RUNNING HEAD: Physical Activity Among People with Disabilities

Physical Activity Among People with Disabilities: A Global Perspective

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Summary

Globally, ~1.5 billion people live with a physical, mental, sensory or intellectual disability, with ~80% living in low- and middle-income countries. This paper provides a global overview of physical activity (PA) prevalence, benefits, promotion and policy for people living with disabilities (PWD). PWD are 16-62% less likely to meet PA guidelines and are at greater risk for the serious health problems of inactivity. Meta-analyses show beneficial effects of PA on cardiovascular (mean SMD=·69 [CI=·31-1.01], *n*=11) and musculoskeletal fitness (mean SMD=·59 [CI=·31-·87], *n*=10), cardiometabolic risk factors (mean SMD=·39 [CI=·04-·75], *n*=1) and brain/mental health outcomes (mean SMD=·47 [·21-·73], *n*=9). These data also show health benefits can be achieved from PA below 150 min/week and suggest doing some PA is better than doing none. Meta-analyses of interventions to increase PA for PWD have reported effect sizes ranging from 0·29 (0·17-0·41, *k*=10) to 1·00 (0·46-1·53, *k*=10). At the policy level, awareness is starting to increase regarding PWDs' needs for full participation in PA. Worldwide, PA action plans must be adequately resourced, monitored and enforced to truly advance the fundamental rights of PWD to fully participate in PA.

INTRODUCTION

People living with disabilities (PWD)[†] experience poorer health than the general population.[1] PWD are at greater risk for developing non-communicable chronic diseases, more likely to experience injuries, and develop age-related health conditions at earlier ages. These health inequities are attributable to various factors, including greater barriers to health care, higher rates of health-compromising behaviour, and a lower likelihood of receiving disease prevention and health promotion services compared to people without disabilities.[1] Indeed, as recently highlighted in *The Lancet*, health services are failing the 1.5 billion PWD worldwide.[2]

Although PWD remain underserved, over the past 50 years, the societal response to disability has shifted significantly. Whereas disability was traditionally medicalised as a condition to be treated,[3,4] disability is now recognized as part of the continuum of the human condition[1] that can be generative, creative, affirmative, and enjoyed.[5] New ideas on disability are challenging long-standing assumptions about what it means to be human by questioning humanistic values of autonomy, rationality, and independence.[5] The United Nations (UN) aspires to protect the rights and freedoms of PWD through the *Convention on the Rights of Persons with Disabilities* (CRPD)[6] and includes PWD in its Sustainable Development Goals (SDGs), especially in SDG3 – "ensure healthy lives and promote well-being for all at all ages".[7] Together, these responses are beginning to influence thought, research, and action regarding PA for PWD.

[†] There is considerable sensitivity around the language of disability and no international consensus regarding use of the terms "disabled people," "people with disabilities" or language that foregrounds neither the 'person' nor 'disability' but other aspects of the self. We have used language consistent with the UN Convention on the Rights of Persons with Disabilities and recognize that such terminology is not universally accepted.

In Lancet Physical Activity Series (LPAS) 1 and 2 papers,[8,9] physical inactivity was associated with 5.3 million deaths and health-care systems costs of $53·8 billion per year worldwide.[10] PWD are at even greater risk than the general population for inactivity-related health consequences and yet the study of PA and health for PWD has been marginalized. From 1999-2019, less than 5% of all articles published in the five highest-impact medical journals focused on PWD and less than 7% of these addressed PA or health (see Supplement 1). As cogently argued in an LPAS1 editorial, PA for PWD is an issue that demands better evidence, surveillance, practice, respect and value.[11]

To begin addressing these inequities, clinicians, scientists, exercise professionals, educators, health-promoters, policy-advisors and policy-makers must understand the current status, and the many benefits, of PA for PWD worldwide. Drawing on three meta-reviews produced specifically for this LPAS3 paper, we provide a narrative overview of the current knowledge regarding PA for PWD, identify knowledge and action gaps, and formulate recommendations for bridging gaps with the general population. Specific objectives are to: (1) provide an overview of PA epidemiology for PWD worldwide with regard to prevalence and health benefits; (2) review factors related to PA participation and interventions to increase PA for PWD; and (3) discuss international PA policy actions and recommendations for PWD.

1. THE EPIDEMIOLOGY OF PA AMONG PWD

1.1 PA prevalence for PWD

There are no comprehensive global estimates of PA among PWD. Global PA surveillance systems (e.g. STEPs[12]) do not include measures to assess disability, and most national and international disability surveillance systems do not include measures of PA. Many PWD are excluded from population-level data sets on PA. Because PA for PWD is not a consistently prioritized measurement within current surveillance systems, longitudinal data do not exist to estimate patterns of PA for PWD over time.

Virtually all available population data on PA for PWD come from High Income Countries (HIC) in North America and north-western Europe (see Table 1). Prevalence estimates vary greatly across surveillance systems due to different assessment methods, indicating PWD in HIC are 16-62% less likely to meet PA recommendations than people without disabilities.[17] Estimates of the proportion of adults with disabilities living in HIC who meet PA guidelines range from 20·6% to 60·1%.[17, 20] In contrast, estimates for adults without disabilities in those same studies range from 53·7% to 91·1%. For children with disabilities (CWD), estimates of those meeting PA guidelines in 15 European countries, aged 11-15 years, vary from 8·5% to 40·4%,[16] with girls being less active than boys. Although only ~20% of 11-17 year-olds worldwide meet PA guidelines[21], physical education is compulsory in 97% of countries; just 72% of CWD who attend school have access to physical education[22], suggesting lower levels of school-based PA in CWD.

INSERT TABLE 1 ABOUT HERE

Approximately 80%[1] of PWD live in Low to Middle Income Countries (LMIC) and yet PA and disability data from LMIC are scarce. This situation falls unacceptably short of the UN General Assembly’s SDGs which explicitly reference PWD, including Goals 3, 4, 10, and 11 (Good Health and Well-Being; Quality Education; Reduced Inequality; Sustainable Cities and Communities, respectively).[7] The most comprehensive data set we could find is a cross-sectional study conducted in 46 LMIC. Adults with various chronic physical conditions (including, but not limited to disabling conditions such as arthritis, hearing problems, and visual impairment), particularly older adults, were significantly less likely to meet PA guidelines than adults without those conditions.[23] Challenges to estimating PA rates of PWD in LMIC include a lack of comprehensive surveillance systems,[24] a need for cultural- and language-specific tools to screen and identify PWD[25] and a need for improved, standardized PA measures. Additionally, because 98% of CWD in LMIC do not attend school,[26] school-based assessments of PA are infeasible.

The lack of standardized disability and PA measures is a challenge for both LMIC and HIC. Definitions of disability often vary across sectors (social, medical, educational, etc.), so it is important for public health surveillance systems to use standardized disability measures. Standardized PA measures are necessary to facilitate comparisons between people with and without disabilities. Table 1 data are derived from surveys that defined disability using ICF (International Classification of Functioning, Disability and Health) classifications[27-29] or questions from the UN Washington Group on Disability statistics,[13] but not all studies consistently use these approaches. Regarding measurement of PA, the self-report instruments used to derive international PA estimates (i.e., IPAQ, GPAQ) have limited validity and reliability data for populations with disabilities.[30-32] Because these instruments place a heavy emphasis on measuring walking activity, alternative measures have been used to assess PA in people with mobility impairments.[33] Together, these challenges have resulted in inconsistent and non-comparable PA and disability measures across surveys and surveillance systems.

1.2 Health benefits of PA for PWD

A rapid review of international literature underpinning the new UK PA guidelines,[34] reported that PA is beneficial for most PWD.[35] Importantly, no evidence suggested PA is harmful for PWD. PA was positively associated with cardiorespiratory fitness, muscular strength, functional skills, psychosocial well-being, and reduced disease risk in people with physical or cognitive disabilities.

Similarly, systematic reviews underpinning the new US[36,37] and WHO[38,39] PA guidelines reported that PA was associated with improved physical function, cognition, and quality of life among people with selected disabilities (e.g., related to multiple sclerosis, spinal cord injury, Parkinson's disease, schizophrenia, stroke). However, for many other outcomes such as mortality and noncommunicable diseases, and for people with intellectual disabilities, insufficient evidence was available about the effects of PA.

