Larissa Santos Pinto Pinheiro

EPIDEMIOLOGIA DE PROBLEMAS DE SAÚDE E AVALIAÇÃO PERIÓDICA NO ESPORTE PARALÍMPICO

Belo Horizonte

Escola de Educação Física, Fisioterapia e Terapia Ocupacional / UFMG

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EPIDEMIOLOGIA DE PROBLEMAS DE SAÚDE E AVALIAÇÃO PERIÓDICA NO ESPORTE PARALÍMPICO

Tese apresentada ao Programa de Pós Graduação em Ciências da Reabilitação da Escola de Educação Física, Fisioterapia e Terapia Ocupacional da Universidade Federal de Minas Gerais

Linha de Pesquisa: Estudo do Desempenho Motor e Funcional Humano

Orientador: Prof. Dr. Renan Alves Resende Coorientadora: Prof. Dra. Andressa Silva Coorientadora: Prof. Dra. Juliana Melo Ocarino

Belo Horizonte

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EPIDEMIOLOGIA DE PROBLEMAS DE SAÚDE E AVALIAÇÃO PERIÓDICA NO ESPORTE PARALÍMPICO

LARISSA SANTOS PINTO PINHEIRO

Tese submetida à Banca Examinadora designada pelo Colegiado do Programa de Pós-Graduação em CIÊNCIAS DA REABILITAÇÃO, como requisito para obtenção do grau de Doutor em CIÊNCIAS DA REABILITAÇÃO, área de concentração DESEMPENHO FUNCIONAL HUMANO.

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I Co 13:2

RESUMO

Com o aumento do desempenho dos paratletas em competições esportivas, há um risco aumentado da ocorrência de problemas de saúde. Essa tese teve por objetivo geral estabelecer a epidemiologia dos problemas de saúde em paratletas e descrever orientações específicas para a equipe de saúde do esporte em relação à avaliação periódica de saúde. O primeiro estudo investigou a prevalência, incidência e perfil de lesões musculoesqueléticas em paratletas. Para isso foi realizado uma revisão sistemática da literatura científica em agosto de 2019, com atualização em maio de 2020, nas bases de dados MEDLINE, EMBASE, AMED, SPORTSDiscus e CINAHL, tendo sido incluídos quarenta e dois estudos. A partir da metanálise realizada foi encontrado uma prevalência de 40,8% e incidência de 14,3 lesões musculoesqueléticas por 1.000 atleta-dias. As lesões mais prevalentes foram em ombro nos paratletas que não deambulam, e em membros inferiores nos paratletas que deambulam. O segundo estudo descreveu as características, prevalência, incidência e o impacto dos problemas de saúde dos paratletas das modalidades esportivas do atletismo, halterofilismo e natação do Centro de Referência Paralímpico Brasileiro de Belo Horizonte, durante uma temporada esportiva e comparou a prevalência de problemas de saúde entre as modalidades. Durante o período de outubro de 2019 a março de 2020, 35 paratletas participaram do estudo. A maioria das lesões ocorreu no ombro e a maioria das doenças causou sintomas respiratórios e gastrointestinais. A prevalência semanal média e a incidência foram de 40,6% e 12,7 problemas de saúde por 1.000 atleta-horas, respectivamente. O halterofilismo teve a maior prevalência de problemas de saúde, incluindo os de maior gravidade, a natação teve a menor prevalência de lesões e o atletismo teve a menor prevalência de doenças. Por fim, o terceiro estudo descreveu, através de uma declaração de posicionamento, considerações específicas para a equipe de saúde do esporte em relação à avaliação periódica de saúde em paratletas dos quatro principais grupos de deficiências: intelectual, musculoesquelética, neurológica e visual. Ao total, 16 especialistas internacionais no esporte paralímpico, incluindo epidemiologistas, fisioterapeutas, médicos do esporte e do exercício, reuniram-se por videoconferências para discutir o propósito, os métodos e os temas da declaração de posicionamento. Os autores foram divididos em grupos de trabalho, de acordo com sua expertise, e foram solicitados a escrever as considerações específicas relacionadas ao estado clínico, cardiorrespiratório, neuromusculoesquelético, nutricional, saúde mental e do sono, concussão e as particularidades da avaliação da saúde da mulher paratleta. Posteriormente essas informações foram compiladas e revisadas por todos os autores da declaração de posicionamento. Dessa forma, os estudos apresentados nessa tese contribuem para o melhor monitoramento de problemas de saúde em paratletas e avaliação periódica realizada pela equipe de saúde do esporte.

Palavras-chave: Epidemiologia; Lesão; Doença; Avaliação; Esportes Paralímpicos; Atletas Paralímpicos.

ABSTRACT

Para athletes have experienced a high risk of health problems due to their increased performance in sports competitions in recent years. The main aim of this thesis was to investigate the epidemiology of health problems in para athletes and describe recommendations and guidance for sports health teams regarding periodic health assessments. The first study investigated the prevalence, incidence and profile of musculoskeletal injuries in this population. A systematic review was conducted in August 2019, with an update in May 2020, in the MEDLINE, EMBASE, AMED, SPORTSDiscus and CINAHL databases; forty-two studies were included. The prevalence of musculoskeletal injuries was 40.8% and the incidence was 14.3 per 1000 athlete-days. Injuries were more prevalent in the shoulder for non-ambulant para athletes and in the lower limbs, for ambulant para athletes. The second study described the characteristics, prevalence, incidence, and burden of health problems in para athletes from the Brazilian Paralympic Reference Center, in Belo Horizonte, during a sports season. It compared the prevalence of health problems among the athletics, powerlifting and swimming sports modalities. From October 2019 to March 2020, 35 para athletes participated in the study. Most injuries occurred in the shoulder, and most illnesses caused respiratory and gastrointestinal symptoms. The average weekly prevalence and incidence rate of health problems were 40.6% and 12.7 health problems per 1000 athlete-hours, respectively. Powerlifting had the highest prevalence of all and substantial health problems, swimming had the lowest prevalence of injuries and athletics had the lowest prevalence of illnesses. Finally, the third study described specific considerations and guidance for sports health teams regarding periodic health evaluation in para athletes from the four major impairment groups (intellectual, musculoskeletal, neurological and visual disabilities). A panel of 16 international experts (epidemiologists, physiotherapists, and sport and exercise physicians) with expertise in para athlete health met by video conference to discuss the position statement's purpose, methods, and themes. They were divided in working groups and asked to add specific considerations related to clinical, cardiorespiratory, neuromusculoskeletal, and nutritional status, mental and sleep health, concussion, and the particularities of female para athletes health assessments. All authors from the position statement compiled and reviewed the initial drafts. Thus, the studies presented in this thesis contribute to better monitoring para athletes' health problems and periodic health evaluation conducted by sports health teams.

Keywords: Epidemiology; Injury; Illness; Assessment; Para Sports; Para Athletes.

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1 PREFÁCIO

A presente tese foi elaborada no formato opcional, de acordo com a RESOLUÇÃO Nº004 /2018, de 03 de abril de 2018, do Programa de Pós Graduação em Ciências da Reabilitação da Universidade Federal de Minas Gerais.

A primeira parte da tese é composta pela introdução, na qual é apresentada a base teórica e revisão da literatura, problematização, justificativa e objetivos dos três estudos que compõem a tese. Em seguida, são apresentados:

- Artigo 1 publicado no *British Journal of Sports Medicine*.
- Artigo 2 submetido no *Disability and Health Journal*, o qual se encontra na terceira rodada de revisão.
- Artigo 3 em fase final de escrita.

Por último são apresentadas as considerações finais da tese, os apêndices, anexos e o mini-currículo.

1.1 Atividades desenvolvidas no Doutorado

- Artigos completos publicados em periódicos

Título: Sleep in Paralympic athletes and its relationship with injuries and illnesses

Autores: Andressa Silva, **Larissa Santos Pinto Pinheiro**, Samuel Silva, Henrique Andrade, Andre Gustavo Pereira, Flavia Rodrigues da Silva, Renato Guerreiro, Bruna Barreto, Renan Resende, Marco Túlio de Mello

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Autores: Larissa Santos Pinto Pinheiro, Andressa Silva, Juliana Melo

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2 INTRODUÇÃO

O crescimento do esporte paralímpico nas últimas décadas tem promovido o aumento do desempenho dos paratletas (IPC, 2016). Como resultado da maior exposição aos treinamentos e competições, observa-se um risco aumentado deproblemas de saúde, tais como lesões e doenças (CLARSEN *et al.,* 2021; FAGHER *et al.,* 2020a; STEFFEN *et al.,* 2022). Durante os Jogos Paralímpicos Rio 2016 foi possível perceber altas taxas de prevalência e incidência de problemas de saúde. Foi registrada incidência de 10 lesões por 1000 atleta-dias (intervalo de confiança de 95% [IC 95%] 9,1−10,9) e 12,1% dos atletas relataram pelo menos uma lesão (DERMAN et al., 2018a), enquanto a incidência de doença foi de 10 doenças por 1000 atleta-dias (IC 95% 9,2−10,9) e a prevalência de 12,4% (DERMAN *et al.,* 2018b). Dessa forma,conhecer a epidemiologia e o perfil dos problemas de saúde contribuirá com os esforços do Comitê Paralímpico Internacional em proteger a saúde dos paratletas.

De acordo com o consenso do Comitê Olímpico Internacional sobre métodos para registrar e relatar dados epidemiológicos sobre lesões e doenças no esporte, a prevalência de problemas de saúde pode ser calculada em um ponto do tempo, considerando o número de casos existentes pelo número total da população em risco (BAHR *et al.,* 2020). Essa medida pode ser repetida semanalmente, sendo possível a partir disso relatar, por exemplo, a prevalência média ao longo da temporada esportiva e também comparar diferentes fases da temporada. Outro possível cálculo a ser realizado trata-se da prevalência por período, que se refere à proporção de atletas que relataram um problema de saúde em qualquer momento durante o período considerado. Por exemplo, pode ser calculada a prevalência durante a temporada esportiva, o que inclui tanto atletas que já tinham o problema de saúde no início do período de estudo, quanto aqueles atletas que relataram o problema de saúde ao longo desse período (BAHR *et al.,* 2020). Já o cálculo da incidência se refere ao número de novas lesões e/ou doenças que foram reportadas durante um período de tempo definido (BAHR *et al.,* 2020).

Além dos dados de prevalência e incidência, o conceito de impacto (do

inglês *burden*) tem sido cada vez mais utilizado para reportar a gravidade do problema de saúde e seu impacto geral para o atleta (BAHR *et al.,* 2020). O impacto pode ser expresso como o número de dias de afastamento por 1000 horas de exposição (BAHR; CLARSEN; EKSTRAND, 2018). Levando em consideração a alta prevalência de condições médicas pré-existentes nos paratletas, as taxas de prevalência e incidência de problemas de saúde nessa população podem subestimar seu verdadeiro ônus. Assim, analisar o impacto nessa população pode ser interessante para a equipe de saúde do esporte identificar quais problemas de saúde precisam ser focados em um plano de gerenciamento de risco. Por exemplo, os Jogos Paralímpicos de Tóquio 2020 apresentaram as menores taxas de incidência e prevalência de lesão e doença já reportadas em Jogos Paralímpicos. Foram registrados 5,8 lesões por 1000 atleta-dias (IC 95% 5,3−6,5) com uma prevalência de 8% (DERMAN *et al*., 2022a) e 4,2 doenças por 1000 atleta-dias (IC 95% 3,8−4,8) com uma prevalência de 5,9% (DERMAN *et al*., 2022b). Entretanto, a gravidade das lesões nos Jogos Paralímpicos de Toquio 2020, expressa pelo impacto, foi de 10,9 dias de afastamento por 1000 atleta-dias (IC 95% 8,6−13,8) (DERMAN *et al*., 2022a) e das doenças foi de 4,9 dias de afastamento por 1000 atleta-dias (IC 95% 3,5−6,9) (DERMAN *et al*., 2022b). Ou seja, apesar das baixas taxas de prevalência e incidência, considerando o curto período dos Jogos Paralímpicos (12 dias) e o tempo de afastamento prolongado que determinado problema de saúde pode causar, a estimativa do impacto é importante para entender as características das lesões graves e, consequentemente, minimizar a probabilidade de sua ocorrência.

Os estudos sobre lesões musculoesqueléticas em paratletas apontam que lesões de partes moles, como as contusões, e lesões articulares, como as entorses, são as mais comuns. Além disso, em competições esportivas, as lesões de início repentino (lesões agudas) são mais frequentes que as lesões conhecidas como lesões de início gradual (lesões por *overuse*) (DERMAN *et al*., 2018a; WILLICK *et al*., 2013). A maior parte dos estudos que investigaram o perfil das lesões no esporte paralímpico demonstrou que o ombro é a região corporal mais frequentemente afetada, principalmente em modalidades esportivas compostas majoritariamente por atletas que não deambulam, como no basquete, rugby e esgrima em cadeira de rodas e halterofilismo (DERMAN

et al., 2018a; WILLICK *et al*., 2016). Em contrapartida, as lesões nos membros inferiores, principalmente na região da coxa e no joelho, são as mais comuns em paratletas que deambulam, como no futebol de cinco e no atletismo, especificamente nas provas de pista e rua (BLAUWET *et al*., 2016; DERMAN *et al*., 2013).

Nos Jogos Paralímpicos Rio 2016, o halterofilismo esteve entre as dez modalidades com a maior taxa de incidência de lesões: 11,1 lesões por 1000 atleta-dias (IC 95% 7,3−16,9) (DERMAN *et al*., 2018a). Como descrito anteriormente, os estudos que investigaram a epidemiologia de lesões no halterofilismo observaram que o ombro foi a região corporal mais acometida (ONA AYALA *et al*., 2019; WILLICK *et al*., 2016). Trata-se de uma modalidade na qual competem atletas com oito tipos de deficiências elegíveis: deficiência de força muscular, deficiência de amplitude de movimento passiva, ataxia, atetose, hipertonia, diferença de comprimento de membros, baixa estatura e deficiência em membros (IPC, 2015). Muitos desses atletas utilizam dispositivos de auxílio como cadeiras de rodas manual, bengalas ou muletas em suas atividades de vida diária como transferências, elevação corporal para alívio de pressão e até mesmo os movimentos repetidos ocasionados pela propulsão em cadeira de rodas. Somado a isso, tem-se as cargas de treinamento e a própria característica do gestual esportivo, o supino, que impõem uma demanda elevada na articulação do ombro desses paratletas (MORROW *et al*., 2010; ONA AYALA *et al*., 2019; VAN DRONGELEN *et al*., 2005).

Outra modalidade com alta taxa de incidência de lesões durante os Jogos Paralímpicos Rio 2016 e Tóquio 2020 foi o atletismo: 10,1 lesões por 1000 atleta-dias (IC 95% 8,5−12,0) (DERMAN *et al*., 2018a) e 7,8 lesões por 1000 atleta-dias (IC 95% 6,6−9,3), respectivamente (DERMAN *et al*., 2022a). O atletismo é uma modalidade que permite a elegibilidade de grande variabilidade de tipos de deficiência. Além dos oito tipos de deficiência física descritos anteriormente, no atletismo ainda há a elegibilidade de atletas com deficiência visual e intelectual (IPC, 2018a). Dessa forma, a gama de lesões presentes no atletismo depende do tipo de prova (pista ou campo) e também do tipo de deficiência do atleta. Durante os Jogos Paralímpicos Londres 2012, os paratletas que deambulavam apresentaram a maior proporção de lesões na região da coxa (16,4% de todas as lesões do atletismo), o que foi observado

predominantemente em paratletas de provas de pista. Por outro lado, paratletas que utilizavam cadeira de rodas apresentaram a maior proporção de lesões na região de ombro (19,3% de todas as lesões), o que foi observado predominantemente em paratletas de provas de campo (BLAUWET *et al*., 2016). Assim como no halterofilismo, a lesão na região do ombro de paratletas do atletismo que não deambulam, como no caso dos arremessadores ou paratletas da corrida em cadeira de rodas, pode estar associada ao desequilíbrio entre as capacidades necessárias para lidar com as demandas de execução de atividades esportivas e de vida diária (FONSECA *et al*., 2007). Em relação às lesões de membros inferiores, fatores como a protetização e as alterações de estabilidade postural em atletas com deficiência visual podem contribuir para as alterações da biomecânica da corrida e salto (FLETCHER; GALLINGER; PRINCE, 2021; MAGNO E SILVA *et al*., 2013b; MORRIËN; TAYLOR; HETTINGA, 2017).

Em contrapartida, durante os Jogos Paralímpicos Rio 2016, a natação foi a modalidade que apresentou a menor taxa de incidência de lesões se comparada a todas as outras modalidades, sendo 7,1 lesões por 1000 atleta-dias (IC 95% 5,4−9,4) (DERMAN *et al*., 2018a). E, durante os Jogos Paralímpicos de Tóquio 2020, a incidência de lesões da natação foi ainda menor, 3,1 lesões por 1000 atleta-dias (IC 95% 2,0−4,7) (DERMAN *et al*., 2022a). Na natação são elegíveis atletas com deficiências física, visual e intelectual (IPC, 2018b). Estudos epidemiológicos têm reportado as regiões do ombro e tronco como as mais afetadas em paratletas da natação (MAGNO E SILVA *et al*., 2013a; SEBASTIAN *et al*., 2019). Isso pode estar relacionado com o fato da propulsão durante o nado ser realizada preferencialmente pelos membros superiores e muitas vezes os paratletas dessa modalidade apresentam perfil antropométrico que pode afetar sua capacidade de produzir força simétrica entre os membros, como por exemplo, uma amputação unilateral de membros superiores (FLETCHER; GALLINGER; PRINCE, 2021; HOGARTH *et al*., 2020).

Weiler *et al*. (2016) conduziram uma revisão sistemática sobre lesões esportivas sofridas por atletas com deficiência, mas a grande variabilidade nas taxas de lesões relatadas pelos estudos impediu os autores de realizar uma metanálise. Nesta revisão, os autores incluíram estudos que não apresentavam

uma definição clara de lesões esportivas, o que pode ter contribuído para essa variabilidade nas taxas de lesões. Além disso, desde a publicação dessa revisão, em 2016, novos estudos sobre lesões esportivas em paratletas foram realizados. Com o objetivo de orientar pesquisadores envolvidos com o esporte paralímpico, um grupo de pesquisadores compostos por profissionais do comitê médico e do grupo de gerenciamento do Comitê Paralímpico Internacional publicou um consenso para uniformizar as nomenclaturas e definições durante a coleta, registro e interpretação de dados relativos à saúde do paratleta (DERMAN *et al*., 2021). Esses pesquisadores acreditam que a partir de definições consistentes, as pesquisas científicas realizadas com os paratletas promoverão uma melhor compreensão dos seus problemas de saúde e poderão contribuir de forma mais assertiva nos serviços médicos prestados em eventos esportivos com paratletas (DERMAN *et al*., 2021).

Além das lesões musculoesqueléticas, o monitoramento dos problemas de saúde em geral, incluindo doenças, foi recentemente definido como um dos principais objetivos das pesquisas científicas na área esportiva, a fim de prevenir tais problemas de saúde (FINCH *et al*., 2017). A identificação e intervenção precoce de problemas de saúde são especialmente importantes em paratletas, pois além de eles apresentarem maior prevalência de lesões e doenças que atletas sem deficiência, também apresentam maior gravidade dos problemas de saúde (CLARSEN *et al*., 2021). Especificamente em relação às doenças, estudos apontam que paratletas apresentam maiores taxas de incidência e gravidade de doenças do que de lesões, as quais também resultam em um maior período de afastamento do esporte (HIRSCHMÜLLER *et al*., 2021; STEFFEN *et al*., 2022).

Como descrito anteriormente, a natação foi a modalidade dos Jogos Paralímpicos Rio 2016 com a menor taxa de incidência de lesões. Entretanto, diferentemente da epidemiologia de lesões, a incidência de doenças na natação durante essa competição foi maior do que todas as outras modalidades, sendo 12,6 doenças por 1000 atleta-dias (IC 95% 10,2−15,6) (DERMAN *et al*., 2018b). Já o atletismo e o halterofilismo mostraram 10,3 (IC 95% 8,7−12,3) e 8,1 (IC 95% 5,0−13,2) doenças por 1000 atleta-dias, respectivamente (DERMAN *et al*., 2018b). E nos Jogos Paralímpicos de Tóquio 2020, a natação e o atletismo estiveram entre as dez modalidades com maior incidência de doenças: 4,4 (IC

95% 3,2−6,1) e 4,4 (IC 95% 3,5−5,5) doenças por 1000 atleta-dias, respectivamente (DERMAN *et al*., 2022b). O sistema respiratório é comumente descrito como o mais afetado entre os paratletas, principalmente na natação, seguido de infecções nos tratos gastrointestinal e urinário (DERMAN *et al*., 2018b; PYNE; VERHAGEN; MOUNTJOY, 2014). Particularmente quanto às doenças do trato urinário, é frequente que paratletas com lesão medular, deficiência comum nas modalidades paralímpicas do atletismo, halterofilismo e natação, desenvolvam infecções desse sistema corporal após um longo percurso de viagem, por exemplo (DERMAN *et al*., 2013, 2016b; HIRSCHMÜLLER *et al*., 2021). As altas taxas de incidência de doença muitas vezes estão relacionadas à própriadeficiência, já que paratletas apresentam condições médicas únicas relacionadas ao seu tipo de diagnóstico, que podem afetar a função imunológica e contribuir com o maior risco de infecção (BROMMER *et al*., 2016; DERMAN *et al*., 2021). Dessa forma, a compreensão do perfil das doenças em cada uma das modalidades permite à equipe de saúde o planejamento de estratégias preventivas específicas. Por exemplo, é possível adotar a realização frequente de exames urológicos em paratletas com lesão medular, o distanciamento social até a remissão completa de sintomas de problemas de saúde infectocontagiosos, e higienização adequada, tanto das mãos, quanto de equipamentos, já que essas doenças representam a maior parte daquelas apresentadas por paratletas (FAGHER *et al*., 2020b; HIRSCHMÜLLER *et al*., 2021).

A maioria dos estudos relacionados à epidemiologia de lesões e doenças em paratletas envolveu períodos de competições esportivas, como os Jogos Paralímpicos. A maior frequência de lesões de início repentino (DERMAN *et al*., 2013, 2018a) pode estar relacionada ao fato de as lesões de início gradual serem frequentemente subnotificadas durante eventos e competições esportivas, uma vez que a maioria das definições de lesão é baseada no afastamento da participação do atleta de treinos ou competições ou na necessidade de atendimento médico, o que dificulta a detecção de lesões que tem início insidioso e, muitas vezes, gravidade de leve a moderada, como as lesões de início gradual (WEILER *et al*., 2016). O acompanhamento ao longo de uma temporada esportiva pode ser capaz de capturar um maior número de problemas de saúde e, principalmente, identificar lesões menos graves, além de monitorar

mudanças a longo prazo na frequência e nas circunstâncias da lesão (WEILER *et al*., 2016). A utilização de questionários que permitam acompanhar a ocorrência de problemas de saúde contribui tanto para a caracterização de lesões e doenças, quanto para identificar os mecanismos de ocorrência da lesão e seus fatores associados (CLARSEN *et al*., 2020). Algumas pesquisas sobre a epidemiologia dos problemas relacionados à saúde em paratletas têm utilizado uma ferramenta de registro amplamente conhecida, o Questionário para Problemas de Saúde no Esporte do *Oslo Sports Trauma Research Center* (OSTRC-H) já traduzido e com adaptação transcultural para a versão brasileira (BUSCH *et al*., 2019; HIRSCHMÜLLER et al., 2021; KUBOSCH *et al*., 2017; PIMENTA; HESPANHOL; LOPES, 2021). Este questionário permite aos pesquisadores obter informações sobre todos os tipos de problemas de saúde, incluindo lesões e doenças (CLARSEN *et al*., 2014). A partir disso, a equipe esportiva é capaz de avaliar e implementar estratégias de prevenção e tratamento dos problemas de saúde mais prevalentes e/ou de maior gravidade que contribuem para um maior período de afastamento do paratleta (DERMAN *et al*., 2021; IPC, 2016).

Apesar de os dados epidemiológicos de lesões e doenças serem primordiais para o acompanhamento contínuo do estado geral de saúde dos paratletas, apenas o conhecimento desses dados não é suficiente para o entendimento integral da saúde do paratleta. Observando a necessidade desse acompanhamento frequente, o Comitê Olímpico Internacional estabeleceu o consenso sobre a avaliação periódica de saúde do atleta de elite com o objetivo de compreender a condição de saúde do atleta e os riscos de futuras lesões e doenças (LJUNGQVIST *et al*., 2009). Tal avaliação periódica também pode servir como ferramenta de monitoramento contínuo de saúde do atleta (LJUNGQVIST *et al*., 2009). Considerando que no esporte paralímpico há uma gama de perfis de paratletas que utilizam equipamentos próprios para competir, como cadeira de rodas ou dispositivos protéticos, em diferentes níveis de classificação funcional, a avaliação periódica de saúde desses atletas deve levar em conta essas especificidades. Tais fatores aumentam a complexidade de estratégias projetadas para reduzir o risco de lesões e doenças. Entretanto, ao avaliar tais particularidades a equipe de saúde do esporte terá ferramentas para implementação de abordagens mais individualizadas e diferenciadas para tratar

eprevenir a ocorrência de problemas de saúde em paratletas (DERMAN *et al*., 2021; VAN DE VLIET, 2012).

A avaliação periódica de saúde do paratleta pode ser dividida para os quatro grandes grupos de deficiência, considerando as características únicas de cada um: intelectual, musculoesquelética, neurológica e visual (DERMAN *et al*., 2021). Ela deve englobar as diferentes áreas de saúde do esporte, como a avaliação clínica, cardiorrespiratória, neuromusculoesquelética, estado nutricional, saúde mental e do sono, concussão e as particularidades da mulher paratleta (BLAUWET *et al*., 2017; GRADE *et al*., 2022; LJUNGQVIST *et al*., 2009; WEILER *et al*., 2021). Dessa forma, seria possível identificar precocemente e intervir em tempo hábil em condições que poderiam incapacitar a participação esportiva do paratleta ou prejudicar seu desempenho (HAWKESWOOD *et al*., 2014; LJUNGQVIST *et al*., 2009). Além do aspecto preventivo, a avaliação periódica de saúde também identifica se a condição de saúde atual do atleta está adequada para a sua participação esportiva (LJUNGQVIST *et al*., 2009). Tal fator torna-se ainda mais relevante no contexto dos paratletas, já que eles demoram mais tempo para procurar por suporte médico e, quando lesionados, experimentam a perda de funcionalidade tanto no esporte quanto em suas vidas diárias (FAGHER *et al*., 2016). A figura 1 exemplifica aspectos que poderiam ser considerados na avaliação periódica de saúde do paratleta por parte da equipe de saúde do esporte.

Figura 1 – Exemplificação da avaliação periódica de saúde em atletas com deficiência intelectual, musculoesquelética, neurológica, e visual.

Fonte: Elaborado pelo autor, 2023.

Assim, o monitoramento da ocorrência dos problemas de saúde ao longo da temporada esportiva associada à avaliação periódica de saúde são necessárias para compreender em profundidade as lesões e as doenças em paratletas. Dessa forma, é possível que estudos futuros investiguem a possível relação da ocorrência e da gravidade dos problemas de saúde com diferentes fatores, como deficiência de função muscular, sono e carga de treinamento, para assim poder traçar estratégias de prevenção e reabilitação mais eficazes.

OBJETIVOS

1.1 Objetivo geral

Estabelecer a epidemiologia dos problemas de saúde em paratletas e descrever orientações específicas para a equipe de saúde do esporte em relação à avaliação periódica de saúde.

1.2 Objetivo principal do estudo 1

- Investigar a prevalência, incidência e perfil de lesões musculoesqueléticas em paratletas.

1.2.1 Objetivo secundário do estudo 1

- Investigar se a qualidade metodológica e o tamanho amostral dos estudos influenciam na prevalência e incidência de lesões.

1.3 Objetivos principais do estudo 2

- Descrever as características, prevalência, incidência e o impacto dos problemas de saúde dos paratletas do Centro de Referência Paralímpico Brasileiro de Belo Horizonte durante uma temporada esportiva.
- Comparar a prevalência de problemas de saúde dos paratletas das modalidades esportivas do atletismo, halterofilismo e natação.

1.4 Objetivo principal do estudo 3

- Descrever considerações específicas para a equipe de saúde do esporte em relação à avaliação periódica de saúde em paratletas.

Prevalence and incidence of injuries in para athletes: a systematic review with meta-analysis and GRADE recommendations

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ABSTRACT

Objective To investigate prevalence, incidence and profile of musculoskeletal injuries in para athletes.

Design Systematic review.

Data sources Searches were conducted in MEDLINE, EMBASE, AMED, SPORTSDiscus, CINAHL and hand searching.

Eligibility criteria Studies were considered if they reported prevalence or incidence of musculoskeletal injuries in para athletes. Study selection, data extraction and analysis followed the protocol. Meta-analyses were conducted to estimate the prevalence and incidence rate among studies and subgroup analyses investigated whether methodological quality and sample size of the studies influenced on the estimated injury prevalence and incidence. The Grading of Recommendations Assessment, Development and Evaluation system determined the strength of evidence.

