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Relationship between physical activity and disability in low back pain: A systematic review and meta-analysis

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It is often assumed that patients with pain-related disability due to low back pain (LBP) will have reduced physical activity levels, but recent studies have provided results that challenge this assumption. The aim of our systematic review was to examine the relationship between physical activity and disability in LBP. The literature search included 6 electronic databases and the reference list of relevant systematic reviews and studies to May 2010. To be included, studies had to measure both disability (eg, with the Roland Morris Disability Questionnaire) and physical activity (eg, by accelerometry) in patients with non-specific LBP. Two independent reviewers screened search results and extracted data, and authors were contacted for additional data. Correlation coefficients were pooled using the random-effects model. The search identified 3213 records and 18 studies were eligible for inclusion. The pooled results showed a weak relationship between physical activity and disability in acute or subacute (<3 months) LBP ($r = -0.08$, 95% confidence interval = −0.17 to 0.002), and a moderate and negative relationship in chronic (>3 months) LBP ($r = -0.33$, 95% confidence interval = −0.51 to −0.15). That is, persons with acute or subacute LBP appear to vary in the levels of physical activity independent of their pain-related disability. Persons with chronic LBP with high levels of disability are also likely to have low levels of physical activity.

1. Introduction

Persons with non-specific low back pain (LBP) often report impaired ability to perform daily activities. The impact of pain on a patient's daily functioning can be expressed as a patient's level of disability or a reduction in physical functioning. It is often assumed that patients who feel more disabled and thus report more daily life restrictions due to LBP will be those who are less physically active. This is reflected in treatments recommended for LBP, which typically promote increased physical activity to aid recovery and reduce disability. In acute LBP, persons are advised to stay active and avoid bed rest [22]; in chronic LBP, active approaches, such as cognitive behavioral therapy and exercise, are recommended over passive treatments [23]. However, the assumption that physical activity and disability are correlated, where persons with low back pain who have high levels of disability also have low activity levels, has not been unambiguously confirmed [3]. Moreover, a recent systematic review showed that persons with chronic LBP have similar levels of physical activity compared with healthy controls [40].

Although the concepts of "disability" and "physical activity" appear to share many similarities as they both reflect the impact of pain on daily functioning, they are not identical. *Disability* has been defined by the World Health Organisation (WHO) as any restriction or lack of ability to perform an activity within the range considered normal for a human being [47]. This definition is revised in the WHO classification of Functioning, Disability and Health (ICF), in which *disability* is used as an umbrella term to cover 3 broad aspects of health: body functions and structures, activity limitations, and participation restrictions [48]. Pain-related disability questionnaires in LBP focus on decrease in capacity of performance and altered performance of activities of daily living, but also cover other limitations of health under the ICF definition [12]. The WHO refers to *physical activity* as "any bodily movement

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produced by skeletal muscle that results in a substantial increase over the resting energy expenditure" [5,48]. In the ICF, *activity* is referred to as "the execution of a task or action by an individual". Therefore, where disability focuses on what persons cannot do, the concept of physical activity focuses on what persons are able to do or actually do in daily living.

The relationship between disability and physical activity in LBP may be influenced by how these concepts are conceptualised and measured. Disability has long been regarded as a core outcome in LBP [8] and is most commonly measured by self-report questionnaires. Measurement of physical activity is relatively new to LBP research, and can be conducted via self-reports (eg, Baecke Physical Activity Questionnaire, diary) or instruments of movement registration (eg, pedometer, accelerometer) [43]. Recent studies that measure both of these constructs in persons with LBP have provided results that challenge the common beliefs regarding the levels of physical activity and its relationship with disability in LBP [3,40]. Therefore, the aim of this study was to conduct a systematic review and meta-analysis to examine the relationship between physical activity and disability in acute, subacute, and chronic non-specific LBP.

2. Methods

To be included in this review, studies had to measure both disability and physical activity in patients with non-specific LBP at the same time point or over a comparable time period prospectively and quantitatively. Disability had to be assessed by a self-report questionnaire measuring disability (eg, Roland Morris Disability Questionnaire, Oswestry Disability Index). Self reports of physical activity (eg, Baecke Physical Activity Questionnaire, International Physical Activity Questionnaire) or instruments of movement registration (eg, pedometer, accelerometer) were accepted as measures of physical activity [43]. Case studies or series were not included. Studies that recruited mixed populations or LBP caused by serious pathology were excluded, except where data for participants with non-specific LBP were reported separately and could be extracted. We included studies published in English, German, Dutch, Portuguese, Spanish, and Italian.