For the purpose of this paper, we conducted a systematic review resulting in 36 meta-analysis studies in which a) a PA prescription/program/intervention was implemented among children, youth or adults with a disability, and b) one or more cardiovascular, musculoskeletal, cardiometabolic, or mental-/brain-health outcomes were measured (see Supplementary Files 2-5). Thirty-three meta-analyses (92%) reported statistically significant effects in favour of intervention versus control groups. Figure 1 shows the frequency of statistically significant and non-significant effects for each outcome category. Overall, the meta-analyses consistently reported significant positive effects of PA on cardiovascular and musculoskeletal health. Over half the meta-analyses of cardiometabolic outcomes reported nonsignificant effects. Results for mental/brain-health were mixed. For studies that reported a standardized mean difference (SMD; n=28), average effect sizes and confidence intervals for each outcome were: cardiovascular (mean SMD=·69 [CI=·31-1·01], *n*=11), musculoskeletal (mean SMD=0·59 [CI=·31-·87], *n*=10); cardiometabolic (mean SMD=·39 [CI = ·04-·75], *n*=1); and brain/mental health outcomes (mean SMD=0·47 [CI=·21-·73], *n*=9). Mean effects were relatively unchanged after removing 18 meta-analyses of "Critically Low" quality.

INSERT FIGURE 1 ABOUT HERE

Overall, there is evidence that PWD can derive some of the PA benefits previously observed in the general population. The relatively small number of adequately powered studies may explain some inconsistencies. The reviews also show that PA epidemiology is an under-researched area for PWD, in need of more high-quality studies to better estimate the health risks and benefits of PA in different populations, and to identify doses of PA that maximize health benefits.

The UK and US PA guideline reports concluded that for substantial health benefits, PWD should do 150 minutes/week of moderate to vigorous intensity PA and two sets of challenging strength and balance exercises twice per week.[35, 36] The WHO guidelines recommend children and adolescents living with disabilities do at least an average of 60 minutes/day of moderate to vigorous-intensity PA. Vigorous-intensity aerobic activities as well as activities that strengthen muscle and bone should be incorporated on at least three days a week. For adults living with disabilities, WHO recommends to undertake regular PA and try to do at least 150-300 minutes of moderate-intensity PA (or an equivalent of vigorous intensity PA) throughout the week, and muscle-strengthening activities on 2 or more days a week for additional health benefits.[38,39] The guidelines emphasize that doing some physical activity is better than doing none and PWD can achieve meaningful health benefits from PA well below the 60 min/day (children/adolescents) or 150 min/week (adults) threshold. Indeed, the dose of aerobic PA prescribed in most of the adult studies in Figure 1 was less than 150 min/week. These findings reflect that health benefits of PA are graded, and the biggest benefits are achieved when completely inactive people make small increases in PA,[37,38,39] even of light intensity. Because so many PWD are completely inactive, transitioning to even low levels of PA could have a major population health impact.[37,38]

Furthermore, there is a dose-response relationship whereby all PA accumulated throughout the day (from light, to moderate, and vigorous PA)[37] is considered beneficial. This is especially important for PWD experiencing barriers to achieving the guidelines, because lower levels of PA can be beneficial to health and functioning. Accordingly, disability-specific guidelines that prescribe lower, minimum amounts of PA required to achieve meaningful benefits[35, 40, 41] may be more appropriate than generic guidelines which are often perceived as unachievable, especially in people with low mobility.[42,43] Some recent generic guidelines take a more inclusive approach by specifically including PWD and emphasizing the ‘doing some PA is better than none’ message.[39,44]

Studies of sedentary behaviour for PWD are nearly non-existent[38,39] and complicated by challenges in defining sedentary behaviour for people with mobility impairments.[45-47] Nevertheless, the recent addition of sedentary behaviour guidelines[38,39] and messages to PA guidelines may be especially important for inactive PWD. However, the ‘sit less move more’ message is considered inappropriate by many people with mobility impairments. A good example of a more appropriate message is ‘don’t be still for too long’, which was co-constructed by PWD during the UK guideline development process.[35, 41, 48]

In summary, the documented health benefits of PA for PWD justify recommendations for increased PA and reduced sedentary time. Efforts are needed, however, to tailor recommendations to the needs and realities of diverse populations of PWD, especially for those who have very low baseline PA levels. PWD can benefit from increases in PA that are much lower than population guidelines.

2.FACTORS ASSOCIATED WITH PA AND INTERVENTIONS TO INCREASE PA

2.1Factors Associated with PA for PWD

Dozens of studies have documented factors associated with PA participation among PWD living in HIC. Most of these studies have been qualitative, involving participant-generated lists of PA barriers and facilitators. Unlike research in the general population, relatively few studies of PWD have quantitatively measured and compared the strength of relationships between potential correlates (e.g., social support, fatigue) and PA participation.

Research on factors related to PA in people with *physical* disabilities was synthesized in a systematic review of 22 review articles.[49] Qualitative information on 208 factors was extracted and catalogued. For the present paper, we augmented that review by systematically searching for literature reviews that addressed factors related to PA in people with *sensory* or *intellectual* disabilities. Six reviews were identified,[50-55] yielding 21 additional factors (see Supplementary Files 6 and 7). The aggregated 229 factors were categorized according to common themes and classified within a social ecological model (Figure 2).

INSERT FIGURE 2 ABOUT HERE

PA barriers and facilitators for PWD are well-documented in HIC (see Textbox 1 for a discussion regarding LMIC). Research efforts must now focus on developing, testing and delivering PA-enhancing interventions with, and for PWD living in these countries. Figure 2 highlights the need for interventions addressing multiple levels of influence. For example, a lack of disability-related PA information/knowledge is a barrier not just at the intrapersonal level (i.e., attitudes/beliefs/ perceived benefits), but also at the interpersonal (i.e., negative social attitudes), institutional and community levels. Lack of information/knowledge limits the ability of key individuals and organizations (e.g., teachers, physiotherapists, community centres) to support PWD in becoming more active. While PA information/knowledge alone is insufficient to elicit and sustain behaviour change, it is often a necessary element. Figure 2 can also be used to facilitate decision-making with stakeholders about designing interventions to impact specific barriers (e.g., policy-level interventions to address transportation barriers). A multi-level approach to PA intervention design and research aligns with a social-relational understanding of disability as arising from disabling and discriminatory social, cultural and environmental conditions.[56,57]

INSERT TEXTBOX 1 ABOUT HERE

2.2 Interventions to Increase PA Outside of Research and Clinical Settings

Most PA-enhancing intervention studies involving PWD have focused on increasing leisure-time PA, walking, or total daily PA. Virtually all of these studies were conducted in HIC and targeted intrapersonal- or interpersonal-level factors.

We conducted a systematic review of meta-analyses and qualitative meta-syntheses of studies that delivered a PA-enhancing intervention to children, adolescents or adults with disabilities. Ten reviews were identified[69-78] (see Supplementary Files 9 and 10). The reviews consisted largely of randomized controlled trials, with most trials having at least some risk of bias. Across seven meta-analyses of studies involving people with *physical disabilities*, average post-intervention effect sizes (and 95% confidence intervals) for PA behaviour change ranged from ·29 (·17-·41, k=10) to 1.00 (·46-1·53, k=10), median ES=·64 (·43-·83, k=10). For adults, the use of behaviour change techniques (BCTs)--particularly self-monitoring, problem solving, action planning, feedback on outcomes of behaviour, social support, reframing thoughts, identifying barriers, instruction on how to perform the behaviour, and information about health consequences[73-75]--was positively associated with behaviour change.[73,74] In a qualitative meta-synthesis, PWD reported that effective interventions were flexible and adaptable to individual needs, autonomy-supportive, and conducted in inclusive, non-judgmental environments. For children and adolescents with physical disabilities, less is known about factors influencing intervention effectiveness. Interventions have been recommended to address contextual facilitators and barriers, use behaviour change theories, and incorporate BCTs (particularly self-monitoring, positive reinforcement, and monitoring and feedback from others[71, 79]).

Regarding people with *intellectual disabilities*, one meta-analysis of two interventions involving children reported no significant effects on PA (average ES=·20 [-·57-·97]).[69] Neither intervention employed behaviour change theories or targeted factors that are known to influence PA in this population. A meta-analysis of 14 studies involving adolescents and adults reported an average ES of ·41 (·19-·63).[70] Interventions with more frequent sessions and shorter session duration were most effective.