Results Forty-two studies were included. The prevalence of musculoskeletal injuries was 40.8% (95% CI 32.5% to 49.8%). Because of imprecision, indirectness and inconsistency, the strength of evidence was very low quality. The incidence of musculoskeletal injuries was 14.3 injuries per 1000 athlete-days (95% CI 11.9 to 16.8). The strength of evidence was low quality because of imprecision and indirectness. The subgroup analyses revealed that the sample size influenced on estimated injury prevalence and methodological quality influenced on estimated incidence. Injuries were more prevalent in the shoulder, for non-ambulant para athletes, and in the lower limbs, for ambulant para athletes.

Summary/conclusion Para athletes show high prevalence and incidence of musculoskeletal injuries. Current very low-quality and low-quality evidence suggests that future high-quality studies with systematic data collection, larger sample size and specificities of para athletes are likely to change estimates of injury prevalence and incidence in para athletes.

PROSPERO registration number CRD42020147982.

INTRODUCTION

Since the first Paralympic Games in Rome in 1960, with 400 athletes with spinal cord injury from 23 countries,[1] the number of athletes with disabilities competing at major sports events has grown exponentially, reaching 4328 athletes from 160 countries in 22 sports at the Rio 2016 Summer Paralympic Games.[2] Especially for individuals with a disability, sports practice has a positive impact on cardiovascular fitness, self-efficacy, self-perceived quality of life and community participation.[3 4] Although sport participation is beneficial, it also comes with a risk of musculoskeletal injuries.[5 6]

Comparison of the injury incidence rates between Paralympic Games and the Olympic Games shows to which extent sports injuries need attention in athletes with disabilities, henceforward defined as para athletes. During the 2016 summer Paralympic Games, a total of 510 injuries were reported in 441 athletes, with an injury incidence rate of 10 injuries per 1000 athlete-days.[7] This incidence rate was almost twice as high when compared with the 5.7 injuries per 1000 athlete-days during the 2016 summer Olympic Games.[8] In addition to a high incidence rate, the profile of Paralympic sports injuries is extremely variable.[9] The different levels of para athletes' classification favour the participation of athletes with different types and degrees of disabilities in the same sport modality. This wider presentation of disability may help explain the great variety of injury profiles in Paralympic sports.[10 11]

The consequences of injuries in para athletes are often not limited to sports time loss or reduced sports performance. Injuries also frequently pose an additional barrier to activities of daily living in para athletes.[6] For example, an upper limb muscle injury in a disabled wheelchair javelin thrower can also affect his or her ability for independent locomotion during daily living.[4] Thus, to prevent these injuries, the first step is to understand the extent of the sports injury problem.[12] Weiler *et al*[13] conducted a systematic review of sports injuries in athletes with disabilities but the wide variability in reported injury rates prevented the authors to conduct a meta-analysis. The inclusion of studies without clear definition of sports injury might have contributed to this wide variability. Furthermore, another methodological shortcoming in this area is that estimates of prevalence and incidence comes from studies with small samples. Since the publication of this previous review in 2016,[13] new large studies on Paralympic sports injuries have been conducted, including longitudinal studies. Therefore, the primary aim of this systematic review with meta-analysis was to

investigate the prevalence, incidence and profile of musculoskeletal injuries in para athletes. As a secondary aim, we investigated whether methodological quality and sample size influenced the prevalence and incidence reported.

METHODS

Search strategy

For this systematic review, we followed recommendations from the Joanna Briggs Institute Reviewers' Manual,[14] the Cochrane Collaboration[15] and Preferred Reporting Items for Systematic Reviews and Meta-Analyses reporting guidelines.[16] The review's protocol was registered at PROSPERO (CRD42020147982). Search strategies were conducted in August 2019 and updated in May 2020 in MEDLINE, EMBASE, AMED, SPORTSDiscus and CINAHL. In addition, we handsearched the reference list of previous reviews on the topic. There was no date or language restriction. Our sensitive search strategy included the combination of the following terms 'prevalence', 'incidence', 'epidemiology', 'injury' and 'para athlete'. Online supplemental material 1 shows a detailed search strategy for each database.

Eligibility criteria

We included published studies that reported the prevalence or incidence of musculoskeletal injuries in para athletes, including prospective, and retrospective cohort studies, without language, sample size, age or publication date restrictions. Para athlete is a general term used for athletes with an impairment who participate at any competitive level.[10] To be included, studies should report the prevalence or incidence of musculoskeletal injury in para athletes, along with a clear definition of musculoskeletal injury. Given that definitions of musculoskeletal injuries are extremely variable in the literature, any type of definition was accepted. When studies reported data from the same cohort or event, with similar methodology and the same definition of injury, only the study with global data on prevalence and incidence of injury was included.

Study selection and data extraction

Two reviewers (LSPP and FOM) independently screened titles and abstracts and assessed potential full texts. A third reviewer (RR) solved any between-reviewer disagreements.

Two reviewers (LSPP and FOM) also independently extracted descriptive and outcome data of all included studies. A third reviewer (RR) solved any discrepancies between data extractions. Descriptive information included data collection setting, sample characteristics (eg, sex, age, sport, disability, years of practising in para sports), injury characteristics (eg, injury definition, professional responsible for injury diagnosis and record, number of sports injuries), the prevalence and incidence rate of injuries with 95% CIs per study. When these data were not provided, we estimated prevalence and incidence rate using the number of athletes injured, reported number of injuries, total sample and time frame of the competition. For incidence rate, if the time frame of the competition was not reported we contacted authors or performed an internet search to clarify the start and closing dates of the competition, considering the number of days of the competition. When a study reported more than one competition, the injury incidence rate was calculated for each competition. Prevalence was estimated as the proportion of athletes affected by injury at any given time,[17] and incidence rate was estimated as the number of injuries divided by the total person-time at risk (athlete exposures).[18]

Assessment of the methodological quality

Two independent reviewers (LSPP and FOM) assessed the methodological quality of included studies using 'The Joanna Briggs Institute Prevalence Critical Appraisal Tool'.[14] A third reviewer (RR) solved potential disagreements regarding the risk of bias scoring. Each item was rated as 'yes', 'no', 'unclear' or 'not applicable' according to information available in each study, with a maximum score of nine points. One of the items in this tool is sample size. To evaluate if the sample size of each included study was appropriate, we used the following equation: sample size$=\frac{Z_{1-\alpha/2}^{2} \cdot p(1-p)}{d^2}$

where p was the expected prevalence (12.1%), defined based on a previous study,[7] Z was the confidence level (1.96), and d was the precision (5.0%).[19] The sample size estimation resulted in a minimum required sample size of 163 participants. A third reviewer (RR) solved potential disagreements regarding the risk of bias scoring.

Data analysis

Descriptive statistics were used to summarise data in meta-analysis. The prevalence and in incidence rate estimated from individual studies were pooled, using a random-effects model.[15] Studies that reported injury prevalence and incidence from the same subgroups of a larger sample during the same competitive event were excluded from the analysis. I^2 was used to explain what proportion of the observed variance was attributed to the variance in true effects rather than to sampling error.[20] A prediction interval was used to access the heterogeneity, that is, how much effect size varies across studies.[20]

Quality of evidence

To summarise the overall quality of the evidence the Grading of Recommendations Assessment, Development and Evaluation (GRADE system)[21] was used for the meta-analysis pooling prevalence and incidence data from all included studies. Scoring of evidence started at high-quality evidence which was downgraded one level if one of the following prespecified criteria was present: (1) poor methodological quality (downgraded if ≥25% of the studies included in the meta-analysis used inappropriate sampling method or statistical analyses (ie, items 2 and 8 in The Joanna Briggs Institute Prevalence Critical Appraisal Tool)); (2) imprecision (downgraded if ≥25% of the included studies did not present minimum required sample size of 163 participants); (3) indirectness (downgraded if ≥25% of the included studies did not use valid and reliable methods for data collection, for example, validated questionnaires previously described in the literature or standardised systems for recording sports injuries) and (4) inconsistency (downgraded if prediction interval has a variation ≥0.5 between upper and lower limits). These prespecified criteria were defined considering the items of Joana Briggs that correspond to the GRADE system criterion, for example, items 2 and 8 for poor methodological quality, and the corresponding index of the meta-analysis, such as the prediction interval for indirectness criterion.

We performed subgroup analyses to investigate whether methodological quality and sample size influenced overall estimates of prevalence and incidence. For the subgroup analysis, the criteria used to classify studies in high and lower methodological quality was the median score of The Joanna Briggs Institute Prevalence Critical Appraisal Tool. Studies that presented median risk of bias ≤6 points out of 9 were pooled as lower methodological quality. For the sample size subgroup analysis, the cut-off sample of 163 para athletes were used to classify studies into small and

large sample size. For the subgroup analyses, if there was no overlap between 95% CIs between subgroups, we interpreted that each subgroup provided different estimates. All analyses were performed using Comprehensive Meta-Analysis, V.2.0 (Biostat, Englewood, New Jersey, USA).

RESULTS

Flow of studies

The electronic search strategy identified 4092 records from the selected databases after excluding duplicates. After screening titles, abstracts and reference lists, 74 potentially relevant records underwent full-text review, including one additional study found by handsearching. Twenty-three studies failed to meet the inclusion criteria, eight studies did not provide information after contact and one study was excluded because it reported data from the same event, using similar methodology, and using the same injury definition than another included study. Thereby, 42 studies were included in this review. Figure 1 shows the flow chart of studies through the review.

Characteristics of included studies

Twenty-five out of 42 studies included reported both injury prevalence and incidence rates,[7 22–45] 7 studies only reported prevalence data[46–52] and 10 studies only reported incidence rates.[3 53–61] Of the 35 studies with incidence data, 20 studies reported injury incidence rate per days,[3 22–29 33 39 41–44 53 55–58] 5 studies reported incidence per hours,[31 32 34 59 60] 5 studies reported injury incidence rate in different competitions,[35–37 45 54] three studies differentiated the injury incidence rate between precompetitive and competitive periods,[7 30 40] one study reported injury incidence rate per 1000 athlete exposures,[61] and one study reported injury incidence rate per 100 athlete competitions.[38] The number of participants ranged from 11[32] to 3657,[7] with a mean of 390.9 participants and median of 135.5. Regarding sex, 2 (4.8%) studies were conducted with females,[47 50] 4 (9.5%) with males[22 33 36 58] and 36 (85.7%) with both sexes.[3 7 23–32 34 35 37–46 48 49 51–57 59–61] Six studies were performed with wheelchair para athletes,[22 27 33 47 50 59] 11 studies with ambulant para athletes[25 32 34–38 41 44 52 58] and 25 studies with both wheelchair

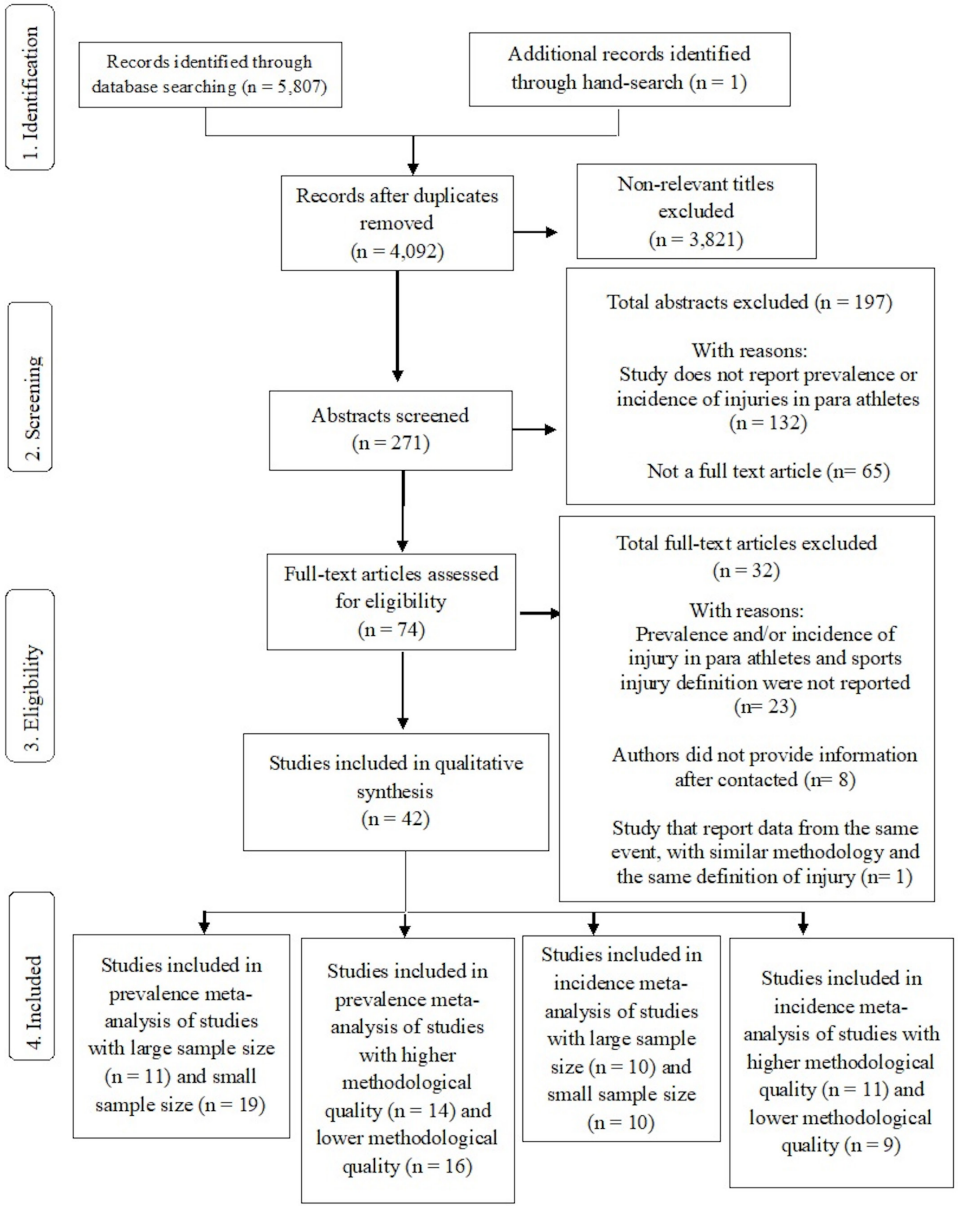

Figure 1 PRISMA flow chart of studies through the review. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

Table 1 Methodological quality of the included studies (n=42)

Study	1	2	3	4	5	6	7	8	9	Overall score (0–9)
Antonietti *et al*, 2008[22]	Y	Y	N	Y	Y	Y	Y	Y	Y	8
Bauerfeind *et al*, 2015[33]	Y	Y	N	Y	N	Y	U	Y	N	5
Bernardi *et al*, 2003[46]	Y	Y	Y	Y	Y	Y	Y	Y	Y	9
Blauwet *et al*, 2016[3]	Y	Y	Y	Y	Y	Y	Y	Y	Y	9
Chung *et al*, 2012[59]	Y	Y	N	Y	N	U	U	Y	N	4
Curtis *et al*, 1999[47]	Y	Y	N	Y	U	Y	U	Y	U	5
Derman *et al*, 2016[39]	Y	Y	Y	Y	Y	Y	Y	Y	Y	9
Derman *et al*, 2018[7]	Y	Y	Y	Y	Y	Y	Y	Y	Y	9
Derman *et al*, 2020[40]	Y	Y	Y	Y	Y	Y	Y	Y	Y	9
Fagher *et al*, 2019[41]	Y	Y	N	Y	Y	Y	Y	Y	Y	8
Fagher *et al*, 2020[48]	Y	Y	N	Y	Y	Y	Y	Y	Y	8
Fagher *et al*, 2020[31]	Y	Y	N	Y	Y	Y	Y	Y	Y	8
Ferrara *et al*, 1992[53]	Y	Y	N	Y	N	U	N	U	U	3
Ferrara *et al*, 1992[42]	Y	Y	Y	Y	U	Y	Y	Y	U	7
Ferrara and Davis, 1994[43]	Y	Y	Y	Y	Y	Y	U	Y	U	7
Ferrara and Buckley, 1996[61]	Y	Y	Y	Y	Y	Y	U	Y	U	7
Ferrara *et al*, 2000[54]	Y	Y	Y	U	U	U	U	U	U	3
Gajardo *et al*, 2019[44]	Y	Y	N	Y	Y	N	Y	Y	Y	7
Gawroński *et al*, 2013[45]	Y	Y	N	Y	Y	Y	U	Y	U	6
Haykowsky *et al*, 1999[32]	Y	Y	N	Y	N	Y	U	N	N	4
Hollander *et al*, 2019[55]	Y	Y	N	Y	Y	Y	Y	Y	U	7
Kubosch *et al*, 2017[23]	Y	Y	N	Y	U	Y	Y	Y	U	6
Lankhorst *et al*, 2019[34]	Y	Y	N	Y	Y	N	Y	Y	Y	7
Magno e Silva *et al*, 2013[35]	Y	Y	N	Y	Y	N	U	Y	U	5
Magno e Silva *et al*, 2013[36]	Y	Y	N	Y	Y	N	U	Y	U	5
Magno e Silva *et al*, 2013[37]	Y	Y	N	Y	Y	N	U	Y	U	5
Marqueta *et al*, 2005[24]	Y	Y	N	Y	N	U	U	N	U	3
McCormick *et al*, 1990[25]	Y	Y	Y	Y	Y	Y	U	Y	N	7
Nyland *et al*, 2000[56]	Y	Y	Y	Y	Y	N	N	Y	U	6
Ona Ayala *et al*, 2019[26]	Y	Y	Y	Y	Y	Y	Y	Y	U	8
Patatoukas *et al*, 2011[49]	Y	Y	N	Y	U	N	N	Y	U	4
Ramirez *et al*, 2009[60]	Y	Y	Y	Y	Y	N	N	Y	Y	7
Saffarian *et al*, 2019[38]	Y	Y	Y	Y	U	N	N	Y	N	5
Shimizu *et al*, 2017[50]	Y	Y	N	Y	Y	Y	U	Y	N	6
Taylor and Williams, 1995[27]	Y	Y	N	Y	N	U	N	Y	U	4
Tenforde *et al*, 2019[51]	Y	Y	Y	Y	Y	N	U	Y	N	6
Webborn *et al*, 2006[29]	Y	Y	Y	Y	N	N	U	N	N	4
Webborn *et al*, 2012[57]	Y	Y	Y	U	U	U	U	Y	U	4
Webborn *et al*, 2016[58]	Y	Y	Y	U	Y	Y	Y	Y	Y	8

Continued

Table 1 Continued

Study	1	2	3	4	5	6	7	8	9	Overall score (0–9)
Willick *et al*, 2013[30]	Y	Y	Y	Y	Y	Y	Y	Y	U	8
Willick *et al*, 2016[28]	Y	Y	Y	Y	Y	Y	Y	Y	U	8
Zwierzchowska *et al*, 2020[52]	Y	Y	N	Y	Y	N	U	Y	Y	6
Total 'yes' scores	42	42	20	39	28	24	18	37	14	

1. Was the sample frame appropriate to address the target population?
2. Were study participants sampled in an appropriate way?
3. Was the sample size adequate?
4. Were the study subjects and the setting described in detail?
5. Was the data analysis conducted with sufficient coverage of the identified sample?
6. Were valid methods used for the identification of the condition?
7. Was the condition measured in a standard, reliable way for all participants?
8. Was there appropriate statistical analysis?
9. Was the response rate adequate, and if not, was the low response rate managed appropriately?

N, no; NA, not applicable; U, unclear; Y, yes.

and ambulant para athletes.[3 7 23 24 26 28–31 39 40 42 43 45 46 48 49 51 53–57 60 61] Twenty studies were sport-specific,[3 22–24 26–28 32 33 35–37 41 44 47 50 52 53 55 59] 19 were multisport[7 25 29–31 38–40 42 43 45 46 48 49 54 56–58 60] and 3 studies did not report para sport modality.[34 51 61] Ten studies did not report para athlete disabilities,[26 28–30 39 42 54 57 59 61] 22 studies presented information about classification level of para athletes,[3 7 22 24 26 32 41 35–41 43 44 48 50 52 55 57–59] 23 studies specified the assistive devices used by para athletes,[3 7 22 24 26–28 30 31 33 39 40 46–48 50 51 53 55–57 59 60] and in 30 studies the injury diagnosis was confirmed by a medical practitioner.[3 7 23 25 26 28–31 33–40 45 46 48 50 51 54–61] Only five studies presented longitudinal prospective design,[23 31 34 59 60] while 37 studies reported retrospective or competitive events data.[3 7 22 24–30 32 33 35–58 61] Online supplemental material 2 shows the characteristics of the included studies and demonstrates the level of inconsistency in injury definitions and the report of para athletes' exposure (days, hours or competition).

Quality assessment

Methodological quality issues are reported in table 1. None of the studies had a negative or unclear answer to item 2, 22 studies did not present appropriate sample size,[22–24 27 31–37 41 44 45 47–50 52 53 55 59] 18 studies did not use valid methods for data collection or did not clearly present the methods used for data collection,[24 27 29 34–38 44 49 51–54 56 57 59 60] and 5 studies had a negative or unclear answers to item 8.[24 29 32 53 54] Twenty-one studies scored ≤6 out of 9.[23 24 27 29 32 33 35–38 45 47 49–54 56 57 59] Mean (SD) methodological quality of the included studies was 6.3 (1.8) out of 9 (ranging from 0 to 9).

Prevalence of musculoskeletal injuries in para athletes

The pooled prevalence estimates including data from 30 studies (n=12 151)[7 22–25 27 29–52] found was 40.8% (95% CI 32.5% to 49.8%; I^2: 97.7%; prediction interval: 0.1–0.8). The overall quality of evidence was rated as very low quality (ie, downgraded due to imprecision, indirectness and inconsistency) (table 2). The subgroup analysis based on higher and lower methodological quality revealed no significant difference. The pooled estimate for studies with higher methodological quality (n=10 408)[7 22 25 30 31 34 39–44 46 48] was injury prevalence of 34.7% (95% CI 25.4% to 45.4%; I^2: 98.2%; prediction interval: 0.1–0.8) and for studies with lower methodological quality (n=1743)[23 24 27 29 32 33 35–38 45 47 49–52] was 47.4% (95% CI 32.1% to 63.3%; I^2: 95.8%; prediction interval: 0.1–0.9) (figure 2). For the subgroup analysis based on study sample size, studies with large sample size showed significantly lower prevalence estimate than studies with small sample size. While studies with large sample size (n=11 068)[7 25 29 30 38–40 42 43 46 51] showed injury prevalence of 18.5% (95% CI 12.7% to 26.1%; I^2: 98.3%; prediction interval: 0.1–0.6), the prevalence estimate from studies with small sample size (n=1083)[22–24 27 31–37 41 44 45 47–50 52] was 58.3% (95% CI 48.2% to 67.8%; I^2: 88.1%; prediction interval: 0.2–0.9) (online supplemental material 3).

Incidence rate of musculoskeletal injuries in para athletes

For incidence rate, the pooled estimate including data from 20 studies (n=11 608)[7 22–25 27 29 30 33 39–45 53 55–57] that reported injury incidence rate per days and also the number of injuries, sample size and exposure in days. The incidence rate was 14.3 injuries per 1000 athlete-days (95% CI 11.9 to 16.8; I^2: 98.4%; prediction interval was 0.1–0.2). The overall quality of evidence was rated as low quality (ie, downgraded due to imprecision and indirectness) (table 2). The subgroup analysis showed a significant lower incidence rate in studies of higher methodological quality

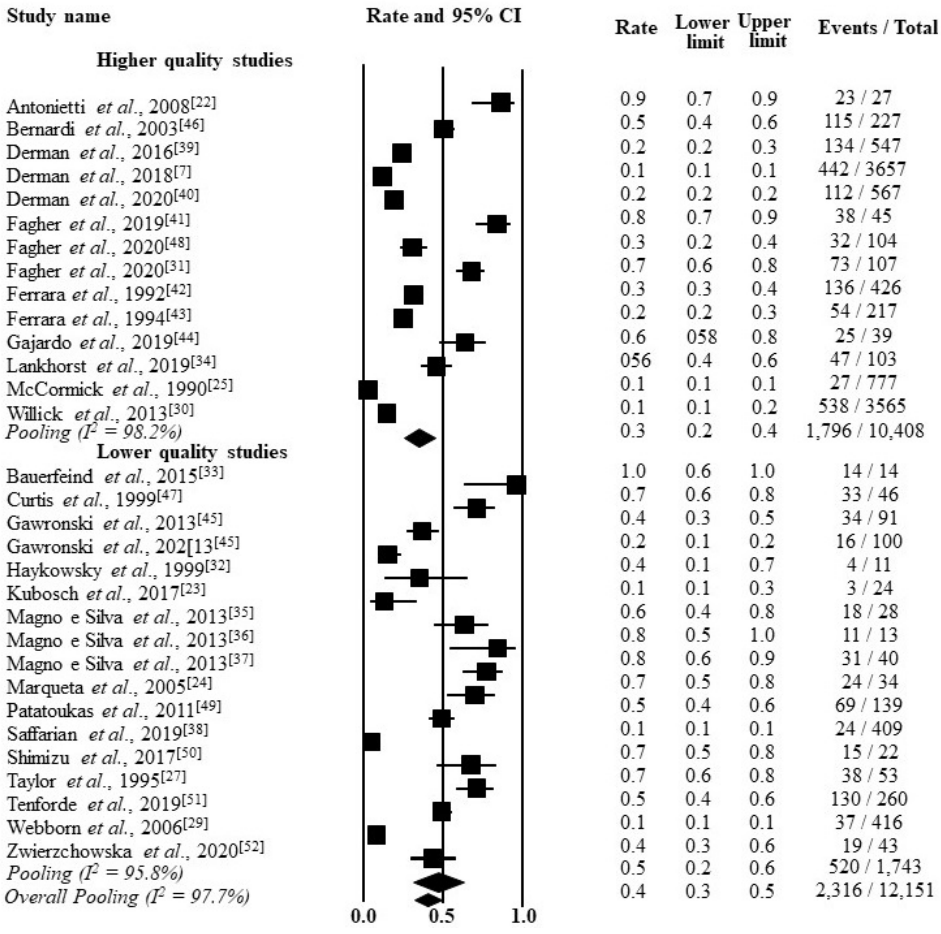

Figure 2 Meta-Analysis for overall injuries prevalence in para athletes and subgroup analysis for studies with higher and lower methodological quality.

as compared with studies with lower methodological quality. The pooled estimate for studies with higher methodological quality (n=9999)[7 22 30 39–44 55] was injury incidence rate of 11.7 per 1000 athlete-days (95% CI 8.9 to 14.5; I^2: 98.6%; prediction interval was 0.1–0.4) and pooling of 1609 para athletes from studies with lower methodological quality[23 24 27 29 33 45 53 56 57] estimated the injury incidence of 23.1 per 1000 athlete-days (95% CI 17.1 to 29.2; I^2: 98.4%; prediction interval was 0.1–0.4) (figure 3). The subgroup analysis showed no clear difference with regards to sample size. While studies with large sample size (n=10 981)[7 25 29 30 39 40 42 43 56 57] estimated an injury incidence rate of 14.4 per 1000 athlete-days (95% CI: 11.1 to 17.7; I^2: 98.8%; prediction interval was 0.1–0.2) studies with small sample size (n=627)[22–24 27 33 41 44 45 53 55] showed an incidence rate of 14.7 per 1000 athlete-days (95% CI: 11.1 to 18.5; I^2: 97.4%; prediction interval: 0.1–0.3) (online supplemental material 4).

Injury profile in para athletes

Eighteen studies found that the shoulder was the body location most frequently affected by injuries,[7 22 23 26 28 30–33 39–42 44 46–48 59] mainly in sports with non-ambulant para athletes, like wheelchair basketball,[22] wheelchair rugby,[33] wheelchair foil fencer[59] and powerlifting.[26 28] In other four studies, most of the injuries occurred in upper limbs.[27 52 53 61] Nine studies reported that lower limbs injuries were the most common for ambulant para athletes,[24 34 36–38 43 51 58 60] and in three studies, the trunk was the most frequently injured region.[35 54 55] Four studies found similar prevalence of upper and lower limb injuries,[3 29 56 57] and four studies did not report injuries by body location.[25 45 49 50] In general, strain, sprains and contusions were the most common injuries in para athletes.[3 24 25 29 31 33–38 41 45 46 49 52 54 55 59–61] Most of the studies that included sudden and gradual onset injuries reported that sudden onset injuries are more frequent than

Table 2 Evidence table for outcome measure

Outcomes	Risk of bias*	Imprecision†	Indirectness‡	Inconsistency§	No of para athletes	Quality
Injuries prevalence in para athletes	No serious risk of bias	Serious imprecision	Serious indirectness	Serious inconsistency	12 151	Very low quality
Injuries incidence rate in para athletes	No serious risk of bias	Serious imprecision	Serious indirectness	No serious inconsistency	11 608	Low quality

*More than 25% of studies with a risk of bias (ie, inappropriate sampling method or statistical analyses).
†More than 25% of studies with small sample size.
‡More than 25% of studies did not use valid and reliable methods for data collection.
§Heterogeneity across the studies (prediction interval has a variation ≥0.5 between upper and lower limits).

