	Yes	Yes	Yes	Yes	Yes	5*****

Note.
[a] Are there clear research questions?.
[b] Do the collected data address the research questions?.
[c] Is there an adequate rationale for using a mixed methods design to address the research question?.
[d] Are the different components of the review effectively integrated to answer the research questions?.
[e] Are the results adequately brought together to answer the research questions?.
[f] Are divergences and inconsistencies between quantitative and qualitative results adequately addressed?.
[g] Do the different components of the review adhere to the quality criteria of each tradition of the methods involved?.

Table 5
Quality Assessment Results for Qualitative studies.

Studies	Types	Evaluation Result							Overall MMAT Score
		S1[a]	S2[b]	1.1[c]	1.2[d]	1.3[e]	1.4[f]	1,5[g]	
Anna Carin Aho et al. (2022)	Qualitative study	Yes	Yes	Yes	Yes	Yes	Yes	Yes	5*****
T. N. Kirk et al. (2021)		Yes	Yes	Yes	Yes	Yes	Yes	Yes	5*****
Hannah Macdougall et al. (2016)		Yes	Yes	Yes	Yes	Yes	Yes	Yes	5*****

Note.
[a] Are there clear research questions?.
[b] Do the collected data address the research questions.
[c] Is the qualitative approach appropriate to answer the research question?.
[d] Are the qualitative data collection methods adequate to address the research question?.
[e] Are the findings adequately derived from the data?.
[f] Is the interpretation of results sufficiently substantiated by data?.
[g] Is there coherence between qualitative data sources, collection, analysis, and interpretation?.

captures a broad range of cultural and environmental contexts, allowing for cross-national comparisons and shedding light on both global challenges and region-specific nuances in the study of athletes with disabilities.

Among the included studies, 30 utilized quantitative descriptive designs, offering detailed statistical insights. Two studies employed quantitative non-randomized methods, adding further depth to the data through comparative analysis. Additionally, one mixed-methods study integrated both quantitative and qualitative approaches, strengthening the overall findings. Lastly, three studies were qualitative, providing rich, nuanced perspectives on individual experiences and societal contexts. This range of methodologies contributed to a more comprehensive understanding of the multifaceted issues related to disabilities in sports coaching.

The participants in the included studies encompassed a broad range of demographics, including both male and female athletes, spanning from adolescence to adulthood. The studies featured a wide spectrum of disabilities: physical disabilities such as cerebral palsy (CP), spina bifida, spinal cord injuries, amputations, and muscular dystrophy, alongside visual and auditory impairments like blindness and deafness. There were also cases of intellectual and developmental disabilities. This diversity ensured the review captured the distinct challenges associated with different impairment types. Additionally, participants varied in experience levels, from novices to elite athletes, allowing for a comprehensive exploration of how societal and structural factors influence coaching practice across different stages of athletic development. This broad representation across demographics and skill levels is essential for understanding the complexities of coaching athletes with disabilities.

3.2. Quality assessment

A total of 36 articles were assessed for quality using the MMAT. Among these, 30 were quantitative descriptive studies (Table 2), 2 were quantitative non-randomized studies (Table 3), 1 was a mixed methods study (Table 4), and 3 were qualitative studies (Table 5). Of the evaluated articles, 24 met 100 % of the quality criteria, achieving the highest possible MMAT score. Additionally, 6 articles met 80 % of the quality criteria, while another 6 met 60 %. These results indicate that the majority of the included studies are of high quality, ensuring robust methodologies were employed in analyzing societal attitudes and structural barriers in coaching athletes with disabilities.

3.3. Pathophysiological factors

3.3.1. Performance differences

Wheelchair athletes, such as those in tennis and basketball, experience distinctive strength challenges due to reliance on upper

body power in movements traditionally supported by lower body muscles [3]. For example, wheelchair tennis players struggle to generate serve force due to limited lower body mobility, which shifts demands to the upper body [3,11]. Targeted training, such as upper limb strength and hypertrophy programs (e.g., Bill Starr method), has proven effective in enhancing upper body power, narrowing performance gaps in sports that require substantial upper body strength [12]. In wheelchair basketball, where similar adaptations are required, muscle activation and coordination become crucial; tools like surface electromyography (EMG) assist coaches in tracking muscle fatigue, allowing adjustments in training to maintain performance during high-intensity activities [13,14].