Interventions delivered at institutional- and community-levels generally aim to change knowledge or practices of individuals and organizations. Some real-world examples include formulating guidelines for constructing accessible built environments[80] (e.g., trails, recreation centres, pools), developing inclusivity training programs for physical education teachers,[81] and establishing programs that loan equipment for adapted physical activities.[82] The few studies testing the effectiveness of these types of interventions have produced mixed findings. For instance, a nation-wide Canadian study found that an educational intervention, designed to strengthen health care providers' intentions to discuss leisure-time PA with patients with physical disabilities, had no long-term effects.[83] Conversely, a Dutch national project[84] provided training to staff in 18 rehabilitation institutions on how to deliver PA counselling, and built collaborations between hospital staff and community-based PA providers. Over a 3-year period, the program reached 5873 patients with various disabilities and significantly impacted PA participation.

Policy-level interventions include efforts to change legislation, laws, codes, regulations rules, and practices that are developed and implemented by governments, government agencies, and nongovernmental organizations such as businesses and schools. Some examples include policies to fund sports programs and equipment for PWD, to provide accessible transportation, and to ensure built environments are accessible.[85, 86] While some policy-level changes have proven effective for increasing PA in the general population,[87, 88] we are unaware of any studies testing the effectiveness of policy changes for increasing PA for PWD.

3. INTERNATIONAL POLICY ACTIONS AND RECOMMENDATIONS FOR PWD

Various international treaties and policies pertain to PA for PWD. For example, the UN Convention on the Rights of the Child[89] supports children's rights to participate fully in sport and other types of PA by advocating for non-discrimination and devotion to the child's best interests and development. The UN CRPD[6] explicitly recognizes the importance of PA by stating that PWD have the basic human right to participate on an equal basis with others in recreational, leisure and sporting activities. (See Textbox 2 for a discussion of disability sport as an agent of social change).

INSERT TEXTBOX 2 AND FIGURE 3 ABOUT HERE

A more recent international policy example is the WHO Global Action Plan on PA (GAPPA) 2018-2030.[122] The GAPPA, in its emphasis on "equity across the life course," recognizes that disparities in PA participation experienced by PWD are not because PWD have a 'medical problem.' Rather, consistent with social and social-relational models of disability, [56, 57, 123, 124] disparities reflect limitations and inequities in socioeconomic determinants and opportunities for PA. Thus, one target of GAPPA is to ensure equal opportunities and reduce inequalities in PA participation by empowering the social, economic and political inclusion of all people. Another target is to eliminate discriminatory laws, policies and practices and promote appropriate legislation and action. Reflecting GAPPA's call for "equity across the life course",[122] PA policy development for PWD can be found in some national, government-endorsed PA guideline recommendations and WHO's 2020 PA guidelines. Historically, national and international PA recommendations mostly ignored PWD. Recently, however, recommendations for PWD were included in the 2018 PA Guidelines for Americans,[36] the 2019 UK Chief Medical Officers' (CMO) PA Guidelines,[34] and the 2020 WHO PA Guidelines.[39]

PA policies, recommendations and resources must incorporate the values, needs and preferences of PWD, relevant rights holders, and stakeholders. It is imperative that scientists and policy makers abide by the philosophy of '*Nothing About Us Without Us'* to co-produce research, recommendations, policy and other knowledge products (see Textbox 3). For example in an integrated knowledge translation research project, people with physical, mental, cognitive and/or sensory impairments, social and health-care workers, and user-led organizations (e.g., Disability Rights UK), advocated the UK PA recommendations for PWD and translated these into a meaningful, co-produced communication format.[48]

INSERT TEXTBOX 3 ABOUT HERE

International policies and national recommendations are beginning to translate into increased awareness of PWDs' needs for full participation in PA, but there is much more work to be done to advance inclusive policy and practice.[38] For instance, policies and planning documents must go further than simply noting the need for greater accessibility. They must include action plans empowering PWD to participate in PA. They must challenge and prevent ableism; that is, favouritism and ideals associated with able-bodiedness. Most importantly, they must be adequately funded, implemented, monitored and enforced.

DISCUSSION

In this paper, we have provided an overview of knowledge regarding PA in people living with disabilities, worldwide. In doing so, we have highlighted significant disparities, injustices, research gaps, priorities, and challenges for moving forward. There are large disparities in PA participation rates between PWD and those without. Drawing on the limited available data, it is estimated that PWD are 16-62% less likely than the general population to meet the 2010 WHO PA guidelines. The magnitude of this disparity varies across disability types and is greatest for those with multiple impairments. The large range of estimated differences (16-62%) reflects differences in study methodologies (i.e. how PA was assessed and PWD were defined), and illustrates the difficulties in getting good population-level PA estimates for PWD.

The near-absence of population-level PA data for PWD in HIC and the total absence of such data in LMIC are serious problems. Whilst many countries collect data on PA in the general population, most do not gather PA data for PWD. Worldwide, coordinated efforts are needed to address the call from the WHO's GAPPA to strengthen the reporting of PA data in order to monitor progress towards reducing PA disparities.[123] Population PA estimates are the cornerstone of national and international PA action plans. As laid out in Article 31 of the CRPD, governments and organizations must collect appropriate information, including statistical and research data, to formulate and implement policies giving effect to the rights of PWD.

Compared to the general population, far less high-quality research has been conducted on the health benefits of PA for PWD. The PA epidemiological evidence base for PWD tends to be siloed within medicalized conditions rather than being built across all populations, and most disability-related research has focused on improving function rather than health. Furthermore, intervention studies have typically focused on short-term outcomes and have been conducted in scientific or clinical settings. Consequently, the effects of lifestyle PA, particularly on NCD risk, are virtually unknown. This knowledge gap is compounded by neglecting to measure disability as part of population surveillance and underrepresenting PWD in prospective cohort studies. This gap can, and must be alleviated by adjusting study inclusion/exclusion criteria and removing participation barriers[129,130] that currently exclude up to 15% of the world's population (i.e., PWD) from population-level health studies.

Disability research also lags behind general population research in identifying the strongest influences on PA and targeting those factors in interventions. Most interventions have not been theory-based and have addressed only intra- or inter-individual factors. Theory-based interventions are more effective.[73] Efforts should be directed to target factors at all social ecological model levels, and all PA types (leisure, transport, household, education, occupational) and intensities. Reducing sedentary time will also be beneficial especially in the least physically active. In addition, tailored PA messages, information and recommendations, co-produced with PWD, are required to address the unique challenges, preferences and needs of PWD.[41, 131]

PA policy makers and programmers must ensure the CRPD basic right to "full and effective participation" is upheld. It is not enough to create policies and programs that increase the numbers of PWD participating or their time spent in PA. Full and effective PA participation means having quality PA experiences that satisfy the individual's values and needs of belongingness, autonomy, challenge, mastery, engagement and/or meaning in the PA context.[132, 133] Research and resources co-produced by people with lived experience of disability, scientists, health and social workers, and other stakeholders are needed, along with policies to foster optimal quality participation by PWD in PA contexts.[134, 135]

There are many challenges to addressing these gaps, disparities and priorities. First, because PWD are a tremendously heterogenous group (e.g., in age, type of disability, level of function, years living with disability), there are no ‘one-size fits all’ solutions. Issues and solutions that may be relevant to one sub-group of PWD may be irrelevant to another.[43] Second, consensus and consistency are lacking on how to define and measure disability and how to measure PA among PWD.[136] Resolving these measurement issues would facilitate international collaboration on large-scale studies of PA, health and psychosocial outcomes. Third, editors of mainstream health journals are often biased against publishing studies of PWD because they believe their readers are uninterested in disability[137] and lower-incidence conditions that cause disability. These editorial practices marginalize disability research and undermine scientists’ abilities to reach wider clinical and public health audiences than typically reached by valued disability-specific journals.

And finally, improving the PA levels of PWD will require more than guidelines and action plans. There is no evidence that appropriate resources have been committed to deliver PA-enhancing actions across the social ecological model for PWD at national or global levels. While resourcing is an issue for GAPPA in general,[122] it is even more critical for PWD. PWD represent 1.5 billion of the world’s population—the equivalent of the Americas—with about 80% living in LMIC. Given the size and needs of this population, relying solely on individualized approaches, medicalising disability to a set of clinical conditions, and deferring to specialists to help PWD meet their PA needs is not enough. A true population/public health approach is required. It is time to make a serious commitment to upholding the basic human right of PWD to fully participate in PA.[6] Investing in, and appropriately resourcing global and national PA action plans for PWD, are necessary steps to advance human rights, and to progress the UN’s Sustainable Development Goal of ensuring healthy lives and promoting well-being for all.[7]

KEY MESSAGES

- Worldwide, an estimated 1.5 billion people live with some form of disability (i.e., "long-term physical, mental, intellectual or sensory impairments which, in interaction with various barriers, may hinder their full and effective participation in society on an equal basis with others.")