A sensitive search was conducted in Medline (via OvidSP), EMBASE (via OvidSP), CENTRAL (via The Cochrane Library), CINAHL (via Ebsco), PEDro (www.pedro.org.au), and PsycINFO (via OvidSP) from inception to 14 May 2010. We also searched the reference list of relevant systematic reviews and included studies, and contacted experts in the field for potential studies. To identify studies of LBP, we used the Cochrane Back Review Group search strategy (www.cochrane.iwh.on.ca/pdfs/CBRG_searchstrat_Sept08.pdf). In addition, we used a combination of subject headings and key words to identify self-report measures of disability (eg, disability evaluation, Roland, Oswestry, Quebec) and outcome measures of physical activity. An example of the search strategy is given in Appendix A.

Two reviewers independently screened titles, abstracts, and then full-text articles for eligibility. All full-text screening was accompanied by a custom-designed screening form. Data extraction was performed by 2 independent reviewers using a custom-designed data extraction form. For both screening and extraction, disagreements were first resolved in discussion and then, if necessary, arbitrated by an independent third reviewer. Both the screening and extraction forms were piloted before use. The following data were extracted: the type of study, sample size, age and gender of participants, duration of LBP, disability measure, physical activity measure, and correlation between disability and physical activity. If studies reported data on more than 1 disability measure, we extracted data using, in a predefined order of preference, the Roland-Morris Disability Questionnaire, the Oswestry Disability Index, and the Quebec Back Pain Disability Scale, based on the frequency these measures are used in LBP literature [12]. For longitudinal studies, data collected at baseline and the last follow-up were extracted if the 2 time points fell into different back pain durations (ie, acute/subacute versus chronic). Otherwise, only baseline data were extracted.

We contacted authors for additional data where necessary. If authors could not be contacted after 3 attempts or data on the correlation between disability and physical activity measures could not be obtained, the study was excluded. Included studies were grouped into acute/subacute (<6 weeks or 6 weeks to 3 months) or chronic (>3 months) based on the duration of back pain [23]. We pooled data across studies using the random-effects model using MetaWin 2.1, and correlation coefficients reported as Pearson's r or Spearman's rho were analysed together. Some studies reported more than 1 measure of physical activity (eg, physical activity was measured by self report and accelerometry), and therefore provided more than 1 correlation coefficient between physical activity and disability. In these cases, we chose the correlation coefficient showing the strongest correlation to include in the meta-analysis, regardless of whether the direction of the correlation was negative or positive. Sensitivity analyses were conducted where, in studies providing more than 1 correlation coefficient between physical activity and disability, the strongest correlation in the negative direction ("lower bound analysis") and the strongest correlation in the positive direction ("higher bound analysis") were included in the meta-analysis. As a guide, we used 0.10, 0.30 and 0.50 as cut-off points to interpret the strength of the pooled correlation as small ($r = 0.10$ to <0.30), medium ($r = 0.30$ to <0.50), and large ($r \geqslant 0.50$) [6]. We followed the PRIMSA Checklist [29] in reporting our study (Appendix B).

3. Results

From the 3213 records identified by the search, 335 full-text articles were screened (Fig. 1). Most full-text articles were excluded because they did not measure physical activity and disability concurrently. We contacted authors of 34 studies for additional data not contained in the published paper; authors from most studies replied, and authors from 17 studies provided the necessary data. Eighteen studies from 21 articles fulfilled the inclusion criteria [3,7,10,16,18,19,24–26,28–32,34,36,37,41,42,46]. Three studies had each published data in 2 separate publications, and we used both publications to support each study [3,31,32,36,37,42].