3.3.2. *Body composition*

Variations in body composition also affect performance, particularly muscle fiber distribution in athletes with disabilities [15]. For instance, cerebral palsy (CP) athletes often possess a higher proportion of type I fibers, impacting explosive strength and sprinting capacity [16]. Elite-level training can, however, significantly improve endurance and cardiovascular fitness, aligning CP athletes' performance more closely with that of able-bodied peers [12]. For athletes with spinal cord injuries at or above the T6 level, heavy resistance and aerobic exercises, such as handcycling, are instrumental in improving upper extremity strength and cardiovascular capacity, though they require careful monitoring to avoid autonomic dysregulation [17].

3.3.3. *Injury risks*

The unique physical demands placed on athletes with disabilities heighten their risk of overuse injuries, particularly in the upper limbs of wheelchair athletes [11,18]. Structured strength and coordination programs, emphasizing posterior movements, scapula and glenohumeral mobility and strength, can help minimize injury risks and optimize force generation [19,20]. For wheelchair basketball players, continuous upper body fatigue risks both central and peripheral strain, highlighting the importance of strength and endurance training in reducing injury likelihood [12,21]. Neuromuscular limitations in CP athletes, including impaired motor unit recruitment, further contribute to injury susceptibility, making preventive training a critical component of coaching strategies [15,16].

