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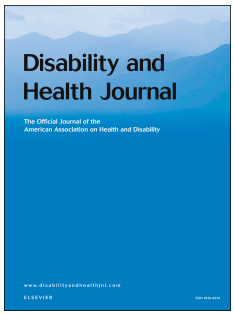

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A scoping review on interventions to promote physical activity among adults with disabilities

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The overall results of the review were presented at the XI European Congress of Adapted Physical Activity in Olomouc, 2016. The results of the review concerning the

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identification of behavior change techniques using the Behaviour Change Techniques Taxonomy version 1 were presented at the XII European Network of Young Specialists in Sport Psychology Conference in Warsaw, 2016.

Keywords: behavior change techniques taxonomy; spinal cord injury; multiple sclerosis; International Classification of Functioning, Disability and Health.

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Title: A scoping review on interventions to promote physical activity among adults with disabilities

Abstract

Background: Despite the strong evidence that physical activity (PA) is a key determinant of health, there is limited knowledge on the content and outcomes of PA promotion interventions among individuals with disabilities.

Objective: To conduct a scoping review in order to examine the published literature on PA promotion interventions among adults with disabilities.

Methods: A scoping review following the methodological framework provided by Arksey and O'Malley used electronic databases (MEDLINE, PsycINFO, and CINAHL), reference lists, and journals to locate studies. Inclusion criteria were based on study aim, outcome measures, and a disability definition by the WHO International Classification of Functioning, Disability and Health. The Behavior Change Techniques Taxonomy version 1 and Furlan and collaborators' risk of bias assessment were utilized during the data charting stage.

Results: Thirty-eight articles met the inclusion criteria. Most of the studies (70%) reported a significant increase in PA behaviour immediately following intervention. However, less than half of the studies (46%) examined the maintenance of pre- / post-test differences. The number of identified behavior change techniques was significantly higher for successful PA promotion interventions than for interventions with no effects on PA. Approximately one-third of studies (32%) were rated as having a high risk of bias.

Conclusions: Although findings support the idea that PA promotion interventions produce positive changes in PA behavior for a variety of disability conditions, risk of bias assessment calls for prudence. There are opportunities for continued development of the area of PA promotion among individuals with disabilities through systematic reviews and meta-analyses.

Keywords: Behavior change techniques taxonomy; spinal cord injury; multiple sclerosis; International Classification of Functioning, Disability and Health.

Introduction

From the International Classification of Functioning, Disability and Health (ICF), disability is understood as an all-embracing term covering impairments, activity limitations, and participation restrictions.[1] According to the *World report on disability*,[2] approximately 15% of the inhabitants worldwide live with some form of disability, and a substantial increase in the global disability prevalence is expected in the upcoming years.

In comparison with the general population, the health of individuals with disabilities tends to be poorer.[2, 3] Similarly, individuals with disabilities face an elevated prevalence of secondary conditions,[4, 5, 6] broadly defined as "medical, social, emotional, family, or community problems that a person with a primary disabling condition likely experiences" (p. 145).[7] Although preventable,[8] secondary conditions affect the health of individuals with disabilities[9, 10] and cause a significant economic burden in the form of increased medical costs.[11, 12]

Strong evidence shows physical activity (PA) can help in reducing the incidence and severity of secondary conditions among individuals with disabilities.[13] Research has noted a wide range of physical, cognitive, affective, and social benefits for those individuals with disabilities engaging in PA behavior.[14, 15] However, different studies indicate that individuals with disabilities engage in less PA than the general population.[16-18] For instance, data from the Behavioral Risk Factor Surveillance System revealed that nearly double as many Americans with disabilities (25.6%) were physically inactive compared with those without disabilities (12.8%).[19] This disparity in PA engagement has been explained by the higher prevalence of PA barriers among individuals with disabilities (e.g., individual, social, and environmental barriers).[20-22]

Given the high rates of physical inactivity, adopting an active lifestyle is an important public health goal for individuals with disabilities.[23] Indeed, health organizations such as the American College of Sports Medicine and the American Heart Association have commenced to report specific PA recommendations for individuals with disabilities.[24] Moreover, there have been repeated calls for the implementation of health promotion interventions targeting PA.[25] While numerous PA promotion interventions have addressed individuals with disabilities in past years,[26, 27] few reviews have attempted to examine their effectiveness and core characteristics.[28]

Characterising the content used in PA and other health-related promotion interventions is fundamental for reporting, replicating, and synthesising evidence.[29, 30] The Behavior Change Technique Taxonomy version 1 (BCTTv1) is a method of specifying intervention content developed by Michie and collaborators,[31] including 93 Behavior Change Techniques (BCTs) grouped within 16 categories. A BCT is defined as "an observable, replicable, and irreducible component of an intervention designed to alter or redirect causal processes that regulate behavior" (p. 23).[31] BCTTv1 can provide a greater level of intervention details for synthesis, comparison, and replication of studies.

To the authors' knowledge, there is no record of previous reviews on PA promotion interventions among individuals with a wide range of disabilities. A review of the PA promotion literature may highlight the feasibility of undertaking systematic reviews for specific types of disabilities or health conditions and identify research gaps. Further, such a review could potentially enhance the quality of future PA promotion interventions. Therefore, the primary aim of this study was to conduct a scoping review to examine the published literature on PA promotion interventions among adults with disabilities. The analyses were focused on the outcomes (i.e., PA promotion effectiveness) and the intervention content (i.e., reported BCTs) of studies included in the review.