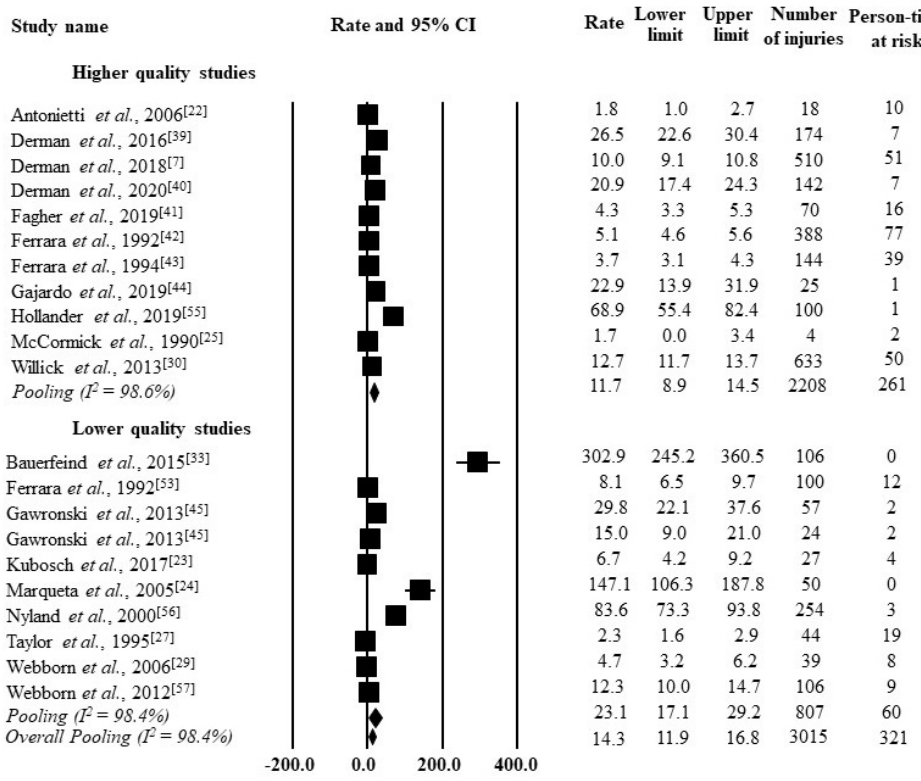

Figure 3 Meta-Analysis for overall injuries incidence rate in para athletes and subgroup analysis for studies with higher and lower methodological quality.

gradual onset injuries and only one study reported similar data for gradual and sudden onset injuries.[45] Between winter sports, para alpine skiing/snowboard had a higher incidence rate of injuries,[39 40] while between summer sports, football 5-a-side had the highest injury incidence rates[7 30] (online supplemental material 5).

DISCUSSION

The purpose of this systematic review with meta-analysis was to investigate the prevalence, incidence and profile of musculoskeletal injuries, including body location, type of injury and sports with the highest number of injuries, in para athletes. Our findings showed that musculoskeletal injury prevalence in para athletes was 40.8% (95% CI 32.5% to 49.8%) and musculoskeletal injury incidence rate was 14.3 injuries per 1000 athlete-days (95% CI 11.9 to 16.8). According to the GRADE system, pooling of studies on injury prevalence in para athletes provided very low-quality evidence, and pooling of studies on injury incidence rate provided low-quality evidence. The subgroup analysis based on study sample size showed a significant lower injury prevalence (18.5%, 95% CI 12.7% to 26.1%) in studies of large sample size in comparison to studies with small sample size (58.3%, 95% CI 48.2% to 67.8%). The subgroup analysis based on methodological quality showed a significant lower injury incidence (11.7 per 1000 athlete-days, 95% CI 8.9 to 14.5) in studies of higher methodological quality as compared with studies with lower methodological quality (23.1 per 1000 athlete-days, 95% CI 17.1 to 29.2). Sudden-onset injuries were more frequent than gradual onset injuries. Strains, sprains and contusions were the most common injury type and the body regions most frequently affected were the shoulder for wheelchair athletes and the lower limbs for ambulant para athletes.

Prevalence and incidence rates of musculoskeletal injuries in para athletes are higher than in able-bodied athletes. For example, during the last summer Paralympic Games (Rio 2016), the prevalence of injuries was 12.1%,[7] while in the Olympic Games in the same year it was 8%.[8] Incidence of injuries followed the same pattern, with 10 injuries per 1000 athlete-days in Paralympic Games[7] and 5.7 injuries per 1000 athlete-days during the Olympic Games.[8] The high injury prevalence and incidence rates in para athletes show that the mechanisms of occurrence of musculoskeletal injuries in this population need to be better understood. Para athletes can be categorised in different groups, varying between para athletes with loss of muscle strength and para athletes with intellectual impairment.[11] Then, these different profiles of para athletes require different approaches to treat and prevent the occurrence of musculoskeletal injuries. Furthermore, para athletes use different equipment to compete, such as a wheelchair or prosthetic devices, which increases the complexity of strategies designed to reduce injury risk.[4] Sports injuries in para athletes, unlike able-bodied athletes, can also be related to their own disability or to the assistive device they use in their daily lives. For this reason, to better understand para athletes' injuries and related factors, full knowledge of the specificities of the sport modality and the para athlete classification level are required to design and implement more individualised approaches. However, some studies still do not report this type of information.[13 62 63] Although most of the included studies reported the type of disability (76%) and had injury diagnosis confirmed by a medical practitioner (70%), almost half did not provide information about the para athlete classification level or the use of assistive devices. One of the few studies that provided this information demonstrated that para athletes that did not use any assistive devices had a higher injury

prevalence.[48] Thus, future studies should report this information to allow better understanding on para athlete injuries profile and related factors.

The subgroup analysis showed that the estimated prevalence and incidence of musculoskeletal injuries in para athletes was influenced by the studies' sample size and methodological quality, respectively. More specifically, studies with small sample size overestimated the injury prevalence (58.3%) in comparison to studies with large sample sizes (18.5%). For injury incidence rate, studies with higher methodological quality showed significantly lower incidence (11.7 per 1000 athlete-days) than studies with lower methodological quality (23.1 per 1000 athlete-days). This also was observed in previous systematic review with athletes with disability that reported a lower injury risk in studies with larger sample populations and higher methodological quality.[13] There are fewer large competitions in para athlete sports in comparison to able-bodied sports, which may help to explain the small number of studies with appropriate sample size to estimate prevalence and incidence of musculoskeletal injuries in para athletes.[64] Most of these large sample studies were performed during Paralympic games,[7 29 30 39 40] which might not represent injuries rates in non-elite para athletes. Large para athletes training centres and national organisations are key to the development of future studies with large samples, high methodological quality and including prospective data collection throughout different seasons, which will provide more consistent information regarding musculoskeletal injuries in para athletes. Nevertheless, the high prevalence and incidence rates data showed by the present review highlight the need to better understand and hopefully prevent the occurrence of musculoskeletal injuries in para athletes.

The shoulder was the most affected body region in wheelchair para athletes, which can be explained by the higher demands of the upper limbs in their daily activities[4] and during sports practice. Studies that assessed scapular kinematics in wheelchair para athletes demonstrated scapular asymmetries during wheelchair propulsion[65 66] that, along with muscle imbalance and excessive training load, may increase the occurrence of shoulder injuries.[67 68] Most of the ambulant para athletes were from sport modalities that have the highest injury incidence rates in summer Paralympic Games, such as football 5-a-side and athletics, which might help to explain why the lower limbs were the body regions most frequently affected in these para athletes.[7 30] In the present review, sudden onset injuries were more frequent than gradual onset injuries. This may be related to the fact that gradual-onset injuries are often under-reported, since most of the injury definitions are based on 'time-loss' or 'medical attention'[13] and few studies performed a longitudinal follow-up,[23 31 34 59 60] so consequently might not detect most of the gradual-onset injuries.

Our results regarding location and type of musculoskeletal injuries are in agreement with the results of non-systematic reviews.[9 10 69] The heterogeneity in para sports, due to a large number of modalities and also to the different athlete classification levels for the same modality, increases the inconsistency of information about prevalence and incidence of musculoskeletal injuries in para athletes. In addition, the heterogeneity in the methods used by studies with para athletes, compromises pooling of data. One of the main problems is the different musculoskeletal injury definitions. Similar to Olympic sports, para sports also has a wide variety of injuries definition.[70] As an attempt to solve this problem, the International Olympic Committee very recently established a consensus statement about methods for recording and reporting of epidemiological data on injury and illness in sport.[71] A similar consensus should be developed for Paralympic sports and their specificities. Finally, most of the studies used different procedures to report prevalence and incidence rate data, did not mention a clear definition of these variables, and did not present all information used to compute these data, such as number of injuries, number of athletes injured, the total number of athletes and exposure.[18] As well as data records, studies should use valid and reliable methods to assess injuries rate, such as the Oslo Sports Trauma Research Center Questionnaire on Health Problems .[23 72]

Weiler *et al*[13] conducted a systematic review of sports injuries in athletes with disabilities and also demonstrated high variability in reported injury rates. They suggested that future studies should better define injury, use standardised methods of data collection and report para athletes demographic data to improve quality of injury epidemiological data. Following these steps and focusing on para athletes specificities, future researches will allow the construction of a more consistent and robust knowledge about musculoskeletal injuries in para athletes that will allow para athletes, sport teams and institutional boards to elaborate more effective approaches to the injury in para sport problem.

This study had some limitations. First, age or level of sports participation were not defined as exclusion criteria, which allowed a wider range of included studies and consequently increased heterogeneity levels in the data. However, as studies with para athletes are less common, we had to use less restricted inclusion criteria to review data on musculoskeletal injuries in this population. Level of competition, classification levels, injury severity and type of injury might also influence on estimated prevalence and incidence rates of injuries in para athletes and were not controlled in this review. However, this was not possible because most of the studies did not report this information. The strength of the current evidence was downgraded due to imprecision, indirectness and inconsistency about injury prevalence and downgraded due to imprecision and indirectness about injury incidence rate in para athletes, presenting very low-quality and low-quality evidence, respectively.

Future high-quality studies with consistent information on the parameters used to calculate the injury prevalence and incidence rate, and valid and reliable methods for data collection are likely to impact on the estimated prevalence and incidence of musculoskeletal injuries in para athletes. To improve the quality of injury epidemiological data in para athletes, studies must properly define injury, including their type of presentation (sudden or gradual onset), severity and also follow the recommendations in the scientific literature regarding the appropriate methods to report athlete exposure and to inform about injuries risk and burden.[71] In addition, studies should report para athlete's demographic data, including type of disability, equipment used for sport practice or during daily activities, level of competition and other relevant daily demands, such as side jobs. Finally, more prospective studies that investigate the relationship between modifiable factors and injuries occurrence in para athletes, such as use of equipment and training and competition volume and intensity may form the basis for the design of more effective strategies to prevent and manage injuries in para athletes.

CONCLUSION

The reviewed studies demonstrated that musculoskeletal injury prevalence in para athletes was 40.8% (95% CI 32.5% to 49.8%) and injury incidence rate was 14.3 injuries per 1000 athlete-days (95% CI: 11.9 to 16.8). The subgroup analysis based on study sample size showed a significant lower injury prevalence

in studies of large sample size as compared with studies with small sample size. For the incidence rate, studies with higher methodological quality showed a significant lower injury incidence rate in comparison to studies with lower methodological quality. Sudden-onset injuries are more frequent than gradual onset injuries in para athletes. Shoulder was the body region most commonly injured for non-ambulant para athletes, while lower limbs were the most frequently injured region for ambulant para athletes. The heterogeneity between para athletes and the poor methodological quality of the studies promote greater inconsistency in the information on the injury prevalence and incidence in para athletes. Therefore, current very low-quality and low-quality evidence suggests that prevalence and incidence rate, respectively, are likely to change with future high-quality studies, observing a large sample size, systematic data collection with reliable and validated methods and with attention to the specificities of para athletes. Findings of this systematic review demonstrate that para athletes, sports teams and para sport institutional boards should be aware of the high prevalence and incidence levels of musculoskeletal injuries in para athletes.

What is already known

- The heterogeneity in para sports increases the inconsistency of information about prevalence and incidence of musculoskeletal injuries in para athletes.
- There is still a need for consensus on epidemiological research methodology, including sports injury definition in para sports.
- In para athletes, shoulder is the most frequently affected body location by injuries in non-ambulant para athletes, and lower limbs injuries are the most common in ambulant para athletes.

What are the new findings

- This was the first systematic review with meta-analysis on injury prevalence and incidence in para athletes that uses Grading of Recommendations Assessment, Development and Evaluation recommendations to assess the overall quality of evidence.
- The subgroup analyses revealed that the sample size influenced the estimated injury prevalence and methodological quality influenced the injury incidence rate.
- Between winter sports, para alpine skiing/snowboard had the highest incidence of injuries, while between summer sports, football 5-a-side had the highest incidence of injuries.

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Supplementary material 1

Search strategy conducted in August 2019 and updated in May 2020

OVID (Medline, Embase, AMED)

1. incidence.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
2. prevalence.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
3. epidemiology.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
4. rate*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
5. 1 or 2 or 3 or 4
6. injur*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
7. trauma.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
8. 6 or 7
9. (adaptive adj sport). mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
10. para*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
11. disab*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
12. impairment*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

13. 9 or 10 or 11 or 12
14. athlet*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
15. player*.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
16. sport*.mp [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
17. 14 or 15 or 16
18. 5 and 9 and 14 and 18

EBSCO (SPORTDiscus and CINAHL)

S18 S14 AND S15 AND S16 AND S17

S17 S11 OR S12 OR S13

S16 S7 OR S8 OR S9 OR S10

S15 S5 OR S6

S14 S1 OR S2 OR S3 OR S4

S13 sport*

S12 player*

S11 athlet*

S10 impairment*

S9 disab*

S8 para*

S7 adaptive and sport

S6 trauma

S5 injur*

S4 rate*

S3 epidemiology

S2 prevalence

S1 incidence

Supplementary material 2

Characteristics of the included studies (n = 42)

Study, year, setting, injury record	Sample size, sex, age	Sport, mean practice duration	Disability	Injury definition	Exposure (days)	Sports injuries	Prevalence	Incidence rate (95% CI)
Studies reporting on both prevalence and incidence rates (n = 25)								
Antonietti *et al.*, 2008[22] Location: Brazil Sample selection: convenience Injury record: Physiotherapy students	n* = 27 Sex: male Average age: 30.1 (SD 10.6) years	Sport: wheelchair basketball Mean practice duration: 48.9 (SD 62.5) months	Spinal cord injury	Some participants presented injury with pathological diagnosis established by prior medical evaluation. Those who had no previous pathological diagnosis, it was considered pain as a complaint and injury was considered non-specific.	365	18	86.6% (23**)	1.8 (95% CI,1.0–2.7) injuries per 1000 athlete-days[a]
Bauerfeind *et al*., 2015[33] Location: Poland Sample selection: convenience Injury record: National Team physiotherapists and medical histories of the athletes	n* = 14 Sex: male Average age: 29.5 (SD 5.7) years	Sport: wheelchair rugby Mean practice duration: 6.68 (SD 3.66) years	Spinal cord injury and others	Sports injuries were defined as bodily injuries that arise during training or competition, and stopped, limited or modified participation in sports activities for one day or more	Mean of training and tournament days = 25 (SD 5.6) days	106	100% (14**)	302.8 (95% CI, 245.2–360.5) injuries per 1000 athlete-days[a]

Derman *et al.*, 2016[39] Location: Sochi 2014 Winter Paralympic Games Sample selection: convenience Injury record: ATOS system supplied to the medical staff employed by the Sochi Organising Committees of the Olympic and Paralympic Games (SOCOG) and WEB-IISS	n* = 547 Sex: both sex Average age: from 13 years	Sport: alpine skiing/ snowboarding, cross-countryskiing / biathlon, ice sledge hockey, wheelchair curling Mean practice duration: not reported	Not reported	Injury was specifically defined as 'any newly acquired injury as well as exacerbations of pre-existing injury that occurred during training and/or competition in the games period of the Sochi 2014 Winter Paralympic Games'	12	174	24.5 % (134**)	26.5 (95% CI, 22.7–30.8) injuries per 1000 athlete-days
Derman *et al.*, 2018[7] Location: Rio 2016 Summer Paralympic Games Sample selection: convenience Injury record:	n* = 3657 Sex: both sex Average age: from 12 years	Sport: archery, boccia, canoe, cycling (track and road), equestrian, football 5-a-side, football 7-a-side, goalball, judo, para athletics, para powerlifting, para swimming,	Limb deficiency (amputation, dysmelia, congenital deformity), visual impairment, spinal cord injury, central neurological injury (cerebral palsy, traumatic brain injury, stroke, other	Injury was specifically defined as 'any newly acquired injury as well as exacerbations of pre-existing injury that occurred during training and/ or competition in the games period of the	Overall: 14 Pre-competition: 3 Competition: 11	Overall: 510 Pre-competition: 141 Competition: 369	Overall: 12.1% (441**) Pre-competition: 3.7% (134**) Competition: 8.9% (325**)	Overall: 10.0 (95% CI, 9.1–10.9) injuries per 1000 athlete-days Pre-competition: 12.9 (95% CI, 10.9–15.2) injuries per 1000 athlete-days Competition: 9.2 (95% CI, 8.3–10.2) injuries per 1000 athlete-days

WEB-IISS		rowing, sailing, shooting para sport, sitting volleyball, table tennis, triathlon, wheelchair basketball, wheelchair fencing, wheelchair rugby and wheelchair tennis Mean practice duration: not reported	neurological impairment), other, *Les autres* (non-spinal polio myelitis, ankylosis, leg shortening, joint movement restriction, nerve injury resulting in local paralysis), intellectual impairment, unknown, short stature	Rio 2016 Summer Paralympic Games'				
Derman *et al.*, 2020[40] Location: Pyeongchang 2018 Paralympic Winter Games Sample selection: convenience Injury record: Polyclinic datasets and WEB-IISS	n* = 567 Sex: both sex Average age: 32.1 (SD 10.3) years	Sport: para alpine skiing, para snowboard, para Nordic skiing (combining para cross-country skiing and para biathlon), para ice hockey and wheelchair curling Mean practice duration: not reported	Limb deficiency (amputation, dysmelia and congenital deformity), spinal cord injury, visual impairment, central neurologic injury (cerebral palsy, traumatic brain injury, stroke and other neurological impairments), *Les autres*, unknown	Injury was defined as 'any newly acquired injury as well as exacerbations of pre-existing injury that occurred during training and/or competition in the games period of the Pyeongchang 2018 Paralympic Winter Games'	Overall: 12 Pre-competition: 3 Competition: 9	Overall: 142 Pre-competition: 33 Competition: 109	Overall: 19.8% (112**) Pre-competition: 5.5% (31**) Competition: 16.8% (95**)	Overall: 20.9 (95% CI, 17.4–25.0) injuries per 1000 athlete-days Pre-competition period: 19.4 (95% CI, 13.6–27.6) injuries per 1000 athlete-days Competition: 21.4 (95% CI, 17.4–26.3) injuries per 1000 athlete-days
Fagher *et al*., 2019[41] Location:	n* = 45 Sex: both sex Average age:	Sport: judo Mean practice duration: not	Visual impairment	Sports injury was defined and questioned to the	365	70	84% (38**)	4.3 (95% CI, 3.3–5.3) injuries per 1000 athlete-days[a]

United Kingdom Sample selection: convenience Injury record: Bachelor student	from 18 years	reported		athletes as: 'Have you had any new musculoskeletal pain, feeling or injury during the past year that caused changes in normal training or competition to the mode, duration, intensity, or frequency, regardless of whether or not time is lost from training or competition?'				
Ferrara *et al.*, 1992[42] Location: USA Sample selection: convenience Injury record: investigator	n* = 426 Sex: both sex Average age: 25.6 years	Sport: track, field, weightlifting, swimming and others Mean practice duration: 5.8 years	Not reported	The definition of injury was 'any trauma to the participant that occurred during any practice training, or competition session that caused the athlete stop, limit, or modify participation for 1 d or more'	180	388	32% (137**)	5.1 (95% CI, 4.5–5.7) injuries per 1000 athlete-days[a]
Ferrara *et al.*, 1994[43] Location: USA Sample selection: convenience Injury record:	n* = 217 Sex: both sex Average age: 24.2 (SD 7.8) years	Sport: track, field, weightlifting, soccer, cycling, wheelchair team handball, boccia, slalom, equestrian,	Cerebral palsy	The definition of injury was 'any trauma to the body that occurred during a practice, training, or competition session that caused	180	144	25% (54**)	3.7 (95% CI, 3.1–4.3) injuries per 1000 athlete-days[a]

investigator		bowling and cross-country Mean practice duration: 6.2 (4.1) years		the athlete to stop, limit, or modify participation in sports for 1 or more days'				
Gajardo *et al*., 2019[44] Location: Southern Championship of the National Goalball League of Chile 2017. Sample selection: convenience Injury record: Kinesiology students	n* = 39 Sex: both sex Average age: 41 (SD 14.9) years	Sport: goalball Mean practice duration: not reported	Visual impairment	Physical injury or ailment was defined as 'any musculoskeletal or neurological ailment related to sport and generating alterations in training / competition'	28	25	64% (25**)	22.9 (95% CI, 13.9–31.9) injuries per 1000 athlete-days[a]
Gawroński *et al.,* 2013[45] Location: Beijing 2008 and London 2012 Sample selection: convenience Injury record: two team physicians	n* = 91 in Beijing and 100 in London Sex: both sex Average age: 32 (SD 11) years in Beijing and 32 (SD 10) years in London	Sport: equestrian, cycling, athletics, archery, swimming, powerlifting, shooting, wheelchair basketball, wheelchair fencing, wheelchair tennis, table tennis, rowing Mean practice	Amputation, spinal cord injury, *Les autres*, cerebral palsy, visual impairment, intellectual disability	Injury was defined as 'a newly acquired musculoskeletal symptom or an exacerbation of a pre-existing (chronic) injury that occurred during training and/or competition'	Beijing: 21 days London: 16 days	Beijing: 57 London: 24	Beijing: 37.4% (34**) London: 16% (16**)	Beijing: 29.8 (95% CI, 22.1– 37.6) injuries per 1000 athlete-days London: 15 (95% CI, 9.0–21.0) injuries per 1000 athlete-days

		duration: not reported						
Kubosch *et al.*, 2017[23] Location: Germany Sample selection: convenience Injury record: OSTRC questionnaire	n* = 24 Sex: both sex Average age: 36.5 (SD 9.7) years	Sport: paracycling Mean practice duration: not reported	Paraplegia, extremity disability, Injury Cerebral Palsy/skull injury, visual impairment and pilot	Acute injury was defined as 'any musculoskeletal complaint caused by previous acute trauma' and overload injuries were defined as 'musculoskeletal complaints that resulted in acute trauma or exacerbation of existing complaints, and persisted for days, weeks, or months without connection to a relevant event'	168	27	14% (3**)	6.7 (95% CI, 4.2–9.2) injuries per 1000 athlete-days[a]
Marqueta *et al.*, 2005[24] Location: Netherlands Sample selection: convenience Injury record: not reported	n* = 34 Sex: both sex Average age: 26.6 (range from 15 to 41) years	Sport: athletics Mean practice duration: not reported	Visual impairment, cerebral palsy, amputation, upper limb atrophy, brachial paralysis, superior limb agenesis, tetraplegia, paraplegia and Charcot-Marie-Tooth disease	Injury was defined as 'any circumstance that affecting the musculoskeletal system has motivated a consultation medical and / or assistance by both the doctor as by the physiotherapists of the selection'	10	50	70.5% (24**)	147.1 (95% CI, 106.3–187.8) injuries per 1000 athlete-days[a]
McCormick *et al.*, 1990[25]	n* = 777 Sex: both sex	Sport: soccer, equestrian, track /	Intellectual impairment	A sports injury was defined as 'an injury	3	4	3.5% (27**)	1.7 (95% CI, 0–3.4) injuries per 1000

Location: USA Sample selection: convenience Injury record: Paediatrician, paediatric resident trainee, or registered nurse	Average age: not reported	field, swimming / diving, gymnastics Mean practice duration: not reported		resulting directly from participation in a sports event'				athlete-days[a]
Ona Ayala *et al.*, 2019[26] Location: Rio 2016 Paralympic Games Sample selection: convenience Games Injury record: WEB-IISS	n* = 180 Sex: both sex Average age: range from 12 to 75 years	Sport: powerlifting Mean practice duration: not reported	Not reported	Injury was defined as 'any newly acquired injury as well as exacerbations of preexisting injury that occurred during training and/or competition of the 3-day pre-competition and 7-day competition period at the Rio 2016 Paralympic Games'	10	22	78% (141**)	15.6 (95% CI, 9.61–21.59) injuries per 1000 athlete-days
Taylor *et al.*, 1995[27] Location: England Sample selection: convenience Injury record: self-reported	n* = 53 Sex: both sex Average age: 59% of athletes were aged from 25 to 39 years	Sport: wheelchair race Mean practice duration: 3 years (interquartile range of 1-5.75)	The most commonly were spinal cord injuries and spina bifida	An injury was defined as 'pain in any part of the body that affected or prevented the athlete from training or competing for at least 1 day'	365	44	72% (38**)	2.3 (95% CI, 1.6–2.9) injuries per 1000 athlete-days[a]
Willick *et al.*,	n* = 163	Sport:	Not reported	Injury was defined as	7	38	23.3%	3.3 (95% CI, 24.0–42.6)

2016[28] Location: London 2012 Paralympic Games Sample selection: convenience Injury record: LOCOG and WEB-IISS	Sex: both sex Average age: range from 13 to 67 years	powerlifting Mean practice duration: not reported		'any newly acquired injury as well as exacerbations of preexisting injury that occurred during training and/or competition of the 14-day pre-competition and competition period of the London 2012 Paralympic Games'			(38**)	injuries per 1000 athlete-days
Webborn *et al.*, 2006[29] Location: 2002 Salt Lake Winter Paralympic Games Sample selection: convenience Injury record: authors of the study, team physicians and other medical personnel	n* = 416 Sex: both sex Average age: 33 (range from 17 to 58) years	Sport: alpine skiing, nordic skiing and sledge hockey Mean practice duration: not reported	Not reported	The authors considered important to describe all sport-related conditions that might conceivably medical personnel affect the performance or functional capacity of the winter Paralympic athlete	20	39	9% (39**)	4.7 (95% CI, 3.2–6.2) injuries per 1000 athlete-days[a]
Willick *et al.*, 2013[30] Location: London 2012 Paralympic	n* = 3565 Sex: both sex Average age: 30 (range from 13 to 67) years	Sport: football 5-a-side, powerlifting, goalball, wheelchair	Not reported	Injury was defined as 'any sport-related musculoskeletal or neurological complaint prompting	Overall: 14 Pre-competition: 3 Competitio	Overall: 633 Pre-competition: 158	15.1% (539**)	Overall: 12.7 (95% CI 11.7–13.7) injuries per 1000 athlete-days Pre-competition: 14.8 (95% CI, 12.6–17.3)