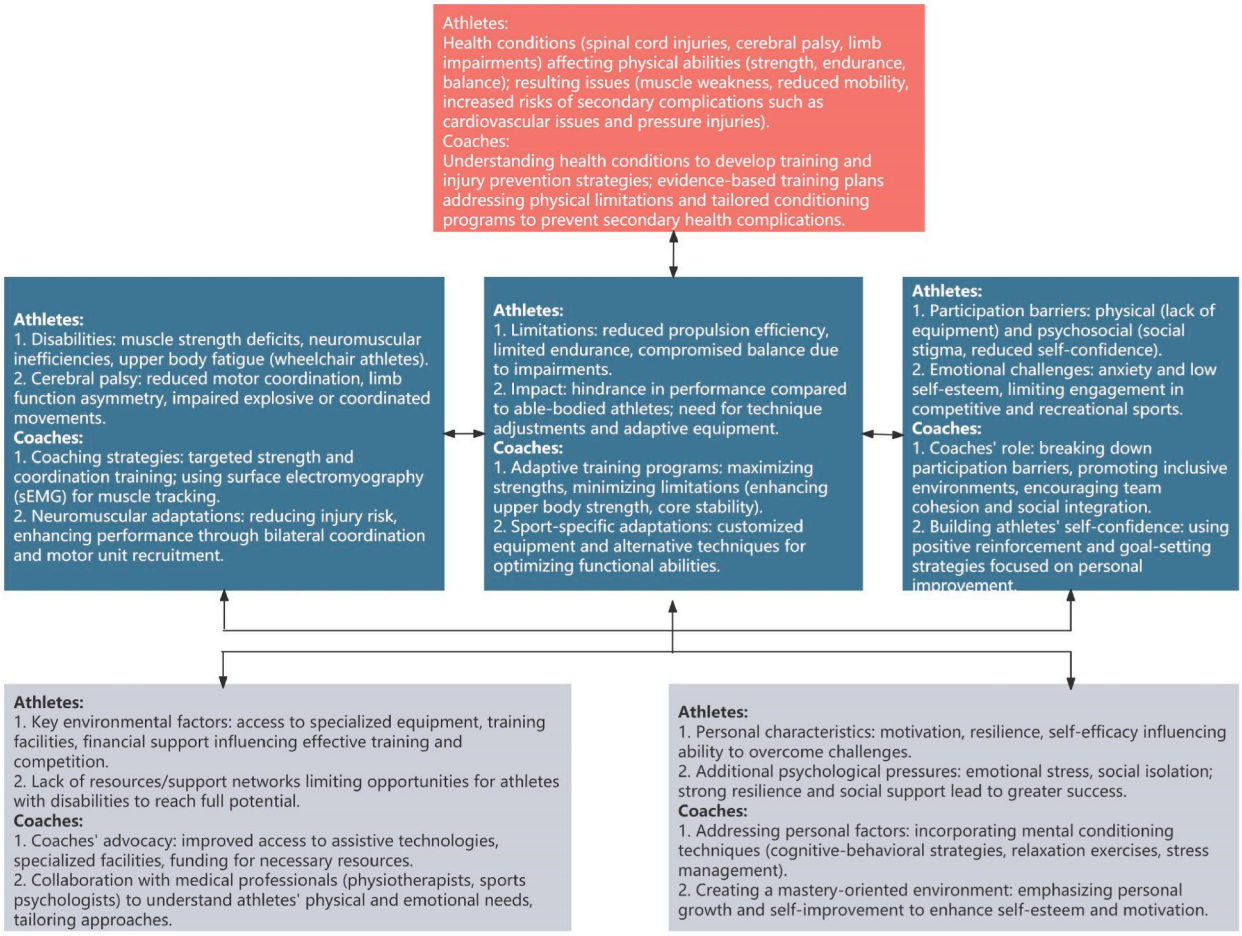

Fig. 3. ICF framework for adaptive sports coaching.

3.4. Psychosocial factors

3.4.1. Mental health challenges

Athletes with disabilities face distinct mental health challenges, balancing the demands of managing a disability with those of high-performance sports [2]. Studies show that wheelchair athletes often exhibit an "Iceberg Profile," marked by low levels of tension and depression but high vigor, demonstrating their resilience in handling physical and psychological pressures in competitive settings [3]. However, athletes who acquired disabilities later in life may experience heightened anger and frustration, driven by societal stigma and physical limitations [6]. Coaches play a crucial role in fostering resilience by implementing training programs that build both physical and emotional strength, helping athletes adapt to fatigue and stress [17,22].

3.4.2. Motivation and team dynamics

Motivation in disabled athletes often centers on a mastery-oriented mindset, focusing on personal growth over competition [18,23]. This approach, supported by Achievement Goal Theory, fosters sustained engagement, particularly in individual sports like wheelchair racing and swimming [16,24]. Coaches can strengthen this motivation by encouraging self-efficacy and skill development [17]. Additionally, strong team dynamics provide psychosocial support, reducing feelings of isolation and reinforcing a sense of belonging [24]. Team-building activities further enhance these dynamics, creating an environment where social bonds support both personal and athletic growth [13].

3.4.3. Moral disengagement and empathy

Disabled athletes frequently display heightened empathy and reduced moral disengagement, likely stemming from their personal experiences, which fosters positive team dynamics and ethical sportsmanship [3,24,25]. This empathy helps build collaborative relationships and reduces antisocial behaviors, such as aggression, which strengthens team cohesion [26]. Coaches who emphasize empathy and ethical values can cultivate inclusive team environments, positioning sports as a means for social inclusion and ethical development [27,28].

3.5. Interaction between pathophysiological and psychological effects

3.5.1. Interdependence of physical conditioning and psychological well-being

The interplay between pathophysiological and psychological factors deeply influences athletes with disabilities [2,29]. Physical conditioning not only enhances physical capacity but also promotes psychological benefits, such as improved mood, reduced anxiety, and greater resilience, highlighting the holistic impact of training [6]. For example, strength and endurance training for wheelchair athletes contributes to mental resilience by supporting coping mechanisms like emotional regulation and focused mental stamina [13]. Techniques like biofeedback and stress management can further stabilize psychological responses to physical limitations, such as muscle spasms or fatigue [26,30].

3.5.2. Emotional impact of physical constraints and constructive focus

Physical limitations often lead to frustration among athletes with disabilities, yet this emotional tension can be harnessed constructively [18,27,31]. By applying techniques like Rational Emotive Behavior Therapy (REBT) and biofeedback, coaches can help athletes reframe negative emotions, transforming them into strengths that enhance focus and competitive drive [13,32]. This emotional adaptability not only mitigates the effects of physical constraints but also strengthens mental fortitude [23].

3.5.3. Medication's role in psychological adaptation

Certain medications used to manage physical symptoms, like muscle relaxants, can impact athletes' psychological states by influencing emotional stability and energy levels [16,33]. Balancing pathophysiological needs with mental readiness for competition requires an integrated approach, underscoring the complex relationship between managing medical needs and achieving psychological resilience [25,34].