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Methods

The methodological framework provided by Arksey and O'Malley,[33] along with subsequent enhancements to the methodology,[34-36] constitutes the outline in which the present scoping review was conducted. Scoping reviews share some characteristics with systematic reviews. For example, the use of a rigorous and replicable method, reducing the risk of bias.[37] Nonetheless, unlike systematic reviews directed to precise questions, scoping reviews usually provide a broad overview or "map" of a topic.[38, 39] The wide breadth of the present study's research question supports the adoption of a scoping review method. As proposed by Arksey and O'Malley,[33] the scoping review included five stages.

1. Identifying the research question.

What is known about PA promotion interventions among adults with disabilities? This stage comprised of clearly defining the key terms of the scoping review. An operational definition for disability based on the ICF and Peterson-Besse and collaborators' scoping review[40] was used to facilitate the screening and eligibility processes. Specifically, disability was defined as a disabling condition or functional limitation falling into at least one of the following functional categories: physical, sensory, cognitive, or activity limitation.

2. Identifying relevant studies.

The following electronic databases were searched: MEDLINE, PsycINFO, and CINAHL. The search strategy was based on previous recommendations on searching for disability[41] (complete search strategy is available as online supplemental material). Peer-reviewed articles written in English and published between 2001 and 2016 were sought. The starting point of the search (i.e., 2001) was chosen in accordance with the publication date of the disability operational definition by the ICF.[1] Journals, reference lists of included studies, and previous reviews related to PA and disability were manually searched.

3. Study selection.

Studies were included if they met the following criteria: (1) included participants aged 18-65 with a disability, according to the operational disability definition; (2) aimed to

promote PA behavior in any type or form to the participants; (3) assessed PA behaviour through questionnaires or tracking devices (e.g., pedometer or accelerometer). It should be acknowledged that mental health disabilities were not included in this review. Although important, they are singular enough to deserve separate attention and would be better addressed using a different conceptual framework (e.g., the Diagnostic and Statistical Manual of Mental Disorders). Two reviewers (*authors' initials*) applied the inclusion criteria to the identified articles, resolving all disagreements by consensus.

4. & 5. Charting the data, summarizing and reporting the results.

Descriptive data from the studies were extracted, including information regarding research design, risk of bias, participants, PA measures, PA findings, and intervention characteristics. Two independent reviewers participated in the risk of bias assessment, charting the PA findings, and applying the BCTTv1 (*authors' initials*, respectively). Reviewers participating in the coding of BCTs were trained[42] and employed a qualitative analysis software package (ATLAS.ti 7). For the remaining charted data, one reviewer (*author's initials*) carried out the process and a random sample of one-third of studies were checked by a second reviewer (*author's initials*) to guarantee consistency. Again, all discrepancies were discussed between reviewers until a consensus was reached.

Unlike most systematic reviews, scoping reviews do not reject studies based on a risk of bias assessment.[33] In the present study, assessing the risk of bias was conducted to describe the available literature and to better inform the feasibility of a full systematic review. Criteria and instructions to assess the risk of bias followed the recommendations from Furlan and collaborators,[43] adapted from the Cochrane Handbook of Reviews of Interventions.[44] Different criteria associated with risk of bias were analysed: *adequate randomization*; *allocation concealment*; *blinding of participants, intervention providers*, and *outcomes assessors*; *drop-out rate*; *complete outcome data*; *freedom from selective outcome reporting*; *groups similar at baseline*; *avoidance of co-interventions*; *intervention compliance*; and *equal timing of outcomes assessment*. Each criterion was marked "yes" (when the risk of bias criterion was met), "no" (when the risk of bias criterion was not met), or "not present" (when the risk of bias criterion was not reported). Authors of included studies were contacted when necessary to attain additional information. A risk of bias score for each included study was calculated by

summing the total number of criterion marked "yes". When at least six of the 12 risk of bias criteria were met studies were rated as having a low risk of bias. Studies in which fewer than six of the 12 risk of bias criteria were met or with important flaws (e.g., 70% drop-out in one group) were rated as having a high risk of bias.

Mann-Whitney and chi-square tests with significance level set at $p < 0.05$ were performed to compare the included studies (e.g., PA findings or interventions' characteristics) based on the binary risk of bias assessment (high risk of bias vs low risk of bias). In addition, Mann-Whitney tests with significance level set at $p < 0.05$ were conducted to compare the interventions' characteristics (e.g., number of BCTs used or length of the intervention) based on the binary effectiveness result for PA promotion (effective vs non-effective). Statistical analyses were performed for all studies and after excluding high risk of bias studies (i.e., sensitivity analysis).

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Results

Of the 1822 articles initially identified, 38 articles from 37 studies met the inclusion criteria (Figure 1). A Flowchart detailing study selection is available as online supplemental material. Table 1 shows descriptive data for each included study in the following areas: study descriptives, research design, risk of bias score, participants, measures, intervention, and PA findings.

Publication date and study location

More than half of the studies (57%) included in the review were published between 2010 and 2015, nearly doubling the number of studies published during the previous five-year period (2005 and 2010, 30%). Approximately half of the studies (51%) were conducted in the United States of America, followed by the United Kingdom (19%), Canada (11%), the Netherlands (11%), and three European countries with a single study published during the period under review; Denmark, Austria, and Sweden.