Games Sample selection: convenience Injury record: London Organizing Committee of the Olympic and Paralympic Games (LOCOG) and own teams medical staff, utilizing a web-based injury and illness surveillance system (WEB-IISS)		fencing, wheelchair rugby, athletics, judo, wheelchair tennis, table tennis, wheelchair basketball, football 7-a-side, seated volleyball, cycling track, equestrian, swimming, archery, boccia, cycling road, sailing, rowing, shooting Mean practice duration: not reported		an athlete to seek medical attention, regardless of whether or not the complaint resulted in lost time from training or competition'	n: 11	Competitio n: 475		injuries per 1000 athlete-days Competition:12.1 (95% CI, 11.0–13.3) injuries per 1000 athlete-days
Fagher *et al*., 2020[31] Location: Sweden Sample selection: convenience Injury record: an eHealth based self-report application adapted to Paralympic	n* = 107 Sex: both sex Average age: range from 18 to 63 years	Sport: cycling, para athletics, para cross-country skiing, triathlon, canoe, goalball, judo, para alpine skiing, para ice hockey, para swimming, table tennis, wheelchair basketball, wheelchair rugby,	Physical, visual and intellectual impairments, central neurological impairment, *les autres*, limb deficiency, spinal cord injury	Sports-related injuries and illnesses in Paralympic sport (SRIIPS) were defined as 'any new musculoskeletal pain, feeling, injury, illness or psychological complaint that caused changes in normal training or competition to the	365	179	68% (73**)	6.9 (95% CI, 6.0–8.0) per 1000 hours[c]

athletes		wheelchair tennis, boccia, equestrian, sailing, shooting para sport, wheelchair curling. Mean practice duration: 5.8 years		mode, duration, intensity, or frequency, regardless of whether or not time was lost from training or competition'				
Haykowsky *et al.*, 1999[32] Location: Canada Sample selection: convenience Injury record: not reported	n* = 11 Sex: both sex Average age: from 22 to 75 years	Sport: powerlifting Mean practice duration: 5 (range: 0.25-11) years	Visual impairment	Injury was considered as powerlifting-related injuries that required medical intervention (from a physician, chiropractor, or physical therapist) and that resulted in an interruption in training for more than one day	365	Not reported	36% (4**)	0.1 injuries per 100 hours of training[b]
Lankhorst *et al.*, 2019[34] Location: Netherlands Sample selection: convenience Injury record: Questionnaire based on recommendation	n* = 103 Group 0 (no participation in organized sport at all): 18 Group 1 (sports participation at sport club one time per week): 21 Group 2 (sports	Sport: not reported Mean practice duration: not reported	Cardiovascular, pulmonary, musculoskeletal, metabolic or neuromuscular disorders according to the classification of the American College of Sports Medicine	Injury was defined as 'any new musculoskeletal pain, feeling or injury which results from participation in recreational physical activity or sports and causes changes in physical activities including sports	360 (Cumulative hours of physical activity during 1 year per group – group 0: 10,674; group 2:	86 Group 0: 9 Group 1: 17 Group 2: 60	46% (47**)	Group 0: 0.84 (95% CI, 0.38–1.6) per 1000 h of physical activity[c] Group 1: 1.88 (95% CI, 1.1–3.1) per 1000 h of physical activity[c] Group 2: 1.33 (95% CI, 1.0–1.7) per 1000 h of physical activity[c]

s of the Dutch Ministry of Health, Welfare and Sport (VWS) and designed in an online web-based tool	participation at sport club two or more times per week): 64 Sex: both sex Average age: 14.4 (SD 2.7) years			activities, regardless of whether or not time is lost from physical activity, sports training or competition'	9,019; group 2: 44,937)			
Magno e Silva *et al.*, 2013[35] Location: Brazil Sample selection: convenience Injury record: multidisciplinary Brazilian medical team	n* = 28 Paralympic Games 2004: 3 athletes Pan American Games 2005: 23 athletes IBSA World Championships 2007: 14 athletes Pan American Games 2007: 13 athletes Beijing 2008: 3 athletes Sex: both sex Average age: 36.5 (SD 9.7) years	Sport: swimming Mean practice duration: not reported	Visual impairment	A reportable injury was defined as 'any injury that caused an athlete to stop, limit, or modify participation for 1 or more days'	Paralympic Games 2004: 12[a] Pan American Games 2005: 20[a] IBSA World Championships 2007: 13[a] Pan American Games 2007: 17[a] Beijing 2008: 12[a]	Overall: 41 Paralympic Games 2004: 4 injuries American Games 2005: 7 injuries IBSA World Championships 2007: 22 injuries Pan American Games 2007: 6 injuries Beijing 2008: 2 injuries	Overall: 64% (18**) Paralympic Games 2004: 100% (3**) Pan-American Games 2005: 35% (8**) World Championship International Blind Sports Federation 2007: 79% (11*) Para Pan-American Games 2007: 38%	Overall: 0.3 injuries per athlete per competition Paralympic Games: 111.1 (95% CI, 2.2–220.0) injuries per 1000 athlete-days[a] Pan American Games 2005: 15.2 (95% CI, 3.9–26.5) injuries per 1000 athlete-days[a] IBSA World Championships 2007: 120.9 (95% CI, 70.4–171.4) injuries per 1000 athlete-days[a] Pan American Games 2007: 27.2 (95% CI, 4.4–48.9) injuries per 1000 athlete-days[a] Beijing 2008: 55.6 (95% CI, 0–132.6) injuries per 1000 athlete-days[a]

							(5**) Paralympic Games 2008: 33% (1**)	
Magno e Silva *et al.*, 2013[36] Location: Brazil Sample selection: convenience Injury record: multidisciplinary Brazilian medical team	n* = 13 Paralympic Games 2004: 8 athletes Pan American Games 2005: 8 athletes IBSA World Championships 2007: 8 athletes Pan American Games 2007: 8 athletes Beijing 2008: 8 athletes Sex: male Average age: 36.5 (SD 9.7) years	Sport: football 5-a-side Mean practice duration: not reported	Visual impairment	A reportable injury was defined as 'any injury that caused an athlete to stop, limit or modify participation for one or more days'	Paralympic Games 2004: 12[a] Pan American Games 2005: 20[a] IBSA World Championships 2007: 13[a] Pan American Games 2007: 17[a] Beijing 2008: 12[a]	Overall: 35 Paralympic Games 2004: 12 injuries American Games 2005: 6 injuries IBSA World Championships 2007: 7 injuries Pan American Games 2007: 3 injuries Beijing 2008: 7 injuries	Overall: 84.6% (11**) Paralympic Games 2004: 87.5% (7**) IBSA Para Pan-American Games 2005: 62.5% (5**) IBSA World Championship 2007: 62.5% (5**) Para-Panamerican Games 2007: 37.5% (3**) Paralympic	Overall: 0.1 injuries per match Paralympic Games 2004: 125.0 (95% CI, 54.3–195.7) injuries per 1000 athlete-days[a] Pan American Games 2005: 37.5 (95% CI, 7.5–67.5) injuries per 1000 athlete-days[a] IBSA World Championships 2007: 67.3 (95% CI, 17.5–117.2) injuries per 1000 athlete-days[a] Pan American Games 2007: 22.1 (95% CI, 0–47.0) injuries per 1000 athlete-days[a] Beijing 2008: 72.9 (95% CI, 18.9–126.9) injuries per 1000 athlete-days[a]

							Games 2008: 50.0% (4**)	
Magno e Silva *et al*., 2013[37] Location: Brazil Sample selection: convenience Injury record: multidisciplinary Brazilian medical team	n* = 40 Paralympic Games 2004: 11 athletes Pan American Games 2005: 28 athletes IBSA World Championships 2007: 28 athletes Pan American Games 2007: 19 athletes Beijing 2008: 22 athletes Sex: both sex Average age: 36.5 (SD 9.7) years	Sport: athletics Mean practice duration: not reported	Visual impairment	A reportable injury was defined as 'any injury that caused an athlete to stop, limit, or modify participation for 1 ≥ d'	Paralympic Games 2004: 12[a] Pan American Games 2005: 20[a] IBSA World Championships 2007: 13[a] Pan American Games 2007: 17[a] Beijing 2008: 12[a]	Overall: 77 Paralympic Games 2004: 11 injuries American Games 2005: 16 injuries IBSA World Championships 2007: 28 injuries Pan American Games 2007: 11 injuries Beijing 2008: 11 injuries	Overall: 78% (31**) Paralympic Games 2004: 82% (9**) IBSA Para Pan-American Games 2005: 46% (13**) IBSA World Championship 2007: 61% (17**) Para Pan-American Games 2007: 47% (9**) Paralympic Games 2008: 36% (8**)	Average incidence rate of 0.4 injuries per athlete per competition Paralympic Games 2004: 83.3 (95% CI, 34.1–132.6) injuries per 1000 athlete-days[a] Pan American Games 2005: 111.1 (95% CI, 2.2–220.0) injuries per 1000 athlete-days[a] IBSA World Championships 2007: 76.9 (95% CI, 48.4–105.4) injuries per 1000 athlete-days[a] Pan American Games 2007: 34.1 (95% CI, 13.9–54.2) injuries per 1000 athlete-days[a] Beijing 2008: 41.7 (95% CI, 17.0–66.3) injuries per 1000 athlete-days[a]
Saffarian *et al*., 2019[38] Location: 2013	n* = 409 Sex: both sex Average age:	Sport: archery, badminton, basketball,	Dwarfism	An injury or illness was described as 'any symptom that	8	24	5.9% (24**)	0.78 injury per 100 athlete-competitions

World Dwarf Games (USA) Sample selection: convenience Injury record: Physician or athletic training staff	Futures (6 years and younger), Junior A (7–11 years old), Junior B (12–15 years old), Open (any age), and Masters (35 and older)	boccia, floor hockey, kurling, powerlifting, shooting, soccer, swimming, table tennis, track and field, and volleyball Mean practice duration: not reported		an athlete was experiencing that led them to seek medical consultation from either an athletic trainer or a physician present at the games'				
Studies reporting only on prevalence (n = 7)								
Bernardi *et al*., 2003[46] Location: Italy Sample selection: randomly Injury record: Sports physicians	n* = 227 Sex: both sex Average age: range from 12 to 64 years	Sport: wheelchair tennis, fencing, athletics, swimming, wheelchair basketball and others Mean practice duration: not reported	Spinal cord injury, amputation, cerebral palsy and *Les autres* (disorders resulting in locomotor disabilities that did not fit into the previously mentioned categories)	'Sport-related muscle pain' was defined as any muscle pain experienced during the past 12 months that occurred during sport activity (training or competition) and/or was reported as a consequence of physical exercise, causing discomfort for at least 1 d and not being related to systemic disease	365	Not reported	50.7% (115**)	Not reported
Curtis *et al.*, 1999[47] Location: USA Sample selection: convenience	n* = 46 Sex: female Average age: 33.2 (SD 9.1) years	Sport: wheelchair basketball Mean practice duration: not reported	Spinal cord injury, lower extremity musculoskeletal and neuromuscular disabilities, post-polio, spina bifida	Wheelchair User's Shoulder Pain Index (WUSPI) was used to measure shoulder pain	Not reported	Not reported	72% (33**) of the subjects reported shoulder pain since	Not reported

Injury record: assistants			and amputation				wheelchair use and 89.1% (41**) of the subjects reported upper extremity pain since beginning wheelchair use	
Fagher *et al*., 2020[48] Location: Sweden Sample selection: convenience Injury record: Sports physiotherapists	n* = 104 Sex: both sex Average age: 29 (Interquartile range 23-36) years	Sport: cycling, para athletics, para cross-country skiing, triathlon, canoe, goalball, judo, para alpine skiing, para ice hockey, para swimming, table tennis, wheelchair basketball, wheelchair rugby, wheelchair tennis, boccia, equestrian, sailing, shooting para sport, wheelchair curling. Mean practice	Limb deficiency (amputation, dysmelia, congenital deformity), spinal cord injury, *Les autres*, central neurological injury (cerebral palsy, traumatic brain injury, stroke, other neurological), intellectual impairment, visual impairment, wheelchair athletes	The definition of current sports-related injuries and illnesses in Paralympic sport (SRIIPS) was: 'any new musculoskeletal pain, feeling, injury, illness or psychological complaint that caused changes in normal training or competition to the mode, duration, intensity, or frequency, regardless of whether or not time is lost from training or competition'	365	Not reported	31% (32**)	Not reported

		duration: 10 (Interquartile range 5-16) years						
Patatoukas *et al*., 2011[49] Location: 2000 Panhellenic Championship for Athletes with Disabilities (Greece) Sample selection: convenience Injury record: not reported	n* = 139 Sex: both sex Average age: 32.8 (SD 8.6) years	Sport: wheelchair basketball, standing track & field, swimming, wheelchair field, gym, wheelchair track, powerlifting, wheelchair dancing, shooting Mean practice duration: 7.2 (SD 5) years	Spinal cord injury, poliomyelitis, cerebral palsy, acquired brain injury, amputation, other disabilities (arthrogryposis, dysmelias, dwarfism, etc) and *Les Autres*	Athletic injury was defined as 'any injury that caused an athlete to stop, limit or modify participation for 1 day or more'	Not reported	178	49.6% (69**)	Not reported
Shimizu et al., 2017[50] Location: 2014 Asian Para Games (Japan) Sample selection: convenience Injury record: two physicians	n* = 22 Sex: female Average age: 29.1 (SD 8) years	Sport: wheelchair basketball Mean practice duration: 8.6 (SD 5.8) years	Central nervous system disorders (spinal cord injurys, spina bifida, cerebral palsy) and skeletal system disorders (transtibial amputation, hip disorder, knee disorder and ankle disorder)	Deep tissue injury (DTI) was defined as 'a purple or maroon localized area of discolored intact skin or a blood-filled blister due to damage to the underlying soft tissue from pressure and/or shear forces'	Not reported	23	68.2% (15**)	Not reported
Tenforde *et al.*, 2019[51] Location: USA Sample selection:	n* = 260 Sex: both sex Average age: 31.7 (SD 11.5) years	Sport: not reported Mean practice duration: not reported	Spinal cord injury, lower limb amputee, neurological injury, visual impairment, cerebral palsy,	Bone stress injury was defined as 'either stress reaction or stress fracture'	Not reported	Not reported	50% (130**)	Not reported

convenience Injury record: authors of the study			others, upper limb amputee, musculoskeletal disorder, arthrogryposis					
Zwierzchowska *et al.*, 2020[52] Location: Goalball European Championship Sample selection: convenience Injury record: authors assisted by a coach and team interpreter	n* = 43 Sex: both sex Average age: 26 years	Sport: goalball Mean practice duration: 6 years	Visual impairment	Sports injury was defined as "damage to body tissue resulting from practicing a sport or exercise" and the authors also used the time of absence from training and competitions as a criterion for classification of injury	9	Not reported	44% (19**)	Not reported
Studies reporting only on incidence rates (n = 10)								
Blauwet *et al.*, 2016[3] Location: London 2012 Paralympic Games Sample selection: convenience Injury record: London Organizing Committee of the Olympic and	n* = 977 Sex: both sex Average age: from 13 years	Sport: athletics Mean practice duration: not reported	Amputation, visual impairment, cerebral palsy, short stature and other disorders	Injury was defined as any newly acquired injury as well as exacerbations of preexisting injury that occurred during training and/or competition of the 14 day pre-competition and competition period of the London 2012 Paralympic Games	10	216	Not reported	22.1 (95% CI, 19.5–24.7) injuries per 1000 athlete-days

Paralympic Games (LOCOG) and own teams medical staff, utilizing a web-based injury and illness surveillance system (WEB-IISS)								
Ferrara *et al*., 1992[53] Location: USA Sample selection: convenience Injury record: self-reported	n* = 68 Sex: both sex Average age: 29.6 (SD 9.5) years	Sport: skiing Mean practice duration: 6.7 (SD 4.5) years	Leg and arm amputation, spinal cord injury, visual impairment, spina bifida, multiple sclerosis, muscular dystrophy and undescribed impairments	The definition of injury was 'any trauma to the participant that occurred during any practice training, or competition session that resulted in the cessation, limitation, or modification of the athlete's participation in the sport for at least 24 hours'	182	100	Not reported	8.1 (95% CI, 6.5–9.7) injuries per 1000 athlete-days[a]
Ferrara *et al*, 2000[54] Location: 1990 World Games and Championship (WC) in Assen, Holland, 1991	n* = 1360 (overall) WC: 220 athletes PT: 345 athletes PGI: 360 athletes AC: 55 athletes	Sport: multi sports events ranged from 14 to 21 different sports Mean practice duration: not reported	Not reported	A reportable injury was defined as 'an injury/illness that was evaluated by the US Medical Staff during these competitions'	WC: 13[a] PT: 12[a] PGI: 24[a] AC: 7[a] PGII: 14[a]	Overall: 1037 WC: 52 PT: 170 PGI: 387 AC: 22 PGII: 406	Not reported	WC: 18.2 (95% CI, 13.2–23.1) injuries per 1000 athlete-days[a] PT: 41.1 (95% CI, 34.9–47.2) injuries per 1000 athlete-days[a] PGI: 44.8 (95% CI, 40.3–49.3) injuries per

US Paralympic Trials (PT) in Hempstead, New York, 1992 Paralympic Games (PGI) in Barcelona, Spain, 1994 World Athletics Championships (AC) in Berlin, Germany, and 1996 Paralympic Games (PGII) in Atlanta, USA Sample selection: convenience Injury record: medical staff	PGII: 380 athletes Sex: both sex Average age: not reported							1000 athlete-days[a] AC: 57.1 (95% CI, 33.3–81.0) injuries per 1000 athlete-days[a] PGII: 76.3 (95% CI, 68.9–83.7) injuries per 1000 athlete-days[a]
Hollander *et al*., 2019[55] Location: Wheelchair Basketball World Championships 2018 in Germany Sample selection: convenience	n* = 132 Sex: both sex Average age: 29.7 (SD 6.1) years	Sport: wheelchair basketball Mean practice duration: not reported	Spinal cord injury	Injury was defined as 'any newly incurred musculoskeletal complaint (traumatic or overuse) and/or concussion during the tournament receiving medical attention regardless of the consequences for participation'	11	100	Not reported	68.9 (95% CI, 55.4–82.4) injuries per 1000 athlete-days

Injury record: IOC injury surveillance system for multi-sports events								
Nyland *et al.*, 2000[56] Location: 1996 Paralympic Games (USA) Sample selection: convenience Injury record: United States Olympic Committee (USOC)	n* = 304 Sex: both sex Average age: not reported	Sport: athletics, wheelchair basketball, cycling, equestrian, fencing, boccie, goalball, judo, quad rugby, lawn bowling, powerlifting, soccer, swimming, table tennis, tennis, sitting volleyball, standing volleyball Mean practice duration: not reported	Physical disabilities, visual impairment, cerebral palsy, stroke, acquired or congenital motor dysfunction and spinal cord injury	Soft tissue injuries were operationally defined as strain, sprain, tendonitis, bursitis, or contusion	10	254	Not reported	83.6 (95% CI, 73.3–93.8) injuries per 1000 athlete-days[a]
Webborn *et al.*, 2012[57] Location: 2010 Vancouver Paralympic Games Sample selection:	n* = 505 Sex: both sex Average age: not reported	Sport: alpine skiing, nordic skiing (include biathlon), ice sledge hockey and wheelchair curling Mean practice	Not reported	Injury was defined as ‘any sports-related musculoskeletal complaint that caused the athlete to seek medical attention during the study period,	17	106 injuries (actual injuries reported as 120 but need to remove 14 as states	Not reported	12.4 (95% CI, 10.0–14.7) injuries per 1000 athlete-days[a]

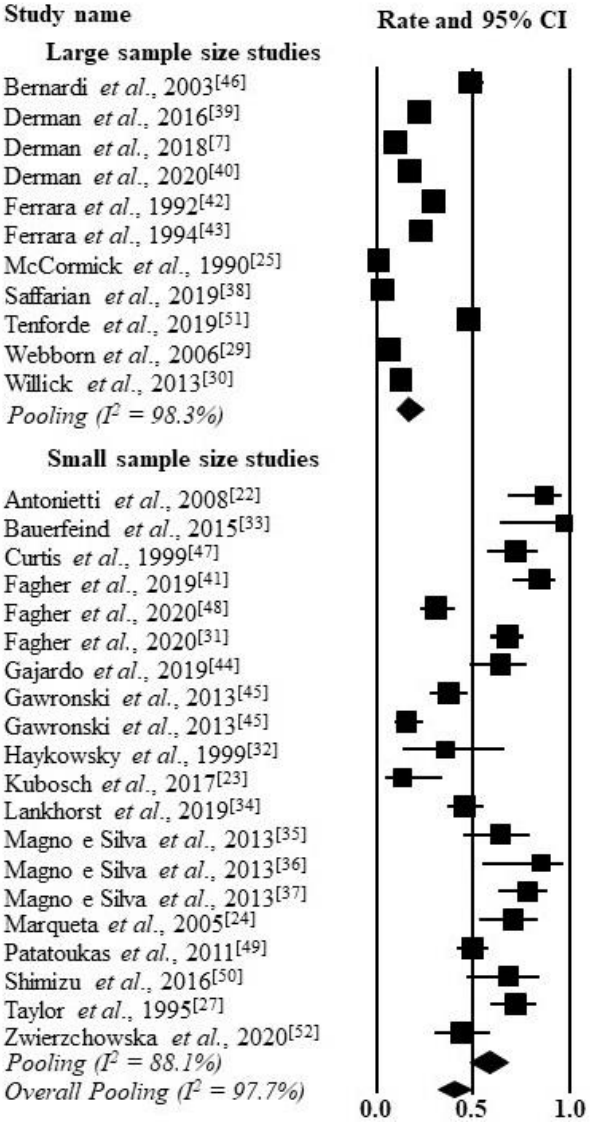
convenience Injury record: staff at the Polyclinics and venue medical		duration: not reported		regardless of the athlete's ability to continue with training or competition'		were not sports related)		
Webborn *et al*., 2016[58] Location: London 2012 Paralympic Games Sample selection: convenience Injury record: LOCOG and WEB-IISS	n* = 70 in Football 5-a-side and 96 in Football 7-a-side Sex: male Average age: not reported	Sport: football 5-a-side and football 7-a-side Mean practice duration: not reported	Visual impairment and central neurologic injury (cerebral palsy and traumatic brain injury)	Injury was defined as 'any newly acquired injury, as well as exacerbations of pre-existing injury that occurred during training and / or competition of the 14-day pre-competition and competition period of the London 2012 Paralympic Games'	14	Football 7-a-side: 22 Football 7-a-side: 14	Not reported	Football 5-a-side: 22.4 (95% CI, 14.1–33.8) injuries per 1000 athlete-days Football 7-a-side: 10.4 (95% CI, 5.4–15.5) injuries per 1000 athlete-days
Chung *et al.*, 2012[59] Location: China Sample selection: convenience Injury record: Physiotherapists	n* = 14 Sex: both sex Average age: 28.6 (SD 6.8) years	Sport: wheelchair foil fencers Mean practice duration: 10.1 (SD 5.3) years	Not reported	Injury was defined as trauma that occurred during a training / competition and prevented the athlete from continuing fencing activity for at least 1 day	24664 hours[b]	95	Not reported	3.9 per 1000 athlete hours (95% CI, 3.1–4.7)[c]
Ramirez *et al.*, 2009[60] Location: USA Sample selection:	n* = 210 Sex: both sex Average age: 18 (range from 10 to 23) years	Sport: adapted basketball, field hockey, soccer and softball Mean practice	Autism, emotional disturbance, learning disability, mental retardation orthopedic disability,	Injury episodes were defined as 'events resulting in immediate removal of the athlete from	19012 hours[a,b]	38	Not reported	2.0 injuries per 1000 athlete hours (95% CI, 1.4–2.6)[a,c]

convenience Injury record: study data collectors		duration: not reported	sensory disability, multiple disability, other health impairment	the session and medical treatment by school staff or transport to a hospital'. Injury diagnoses were defined as 'the physical trauma sustained to the body region of an athlete during the injury event'				
Ferrara *et al.*, 1996[61] Location: USA Sample selection: convenience Injury record: Athletes With Disabilities Injury Registry (ADIR) staff	n* = 319 Sex: both sex Average age: 31.6 (SD 9.3) years	Sport: not reported Mean practice duration: 7.8 (SD 6.5) years	Not reported	An injury was defined when 'a scheduled practice or competition was modified, missed, or interrupted due to an injury, illness, or pain for 1 day or more'	From April 1990 until September 1992	102	Not reported	9.4 injuries per 1000 athlete-exposures

CI: confidence interval
SD: standard deviation
n*: sample size
**Corresponds to the absolute prevalence of injury in para athletes
[a] Deduced or calculated from the study
[b] Exposure in hours
[c] Incidence Rate per 1000 h exposure

Supplementary material 3

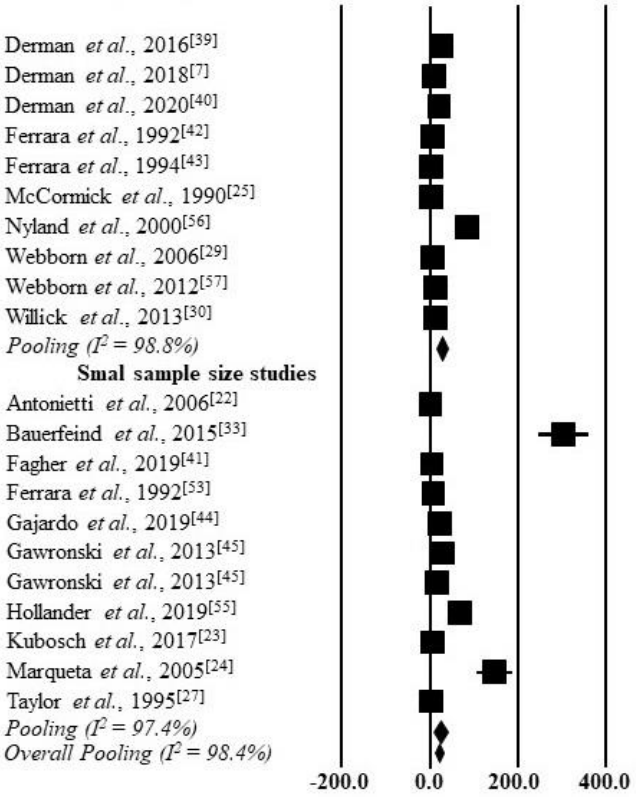
Meta-analysis for overall injuries prevalence in para athletes and subgroup analysis for studies with large and small sample size



Study name	Rate	Lower limit	Upper limit	Events / Total
Large sample size studies				
Bernardi *et al.*, 2003[46]	0.5	0.4	0.6	115 / 227
Derman *et al.*, 2016[39]	0.2	0.2	0.3	134 / 547
Derman *et al.*, 2018[7]	0.1	0.1	0.1	442 / 3657
Derman *et al.*, 2020[40]	0.2	0.2	0.2	112 / 567
Ferrara *et al.*, 1992[42]	0.3	0.3	0.4	136 / 426
Ferrara *et al.*, 1994[43]	0.2	0.2	0.3	54 / 217
McCormick *et al.*, 1990[25]	0.1	0.1	0.1	27 / 777
Saffarian *et al.*, 2019[38]	0.1	0.1	0.1	24 / 409
Tenforde *et al.*, 2019[51]	0.5	0.4	0.6	130 / 260
Webborn *et al.*, 2006[29]	0.1	0.1	0.1	37 / 416
Willick *et al.*, 2013[30]	0.1	0.1	0.2	538 / 3565
Pooling (I^2 = 98.3%)	0.2	0.1	0.3	1,749 / 11,068
Small sample size studies				
Antonietti *et al.*, 2008[22]	0.9	0.7	1.0	23 / 27
Bauerfeind *et al.*, 2015[33]	1.0	0.6	1.0	14 / 14
Curtis *et al.*, 1999[47]	0.7	0.6	0.8	33 / 46
Fagher *et al.*, 2019[41]	0.8	0.7	0.9	38 / 45
Fagher *et al.*, 2020[48]	0.3	0.2	0.4	32 / 104
Fagher *et al.*, 2020[31]	0.7	0.6	0.8	73 / 107
Gajardo *et al.*, 2019[44]	0.6	0.5	0.8	25 / 39
Gawronski *et al.*, 2013[45]	0.4	0.3	0.5	34 / 91
Gawronski *et al.*, 2013[45]	0.2	0.1	0.2	16 / 100
Haykowsky *et al.*, 1999[32]	0.4	0.1	0.7	4 / 11
Kubosch *et al.*, 2017[23]	0.1	0.1	0.3	3 / 24
Lankhorst *et al.*, 2019[34]	0.5	0.4	0.6	47 / 103
Magno e Silva *et al.*, 2013[35]	0.6	0.4	0.8	18 / 28
Magno e Silva *et al.*, 2013[36]	0.8	0.5	1.0	11 / 13
Magno e Silva *et al.*, 2013[37]	0.8	0.6	0.9	31 / 40
Marqueta *et al.*, 2005[24]	0.7	0.5	0.8	24 / 34
Patatoukas *et al.*, 2011[49]	0.5	0.4	0.6	69 / 139
Shimizu *et al.*, 2016[50]	0.7	0.5	0.8	15 / 22
Taylor *et al.*, 1995[27]	0.7	0.6	0.8	38 / 53
Zwierzchowska *et al.*, 2020[52]	0.4	0.3	0.6	19 / 43
Pooling (I^2 = 88.1%)	0.6	0.5	0.7	567 / 1,083
Overall Pooling (I^2 = 97.7%)	0.4	0.3	0.5	2,316 / 12,151

Supplementary material 4

Meta-analysis for overall injuries incidence rate in para athletes and subgroup analysis for studies with large and small sample size



Rate	Lower limit	Upper limit	Number of injuries	Person-time at risk
26.5	22.6	30.4	174	7
10.0	9.1	10.8	510	51
20.9	17.4	24.3	142	7
5.1	4.6	5.6	388	77
3.7	3.1	4.3	144	39
1.0	0.0	3.4	4	2
83.6	73.3	93.8	254	3
4.7	3.2	6.2	39	8
12.3	10.0	14.7	106	9
12.7	11.7	13.7	633	50
14.4	11.1	17.7	2394	252
1.8	1.0	2.7	18	10
302.9	245.2	360.5	106	0
4.3	3.3	5.3	70	16
8.1	6.5	9.7	100	12
22.9	13.9	31.9	25	1
29.8	22.1	37.6	57	2
15.0	9.0	21.0	24	2
68.9	55.4	82.4	100	1
6.7	4.2	9.2	27	4
147.1	106.3	187.8	50	0
2.3	1.6	2.9	44	19
14.7	11.1	18.5	621	69
14.3	11.9	16.8	3015	321

