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Periodic health evaluation in Para athletes: a position statement based on expert consensus

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ABSTRACT

Para athletes present a broad range of sports-related injuries and illnesses, frequently encountering barriers when accessing healthcare services. The periodic health evaluation (PHE) is a valuable tool for continuously monitoring athletes' health, screening for health conditions, assisting in the surveillance of health problems by establishing baseline information and identifying barriers to athlete's performance. This position statement aims to guide sports healthcare providers in the PHE for Para athletes across key impairment categories: intellectual, musculoskeletal, neurological and vision. A panel of 15 international experts, including epidemiologists, physiotherapists, optometrists and physicians with expertise in Para athlete health, convened via videoconferences to discuss the position statement's purpose, methods and themes. They formed working groups to address clinical, cardiorespiratory, neuromusculoskeletal, nutritional status, mental and sleep health, concussion and female Para athlete health assessment considerations. The PHE's effectiveness lies in its comprehensive approach. Health history review can provide insights into factors impacting Para athlete health, inform physical assessments and help healthcare providers understand each athlete's needs. During the PHE, considerations should encompass the specific requirements of the sport modality and the impairment itself. These evaluations can help mitigate the common tendency of Para athletes to under-report health issues. They also enable early interventions tailored to the athlete's health history. Moreover, the PHE serves as an opportunity to educate Para athletes on preventive strategies that can be integrated into their training routines, enhancing their performance and overall health. This position statement can potentially enhance clinical translation into practice and improve the healthcare quality for Para athletes.

INTRODUCTION

Participation in adaptive sport improves the physical and mental quality of life for people with physical disabilities, mainly by reducing the probability of new health events.[1] However, despite these benefits, challenges with athlete participation and safety still exist. Para athletes experience a large variability of sports-related health problems and tend to take longer to seek medical support when their complaint is related to their impairment.[2] It has been suggested that this phenomenon is related to Para athletes being both more used to pain or discomfort and that they experience additional barriers to accessing healthcare, such as the lack of physicians or physiotherapists within sports teams.[2–5] Consequently, there may be delays in identifying health problems, which may have clinical and performance implications. For example, an untreated urinary tract infection in a Para athlete with spinal cord injury (SCI) may progress to kidney inflammation, subsequently impairing their athletic performance.[2 6] Research related to data collection and reporting of injury and illness in Para athletes has evolved/developed in recent years, including the continual monitoring of athletes in longitudinal studies.[7–12] To illustrate, two recent studies show that the average weekly prevalence of health problems was 40.6% over 24 weeks and 48.0% over a 40-week health monitoring period among Brazilian and Dutch Para athletes, respectively.[7 12] Additionally, the average prevalence of health problems in Paralympic athletes is higher than in Olympic athletes, with illnesses representing the greatest burden for Paralympic athletes.[13] Considering these high rates, closer athlete health monitoring may allow the early identification of health problems that could otherwise impair these athletes' sports participation, training, performance and practice.

To know whether a reported health problem is related to a specific sport event, the impairment itself, or other factors, clinicians and scientists must be aware of the baseline athlete health in the presence of

impairment. The International Olympic Committee (IOC) consensus statement on periodic health evaluation (PHE) provided practical recommendations on how to assess elite athletes.[14 15] According to this consensus, the PHE is a valuable tool to continually monitor athletes' health, promote safe participation in sports, screen health conditions that may place an athlete at risk and identify barriers to participation and performance.[14] Although some screening tests before competition have gained greater attention because of their association with injury or illness risk (eg, eccentric hamstring strength),[16 17] it is questionable whether there is enough evidence to suggest they can predict injury or illness with sufficient accuracy, especially because there is no continual assessment of the athlete throughout the sports season.[18 19] Other useful roles for the PHE include assisting with the surveillance of health problems by providing baseline information for each athlete and providing the sports healthcare team with useful information in the case of emergencies.[20] Yet, no PHE is adapted to Para athletes and their specific impairments, and we propose that this adaptation is necessary given their unique medical backgrounds and associated risk factors. For instance, athletes with neurological impairments have a higher burden of respiratory problems compared with athletes with musculoskeletal impairments, indicating a greater risk of respiratory infection due to neurological deficiencies.[4]

Para athletes often have unique and varied background health impairments that can lead to additional complexity in a sporting environment, including the need for various adaptive equipment in order to compete. This requires more specific information about each Para athlete, and potential adaptation of reporting systems and also increases the complexity of strategies designed to prevent and reduce health problems.[21 22] For this reason, PHE performed by a multidisciplinary team is required to better understand each Para athlete's general health state and identify risk factors that, if unaddressed, could lead to adverse health or performance consequences. The PHE is especially relevant to allow the clinician to monitor the progression of a Para athlete's health status over time and to design and implement individualised approaches. This position statement describes general considerations for the PHE of Para athletes. In doing so, we address the different impairment types, the frequency of the PHE, the implications and the contextual factors that can guide sport healthcare providers with Para athletes.

METHOD

The lead authors (LP, EV and RR) invited five additional authors from across the globe (KF, OHA, RW, CAB and CAO) to write this position statement. The selection of these authors was based on their status as renowned researchers in Paralympic sports. Consequently, they could significantly contribute with strong theoretical and scientific foundations to the development of this position statement. The authors met by videoconference as a core team to discuss this position statement's purpose, method and themes. They assigned each core member to chair a working group focused on one of the discussed themes. There are according to the International Paralympic Committee Athlete Classification Code 2017, 10 impairment types that make an athlete eligible for participation in Para sports that are sanctioned by the International Paralympic Committee (IPC): intellectual impairment, vision impairment (VI) and 8 different forms of physical impairment. To simplify, we allocated each of these impairment types to one of four primary impairment types most commonly represented in Para sports (ie, intellectual, vision, musculoskeletal and neurological impairments), considering the Para sport translation of the IOC consensus.[23] Each group was asked to add specific considerations related to clinical, cardiorespiratory, neuromusculoskeletal, lifestyle-related factors (nutritional status, mental and sleep health), concussion and female Para athlete health domains.

Each core member was tasked to invite additional experts who work with Para athletes in clinical or research settings to their working group. Two additional experts were invited at a later stage to provide a critical review of the manuscript, as chair and member of the IPC Medical Committee, respectively. This resulted in a panel of 15 international experts (LP, EV, JO, KF, OHA, KD, DLM, RW, CAO, CAB, JL, WD, NW, AS and RR) who were selected based on their involvement in various clinical and academic Para athlete settings. Our panel includes epidemiologists, physiotherapists, optometrists, physicians with expertise in Para athlete health, and two authors with lived experience as a Para athlete. Table 1 summarises the list of the panel, their characteristics and expertise.