Research design and risk of bias assessment

The majority of the studies were titled as randomized controlled trials. Only three of 37 studies (8%) were pre- and post-intervention studies with no control group. Risk of bias scores for the studies ranged from 4 to 9 with a mean score of 6.61 (range 0-12; *SD* = 1.37). A total of 12 studies (32%) did not achieve at least six points as final score or presented important flaws and were consequently marked as high risk of bias studies. In relation to the scoring per risk of bias criterion, freedom from selective outcome reporting, equal timing of outcomes assessment, and groups similar at baseline were met in most of the studies (97%, 85%, and 85%, respectively). On the other hand, avoidance of co-interventions, blinding of participants, and blinding of care providers were met only in few studies (20%, 9%, and 15%, respectively). Complete scoring per risk of bias criterion is available as online supplemental material. The initial inter-reviewer agreement (average kappa of .64, *SD* = 0.15) was adequate.[45]

Participants

The total number of participants included in the review was 3956. The number of participants per study ranged from 12 to 599 (*M* = 106.11 participants, *SD* = 104.74). The participants' mean age across the studies was 48.95 years (*SD* = 8.93). Around two

thirds of the studies (65%) had a sample of between 50 and 150 participants. The remaining studies included less than 50 participants (22%) or, to the lesser extent, more than 150 (14%). Among the studies which targeted a specific health condition (73%), spinal cord injury and multiple sclerosis had the highest number of included PA promotion studies (19% and 14%, respectively).

Measurements

A great number of studies (65%) based their measurements solely on self-report(s), such as questionnaires or inventories. Other studies (22%) combined self-report(s) with PA tracking devices. There were limited studies (13%) whose measurements were exclusively based on PA tracking devices. A number of 19 different self-reports were identified across the studies, five of them being non-standardized. Practically all the studies included pre- and post-measurements, whereas less than half of them (46%) included follow-up measures. Distinction between primary and secondary outcomes was specified in 21 studies (57%), where PA behavior was cited as primary outcome in 15 of them.

Interventions' characteristics

One experimental and one control group commonly defined the intervention conditions (78%), yet some studies (14%) incorporated an additional experimental group. Most of the studies (78%) attempted to modify PA behavior only, while others targeted additional health behaviors along with PA such as nutrition (19%) or responsible health practices (11%). A theoretical framework guiding the intervention was reported in 17 studies (46%).

Of the 93 hierarchically-clustered techniques composing BCTTv1, 39 were coded at least once among the intervention descriptions. Of these, 25 techniques were identified at least twice. Table 2 shows the most commonly observed BCTs among the included studies ($M = 6.78$, $SD = 2.77$). In BCTTv1 techniques are grouped in 16 categories. It should be noted that ten of the most observed BCTs belong to three categories: goals and planning (*problem solving, action planning, goal setting – behavior, goal setting – outcome,* and *review behavior goal*), feedback and monitoring (*self-monitoring of behavior, monitoring of behavior by others without feedback,* and *feedback on behavior*), and social support (*social support – unspecified* and *social support –*

practical). The remaining seven BCTs represented in Table 2 are part of six different categories.

Findings: PA pre/post-test and follow-up differences

Over two thirds of the studies (70%) reported a significant increase in PA behavior immediately following intervention. Among them, six of nine studies counting with follow-up measures achieved PA maintenance. On the other hand, 11 studies (30%) reported no significant PA changes immediately following intervention.

Studies' characteristics by risk of bias assessment

Studies rated as having a high risk of bias were examined in contrast with studies rated as having a low risk of bias. At post-test level, a chi-square test of independence indicated that high risk of bias studies were more likely to report an increase in PA behavior than were low risk of bias studies, $X^{2\,(1)} = 4.18$, $p = .043$. There were no statistically significant differences in PA maintenance, number of BCTs, intervention duration, or theory guidance.

Interventions' characteristics by PA findings

Studies linked with PA promotion were examined in contrast with studies where no effects on PA behavior were described. At post-test level, a Mann-Whitney test indicated that the number of BCTs coded were higher for studies reporting a significant increase in PA behavior (*Mdn* = 6) than for studies reporting no significant PA changes (*Mdn* = 5), $U = 71.5$, $p = .013$. There were no statistically significant differences based on either the length of the intervention or the use of a theoretical framework. The same results were found after excluding high risk of bias studies. That is, at post-test level (n = 25) the number of coded BCTs was higher for low risk of bias studies reporting a significant increase in PA behavior (*Mdn* = 6.5) than for low risk of bias studies reporting no significant PA changes (*Mdn* = 5), $U = 39$, $p = .048$.

Discussion

The increased number of studies aiming at PA promotion among adults with disabilities is a favorable trend in the field of PA and disability. Previous studies have indicated that the disability literature is still in early stages of maturity and claimed for a greater intervention development.[46, 47] Overall, findings support a positive effect of PA promotion interventions among adults with a wide variety of disability conditions, especially immediately following intervention. In the context of current literature, past research with individuals with disabilities has already evidenced that health promotion interventions result in improved health behaviors such as nutrition or stress management.[48, 28] Yet, to our knowledge, this is the first review suggesting that PA promotion efforts produce positive changes in PA behavior across various types of disabilities.

However, results from the risk of bias assessment call for cautiousness, as approximately one-third of the included studies were rated as having a high risk of bias. Moreover, the significant difference between the studies' PA findings based on the binary risk of bias assessment may be indicative of an exaggerated intervention effect by the high risk of bias studies. Empirical evidence suggests that intervention effects tend to be overestimated in studies rated as high risk of bias compared to studies rated as low risk of bias.[44] For all this, the effectiveness of PA promotion interventions among adults with disabilities would be better addressed through systematic reviews or meta-analyses. These literature review methods commonly use the risk of bias assessment as an additional inclusion criterion for studies.

Blinding of conditions, allocation concealment, and avoidance of co-interventions have been important sources of risk of bias among the included studies and deserve special attention in upcoming studies. Although it may be challenging to avoid some of these risks of bias depending on the nature of the intervention (e.g., blinding of participants and intervention providers in an exercise program), some other criteria are likely to be met with less difficulty (e.g., blinding of outcome assessors and allocation concealment). This will contribute to strengthening the available evidence.