The sample size of the included studies ranged from 13 [45] to 459 [30], with a total of 2495 participants across the 18 studies. Most studies recruited male and female participants with an average age in the 40s. Two studies exclusively recruited female participants [24,25], and 1 study recruited participants aged 65 years or older [46]. To measure self-reported disability, all but 1 study [30] used 1 of the 3 following questionnaires: the Roland-Morris Disability Questionnaire, the Oswestry Disability Index, or the Quebec Back Pain Disability Scale. Fourteen studies used self-reports to measure physical activity, ranging from validated questionnaires such as the Baecke Physical Activity Questionnaire [18,34,36,37] to self reports of exercise performed within a period of time [7,30]. All 7 studies that measured physical activity using an instrument of movement registration used accelerometers [3,16,19,31,41,42,44,45]. Three of the included studies provided data on participants with acute/subacute LBP as well as long-term follow up data for participants with persisting pain [3,7,36,37,42]. Data from these studies were extracted for both the acute/subacute (baseline) and chronic (last follow-up) time points.

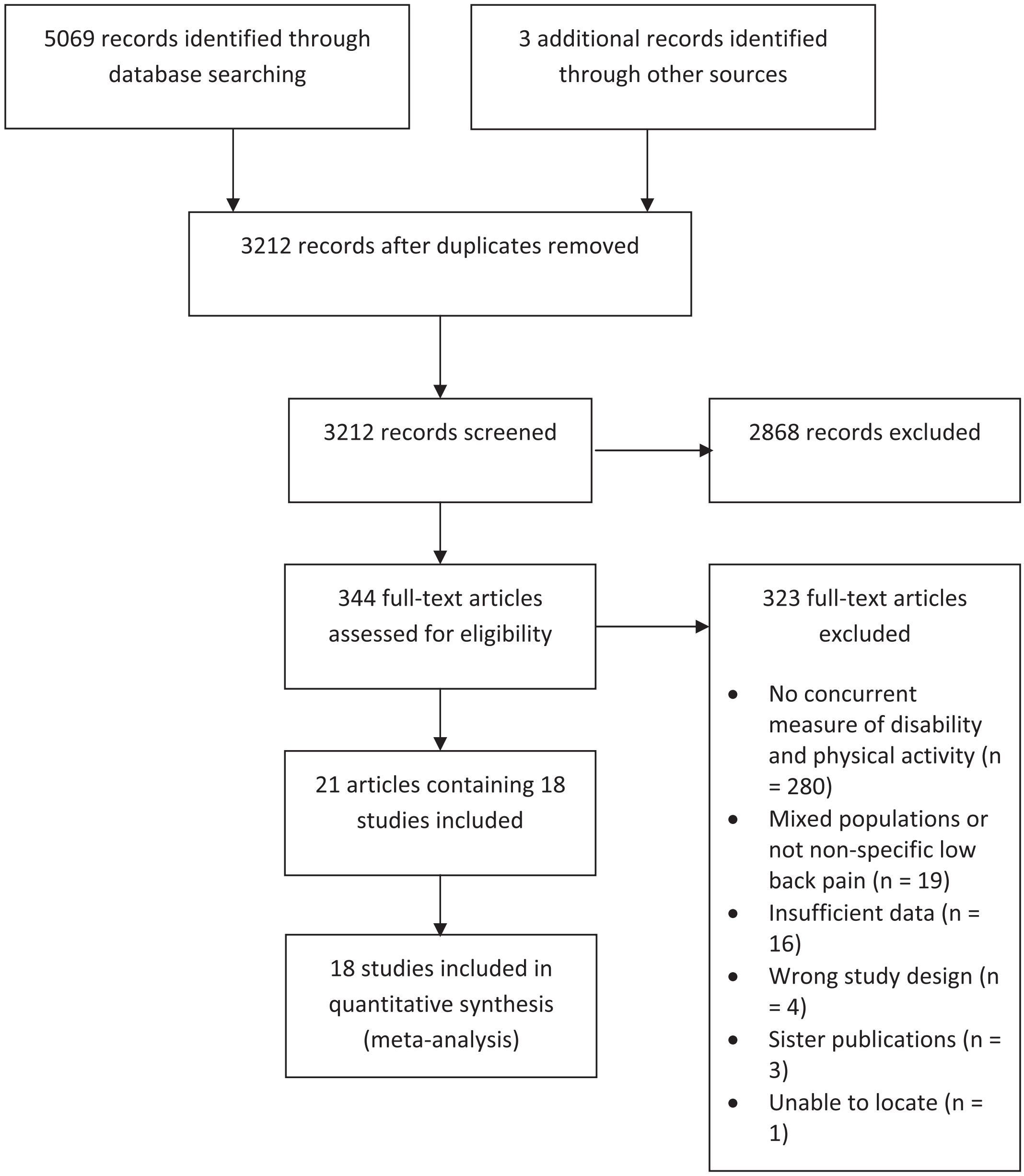

Fig. 1. Flow of study.

