

# Effects of Low Back Pain on Balance Performance in Older People: A Systematic Review and Meta-analysis

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## Research article

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# Abstract

**Background:** Research suggests that individuals with low back pain (LBP) may have poorer motor control compared to their healthy counterparts; however, the sample population of almost 90% of related articles are young and middle-aged people. There is still a lack of a systematic review about the balance performance of elderly people with low back pain. This study aimed to conduct a systematic review and meta-analysis to understand the effects of LBP on balance performance in elderly people.

**Methods:** This systematic review and meta-analysis included a comprehensive search of PubMed, Embase, and Cochrane Library databases for full-text articles published before January 2020. Two independent reviewers screened the relevant articles, and disagreements were resolved by a third reviewer.

**Results:** Thirteen case-control studies comparing balance performance parameters between LBP and healthy subjects and four randomised controlled studies on physical therapy to improve the balance performance of elderly people with LBP were included. The experimental group (LBP group) was associated with significantly larger area of centre of pressure movement ( $P < 0.001$ ), higher velocity of centre of pressure sway in the anteroposterior and mediolateral directions ( $P = 0.01$  and  $P = 0.02$ , respectively), longer path length in the anteroposterior direction ( $P < 0.001$ ), slower walking speed ( $P = 0.05$ ), and longer timed up and go test time ( $P = 0.004$ ) than the control group.

**Conclusion:** The results showed that balance performance was impaired in elderly people with LBP. We should pay more attention to the balance control of elderly people with LBP.

## Background

United Nations data show that the world's population aged  $\geq 60$  years will triple by 2050<sup>[1]</sup>. Rapidly growing aging populations have increased the prevalence of diseases such as musculoskeletal pain. The reported prevalence of muscular and skeletal pain is 65–85% in elderly people<sup>[2, 3]</sup>; of them, 36–70% had LBP<sup>[3, 4]</sup>. LBP, the most common health problem among older adults, results in pain and disability<sup>[5]</sup>. Moreover, elderly people with LBP are often underreported and inadequately provided with treatment<sup>[6]</sup>. Untreated or undertreated older individuals with LBP may experience sleep disturbances, limitations to their social and recreational activities, psychological distress, decreased cognition, rapid deterioration of functional ability, and falls, ultimately causing great burdens on family and society<sup>[7–9]</sup>.

Balance, which is fundamental to activities of daily living, is affected in patients with LBP<sup>[10]</sup>. Most functional tasks in daily life require balance in the horizontal and vertical directions. Impaired balance is associated with poor motor control, the ability for one to maintain their balance and body orientation in space<sup>[11]</sup>. Previous studies demonstrated that patients with LBP may have impaired motor control<sup>[12–14]</sup>, which would further affect their motor performance and behaviour.

Balance dysfunction in the aging population is based on knowledge of the normal aging processes, loss of sensory elements, and loss of musculoskeletal function<sup>[15]</sup>. Motor performance declines with age due

to biological changes (e.g. mobility, physical inactivity), which in turn can lead to falls<sup>[16, 17]</sup>. LBP is a known independent risk factor for repeated falls in older women<sup>[18]</sup>.

What is the effect of aging combined with LBP? Here we aimed to conduct a systematic review and meta-analysis to understand the effects of low back pain in elderly people with the ultimate goal of providing better clinical research and treatment guidelines.

## Methods

### Literature search strategy

This review was conducted according to the guidelines outlined in the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) statement<sup>[19]</sup>. Two independent investigators screened the titles and abstracts of the retrieved studies to identify those appropriate for full-text review. Subsequently, they independently assessed the papers in full to identify the studies to be included in the analysis. Any disagreements about inclusion were resolved by discussion and through arbitration by a third reviewer.

### Selection criteria

The inclusion criteria were as follows:

1. Participants included elderly people with a mean age of  $\geq 60$  years who had chronic LBP
2. Randomised controlled trials (RCTs) or case-control studies
3. Intervention consisted of conservative treatment (e.g. exercise and manual therapy such as massage)
4. Outcome measures included a measure of motor performance (e.g. balance and gait) that uses highly valid and reliable methods (such as static and dynamic petrographic analyses, centre of pressure [COP] analysis, centre of gravity analysis, and timed up and go test) to reflect their dynamic or static balance or motor performance
5. All articles had to have been available in the English language and published in full within a peer-reviewed journal

The following exclusion criteria were used:

1. Intervention is surgical
2. Relevant outcome measures did not include balance or motor performance
3. Articles appeared only in abstract format or included insufficient detail to gauge study quality and extract results
4. Case reports or experimental studies

### Study Selection

The search strategy is displayed in Figure 1. Two reviewers independently screened all abstracts of articles potentially meeting the inclusion criteria; the full texts of those articles were subsequently reviewed. The reviewers then met with the entire review team and resolved any disagreements via consensus. The initial search yielded 2291 publications. Following the title and abstract screening, 35 full-text articles were retrieved. The full-text review was completed to determine final inclusion; 17 articles (13 case-control studies<sup>[20-32]</sup>, four RCTs<sup>[33-36]</sup>) met the inclusion criteria. Only the 13 case-control studies were included in the meta-analysis.