Along with study design, an additional effort to improve study reporting is recommended for future research. Most of the included studies were lacking relevant information on how the study was conducted, which evokes a key obstacle in the

assessment of risk of bias.[44] Well conducted studies may be rated as high risk of bias studies if researchers fail to report several risk of bias criteria and do not respond to clarification inquiries. Researchers can minimize incomplete reporting by using consensus reporting guidelines (e.g., CONSORT, TREND, or STROBE statements). The use of CONSORT reporting guidelines[49] has been shown to improve the reporting of RCTs.[50]

Few studies managed to include follow-up measures to draw long-term conclusions on the effectiveness of the PA promotion interventions. Less than half of the studies reported data on PA maintenance. For the rest of studies, long-term effects may have been examined but not reported, if researchers failed to find statistically significant results. Indeed, non-statistically significant results are less likely to be published.[51] A growing concern in upcoming PA promotion interventions is the need to plan, perform, and report assessments for both short- and long-term effects.

Determining the feasibility of undertaking a full systematic review in the scientific literature is frequently associated to scoping reviews.[33] Spinal cord injury and multiple sclerosis were the most common health conditions among the included studies, which suggests that the body of evidence may be wide enough to conduct systematic reviews of PA promotion interventions specifically for these two health conditions. At the point of publication, no known specific reviews have been published. Nevertheless, in the case of spinal cord injury the quality of the evidence was poorly scored according to our risk of bias assessment;[43] five of seven studies were considered as having a high risk of bias. This may be relevant information for future reviewers as risk of bias ratings are typically part of the inclusion criteria in systematic reviews.

A wide variability of different self-reports were utilized among the studies included in our review. This constitutes a challenge for upcoming systematic reviews and meta-analyses, since the lack of homogeneity in measurements could limit the comparison between studies. Nonetheless, the broad scope of our review may explain part of this variability, due to the presence of several self-reports tailored to one health condition (e.g., LTPAQ-SCI: Leisure Time Physical Activity Questionnaire for People with Spinal Cord Injury).

Consistent with the ICF framework, we added the presence of functional limitations as part of the participants' selection criteria. Some studies could not be included in the

review due to poor reporting as far as functional limitations are concerned. Consequently, a suggestion for future research is to improve the description of the participants and include those elements that can define them as individuals with disabilities, according to the ICF criteria[1] and other contemporary approaches to disability. This means that, besides impairments and health conditions, possible activity limitations and participation restrictions should be assessed and reported.

Several reviews with individuals without disabilities have concluded that health promotion interventions in general,[52] and PA promotion interventions in particular,[53] which are based on explicitly described theoretical constructs are more effective than those not using theory. However, for the included studies, theory-based interventions seemed equally effective in PA promotion compared to studies that did not report theoretical guidance. Further research is needed specifically addressing the effectiveness of theory-based interventions in PA promotion among individuals with disabilities.

In relation to the interventions' characteristics, recent systematic reviews related to PA promotion for individuals without disabilities have reported a similar average number of BCTs per intervention.[54, 55] The most observed BCTs were also analogous to the ones most coded in our review. In the work of Gardner and collaborators,[55] a review of BCTs within sedentary behavior reduction interventions for adults, four of the five most used techniques coincide with the five BCTs most commonly observed in our review. Our finding that the number of utilized BCTs plays a relevant role in the PA promotion intervention effectiveness has also been reported in previous systematic reviews.[56, 57] Implications for future studies include the need for designing and implementing multicomponent interventions if meaningful effects on PA behavior are pursued. Nevertheless, it should be noted that researchers may purposefully use one or a small number of technique(s) to better attribute the PA behavior changes towards certain BCTs. In order to design multicomponent interventions, the use of BCT lists could boost the utilization of techniques not previously considered. Adopting internationally validated standards may not just facilitate intervention design but could also simplify reviewing attempts and enable research replication. For all this, we emphasize the use of Michie and collaborators' taxonomy[31] in future research.

Study limitations

Only published literature in English was searched for our review, which may have resulted in missing relevant information (e.g., grey literature or studies reported in other languages different than English). However, the scientific literature is conflicting in relation to language bias. Evidence exists suggesting that the use of English-language restrictions does not affect the results from systematic reviews and meta-analyses.[58] This is possibly due to the increasing use of English as the publication language of articles.

The adopted disability definition through the ICF may have also constrained our findings. Nonetheless, the challenge of disability definition is inherent to any reviewing effort including individuals with disabilities. By adopting a functional approach at the study selection stage we intended to be consistent with the ICF disability scheme,[1] widely recognized and commonly used. Future reviews need to be carefully planned in order to make the selected disability scheme operational in the selection process.

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Conclusion

Based on the results of the scoping review, there is a positive effect of PA promotion interventions among adults with a wide variety of disability conditions. Nevertheless, the risk of bias assessment invites us to be cautious when interpreting these results. Around one-third of the studies were rated as having a high risk of bias and a sensitivity analysis suggests an overestimating intervention effect (false positive) by the high risk of bias studies in comparison to those rated as having a low risk of bias. As such, establishing inclusion criteria based on the assessment of risk of bias appears to be essential in future reviewing attempts. Improvements in designing and reporting upcoming studies would contribute to the strength of the available evidence. Similarly, prospective use of rigorous guidelines and classifications (e.g., ICF, CONSORT guidelines, or BCT taxonomies) would benefit future reviewing efforts. In this regard, results indicate that there are opportunities for systematic reviews and meta-analyses within the area of PA promotion for individuals with disabilities.