Supplementary material 5

Studies that reported injury profile in para athletes

		Studies
Most affected body location	**Shoulder**	Antonietti *et al*., 2008[22], Bauerfeind *et al*., 2015[33], Bernardi *et al*., 2003[46], Chung *et al*., 2012[59], Curtis *et al*., 1999[47], Derman *et al*., 2016[39], Derman *et al*., 2018[7], Derman *et al*., 2020[40], Fagher *et al.*, 2019[41], Fagher *et al*., 2020[31], Fagher *et al.*, 2020[48], Ferrara *et al*., 1992[42], Gajardo *et al*., 2019[44], Haykowsky *et al*., 1999[32], Kubosch *et al*., 2017[23], Ona Ayala *et al*., 2019[26], Willick *et al*., 2013[30], Willick *et al*., 2016[28]
	Upper limbs	Ferrara *et al*., 1992[53], Ferrara *et al*., 1996[61], Taylor *et al*., 1995[27], Zwierzchowska *et al*., 2020[52]
	Lower Limbs	Ferrara *et al*., 1994[43], Lankhorst *et al*., 2019[34], Magno e Silva *et al*., 2013[37], Magno e Silva *et al*., 2013[36], Marqueta *et al*., 2005[24], Ramirez *et al.*, 2009[60], Saffarian *et al*., 2019[38], Tenforde *et al*., 2019[51], Webborn *et al*., 2016[29]
	Trunk	Ferrara *et al.*, 2000[54], Magno e Silva *et al*., 2013[35], Hollander *et al.*, 2019[55]
Type of injury	**Soft tissue injury**	Bauerfeind *et al*., 2015[33], Bernardi *et al*., 2003[46], Blauwet *et al*., 2016[3], Chung *et al*., 2012[59], Fagher *et al.*, 2019[41], Fagher *et al.*, 2020[31], Ferrara *et al*., 1996[61], Ferrara *et al.*, 2000[54], Gawroński *et al.*, 2013[45], Hollander *et al.*, 2019[55], Lankhorst *et al*., 2019[34], Magno e Silva *et al*., 2013[35], Magno e Silva *et al*., 2013[37], Magno e Silva *et al*., 2013[36], Marqueta *et al*., 2005[24], McCormick *et al*., 1990[25], Patatoukas *et al.*, 2011[49], Ramirez *et al.*, 2009[60], Saffarian *et al*., 2019[38], Webborn *et al*., 2006[29], Zwierzchowska *et al*., 2020[52]
Injury presentation	**Sudden onset**	Antonietti *et al*., 2008[22], Bernardi *et al*., 2003[46], Blauwet *et al*., 2016[3], Derman *et al*., 2016[39], Derman *et al*., 2018[7], Derman *et al*., 2020[40], Fagher *et al.*, 2019[41], Ferrara *et al.*, 2000[54], Magno e Silva *et al*., 2013[36], Marqueta *et al*., 2005[24], Nyland *et al*., 2000[56], Saffarian *et al*., 2019[38], Tenforde *et al*., 2019[51], Webborn *et al*., 2006[29], Webborn *et al*., 2016[58], Willick *et al*., 2013[30], Zwierzchowska *et al*., 2020[52]
	Gradual onset	Bauerfeind *et al*., 2015[33], Fagher *et al.*, 2020[31], Fagher *et al.*, 2020[48], Ferrara *et al*., 1992[42], Ferrara *et al.*, 1992[53], Kubosch *et al*., 2017[23], Hollander *et al.*, 2019[55], Magno e Silva *et al*., 2013[35], Magno e Silva *et al*., 2013[37], Ona Ayala *et al*., 2019[26], Taylor *et al*., 1995[27], Webborn *et al.*, 2012[57], Willick *et al*., 2016[58]

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Original Article

Prevalence and incidence of health problems and their characteristics in Brazilian para athletes: A one-season single-center prospective pilot study

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ABSTRACT

Background: Para athletes experience high prevalence and incidence of health problems related to sport. Despite this, there are few longitudinal studies.
Objective: To describe the characteristics, prevalence, incidence, and severity of health problems in para athletes from one of the Brazilian Paralympic Reference Centers during a sports season and to compare the prevalence of health problems between para athletics, para powerlifting, and para swimming.
Methods: This prospective pilot study was conducted from October 2019 to March 2020. The Oslo Sports Trauma Research Center Questionnaire on Health Problems was used to record injuries and illnesses every week for 24 weeks. The characteristics, prevalence, incidence, and severity of health problems were described for each modality. The prevalence of health problems was compared among the three sport modalities.
Results: Thirty-five para athletes participated. Most of the injuries occurred in the shoulder, and most illnesses caused respiratory and gastrointestinal symptoms. The average weekly prevalence and the incidence rate of health problems were 40.6% (95% CI 17.0–64.4) and 12.7 (95% CI 9.6–15.9) per 1000 athlete hours, respectively. Para powerlifting had the highest prevalence of all and substantial health problems; para swimming had the lowest prevalence of injuries; and para athletics had the lowest prevalence of illnesses.
Conclusions: This group of Brazilian para athletes showed a high prevalence and incidence of health problems throughout the season. Para athletics, para powerlifting, and para swimming each had a different prevalence of injuries and illnesses.

The prevalence and incidence of health problems in para athletes are high.[1] During the 2016 Summer Paralympic Games in Rio de Janeiro, approximately 12% of para athletes had an injury or illness, with an incidence of 10 injuries and illnesses per 1000 athlete days.[2,3] The Pyeongchang 2018 Paralympic Winter Games had even higher rates – approximately 20% of para athletes had at least one injury, and 14% had at least one illness, which resulted in 21 injuries and 13 illnesses per 1000 athlete days.[4,5] This high prevalence and incidence of health problems also occur out of competition, as demonstrated by Fagher et al. (2020)[6] and Hirschmüller et al. (2021),[7] and may compromise para athletes' performance during sports season because they may need to reduce training volume and intensity. In addition, health problems

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may compromise para athletes' performance in daily living activities, like independent locomotion for those who need assistive devices,[6,7] and consequently restrict social participation.

The profile and incidence of health problems vary between Paralympic sports modalities. In Rio 2016 Summer Paralympic Games, para powerlifting and athletics were among the ten sport modalities with the highest injury incidence rates, while para swimming had the lowest rates.[2] On the other hand, para swimming had the greatest illness incidence rate.[3] The impairment type, the classification category, and the sports modality's characteristics and demands play an important role in athletes' injuries and illnesses profiles. For example, the shoulder is the body region most frequently affected by injuries in non-ambulant para athletes, such as those who compete in seated field sport modalities, wheelchair racing, and para powerlifting.[8–11] In addition, respiratory tract infections are among the most reported type of illness in swimming para athletes.[3,7,12] Therefore, identifying the profile and occurrence rates of health problems of each modality may help design more specific prevention and rehabilitation programs.

Most studies on the epidemiology of health problems in para athletes were limited to specific competitions, such as the Paralympic Games.[2–5,13–15] Although these studies provided valuable information, they do not provide data on health problems throughout the sports season. Therefore, this study aimed to describe the characteristics of injuries and illnesses and establish the prevalence, incidence, and severity of health problems of para athletics, para powerlifting, and para swimming athletes of one of the Brazilian Paralympic Reference Centers during a sports season. In addition, we compared the prevalence of health problems among the three sport modalities.

Methods

Study design and ethics approval

This study was a 24-week prospective pilot study conducted in a Brazilian Paralympic Reference Center, in Belo Horizonte/Minas Gerais, from October 2019 to March 2020. It was approved by the Ethical Research Committee of the Universidade Federal de Minas Gerais (number 27518619.4.0000.5149).

Recruitment and participants

The sample was selected for convenience and included para athletics, para powerlifting, and para swimming, the three sport modalities practiced at the Brazilian Paralympic Reference Center selected. The respective athletes and their guides, of both sexes, without age restriction, that participated in at least one regional competition were invited to participate (N = 37). Before enrollment, potential study participants received a comprehensive overview of the study procedures. An oral presentation was conducted to facilitate comprehension of para athletes with visual or intellectual impairments. Parents or guardians of para athletes younger than 18 years also participated in this presentation.

Initially, the participants provided the following baseline data: (i) athlete demographics (sex, age, height, and mass); (ii) impairment characteristics (type of impairment and sports classification); (iii) sports characteristics (years active in Paralympic sport, type of sport, and hours per week engaged in training and competition).

Data collection tool

The Oslo Sports Trauma Research Center Questionnaire on Health Problems (OSTRC-H),[16,17] electronic version, was used to record all types of health problems reported by para athletes. Adjustments were made by using voice applications and verbal administration to accommodate those with visual and intellectual impairments, respectively. The questionnaire contains four key questions about the consequences of health problems on sports participation, training volume, sports performance, and the degree to which they have experienced symptoms during the past week. If the athlete answered full participation without problems, no training reduction, no performance reduction, and no symptoms, the questionnaire was finished for that week. If any health problem was reported, the para athlete was asked to indicate whether the problem was an injury or illness, as well as the anatomical location affected (for injuries) and the major symptoms (for illnesses), for example, fever, nausea, and fatigue. An athlete who had multiple health problems in a week answered the four key questions for each health problem experienced. The questionnaire was marked completed when each health problem was recorded.[16,17] Based on the response to each question, each para athlete's weekly severity score was calculated. The score ranged from 0 to 100 where the higher the score the worse the outcome for the para athlete.[16,17] Para athletes also reported training exposure in hours every week.

Data collection

A pilot study was conducted for familiarization with the questionnaire four weeks before the actual start of data collection. The questionnaire was sent as a link via text message every Monday for the duration of the study, from October 2019 to March 2020, corresponding to the pre-season period and competitive phase. A reminder was sent on Wednesday and Friday to those who did not respond on Monday. The main researcher (LSPP), who is also a physiotherapist that works at the Brazilian Paralympic Reference Center with ten years of expertise, received, compiled all weekly information, and contacted para athletes when they reported a health problem to determine the type and nature of each health problem and to classify the mode of onset of health problems. Data confidentiality and privacy were maintained. Para athletes who reported any injury complaint were followed up by the Physiotherapy team or, in the case of illness, by the Medical team. Preventive measures were also part of the para athletes' routine, and all stakeholders who work at Brazilian Paralympic Reference Center are coaches, clinicians, and professors specialized in the area and with at least five years of experience.

Definition and classification of reported health problems

An injury was defined as "tissue damage or other derangement of normal physical function due to participation in sports, resulting from a rapid or repetitive transfer of kinetic energy."[18] The type of injury presentation was classified as a sudden onset injury resulting from a clear acute mechanism or a gradual onset injury resulting from a repetitive mechanism.[18] Illness was defined as "a complaint or disorder experienced by the para athlete, not related to injury, that involved other body systems, including health problems in physical (e.g., influenza) and mental (e.g., depression) well-being."[18] Health problems may result directly or indirectly from participation in a competition or training.[19] In the current study, health problems resulting indirectly from participation in activities, such as getting around with assistive devices like crutches and wheelchairs or common diseases in para athletes with spinal cord injury (e.g., neurogenic bladder), were also considered in the registry of health problems. These conditions may affect para athletic health, irrespective of their consequences on para athlete's sports participation or performance or whether the para athlete sought medical attention. This follows a broader concept of injury or illness specifically proposed for this population.[19]

Data analysis and statistics

Weekly prevalence was calculated by dividing the number of para athletes reporting any type of health problem (sudden or gradual onset injuries and illnesses) by the number of questionnaire respondents each week.[17] At the end of the study, the mean prevalence and the corresponding 95% confidence interval (95% CI) were calculated over the entire follow-up period.[17] The prevalence of substantial problems for each measure was also calculated, with substantial problems defined as those leading to moderate or severe reductions in training volume, moderate or severe reductions in sports performance, or complete inability to participate in sport.[17]

Incidence and the corresponding 95% CIs were calculated as the number of new cases divided by the time at risk in hours. The result was multiplied by 1000 to obtain the rate per 1000 h.[20,21] Considering the para sport context, we also calculated the incidence of subsequent recurrent health problems (i.e., same injury type as index injury and diagnosis as index illness).[19] The cumulative severity score was calculated for each health problem by summing the severity score for each reported week. The average weekly severity score was calculated by dividing the cumulative severity score by the number of weeks over which the problem was reported.[22] The total amount of complete time-loss was calculated for each health problem by summing the weekly reported time loss.[17] The burden of the different health problems was reported as the total number of days lost per 1000 h of exposure.[23]

Each modality presented demographic characteristics as means and standard deviation (SD). Data were tested for normal distribution using the Shapiro–Wilk test. The sports modalities were compared with a one-way analysis of variance (ANOVA) or Kruskal–Wallis test according to data distribution. Tukey or Mann–Whitney post hoc tests located the significant difference. All statistical tests were performed using the SPSS software 20 (IBM, Windows, USA) with α set a 0.05 and CI 95%.

Results

A total of 35 para athletes (8 females and 27 males) participated in this study. They competed in regional, national, and international levels in a total of three competitions during the sports season. Two guides were excluded from the analysis. The para athletes had the following impairments: musculoskeletal physical impairment (limb deficiency [N = 6], short stature [N = 2], and impaired passive range of motion [N = 1]), neurological physical impairment (brain disorders [N = 2], spinal cord-related disorders [N = 10], and neuromuscular disorders [N = 4]), visual impairment (N = 7), and intellectual impairment (N = 3). Supplementary material 1 presents the schematic representation of para athletes impairments in each sport modality. Eleven practiced para athletics (3 females and 8 males; functional classification: B1, F11, T11, T37, T46, T47, and T54), 12 practiced para powerlifting (2 females and 10 males; competing in categories ranging from under 50 Kg to over 107 Kg weight classes), and 12 practiced para swimming (3 females and 9 males; functional classification: S4, S5, S6, S9, S10, S11, S14, SB8 and SM9). Some of them used adaptive equipment for all activities: manual wheelchair (N = 12), lower limb prosthesis (N = 4), and crutches and sticks (N = 9). Athletes with visual impairment used personal assistance only during sports practice (N = 2). Anthropometric data and experience in Paralympic sports are available in Table 1. Para powerlifting athletes had less time experience in the sport modality than athletes from para swimming and para athletics ($p < 0.05$).

The average response rate for the 24 weeks of data collection was 78.4% (SD 10.78). The weekly training volume for the 24 weeks, in hours, for each modality, was 7.6 (SD 5.0) in para athletics, 9.1 (SD 5.3) in para powerlifting, and 5.6 (SD 3.8) hours per week in para swimming, resulting in average total weekly training volume of 7.4 (SD 4.9) hours. Complete information about the injuries' location and type of illnesses is provided in Table 2. Supplementary material 2 presents the para athletes health problems related to the impairment type.

The prevalence of health problems and the results of the pairwise comparisons between sport modalities, as well as the incidence and severity of injury and illness, are presented in Table 3. There were differences between sport modalities in the prevalence of health problems [$F(2.69) = 6.988$; $p = 0.002$)], with powerlifting presenting significantly higher health problems prevalence than para athletics ($p = 0.046$) and para swimming ($p = 0.001$); injuries [$F(2.69) = 7.262$; $p = 0.001$)], with para swimming presenting significantly lower injury prevalence than para athletics ($p = 0.023$) and para powerlifting ($p = 0.001$); illnesses [$x^2(2) = 13.011$; $p = 0.001$], with para athletics presenting significantly lower illness prevalence than para powerlifting ($p = 0.015$) and para swimming ($p = 0.004$); and substantial health problems [$x^2(2) = 23.475$; $p = 0.000$], with para powerlifting presenting higher substantial health problems prevalence than para athletics ($p = 0.000$) and para swimming ($p = 0.000$). Health problems prevalence over 24 weeks for each modality are presented in Fig. 1.

Discussion

The findings of the present study may help the development of strategies to properly identify, monitor, and prevent health problems in para athletes. Longitudinal monitoring enables the sports team to understand each modality's health problems throughout the season. It allows early identification, monitoring, and intervention of health problems, mainly those with gradual onset.[24,25]

There was a fluctuation in the prevalence of health problems during the 24 weeks of follow-up, as demonstrated in Fig. 1. Para powerlifting had a higher prevalence of health problems than other sport modalities. This may be explained by the high training volume with heavy loads and the repetitive characteristic of the sports gesture in this modality (i.e., the bench press).[9,26] Furthermore, our para powerlifting sample was less experienced in para sports and had greater body mass index (marginally statistical difference) than athletes from para athletics and para swimming. The interaction of all these determinants could explain this finding. In addition, most of para powerlifting athletes in this study had neurological impairments (e.g., spinal cord-related disorders, myelomeningocele, and post-polio), which is associated with increased prevalence of illnesses,[7,25] as presented in Supplementary material 2, and consequently may help to explain the higher prevalence of health problems in this sport modality. Para powerlifting also had high cumulative severity scores for substantial sudden and gradual onset injuries, suggesting that the health problems in this modality resulted in moderate to severe reductions in training volume, performance, and even complete inability to participate in sport. Therefore, para powerlifting teams should implement preventive exercise in regular training with their athletes, based on assessing the athletes' physical parameters and considering the training load.[9,10] These strategies may be helpful to decrease the impact that the injury could have in activities of daily living for athletes depending on a wheelchair or crutches for mobility.[25]

Para swimming had the lowest prevalence of injuries. This may be explained by the lower weekly training volume of para swimming compared to para powerlifting and para athletics. On the other hand, para swimming had a higher prevalence of substantial illnesses than para athletics. These findings are consistent with the Rio 2016 Summer Paralympic Games when para swimming had the

Table 1
Mean (standard deviation) anthropometric data and experience in Paralympic sports (n = 35).

	Total	Para athletics	Para powerlifting	Para swimming	P-value
Age (years)	35.1 (11.7)	32.1 (7.6)	36.2 (8.6)	36.8 (16.9)	0.595
Body mass (Kg)	73.2 (17.3)	72.9 (19.1)	78.4 (20.2)	68.2 (11.2)	0.504
Height (cm)	170 (0.2)	170 (0.1)	170 (0.2)	170 (0.1)	0.228
BMI (Kg/m^2)	26.1 (7.1)	23.8 (5.3)	29.8 (9.8)	24.4 (3.4)	0.066
Experience in Paralympic sports (years)	3.9 (5.1)	5.9 (5.6)	0.4 (0.2)	5.7 (5.6)	<0.005

BMI, body mass index.

lowest injury incidence rate and the highest illness incidence.[2] In the present study, the symptoms reported by para swimming athletes suggest illnesses in the respiratory and gastrointestinal systems, which is also reported in previous studies.[3,12,27] Some extrinsic and intrinsic causal factors may be related to the higher prevalence of respiratory and gastrointestinal illnesses in these para athletes. For example, the lack of hygiene in the pool and locker rooms, the interaction between athletes that can increase the risk of contamination, the quality of water in the sport environment, and even specific health conditions, such as allergic rhinitis, which can spread quickly among many athletes.[12] The management teams, athletes, and respective support personnel should, therefore, be encouraged to implement preventive measures, such as hygienic measures, sneezing into the elbow, and washing hands frequently within their sport.[28] Furthermore, future studies should investigate the possible causes related to the increased risk of illness in para swimming athletes, so that preventive measures are specifically directed to the needs of this group.

Para athletics had a significantly lower illness prevalence than the other sport modalities. This is likely as a result of our sample of para athletes being composed mostly of visually impaired athletes. Athletes with neurologic impairment were reported in previous studies to have a higher prevalence of illness.[7,25] Our results reflect that health problems in para athletes are also related to their respective impairments.[25] Therefore, collecting data about the type of disability, the modality practiced, the adaptive equipment, and looking at the athlete individually are necessary to achieve success in the risk management health problems by para sports teams.

The shoulder was the region most affected by injuries, followed by the ankle and hip/groin. Para powerlifting accounted for 75.4% of shoulder injuries. This may be explained by the high training volume with heavy loads and repetitive demand of para powerlifting on upper limbs, which along with muscle imbalance and asymmetry, may help explain the higher number of injuries in this body region.[9,10,29] In addition, most of our sample consisted of athletes with spinal cord-related disorders, who used assistive devices, such as wheelchairs, crutches, and walking sticks for locomotion. Therefore, this may also have contributed to the high cumulative severity scores reported in para powerlifting. In contrast, para athletics accounted for 78.7% of all lower limb injuries, most at the ankle and hip/groin. Most of our sample was composed of track athletes. Therefore, the higher demand on lower limbs of the athletes of this modality may help to explain this finding. Also, para athletes' impairment and consequently musculoskeletal deficits and biomechanical compensations during running may be partly responsible for these numbers.[11,30] These findings suggest that the para sports health team should carefully monitor the occurrence and severity of shoulder injuries in non-ambulant athletes and ankle and hip/groin injuries in para athletics. In addition, future

Table 2
Para athletes injuries location and illnesses symptoms, n (%).

	Para athletics	Para powerlifting	Para swimming	Total
Injuries				
Shoulder (including clavicle)	1 (1.3)	52 (59.8)	16 (27.6)	69 (31.4)
Ankle	23 (30.7)	0 (0.0)	0 (0.0)	23 (10.5)
Hip and groin	22 (29.3)	0 (0.0)	0 (0.0)	22 (10.0)
Elbow	0 (0.0)	16 (18.4)	3 (5.2)	19 (8.6)
Knee	6 (8.1)	0 (0.0)	11 (19.0)	17 (7.7)
Abdomen	0 (0.0)	0 (0.0)	15 (25.9)	15 (6.8)
Upper arm	0 (0.0)	11 (12.6)	0 (0.0)	11 (5.0)
Thoracic spine	6 (8.1)	3 (3.4)	1 (1.7)	10 (4.5)
Lumbar spine	4 (5.3)	2 (2.3)	3 (5.2)	9 (4.1)
Neck	4 (5.3)	2 (2.3)	2 (3.4)	8 (3.6)
Foot/toes	4 (5.3)	0 (0.0)	2 (3.4)	6 (2.7)
Thigh	1 (1.3)	0 (0.0)	3 (5.2)	4 (1.8)
Lower leg	3 (4.0)	0 (0.0)	0 (0.0)	3 (1.4)
Others	0 (0.0)	1 (1.1)	2 (3.4)	3 (1.4)
Hand/fingers	1 (1.3)	0 (0.0)	0 (0.0)	1 (0.5)
Total	**75 (100.0)**	**87 (100.0)**	**58 (100.0)**	**220 (100.0)**
Illnesses symptoms				
Abdominal pain	0 (0.0)	1 (6.3)	4 (21.1)	5 (12.8)
Fatigue/malaise	1 (25.0)	2 (12.5)	2 (10.5)	5 (12.8)
Nausea	0 (0.0)	2 (12.5)	3 (15.8)	5 (12.8)
Blocked nose/runny nose/sneezing	0 (0.0)	1 (6.3)	3 (15.8)	4 (10.3)
Diarrhea	0 (0.0)	3 (18.8)	1 (5.3)	4 (10.3)
Fever	0 (0.0)	1 (6.3)	3 (15.8)	4 (10.3)
Headache	0 (0.0)	4 (25.0)	0 (0.0)	4 (10.3)
Sore throat	1 (25.0)	0 (0.0)	0 (0.0)	1 (2.6)
Other	2 (50.0)	2 (12.5)	3 (15.8)	7 (17.9)
Total	**4 (100.0)**	**16 (100.0)**	**19 (100.0)**	**39 (100.0)**

Table 3
Mean weekly prevalence, incidence rates, cumulative and average severity score, burden and time loss of all and substantial health problems, injury, sudden onset injury, gradual onset injury and illness for para athletics, para powerlifting, and para swimming. The results of the pairwise comparisons of prevalence between modalities are presented in the last column.

	All modalities	Para athletics	Para powerlifting	Para swimming	P-value
All health problems					
Prevalence	40.6 (17.0–64.4)	38.3 (0.0–76.8)[a]	48.3 (0.0–93.5)[b]	33.7 (0.0–71.4)[a]	0.002
Prevalence of substantial	16.8 (1.6–32.1)	10.1 (0.0–40.2)[a]	29.6 (0.0–64.3)[b]	11.1 (0.0–33.2)[a]	<0.001
Incidence	12.7 (9.6–15.9)	10.3 (5.5–15.1)	11.3 (6.6–16.0)	18.5 (11.0–26.1)	
Incidence of substantial	10.5 (7.7–13.4)	6.9 (3.0–10.8)	16.4 (10.7–22.1)	4.0 (0.5–7.6)	
Cumulative severity	197.0 (83.5–469.5)	197.0 (142.0–432.5)	341.5 (114.3–626.0)	136.5 (51.0–278.3)	
Cumulative severity of substantial	79.0 (8.5–315.0)	37.0 (0.0–243.0)	302.0 (83.5–420.5)	42.0 (8.5–187)	
Average severity	29.8 (22.4–42.5)	25.0 (20.7–29.9)	38.0 (32.0–55.6)	27.9 (20.3–40.7)	
Average severity of substantial	67.0 (8.5–134.9)	37.0 (0.0–79.0)	143.0 (83.5–163.1)	25.0 (8.5–70.3)	
Health problems burden	48.7 (42.6–54.9)	27.9 (20.1–35.7)	47.7 (38.0–57.4)	79.7 (64.0–95.4)	
Total days of time loss	241	49	93	99	
All injuries					
Prevalence	33.4 (12.0–55.0)	36.5 (0.0–74.1)[a]	41.1 (0.0–83.8)[a]	25.5 (0.0–58.0)[b]	0.001
Prevalence of substantial	13.1 (0.5–26.3)	8.8 (0.0–36.5)[a]	25.8 (0.0–57.6)[b]	4.8 (0.0–19.0)[c]	<0.001
Incidence	10.7 (7.8–13.6)	9.7 (5.1–14.4)	7.7 (3.8–11.6)	16.9 (9.7–24.1)	
Incidence of substantial	7.9 (5.4–10.4)	5.7 (2.2–9.3)	12.3 (7.4–17.2)	2.4 (0.0–5.2)	
Incidence of subsequent recurrent injuries	25.3 (20.8–29.7)	24.6 (17.3–32.0)	26.7 (19.4–33.9)	24.2 (15.5–32.8)	
Cumulative severity	87.0 (15.0–356.0)	134.0 (36.0–310.0)	338.0 (78.5–448.5)	68.0 (24.5–69.3)	
Cumulative severity of substantial	0.0 (0.0–203.5)	12.5 (0.0–54.3)	185.0 (23.0–359.5)	0.0 (0.0–33.5)	
Average severity	53.0 (12.0–113.6)	58.8 (28.5–85.7)	110.3 (50.8–139.8)	36.3 (24.5–69.3)	
Average severity of substantial	0.0 (0.0–71.0)	12.5 (0.0–54.3)	84.5 (23.0–128.1)	0.0 (0.0–23.0)	
Injury burden	28.7 (24.0–33.4)	17.1 (11.0–23.2)	33.4 (25.2–41.5)	37.9 (27.0–48.7)	
Total days of time loss	142	30	65	47	
Sudden onset injuries					
Prevalence	9.5 (0.0–21.1)	8.3 (0.0–39.2)[a]	11.7 (0.0–41.6)[a]	8.3 (0.0–45.7)[a]	0.163
Prevalence of substantial	3.6 (0.0–11.3)	1.8 (0.0–31.4)[a]	7.8 (0.0–38.9)[b]	1.2 (0.0–31.4)[a]	0.002
Incidence	7.1 (4.7–9.4)	6.3 (2.6–10.0)	4.6 (1.6–7.6)	15.0 (6.0–18.2)	
Incidence of substantial	4.4 (2.6–6.3)	2.3 (0.0–4.5)	7.7 (3.8–11.6)	1.6 (0.0–3.8)	
Cumulative severity	17.0 (0.0–47.0)	38.0 (8.0–47.0)	0.0 (0.0–24.0)	28.0 (15.0–57.0)	
Cumulative severity of substantial	0.0 (0.0–48.5)	0.0 (0.0–35.0)	51.0 (15.5–105.5)	0.0 (0.0–0.0)	
Average severity	16.0 (0.0–25.0)	19.0 (8.0–28.0)	0.0 (0.0–16.0)	17.0 (11.7–31.0)	
Average severity of substantial	0.0 (0.0–46.5)	0.0 (0.0–35.0)	48.7 (15.5–65.7)	0.0 (0.0–0.0)	
Sudden onset injury burden	13.1 (9.9–16.3)	5.7 (2.2–9.2)	21.5 (15.0–28.1)	10.5 (4.8–16.2)	
Total days of time loss	65	10	42	13	
Gradual onset injuries					
Prevalence	24.0 (5.7–42.1)	28.2 (0.0–63.5)[a]	29.3 (0.0–64.3)[a]	17.3 (0.0–48.1)[b]	0.001
Prevalence of substantial	9.5 (0.0–20.7)	7.0 (0.0–34.4)[a]	18.0 (0.0–45.7)[b]	3.5 (0.0–31.4)[c]	<0.001
Incidence	3.6 (2.0–5.3)	3.4 (0.7–6.2)	3.1 (0.6–5.5)	4.8 (1.0–8.7)	
Incidence of substantial	3.4 (1.8–5.1)	3.4 (0.7–6.2)	4.6 (1.6–7.6)	24.2 (15.5–32.8)	
Cumulative severity	20.0 (0.0–113.0)	72.0 (0.0–105.0)	20.0 (0.0–93.5)	0.0 (0.0–120.0)	
Cumulative severity of substantial	0.0 (0.0–46.5)	0.0 (0.0–37.0)	134.0 (0.0–184.0)	0.0 (0.0–0.0)	
Average severity	16.0 (0.0–23.0)	18.3 (0.0–24.0)	16.0 (0.0–21.5)	0.0 (0.0–21.4)	
Average severity of substantial	0.0 (0.0–44.2)	12.5 (0.0–37.0)	37.0 (0.0–62.4)	0.0 (0.0–0.0)	
Gradual onset injury burden	15.6 (12.1–19.0)	11.4 (6.4–16.4)	11.8 (7.0–16.6)	27.4 (18.2–36.6)	
Total days of time loss	77	20	23	34	
Illnesses					
Prevalence	5.9 (0.0–115.1)	1.8 (0.0–31.4)[a]	7.2 (0.0–37.3)[b]	8.1 (0.0–38.7)[b]	0.002
Prevalence of substantial	3.7 (0.0–11.3)	1.3 (0.0–32.9)[a]	3.8 (0.0–38.4)[a,b]	6.3 (0.0–38.8)[b]	0.023
Incidence	2.0 (0.8–3.3)	0.6 (0.0–1.7)	3.6 (0.9–6.3)	1.6 (0.0–3.8)	
Incidence of substantial	2.6 (1.2–4.1)	1.1 (0.0–2.7)	4.1 (1.3–6.9)	2.4 (0.0–5.2)	
Incidence of subsequent recurrent illnesses	1.0 (0.1–1.9)	0.6 (0.0–1.7)	0.5 (0.0–1.5)	2.4 (0.0–5.2)	
Cumulative severity	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–26.5)	0.0 (0.0–0.0)	
Cumulative severity of substantial	0.0 (0.0–68.0)	0.0 (0.0–0.0)	44.0 (0.0–84.5)	0.0 (0.0–106.0)	
Average severity	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–17.3)	0.0 (0.0–0.0)	
Average severity of substantial	0.0 (0.0–68.0)	0.0 (0.0–0.0)	44.0 (0.0–68.0)	0.0 (0.0–63.3)	
Illness burden	20.0 (16.1–24.0)	10.8 (6.0–15.7)	14.4 (9.0–19.7)	41.9 (30.5–53.3)	
Total days of time loss	99	19	28	52	