- PWD are 16-62% less likely to meet PA guidelines than people without disabilities, and are at even greater risk than the general population for experiencing the serious health problems associated with inactivity.

- PWD can achieve significant health benefits from PA participation. WHO recently published PA guidelines for PWD. Meaningful benefits can be achieved from PA well below the 150 min/week guideline.

- Disability sport continues to grow and may play a role in promoting empowerment, social inclusion and social participation of PWD worldwide.

- Theory-based interventions are needed to target barriers at all levels of a social ecological model, in order to increase both the quantity and quality of PA participation.

- International PA policies and national PA guidelines are starting to mention PWD. However, policy makers must provide explicit plans on how to ensure and uphold the rights of PWD to full and effective participation in PA. Targeted, evidence-based PA guidelines and co-produced resources are needed.

- The quantity and quality of research on PA for PWD lags far behind PA research in the general population. Virtually all of the extant data on PA and PWD have been collected in HIC. Improved data collection in LMIC must be a priority.

- International coordinated efforts are needed to measure and monitor PA levels for PWD and progress toward the UN sustainable development goal of healthy lives and well-being for all. High-quality epidemiological studies are also needed to examine the association between PA and risk of non-communicable diseases for PWD.

- The use of an integrated knowledge translation (IKT) approach to PA research with PWD can expedite the development, dissemination, and implementation of meaningful PA guidelines, policies and programs for PWD.

TEXTBOX 1. FACTORS ASSOCIATED WITH PA AND PA-ENHANCING INTERVENTIONS IN LMIC

Factors associated with PA. A cross-sectional study involving persons with psychosis/ schizophrenia in 47 LMIC found low PA was associated with being male, older, unemployed, living in an urban setting, inadequate food consumption, depression, sleep/energy disturbance, and mobility limitations.[58] Studies from Malaysia indicate primary barriers to PA participation for PWD include a lack of facilities, funding, transportation and equipment; health concerns; older age; and negative attitudes from the public, media and government.[59,60]

PA Interventions. Global PA disparities and inequities for children with disabilities (CWD) reflect a lack of data and intervention strategies targeting this population, especially in LMIC.[61] Intervention challenges include supporting the wide range of complex needs, human resources for delivery of interventions to families, selection of outcomes, engagement with formal systems, cost of interventions, and the need for more rigorous study designs.[62] Regarding promotion of PA for both children and adults with disabilities, LMIC have strengths to build upon,[63] namely, greater overall PA and active transportation. Areas for improvement include quality supports for family and peer interaction, built environments, and government investments,[61] availability of assistive devices and rehabilitation facilities.[64] Organizations in LMIC (e.g., Disabled People's Organisations) can lend expertise and infrastructure for program delivery.[65] There is also potential to incorporate PA into community-based rehabilitation,[66] and improve physical literacy.[67] Emphasis on PA at a national level is often directed by policy, and the need for PA in LMIC has been highlighted. However, efforts to reach PWD are not fully developed and recommendations for PWD are often deferred to healthcare providers given the specialized care needed for this group.[68] Intervention research in LMIC should include the scalability of community-level interventions.[69]

TEXTBOX 2: DISABILITY SPORT PARTICIPATION AS AN AGENT OF SOCIAL CHANGE

Disability sport (AKA adapted sport, parasport) participation is growing internationally (see Figure 3) but remains far greater in HIC than LMIC. Growth is driven largely by government and non-government organizations that frame disability sport as a means to address social inequities experienced by PWD.[97-99] International disability sport events such as the Paralympics, Deaflympics, and Special Olympics include in their missions, the use of disability sport events to promote empowerment, social inclusion, and participation of PWD.[100-104] Likewise, the UN,[105, 106] WHO,[107] UNICEF[108] and UNESCO identify disability sport events and sport programs as agents of social change to address social inequities. But are they effective?

Findings are mixed. Regarding empowerment, negative stereotypes about disability can be mitigated when PWD are characterized as sport participants, even outside the context of a sport event.[109-114] However, the media's framing of disability sport narratives is frequently criticized for perpetuating disability stereotypes; for instance, by portraying athletes with disabilities as superhuman, or disability as a tragedy that must be overcome.[115-118] Regarding inclusion, investments in major sporting events often improve the physical and social accessibility of PA facilities and venues to PWD.[119] Yet unfortunately, these benefits are poorly distributed and do little to address the long-term systemic barriers faced by PWD, particularly among non-host LMIC nations who are often the focus of international PA policy goals. Regarding participation, although the London 2012 Paralympic Games were considered successful in terms of media coverage and increased post-Games disability sport participation in the UK,[120] sport participation started to decline in 2017.[121] Together, these equivocal findings attest to the need for greater critical consideration of how disability sport can achieve a legacy of empowerment, social inclusion and participation for PWD.

TEXTBOX 3. *"NOTHING ABOUT US WITHOUT US":* INTEGRATED KNOWLEDGE TRANSLATION RESEARCH AND PEOPLE WITH DISABILITIES

Societal shifts in attitudes toward PWD must be facilitated by universal policies and programs that fully account for the highly diverse priorities, barriers and circumstances of all PWD. Concomitantly, the design of research, interventions and/or policies aimed at increasing PA for PWD must take into account the immense heterogeneity of PWD and the regional contexts within which they live. Integrated knowledge translation (IKT) research approaches can help achieve these goals.[125] IKT is a powerful, partnership-based approach to ensuring research findings are relevant, useful, and useable. IKT provides for meaningful engagement of researchers with the right research users (those who will use, benefit from, or apply the research; e.g., PWD, disability-focused organizations and policy makers) throughout the research process.

IKT approaches align with the "*Nothing About Us Without Us*" philosophy of the disability rights movement[126] as they require shared decision-making by researchers and research users. Care must be taken, however, to avoid tokenistic engagement of research users, such as asking individuals or organizations to endorse a research product they have not been involved in developing.[127] Tokenism can be avoided by ensuring IKT partners can represent the interests and perspectives of PWD, and recognizing and valuing their diverse knowledge and expertise.[128] IKT approaches shift the focus from doing research *on* PWD to doing research *with* PWD and are critical to rectifying the inherent ableism in national and international PA policies and related resources. Although IKT can take more time and effort than traditional research approaches, IKT-based research can lead to more rapid development and revision of inclusive PA policies (such as GAPPA), and PA resources that are relevant to PWD (see Section 3 for an example). As such, IKT is an invaluable tool for developing PA policies and programs to drive greater PA participation and better quality PA participation experiences for PWD.

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CONFLICT OF INTEREST STATEMENT

The authors declared no conflicts of interest.

CONTRIBUTORS

Kathleen Martin Ginis outlined the manuscript, conducted literature searches, drafted and wrote sections, drafted Figure 2, prepared supplementary files, edited the full manuscript, and managed the manuscript submission and revision processes. Hidde van der Ploeg assisted with outlining the manuscript, drafted and wrote sections, co-edited the full manuscript, and assisted with the revision processes. Charlie Foster drafted and wrote sections. Byron Lai conducted literature searches, drafted and wrote sections, prepared Figure 1, and prepared supplementary files. Christopher McBride drafted and wrote sections. Kwok Ng conducted literature searches, prepared Figure 3, and drafted and wrote sections. Michael Pratt provided feedback on drafts of the manuscript. Celina Shirazipour, Brett Smith, and Priscilla Vasquez drafted and wrote sections. Gregory Heath assisted with outlining the manuscript, conducted literature searches, drafted and wrote sections, and prepared Table 1.

SEARCH STRATEGY AND SELECTION CRITERIA

References for the reviews in this paper were identified through searches of PubMed, CINAHL, and Scopus for articles published from inception until Nov 15, 2019. Additional external searches included articles retrieved from Google Scholar, reference lists of recent systematic reviews, and key experts in the field. Electronic databases were combed using search strings that included several keywords pertaining to the disability group (physical or sensory disability), "exercise" or "physical activity", and type of review (meta-analysis or systematic review). Articles published in English were included. Reviews were excluded if they were not peer-reviewed or included exercise interventions that were delivered as a means of rehabilitation therapy (e.g., body weight support treadmill training or functional electrical stimulation). Specific search details are included in the supplementary files.