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Supplemental materials

Supplemental materials associated with this article can be found, in the online version, at

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*Indicates that the article was included in the review.

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Figure legends

Figure 1. Flow chart for the articles included in the scoping review of literature on physical activity (PA) promotion interventions among adults with disabilities (N = 37).

Table 1. Characteristics of physical activity (PA) promotion studies included in the review (N = 37).

Table 2. Main Behavior Change Techniques (BCTs) coded among the studies included in the review (N = 37).

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Table 1. Characteristics of physical activity (PA) promotion studies included in the review (N = 37).

Study		Participants		Measures		Intervention			Findings
Identifier	**Research design / Risk of bias score***	**Total N, nº of conditions and n per group with completers, (exp; control)**	**Participants' mean age (*SD*) / Health condition**	**PA primary outcome / PA measures†**	**PA timeline measures§**	**Length of intervention / boosters**	**Theory-based intervention**	**Total nº and labels of Behavior Change Techniques¶**	**Significant pre- / post-test & pre-test / follow-up differences in PA#**
Ang et al. (2013)[59]	RCT / 7	216, 2 (107/97; 109/101)	45,8 (11,2)/ Fibromyalgia	Yes / Accelerometer; Self-report (CHAMPS)	Baseline, 3 months (p-t), 6 months (f), 9 months (f)	3 months	Yes (Motivational interviewing)	10 (1.2, 1.3, 1.4, 3.1, 4.1, 5.3, 6.1, 8.1, 8.7, 15.1)	Yes / No
Arbour-Nicitopoulos et al. (2009)[60]	RCT / 7	46, 2 (23/20; 23/18)	49,7 (12,8) / Spinal Cord Injury	Not specified / Self-report (PARA–SCI)	Baseline, 5 weeks, 10 weeks (p-t)	10 weeks	No	4 (1.2, 1.4, 2.3, 7.1)	Yes / -
Bergstrom et al. (2013)[61]	RCT / 6	139, 2 (76/66; 63/63)	37,8 (10,7) / Intellectual impairment	Yes / Pedometer	Baseline, 12-16 months (p-t)	12-16 months	Yes (Social cognitive theory)	4 (3.1, 8.1, 12.1, 12.2)	Yes / -
Blake and Batson (2009)[62]	RCT (pilot trial) / 9	20, 2 (10/10; 10/9)	45,3 (10,8) / Traumatic brain injury	Not specified / Self-report (PSDQ)	Baseline, 2 months (p-t)	2 months	No	3 (4.1, 6.1, 8.1)	No / -
Bombardier et al. (2013)[63]	RCT / 7	92, 2 (44/36; 48/39)	48,4 (8,4) / Multiple sclerosis	No / Self-report (7-PAR)	Baseline, 12 weeks (p-t), 24 weeks (f)	12 weeks	Yes (Motivational interviewing)	9 (1.1, 1.5, 2.1, 2.2, 2.3, 3.1, 3.2, 12.5, 15.1)	Yes / Yes
Brawley et al.	Pre- and post-	13, 1 (13/10)	42 (9,5) /	Not specified	Baseline, 9	9 weeks	No	8 (1.2, 1.3,	yes, no

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(2013)[64]	trial (without control group) / Important flaws		Spinal Cord Injury	/ Self-report (LTPAQ-SCI)	weeks (p-t)			1.4, 1.5, 2.3, 3.1, 6.2, 10.4)	control group
Breyer et al. (2010)[65]	RCT / 4	70, 2 (32/30; 33/30)	60,3 (8,4) / Chronic obstructive pulmonary disease	Yes / Accelerometer	Baseline, 3 months (p-t), 6 months (f), 9 months (f)	3 months	No	5 (1.4, 2.5, 2.6, 4.1, 9.1)	Yes / Yes
Effing et al. (2011)[66]	RCT / 7	159, 2 (80/74; 79/68)	63,4 (7,9) / Chronic obstructive pulmonary disease	No / pedometer	Baseline, 7 months (p-t), 12 months (f)	6 months / 5 months	No	6 (2.3, 2.4, 4.1, 6.1, 8.1, 8.6)	Yes / Yes
Elsworth et al. (2011)[67]	RCT / 7	99, 2 (51/50; 48/48)	56 (12,8) / Neurological condition (e.g.,: Parkinson's disease, cerebral palsy)	Yes / Self-report (PASE); pedometer	Baseline, 3 months (p-t), 6 months (f)	3 months	No	6 (3.1, 3.2, 4.1, 5.3, 6.1, 8.1)	No / No
Ennis et al. (2006)[68]	RCT / 5	64, 2 (34/31 ; 30/30)	45,5 (8,5) / Multiple sclerosis	Yes / Self-report (HPLP II)	Baseline, 8 weeks (p-t)	8 weeks	Yes (Social cognitive theory)	5 (1.3, 5.3, 9.1, 15.1, 16.3)	Yes / -
Farr et al. (2010)[69]	RCT / 7	293, 3 (95/72; 98/73; 100/76)	55,1 (7,1) / Knee osteoarthritis	Yes / Self-report (ACLS); accelerometer	Baseline, 3 months, 9 months (p-t) (1st group); Baseline, 3 months (p-t),	9 months (1st group); 3 months / 6 months (2nd); 9 months (3rd)	No	9 (1.4, 2.1, 2.3, 3.1, 4.1, 5.3, 6.1, 8.1, 8.7)	Yes / No