Prevalence data are mean values in percentage with the 95% confidence interval in parenthesis.
Data followed by a different letter indicate significant differences at $p < 0.05$ for the prevalence of each health problem among modalities.
Incidence data are presented per 1000 athlete hours with the 95% confidence interval in parenthesis.
Cumulative and average severity scores are median and interquartile range 25–75% in parenthesis.
Burden data are days lost per 1000 athlete hours with the 95% confidence interval in parenthesis.

studies should investigate the efficacy of successful strategies implemented to prevent injuries at these body locations that were successful for able-bodied athletes, such as specific muscle strengthening, joint mobility exercise, and sport gesture modification.[31]

We presented the incidence of subsequent recurrent injury, defined as the same injury type as index injury.[19] These findings are especially relevant in the context of para sports since several para athletes have health conditions that reduce the capacity of their neuromusculoskeletal system to fully recover from the high number of injuries they experience.[24] Furthermore, our para athletes were older than able-bodied athletes in the same sport modalities. This was not surprising, since para athletes can acquire an impairment later in life or face challenges in accessing a given

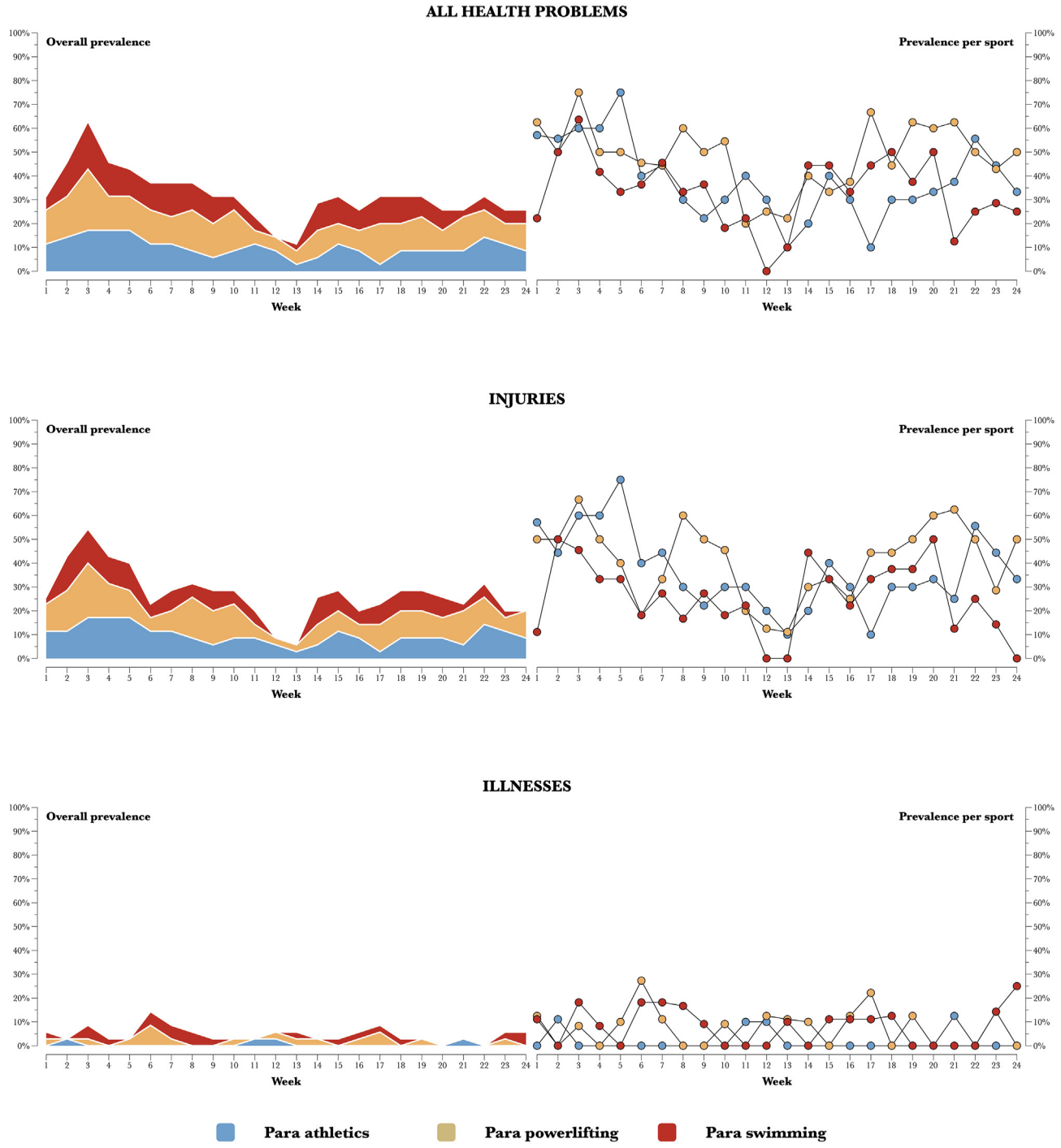

Fig. 1. All health problems, injury, and illness prevalence for each and all sport modalities over 24 weeks.

sport.[32,33] Thus, older age may also contribute to greater difficulty in recovering from previous injuries. In addition, some para athletes perceive decreased training volume as a sign of failure and guilt. Therefore, they often continue to train, despite having an injury.[34] This may help explain our sample's high rates of subsequent recurrent injuries. Finally, para athletes often have to combine sport activities with other areas of life, such as education and work,[35] which may increase demand and also help to explain this type of injury. The high incidence of recurrent injury in the present study reinforces the need for education of para athletes and para sports teams regarding the management and full recovery of index injuries to reduce the occurrence of recurrent injuries in para athletes.

Study limitations

The sample size is a limitation of this study. However, the nature of para athletes sample is highly heterogeneous and specific, in addition to the fact that Paralympic sports are still growing in the number of practitioners and training centers, which renders longitudinal access to larger samples outside competitions difficult. Moreover, our sample was composed of three sport modalities.

Future studies could further investigate the epidemiology of health problems in para athletes related to the impairment type (intellectual, musculoskeletal, neurological, and visual). Our para athletes were monitored by the health team of the sports training center throughout the entire season, especially when they had any health problems. Therefore, the generalizability of the results to other sport modalities should be performed with caution. In addition, we did not discriminate the health problems severity and burden during competition and training periods, which could also be valuable information for para athletes and sports health team. Future studies could also investigate the impact of health problems on para athletes outside sports scenario, for example, the impact of injury severity on the para athlete daily living activities and participation. Finally, the findings of this study should encourage the implementation of health problem surveillance in larger paralympic centers with different types of sport modalities in different countries.

Conclusion

This 24-week prospective study provided the characteristics, prevalence, incidence, and severity of injuries and illnesses of para athletics, para powerlifting, and para swimming athletes from a Brazilian Paralympic Reference Center during a sports season. Body regions most affected by injuries were the shoulder, ankle, and hip/groin. Nausea, abdominal pain, and fatigue/malaise were the most common symptoms of illnesses. Finally, para powerlifting had the highest prevalence of all and substantial health problems; para swimming had the lowest prevalence of injuries; and para athletics had the lowest prevalence of illnesses.

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Conflicts of interest

None.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.dhjo.2023.101511.

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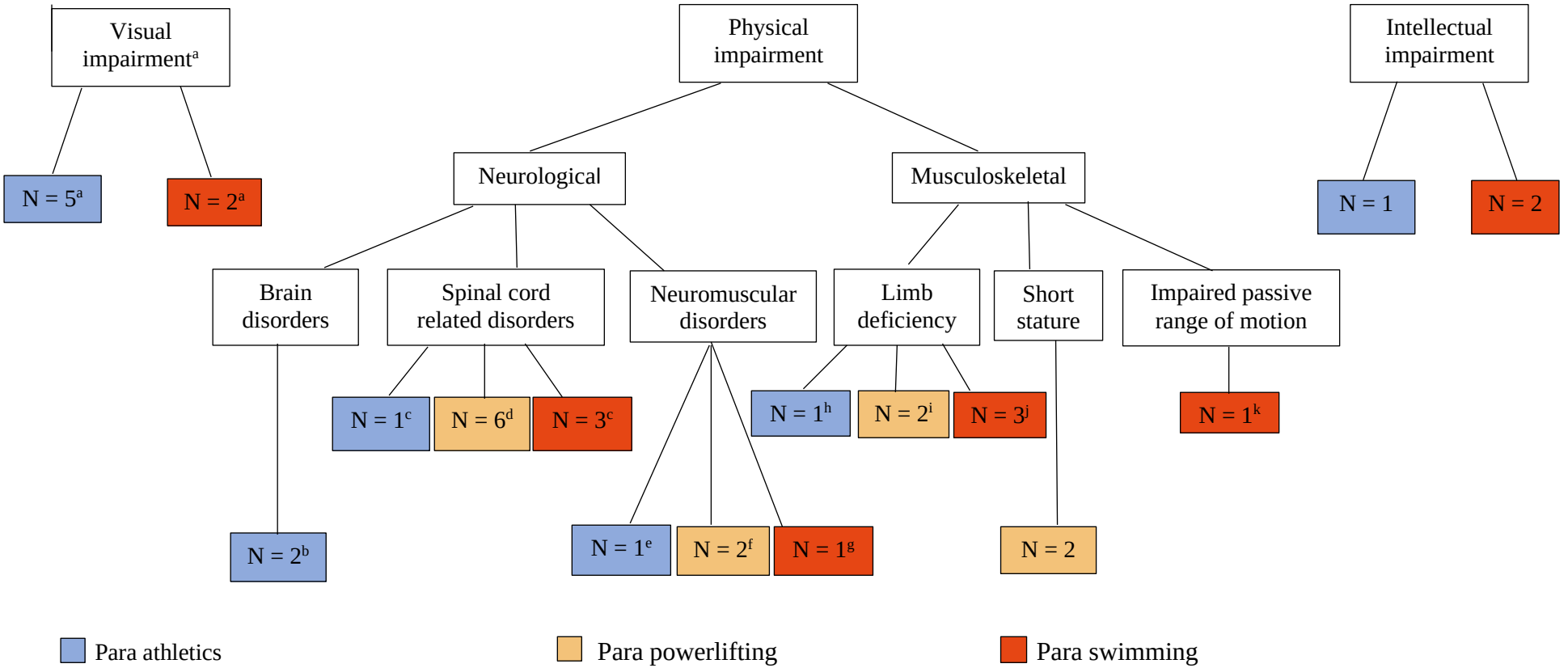
Supplementary material 1 Schematic representation of para athletes impairments



a: blind and low vision; b: stroke and cerebral palsy; c: paraplegic; d: paraplegic and tetraplegic; e: brachial plexus injury; f: myelomeningocele and post-polio; g: post-polio; h: single upper limb amputation; i: single and double lower limb amputation; j: single lower and upper limb amputation; k: arthrogryposis

Supplementary material 2 Para athletes health problems related to the impairment type, n (%).

Impairment type	**Number of injuries**
Intellectual impairment	2 (0.9)
Musculoskeletal impairment	69 (31.4)
Neurological impairment	115 (52.3)
Visual impairment	34 (15.4)
Total	**220 (100.0)**
Impairment type	**Number of illnesses**
Intellectual impairment	0 (0)
Musculoskeletal impairment	8 (20.5)
Neurological impairment	31 (79.5)
Visual impairment	0 (0)
Total	**39 (100.0)**

5 ARTIGO 3

Periodic health evaluation of para athletes: a position statement

Autores

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Artigo em fase final de escrita por todos os autores.

Abstract

The Periodic Health Evaluation (PHE) is a valuable tool used to continually monitor athletes' health, ensuring safe participation in sports, screening for health conditions and identifying barriers to athlete's performance. Additionally, the PHE assists in the surveillance of health problems by establishing baseline information for each athlete and providing crucial information in case of emergencies. It is particularly relevant in the context of para athletes, given their unique impairments and equipment used for competition, which require more individualized approaches to understand their overall health. The aim of this study was to describe specific considerations and guidance for sports health team regarding PHE in para athletes from the four major groups of impairments: intellectual, musculoskeletal, neurological and visual. A panel of international experts (epidemiologists, physiotherapists, sport and exercise physicians), with expertise in para athlete's health, convened by video conference to discuss the position statement's purpose, methods, and themes. They were divided into working groups and asked to add specific considerations related to clinical, cardiorespiratory, neuromusculoskeletal, nutritional status, mental and sleep health, concussion, and the particularities of female para athletes' health assessment. The anamnesis is the first step in the PHE. By conducting an anamnesis, the healthcare team can understand which factors may impact the para athlete's health and use this information to guide the physical assessment.

Specific requirements of the sport modality and the impairment itself should be considered during the PHE. Regular evaluations can help reduce the tendency of para athletes to neglect seeking medical advice for issues related to their impairments. These assessments also facilitate early intervention based on the athlete's medical history. Furthermore, the PHE serves as an opportunity to educate para athletes about preventive measures to be incorporated into their training routines, promoting optimal health and maximizing their performance potential. This position statement has the potential to enhance clinical practice and improve the quality of healthcare provided to para athletes, ultimately promoting their overall health and well-being.

Key words: health, assessment, paralympic, sport

Introduction

The International Olympic Committee (IOC) Consensus Statement about Periodic Health Evaluation (PHE) in elite athletes provided practical recommendations for the assessment of these athletes [1,2]. According to the IOC consensus, the PHE could be a valuable tool to continually monitor the athlete’s health to guarantee safe participation in sport, to screen health conditions that may place an athlete at risk, or to identify conditions that are barriers to athlete’s performance [1]. Although some screening tests before competition have gained greater attention because of their association with injury risk [3,4], there is no strong evidence that such tests can predict injury with sufficient accuracy [5,6]. In addition, there are other useful roles for the PHE. For example, it can assist in the surveillance of health problems by providing useful baseline information about each athlete, and it can also provide the sports health team with useful information should an emergency arise [7].

The PHE is especially relevant for para athletes context since they take longer to seek medical support when their complaint is related to the disability, because they often are more used to pain or discomfort [8]. Consequently, there is a delay in identifying health problems by the sports health team, which can lead to more severe clinical implications [8,9]. Para athletes represent a challenge for healthcare providers. There are para athletes with different impairments and using different equipment competing at the same sport modality, which demands more specific information about each para athlete

and increases the complexity of strategies designed to prevent the occurrence and reduce the severity of health problems [10,11]. For this reason, a PHE is required to design and implement more individualised approaches better to understand para athletes' general state of health. Thus, this position statement describes specific considerations and guidance for sports health teams regarding PHE in para athletes.

Methods

The lead authors (LP, EV and RR) invited seven additional authors from across the globe (EV, KF, OA, RW, CB, WD, NW) to take part in writing this position statement. These authors convened by video conference as a core team to discuss this position statement's purpose, methods, and themes.

They then assigned each core member to chair a working group focused on one of the discussed themes. The themes designated for each working group were divided according to the main disability groups in para sports, i.e., intellectual, musculoskeletal, neurological and visual impairments, considering the para sport translation of the IOC Consensus [12]. They were asked to add specific considerations related to clinical, cardiorespiratory, neuromusculoskeletal, nutritional status, mental and sleep health, concussion and the particularities of female para athletes health assessment.

They tasked each core member to invite additional experts who work with para athletes in a clinical or research setting to their working group. This resulted in a panel of 16 international experts (EV, JMO, KF, OA, KD, DM, RW, HK, CO, CB, JL, WD, NW and AS), who were selected based on their involvement in various academic and clinical para athlete settings. Our panel includes epidemiologists, physiotherapists, and sport and exercise physicians with expertise in para athlete's health.

The working groups created initial drafts for their tasked theme, which LP, EV and RR subsequently compiled into a first complete draft of this position statement. This was circulated to the entire panel through email and discussed in a group video conference, during which we discussed necessary revisions. All panel members were invited to review the manuscript, suggest edits and participate in further video conferences until a final statement was agreed on. In total, there were three video interactions for the position statement.

General considerations for PHE in para athletes

Anamnesis

The anamnesis aims to identify information regarding para athlete health conditions. Therefore, any health professional (e.g., physician, physiotherapist, psychologist, nutritionist) may perform the anamnesis/assessment with all para athletes. The anamnesis allows health staff to understand which factors may influence the para athlete's health regarding risk-preventive measures and helps to guide physical assessment [13]. It includes extensive content to accommodate complex medical issues commonly arising in the para athlete population [11]. The health professional that conducts the anamnesis should direct their questions according to the para athletes' systems with reduced function [11]. For example, the sports physician may ask questions regarding bladder control, urinary tract infections, or issues surrounding skin breakdown that are highly relevant to a person with a spinal cord injury [14].

Sport demands and disability evaluation during physical assessment

The specific demand of the sport modality should be considered to define the parameters of neuromusculoskeletal, nutritional, and exercise physiology assessment. For example, the tests used to evaluate neuromusculoskeletal performance should be chosen based on clinical reasoning, on the best scientific evidence available regarding the test's psychometric properties and the athlete's ability to perform it. Healthcare professionals should consider the specific demand of the sport modality to the neuromusculoskeletal system (e.g. biomechanics of the sports gesture) along with the para athlete impairment to decide the assessment parameters (e.g. muscle function, neuromuscular control, flexibility, joint mobility) [13,15]. In addition to the specific characteristics of the sport, the training load, periodization and the number of competitions in a sports season should be investigated. These aspects greatly demand the para athlete's health and require proper functioning of their neuromusculoskeletal system. Furthermore, the use of tests already described in the literature for assessing people with disabilities should be considered, respecting individualities and understanding the specificity of para sport context [16].

Equally, the nutritional assessment should include aspects related to the sports demand and the athlete's impairment. Following up on the para athlete's training periodization, body mass, and composition changes is important to adjust energy intake accordingly [17]. One of the main challenges a sports nutritionist faces when working with para athletes is estimating their energy requirements [17–19]. For example, energy consumption in a wheelchair race will differ from wheelchair basketball games [20]. This assessment helps to prevent the imbalance between energy consumption and expenditure, which can lead to greater muscle fatigue, risk of injury and worse performance [21]. Besides that, as some individuals with visual impairment may experience light sensitivity and avoid daylight, specifically screening for vitamin D deficiency can also be recommended [22]. To summarize, the physical assessment process involves what is available in the scientific literature, and mainly the clinical reasoning that seeks to identify the capacities necessary for the para athlete to perform the sport modality with an increased level of safety and performance [15].

Female para athlete

During the PHE of female para athletes, the healthcare providers must be aware of general sports-related health problems among female athletes, such as the female athlete triad, reproductive health and non-accidental harms (e.g., harassment, abuse, violence) [23–25].

Low energy availability is an aetiological factor of relative energy deficiency. This syndrome includes impaired metabolic rate, menstrual function, bone health, immunity, protein synthesis and cardiovascular health, and consequently compromises physiological functioning [25]. There is a lack of scientific literature about relative energy deficiency in female para athlete, however, some studies have shown that it is prevalent among persons with impairments [26–28]. In the PHE of these female para athletes, the healthcare provider should further investigate energy deficiency and menstrual dysfunction. Especially in female athletes with a central neurologic injury, who may have hypothalamic–pituitary axis alterations and baseline menstrual function, regardless of energy status [29–31]. Besides that, physicians should also be aware of the effects of oral contraceptives on the sports performance

of female para athlete during the PHE. Both the healthcare professional and the female athlete must make a shared decision, considering the individual's response (i.e., to what degree they might be affected) and requirement (e.g., contraceptive or medical need) of the oral contraceptive consumption and discuss the options for contraception [26,32]. Likewise, sexual dysfunction should be investigated with female para athletes during the PHE. Therefore, physicians must be prepared to give advice and become familiar with female sexual rehabilitation assistive technologies [33].

Screening the risk factors for concussion in female para athletes is highly recommended during the PHE [34]. Concussion rates are higher for females than male athletes in sports with similar rules [35]. Also, the severity and recovery from concussions are worse in female athletes [36]. Particularly in para sport, female visual-impaired athletes report high concussion rates. The most important steps in concussion management are recognising that a concussion may have occurred and removing the para athlete from the game or practice for further assessment [37]. Considering that physicians caring for female para athletes should remain mindful of these athletes' vulnerability to concussion, especially in sports where the risk of concussion is high, such as football 5-a-side, para alpine skiing, para ice hockey, para taekwondo and para boxing [26].

Lastly, children and adults with impairment are at alarmingly high risk of physical, social, sexual and psychological harassment, and there is an estimation that athletes with a physical and/or intellectual impairment may be up to four times more likely to be victimised [38]. Thus, investigating the non-accidental harms should be part of the PHE carried out by the sports health team. Regarding female para athletes, it is already known that they report a higher prevalence of sexual violence when compared with male para athletes [24]. Once abuse is suspected, the sports health team should offer a safe, confidential and private space using neutral questions or statements, i.e. "Because difficult relationships affect health, I'm asking my athletes about it" [26]. A multidisciplinary team with psychologists and/or socio-behavioural experts and a safeguarding programme implementation by sports managers will contribute to a safe sport, i.e., sporting environments free from non-accidental harms of all kinds [24,26].

Considerations for PHE in para athletes by impairment

Intellectual impairment

The intellectual impairment athletes compete in athletics, swimming and table tennis sports modalities [39]. Intellectual impairment does not directly influence the results of the physical and functional tests during the PHE. Nonetheless, some points should be addressed by sports health teams. The results from an assessment may have limitations when validity is influenced by athlete understanding (e.g. pain score or maximal effort) [40]. Therefore, we must consider each test's explanation and adapt explanations where possible so that all athletes fully understand what is required for a valid test. We must also allow extra time to explain and perform an assessment, ensuring that the test requirements are understood and that training attempts can be completed.

We cannot assume that an athlete understands the context of all questions and instructions during assessments where an athlete is expected to complete a questionnaire (e.g., overall health, nutrition, sleep, Likert scores). We recommend that questions are tailored and validated to the athletes' abilities and needs, perhaps considering visual analogues that may be better understood than words alone. In the absence of such validations, the presence of a third corroborative person (e.g., spouse, family, carer) who can help provide understanding and/or answers on the athlete's behalf. Medical data could be obtained from existing (electronic) medical records and athlete management systems, or an athlete could request summary medical data from their general practitioner (family doctor), where provided practicable [11].

Safeguarding and mental health issues are especially important for athletes with intellectual disabilities. Children and adults with intellectual disabilities are more likely to have mental health conditions, poorer physical health, be bullied, and be subjected to mental and physical abuse [24,38,40,41]. Furthermore, one cannot presume an athlete's capacity to understand and make decisions on medical treatment or agree with treatment plans. As a result, when making clinical or performance decisions, always consider medicolegal and ethical issues. Medical decisions must be made in the athlete's best interests, where possible, followed up, and the athletes and their caregivers must be involved in the decision-making process [42]. Table 1 outlines some of the considerations

for the PHE in para athletes with intellectual impairment.

Table 1 – Considerations on Periodic Health Evaluation (PHE) in para athletes with intellectual impairment.

Type of assessment	Intellectual impairment
Neuromuscular control	Tests that require multiple tasks should be avoided. If required, 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) in these tasks is currently poorly understood.
Muscle function	Muscle performance parameters should be evaluated, considering that, in general, athletes with an intellectual impairment present lower strength than other individuals [41].
Mobility/ flexibility	Not applicable
Fitness and cardiovascular screening	Questionnaires on self-reported symptoms during exercise may be unreliable due to recall issues. While screening, the healthcare professional must rely on a carer for the athlete's cardiovascular and family history. This can, for instance, be a family member or the family doctor.
Clinical conditions	Conduct interviews instead of questionnaires. When an interview is impossible, have a third person complete the necessary questionnaires. If possible, seek access to medical records from, e.g., a family doctor. Athletes with intellectual disability have worse dental health and, therefore, greater dental health needs than the rest of the population [77–80]. Thus, regular oral/dental health checks are advisable for these athletes.
Nutritional status	Given issues with the validity of self-reported data, it is recommended to have a third person complete any necessary nutritional questionnaires. There are recorded issues in individuals with intellectual impairment and nutrition [81,82]. Hence, rather than implement efforts to assess the nutritional status, one could seek optimal nutrition education at each reasonable opportunity. Available Metabolic Equivalent of Task (MET) data for able-bodied athletes are likely suitable to estimate energy expended through physical activity for athletes with intellectual impairment [17].

Sleep health	Given issues with the validity of self-reported data, it is recommended to use objective data instead of questionnaires, e.g., actigraphy and accelerometers [67,83].
Mental health	Use the Sport Mental Health Assessment Tool 1 (SMHAT-1) to assess elite athletes potentially at risk for or already experiencing mental health symptoms and disorders and the Sport Mental Health Recognition Tool 1 (SMHRT-1) for athletes and their entourage (e.g., friends, fellow athletes, family and coaches) [84]. Also, the Patient Health Questionnaire-4 (PHQ-4) is used as a valid and suitable tool for continuous mental health evaluation in elite para athletes [85]. Mental health issues are often present in athletes with intellectual impairment but are also often overlooked. These issues are more challenging to diagnose in the presence of intellectual impairment, and few screening tools are validated for this population [24,86]. Athletes are unlikely to recognise their symptoms, and it is recommended to rely on a carer as they may recognise changes in behaviours. If there is a previous medical history regarding mental health, try to obtain that data with the athlete's permission [42].
Concussion	Will be required additional considerations for the “disorientation or confusion", “blank or vacant look”, and "requires understanding” for some athletes with intellectual impairment during the Sport Concussion Assessment Tool 5 (SCAT5) assessment [37].

Musculoskeletal impairment

The musculoskeletal impairment group includes para athletes with a limb deficiency, short stature, leg length difference and impaired passive range of motion [12]. These para athletes compete in almost all sports sanctioned by the International Paralympic Committee (IPC) [39].

One of the key factors of this group is the prosthesis and residual limb assessment. Maintaining continuous tissue surveillance during various activities such as training, travel, and daily routines is crucial. The volume of the residual limb can change in the short term, during the acute phase of training or competition, due to factors like blood flow and muscle activity, and in the long term, due to tissue adaptation caused by the training load [43,44]. Therefore, it is essential to regularly evaluate the fit of the prosthetic and monitor any 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 prosthetic can further aggravate skin breakdown and increase the risk of infection [43,45]. Besides that, amputee athletes have driven many advances in prosthetic technology. The prosthetic evaluation should be tailored to the individual, their sport and their level of competition [44]. Thus, the biomechanical assessment of activities performed with the prosthesis and a basic understanding of the technical aspects of the equipment must also be considered in assessing these para athletes [44]. Table 2 outlines some of the considerations for the PHE in para athletes with musculoskeletal impairment.

Table 2 – Considerations on Periodic Health Evaluation (PHE) in para athletes with musculoskeletal impairment.