3.5.4. Psychological gains from physical training and social support

Structured training programs foster both physical and psychological growth, enhancing self-efficacy and confidence in athletes with disabilities [24,28]. For instance, wheelchair tennis players often experience increased self-assurance as they observe tangible physical improvements, helping to close the perceived gap with able-bodied athletes and reduce competition-related anxiety [35,36]. Additionally, supportive training environments, where inclusive practices encourage empathy and mutual respect, play a significant role in building social connections [2,37]. Interactions with teammates and coaches reinforce a sense of belonging and social identity, which enhances emotional resilience and integration within both athletic and broader social contexts [6,38].

4. Discussion

The interaction between pathophysiological and psychosocial factors shapes both coaching strategies and performance outcomes for athletes with disabilities. Effective coaching must integrate responses to physical challenges while fostering mental resilience, emotional regulation, and social belonging. This holistic approach recognizes that physical conditioning can bolster psychological resilience, just as a strong mental state can enhance physical performance.

We applied the ICF model, shown in Fig. 3, to represent these complex interdependencies. The ICF framework illustrates how body functions, activity limitations, and participation restrictions intersect with environmental and personal factors. This structure provides coaches with a comprehensive perspective to design tailored programs that address immediate physical demands and support long-term psychosocial development, fostering inclusive and adaptive coaching strategies.

4.1. Impact of pathophysiological factors on coaching strategies

This review highlights how specific pathophysiological factors shape coaching strategies for athletes with disabilities, particularly focusing on upper body strength and endurance limitations in wheelchair sports. For wheelchair athletes, targeted strength training methods, such as the Bill Starr approach, are recommended to build upper body strength and reduce performance gaps compared to able-bodied athletes [14]. Neuromuscular adaptation training is also essential, as it enhances coordination and force output under fatigue conditions [2]. Tools like surface EMG further support coaches in monitoring fatigue, allowing adjustments in training intensity to better manage fatigue and optimize performance [39,40].

In contrast to broader recommendations found in previous studies, this review provides detailed insights into sport-specific physiological demands, such as how upper body strength deficits impact key movements in wheelchair tennis and basketball, including serving and sprinting [21,41]. By emphasizing upper body hypertrophy and neuromuscular adaptation, this review offers practical strategies to enhance endurance, manage fatigue, and improve overall performance in strength-demanding sports [42–44].

This approach not only aims to elevate athletic performance but also provides solutions for injury prevention related to upper body fatigue in high-intensity wheelchair sports. Through individualized strength and coordination programs, coaches gain actionable guidance on tailoring training to meet the unique demands of athletes with disabilities, bridging gaps in existing research on adaptive strategies to enhance both performance and safety [15].

4.2. The role of psychosocial considerations in athlete development

Psychosocial factors are crucial in enhancing both the growth and well-being of athletes with disabilities, complementing the physiological adaptations discussed earlier [17]. Research underscores the importance of fostering self-acceptance, autonomy, and environmental mastery to support mental health and athletic performance [42]. By incorporating psychological training—such as biofeedback, relaxation techniques, and emotional regulation strategies—coaches can help athletes manage anxiety, anger, and motivation effectively [45]. This approach not only builds mental resilience and emotional stability but also reinforces physical adaptations, creating a balanced coaching strategy [23,46].

Social support and structured team-building activities are essential for promoting a sense of inclusion and motivation through peer connections [16]. Coaches can play a pivotal role in reducing isolation and building athletes' confidence by developing supportive team environments that help athletes overcome stigma-related challenges [47]. These social networks align closely with physical training programs, contributing to enhanced confidence, motivation, and overall satisfaction in sports experiences [19,25].

Moreover, this review emphasizes the often-overlooked aspect of moral and ethical development in disabled athletes' psychosocial growth [24]. While resilience and social integration are commonly addressed, fostering ethical conduct through sports provides a unique opportunity for personal growth [39]. By integrating moral development into coaching, particularly within inclusive sports environments, coaches can nurture athletes' empathy, ethical responsibility, and sportsmanship. This comprehensive approach not only supports athletes' individual development but also contributes to a more inclusive and respectful sports culture [48].

4.3. Interplay between physical and mental health in adaptive sports

This review examines the critical interaction between physical and psychological health in adaptive sports for athletes with disabilities, emphasizing how physical training can foster psychological resilience and mental well-being [17]. While existing literature often highlights external stressors—such as accessibility issues, financial limitations, and communication barriers—that increase psychological strain in para-athletes, this review shifts focus to the internal dynamics between physical training and psychological outcomes [49]. Specifically, it explores how physiological improvements through targeted training can enhance athletes' emotional regulation, motivation, and mental focus, thus directly supporting their psychological health [50,51].