## Quality assessment

RCT study quality was assessed using the PEDro methodological quality scale<sup>[37]</sup>, an evaluation tool with 11 tests and a total score of 11 points. The higher the score, the higher the research design quality. Quality was also assessed using the Cross-sectional/Prevalence Study Quality (AHRQ)<sup>[38]</sup>, which also has 11 tests and a total score of 11 points<sup>[38]</sup>. The two researchers independently evaluated all studies that met the inclusion criteria; there were no significant intergroup differences.

## Data Extraction

For each study that met the full inclusion and exclusion criteria, information regarding study design and outcome measures (e.g. COP, one-leg stance time) were extracted. The major results of each study were briefly summarised; all focused on balance function. The meta-analysis data were collected from the results sections and tables of the manuscripts. The graphs were also used to extrapolate the data. If it was impossible to collect the data from the manuscript, the corresponding author of the manuscript was contacted twice before the study was excluded.

# Results

## Search Findings

Figure 1 illustrates the search findings. Using the search terms, 1059 articles were detected in PubMed, 112 in EMBASE, and 1120 in the Cochrane Library. Of these 2291 articles, the first reviewer retained 107 articles after the first screening round and the second reviewer retained 79. Altogether, the remaining articles were screened a second time using the five criteria; articles were assessed and retained based on their quality.

Table 1 details the characteristics of the 13 included case-control studies of the effects of LBP on motor performance in elderly people. We used the AHRQ to assess study quality (Table 2).

Table 3 details the characteristics of the included studies of the effects of physical therapy on motor performance in elderly people; four articles met the criteria requirement, but the main outcome was not about the motor performance or balance function. Four RCTs studies were assessed using the PEDro methodological quality scale.

After a detailed screening, we ultimately used the data of case-control studies to conduct the meta-analysis.

**Table 1 Basic characteristics of included case-control studies**

References	Design	Basic data of Participant				Condition	Outcome measure ( motor performance )
		LBP (ages) n		Health (ages) n			
Yi-Liang (2015) <sup>[20]</sup>	Case-control	60.5 (4.1)	13	59.7 (3.0)	3	Single-leg standing	TUG STS
Ito (2018) <sup>[21]</sup>	case-control	75.5 (5.1)	28	73.7 (5.7)	46	eyes closed Muscle Vibration gastrocnemius lumbar multifidus	RPW
Brumagne (2004) <sup>[22]</sup>	case-control	63	10	63	0	(1) control (no vibration); (2) bilateral vibration of the triceps surae tendons; (3) bilateral vibration of the tibialis anterior tendons; (4) bilateral vibration of the paraspinal muscle bellies	COP
Ito(2017) <sup>[23]</sup>	case-control	76.7 (4.2)	47	73.8 (4.9)	4	Muscle Vibration. gastrocnemius lumbar multifidus	RPW
Lee(2016) <sup>[24]</sup>	Case-control	64.5 (5.7)	30	66.2 (4.5)	6	Postural perturbation	COP
Iversen 2009 <sup>[25]</sup>	case-control	75.5 (5.1)	28	73.7 (5.7)	6	static standing	TUG COP

References	Design	Basic data of Participant				Condition	Outcome measure (motor performance)
		LBP [ages] n		Health [ages] n			
Kendall(2018) <sup>[26]</sup>	case-control	82.4 (4.6)	24	81.1 (4.3)	19	static standing	COP
Sung(2017) <sup>[27]</sup>	case-control	65.1 (3.5)	51	63.6 (1.5)	59	walk	gait parameters
Lihavainen(2010) <sup>[28]</sup>	case-control	80.6 (4.8)	29	80.1 (4.4)	314	static standing eyes open eyes close Feet together	COP
Champagne(2012) <sup>[29]</sup>	Case-control	68.9 (6.6)	15	69.4 (6.4)	15	-----	TUG One-leg stance Walking speed
Hicks(2018) <sup>[30]</sup>	case-control	69.3 (6.7)	54	71.1 (6.8)	54	walk	gait parameters
Silva(2016) <sup>[31]</sup>	case-control	70.0 [8]	10	73.0 (7)	10	one-leg stance	COP
Kato(2019) <sup>[32]</sup>	case-control	77.4 (4.2)	21	78.1 (4.4)	17	one-leg standing	standing time