The goal of the working group was to establish specific parameters for the PHE in Para athletes, facilitating the development of a practical tool for clinical use. This inaugural analysis of PHE for Para athletes lays the foundation for subsequent investigations into the validity, reliability and effectiveness of these assessments, using structured consensus methodologies.

Figure 1 describes the steps of this position statement.

General considerations for PHE in Para athletes

Health and impairment history

The health history aims to identify important information regarding Para athlete health concerns and conditions. A structured questionnaire that is tailored for Para athletes is recommended. Therefore, it can be used by any health professional (eg, physician, physiotherapist, psychologist, optometrist and nutritionist). It should include questions related to the history of the impairment: aetiology (eg, traumatic, medical or genetic causes), age of onset, medical treatments (eg, drugs, surgical and medical treatments, orthosis/prothesis, medical devices and technical aids), complications, historical rehabilitation and current status. It allows health professionals to understand which factors may influence the Para

Table 1 The expert panel composition

Panel member no.	Gender	Country	Expertise	Years of experience in para sport
1 LP	Female	Brazil	Sports physiotherapist and researcher specialised in the health problems and physical performance of Para athletes. Experienced in working across multiple Para sports, including athletics, powerlifting, swimming and taekwondo.	6
2 EV	Male	Netherlands	Sports scientist and epidemiologist, with expertise in sports injury prevention and the promotion of physical activity as part of daily life, including the context of Para sports. Authored or coauthored over 300 peer-reviewed publications, with an H-index of 79.	12
3 JO	Female	Brazil	Physiotherapist and renowned researcher, with expertise in rehabilitation sciences, focusing on sports and musculoskeletal conditions. Conducts studies on health problems and physical performance in Para athletes.	5
4 KF	Female	Sweden	Physiotherapist and researcher, with expertise in physical activity and sports medicine. Focuses on the health and well-being of Para athletes, aiming to develop tailored health prevention resources for this group.	10
5 OHA	Male	United Kingdom	Sports physiotherapist and researcher working across various Para sports, with a particular focus on concussion in Para sports. Serves as the Medical and Sports Science Director at the International Federation of Cerebral Palsy Football and is a member of the Medical Committee for the International Blind Sports Association.	20
6 KD	Female	Canada	Optometrist and researcher, with expertise in Para sport for athletes with a visual impairment. A leader in the field of sports vision and concussion rehabilitation, contributing to the development of one of the first sport-specific classification systems for Para athletes with vision impairment, as well as national and international guidelines on concussion management.	8
7 DLM	Male	Netherlands	Optometrist and sports scientist. Expertise in classification for athletes with a vision impairment. Director of the International Paralympic Committee Classification Research and Development Centre for Athletes with Vision Impairment.	12
8 RW	Male	United Kingdom	Sports physician and researcher. Working in multiple Para sports, focused on optimising performance and understanding the unique physiological and psychological needs of Para athletes.	18
9 CAO	Female	Kenya	Sports physician. Working in rehabilitation medicine for persons with spinal cord injury and with Para and non-Para sports. Researcher focusing on sports performance, health and well-being of athletes with disabilities.	4
10 CAB	Female	USA	Sports physician with experience in Para athlete research, focusing on the health and performance of athletes with disabilities. Lived experience as a Para athlete.	25
11 JL	Male	Sweden	Physician and renowned researcher with expertise in rehabilitation medicine and neurology. Focuses on neuromuscular disorders and the effects of physical activity on individuals with disabilities. Standing member of the Medical Committee of the International Paralympic Committee. Authored or co-authored over 300 peer-reviewed publications, with an H-index of 68.	15

Continued

Table 1 Continued

Panel member no.	Gender	Country	Expertise	Years of experience in para sport
12 WD	Male	South Africa	Sports physician and clinical researcher in Para sport. Chairperson of the International Paralympic Committee Medical Commission. Authored or coauthored over 250 peer-reviewed publications, with an H-index of 54.	24
13 NW	Male	UK	Sports physician and clinical researcher in Para sport, contributing to the development of guidelines and practices for sports medicine in the context of disability sports. Lived experience as a Para athlete.	32
14 AS	Female	Brazil	Physiotherapist and researcher, focusing on the relationship between psychobiological aspects, sleep and health problems in Para athletes. Working in multiple Para sports in Brazilian Paralympic Committee.	18
15 RR	Male	Brazil	Physiotherapist and researcher with expertise in sports injury prevention and rehabilitation, working in a Brazilian Paralympic Centre. Contributes to research on the performance, health and well-being of Para athletes.	6

athletes' health, informs risk-preventive measures, guides the physical assessment[24] and includes extensive information to accommodate common but complex health issues in the Para athlete population.[22] Health professionals conducting assessments should incorporate standard questions and tailor their evaluations to account for the physiological systems with impaired function in Para athletes[22] and consider the practical methods of data collection considering the potential impact of the impairment. For example, a health professional may inquire about bladder control, urinary tract infections or issues surrounding skin breakdown that are highly relevant to a person with SCI.[25] A high proportion of Para athletes also use various medications and supplements. These should be carefully reviewed for their impact on health problems management and for compliance with antidoping regulations.[26] During the medical history assessment, healthcare providers should inquire about previous illnesses, including allergies, current physiological symptoms, hospitalisations, surgical procedures and any conditions of life that could be associated with their health history. This includes travel history, family health histories and other activities such as work or leisure.[22]

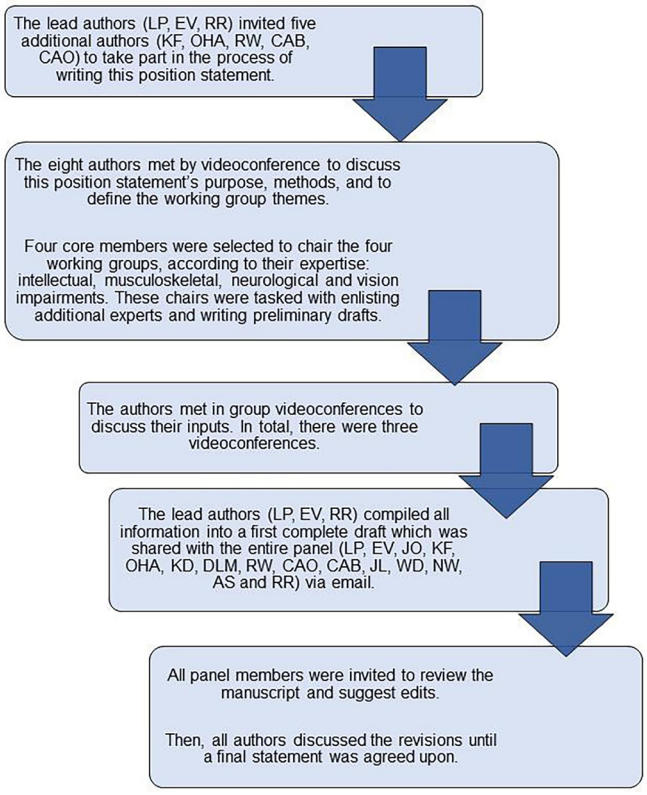

Figure 1 A flow diagram providing an overview of the writing process of this position statement.