References

1. World Health Organization. World Report on Disability. 2011 [Accessed November 2019] Available from: https://www.who.int/disabilities/world_report/2011/report.pdf.
2. The Lancet. Prioritising disability in universal health coverage. *Lancet (London, England)*. 2019;**394**(10194):187.
3. Barnes C. Disabled people in Britain and discrimination. London: Hurst; 1991.
4. McConachie H, Colver AF, Forsyth RJ, Jarvis SN, Parkinson KN. Participation of disabled children: how should it be characterised and measured? *Disabil Rehabil*. 2006;**28**(18):1157-64.
5. Goodley D, Lawthom R, Runswick Cole K. Posthuman disability studies. *Subjectivity*. 2014;**7**(4):342-61.
6. United Nations, Department of Public Information. Convention of the Rights of Persons with Disabilites. 2006 [Accessed 25 May 2016] Available from: http://www.un.org/disabilities/convention/conventionfull.shtml.
7. United Nations. Sustainable Development Goals [Accessed 2019] Available from: https://sustainabledevelopment.un.org/sdgs.
8. The Lancet Series. Physical Activity 2012 [Accessed 2019] Available from: https://www.thelancet.com/series/physical-activity.
9. The Lancet Series. Physical Activity 2016: Progress and Challenges [Accessed 2019] Available from: https://www.thelancet.com/series/physical-activity-2016.
10. Ding D, Lawson KD, Kolbe-Alexander TL, Finkelstein EA, Katzmarzyk PT, van Mechelen W, et al. The economic burden of physical inactivity: a global analysis of major non-communicable diseases. *The Lancet*. 2016;**388**(10051):1311-24.
11. Rimmer JH, Marques AC. Physical activity for people with disabilities. *Lancet*. 2012;**380**(9838):193-5.
12. World Health Organization. STEPwise approach to noncommunicable disease risk factor surveillance (STEPS) [Accessed 2019] Available from: https://www.who.int/ncds/surveillance/steps/riskfactor/en/.
13. Madans JH, Loeb ME, Altman BM. Measuring disability and monitoring the UN Convention on the Rights of Persons with Disabilities: the work of the Washington Group on Disability Statistics. *BMC Public Health*. 2011;**11** (Suppl 4):S4.
14. World Health Organization. Global recommendations on physical activity for health. Geneva: World Health Organization, 2010.
15. Wilson PB, Haegele JA, Zhu X. Mobility status as a predictor of obesity, physical activity, and screen time use among children aged 5-11 years in the United States. *J Pediatr*. 2016;**176**:23-9.e1.
16. Ng K, Tynjälä J, Sigmundová D, Augustine L, Sentenac M, Rintala P, et al. Physical activity among adolescents with long-term illnesses or disabilities in 15 European countries. *Adapt Phys Activ Q*. 2017;**34**(4):456-65.
17. Carroll DD, Courtney-Long EA, Stevens AC, Sloan ML, Lullo C, Visser SN, et al. Vital signs: disability and physical activity--United States, 2009-2012. *MMWR Morb Mortal Wkly Rep*. 2014;**63**(18):407-13.
18. Brown DR, Carroll DD, Workman LM, Carlson SA, Brown DW. Physical activity and health-related quality of life: US adults with and without limitations. *Qual Life Res*. 2014;**23**(10):2673-80.

19. Sport England. Active Lives Adult Survey May 16/17 Report 2017 [Accessed 2019 Dec 10] Available from: https://www.sportengland.org/media/12458/active-lives-adult-may-16-17-report.pdf
20. de Hollander EL, Proper KI. Physical activity levels of adults with various physical disabilities. *Prev Med Rep*. 2018;**10**:370-6.
21. Guthold R, Stevens GA, Riley LM, Bull FC. Worldwide trends in insufficient physical activity from 2001 to 2016: a pooled analysis of 358 population-based surveys with 1.9 million participants. *Lancet Glob Health*. 2018;**6**(10):e1077-e86.
22. United Nations Educational Scientific and Cultural Organization. World-wide survey of school physical final report 2013. 2014 Available from: https://unesdoc.unesco.org/ark:/48223/pf0000229335.
23. Vancampfort D, Koyanagi A, Ward PB, Rosenbaum S, Schuch FB, Mugisha J, et al. Chronic physical conditions, multimorbidity and physical activity across 46 low- and middle-income countries. *Int J Behav Nutr Phys Act*. 2017;**14**(1):6.
24. Ding D, Ramirez Varela A, Bauman AE, Ekelund U, Lee I-M, Heath G, et al. Towards better evidence-informed global action: lessons learnt from the Lancet series and recent developments in physical activity and public health. *Br J Sports Med*. 2020;54:462-468
25. Bornstein MH, Hendricks C. Screening for developmental disabilities in developing countries. *Soc Sci Med*. 2013;**97**:307-15.
26. United Nations. From Exclusion to Equality: Realizing the rights of persons with disabilities - Handbook for Parliamentarians on the Convention on the Rights of Persons with Disabilities and its Optional Protocol 2007 [Accessed 2020] Available from: https://www.un.org/esa/socdev/enable/documents/ipuhb.pdf.
27. World Health Organization. International Classification of Functioning, Disability, and Health (ICF). Geneva: World Health Organization, 2001.
28. World Health Organization. International Classification of Functioning, Disability and Health: Children & Youth version: ICF-CY. Geneva: World Health Organization, 2007.
29. World Health Organization. How to use the ICF: A practical manual for using the International Classification of Functioning, Disability and Health (ICF). Exposure draft for comment. Geneva: 2013.
30. Tierney M, Fraser A, Kennedy N. Criterion validity of the International Physical Activity Questionnaire Short Form (IPAQ-SF) for use in patients with rheumatoid arthritis: comparison with the SenseWear Armband. *Physiotherapy*. 2015;**101**(2):193-7.
31. Menezes D, Laranjo L, Marmeleira J. Criterion-related validity of the short form of the international physical activity questionnaire in adults who are Deaf. *Disabil Health J*. 2017;**10**(1):33-8.
32. Moss SJ, Czyz SH. Level of agreement between physical activity levels measured by ActiHeart and the International Physical Activity Questionnaire in persons with intellectual disability. *Disabil Rehabil*. 2018;**40**(3):360-6.
33. Lankhorst K, Oerbekke M, van den Berg-Emons R, Takken T, de Groot J. Instruments measuring physical activity in individuals who use a wheelchair: A systematic review of measurement properties. *Arch Phys Med Rehabil* [Internet]. 2019 Oct 10;10.1016/j.apmr.2019.09.006.
34. Government of the United Kingdom, Department of Health and Social Care. UK Chief Medical Officers' Physical Activity Guidelines. 2019 Available from:

https://www.gov.uk/government/publications/physical-activity-guidelines-uk-chief-medical-officers-report.
35. Public Health England. Physical activity for general health benefits in disabled adults: Summary of a rapid evidence review for the UK Chief Medical Officers' update of the physical activity guidelines. London, UK.2018 Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/748126/Physical_activity_for_general_health_benefits_in_disabled_adults.pdf.
36. US Department of Health and Human Services. Physical Activity Guidelines for Americans, 2nd edition. Washington, DC.2018 Available from: https://health.gov/paguidelines/second-edition/pdf/Physical_Activity_Guidelines_2nd_edition.pdf.
37. 2018 Physical Activity Guidelines Advisory Committee. 2018 Physical Activity Guidelines Advisory Committee Scientific Report. Washington, DC: US Department of Health and Human Services; 2018 Available from: https://health.gov/paguidelines/second-edition/report/.
38. Carty C, van der Ploeg HP, Biddle SJ, Bull F, Willumsen J, Lee L, Kamenov K, Milton K. The first global physical activity and sedentary behavior guidelines for people living with disability. *J Phys Act Health.* 2021 Jan 3;**18**(1):86-93.
39. Bull F, Al-Ansari SS, Biddle S, et al. World Health Organization 2020 guidelines on physical activity and sedentary behaviour. *Br J Sports Med*. 2020;**54**(24):1453.
40. Martin Ginis KA, van der Scheer JW, Latimer-Cheung AE, Barrow A, Bourne C, Carruthers P, et al. Evidence-based scientific exercise guidelines for adults with spinal cord injury: An update and a new guideline. *Spinal Cord*. 2018;**56**(4):308-21.
41. Smith B, Wightman L. Promoting physical activity to disabled people: messengers, messages, guidelines and communication formats. Disability and Rehabilitation [Internet]. Taylor & Francis. 2019;10.1080/09638288.2019.1679896:[1-5 pp.]. Available from: https://doi.org/10.1080/09638288.2019.1679896.
42. Warburton DER, Bredin SSD. Health benefits of physical activity: a systematic review of current systematic reviews. *Curr Opin Cardiol*. 2017;**32**(5):541-56.
43. Martin Ginis KA, Latimer-Cheung AE, West CR. Commentary on "The First Global Physical Activity and Sedentary Behavior Guidelines for People Living With Disability". *J Phys Act Health*. 2021 Mar 19;**1**(aop):348-9. Doi: 10.1123/jpah.2020-0871
44. Carty C, Van Der Ploeg HP, Biddle SJ, Bull F, Willumsen J, Lee L, Kamenov K, Milton K. Response to "Commentary on: The First Global Physical Activity and Sedentary Behavior Guidelines for People Living With Disability". *J Phys Act Health*. 2021 Mar 19;**18**(4):350-1.
45. Tremblay MS, Aubert S, Barnes JD, Saunders TJ, Carson V, Latimer-Cheung AE, et al. Sedentary Behavior Research Network (SBRN) - Terminology Consensus Project process and outcome. *Int J Behav Nutr Phys Act*. 2017;**14**(1):75.
46. Todd KR, Martin Ginis KA. Physical activity and spinal cord injury: Lessons learned at the lowest end of the physical activity spectrum. *Kinesiol Rev*. 2019;**8**(1):54-62.
47. Copeland JL. Sedentary time in older adults: Sitting is not the new smoking. *Kinesiol Rev*. 2019;**8**(1):70-6.
48. Smith B, Kirby N, Skinner B, Wightman L, Lucas R, Foster C. Infographic. Physical activity for disabled adults. *Br J Sports Med*. 2019;**53**(6):335-6.

49. Martin Ginis KA, Ma JK, Latimer-Cheung AE, Rimmer JH. A systematic review of review articles addressing factors related to physical activity participation among children and adults with physical disabilities. *Health Psych Rev*. 2016;**10**(4):478-94.
50. Haegele JA, Porretta D. Physical activity and school-age individuals with visual impairments: a literature review. *Adapt Phys Activ Q*. 2015;**32**(1):68-82.
51. Bodde AE, Seo DC. A review of social and environmental barriers to physical activity for adults with intellectual disabilities. *Disabil Health J*. 2009;**2**(2):57-66.
52. Bossink LWM, van der Putten AAJ, Vlaskamp C. Understanding low levels of physical activity in people with intellectual disabilities: A systematic review to identify barriers and facilitators. *Res Dev Disabil*. 2017;**68**:95-110.
53. Dairo YM, Collett J, Dawes H, Oskrochi GR. Physical activity levels in adults with intellectual disabilities: A systematic review. *Prev Med Rep*. 2016;**4**:209-19.
54. Hutzler Y, Korsensky O. Motivational correlates of physical activity in persons with an intellectual disability: A systematic literature review. *J Intellect Disabil Res* 2010;**54**:767-86.
55. McGarty AM, Melville CA. Parental perceptions of facilitators and barriers to physical activity for children with intellectual disabilities: A mixed methods systematic review. *Res Dev Disabil*. 2018;**73**:40-57.
56. Thomas C. Sociologies of disability and illness: Contested ideas in disability studies and medical sociology. Basingstoke: Palgrave Macmillan; 2007.
57. Thomas C. Theorising disability and chronic illness: Where next for perspectives in medical sociology? *Soc Theory Health*. 2012;**10**(3):209-28.
58. Stubbs B, Vancampfort D, Firth J, Hallgren M, Schuch F, Veronese N, et al. Physical activity correlates among people with psychosis: Data from 47 low- and middle-income countries. *Schizophr Res*. 2018;**193**:412-7.
59. Wilson NC, Khoo S. Benefits and barriers to sports participation for athletes with disabilities: the case of Malaysia. *Disability & Society*. 2013;**28**(8):1132-45.
60. Mat Rosly M, Halaki M, Hasnan N, Mat Rosly H, Davis GM, Husain R. Leisure time physical activity participation in individuals with spinal cord injury in Malaysia: barriers to exercise. *Spinal Cord*. 2018;**56**(8):806-18.
61. Tremblay MS, Barnes JD, González SA, Katzmarzyk PT, Onywera VO, Reilly JJ, et al. Global Matrix 2.0: Report card grades on the physical activity of children and youth comparing 38 countries. *J Phys Act Health*. 2016;**13**(s2):S343-S66.
62. Yousafzai AK, Lynch P, Gladstone M. Moving beyond prevalence studies: screening and interventions for children with disabilities in low-income and middle-income countries. *Arch Dis Child*. 2014;**99**(9):840-8.
63. Hallal PC, Andersen LB, Bull FC, Guthold R, Haskell W, Ekelund U. Global physical activity levels: surveillance progress, pitfalls, and prospects. *Lancet (London, England)*. 2012;**380**(9838):247-57.
64. Bright T, Wallace S, Kuper H. A systematic review of access to rehabilitation for people with disabilities in low- and middle-income countries. *Int J Environ Res Public Health*. 2018;**15**(10):2165.
65. Young R, Reeve M, Grills N. The functions of Disabled People's Organisations (DPOs) in low and middle-income countries: A literature review. *Disability, CBR and Inclusive Development (DCID)*. 2016;**27**(3):27.

66. Iemmi V, Kumar KS, Blanchet K, Gibson L, Hartley S, Murthy GVS, et al. Community-based rehabilitation for people with physical and mental disabilities in low- and middle-income countries. *Cochrane Database Syst Rev*. 2017;**3**:CD010617.
67. Spengler JO. Physical Literacy: A Global Environmental Scan. The Aspen Institute, Project Play, 2015.
68. Pratt M, Perez LG, Goenka S, Brownson RC, Bauman A, Sarmiento OL, et al. Can population levels of physical activity be increased? Global evidence and experience. *Prog Cardiovasc Dis* 2015;**57**(4):356-67.
69. McGarty AM, Downs SJ, Melville CA, Harris L. A systematic review and meta-analysis of interventions to increase physical activity in children and adolescents with intellectual disabilities. *J Intellect Disabil Res*. 2018;**62**(4):312-29.
70. Shin I-S, Park E-Y. Meta-analysis of the effect of exercise programs for individuals with intellectual disabilities. *Res Dev Disabil*. 2012;**33**(6):1937-47.
71. Reedman S, Boyd RN, Sakzewski L. The efficacy of interventions to increase physical activity participation of children with cerebral palsy: a systematic review and meta-analysis. *Dev Med Child Neurol*. 2017;**59**(10):1011-8.
72. Casey B, Coote S, Hayes S, Gallagher S. Changing Physical Activity Behavior in People With Multiple Sclerosis: A Systematic Review and Meta-Analysis. *Arch Phys Med Rehabil*. 2018;**99**(10):2059-75.
73. Ma JK, Martin Ginis KA. A meta-analysis of physical activity interventions in people with physical disabilities: Content, characteristics, and effects on behaviour. *Psych Sport Exerc*. 2018;**37**:262-73.
74. Stretton CM, Mudge S, Kayes NM, McPherson KM. Interventions to improve real-world walking after stroke: a systematic review and meta-analysis. *Clin Rehabil*. 2017;**31**(3):310-8.
75. Williams TL, Ma JK, Martin Ginis KA. Participant experiences and perceptions of physical activity-enhancing interventions for people with physical impairments and mobility limitations: a meta-synthesis of qualitative research evidence. *Health Psychol Rev*. 2017;**11**(2):179-96.
76. Bania T, Dodd KJ, Taylor N. Habitual physical activity can be increased in people with cerebral palsy: a systematic review. *Clin Rehabil*. 2011;**25**(4):303-15.
77. Dennett R, Gunn H, Freeman JA. Effectiveness of and user experience with web-based interventions in increasing physical activity levels in people with multiple sclerosis: A systematic review. *Phys Ther*. 2018;**98**(8):679-90.
78. Sangelaji B, Smith CM, Paul L, Sampath KK, Treharne GJ, Hale LA. The effectiveness of behaviour change interventions to increase physical activity participation in people with multiple sclerosis: a systematic review and meta-analysis. *Clin Rehabil*. 2016;**30**(6):559-76.
79. McPherson AC, Keith R, Swift JA. Obesity prevention for children with physical disabilities: a scoping review of physical activity and nutrition interventions. *Disabil Rehabil*. 2014;**36**(19):1573-87.
80. Department of Economic and Soial Affairs. Accessibility and Development: environmental accessibility and its implications for inclusive, sustainable and equitable development for all 2013 [Accessed 2020] Available from: https://www.un.org/disabilities/documents/accessibility_and_development_june2013.pdf.
81. Mauerberg-deCastro E, Klavina A, Kudlacek M, Sit C, Inal S. An International Perspective in Physical Education and Professional Preparation in Adapted Physical Education