In addition, although previous studies caution against the risks of over-identification with athletic roles (which can lead to vulnerability following injury or retirement), this review underscores the psychological benefits of physical training, especially in strength and endurance sports. Improvements in physical conditioning have been shown to boost self-efficacy and reduce competition-related anxiety, highlighting the positive influence of physiological progress on psychological resilience [52]. This review further identifies specific strategies, such as cognitive-behavioral techniques, that coaches can employ to help athletes manage emotional challenges related to physical limitations.

By examining the internal mechanisms through which physical training impacts psychological health, this review fills a gap in the literature, providing a structured framework on how pathophysiological gains contribute to emotional resilience. It also offers practical recommendations for coaches, advocating for an integrated approach that combines physical and psychological training to produce comprehensive benefits for athletes with disabilities [16].

4.4. Practical implications for coaching

When designing effective training regimens for athletes with disabilities, coaches must integrate both pathophysiological and psychosocial considerations outlined in the ICF framework. This approach not only enhances athletic performance but also promotes psychological resilience, intrinsic motivation, and team dynamics [2]. The ICF framework emphasizes a holistic approach, addressing both physical and psychological dimensions of disability, guiding coaches in recognizing and addressing the unique needs and barriers faced by these athletes.

4.4.1. Pathophysiological factors and injury prevention

Due to the high upper body demands in wheelchair sports like tennis and basketball, injury prevention should focus on monitoring the shoulder and elbow regions for fatigue and joint strain. Coaches should implement strength-hypertrophy programs targeting upper limb resilience, enabling athletes to withstand repetitive high-force actions, consistent with the ICF framework's "body functions and structures" domain [6,14]. For athletes with neuromuscular conditions, targeted neuromuscular training is essential for enhancing motor unit recruitment and reducing movement asymmetry, thereby improving consistency in performance. Technologies such as EMG enable real-time monitoring of muscle activation patterns, allowing coaches to make dynamic adjustments in training intensity to minimize fatigue risks while optimizing performance [15,53,54].

4.4.2. Performance monitoring and adaptation

Disabled athletes often experience specific physiological limitations, such as reduced explosive power and altered movement mechanics, requiring coaches to tailor sport-specific programs accordingly. The ICF framework underscores the importance of personal and environmental factors, prompting coaches to design individualized programs that enhance upper body coordination, manage fatigue, and improve movement efficiency [6]. This can include resistance and weighted training to aid athletes in better controlling muscle output during actions. By using surface EMG to monitor fatigue, coaches can adjust training intensity promptly, preventing overtraining and allowing intensity to match the athlete's physiological condition [14].

4.4.3. Psychosocial considerations and motivation techniques

Intrinsic motivation is crucial for sustaining commitment, especially for athletes with disabilities who may face additional social and physical challenges [11]. According to the ICF framework's focus on individual and environmental factors, fostering a mastery-oriented environment is essential [6,20,23]. Coaches can build self-efficacy and psychological resilience by creating an autonomy-supportive climate that emphasizes personal growth rather than comparisons with able-bodied athletes [26,33]. For example, by using positive reinforcement, goal setting, and celebrating individual achievements, coaches can help athletes recognize their progress [2]. Tracking physical improvements reinforces athletes' sense of control over their performance, enhancing mental resilience [6]. For athletes struggling with self-confidence or psychological stress, coaches can apply task-oriented strategies to shift focus from comparison to self-improvement, fostering lasting self-confidence and self-identity [3].

4.4.4. Team dynamics and emotional support

The ICF framework highlights the role of social inclusion and supportive environments in enhancing both performance and well-being. In team sports, coaches should encourage positive peer relationships and team cohesion, creating an inclusive space where athletes with disabilities feel valued [14]. Additionally, gender-specific support may be beneficial, as it ensures that emotional reinforcement meets individual needs. For female athletes, incorporating peer support group activities can improve emotional expression and belonging, aligning with their unique psychological needs [16,25]. These team-building strategies allow coaches to foster an environment that supports both performance and mental well-being [11].