Structured physical assessment

The physical assessment for Para athletes encompasses all body systems directly and indirectly related to the athlete's impairment and sport modality. For example, regarding impairment-related aspects, cardiovascular assessments, such as physical examination, may reveal certain physiological adaptations depending on the impairment type. These adaptations, such as restricted maximum heart rate responses in athletes with a high SCI, should be carefully distinguished from abnormalities.[27]

Healthcare providers should consider the most common illnesses in Para athletes during physical assessments, such as respiratory tract infections and gastrointestinal problems.[4] For instance, respiratory dysfunctions resulting from neurological impairments or congenital malformations may increase infection risk and limit the ability to perform endurance training; or inappropriate fibre intake and suboptimal meal timing could further trigger a neurogenic bowel related to athletes' underlying pathophysiology.[4] Therefore, both systems should be evaluated thoroughly in Para athletes.[28]

Additionally, all other body systems relevant to the athlete's clinical condition should be assessed during the physical examination. This includes the metabolic and endocrine system to prevent metabolic syndrome, common in athletes with mobility impairments and individuals with SCI[29]; the cutaneous system, especially skin evaluation in athletes who use mobility aids and prostheses[30 31]; the neurological system, encompassing sensory and muscle tone disorders that can affect both daily activities and sports performance[30 32 33]; and the musculoskeletal systems, including bone health, as individuals with disabilities often experience impaired bone density and quality due to immobility, reduced weight-bearing and other neuroendocrine-related factors, as well as sport-specific behaviours in adaptive athletes.[34] Cognitive and psychological conditions, as well as sleep health, must also be considered in the physical assessment.[35 36]

Sport demands and impairment considerations

The sport-specific demands should be considered to define neuromusculoskeletal, nutritional and exercise physiology assessment parameters. For instance, the tests used to evaluate neuromusculoskeletal performance should be chosen based on clinical reasoning, the best scientific evidence regarding the test's psychometric properties and the athlete's capabilities. Healthcare providers should consider the sport-specific demands to the neuromusculoskeletal system (eg, sports biomechanics) along with the Para athlete's impairment to decide the assessment parameters (eg, muscle function, neuromuscular control, flexibility and joint mobility).[24 37] A crucial aspect is that tests are accessible and valid for Para athletes. In addition to the sport-specific characteristics, training load, periodisation, rest and the number of competitions in a season should be investigated, as these aspects can place great demands on Para athletes' health and require proper functioning of their neuromusculoskeletal system. Furthermore, using tests already described in the literature for assessing people with impairments should be considered, respecting individualities and understanding the Para sport context.[38]

A nutritional assessment should include body mass, height and body mass index (BMI) measurement and also aspects related to the sports demands and Para athletes' impairment. Following up on the Para athletes' training periodisation, body mass and composition changes is important to adjust energy intake accordingly.[39] One of the main challenges a sports nutritionist faces when working with Para athletes is estimating their energy requirements given baseline differences in sport modality and the impact of the athlete's impairment on energy expenditure.[39–41] For example, energy consumption is higher in amputees than in the general population due to gait inefficiency and wheelchair users experience reduced daily energy expenditure, primarily due to muscle atrophy.[42] For athletes with cerebral palsy, energy expenditure is an additional key consideration. Ataxic or athetotic symptoms can lead to uncontrolled shaking and twitching, which may considerably increase the basal metabolic rate.[43] This assessment helps to prevent the imbalance between energy consumption and expenditure, leading to greater muscle fatigue, decreased performance and risk of injury.[44] Besides that, some individuals with VI may experience light sensitivity and avoid daylight.[45] Conversely, people with albinism demonstrate greater responses of vitamin D production to lower levels of sun exposure than people with darker skin.[46] So, screening for vitamin D deficiency can also be recommended. To summarise, the physical assessment—considering sports demands and impairments—involves drawing from scientific literature and clinical reasoning to identify the capacities necessary for Para athletes to perform the sport safely and effectively.[37]

Female Para athletes

In addition to the impairment-specific considerations outlined below, during the PHE of female Para athletes, healthcare providers must be aware of conditions and domains that may disproportionately impact the health of female athletes, such as relative energy deficiency in sport (RED-S), reproductive health and non-accidental harm (eg, harassment, abuse and violence).[47–49]

Low energy availability is an aetiological factor of RED-S. This syndrome includes decreased metabolic rate, menstrual function, bone health, immunity, protein synthesis and cardiovascular health, which may compromise physiological functioning.[49] Despite being prevalent among persons with impairments,[26–28] there is little evidence of relative energy deficiency in female Para athletes. In the PHE of these individuals, healthcare providers should further investigate energy deficiency and menstrual dysfunction, especially in those with a central neurological injury and who may have hypothalamic–pituitary axis alterations in baseline menstrual function, regardless of energy status.[50–52] Healthcare providers should also be aware of the effects of oral contraceptives on female Para athlete sports performance during the PHE. Healthcare providers and the female Para athlete must collaboratively decide on the use of oral contraceptives. This decision should consider the individual's specific response to the contraceptive method and the necessity of the contraceptive method, whether for medical purposes or as birth control. Additionally, they should discuss alternative contraception options and evaluate the risks associated with hormonal contraceptives, including venous thrombosis and pulmonary emboli.[53–55] When recording and reporting epidemiological data on injury and illness in female athletes, clinicians and researchers should consider the supplement to the IOC consensus statement on female athlete health domains.[56]