and Adapted Physical Activity. In: Ennis CD, editor. Routledge Handbook of Physical Education Pedagogies. 1st ed. UK: Routledge Taylor & Francis; 2017. p. 241-61.
82. BC Wheelchair Sports. Wheelchair Loan Program [Accessed 2020] Available from: http://bcwheelchairsports.com/get-involved/wheelchair-loan-program.
83. Tomasone JR, Martin Ginis KA, Estabrooks PA, Domenicucci L. 'Changing Minds': Determining the effectiveness and key ingredients of an educational intervention to enhance health care professionals' intentions to prescribe physical activity to patients with physical disabilities. *Implement Sci*. 2014;**9**:30.
84. Hoekstra F, Hoekstra T, van der Schans CP, Hettinga FJ, van der Woude LHV, Dekker R. The implementation of a physical activity counseling program in rehabilitation care: findings from the ReSpAct study. *Disabil Rehabil*. 2019;**17**:1-12.
85. Hoekstra F, Roberts L, van Lindert C, Martin Ginis KA, van der Woude LHV, McColl MA. National approaches to promote sports and physical activity in adults with disabilities: examples from the Netherlands and Canada. *Disabil Rehabil*. 2019;**41**(10):1217-26.
86. Shikako-Thomas K, Law M. Policies supporting participation in leisure activities for children and youth with disabilities in Canada: from policy to play. *Disability & Society*. 2015;**30**(3):381-400.
87. Heath GW, Brownson RC, Kruger J, Miles R, Powell KE, Ramsey LT. The effectiveness of urban design and land use and transport policies and practices to increase physical activity: A systematic review. *J Phys Act Health*. 2006;**3**(s1):S55-s76.
88. Lonsdale C, Rosenkranz RR, Peralta LR, Bennie A, Fahey P, Lubans DR. A systematic review and meta-analysis of interventions designed to increase moderate-to-vigorous physical activity in school physical education lessons. *Prev med*. 2013;**56**(2):152-61.
89. UNICEF. United Nations Convention on the Rights of the Child. London: UNICEF UK; 1990 [Accessed 12 Aug 2019] Available from: https://downloads.unicef.org.uk/wp-content/uploads/2016/08/unicef-convention-rights-child-uncrc.pdf?_ga=2.176452960.475519156.1578421279-1980603782.1578421279.
90. Brittain I. From Stoke Mandeville to Sochi: A History of the Summer and Winter Paralympic Games. Champaign, IL: Common Ground Publishing; 2014.
91. Special Olympics World Winter Games Austria 2017. The Athletes 2017 [Accessed 2019] Available from: http://www.austria2017.org/en/games-2017/the-athletes.
92. Special Olympics World Summer Games Abu Dabi 2019. Find an Athlete 2019 [Accessed 2019] Available from: https://www.abudhabi2019.org/athlete-directory.
93. Rio 2016 Paralympic Games. Participation Numbers 2016 [Accessed 2019] Available from: https://www.paralympic.org/rio-2016/results/participants.
94. Pyeongchang 2018 Paralympic Winter Games. Pyeongchang 2018 Countries 2018 [Accessed 2019] Available from: https://www.paralympic.org/pyeongchang-2018/countries.
95. 2017 Samsun Summer Deaflympics. Countries participated 2017 [Accessed 2019] Available from: https://deaflympics.com/games/2017-s.
96. Valtellina - Valchiavenna Winter Deaflympics 19. Countries participated 2019 [Accessed 2019] Available from: https://www.deaflympics.com/games/2019-w.
97. Sport for Development and Peace, International Working Group. Harnessing the power of sport for development and peace: Recommendations to governments. 2008 [Accessed 2019] Available from: https://www.sportanddev.org/sites/default/files/downloads/rtp_sdp_iwg_harnessing_the_power_of_sport_for_development_and_peace.pdf.

98. Silva CF, Howe PD. The social empowerment of difference: The potential influence of para sport. *Phys Med Rehabil Clin N Am*. 2018;**29**(2):397-408.
99. Blauwet C, Willick SE. The Paralympic Movement: using sports to promote health, disability rights, and social integration for athletes with disabilities. *PM&R*. 2012;**4**(11):851-6.
100. Invictus Games Foundation. The Invictus Games Story. 2016 [Accessed 2019] Available from: https://invictusgamesfoundation.org/foundation/story/.
101. Cybathlon. About Cybathlon: Concept and Goals. 2019 [Accessed 2019] Available from: http://www.cybathlon.ethz.ch/about-cybathlon/concept-and-goals.html.
102. International Paralympic Committee. About the International Paralympic Committee. [Accessed 2019] Available from: https://www.paralympic.org/the-ipc/about-us.
103. Special Olympics. Our Mission. [Accessed 2019] Available from: https://www.specialolympics.org/about/our-mission.
104. Deaflympics. Mission Statement. [Accessed 2019] Available from: https://www.deaflympics.com/icsd/mission-statement.
105. United Nations General Assembly. Sport as Resolution adopted by the General Assembly on 31 October 2014: Sport as a means to promote education, health, development and peace. 2014 [Accessed 2019] Available from: https://www.un.org/en/ga/search/view_doc.asp?symbol=A/RES/69/6
106. United Nations, Department of Economic and Soial Affairs, Disability. Disability Sport. [Accessed 2019] Available from: https://www.un.org/development/desa/disabilities/issues/disability-and-sports.html.
107. Sherrill C. Young people with disability in physical education/physical activity/sport in and out of schools: Technical report for the World Health Organization International Council of Sport Science and Physical Education2004 [Accessed 2019] Available from: https://www.icsspe.org/sites/default/files/YOUNGPEOPLE.pdf
108. UNICEF. The state of the World's Children - Executive Summary: Children with Disabilities. 2013 [Accessed 2019] Available from: https://www.unicef.org/sowc2013/files/SOWC2013_Exec_Summary_ENG_Lo_Res_24_Apr_2013.pdf.
109. Clément-Guillotin C, Rohmer O, Forestier C, Guillotin P, Deshayes M, d'Arripe-Longueville F. Implicit and explicit stereotype content associated with people with physical disability: Does sport change anything? *Psychol Sport Exerc*. 2018;**38**:192-201.
110. Kittson K, Gainforth HL, Edwards J, Bolkowy R, Latimer-Cheung AE. The effect of video observation on warmth and competence ratings of individuals with a disability. *Psychol Sport Exerc*. 2013;**14**(6):847-51.
111. Arbour KP, Latimer AE, Martin Ginis KA, Jung ME. Moving beyond the stigma: the impression formation benefits of exercise for individuals with a physical disability. *Adapt Phys Activ Q*. 2007;**24**(2):144-59.
112. Barg CJ, Armstrong BD, Hetz SP, Latimer AE. Physical disability, stigma, and physical activity in children. *Int J Disabil Dev Edu*. 2010;**57**(4):371-82.
113. Gainforth HL, O'Malley D, Mountenay T, Latimer-Cheung A. Independence and physical activity status moderate stereotypes toward people with a physical disability. *Int J Sport Exerc Psychol*. 2013;**11**(3):244-57.
114. Tyrrell AC, Hetz SP, Barg CJ, Latimer AE. Exercise as stigma management for individuals with onset-controllable and onset-uncontrollable spinal cord injury. *Rehabil Psychol*. 2010;**55**(4):383-90.