**COP**, centre of pressure; **RPW**, relative proprioceptive weighting; **STS**, sit-to-stand test; **TUG**, timed up and go test

**Table 2. Quality assessment of included studies**

Agency for Healthcare Research and Quality (AHRQ)

Study	Item											Score
	Define source of information (survey or review)	List inclusion and exclusion criteria for exposed and unexposed subjects (cases and controls) or refer to previous publications	Indicate whether subjects were recruited	Indicate whether subjects were representative of the population	Indicate if evaluators of subjective components of study were masked to, or other aspects of the status of the participants	Describe any assessments undertaken for quality as surveillance purposes	Explain any patient exclusions	Describe how confidence intervals were assessed or controlled for	If applicable, explain how missing data were handled in the analysis	Summarize patient response rate and completeness of data collection	Clarify what follow-up, if any, was expected and the percentage of patients for whom incomplete data or follow-up was obtained	
Yi-Liang (2015) <sup>[20]</sup>	Y	Y	Y	U	U	Y	N	Y	N	Y	N	6
Ito (2018) <sup>[21]</sup>	Y	Y	Y	U	N	Y	N	N	U	Y	N	5
Brumagne (2004) <sup>[22]</sup>	Y	N	N	N	U	Y	N	Y	U	Y	N	4
Ito (2017) <sup>[23]</sup>	Y	Y	Y	U	N	Y	N	Y	U	Y	N	6
Lee (2016) <sup>[24]</sup>	Y	Y	Y	U	N	Y	N	Y	N	Y	N	6
Iversen (2009) <sup>[25]</sup>	Y	Y	Y	U	U	Y	N	Y	N	Y	N	6
Kendall (2018) <sup>[26]</sup>	Y	Y	Y	U	N	Y	N	Y	N	Y	N	6
Sung (2017) <sup>[27]</sup>	Y	Y	Y	Y	N	Y	N	Y	N	Y	N	7

**Table 2. Quality assessment of included studies**

Agency for Healthcare Research and Quality (AHRQ)

Study	Item											Score
Lihavainen (2010) <sup>[28]</sup>	Y	Y	N	Y	N	N	Y	N	Y	Y	N	6
Champagne (2012) <sup>[29]</sup>	Y	Y	N	Y	N	Y	N	N	Y	Y	N	6
Hicks (2018) <sup>[30]</sup>	Y	Y	Y	U	N	Y	N	N	N	Y	N	5
Silva (2016) <sup>[31]</sup>	Y	Y	Y	Y	N	Y	N	N	N	Y	N	6
Kato (2019) <sup>[32]</sup>	Y	Y	N	Y	N	Y	N	U	N	Y	N	5

N, NO; Y, YES; U, UNCLEAR

**Table 3 Basic characteristics of included randomised controlled trials**

Reference	Design	Basic data		Intervention (n, t)		Outcome measure	P value	PEDro
		Age	Sex	Experimental group	Control group			
Cruz-Díaz (2015) <sup>[34]</sup>	RCT (computer-generated) single blind	71.1 (3.3)	females	physiotherapy and Pilates (n = 47, 6 w)	physiotherapy (n = 50; 6 w)	FES-I TUG NSR	p < 0.05	10
Kim(2017) <sup>[36]</sup>	case-control (quasi-experimental study)	70.4 (1.7)  66.8 (4.4)	females	hollowing lumbar stabilization exercise(n = 17)1 2 w)	bracing lumbar s tabilization exer cise (n = 21; 12 w)	ODI RMDQ TMS. Static Balance.	p > 0.28  (inter group)  p < 0.01  (intra group)	9
De (2017) <sup>[35]</sup>	RCT (sealed envelopes) Double-blind	60.7 (1.63)  60.0 (1.13)	males (7)  Females (13)	foot reflex therapy (n = 10)5 w)	conventional massage (n = 10; 5 w)	VAS RMDQ HRV	p < 0.05	11
Young K(2015) <sup>[33]</sup>	RCT  (not mentioned)	elderly	Not mentioned	proprioceptive neuromuscular facilitation (n = 24)6 w)	swiss ball training (n = 24; 6 w)	VAS TUG FRT Static Balance	p 0.05  (within group)	7

strength; **TUG**, timed up and go test; **VAS**, visual analogue scale

## **Outcome**

**FES-I**, Falls Efficacy Scale-International; **FRT**, functional reach test; **HRV**, heart rate variability; **NRS**, numeric rating scale; **ODI**, Oswestry Disability Index;

**RMDQ**, Roland-Morris Disability Questionnaire; **TMS**, trunk muscle

### **One-leg stance**

A total of four articles used one-leg stance time to assess the balance function of patients with LBP and their healthy counterparts; however, one just calculated the number of people who stood on a single leg for 20 seconds; therefore, we extracted data from three articles. No significant difference was noted between the two groups (Figure 2).