Screening for risk factors for concussion is particularly recommended for female Para athletes during the PHE.[57] Concussion rates are higher for females than for male athletes in sports with similar rules.[58] Moreover, the severity of, and recovery from, concussion tends to

be worse in female athletes.[59] Particularly in Para sports, female athletes with visual impairment report high concussion rates.[57] Healthcare providers assessing female Para athletes should be aware of their vulnerability to concussion, especially in sports with a high risk of concussion, such as football 5-a-side, para-alpine skiing, para ice hockey, para taekwondo, para judo, para-cycling, para-swimming and para boxing.[54 60]

Lastly, individuals with impairments, whether children or adults face a disproportionately high risk of various forms of abuse, including physical, social, sexual and psychological. Notably, athletes with physical or intellectual impairments are four times more likely to suffer abuse.[61] Thus, investigating non-accidental harm and abuse should be considered within PHE carried out by sports healthcare providers. Female Para athletes report a higher prevalence of sexual violence than their male counterparts.[48] Once abuse is suspected, the sports healthcare provider must offer a safe, confidential, and private space and use neutral questions or statements, that is, 'Because difficult relationships affect health, I'm asking my athletes about it'.[54] A multidisciplinary team of healthcare providers with psychologists, sociobehavioural experts and sports managers implementing a safeguarding programme will contribute to a safe sport. This fundamentally means making sporting environments free of non-accidental harms.[48 54]

Impairment-specific considerations for the PHE in Para athletes

Below, we present explanations for each of the four major groups of impairments, including concepts, available evidence from the scientific literature and considerations from the group of experts. For each group of impairments, a table of the PHE recommendations was developed.

Intellectual impairment

Athletes with an intellectual impairment, which must be present before the age of 18, experience restrictions in intellectual functioning and adaptive behaviour that affect conceptual, social and practical skills required for everyday life.[62] Elite athletes with intellectual impairment compete in athletics, swimming and table tennis during the Paralympic Games and in other sports competitions, for example, Virtus games.[63] They commonly experience associated physical disorders, including difficulties with postural balance, muscle strength and cardiovascular endurance.[64] Sports healthcare providers should address these aspects when conducting the PHE. The results from an assessment may have limitations when validity is influenced by the athlete's ability to adequately comprehend the task (eg, pain score or maximal effort).[64] Therefore, each test's explanation should be thoughtfully considered and adapted as necessary to maximise the athlete's understanding of the required tasks. Extra time to explain and perform any assessment must also be considered to ensure the test requirements are understood as best as possible and training attempts can be completed.

We cannot assume that the athlete understands the context of all questions and the instructions given during assessments in which the athlete provides verbal or written answers, for instance, when answering a questionnaire (eg, about overall health, nutrition, sleep and Likert scales). We recommend that questions are tailored and validated to the athletes' abilities and needs, possibly considering visual analogue scales that may be better understood than words alone. In the absence of such validations, the presence of a third corroborative person (eg, spouse, family or caregiver) who can help understand the questions and/or answers on the athlete's behalf will be of benefit. Medical data could be obtained from existing (electronic) medical records and athlete management systems, or the clinician could request summary medical data from their general practitioner (family doctor) when possible.[22]

Safeguarding and mental health issues are especially important for athletes with intellectual impairment. Children and adults with intellectual impairment are more likely to have mental health disorders, poorer physical health (such as increased risk for various cardiometabolic diseases associated with obesity), be bullied and be subjected to psychological and physical abuse.[48 61 64 65] Furthermore, one cannot presume an athlete's capacity to understand and make decisions regarding medical treatment or agree with treatment plans. As a result, health, legal and ethical issues must always be considered when making clinical or performance decisions. Indeed, health-related decisions should prioritise the athlete's best interests, involving the athletes and their caregivers in decision-making.[66] Table 2 outlines some of the considerations for the PHE in Para athletes with intellectual impairment.

Musculoskeletal impairment

Athletes with musculoskeletal impairment can have a limb deficiency, short stature, leg length difference and/or impaired passive range of motion.[23] These Para athletes compete in almost all sports sanctioned by the IPC.[63]

One of the key considerations for some athletes in this group is the assessment of prostheses and the residual limb. Maintaining continuous surveillance of the skin and tissue of the residual limb during activities such as training, travel and daily routines is crucial. The residual limb volume can undergo short-term changes during the acute phase of training or competition due to factors like blood flow and muscle activity and long-term changes due to tissue adaptation caused by training load.[31 67] Therefore, it is essential to regularly evaluate the prosthetic's fit and monitor potential reactions to a high training load. The skin is susceptible to chafing and breakdown from sheer or impact forces, while excessive sweating within the prosthesis can further aggravate skin breakdown and increase infection risk.[67 68] Other types of

Table 2 Considerations on PHE in Para athletes with intellectual impairment

Type of assessment	Intellectual impairment
History of underlying health conditions	Conduct interviews instead of questionnaires. When an interview is impossible, have a caregiver help complete the necessary questionnaires. If possible, seek access to medical records (eg, from a family doctor). Regular dental health checks are advisable for these athletes since they have an increased risk of dental health problems.[101–104]
Cardiorespiratory screening	Self-report questionnaires on symptoms during exercise may be unreliable due to recall issues. Healthcare providers must rely on a carer for the athlete's cardiovascular and family history, and this can, for instance, be a family member or a family doctor.
Neuromusculoskeletal condition (neuromuscular control, muscle function, mobility and flexibility)	Tests requiring multiple tasks (eg, Modified Star Excursion Balance Test) should be used cautiously. If needed, ensure that more time is available for the athlete to understand the required tests and to repeat tasks. Be aware that the standard tests are mainly to understand the peripheral nervous and muscular systems. The role of the central nervous system (brain) and intellectual impairment in these tasks is poorly understood. Muscle strength parameters should be evaluated since athletes with an intellectual impairment present lower strength than others.[65]
Nutritional status	Have a third person help complete any necessary nutritional questionnaires, considering the issues with the validity of self-reported data. Seek optimal nutrition education at each reasonable opportunity rather than implement efforts to assess the nutritional status.[105 106] Available metabolic equivalent of task data for able-bodied athletes are likely suitable to estimate energy expended through physical activity for athletes with intellectual impairment.[39]
Mental health	The Sports Mental Health Assessment Tool 1 to assess elite athletes potentially at risk for or already experiencing mental health symptoms and disorders, and the Sports Mental Health Recognition Tool 1 for athletes and their entourage (eg, friends, fellow athletes, family and coaches) can be used. However, caution is advised in their interpretation, as they are not validated for athletes with intellectual impairments.[107] The use of the Patient Health Questionnaire 4 as a valid and suitable tool for continuous mental health evaluation in elite Para athletes.[35] Screening tools like Diagnostic Assessment for the Severely Handicapped Scale-II and Mood and Interest and Pleasure Questionnaire could be used to evaluate mental health issues in athletes with intellectual impairment, considering that they are reliable in people with intellectual impairment.[48 108] Try to obtain previous medical history regarding mental health with the athlete's permission, considering they are unlikely to recognise their symptoms.[66]
Sleep health	Use objective data instead of questionnaires (eg, actigraphy and accelerometers). These instruments effectively track the frequency of night-time awakenings associated with the severity of injuries and illnesses in Para athletes.[36 109 110]
Concussion	Additional considerations are required for the 'disorientation or confusion,' 'blank or vacant look' and 'requires understanding' assessments for some athletes with intellectual impairment when using the Sports Concussion Assessment Tool 6.[5 91 92]