115. Jackson D, Hodges CEM, Molesworth M, Scullion R. Reframing Disability? Media, (Dis)Empowerment and Voice in the 2012 Paralympics. London, UK: Routledge; 2015.
116. Peers D. (Dis)empowering Paralympic histories: absent athletes and disabling discourses. *Disability & Society*. 2009;**24**(5):653-65.
117. Ellis K. Beyond the Aww Factor: Human interest Profiles of Paralympians and the media navigation of physical difference and social stigma. *Asia Pacific Media Educator*. 2009;**19**:23-36.
118. Silva CF, Howe PD. The (In)validity of Supercrip Representation of Paralympian Athletes. *J Sport Soc Issues*. 2012;**36**(2):174-94.
119. McGillivray D, McPherson G, Misener L. Major sporting events and geographies of disability. *Urban Geogr*. 2018;**39**(3):329-44.
120. Hodges CE, Jackson D, Scullion R, Thompson S, Molesworth M. Tracking changes in everyday experiences of disability an disability sport within the context of the 2012 London Paralympics. Bournemouth University: CMC Publishing; 2014 Available from: http://eprints.bournemouth.ac.uk/21596/1/Para Report.pdf.
121. Brown C, Pappous A. “The Legacy Element . . . It Just Felt More Woolly”: Exploring the Reasons for the Decline in People With Disabilities’ Sport Participation in England 5 Years After the London 2012 Paralympic Games. *J Sport Soc Issues*. 2018;**42**(5):343-68.
122. World Health Organization. Global action plan on physical activity 2018–2030: More active people for a healthier world 2018 [Accessed 12 Dec 2019] Available from: https://www.who.int/ncds/prevention/physical-activity/global-action-plan-2018-2030/en/.
123. Owens J. Exploring the critiques of the social model of disability: the transformative possibility of Arendt's notion of power. *Sociol Health Illn*. 2015;**37**(3):385-403.
124. Smith B, Bundon A. Disability Models: Explaining and Understanding Disability Sport in Different Ways. In: Brittain I, Beacom A, editors. The Palgrave Handbook of Paralympic Studies;10.1057/978-1-137-47901-3_2. London: Palgrave Macmillan; 2018. p. 15-34.
125. Jull J, Giles A, Graham ID. Community-based participatory research and integrated knowledge translation: advancing the co-creation of knowledge. *Implement Sci*. 2017;**12**(1):150.
126. Charlton J. Nothing About Us Without Us. In: Charlton J, editor. Nothing About Us Without Us: Disability Oppression and Empowerment. California: California Scholarship Online; 2012. p. DOI: 10.1525/california/9780520207950.001.0001.
127. McLaughlin H. Keeping service user involvement in research honest. *The British Journal of Social Work*. 2009;**40**(5):1591-608.
128. Gainforth HL, Hoekstra F, McKay R, McBride CB, Sweet SN, Martin Ginis KA, Anderson K, Chernesky J, Clarke T, Forwell S, Maffin J. Integrated Knowledge Translation Guiding Principles for Conducting and Disseminating Spinal Cord Injury Research in Partnership. *Arch Phys Med Rehabil.* 2020 Oct 28. https://doi.org/10.1016/j.apmr.2020.09.393
129. Walmsley J, Johnson K. Inclusive research with people with learning disabilities: Past, present and futures. London, UK: Jessica Kingsley Publishers; 2003.
130. Mitchell S, Ciemnecki A, CyBulski K, Markesich J. Removing barriers to survey participation for persons with disabilities. Ithaca, NY: Cornell Univeriesty: Rehabilitation Research and Training Center on Disability Demographics and Statistics; 2006 Available from: https://digitalcommons.ilr.cornell.edu/cgi/viewcontent.cgi?article=1191&context=edicollect.
131. Perrier MJ, Martin Ginis KA. Communicating physical activity information to people with physical disabilities. In: Jackson B, Dimmock J, editors. Persuasion and communication in sport, exercise and physical activity. New York: Routledge; 2017. p. 233-49.

132. Martin Ginis KA, Evans MB, Mortenson WB, Noreau L. Broadening the conceptualization of participation of persons with physical disabilities: A configurative review and recommendations. *Arch Phys Med Rehabil*. 2016;**98**(2):395-402.
133. Evans MB, Shirazipour CH, Allan V, Zanhour M, Sweet SN, Martin Ginis KA, et al. Integrating insights from the parasport community to understand optimal experiences: The Quality Parasport Participation Framework. *Psychol Sport Exerc*. 2018;**37**:79-90.
134. Jackson J, Williams TL, McEachern BM, Latimer-Cheung AE, Tomasone JR. Fostering quality experiences: Qualitative perspectives from program members and providers in a community-based exercise program for adults with physical disabilities. *Dis Health J*. 2019;**12**(2):296-301.
135. Shirazipour CH, Evans MB, Leo J, Lithopoulos A, Martin Ginis KA, Latimer-Cheung AE. Program conditions that foster quality physical activity participation experiences for people with a physical disability: a systematic review. *Disabil Rehabil.* 2020;42(2):147-155.
136. National Academies of Sciences Engineering and Medicine. People Living with Disabilities: Health Equity, Health Disparities, and Health Literacy: Proceedings of a Workshop. Washington, DC: The National Academic Press; 2017.
137. Iezzoni LI. Imperatives for HSR Addressing: Individuals with disabilities—The canaries in health care's coal mine. *Medical Care*. 2013;**51**(2):133-6.

Table 1. Available prevalence estimates of PA among PWD from selected countries: children, adults, and older adults

Survey instrument **Country of origin** **World bank economic strata***	**Data methods** **Survey year** **Population(s)**	**Disability domains****	**Proportion meeting WHO PA guidelines***** **(95%CI)**
CHILDREN			
National Health and Nutrition Examination Survey (NHANES) United States HIC	Face-to-Face Interviews/Parental surrogates 2011-2014 Children 5-11 years (n = 2847)	FFL	Boys with no mobility limitations 74.4 Boys with mobility limitations 58.1 Numbers for girls presented in graph only (~64 vs ~51)[15]
WHO Collaborative Cross-national Health Behaviour in School-aged Children (HBSC) study 15 European Countries HIC	School-based Surveys 2013-2014 Adolescents 11, 13, and 15 years (n = 61,329)	FFL	Prevalence range across all 15 countries: Males 14.9-37.8 Females 8.5-21.4[16]
ADULTS			
National Health Interview Survey (NHIS) United States HIC	Face-to-Face Interviews 2009-2012 Adults 15 years and Older	FFL WGQ	No disability 53.7 (53.1-54.2) FFL 31.0 (29.7–32.2) Vision 45.2 (42.2–48.2) Hearing 40.9 (37.7–44.2) Mobility 38.3 (35.6–41.1) Cognitive 20.6 (19.2–22.1)[17]

Behavioural Risk Factor Surveillance System (BRFSS) United States HIC	Telephone-based interviewer-led surveys 2009 Adults 18+ years (n = 357,665)	FFL	Without limitations 70.1 With limitations 50.0[18]
Active Lives Adult Survey, Sport England United Kingdom HIC	Telephone Survey 2016-2017 Adults 18 years and older (n = ~198,000)	FFL	No impairment 65 1 impairment 51 2 impairments 45 3+ impairments 36[19]
Dutch Public Health Monitor 2012 The Netherlands HIC	Written survey 2012 Adults 19 years and older (n=321,656)	FFL	No physical or sensory disability 91.1 Physical or sensory disability 60.1[20]

*High Income Country (HIC) **Functioning and Functional Limitations (FFL): where functioning and disability represent the interaction between health conditions and (diseases, disorders and injuries) and contextual factors (external environmental and internal personal factors); Washington Group Questions (WGQ): difficulty functioning in any of the core domains of vision, hearing, mobility, cognition, self-care, and language communication.[13]

*** The 2010 WHO PA Guidelines for adults (18 years and older)--moderate intensity PA of 150 minutes per week or 75 minutes of vigorous intensity PA per week; and for children (6–18 years) -- 60 minutes of moderate to vigorous intensity PA per day.[14] Studies used different questionnaires to assess PA.

FIGURE 1
Number of statistically significant and non-significant average effects reported across 36 meta-analyses of the effects of PA interventions on cardiovascular, musculoskeletal, cardiometabolic and mental-/brain-health outcomes among children, youth and adults with disabilities.

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Note. *Significant* indicates a statistically significant average effect size showing an advantage for PA versus control conditions (inactive/usual care). No meta-analysis showed a statistically significant advantage for control conditions.

FIGURE 2 Social ecological model showing factors related to PA participation among people with disabilities.

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FIGURE 3 Countries' participation in Paralympic Games, 1960-2018 (top panel). Combined athlete numbers in Summer and Winter Paralympics, Special Olympics and Deaflympics, 2016-2019 (bottom panel).

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Note. Grey = no participation. Russia banned (2016-2018). Data sources: 90-96.