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					9 months (f) (2nd); Baseline, 3-months, 9 months (p-t) (3rd)				
Froehlich-Grobe and White (2004)[70]	RCT / 5	109, 2 (55/32; 54/43)	44,4 (9,8) / Mobility impairment	Not specified / Self-report (non-standardized)	Baseline, 25 weeks (p-t) (measurements every week)	25 weeks	No	5 (2.1, 2.3, 3.1, 5.1, 10.9)	Yes / -
Froehlich-Grobe et al. (2014)[71]	RCT / 7	128, 2 (69/51; 59/35)	44,5 (12,5) / Mobility impairment	Yes / Self-report (non-standardized)	baseline, 1 week, 12 weeks (p-t), 26 weeks (f), 52 weeks (f)	12 weeks / 40 weeks	Yes (Social cognitive theory and the relapse prevention model)	8 (1.1, 1.2, 1.3, 1.4, 3.1, 3.2, 5.1, 12.5)	Yes / Yes
Hartvigsen et al. (2010)[72]	RCT / 8	136, 3 (45/40; 46/42; 45/44)	46,7 (10,9) / Chronic low back pain	No / Accelerometer	4 weeks, 9 weeks (p-t)	8 weeks	No	4 (1.4, 3.1, 4.1, 8.1)	No / -
Haworth et al. (2009)[73]	RCT / 7	55, 2 (26/21; 29/20)	41,6 (12,7) Neurological condition	Yes / Self-report (HAP)	Baseline, 6 weeks (p-t), 12 weeks (f), 24 weeks (f)	4 weeks	Yes (Social cognitive theory)	5 (1.2, 5.3, 8.1, 9.1, 15.1)	No / No
Horner-Johnson et al. (2011)[74]	RCT / 5	134, 2 (67/47; 67/48)	49 / Cross-disability	Not specified / Self-report (HPLP II)	Baseline, 4 months (p-t), 7 months, 10-months	9 months	No	6 (1.3, 3.1, 8.1, 8.6, 13.4, 15.3)	Yes / -
Khalil et al. (2013)[75]	RCT (pilot trial) / 7	25, 2 (13/11; 12/10)	52,7 (13,1)/ Huntington's disease	Not specified / Pedometer	Baseline, 2 months (p-t)	2 months	No	11 (1.1, 1.4, 2.1, 2.3, 3.1, 3.2, 4.1, 6.1, 8.1, 8.7, 9.2)	Yes / -
Latimer et al.	RCT / 5	54, 2 (26/19;	40,6 (10,8)/	Not specified	Baseline, 8	8 weeks	No	6 (1.1, 1.4,	Yes / -

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(2006)[76]		28/18)	Spinal cord injury	/ PARA–SCI)	weeks (p-t)			2.3, 3.1, 3.2, 7.1)	
Latimer et al. (2013)[77]	Pre- and post-trial (without control group) / Important flaws	12, 1 (12/11)	42,9 (15,6)/ Spinal Cord Injury	Not specified / Self-report (LTPAQ-SCI)	Baseline, 4 weeks (p-t)	4 weeks	Yes (Social cognitive theory)	12 (1.1, 1.4, 1.8, 3.1, 3.2, 4.1, 5.3, 6.1, 8.1, 12.5, 15.1, 15.3)	yes, no control group
Marks et al. (2013)[78]	RCT / 8	67, 2 (32/29; 35/35)	45,2 (7,6) / Intellectual impairment	Not specified / Self-report (non-standardized)	Baseline, 3 months (p-t)	3 months	Yes (Social cognitive theory)	6 (1.4, 3.1, 4.1, 6.1, 8.1, 8.6)	Yes / -
McDonough et al. (2013)[79]	RCT / 9	57, 2 (40/35; 17/14)	49,5 (7) / Chronic low back pain	No / Self-report (MGROC)	Baseline, 9 weeks (p-t), 6 months (f)	8 weeks	Yes (5A's framework)	9 (1.1, 1.2, 2.1, 2.2, 2.3, 3.1, 5.3, 9.1, 15.3)	Yes / Yes
Melville et al. (2015)[80]	RCT / 8	102, 2 (54/42; 48/40)	46,3 (12,9) / Intellectual impairment	Yes / Pedometer; Self-report (IPAQ)	Baseline, 12 weeks (p-t), 24 weeks (f)	12 weeks	Yes (Trans theoretical model and social cognitive theory)	8 (1.1, 1.2, 1.4, 1.5, 2.3, 3.1, 5.3, 8.7)	No / No
Motl et al. (2011)[81]	RCT / 6	54, 2 (27/23; 27/25)	45,8 (9,8) / Multiple sclerosis	Yes / Self-report (GLTEQ)	Baseline, 12 weeks (p-t)	12 weeks	Yes (Social cognitive theory)	6 (1.2, 1.3, 2.3, 3.1, 5.3, 16.3)	Yes / -
Pang et al. (2005)[82]	RCT / 9	63, 2 (32/30; 31/30)	64,2 (8,7) / Chronic stroke	Not specified / Self-report (PASIPD)	Baseline, 19 weeks (p-t)	19 weeks	No	6 (1.3, 2.1, 4.1, 6.1, 8.1, 8.7)	No / -
Reichard et al. (2015)[83]	RCT / 5	126, 2 (64/29; 62/31)	52, 4 / Mobility impairment	Not specified / Self-report (non-standardized)	Baseline, 6 months (p-t), 12 months (f)	6 months / 6 months	No	5 (3.1, 3.2, 4.1, 10.10, 12.5)	No / No