PHE, periodic health evaluation.

orthoses used by these athletes (eg, ankle-foot orthosis, knee-ankle-foot orthosis) should also be evaluated during the PHE, both in terms of fit and appropriateness of prescription. The prosthetic/orthotic evaluation should be tailored to each individual, sport and competition level, ensuring the inclusion of a prosthetist/orthotist in the multidisciplinary team wherever feasible.[31] Thus, the biomechanical assessment of activities performed with the prosthesis/orthosis and a basic understanding of the equipment's technical aspects must also be considered in assessing these Para athletes.[31]

Achondroplasia, or short stature, is another common impairment in this group. Medical complications associated with this condition can negatively impact physical

activity levels and overall fitness. Consequently, it is crucial to assess functional exercise capacity and muscle strength using specific tests, such as the 6 min walk test and the 30 s sit-to-stand test, which are particularly useful for this population.[38] Additionally, the nutritional status of these Para athletes should be carefully evaluated, as they have a high prevalence of central obesity and unhealthy dietary habits.[69]

Athletes with impaired passive range of motion, such as those with arthrogryposis, require a thorough evaluation. This should include a detailed clinical history and careful assessment of both passive and active range of motion. Muscle strength should be meticulously measured, and any abnormalities in spinal curves should be investigated.[70] Considerations for the PHE in Para athletes with musculoskeletal impairment are presented in table 3.

Neurological impairment

The neurological impairment group includes Para athletes with brain disorders, spinal cord-related disorders and neuromuscular disorders.[23] Some examples of diagnoses in the brain disorder group are athletes with cerebral palsy, traumatic brain injuries, stroke and multiple sclerosis. In spinal cord-related disorders, the Para athletes could be divided into paraplegic or tetraplegic groups. The neuromuscular group includes stable disorders (eg, postpolio, peripheral nerve injury) and progressive disorders (eg, motor neuron disease, muscular dystrophy and myopathy).[23] These Para athletes also compete in almost all sports sanctioned by the IPC.[63]

SCI and cerebral palsy are common underlying medical conditions in this group. Individuals with SCI often experience pressure sores,[32] which can potentially result in prolonged immobilisation, severely impacting the athlete's career.[71] Hence, regular PHEs and preventive advice against pressure sores are crucial for these athletes.[32 72] Another specific medical and physiological issue in athletes with SCI is autonomic dysreflexia (AD). This is an acute or subacute attack of uncontrolled sympathetic nervous activity characterised by a sudden rise in blood pressure, headache, flushing and sweating and typically occurs in individuals with an injury at or above the T6 level of SCI.[73] AD can be triggered intentionally or unintentionally. The deliberate induction of AD, known as 'boosting', is extremely dangerous and can enhance performance. As a result, boosting is strictly prohibited and banned by the IPC.[74] Both intentional and unintentional induction of AD can be life-threatening, given the acute rise in blood pressure and the associated risk of a hypertensive emergency. Thus, sport healthcare providers must frequently record the blood pressure of Para athletes susceptible to autonomic dysreflexia and promote health education.[30] Autonomic dysfunction caused by SCI is also associated with a higher risk of cardiovascular disease.[75] These Para athletes may have decreased angina sensory feedback and present structural heart abnormalities. Thus, a higher level of suspicion should be given for any cardiac symptoms in these Para athletes.[76 77] The availability of resources and the estimated risk of sudden cardiac death should also be considered during the PHE.[76]

Another very common medical condition in athletes with SCI is neurogenic bowel and bladder. These athletes normally use clean intermittent catheterisation and should be taught about their urinary tract infection risks since they are much more prone to them.[8] Sports healthcare providers should know the infection history of the athlete, including what antibiotics they use to treat any urinary tract infections (eg, whether they have any antibiotic-resistant organisms), and plan with the whole team the bladder emptying during long-distance flights.[30 78] Additionally, providers should query athletes with SCI regarding their bowel management programme and ensure that the athlete has the resources necessary to carry out their programme throughout training and competition. Lastly, athletes who use a wheelchair, whether competitively or as a mobility-assistive device, are at greater risk of shoulder injury.[3] Therefore, neuromusculoskeletal aspects should be evaluated, such as scapular muscle imbalance and asymmetry, shoulder range of motion, and the equipment's technical aspects, including racing chairs.[79–81]

Regarding neuromusculoskeletal considerations in athletes with cerebral palsy, athlete pain is one of the most reported challenges faced by healthcare providers who assess these athletes. Pain is often poorly managed and persists over long periods.[82] Therefore, sports healthcare providers should differentiate between nociceptive, neuropathic or inflammatory pain, investigate the use of specific drugs and electrophysical agents and educate Para athletes about strategies to reduce pain.[82 83] They are also susceptible to injury in the upper and lower limbs, so assessing deformities, fatigue, and abnormal and asymmetric movement patterns is important during the PHE.[33] Table 4 describes some considerations for the PHE in Para athletes with neurological impairment.

Vision impairment

The VI group includes blind and low-vision Para athletes.[84] Elite athletes with VI compete in a range of sports in the Paralympic Games, including alpine and Nordic skiing, athletics, cycling, blind football, equestrian, goalball, judo, rowing, shooting, swimming, and triathlon.[63] Additionally, according to the International Blind Sports Federation, they compete in various other sports.

Effective communication with athletes with VI requires a particular focus on voice intonation and the direction of speech. This approach enhances communication and demonstrates interest.[85] Smartphones and tablets, with accessibility features, are beneficial during the PHE, fostering independence and helping Para athletes achieve their best performance.[86–88] In addition, the presence and health assessment of the guides during the PHE should be considered, as they compete alongside the Para athlete and must maintain good health.