Type of assessment	**Musculoskeletal impairment**
Neuromuscular control	Standardized tests already used in para athletes should be considered the first choice during the assessment, for example, the *L test* to assess agility in amputee athletes [87]. Standardized tests for able-bodied athletes could be used with caution, some adaptations, and considering the validity and reliability of the tests. Consider some biomechanical compensatory strategies that could be used for these athletes.
Muscle function	Standardized tests for able-bodied athletes could be used with caution, some adaptations, and considering the validity and reliability of the tests. For example, using hand-held and isokinetic dynamometers to measure strength, depending on availability [88]. Considering that in the musculoskeletal impairment group, there are athletes with asymmetries between sides for upper and lower limbs, muscle function and joint mobility assessments of the contralateral side may be used as a reference. Special attention in children with arthrogryposis, considering that their bone mineral density is lower than age-matched means, especially in children with limited ambulation, which increases the risk of osteoporosis and fractures [89].
Mobility/ flexibility	Evaluate the mobility and flexibility in the residual limb of athletes with amputation. Special attention to athletes with impaired passive range of motion.
Fitness and cardiovascular screening	Standardized tests that have already been used in para athletes should be considered as the first choice during the assessment, for example, Yoyo intermittent recovery test to assess endurance in amputee athletes [87]
Clinical conditions	Evaluate the prosthetic history in athletes with amputation, issues with skin breakdown, stump pain and prior injuries. The stump should be inspected and palpated to look for skin changes and insensate areas and its ability to withstand the increased stresses of sports activity [44].
Nutritional status	Anthropometric assessment and dietary records should be monitored regularly in adolescents and adults with achondroplasia [90]

	Evaluate energy consumption and expenditure in athletes with amputation, which may have higher energy needs resulting from gait asymmetry [45]. The body composition evaluated by Bioelectrical Impedance Analysis (BIA) is not indicated for athletes with amputation (missing unilateral or lower limbs will impact whole-body resistance measurement). The presence of oedema may also invalidate results [17].
Sleep health	Consider using scales such as Pittsburgh Sleep Quality Index, Athlete Sleep Behavior Questionnaire, and objective parameters for sleep assessment, such as actigraphy [67,83]. Referral to perform the polysomnography exam when necessary. Special attention in para athletes with achondroplasia with midfacial hypoplasia and small thorax could lead to obstructive sleep apnoea [91].
Mental health	Use the SMHAT-1, the SMHRT-1 and the PHQ-4 tools for Paralympic athletes [84,85]. Some individuals with acquired limb deficiency experience more depression, anxiety and anger, which 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 [44].
Concussion	Will be required additional considerations for the “balance/gait difficulties/motor coordination” assessment for some athletes with bilateral lower limb deficiency during the SCAT5 assessment [37]. Will be required additional considerations for the increased incidence of atlantoaxial instability in athletes with achondroplasia during the SCAT5 assessment [37]. During the SCAT5 assessment, it will be required additional considerations for the "weakness or tingling/burning in arms or legs” and “best motor response” assessments in athletes with arthrogryposis given reduced joint range of motion [37].

Neurological impairment

The neurological impairment group includes para athletes with brain disorders, spinal cord-related disorders and neuromuscular disorders. Some examples of diagnoses in the brain disorders group are athletes with cerebral palsy, traumatic brain injuries, stroke or multiple sclerosis. In spinal cord-related disorders, the para athletes could be divided into paraplegic or tetraplegic. On the other hand, the neuromuscular group includes stable disorders (e.g., post-polio and peripheral nerve injury) and progressive disorders (e.g., motor neuron disease, muscular dystrophy and myopathy) [12]. These para athletes also compete in almost all sports sanctioned by the IPC [39].

The most common impairments in this group are spinal cord injury (SCI) and cerebral palsy. One specific medical and physiological issue in athletes with SCI is autonomic dysreflexia. This is an acute attack of uncontrolled sympathetic nervous activity characterized by a sudden rise in blood pressure, headache, flushing and sweating [46]. Although it has been recognized in Paralympic sports, given its potential for performance enhancement, boosting is forbidden and strictly banned by the IPC [47]. It can be life-threatening given the accompanying acute rise in blood pressure with a risk for a hypertensive emergency. Thus, the sports health team must frequently record the blood pressure of athletes susceptible to autonomic dysreflexia and promote the education of these para athletes [48]. Autonomic dysfunction caused by SCI is also associated with a higher risk of cardiovascular disease [49]. These athletes may have decreased sensory feedback of angina and present structural heart abnormalities. Thus, a higher index of suspicion should be given for any cardiac symptoms in these para athletes [50,51]. The availability of resources and the estimated risk of sudden cardiac death should also be considered during the PHE [50]. Another medical condition very common in athletes with SCI is the neurogenic bladder. These athletes normally use intermittent catheterization and should be taught about their urinary tract infection risks since they are much more prone to urinary tract infections [52]. The sports physician should be aware of their infection history, including what antibiotics they use to treat urinary tract infections (e.g. whether they have antibiotics resistant organisms) and also plan with the whole team the bladder emptying during long-distance flights [48,53]. Lastly, athletes who use a wheelchair, whether in competition or

as a mobility assistive device, are at greater risk of shoulder injury [54]. Therefore, neuromusculoskeletal aspects, such as scapular muscle imbalance and asymmetry, shoulder range of motion, and the technical aspects of the equipment, including racing chairs, should be evaluated [55–57].

Regarding neuromusculoskeletal aspects in athletes with cerebral palsy, pain is one of the most commonly reported challenges faced by sports health teams who manage these athletes. It has been shown that pain is not well managed and persists over long periods [58]. Therefore, the sports health team should investigate the use of specific drugs, electrophysical agents and to educate the para athletes about reduced pain strategies [58]. They are also susceptible to injury in both the upper and lower limbs. So, assessing deformities, fatigue, and abnormal and asymmetry movement patterns should be considered during the PHE [59]. Table 3 outlines some of the considerations for the PHE in para athletes with neurological impairment.

Table 3 – Considerations on Periodic Health Evaluation (PHE) in para athletes with neurological impairment.

Type of assessment	Neurological impairment
Neuromuscular control	For athletes with spinal cord injury (SCI) and other more severe forms of lower limb neurological impairment, using balance tests is impossible. Alternative tests, such as the wheelchair error scoring system (WESS), if validated in this setting, may emerge as suitable clinical alternatives [92].
Muscle function	Some modifications are likely in these groups of athletes, but using a 1 to 10-repetition maximum strength test should be an option. The medicine ball throw test for para athletes who use a wheelchair is a simple and feasible test correlated to isokinetic tests [93]. More frequent assessments may be needed in athletes with progressive impairments.
Mobility/ flexibility	Given the consequences of contractures in athletes with neurological impairment, mobility and flexibility exercises should be conducted, especially in the shoulder joint for wheelchair users [94]. In athletes with cerebral palsy, the increased passive and active joint stiffness contributes to reduced joint angular velocities, external joint power, and reductions in step length during the initial acceleration phase of sprinting. So, training interventions should focus on strategies to increase lower limb joint angular velocities [95,96]. Consider the tone/spasticity in athletes with neurologic injury.
Fitness and cardiovascular screening	The cost-benefit of electrocardiogram (ECG) screening in para athletes is more favourable due to the higher prevalence of cardiovascular abnormalities associated with sudden death [50]. Special attention to female athletes and athletes with SCI present more ECG abnormalities not associated with training and potentially an expression of cardiac disease [97]. The wheelchair propulsion test on a treadmill is reliable for assessing cardiorespiratory fitness among manual wheelchair users [98]. The 6-min push test (6MPT) may be useful for predicting fitness levels in para athletes with neurological impairments [99,100].

	Exercise testing in athletes with SCI could be performed through an arm-crank ergometer (Ergometrics and Ergoline 800; Ergoline GmbH), depending on availability [101].
Clinical conditions	Special attention is to the risk for decubitus ulcers due to impaired sensation. Educate the athletes about the daily check at the start and end of each day-body map for areas at high risk for developing decubitus ulcers. Evaluate and promote education on autonomic dysfunction symptoms, urinary tract infection symptoms, and aseptic catheter insertion [48,52]. Evaluate assistive devices, mobility aids and straps for these groups of athletes [48,59].
Nutritional status	Use of weighing scales that can accommodate wheelchairs [17]. Evaluate energy expenditures in athletes with central neurological injury (e.g. athletes with cerebral palsy that present dyskinesis or athetosis with disorderly pattern movement) and athletes who use a wheelchair for daily mobility, likely to have reduced baseline energy needs [102,103]. Evaluate nutrient deficiencies and body weight monitoring in athletes with SCI [104]. Also, measure this population's Resting Energy Expenditure (REE) values because they have lower REE than able-bodied individuals [17]. The body composition evaluated by Dual-Energy X-Ray Absorptiometry (DEXA) is not indicated for individuals with spasms (e.g. SCI, multiple sclerosis, cerebral palsy) since any movement will affect the accuracy of the scan [17]. Also, the body composition evaluated by BIA is not indicated in individuals with SCI (due to changes in total body water content and intra- and extracellular water ratios) [17].
Sleep health	Consider using scales such as Pittsburgh Sleep Quality Index, Athlete Sleep Behavior Questionnaire, and objective parameters for sleep assessment, such as actigraphy [67,83]. Special attention in para athletes with cerebral palsy because snoring is more prevalent among individuals with cerebral palsy, likely due to upper airway and facial muscle tone alterations and may indicate obstructive sleep apnea [105,106].
Mental health	Use the SMHAT-1, the SMHRT-1 and the PHQ-4 tools for Paralympic athletes [84,85].

	Demands or costs of wheelchairs could be sources of stress experienced by athletes who use these mobility and sports devices [107].
Concussion	Special attention for the “neck tenderness” and “weakness or tingling/burning in arms or legs” in athletes with quadriplegia during the SCAT5 assessment [37]. Lesion level must be noted, in athletes with SCI, during the “best motor response” and “cervical spine” assessments of the SCAT5 tool [37]. 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 SCAT5 tool [37]. Lower extremity strength will be affected in athletes with Spina Bifida during the “best motor response” assessments of the SCAT5 tool. Also, special attention should be given to the symptoms of hydrocephalus that can be similar to concussion in these para athletes [37].

Visual impairment

The visual impairment (VI) group includes blind and low-vision para athletes [12]. These para athletes compete in alpine and Nordic skiing, athletics, cycling, blind football, equestrian, goalball, judo, rowing, shooting, swimming and triathlon [39].

For this group of athletes, it is important to remember that when interacting with them, one must pay special attention to both voice intonation and direction when speaking [60]. Smartphones and tablets with built-in accessibility features can be useful during the PHE [61–63]. In addition, the presence of the guide during the assessment and their evaluation should also be taken into account by the sports health team.

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 [64–66]. It is therefore recommended to carefully monitor both the quantity and quality of sleep and consider using a digital sleep tracking device accessible for persons with VI [67]. Regarding light sensitivity, athletes with VI might also have vitamin D deficiency, which should be screened in the PHE [22].

Furthermore, athletes with VI reported a significantly higher incidence rate of concussions, and collisions were the most common injury mechanism among these para athletes [34]. They undergo a different concussion “experience” than their non-VI peers [68], and post-injury signs/symptoms (e.g., dizziness, blurred vision) constitute a VI athlete’s normative baseline. The Concussion in Para Sports Group adapted the Sports Concussion Assessment Tool 5 (SCAT5) [69] to enable its use in all para athletes following concussion, including athletes with VI [37], and this adapted tool is recommended to obtain a baseline for these athletes for PHE purposes. To accurately interpret the VI athlete’s post-concussion visual symptoms relative to their pre-concussion visual symptoms, any PHE must collate a summary of the athlete’s baseline visual status that can be used for assessment purposes. Table 4 outlines some of the considerations for the PHE in para athletes with visual impairment.

Table 4 – Considerations on Periodic Health Evaluation (PHE) in para athletes with visual impairment.

Type of assessment	Visual impairment
Neuromuscular control	The dynamic balance should be evaluated with tests that rely more heavily on proprioceptive or vestibular information (e.g., walking with heels raised or jumping on mats) [108,109]. The complex movements required will need to be adequately described.
Muscle function	Special attention must be given to para athletes with severe vision impairment because they could have less muscle strength than those with mild-moderate impairment [110]. During the assessment, adequate descriptions of the movements are necessary and/or the clinician can move the athlete's body to demonstrate the movement to them.
Mobility/ flexibility	Note that poorer mobility and flexibility in athletes with vision impairment might be associated with modified movements to avoid imbalance or injury (e.g., shorter stride length when walking) [111]. During the assessment, adequate descriptions of the movements are necessary and/or the clinician can move the athlete's body to demonstrate the movement to them. Mobility and flexibility are often impacted by vision impairment. They are poorer in individuals with severe vision impairment than those with mild-moderate impairment (e.g., on the sit-to-reach test) [110].
Fitness and cardiovascular screening	Adults with visual impairment (VI) have a higher prevalence of cardiovascular disease and risk factors than those without VI [112]. So the PHE for these athletes should also include questioning related to cardiovascular comorbidities and any family history [113]. Using large-print formats or having scales read aloud is an important adjustment for athletes with VI. The clinic/facility used for the fitness and cardiovascular screening should be accessible for an individual with VI (e.g., allowing a guide dog to attend if needed). The Yoyo intermittent recovery test has been suggested as not valid in assessing cardiorespiratory fitness in athletes with VI athletes [114].

	To limit iatrogenic consequences, athlete guides should be integrated into any cardiorespiratory testing. Static means of assessing aerobic capacity (e.g., using a stationary exercise bike) may be the preferable means to test in athletes with VI.
Clinical conditions	Audiometry tests and executive function assessments should be periodically conducted because the hearing loss in individuals with low vision and dual-sensory impairments (vision and hearing loss) are common in people with VI [115–119]. Also, executive function abilities have been highlighted as potential cognitive strengths and weaknesses in this population [120,121]. Auditory processing has been proposed as a biomarker of concussion [122]. Therefore, this function should be periodically evaluated in athletes with VI.
Nutritional status	Athletes may avoid daylight due to light sensitivity, and it is recommended to test D-vitamin levels [22]. The athlete should also be asked about routines regarding food shopping, preparing meals, and meal size. Consider involving family members or the guide of the athlete. Available metabolic equivalent of task (MET) data for able-bodied athletes are likely suitable to estimate energy expended through physical activity for athletes with VI [17].
Sleep health	Circadian rhythm may be disturbed, so consider using sleep-tracking devices [67,83].
Mental health	Use the SMHAT-1, the SMHRT-1 and the PHQ-4 tools for Paralympic athletes [84,85]. Persons with visual impairment report higher rates of depression and anxiety compared to the general population, and it has been recommended to better screen for mental health issues in this population [123]. Fatigue is common among persons with VI, and it can, in turn, affect mental health, sports performance, and recovery [124]. It is, therefore, important to screen for fatigue symptoms. It is suggested to use questionnaires that capture mental health issues that can be present both in daily life and sports activities.
Concussion	Understand the para athlete’s baseline visual capacity to interpret post-injury SCAT5 outcomes [37,68]. Athletes with vision/globe absent should not be evaluated for "double vision” and “blank or vacant look” assessments of the SCAT5 tool [37].

Discussion

This position statement brings together information on the PHE of para athletes. We have outlined some considerations for each group of impairments based on the scientific literature and the expertise of professionals from different areas currently working with Paralympic sports.

One of the purposes of the PHE is to prepare and take good care of the para athlete [1]. Although the PHE does not allow predicting injuries, it may allow the health staff to identify better any changes to para athletes' physical and mental status. In other words, PHE allows the formation of a database that allows the follow-up of the para athlete's progression throughout their sporting career. The multidisciplinary team should also be aware that para athletes often do not seek medical consultation for problems inherent to their impairment [8,9]. This delayed report could have severe clinical implications. Thus, periodic assessments can contribute to minimizing this problem and also allow early intervention based on the athlete's history. In addition, the assessment moment can educate the para athletes about preventive measures that may be implemented during practice routine to maintain optimal health and achieve maximal performance [9,70].

The PHE of para athletes should consider both the characteristics of the sport modality and the para athlete impairment. In addition, the PHE could be part of assessing their self-care skills that influence sports training routine (e.g., tying their shoes, changing clothes). The sports health team should acknowledge the support of caregivers or family members in the para athlete's sports practice, especially during the first years of para sports practice [71]. Furthermore, evaluating other contextual factors that may directly impact sports participation is essential, such as education, rehabilitation, functionality and even support from the sports federation to which the athlete belongs [70]. This global assessment will advance inclusion and improve the quality of life of this population [72].

Considering their influence on sports performance, the suitability of assistive devices is another important aspect of the PHE in para athletes [73,74]. Stakeholders need to recruit qualified and experienced medical staff, including a healthcare professional who can evaluate the equipment the para athlete uses. [9,11]. Thereby, the sports health team will be able to act more

effectively in preventing health problems caused by assistive devices and facilitate successful sports participation [75].

Finally, the key to a successful PHE is communication. The multidisciplinary team should discuss the aspects evaluated to outline the goals and must share the data, mainly with the para athlete, to optimize the support [70]. The para athlete's 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 will incite health literacy among para athletes, focusing on clear, accessible and effective health communication [70,76].

Conclusion

The PHE is a valuable tool to monitor athletes' health, identify potential risks, and address barriers to performance. The PHE in para athletes, in particular, poses unique challenges due to their wide variability of impairments and equipment used for sports practice or during daily activities. In this position statement, we described considerations for sports health teams regarding PHE in para athletes, considering the specific impairments (intellectual, musculoskeletal, neurological and visual) and the different physical and mental health aspects. We hope this can be a useful guide for the sports health team. Based on information collected in the available scientific literature and on the expertise of several professionals who work in Paralympic sports, this position statement may contribute to better clinical practice and promote health quality for para athletes.

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6 CONSIDERAÇÕES FINAIS

Os resultados dessa tese corroboram para o fato de que o aumento do desempenho de paratletas ao longo dos anos tem contribuído para o risco aumentado de ocorrência e gravidade de problemas de saúde nessa população. No estudo 1 foi realizada uma revisão sistemática da literatura para investigar a epidemiologia de lesões musculoesqueléticas. Já o estudo 2 caracterizou-se por um estudo prospectivo, longitudinal com o objetivo de caracterizar e estabelecer a prevalência, incidência e o impacto dos problemas de saúde dos paratletas das modalidades de atletismo, halterofilismo e natação do Centro de Referência Paralímpico Brasileiro situado em Belo Horizonte-MG (CRPB). O entendimento dos problemas de saúde dos paratletas inclui a avaliação periódica de saúde, a qual contribui para o rastreamento das condições de saúde que podem colocar um atleta em risco para uma participação segura. Sendo assim, a condução do estudo 3 descreve considerações específicas para a equipe de saúde do esporte na avaliação periódica de saúde em paratletas.

Na revisão sistemática realizada no estudo 1, foi observado que a prevalência de lesões musculoesqueléticas em paratletas foi de 40,8% e a incidência de 14,3 lesões por 1000 atleta-dias, sendo as lesões mais prevalentes as de ombro em paratletas que não deambulam, e as de membros inferiores em paratletas que deambulam. Na época em que foi realizada essa revisão sistemática (Maio de 2020), ainda não havia um consenso sobre os métodos de estudos epidemiológicos no esporte paralímpico, o que aumentava a inconsistência de informações sobre prevalência e incidência de lesões em paratletas nos estudos já publicados. A heterogeneidade dos métodos utilizados em estudos com paratletas, comprometia a qualidade da evidência científica. Dessa forma, a análise de subgrupo revelou que o tamanho da amostra influenciou na estimativa de prevalência de lesões e a qualidade metodológica influenciou na estimativa da incidência de lesões.

Somente em Abril de 2021 foi publicado o consenso realizado pelo grupo de pesquisadores compostos por profissionais do comitê médico e do grupo de gerenciamento do Comitê Paralímpico Internacional sobre o registro e interpretação de dados relativos à saúde do paratleta. A condução do estudo 2 da presente tese seguiu as recomendações do consenso do Comitê Olímpico Internacional no registro e vigilância dos dados de lesão e doença dos paratletas do CRPB, nas modalidades

de atletismo, halterofilismo e natação. Com a publicação do consenso adaptado aos paratletas, foi possível realizar a interpretação dos dados considerando a complexidade do esporte paralímpico. Assim, o estudo 2 realizou o acompanhamento dos paratletas ao longo de uma temporada esportiva e demonstrou que a prevalência semanal média de problemas de saúde foi de 40,6% e a incidência de 12,7 problemas de saúde por 1000 atleta-horas. As regiões corporais mais acometidas por lesões foram ombro, tornozelo e quadril/virilha e os sintomas mais comuns das doenças foram náusea, dor abdominal e fadiga/mal-estar, o que corrobora com os dados presentes na literatura científica. Ao se comparar as modalidades, observou-se que o halterofilismo teve a maior prevalência de problemas de saúde, incluindo os problemas de saúde de maior gravidade, enquanto a natação teve a menor prevalência de lesões e o atletismo a menor prevalência de doenças. Isso permite que a equipe de saúde do esporte do CRPB direcione sua atuação às demandas específicas de cada modalidade.

Por fim, as considerações propostas no estudo 3 sobre a avaliação periódica de saúde em paratletas foi desenvolvida em conjunto com um grupo de pesquisadores e clínicos que atuam diretamente com atletas paralímpicos. Ela permite uma compreensão, por parte da equipe de saúde esportiva, dos riscos para a ocorrência de lesão e doença, do estado de saúde atualizado do paratleta e também a identificação de possíveis barreiras para o desempenho esportivo do paratleta. Essas orientações consideram as especificidades de cada um dos grupos de atletas com deficiências intelectual, musculoesquelética, neurológica e visual e englobam amplamente as condições clínicas, cardiovasculares, neuromusculoesqueléticas, estado nutricional, saúde mental e do sono, concussão e as particularidades da mulher paratleta. Dessa forma, espera-se que os achados da presente tese contribuam para a melhor atuação da equipe de saúde no esporte paralímpico, promovendo o bem estar e a saúde dos paratletas.

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Termo de Consentimento Livre e Esclarecido – TCLE Maiores

Avaliações e Monitoramento de Aspectos Físicos, Fisiológicos e Comportamentais em Atletas Paralímpicos

Pesquisador: Prof. Dr. Marco Túlio de Mello

Prezado, convidamos você a participar da pesquisa "Avaliações e Monitoramento de Aspectos Físicos, Fisiológicos e Comportamentais em Atletas Paralímpicos". Pedimos a sua autorização para a coleta, o depósito, o armazenamento, a utilização e descarte dos dados coletados. A coleta será realizada presencialmente no Centro de Treinamento Esportivo da UFMG e também em formato online através de formulários do Google para avaliar parâmetros decorrentes do isolamento social na pandemia ocasionada pelo COVID-19. A utilização dos dados está vinculada somente a este projeto de pesquisa. Nesta pesquisa, pretendemos avaliar aspectos que influenciam no rendimento esportivo como: sono, carga de treinamento, aspectos biomecânicos e acompanhamento de lesões durante todo o ciclo paralímpico até Paris 2024. Os dados serão coletados no Centro de Treinamento Esportivo da UFMG, local de seu treinamento esportivo. Para a coleta de dados, será solicitado a você que preencha questionários e participe das sessões de treinamento, as quais você já participaria. Além disso, alguns instrumentos específicos serão utilizados, como a actigrafia que será utilizada por um período de 15 dias para avaliar seu ritmo de sono, a polissonografia para avaliar algum possível distúrbio de sono encontrado por meio da actigrafia. Não somente, também participará de filmagens para análises biomecânicas com o intuito de melhorar a técnica do movimento esportivo. As coletas de dados acontecerão em momentos distintos: as avaliações da fisioterapia e controle da carga de treinamento serão semanais, já as avaliações biomecânicas e de sono acontecerão a cada 2 meses.

Os principais riscos inerentes à sua participação na pesquisa são o aparecimento de lesões inerentes à prática da modalidade esportiva. Ressaltamos que este é exatamente o mesmo risco da sua prática diária na modalidade. Podem também ocorrer situações de desgaste ou fadiga muscular. Nestes casos, você tem total liberdade para desistir de participar do estudo, sem nenhum prejuízo. Será fornecida assistência integral por qualquer dano que venha a ocorrer durante sua participação. Em situação de emergência, o Serviço de Atendimento Móvel de Urgência (SAMU / 192) será chamado. Esse será o responsável primário para qualquer eventualidade de cunho médico, e a equipe de pesquisadores acompanhará todos os procedimentos. Você não terá nenhuma remuneração financeira e nem despesa durante a pesquisa, de forma que quaisquer custos inerentes à sua participação serão cobertos pelos pesquisadores.

O principal benefício da sua participação é o acesso a dados qualificados sobre o desempenho na modalidade esportiva, assim como acompanhamento de treinador, nutricionista, psicólogo, fisioterapeuta e médico. Estes dados serão encaminhados a

você em forma de relatório após cada coleta de dados e poderão ser utilizados por você e pela comissão técnica para a melhoria do processo de treinamento.

Rubrica do pesquisador: _____

*Rubrica do participante:*_____

Durante a realização da pesquisa, você está autorizado a solicitar esclarecimentos sobre os protocolos, métodos e objetivos de todas as condutas dos pesquisadores. Além disso, possíveis desconfortos devem ser comunicados e serão prontamente atendidos pelos pesquisadores. Quaisquer informações sobre a pesquisa poderão ser obtidas a partir do contato com o pesquisador, situado na Av. António Carlos, 6627, Escola de Educação Física Fisioterapia e Terapia Ocupacional-EEFFTO, Belo Horizonte, MG, Brasil. CEP 31270-901. Telefones (31)34092324 / (31)99158050, e-mail: tmello@demello.net.br. Informações de caráter ético com o COEP: Comitê de Ética em Pesquisa, situado na Avenida Antônio Carlos, 6627, Unidade Administrativa II, 2º andar sala 2005. Campus Pampulha. Belo Horizonte, MG, Brasil, CEP:31270-901.Telefone:34094592.

Lembramos a possibilidade de você, em qualquer momento e sem penalização de nenhuma ordem, retirar sua participação no estudo, caso haja interesse.

Este termo de consentimento encontra-se impresso em duas vias originais, sendo que uma será arquivada pelo pesquisador responsável, na Universidade Federal de Minas Gerais e a outra será fornecida a você. Os dados, materiais e instrumentos utilizados na pesquisa ficarão arquivados com o pesquisador responsável no Centro de Estudos em Psicobiologia e Exercício que pertence a Escola de Educação Física, Fisioterapia e Terapia Ocupacional da UFMG. Os pesquisadores tratarão a sua identidade com padrões profissionais de sigilo, atendendo a legislação brasileira (Resoluções Nº 466/12; 441/11 e a Portaria 2.201 do Conselho Nacional de Saúde e suas complementares), utilizando as informações somente para fins acadêmicos e científicos, de forma que sua identidade não será divulgada em nenhuma hipótese.

Antes de concordar em participar desta pesquisa e assinar este termo em duas vias, os pesquisadores deverão responder todas as suas dúvidas e, se você concordar em participar do estudo, deve ser entregue uma via deste termo para você.

Eu, _____, portador do documento de Identidade _____, fui informado dos objetivos, métodos, riscos e benefícios da pesquisa, de maneira clara e detalhada e esclareci minhas dúvidas. Sei que a qualquer momento poderei solicitar novas informações e modificar minha decisão de participar se assim o desejar.

Declaro que concordo com a minha participação na pesquisa. Recebi uma via original deste termo de consentimento livre e esclarecido assinado por mim e pelo pesquisador, que me deu a oportunidade de ler e esclarecer todas as minhas dúvidas.

Rubrica do pesquisador: _____

Rubrica do participante:_____

Nome completo do participante

Assinatura do participante

Prof. Dr. Marco Túlio de Mello
Endereço: Avenida Antônio Carlos, 6627
CEP: 31270-901 / Belo Horizonte – MG
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Assinatura do pesquisador

Em caso de dúvidas, com respeito aos aspectos éticos desta pesquisa, você poderá consultar:

COEP-UFMG - Comissão de Ética em Pesquisa da UFMG
Av. Antônio Carlos, 6627. Unidade Administrativa II - 2º andar - Sala 2005.
Campus Pampulha. Belo Horizonte, MG – Brasil. CEP: 31270-901.
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Termo de Consentimento Livre e Esclarecido – TCLE Responsáveis Legais

Avaliações e Monitoramento de Aspectos Físicos, Fisiológicos e Comportamentais em Atletas Paralímpicos

Pesquisador: Prof. Dr. Marco Túlio de Mello

Prezado, convidamos o menor pelo qual o Sr. (a) é responsável a participar da pesquisa "Avaliações e Monitoramento de Aspectos Físicos, Fisiológicos e Comportamentais em Atletas Paralímpicos". Pedimos a sua autorização para a coleta, o depósito, o armazenamento, a utilização e descarte dos dados coletados. A coleta será realizada presencialmente no Centro de Treinamento Esportivo da UFMG e também em formato online através de formulários do Google para avaliar parâmetros decorrentes do isolamento social na pandemia ocasionada pelo COVID-19. A utilização dos dados está vinculada somente a este projeto de pesquisa. Nesta pesquisa, pretendemos avaliar aspectos que influenciam no rendimento esportivo como: sono, carga de treinamento, aspectos biomecânicos e acompanhamento de lesões durante todo o ciclo paralímpico até Paris 2024. Os dados serão coletados no Centro de Treinamento Esportivo da UFMG, local de seu treinamento esportivo. Para a coleta de dados, será solicitado a você que preencha questionários e participe das sessões de treinamento, as quais você já participaria. Além disso, alguns instrumentos específicos serão utilizados, como a actigrafia que será utilizada por um período de 15 dias para avaliar seu ritmo de sono, a polissonografia para avaliar algum possível distúrbio de sono encontrado por meio da actigrafia. Não somente, também participará de filmagens para análises biomecânicas com o intuito de melhorar a técnica do movimento esportivo. As coletas de dados acontecerão em momentos distintos: as avaliações da fisioterapia e controle da carga de treinamento serão semanais, já as avaliações biomecânicas e de sono acontecerão a cada 2 meses.