3.1. Acute/subacute LBP

Seven studies provided data on participants with acute or subacute LBP (Table 1). Mortimer et al. [30] recruited persons with LBP who did not seek care in the last 6 months, so was included in the acute/subacute group. The correlation coefficients of individual studies ranged from $r = -0.19$ [3,16,42,44] to $r = 0.08$ [26]. Two studies measured physical activity by self-report as well as accelerometry [3,42,16], but there was little difference in the correlation of each measure to disability (Table 1). The point estimate of pooled correlations between disability and physical activity in persons with acute or subacute LBP was $r = -0.08$ (95% confidence interval [CI] = −0.17 to 0.003) (Fig. 2).

3.2. Chronic LBP

Fourteen studies provided data on participants with chronic LBP (Table 2). Correlation coefficients for individual studies showed inconsistent results, which ranged from $r = -0.74$ [25] to $r = 0.07$ [19]. Two studies measured physical activity both by self report and accelerometry [3,19,42], showing minimal differences in the correlation between each measure and disability (Table 1). The pooled estimate of the correlations between disability and physical activity in persons with chronic LBP was moderate ($r = -0.33$, 95% confidence interval = −0.51 to −0.15). This correlation was negative, meaning that higher levels of disability were correlated with lower levels of physical activity (Fig. 3).

3.3. Sensitivity analysis

Three of the 7 studies in acute/subacute LBP [3,16,26,42] and 5 of the 14 studies in chronic LBP [3,19,24,25,31,32,42] had more than 1 measure of physical activity and therefore provided more than 1 correlation coefficient between physical activity and disability. The sensitivity analysis showed that the results were robust regardless of which correlation coefficient was included in the meta-analysis (Table 3).

Table 1
Characteristics of studies in acute or subacute low back pain.

	Design (sample size)	Age (y)	Gender (male/female)	Disability measure	Physical activity measure	Correlation[a]
Bousema et al. [3]/ Verbunt [42]	Cohort (n = 111)	44.5 (10.3)	60/51	Quebec Back Pain Disability Scale	Accelerometry over 7 days	Pearson *r* = −0.19 *P* = .05 n = 110
					Physical Activity Rating Scale	Pearson *r* = −0.13 *P* = .16 n = 122
Damush et al. [7]	RCT (n = 211)	45.4 (14.4)	56/155	RMDQ	Time spent performing exercises per week	Pearson's *r* = −0.09 *P* = .19
Hendrick et al. [16]	Cohort (n = 101)	37.8 (14.6)	50/51	RMDQ	Accelerometry over 7 days	Pearson's *r* = −0.14 *P* = .17
					7-Day Physical Activity Recall (7D-PAR) questionnaire	Pearson's *r* = −0.19 *P* = .06
Kuukkanen et al. [26]	Quasi-RCT (n = 90)	39.9 (7.9)	41/49	Oswestry Disability Index	Physical activity at work	Pearson's *r* = 0.08 *P* = .47 n = 82
					Physical activity during leisure time	Pearson's *r* = −0.07 *P* = .55 n = 82
Mortimer et al. [30]	Cohort (n = 459)	41.5 (10.1)	259/200	Von Korff Disability Questionnaire	Self-report of regular physical exercise	Spearman's rho = −0.04 *P* = .38
Staal et al. [36,37]	RCT (n = 134)	38 (8.5)	126/8	RMDQ	Baecke Physical Activity Questionnaire	Pearson's *r* < 0.01 *P* = .92
Verbunt et al. [44]	Cross-sectional (n = 123)	44.1 (10.3)	66/57	Quebec Back Pain Disability Scale	Accelerometry over 7 days	Spearman's rho = −0.19 *P* = .05

Note: All continuous outcomes are reported as mean (SD), unless stated.
METS, metabolic equivalents; RCT, randomized controlled trial; RMDQ, Roland Morris Disability Questionnaire.
[a] Number of participants is the study sample size, unless otherwise stated.