Table 3 Considerations on PHE in Para athletes with musculoskeletal impairment

Type of assessment	Musculoskeletal impairment
History of underlying health conditions	Evaluate the prosthetic history in athletes with amputation, issues with skin breakdown, stump pain and prior injuries. The stump should be thoroughly examined for any skin changes, reduced sensitivity areas and its capacity to withstand the increased stresses associated with sports activities.[31] Screening for atlantoaxial instability or cervical stenosis in athletes with short stature and achondroplasia is critical due to its increased prevalence in this population.[111] These conditions may present subtly, evidenced by symptoms like weakness, sensory deficits or gait disturbances.
Cardiorespiratory screening	Standardised tests already used in Para athletes should be considered the first choice during the assessment (eg, Yo-yo intermittent recovery test to assess endurance in amputee athletes).[112]
Neuromusculoskeletal condition (neuromuscular control, muscle function, mobility and flexibility)	Standardised tests currently employed with Para athletes, such as the *L test* for assessing agility in amputee athletes, should be the preferred assessment method.[112] Standardised tests for able-bodied athletes could be used with cautious adaptations. One should also consider the tests' validity and reliability (eg, the use of hand-held and isokinetic dynamometers to measure strength, depending on availability).[113] Contralateral side muscle function and joint mobility assessments may be used as references, considering that there are athletes with asymmetries between the sides of upper and lower limbs in the musculoskeletal impairment group. Pay special attention to athletes with impaired passive range of motion when evaluating mobility and flexibility. The bone mineral density in children with arthrogryposis is lower than age-matched means, especially in children with limited ambulation, which increases osteoporosis and fracture risk.[114] Evaluate the mobility and flexibility in the residual limb of athletes with amputation. Consider biomechanical adaptations that these athletes can employ. For example, athletes with unilateral prostheses may increase their step length on the prosthetic side during running compared with their contralateral non-prosthetic limb.[115]
Nutritional status	Anthropometric assessment and dietary records should be monitored regularly in adolescents and adults with achondroplasia.[116] Evaluate energy consumption and expenditure in athletes with amputation, who may have higher energy needs resulting from gait asymmetry.[68] The body composition evaluated by bioelectrical impedance analysis is not indicated for athletes with amputation (missing unilateral or lower limbs will significantly impact whole-body resistance measurement). The presence of oedema may also invalidate the results.[39]
Mental health	Use the SMHAT-1, the SMHRT-1 and the PHQ-4 tools to assess mental health symptoms in these Para athletes.[35 107] Special attention is paid to athletes with acquired limb deficiency because they can experience depression, anxiety and anger more commonly, which can result in maladaptive coping mechanisms. Understanding the psychological issues facing athletes with a limb deficiency will allow for early recognition and counselling of personal conflict that might impair sports performance or daily coping strategies.[31]
Sleep health	Consider using scales such as the Pittsburgh Sleep Quality Index, Athlete Sleep Behaviour Questionnaire and objective parameters for sleep assessment (eg, actigraphy).[36 109 117] Perform polysomnography when necessary. Special attention is paid to Para athletes with achondroplasia who have midfacial hypoplasia and small thorax, which could lead to obstructive sleep apnoea.[118]

Continued

Table 3 Continued

Type of assessment	Musculoskeletal impairment
Concussion	Additional considerations are required for the 'balance/gait difficulties/ motor coordination' assessment for some athletes with bilateral lower limb deficiency when using Sports Concussion Assessment Tool 6 (SCAT6).[5 91 92] Additional considerations are required for increased atlantoaxial instability in athletes with achondroplasia when using SCAT6.[5 91 92] When using SCAT6, additional considerations are required for the 'weakness or tingling/burning in arms or legs' and 'best motor response' assessments in athletes with arthrogryposis, given their reduced joint range of motion.[5 91 92]

PHE, periodic health evaluation; PHQ-4, Patient Health Questionnaire 4; SMHAT-1, Sports Mental Health Assessment Tool 1; SMHRT-1, Sports Mental Health Recognition Tool 1.

Athletes with no light perception (full blindness) may experience a disruption in their circadian rhythms, including poor sleep during night-time and tiredness during daytime.[89] It is, therefore, recommended to carefully monitor both the quantity and quality of sleep and consider using a digital sleep-tracking device accessible to the visually impaired.[36] As for light sensitivity, athletes with VI might also have vitamin D deficiency, which should be screened in the PHE.[45]

Para athletes with VI have a significantly higher incidence of concussion than those without impairment, with collisions being the most common injury mechanism among these individuals.[57] They undergo a different concussion 'experience' than their non-VI peers,[90] as postinjury signs and symptoms (eg, dizziness, blurred vision) often constitute a VI athlete's normative baseline. The Sports Concussion Assessment Tool 6 can be used for athletes with VI but must be interpreted with caution given that several sections are likely to be not applicable to these athletes. Adaptations of the assessment tools are needed to enable participation, but the validity of adaptations has not been assessed yet.[5 91 92] To accurately interpret the VI athlete's postconcussion visual symptoms relative to their preconcussion visual symptoms, any PHE must collate a summary of the athlete's baseline status that can be used for assessment purposes. Table 5 outlines some of the considerations for the PHE in Para athletes with VI.

DISCUSSION

This position statement outlines the value and content of a PHE of Para athletes. It outlines, for each of the four key groups of impairment, considerations when conducting a PHE.