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Rejeski et al. (2003)[84]	RCT / 6	147, 2 (74/64; 73/64)	64,7 (6,9) / Cardiovascular disease	Not specified / Self-report (7-PAR)	Baseline, 3 months (p-t), 12 months (f)	3 months / 8 months	No	10 (1.1, 1.2, 2.3, 2.5, 3.1, 4.1, 6.1, 7.1, 8.1, 15.3)	No / No
Rimmer et al. (2009)[85]	RCT / 5	92, 3 (31/28; 30/27; 31/23)	58,8 (11,6)/ Mobility impairment	Not specified / Self-report (PADS)	Baseline, 6 months (p-t)	6 months	Yes (PEP intervention model)	12 (1.1, 1.2, 1.4, 1.5, 2.1, 2.2, 2.3, 3.1, 3.2, 7.1, 8.1, 9.1)	Yes / -
Rimmer et al. (2013)[86]	RCT / 7	102, 3 (32/27; 32/27;38/32)	46,5 (12,7)/ Mobility impairment	Not specified / Self-report (PADS)	Baseline, 9 months (p-t)	9 months	Yes (PEP intervention model)	4 (1.4, 2.2, 3.1, 3.2)	No / -
Rosal et al. (2011)[87]	RCT / 7	252, 2 (124/88; 128/91)	Not available / Diabetes	No / Self-report (non-standardized)	Baseline, 4 months (p-t) , 12 months (f)	3 months / 8 months	Yes (Social cognitive theory)	5 (1.2, 1.3, 2.2, 2.3, 3.1)	No / No
Sandroff et al. (2014)[88]	RCT / 7	82, 2 (41/37; 41/39)	49,5 (8,3) / Multiple sclerosis	Not specified / Self-report (IPAQ)	Baseline, 6 months (p-t)	6 months	Yes (Social cognitive theory)	5 (1.2, 1.3, 1.7, 2.3, 3.1)	Yes / -
Slaman et al. (2015)[89]	RCT / 8	57, 2 (28/19; 29/22)	20 (3) / Spastic cerebral palsy	Yes / Accelerometer; Self-report (PASIPD)	Baseline, 6 months (p-t), 12 months (f)	6 months	No	6 (3.1, 3.2, 4.1, 6.1, 8.1, 9.1)	Yes / No
Steele et al. (2008)[90]	RCT / 5	111, 2 (54/42; 57/47)	65 / Chronic obstructive pulmonary disease	Yes / Accelerometer; Self-report (non-standardized)	Baseline, 5 months (p-t), 12 months (f)	5 months	No	11 (1.2, 1.4, 2.1, 2.3, 2.5, 3.1, 3.2, 4.1, 6.1, 8.1, 8.6)	Yes / No
Suh et al. (2015)[91]	RCT (pilot trial) / 8	68, 2 (34/33; 34/33)	45,9 (9,6) / Multiple sclerosis	Not specified / Self-report (GLTEQ)	Baseline, 6 weeks (p-t)	6 weeks	No	6 (1.1, 1.2, 2.3, 3.1, 4.2, 5.3)	Yes / -
Van der Ploeg	RCT / 6	599, 3	46,6 (13,6)/	Yes / Self-	Baseline, 9	6 weeks (1st	Yes (Trans	7 (1.3, 2.1,	Yes / Yes

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et al. (2006)[92] & Van der Ploeg et al. (2007)[93]		(315/224; 284/218; 603/533)	Cross-disability	report (non-standardized); Self-report (PASIPD)	weeks (p-t), 12 months (f)	group); 9 weeks (2nd)	theoretical model)	2.2, 2.3, 3.1, 3.2, 5.3)	
Van der Scheer et al. (2016)[94]	RCT / 7	29, 2 (14/14; 15/13)	57 (12) / Spinal cord injury	Not specified / Self-report (PASIPD); Odometer (wheelchair)	Baseline, 8 weeks, 16 weeks (p-t)	16 weeks	No	2 (2.1, 8.1)	No / -
Warms et al. (2004)[95]	Pre- and post-trial (without control group) / Important flaws	17, 1 (17/16)	43,2 (11,3) / Spinal Cord Injury	Not specified /Accelerometer; Self-report (non-standardized)	Baseline, 4 weeks (p-t)	4 weeks	Yes (Transtheoretical model)	5 (1.2, 1.3, 1.4, 1.7, 3.1)	yes, no control group
Zemper et al. (2003)[96]	RCT / 4	67, 2 (36/23; 31/20)	47 (15) / Spinal Cord Injury	Not specified / Self-report (HPLP II; PADS)	Baseline, 3 months (p-t), 7 months (f)	3 months	No	5 (1.2, 1.3, 1.7, 3.1, 11.2)	Not available / Yes

* Range of the score: 0-12. Studies marked with six or more points are considered as having low risk of bias, while studies with less than six points or with important flaws are considered as having high risk of bias.[43]

† PSDQ: Physical Self-Description Questionnaire, 7-PAR: 7-Day Physical Activity Recall, PASE: The Physical Activity Scale for Elderly, ACLS: Aerobics Center Longitudinal Study Physical Activity Questionnaire, HAP: Human Activity Profile, HPLP II: Health Promoting Lifestyle Profile II, PASIPD: Physical Activity Scale for Individuals with Physical Disabilities, PADS: Physical Activities with Disability Questionnaire, IPAQ: International Physical Activity Questionnaire, MGROC: Modified Global Rating of Change for Physical Activity, GLTEQ: Godin Leisure-Time Exercise Questionnaire, CHAMPS: Community Healthy Activities Model Program for Seniors, PARA-SCI:

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Physical Activity Recall Assessment for Individuals with SCI, LTPAQ-SCI: Leisure Time Physical Activity Questionnaire for People with Spinal Cord Injury.