4. Discussion

We conducted the first systematic review and meta-analysis to examine the relationship between physical activity and disability in persons with LBP. We found that for persons with acute/subacute LBP there is a weak, and nonsignificant, relationship between levels of physical activity and disability. As the pooled estimate is close to zero and the confidence intervals are tight, we can conclude that for persons with acute/subacute LBP there is no clinically meaningful relationship between physical activity and disability. However, we found a moderate correlation between physical activity and disability for persons with chronic LBP, which indicates that persons with chronic LBP and high levels of disability are also likely to have low levels of physical activity.

The lack of association between physical activity and disability in the acute population is perhaps not surprising, considering that wide variations in levels of physical activity are observed in the general population [2] and levels of physical activity can be influenced by factors other than health status, for example, barriers and preferences for physical activity [33]. Hence, levels of physical activity of persons with acute LBP may vary independently of their pain-related disability.

The moderate and negative relationship between physical activity and disability in chronic LBP highlights that enhancing physical activity and reducing disability indeed might be an important treatment aim in this population. In situations in which measuring both physical activity and disability is constrained by time or resource, clinicians can assume that a person with high disability lev-

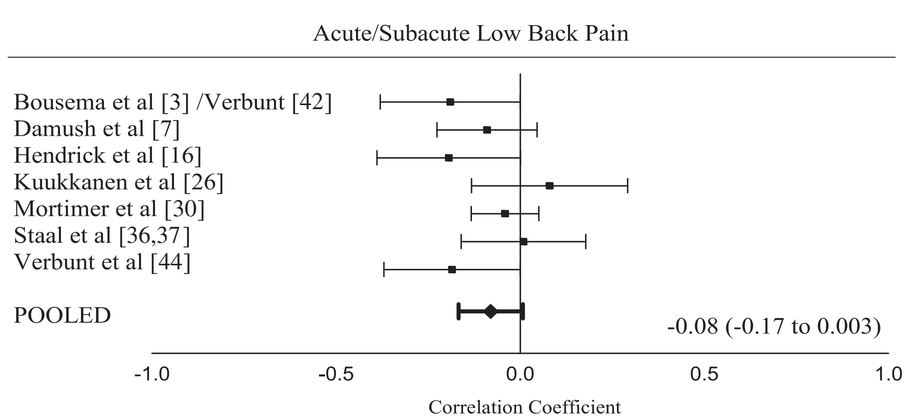

Fig. 2. Forest plot of the seven studies in acute or subacute low back pain. The pooled results indicate little correlation between physical activity and disability.

Table 2
Characteristics of studies in chronic low back pain.

	Design (sample size)	Age (y)	Gender (male/female)	Disability measure	Physical activity measure	Correlation[a]
Bousema et al. [3]/ Verbunt [42]	Cohort (n = 62)	45.6 (9.6)	32/30	Quebec Back Pain Disability Scale	Accelerometry over 7 days	Spearman's rho = −0.18 $P = .17$ n = 58
					Physical Activity Rating Scale	Pearson $r = -0.07$ $P = .62$ n = 62
Damush et al. [7]	RCT (n = 137)	48.5 (14.2)	37/100	RMDQ	Time spent performing exercises per week	Pearson's $r = 0.04$ $P = .68$
Elfving et al. [10]	Cross-sectional (n = 64)	Median = 47 Interquartile ranges = 36.0 to 56.5	25/39	RMDQ	Physical Activity Questionnaire	Pearson's $r = -0.54$ $P < .01$
Heymans et al. [18]	RCT (n = 299)	40.3 (9.8)	236/63	RMDQ	Baecke Physical Activity Questionnaire	Pearson's $r = -0.13$ $P = .02$
Huijnen et al. [19]	Cross-sectional (n = 66)	48.4 (9.9)	37/29	RMDQ	Accelerometry over 14 days	Pearson's $r = -0.12$ $P = .36$
					Electronic diary question "Right now, I am active"	Pearson's $r = 0.00$ $P = .98$
					Electronic diary question "What was my effort between this and the previous beep?"	Pearson's $r = 0.07$ $P = .56$
Kofotolis et al. [24]	RCT (n = 108)	40.2 (11.9)	0/108	Oswestry Disability Index	Physical activity at work	Pearson's $r = -0.72$ P value not available
					Physical activity during leisure time	Pearson's $r = -0.69$ P value not available
Kofotolis et al. [25]	Quasi-RCT (n = 92)	40.5 (6.7)	0/92	Oswestry Disability Index	Physical activity at work	Pearson's $r = -0.74$ P value not available
					Physical activity during leisure time	Pearson's $r = -0.72$ P value not available
Macedo et al. [28]	RCT (n = 139)	49.3 (14.5)	56/83	RMDQ	International Physical Activity Questionnaire (IPAQ) short form	Pearson's $r = -0.11$ $P = .2$
Ryan et al. [31,32]	Cross-sectional (n = 38)	45 (11)	13/25	RMDQ	Accelerometry over 7 days (reported 6 different outputs)	Pearson's $r = -0.21$ to -0.42 for the 6 different outputs $P = .01$ to $.21$
Smeets et al. [34]	RCT (n = 218)	41.3 (9.9)	115/103	RMDQ	Baecke Physical Activity Questionnaire	Pearson's $r = -0.36$ $P < .01$
Staal et al. [36,37]	RCT (n = 120)	Not available, but for the original cohort of 134:38 (8.5)	Not available, but for the original cohort of 134:126/8	RMDQ	Baecke Physical Activity Questionnaire	Pearson's $r = -0.39$ $P < .01$
Van Weering et al. [41]	Cross-sectional (n = 29)	44.4 (13.6)	16/13	RMDQ	Accelerometry over 7 days	Pearson's $r = -0.14$ $P = .55$ n = 26
Verbunt et al. [45]	Cross-sectional (n = 13)	45 (3)	9/4	RMDQ	Accelerometry over 14 days	Pearson's $r = 0.1$ $P = .76$
Weiner et al. [46]	RCT (n = 200)	73.9 (5.8)	86/114	RMDQ	Physical Activity Scale for the Elderly	Pearson's $r = -0.14$ $P = .05$