Os principais riscos inerentes à sua participação na pesquisa são o aparecimento de lesões inerentes à prática da modalidade esportiva. Ressaltamos que este é exatamente o mesmo risco da sua prática diária na modalidade. Podem também ocorrer situações de desgaste ou fadiga muscular. Nestes casos, você, bem como o menor pelo qual você é responsável, têm total liberdade para desistir de participar do estudo, sem nenhum ônus, a qualquer momento. Será fornecida assistência integral por qualquer dano que venha a ocorrer durante da participação do (a) menor pelo (a) qual você é responsável nos procedimentos. Em situação de emergência, o Serviço de Atendimento Móvel de Urgência (SAMU / 192) será chamado. Esse será o responsável primário para qualquer eventualidade de cunho médico, e a equipe de pesquisadores acompanhará todos os procedimentos. Você não terá nenhuma remuneração financeira e nem despesa durante a pesquisa, de forma que quaisquer custos inerentes à sua participação serão cobertos pelos pesquisadores.

Rubrica do pesquisador: _____

*Rubrica do participante:*_____

O principal benefício da sua participação é o acesso a dados qualificados sobre o desempenho na modalidade esportiva, assim como acompanhamento de treinador, nutricionista, psicólogo, fisioterapeuta e médico. Estes dados serão encaminhados a você em forma de relatório após cada coleta de dados e poderão ser utilizados por você e pela comissão técnica para a melhoria do processo de treinamento.

Durante a realização da pesquisa, você está autorizado a solicitar esclarecimentos sobre os protocolos, métodos e objetivos de todas as condutas dos pesquisadores. Além disso, possíveis desconfortos devem ser comunicados e serão prontamente atendidos pelos pesquisadores. Quaisquer informações sobre a pesquisa poderão ser obtidas a partir do contato com o pesquisador, situado na Av. Antônio Carlos, 6627, Escola de Educação Física Fisioterapia e Terapia Ocupacional-EEFFTO, Belo Horizonte, MG, Brasil. CEP 31270-901. Telefones (31)34092324 / (31)99158050, e-mail: tmello@demello.net.br. Informações de caráter ético com o COEP: Comitê de Ética em Pesquisa, situado na Avenida Antônio Carlos, 6627, Unidade Administrativa II, 2º andar sala 2005. Campus Pampulha. Belo Horizonte, MG, Brasil, CEP:31270-901.Telefone:34094592.

Salienta-se a liberdade do responsável legal e do voluntário em recusar, em qualquer momento e sem penalização de nenhuma ordem, a participação no estudo, bem como retirar seu consentimento caso haja interesse.

Este termo de consentimento encontra-se impresso em duas vias originais, sendo que uma será arquivada pelo pesquisador responsável, na Universidade Federal de Minas Gerais e a outra será fornecida ao Sr. (a). Os dados, materiais e instrumentos utilizados na pesquisa ficarão arquivados com o pesquisador responsável no Centro de Estudos em Psicobiologia e Exercício que pertence a Escola de Educação Física, Fisioterapia e Terapia Ocupacional da UFMG. Os pesquisadores tratarão a sua identidade com padrões profissionais de sigilo, atendendo a legislação brasileira (Resoluções Nº 466/12; 441/11 e a Portaria 2.201 do Conselho Nacional de Saúde e suas complementares), utilizando as informações somente para fins acadêmicos e científicos, de forma que sua identidade não será divulgada em nenhuma hipótese.

Antes de concordar em participar desta pesquisa e assinar este termo em duas vias, os pesquisadores deverão responder todas as suas dúvidas e, se você concordar em participar do estudo, deve ser entregue uma via deste termo para você.

Eu, _____, portador do documento de Identidade _____, responsável legal pelo menor _____, identidade _____, fui informado dos objetivos, métodos, riscos e benefícios da pesquisa, de maneira clara e detalhada e esclareci minhas dúvidas. Sei que a qualquer momento poderei solicitar novas informações e modificar minha decisão de participar se assim o desejar.

Declaro que concordo com a participação do menor sob minha responsabilidade voluntário na pesquisa. Recebi uma via original deste termo de consentimento livre e esclarecido assinado por mim e pelo pesquisador, que me deu a oportunidade de ler e esclarecer todas as minhas dúvidas.

Rubrica do pesquisador: _____

Rubrica do participante:_____

Nome completo do participante

Assinatura do participante

Prof. Dr. Marco Túlio de Mello
Endereço: Avenida Antônio Carlos, 6627
CEP: 31270-901 / Belo Horizonte – MG
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Assinatura do pesquisador

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Termo de Assentimento Livre e Esclarecido – TALE

Avaliações e Monitoramento de Aspectos Físicos, Fisiológicos e Comportamentais em Atletas Paralímpicos

Pesquisador: prof. Dr. Marco Túlio de Mello

Prezado, convidamos você a participar da pesquisa "Avaliações e Monitoramento de Aspectos Físicos, Fisiológicos e Comportamentais em Atletas Paralímpicos". Pedimos a sua autorização para a coleta, o depósito, o armazenamento, a utilização e descarte dos dados coletados. A coleta será realizada presencialmente no Centro de Treinamento Esportivo da UFMG e também em formato online através de formulários do Google para avaliar parâmetros decorrentes do isolamento social na pandemia ocasionada pelo COVID-19. A utilização dos dados está vinculada somente a este projeto de pesquisa. Nesta pesquisa, pretendemos avaliar aspectos que influenciam no rendimento esportivo, como: sono, carga de treinamento, aspectos biomecânicos e acompanhamento de lesões durante todo o ciclo paralímpico até Paris 2024. Para a coleta de dados, será solicitado a ele que preencha questionários e participe das sessões de treinamento, as quais ele já participaria. Além disso, alguns instrumentos específicos serão utilizados, como a actigrafia que será utilizada por um período de 15 dias para avaliar seu ritmo de sono e a polissonografia para avaliar algum possível distúrbio de sono encontrado por meio da actigrafia. Não somente, também participará de filmagens para análises biomecânicas com o intuito de melhorar a técnica do movimento esportivo. As coletas de dados acontecerão em momentos distintos: as avaliações da fisioterapia e controle da carga de treinamento serão semanais, já as avaliações biomecânicas e de sono acontecerão a cada 2 meses.

Os principais riscos inerentes à participação na pesquisa são o aparecimento de lesões inerentes à prática da modalidade esportiva. Ressaltamos que este é exatamente o mesmo risco da prática diária na modalidade. Podem também ocorrer situações de desgaste ou fadiga muscular. Nestes casos, você, bem como o menor pelo qual você é responsável, têm total liberdade para desistir de participar do estudo a qualquer momento, sem nenhum prejuízo a vocês. Será fornecida assistência integral por qualquer dano que venha a ocorrer durante da participação do (a) menor pelo (a) qual você é responsável. Em situação de emergência, o Serviço de Atendimento Móvel de Urgência (SAMU / 192) será chamado. Esse será o responsável primário para qualquer eventualidade de cunho médico e a equipe de pesquisadores acompanhará todos os procedimentos. Os pesquisadores também se responsabilizarão em comunicá-lo (a) nestes casos. Você não terá nenhuma remuneração financeira e nem despesa durante a pesquisa, de forma que quaisquer custos inerentes à sua participação serão cobertos pelos pesquisadores.

Rubrica do pesquisador: _____

*Rubrica do participante:*_____

O principal benefício da sua participação é o acesso a dados qualificados sobre o desempenho na modalidade esportiva, assim como acompanhamento de treinador, nutricionista, psicólogo, fisioterapeuta e médico. Estes dados serão encaminhados a você em forma de relatório após cada coleta de dados e poderão ser utilizados por você e pela comissão técnica para a melhoria do processo de treinamento.

Durante a realização da pesquisa, você está autorizado a solicitar esclarecimentos sobre os protocolos, métodos e objetivos de todas as condutas dos pesquisadores. Além disso, possíveis desconfortos devem ser comunicados e serão prontamente atendidos pelos pesquisadores. Quaisquer informações sobre a pesquisa poderão ser obtidas a partir do contato com o pesquisador, situado na Av. António Carlos, 6627, Escola de Educação Física Fisioterapia e Terapia Ocupacional-EEFFTO, Belo Horizonte, MG, Brasil. CEP 31270-901. Telefones (31)34092324 / (31)995159050, e-mail: tmello@demello.net.br. Informações de caráter ético com o COEP: Comitê de Ética em Pesquisa, situado na Avenida Antônio Carlos, 6627, Unidade Administrativa II, 2º andar sala 2005. Campus Pampulha. Belo Horizonte, MG, Brasil, CEP:31270-901.Telefone:34094592.

Lembramos a possibilidade de você, em qualquer momento e sem penalização de nenhuma ordem, retirar sua participação no estudo, caso haja interesse.

Este termo de consentimento encontra-se impresso em duas vias originais, sendo que uma será arquivada pelo pesquisador responsável, na Universidade Federal de Minas Gerais e a outra será fornecida por você. Os dados, materiais e instrumentos utilizados na pesquisa ficarão arquivados com o pesquisador responsável do Centro de Estudos em Psicobiologia e Exercício da UFMG, que pertence a Escola de Educação Física, Fisioterapia e Terapia Ocupacional da UFMG. Os pesquisadores tratarão a sua identidade com padrões profissionais de sigilo, atendendo a legislação brasileira (Resoluções Nº 466/12; 441/11 e a Portaria 2.201 do Conselho Nacional de Saúde e suas complementares), utilizando as informações somente para fins acadêmicos e científicos.

Antes de concordar em participar desta pesquisa e assinar este termo em duas vias, os pesquisadores deverão responder todas as suas dúvidas e, se você concordar em participar do estudo, deve ser entregue uma via deste termo para você.

Eu, _____, portador do documento de Identidade _____, fui informado (a) dos objetivos, métodos, riscos e benefícios da pesquisa, de maneira clara e detalhada e esclareci minhas dúvidas. Sei que a qualquer momento poderei solicitar novas informações e modificar minha decisão de participar se assim o desejar.

Declaro que concordo com a minha participação na pesquisa. Recebi uma via original deste termo de consentimento livre e esclarecido assinado por mim e pelo pesquisador, que me deu a oportunidade de ler e esclarecer todas as minhas dúvidas.

Rubrica do pesquisador: _____

*Rubrica do participante:*_____

Nome completo do participante

Assinatura do participante

Prof. Dr. Marco Túlio de Mello:
Endereço: Avenida Antônio Carlos, 6627
CEP: 31270-901 / Belo Horizonte – MG
Telefones: (31) 3409-2324
E-mail: tmello@demello.net.br

Assinatura do pesquisador

Em caso de dúvidas, com respeito aos aspectos éticos desta pesquisa, você poderá consultar:

COEP-UFMG - Comissão de Ética em Pesquisa da UFMG
Av. Antônio Carlos, 6627. Unidade Administrativa II - 2º andar - Sala 2005.
Campus Pampulha. Belo Horizonte, MG – Brasil. CEP: 31270-901.
E-mail: coep@prpq.ufmg.br. Tel: 34094592.

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: Avaliações e Monitoramento de Aspectos Físicos, Fisiológicos e Comportamentais em Atletas Paralímpicos

Pesquisador: Marco Tulio de Mello

Área Temática:

Versão: 2

CAAE: 27518619.4.0000.5149

Instituição Proponente: Escola de Educação Física da Universidade Federal de Minas Gerais

Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 3.990.279

Apresentação do Projeto:

Trata-se de um projeto que pretende avaliar os parâmetros físicos, fisiológicos e comportamentais de atletas paralímpicos que treinam no Centro de Referência Paralímpico Brasileiro (CRPB/CTE-UFMG) durante o ciclo olímpico visando Paris 2024. Dessa maneira, as avaliações terão início em 2020 e seguirão até 2024, sendo elas: composição corporal, capacidade e potência aeróbia e anaeróbia em testes na esteira, ergômetro de braço e rolo específico para cadeiras de rodas, teste de força muscular, teste de equilíbrio, padrão de sono, assim como acompanhamento longitudinal de lesões e parâmetros biomecânicos visando aprimoramento do gesto esportivo. Após a realização das avaliações, os atletas e treinadores receberão relatórios com os resultados e sugestões para melhorar o rendimento. O projeto está bem escrito e fundamentado e apresenta os elementos necessários para o parecer deste Comitê.

Objetivo da Pesquisa:

O objetivo geral é avaliar e monitorar parâmetros físicos, fisiológicos e comportamentais de atletas paralímpicos do Centro de Treinamento Esportivo da UFMG até 2024 nas modalidades de atletismo, natação e halterofilismo. Os objetivos específicos são: avaliar e monitorar de maneira subjetiva e objetiva a qualidade e a quantidade de sono de atletas paralímpicos até Paris 2024; compreender o perfil de queixas e lesões esportivas em atletas paralímpicos e como se relacionam

os fatores de estrutura e função corporal e
contextuais desses atletas com a ocorrência da lesão esportiva até Paris 2024; monitorar e controlar a carga de treinamento dos atletas paralímpicos até Paris2024; verificar os efeitos da ETCC no desempenho de atletas paralímpicos; avaliar e monitorar variáveis biomecânicas relacionadas ao desempenho dos atletas paralímpicos até Paris 2024; avaliar as percepções subjetivas de sono, de recuperação, de dor e de esforço dos atletas paralímpicos até Paris 2024.

Avaliação dos Riscos e Benefícios:

Os autores informam que os métodos do presente projeto apresenta risco leve para o atleta paralímpico, como dor muscular leve provenientes do treinamento esportivo no qual eles realizam. Nesta eventualidade, o participante será assistido pelos pesquisadores. Quanto aos benefícios, os atletas serão avaliados e monitorados ao longo de 4 anos, sendo que, todas as avaliações realizadas serão posteriormente repassadas quanto aos resultados aos atletas com o objetivo de melhorar seu desempenho e seu rendimento esportivo.

Comentários e Considerações sobre a Pesquisa:

O projeto é factível, pertinente e está bem fundamentado. Apresenta justificativa para sua realização e possíveis benefícios.

Considerações sobre os Termos de apresentação obrigatória:

Apresenta projeto completo com a metodologia, TCLE e TALE bem redigidos, com todos os elementos necessários para garantir ao participante segurança ética. Apresenta carta de anuência dos locais coparticipantes.

Algumas sentenças do TALE e do TCLE ainda ão deixam claro quais procedimentos serão com os atletas e quais com os repsonsáeis.

Recomendações:

Sou a favor, S.M.J., da aprovação do projeto.

Conclusões ou Pendências e Lista de Inadequações:

1- Favor revisar o TALE para menores e TCLE para responsáveis pois algumas frases ainda não deixam claro se os procedimentos serão com os menores ou com os responsáveis.

Considerações Finais a critério do CEP:

Tendo em vista a legislação vigente (Resolução CNS 466/12), o CEP-UFMG recomenda aos Pesquisadores: comunicar toda e qualquer alteração do projeto e do termo de consentimento via emenda na Plataforma Brasil, informar imediatamente qualquer evento adverso ocorrido durante o desenvolvimento da pesquisa (via documental encaminhada em papel), apresentar na forma de

notificação relatórios parciais do andamento do mesmo a cada 06 (seis) meses e ao término da pesquisa encaminhar a este Comitê um sumário dos resultados do projeto (relatório final).

Este parecer foi elaborado baseado nos documentos abaixo relacionados:

Tipo Documento	Arquivo	Postagem	Autor	Situação
Informações Básicas do Projeto	PB_INFORMAÇÕES_BÁSICAS_DO_PROJETO_1471457.pdf	15/03/2020 22:33:35		Aceito
Outros	CartaRespostaPendencia.pdf	15/03/2020 22:32:34	Marco Tulio de Mello	Aceito
TCLE / Termos de Assentimento / Justificativa de Ausência	TCLEParalimpicoCTE.docx	15/03/2020 22:31:01	Marco Tulio de Mello	Aceito
TCLE / Termos de Assentimento / Justificativa de Ausência	TCLERespLegaisParalimpicoCTE.docx	15/03/2020 22:30:50	Marco Tulio de Mello	Aceito
TCLE / Termos de Assentimento / Justificativa de Ausência	TALEparalimpicoCTE.docx	15/03/2020 22:29:14	Marco Tulio de Mello	Aceito
Declaração de Instituição e Infraestrutura	parecerconsubstanciado.pdf	19/12/2019 18:30:37	Marco Tulio de Mello	Aceito
Folha de Rosto	folhaderosto.pdf	19/12/2019 18:28:54	Marco Tulio de Mello	Aceito
Projeto Detalhado / Brochura Investigador	Projeto.pdf	16/12/2019 14:25:35	Marco Tulio de Mello	Aceito
Declaração de Instituição e Infraestrutura	CPB.pdf	16/12/2019 14:25:00	Marco Tulio de Mello	Aceito
Declaração de Instituição e Infraestrutura	CTE.pdf	16/12/2019 14:24:16	Marco Tulio de Mello	Aceito

Situação do Parecer:
Aprovado

Necessita Apreciação da CONEP:
Não

BELO HORIZONTE, 25 de Abril de 2020

Assinado por:
Críssia Carem Paiva Fontainha
(Coordenador(a))

Endereço: Av. Presidente Antônio Carlos,6627 2º Ad Sl 2005
Bairro: Unidade Administrativa II **CEP:** 31.270-901
UF: MG **Município:** BELO HORIZONTE
Telefone: (31)3409-4592 **E-mail:** coep@prpq.ufmg.br

Versão Brasileira do Questionário para Problemas de Saúde no Esporte (OSTRC-Br)

Bem-vindo ao nosso questionário para registro de lesões e doenças:

Desejamos com esse projeto assegurar que você tenha um acompanhamento melhor por parte de sua equipe médica.

Por favor, responda a todas as perguntas, independentemente da existência ou não de ter apresentado algum incomodo/problemas de saúde ***na semana passada***.

Escolha sempre a alternativa que mais reflete o que você sentiu **na semana passada.**

Se por acaso, na semana passada você teve mais de um incomodo/problema de saúde, comece registrando aquele que foi o pior problema. Você poderá registrar os outros problemas no final do questionário.

Sempre que você registrar algum incomodo ou algum problema de saúde a equipe médica será notificada sobre seu caso dentro do prazo de uma semana. Porém, é importante esclarecer que este sistema não substitui seu contato regular com sua equipe médica. Continue a fazer contato direto com a equipe médica/fisioterapeuta quando necessário.

1- PARTICIPAÇÃO NOS TREINAMENTOS E COMPETIÇÕES

Na semana passada, você teve alguma dificuldade/incômodo em **participar no seu esporte** por causa de lesões, doenças ou outros problemas de saúde?

- Participação total, sem dificuldade/incômodo
- Participação total, mas com dificuldade/incômodo
- Participação reduzida, por causa da dificuldade/incômodo
- Não pude participar, devido à dificuldade/incômodo

2- REDUÇÃO NO VOLUME TREINAMENTO

Na semana passada, quanto que você **reduziu o volume de treinamento** por causa de algum incômodo, doença ou outros problemas de saúde?

- Nenhuma redução
- Pequena redução
- Moderada redução
- Grande redução
- Não pude treinar por causa de incômodo, doença ou problema de saúde

3- DIMINUIÇÃO DO DESEMPENHO

Na semana passada, quanto que o incômodo, doença ou problema de saúde **reduziu o seu desempenho**?

- Nenhuma redução
- Pequena redução
- Moderada redução
- Grande redução
- Não pude treinar ou competir por causa de incômodo, doença ou problema de saúde

4- SINTOMAS DA LESÃO OU DOENÇA

Na semana passada, qual foi a **intensidade do seu incômodo ou problema de saúde**?

- Nenhum incômodo/Nenhum problema de saúde
- Pequena intensidade
- Moderada intensidade
- Grande intensidade

5- RESUMO

O incômodo ou problema de saúde relatado nas quatro perguntas acima se refere a uma lesão ou doença?

- Lesão
- Doença

6- ÁREA DA LESÃO

SE O SEU PRINCIPAL PROBLEMA NA SEMANA PASSADA FOI UMA **LESÃO**, POR FAVOR, PREENCHA ESTE ESPAÇO.

Marque/assinale a área lesionada ou que você teve queixa. Se você teve mais que uma lesão, *marque a que foi mais grave*.

- Cabeça/face
- Nuca/pescoço
- Ombro, incluindo a clavícula
- Parte superior do braço
- Cotovelo
- Antebraço
- Punho
- Dedos da mão
- Tórax, incluindo órgãos internos
- Abdômen, incluindo órgãos internos
- Parte superior da coluna (região torácica)
- Parte inferior da coluna (região lombar)
- Pelve
- Quadril/virilha
- Coxa
- Joelho
- Panturrilha/perna
- Tornozelo
- Pés/dedos
- Outra parte do corpo:_____

7- SINTOMAS DA DOENÇA

SE O SEU PRINCIPAL PROBLEMA NA SEMANA PASSADA FOI UMA **DOENÇA** OU **OUTROS PROBLEMAS RELACIONADOS À SAÚDE**, POR FAVOR RESPONDA ESTE ESPAÇO.

Por favor, *marque todos os sintomas* que você teve no decorrer da semana passada.

- ☐ Febre
- ☐ Fraqueza/cansaço
- ☐ Inchaço/edema dos gânglios linfáticos
- ☐ Dor de garganta/garganta inflamada
- ☐ Nariz entupido/corisa/espirros
- ☐ Tosse
- ☐ Dificuldade respiratória/falta de ar
- ☐ Dores de cabeça
- ☐ Enjoo/sensação de mal-estar
- ☐ Diarreia
- ☐ Constipação
- ☐ Desmaio
- ☐ Coceira/erupção cutânea
- ☐ Pulso irregular/taquicardia
- ☐ Dormência/formigamento
- ☐ Ansiedade
- ☐ Depressão
- ☐ Irritação
- ☐ Sintomas nos olhos
- ☐ Sintomas nos ouvidos
- ☐ Sintomas nas vias urinárias ou órgão genitais
- ☐ Dores no peito
- ☐ Dor abdominal
- ☐ Dor em outras regiões. Por favor, Especifique:_____
- ☐ Outros. Especifique:_____

8- COMENTÁRIOS/OUTRAS INFORMAÇÕES

Use este espaço se você deseja nos enviar algum comentário ou informações adicionais sobre esta lesão, doença ou problema de saúde.

_____
_____
_____
_____
_____

9- TEMPO DE AFASTAMENTO

Por favor, informe o **número de dias** da semana passada que você ficou ***completamente incapaz de treinar ou competir*** devido à lesão ou problema de saúde.

☐ 0 dia ☐ 1 dia ☐ 2 dias ☐ 3 dias ☐ 4 dias ☐ 5 dias ☐ 6 dias ☐ 7dias

10- REGISTRO/NOTIFICAÇÃO

Esta é a primeira vez que você registra/relata esta lesão ou doença **através deste questionário?**

- Sim, esta é a primeira vez
- Não, eu já registrei/relatei esse mesmo problema em uma das últimas quatro semanas
- Não, eu já registrei/relatei antes, porém foi há mais de quatro semanas

11- CONTATO COM A EQUIPE MÉDICA

Eu relatei o problema para o:

- ☐ Médico do COTP
- ☐ Outro médico
- ☐ Fisioterapeuta do COTP
- ☐ Outro fisioterapeuta
- ☐ Outro profissional: Por favor, especifique quem e onde ele trabalha:_____
  _____
- ☐ Outra pessoa: Por favor, especifique quem: _____
  _____

12- VOCÊ TEVE ALGUM OUTRO INCÔMODO, DOENÇA OU OUTRO PROBLEMA DE SAÚDE NA SEMANA PASSADA?

- Sim
- Não

LARISSA SANTOS PINTO PINHEIRO

Fisioterapeuta Sócia Especialista SONAFE (Sociedade Nacional de Fisioterapia Esportiva e Atividade Física)

CONTATO

larilu.pinheiro@outlook.com
(31) 97556-6438
Minas Gerais - Brasil

HABILIDADES

Língua inglesa: fala, escreve e compreende bem

Pacote Office: bom domínio

FORMAÇÃO ACADÊMICA

2018-2023 - Doutoranda do Programa de Pós Graduação em Ciências da Reabilitação
Universidade Federal de Minas Gerais com período sanduíche na Vrije Universiteit Amsterdam
Orientador no exterior: Evert Verhagen
Orientador no Brasil: Renan Alves Resende

2016-2018 - Mestrado em Ciências da Reabilitação
Universidade Federal de Minas Gerais
Título: Associação entre a cinemática e o torque dos músculos do tronco e do quadril e o desempenho de corredores no star teste modificado
Orientador: Renan Alves Resende
Co-orientadoras: Juliana M. Ocarino e Natália Franco N. Bittencourt

2014-2015 - Especialização em Fisioterapia Esportiva
Universidade Federal de Minas Gerais

2008-2013 - Graduação em Fisioterapia
Universidade Federal de Minas Gerais

EXPERIÊNCIA PROFISSIONAL

UNIVERSIDADE FEDERAL DE MINAS GERAIS
2017 - atual
Fisioterapeuta do Departamento de Fisioterapia da Escola de Educação Física, Fisioterapia e Terapia Ocupacional e do Centro de Treinamento Esportivo
Carga horária semanal: 30 horas

DINÂMICA SOLUÇÕES EM SAÚDE
2016-2019
Fisioterapeuta atuando na área de Ginástica Laboral
Carga horária semanal: 2 horas

LA BELLE
2015-2017
Fisioterapeuta atuando na área de Pilates
Carga horária semanal: 20 horas

SERVIÇO SOCIAL DA COSNTRUÇÃO CIVIL DO ESTADO DE MINAS GERAIS
2013-2015
Fisioterapeuta atuando na área de Ortopedia
Carga horária semanal: 30 horas

FORMAÇÃO COMPLEMENTAR

CURSO DE QUIROPRAXIA CLÍNICA

2023 - Ministrante Prof. Eduardo Miranda

Carga horária: 100 horas

FUNDAMENTOS DA FISIOTEARAPIA ESPORTIVA

2022 - Sociedade Nacional de Fisioterapia Esportiva e da Atividade Física

Carga horária: 30 horas

PRONTO ATENDIMENTO PRÉ-HOSPITALAR DE EMERGÊNCIA NO ESPORTE

2021 - RECON - Serviços de Fisioterapia, Consultoria e Assessoria na Área de Saúde

Carga horária: 50 horas

DIAGNÓSTICO E TERAPIA MECÂNICA - PARTES A, B

2018-2019 - Centro de Estudos pós Graduação em Diagnóstico e Terapia Mecânica, INST. MCKENZIE

Carga horária: 56 horas

CURSO INTERNACIONAL DE DYNAMIC TAPING

2015 - Dynamic Tape - The Biomechanical Tape

Carga horária: 8 horas

CURSO DO CONCEITO MULLIGAN DE TERAPIA MANUAL

2015 - International Mulligan Concept Teachers Association®, MTCA

Carga horária: 40 horas

CURSO DE CROCHETAGEM FISIOTERAPÊUTICA

2015 - Associação Brasileira de Crochetagem, ABC

Carga horária: 44 horas

PROGRAMA DE APERFEIÇOAMENTO EM REABILITAÇÃO INFANTIL

2014 - Associação Mineira de Reabilitação, AMR, Belo Horizonte

Carga horária: 1100 horas

PILATES: CONDICIONAMENTO ATRAVÉS DA VISÃO CLÍNICA

2013 - Quali Fisioterapia, QUALIFISIO

Carga horária: 100 horas

PARTICIPAÇÃO EM CONGRESSOS E EVENTOS

SPORTSKONGRESS - COPENHAGEN, DINAMARCA

Participação no congresso e apresentação de poster entitulado "Prevalence and incidence of health problems and their characterisation in Brazilian para athletes: a one season prospective study"

02 a 04 de Fevereiro/2023

INTERNATIONAL JUDO TRAINING CAMP EM KOKSIJDE, BÉLGICA

Fisioterapeuta atuando junto a equipe TopJudo Amsterdam

06 a 08 de Janeiro/2023

CAMPEONATO BRASILEIRO LOTERIAS CAIXA SUB-20 DE ATLETISMO

Fisioterapeuta atuando junto a equipe de atletismo do CTE-UFMG

22 a 24 de Abril/2022

CAMPEONATO BRASILEIRO LOTERIAS CAIXA SUB-18 DE ATLETISMO

Fisioterapeuta atuando junto a equipe de atletismo do CTE-UFMG

27 a 29 de Agosto/2021