§ Post-test (p-t) measure was defined as the measurement taking place right after the end of the intervention, while all additional measurement(s) were characterized as follow-up (f).[97]

¶ Behavior Change Techniques Taxonomy version 1, including a comprehensive Behavior Change Techniques description with examples, is available upon request from the first author.

Statistically significant differences for at least one PA outcome. If more than one experimental group, at least one group reporting differences. In case the design included several follow-up measures, the last one was examined for PA maintenance.

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Table 2. Main Behavior Change Techniques (BCTs) coded among the studies included in the review (N = 37).

Variable	Frequency	
	n	%
BCTs†		
Social support - unspecified	29	78
Self-monitoring of behavior	18	48
Behavioral practice/rehearsal	18	49
Problem solving	17	46
Action planning	17	46
Instruction on how to perform the behavior	15	41
Demonstration of the behavior	12	32
Goal setting - behavior	12	32
Information about social & environmental consequences	11	30
Monitoring of behavior by others without feedback	11	30
Goal setting - outcome	10	27
Social support - practical	10	27
Review behavior goal	5	14
Verbal persuasion about capability	5	14
Feedback on behaviour	5	14
Credible source	5	14
Graded tasks	5	14

† List of BCTs identified in at least five different interventions.

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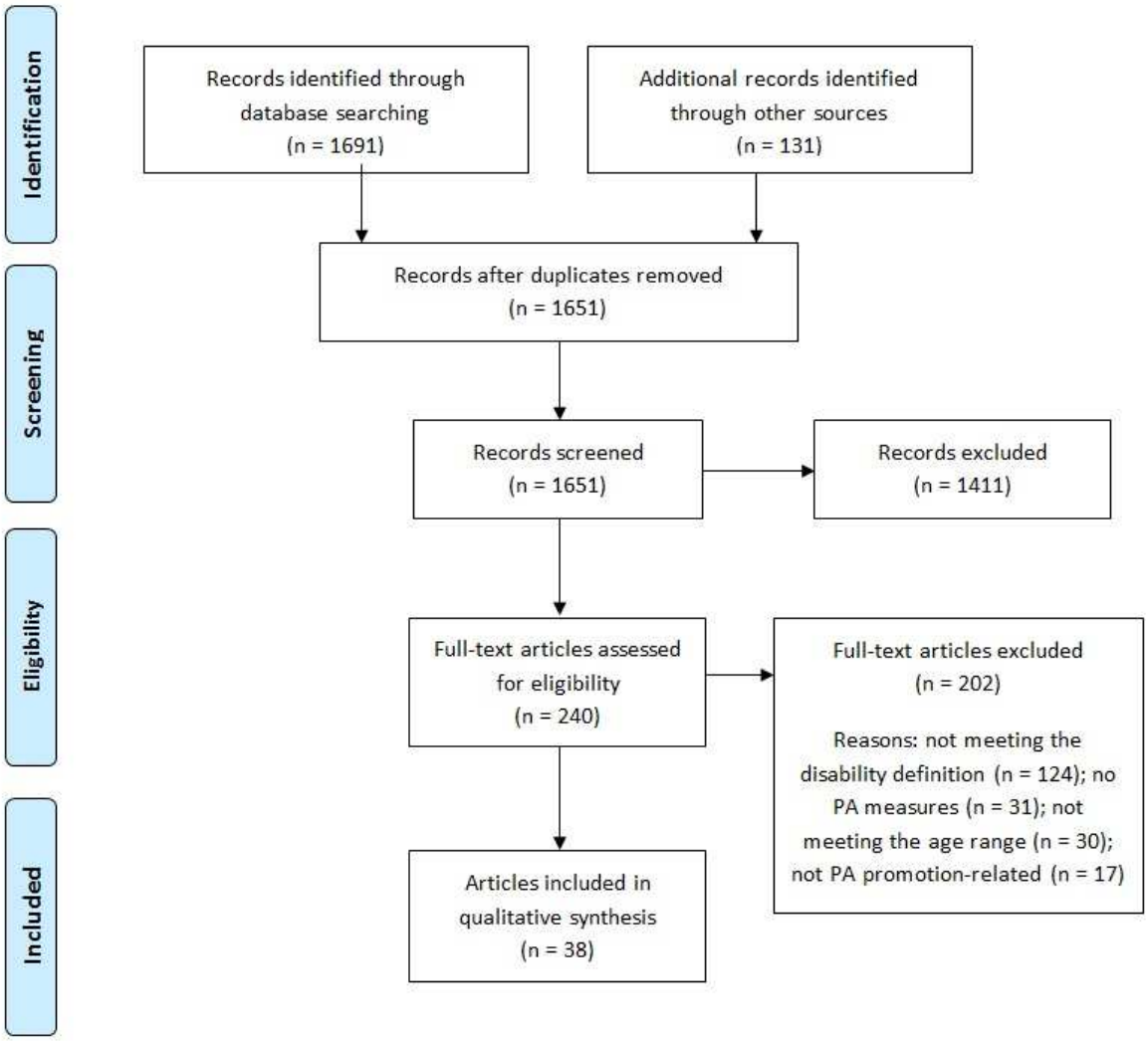
Identification
Screening
Eligibility
Included
Records identified through database searching (n = 1691)
Additional records identified through other sources (n = 131)
Records after duplicates removed (n = 1651)
Records screened (n = 1651)
Records excluded (n = 1411)
Full-text articles assessed for eligibility (n = 240)
Full-text articles excluded (n = 202)
Reasons: not meeting the disability definition (n = 124); no PA measures (n = 31); not meeting the age range (n = 30); not PA promotion-related (n = 17)
Articles included in qualitative synthesis (n = 38)

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