Note: All continuous outcomes are reported as mean (SD), unless otherwise stated.
RCT, randomised controlled trial; RMDQ, Roland Morris Disability Questionnaire.
[a] Number of participants is the study sample size, unless otherwise stated.

els will likely have low levels of physical activity and can design treatment accordingly. In addition, directly monitoring physical activity may be a useful treatment adjunct. For example, monitoring a person's physical activity using an instrument of movement registration, such as pedometer or accelerometer, can be used to provide patient feedback or set quotas for activity progression. However, further studies are required to see if a person's disability levels can be mediated by changes in the levels of physical activity.

The results of this study can be interpreted according the avoidance endurance model [14]. Based on this model, patients can show different activity related behavioral strategies when confronted with pain in the acute phase. They react with avoidance behavior; which means that they will avoid activities because of fear of reinjury. This will eventually result in both a decrease in the level of physical activities and an increase in the level of disability [27]. Alternatively, patients react with endurance behavior; which means that they persist in performing usual activities regardless of pain. These patients continue to maintain a certain level of activity, in the short term, despite having heightened levels of disability. Hence, in acute LBP, avoidance and endurance behaviors can result in varying levels of physical activity, which matches the lack of association found between physical activity and disability in the current study. As pain persists, patients showing endurance behavior who are distressed are thought to eventually reduce their levels of physical activity. This matches the observation in the current study of an association between physical activity and disability in chronic LBP.

In recent years, an increasing number of studies have measured physical activity in persons with LBP [43], but most do not provide data on the correlation of physical activity and disability. The

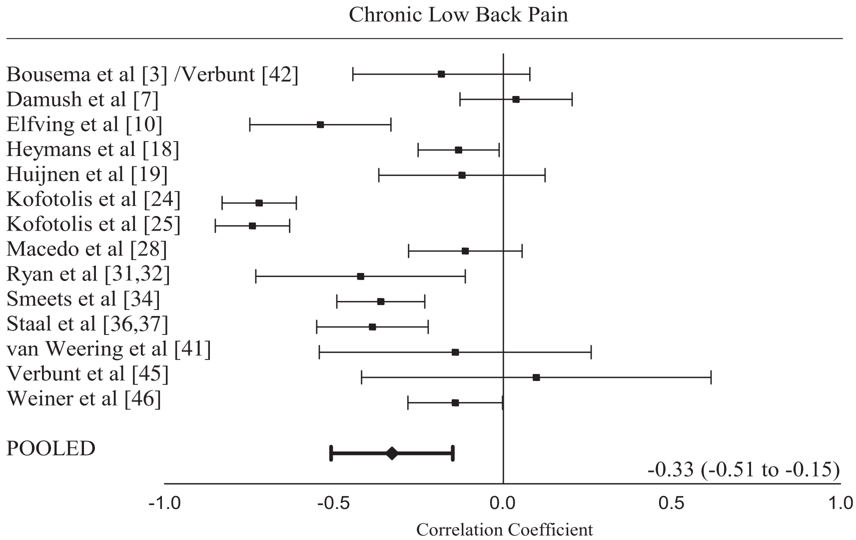

Fig. 3. Forest plot of the 14 studies in chronic low back pain. The pooled estimate indicates a moderate correlation between physical activity and disability.