4.5. Limitations of the literature and future research directions

While this systematic review offers a comprehensive analysis of the pathophysiological and psychosocial measures in adaptive sports and their implications for coaching practice, certain limitations must be acknowledged. First, the heterogeneity of the included studies, particularly in terms of methodological designs and populations, presents challenges in establishing generalizable conclusions. The predominance of quantitative descriptive designs, while providing valuable statistical insights, limits the depth of qualitative understanding of the nuanced experiences of athletes with disabilities. Future research should focus on integrating more robust mixed-methods approaches that allow for the triangulation of quantitative and qualitative data, thereby providing a more holistic understanding of the interplay between physiological factors and psychosocial well-being in these athletes.

Second, geographical disparities in the included studies, with a significant concentration in Western contexts, may hinder the generalizability of the findings to non-Western populations. Given the culturally specific nature of societal attitudes and structural barriers, future studies should aim to expand research to underrepresented regions, particularly in low- and middle-income countries, where access to adaptive sports programs and support structures may differ significantly. Comparative cross-cultural studies would be invaluable in examining how diverse social and economic contexts influence the coaching practice and development of athletes with disabilities.

Third, the reliance on self-reported data in several of the psychosocial studies introduces the potential for bias, particularly in the areas of motivation, emotional regulation, and mental health challenges. Future studies should employ more objective psychological assessments and neurophysiological measures to corroborate self-reported findings, thereby enhancing the reliability of the data.

Additionally, the long-term impact of specific coaching interventions designed to address both pathophysiological deficits and psychosocial challenges remains insufficiently explored. Although short-term benefits of strength and hypertrophy training programs, as well as psychosocial interventions, have been documented, longitudinal studies are necessary to assess the sustainability of these improvements over time and across different competitive levels. Such research would help determine the extent to which early interventions can mitigate performance disparities and enhance psychological resilience over an athlete's career trajectory.

Finally, while this review highlights the interaction between pathophysiological and psychosocial factors, future research should further investigate the bidirectional nature of this relationship. Specifically, there is a need for studies that examine how improvements in psychological well-being, such as enhanced self-efficacy and emotional regulation, can influence physiological adaptations in athletes with disabilities. A more detailed exploration of these mechanisms would provide clearer insights into how integrated coaching approaches can maximize both physical performance and mental health outcomes.

5. Conclusion

This systematic review provides a comprehensive analysis of the complex interplay between pathophysiological and psychosocial factors in adaptive sports, shedding light on their critical implications for coaching practices. Key findings reveal that athletes with disabilities encounter unique physiological challenges, such as upper body strength deficits and altered biomechanics, especially prominent in wheelchair sports. Targeted training in upper body coordination and endurance has proven effective in addressing these issues. Nevertheless, long-term research is needed to assess the sustainability of these interventions in injury prevention and performance optimization.

On the psychosocial front, athletes benefit significantly from emotional resilience, supportive team dynamics, and tailored motivational techniques, all of which enhance both performance and overall well-being. This review identifies gaps in the literature, particularly concerning the social isolation and stigmatization faced by disabled athletes, pointing to the need for further research on psychological support mechanisms like biofeedback and relaxation training for emotional regulation.

Ultimately, our findings underscore the necessity for coaches to adopt a holistic, individualized approach that integrates both physical and mental conditioning tailored to the unique needs of athletes with disabilities. Collaboration with healthcare professionals and mental health specialists will be instrumental in creating inclusive, supportive environments that foster resilience and empower these athletes to achieve their full potential. This review thus advances current knowledge by affirming the importance of an integrated coaching strategy that embraces the dual aspects of pathophysiology and psychosocial support to promote sustainable success in adaptive sports.

CRediT authorship contribution statement

Junyan Liu: Writing – review & editing, Writing – original draft, Validation, Methodology, Investigation, Formal analysis, Conceptualization. **Hongjun Yu:** Writing – review & editing, Project administration, Investigation, Conceptualization. **W. Catherine Cheung:** Writing – review & editing, Investigation, Conceptualization. **Adam Bleakney:** Writing – review & editing, Investigation, Conceptualization. **Yih-Kuen Jan:** Writing – review & editing, Writing – original draft, Validation, Supervision, Project administration, Investigation, Conceptualization.

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The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

List of abbreviations

EMG Electromyography
ICF International Classification of Functioning, Disability and Health

MMAT Mixed Methods Appraisal Tool
PRISMA Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PROSPERO International Prospective Register of Systematic Reviews
SWL: Satisfaction with Life Scale
WHOQOL: World Health Organization Quality of Life.

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