The main purpose of the PHE is to monitor athletes' health and optimise the care of Para athletes.[14] Although the PHE may not necessarily allow injury prediction, serial assessments may help sports healthcare providers better identify changes in Para athletes' physical and mental status over time. A complete assessment should be conducted at the start of the training season in all sport modalities when the person with an impairment begins practising sports, and before major competitions, by a multidisciplinary team of healthcare providers experienced in Para sports. It allows knowledge of a Para athlete's baseline status, outlining their functional profile. However, assessments at the beginning, middle, and end of the season cannot completely describe the athlete's condition, as these assessments only refer to specific moments. Carrying out frequent assessments (eg, every day or at the beginning and end of each week of training) of high-order parameters, which are also simple, quick and easy to implement, is one of the strategies that the sports healthcare providers could adopt in their clinical practice.[93 94] A high-order parameter is an aggregate measure that captures complex interactions among various physiological, biomechanical and psychosocial low-order factors.[93] Monitoring the temporal progression of these high-order parameters could enable the early identification of alterations in Para athletes' health status that may indicate higher risk of injuries. This would allow sports care providers to implement actions to prevent or mitigate the severity of these injuries.[93] Some examples of the evaluation of higher-order parameters would be performance in the vertical jump in athletes with a priority demand on the lower limbs, such as amputee runners, or performance in throwing a medicine ball in athletes with a priority demand on the upper limbs, like those in wheelchair basketball. Thus, the assessment can educate the Para athlete about preventive measures that may be implemented during practice routines to maintain optimal health based on objective and subjective measurements over time to help them achieve maximal performance.[6 9]

Para sports have many unique specificities, making it a challenge to establish normative values. Therefore, using each athlete's data as their control, rather than average values of heterogeneous samples as normative values and conducting periodic assessments is more effective in providing relevant data to track fluctuations in the athlete's overall health

Table 4 Considerations on PHE in Para athletes with neurological impairment

Type of assessment	Neurological impairment
History of underlying health conditions	Special attention should be paid to the risk of pressure sores due to impaired sensation. Inform athletes to perform a daily check at the start and end of each day; use a body map for areas at high risk of developing pressure sores. Evaluate and promote education on autonomic dysfunction symptoms, urinary tract infection symptoms and aseptic catheter insertion.[8 30] Evaluate assistive devices, mobility aids and straps.[30 33]
Cardiorespiratory screening	ECG screening in Para athletes should be considered due to the higher prevalence of cardiovascular abnormalities associated with sudden death.[76] Special attention is paid to female Para athletes and Para athletes with SCI who present more ECG abnormalities that were not associated with training and potentially an expression of cardiac disease.[27] The wheelchair propulsion test on a treadmill is reliable for assessing cardiorespiratory fitness among manual wheelchair users.[119] The 6 min push test may be useful for predicting fitness levels in Para athletes with neurological impairments.[120 121] The Borg Scale of Perceived Exertion is a valuable tool for monitoring cardiovascular function in Para athletes with SCI, given that many athletes do not experience a significant increase in heart rate beyond resting levels during sports practice.[76] Exercise testing in athletes with SCI could be performed using an arm-crank ergometer (Ergometrics and Ergoline 800; Ergoline), depending on availability.[122]
Neuromusculoskeletal condition (neuromuscular control, muscle function, mobility and flexibility)	Some modifications are likely necessary for these athlete groups, but using 1–10 repetitions maximum strength test should be considered. The medicine ball throw test for Para athletes who use a wheelchair is a simple and feasible test correlated to isokinetic tests.[123] More frequent assessments may be needed in athletes with progressive impairments. Mobility and flexibility assessment should be conducted, especially in the shoulder joints for wheelchair users, given the contracture consequences in athletes with neurological impairment.[124] Evaluating the initial acceleration phase of sprinting in athletes with cerebral palsy, considering the increased passive and active joint stiffness.[115 125] Training interventions should focus on strategies to increase lower limb joint angular velocities. Consider the tone and spasticity in athletes with neurologic injury. Bone heath monitoring should be performed in athletes with acquired brain injury, cerebral palsy and SCI due to their high risk of osteopenia and osteoporosis.[126]
Nutritional status	Using weighing scales that can accommodate wheelchairs is recommended.[39] Evaluate energy expenditures in athletes with central neurological injury (eg, athletes with cerebral palsy who present dyskinesis or athetosis with disorderly pattern movement) and athletes who use a wheelchair for daily mobility, with likely reduced baseline energy needs.[127 128] Evaluate nutrient deficiencies and body weight monitoring in athletes with SCI[129] and measure the Resting Energy Expenditure (REE) values in this population—they have lower REE than able-bodied individuals.[39] The body composition evaluated by dual-energy X-ray absorptiometry is not indicated for individuals with spasms (eg, SCI, multiple sclerosis, cerebral palsy) since any movement will affect the accuracy of the scan.[39] The body composition evaluated by BIA is not indicated for individuals with SCI due to changes in total body water content and intracellular and extracellular water ratios.[39] Special attention to the intake of fibres and micronutrients in athletes with SCI, due to autonomic imbalance in the gastrointestinal tract, which could affect colonic motility, mucosal secretions and intestinal barrier permeability.[130]
Mental health	Use the SMHAT-1, the SMHRT-1 and the PHQ-4 tools to assess mental health symptoms in these Para athletes.[35 107] Demands or costs of wheelchairs could be sources of stress experienced by athletes who use these mobility and sports devices.[131]

Continued

Table 4 Continued

Type of assessment	Neurological impairment
Sleep health	Consider using scales such as the Pittsburgh Sleep Quality Index, Athlete Sleep Behaviour Questionnaire and objective parameters for sleep assessment (eg, actigraphy).[36 109 117] Special attention to Para athletes with cerebral palsy—snoring is more prevalent among those individuals, likely due to alterations in the upper airway and facial muscle tone and may indicate obstructive sleep apnoea.[132 133]
Concussion	Special attention is required for the 'neck tenderness' and 'weakness or tingling/burning in arms or legs' in athletes with tetraplegia when using Sports Concussion Assessment Tool 6 (SCAT6).[5 91 92] Lesion levels must be evaluated in athletes with SCI during the 'best motor response' and 'cervical spine' assessments of SCAT6.[5 91 92] Athletes with cerebral palsy should not be evaluated for the 'weakness or tingling/burning in arms or legs' and 'balance/gait difficulties/motor coordination' assessments of the SCAT6 tool.[5 91 92] Lower extremity strength will be affected in athletes with spina bifida during the 'best motor response' assessments of SCAT6. We suggest special attention to the symptoms of hydrocephalus that can be similar to concussion in these Para athletes.[5 91 92] For assessing balance in athletes with SCI, the Wheelchair Error Scoring System is a suitable clinical alternative.[134]

BIA, bioelectrical impedance analysis; PHE, periodic health evaluation; PHQ-4, Patient Health Questionnaire 4; SCI, spinal cord injury; SMHAT-1, Sports Mental Health Assessment Tool 1; SMHRT-1, Sports Mental Health Recognition Tool 1.

status throughout the sports season. This allows the sports healthcare providers to detect irregularities and analyse moments the athlete may be most susceptible to health problems, thus prompting preventive action.[93 94]