strength of this study is that we were able to obtain additional data from the authors to estimate a correlation. A limitation of the study is that we did not analyze the association between disability and physical activity measured by self report or by an instrument of movement registration separately. However, the studies that provided the results showed similar associations between disability and physical activity regardless of whether physical activity was measured by self report or by an instrument [3,16,19,42]. Previous results have shown that factors such as social desirability [1] or the level of depression [19] can influence a person's self report of physical activity, whereas instruments of movement registration, particularly when worn over a period of time, may minimize this issue. In future research, separate analysis for self-reported activity and movement registration could be considered.

We chose to classify LBP based on the duration of pain to explore the relationship between physical activity and disability. This follows the convention of how LBP is commonly classified, particularly with regard to recommending treatments in guidelines [22]. Recent studies have suggested other ways of classifying patients with LBP, for example, based on symptom fluctuation or persistence [9,38] or prognostic factors [15]. It is possible that the relationship between physical activity and disability is different across subgroups of LBP. This can be examined in future studies, but a challenge in this area is that, currently, equivocal evidence is lacking to support any subgrouping system [21]. Future studies may also be needed to confirm the strength of the association between physical activity and disability after adjusting for other factors. For example, previous studies have found a significant correlation between disability and fear avoidance beliefs, but vary in their findings on the significance of this correlation after controlling for other factors such as pain intensity [11,13].

Results of our systematic review indicate that the relationship between physical activity and disability in LBP is not as commonly assumed. Similar to our results, other studies suggest that the role of physical activity in LBP is not straightforward. Heneweer et al. [17] found that the relationship between physical activity and the risk of chronic LBP forms a U-shaped distribution, meaning that both too little and too much activity presented increased risks of chronic LBP. Van Weering et al. [40] showed that persons with chronic LBP have similar levels of physical activity compared with controls. However, although the overall level of physical activity, expressed as the total count of movement above a threshold, may be similar, some studies suggest that patterns of physical activity may differ [31,35] and such fluctuations are disabling [20]. Future advances in the development of sophisticated instruments of movement registration may assist the monitoring of the type and pattern of activity in persons with LBP, provide further insights to the role of physical activity in LBP and present new treatment avenues [4,39].

Traditionally it has often been assumed that persons with pain-related disability caused by LBP will have reduced physical activity levels, and treatment for LBP emphasizes maintaining or gradually increasing one's activity level. We found that in acute/subacute LBP, there appears to be no significant correlation between levels of physical activity and disability. This means that some patients with acute LBP will be able to maintain a level of physical activity despite reporting pain-related disability, whereas some reporting low levels of disability will have limitations in physical activity. Further research is required to determine whether a low level of physical activity in acute/subacute LBP is a prognostic factor for persisting pain. In chronic LBP, persons with higher levels of disability are likely to have lower levels of physical activity. For these patients, providing interventions to increase their levels of physical activity seems warranted, but further research is required to determine whether these interventions can also lead to reduced pain-related disability.

Table 3
Sensitivity analysis presented as mean (95% confidence interval).

	Acute/subacute low back pain	Chronic low back pain
Main results[a]	−0.08 (−0.17 to 0.003)	−0.33 (−0.51 to −0.15)
Lower bound analysis[b]	−0.09 (−0.16 to −0.02)	−0.33 (−0.51 to −0.15)
Higher bound analysis[c]	−0.08 (−0.14 to 0.004)	−0.28 (−0.46 to −0.11)

[a] Correlation coefficients showing the strongest correlation, regardless of the direction, were included in the meta-analysis.
[b] Correlation coefficients showing the strongest correlation in the negative direction were included in the meta-analysis.
[c] Correlation coefficients showing the strongest correlation in the positive direction were included in the meta-analysis.

Conflict of interest statement

There are no conflicts of interest.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.pain.2010.11.034.

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