The PHE of Para athletes should consider both the athlete's sport and their impairment characteristics. In addition, their self-care skills that influence their ability to maintain a regular training routine (eg, tying their shoe(s) or changing clothes) could be part of the PHE. Sports healthcare providers should consider the support of caregivers or family members in the Para athlete's sports practice, especially during the initial years.[95] Furthermore, evaluating other contextual factors that may directly impact sport participation is essential, including factors such as the athlete's education, rehabilitation, functionality and support from sports federations they belong to.[9] This global assessment can help facilitate inclusion and improve the Para athletes' quality of life.[96]

Considering their influence on sports performance, the suitability of assistive devices is another important aspect of the PHE in Para athletes.[97 98] Stakeholders should recruit qualified and experienced healthcare providers, including those able to evaluate the equipment the Para athlete uses.[6 22] Thereby, sports healthcare providers should be able to act more effectively to prevent health problems that assistive devices could cause and facilitate successful sports participation.[99]

Finally, the key to a successful PHE is communication between the sports healthcare team, trainers, coaches and the Para athlete. Healthcare providers should discuss the goals and explain the results with the Para athlete to optimise support.[9] The Para athletes' needs, desires and goals should be outlined and balanced with the assessment results, and the shared decision-making process should be part of the PHE. Ultimately, this can incite health literacy among Para athletes, focusing on clear, accessible and effective health communication.[9 100]

The limitations of a position statement must be highlighted when you consider our recommendations. First, we attempted to broadly encompass aspects related to the PHE of Para athletes. However, due to the heterogeneity in Para sports, much of this information may not reflect the specific considerations that should be taken into account for certain sports or impairments. Additionally, a complete PHE will depend on the human, physical and financial resources of the sports centre and must be adapted to each para athlete. Second, our content is based primarily on the expertise and experiences of clinical and research professionals currently working within Para sports. Where possible, we have, of course, supported our recommendations with available literature. However, scientific evidence on the validity, reliability and effectiveness of PHEs in Para athletes is severely limited. In light of this, we understand that our current statement, with an extensive review scientific literature published to date, is an initial—but important—step towards more and better clinical research to improve Para athlete care. We believe that the next step could entail more formal consensus methodologies (eg, through a Delphi method) to develop stronger recommendations towards Para

Table 5 Considerations on PHE in Para athletes with vision impairment (VI)

Type of assessment	VI
History of underlying health conditions	Audiometry tests and executive function assessments should be periodically conducted because hearing loss in individuals with low vision and dual-sensory impairments (vision and hearing loss) are common in people with VI.[135–139] Executive functions have been highlighted as potential cognitive strengths and weaknesses in this population.[140 141] Auditory processing should be periodically evaluated in athletes with VI, considering it has been proposed as a biomarker of concussion.[142] VI are often progressive, with their severity expected to worsen over time. Regular eye examinations are necessary to monitor this progression and to distinguish between typical progression and temporary changes, such as those caused by concussion or inappropriate medication use.[143] In cases where autoimmune conditions cause VI, it is recommended to concurrently assess for other potential consequences of autoimmune diseases in those cases.[144]
Cardiorespiratory screening	Adults with VI have a higher prevalence of cardiovascular disease and risk factors than those without VI.[145] The PHE for these athletes should also include questions related to cardiovascular comorbidities and family history.[146] Using large-print formats or having scales read aloud is an important accessibility adjustment for athletes with VI. The fitness and cardiovascular screening clinic should be accessible for an individual with VI (eg, using high-contrast labelling, haptic guidance and allowing a guide dog to be in attendance if needed). The Yo-yo intermittent recovery test has been considered invalid in assessing cardiorespiratory fitness in athletes with VI.[147] Athlete guides should be integrated into any cardiorespiratory testing. Static means of assessing aerobic capacity (eg, a stationary exercise bike) may be the preferred means of testing athletes with VI.
Neuromusculoskeletal condition (neuromuscular control, muscle function, mobility and flexibility)	Dynamic balance should be evaluated with tests that rely more heavily on proprioceptive or vestibular information (eg, walking with heels raised or jumping on mats).[148 149] The complex movements required to evaluate neuromuscular control should be adequately described. Special attention must be given to Para athletes with severe VI because they could have less muscle strength than those with mild-moderate impairment.[150] During the assessment, adequate movement descriptions are necessary, and the clinician can move the athlete's body to demonstrate the movement to them. When evaluating mobility and flexibility in athletes with VI, consider that they are poorer in individuals with severe VI than those with mild-moderate impairment (eg, on the sit-to-reach test)[150]; and poorer mobility and flexibility might be associated with modified movements to avoid imbalance or injury (eg, shorter stride length when walking).[151]
Nutritional status	It is recommended to test vitamin D levels, given that athletes may avoid daylight due to light sensitivity.[45] Athletes should also be asked about routines regarding food shopping, preparing meals, and meal sizes. Consider involving the athlete's family members or a carer. Available MET data for able-bodied athletes are likely suitable to estimate energy expenditure in physical activity for athletes with VI.[39]
Mental health	Use the SMHAT-1, the SMHRT-1 and the PHQ-4 tools for Para athletes.[35 107] We recommend better screening this population for mental health issues because individuals with VI report higher rates of depression and anxiety than the general population.[152] We suggest screening for fatigue symptoms, considering that visual and mental fatigue is common among individuals with VI and can affect mental health, sports performance and recovery.[153] We suggest using questionnaires that capture mental health issues that can be present both in daily life and sports activities.
Sleep health	Using sleep-tracking devices considering that the circadian rhythm may be disturbed.[36 109]
Concussion	The Sports Concussion Assessment Tool 6 can be used for athletes with VI, but must be interpreted with caution.[5 92]

MET, metabolic equivalent of task; PHE, periodic health evaluation; PHQ-4, Patient Health Questionnaire 4; SMHAT-1, Sports Mental Health Assessment Tool 1; SMHRT-1, Sports Mental Health Recognition Tool 1.

athlete healthcare and develop an agenda for future research.

CONCLUSION

The PHE is a valuable tool for monitoring athlete health, identifying potential risks and addressing performance barriers. The PHE in Para athletes, in particular, poses unique challenges due to the wide variability of impairments in Para athletes and the equipment used for sports practice or during daily activities. In this position statement, we described considerations for sport healthcare providers when providing PHE in Para athletes, including recommendations for specific impairment types (ie, intellectual, musculoskeletal, neurological and VI) and different physical and mental health considerations. We are confident that the results can help sports healthcare providers. Based on the information collected in the available scientific literature and the expertise of professionals in Para sports, this position statement can contribute to better clinical practice and promote health in Para athletes.

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