Figure 2. One-leg stance

### **COP area**

A total of four studies used COP parameters to measure motor performance, which was recognised as a valid and reliable method. The larger the COP area, the worse the balance. Older adults with LBP had a longer path length and larger area of COP movements than older adults without LBP (Figure 3).

### **COP anteroposterior velocity, mediolateral velocity, and anteroposterior range**

A total of four studies used COP sway velocity parameters to measure motor control (Figures 4 and 5), while two studies used COP sway range parameters to measure motor control (Figure 6). The higher the COP sway velocity, the longer path length in the anteroposterior direction and the more unstable the patient. The three parameters also demonstrated that older adults with LBP would have higher velocity and larger COP movements than older adults without LBP.

### **Gait (speed) and TUG**

A total of three studies use the gait test (Figure 7) and two studies use the TUG (Figure 8) to compare the dynamic balance between individuals with LBP and those without LBP. The result showed that, compared to healthy individuals, patients with LBP walked more slowly and needed more time to complete the TUG test.

### **Relative Proprioceptive Weighting**

Two studies compared the RPW between the two groups but found no significant intergroup difference (Figure 9).

### **Risk bias of the studies included in the meta-analysis and sensitivity analysis**

Using STATA software to assess the study biases and sensitivity analysis (Table 4), the sensitivity results suggested that our meta-analysis results are relatively stable.

**Table 4. Risk bias of the studies included in the meta-analysis**

Outcome	One-leg stance	COP area	COP AP velocity	COP ML velocity	COP AP range	Gait	RPW
Egger's test (p value)	0.365	0.273	0.929	0.161	0.184	0.037	0.682

**COP**, centre of pressure; **RPW**, relative proprioceptive weighting; **AP** anteroposterior; **ML**

## Discussion

To our knowledge, this is the first systematic review and meta-analysis to focus on LBP and motor performance in elderly people. This systematic review aimed to estimate the effect of LBP and physical therapy on motor performance in elderly people. Our results demonstrated that elderly people with LBP have poorer motor performance than those without LBP. In our rapidly aging society, the proportion of elderly patients with chronic LBP is increasing annually, and the occurrence of pain, bad moods, functional inactivity, reduced quality of life, and increase in fall risk also increase<sup>[39]</sup>. We must provide effective intervention measures to improve elderly peoples' quality of life and reduce the economic losses and physical and emotional traumacaused by chronic LBP.

The aging process results in changes in the central nervous system, peripheral nervous system, and the musculoskeletal system<sup>[40,41]</sup>. Pain itself has a wide range of effects on motor function<sup>[42]</sup>. People who experience chronic pain display changes in motor patterns, exercise coordination, and the ability to maintain stability in response to external disturbances. Pain induces spinal motility restrictions, lumbar proprioceptive losses, weakening of lower-extremity sensory feedback, and trunk muscle weakness and atrophy<sup>[26,28,29,32]</sup>. Thus, when aging is combined with LBP, impaired motor performance and balance dysfunction worsen. However, almost 90% of articles to date focused on young and middle-aged people. It is conceivable that conditions associated with younger and middle-aged people are more optimistic no matter the motor performance or responsive to treatment. It is also possible that older adults with LBP should be subjected to different assessments and interventions than younger adults to account for the differences in therapeutic approaches and treatment outcomes. Given the age disparities in LBP people, in addition to solving the pain issue, it is important to focus on the motor performance and balance

function of older individuals. As we all know, balance control with age is among the major risk factors for falls, which is a difficult problem what the world faces, especially as the population continues to age<sup>[43]</sup>.

Poor motor performance in elderly people with LBP means they cannot perform accurate movements and ambulation<sup>[44,45]</sup>, which in turn affect their physical activities. In our result, TUG, one-leg stance, postural sway, and gait are valid fall-risk assessment tools<sup>[46-49]</sup>; poor outcomes on the TUG and postural sway tests may indicate an increased risk of falling that could lead to disastrous consequences. Problems with motor performance or balance are also reportedly

associated with fall risk. Physical therapists in the clinical setting should be aware of an increased risk of falling among their patients.

There is some evidence that LBP impacts the equilibrium of older individuals. However, only one study in this review assessed reactive motor performance function, and none assessed

the effect of dual tasks on motor performance in older individuals with LBP. The two conditions are very important in the occurrence of falls among elderly people. Our results demonstrated that the group of elderly patients with LBP has not received sufficient attention, as there were only four articles about the effect of physical therapy on motor performance in this population. Future studies must focus more on this issue, especially on motor performance or balance function in these patients. The results of this review depended on the outcome measures examined, and the small sample sizes may have limited the power of our findings. Therefore, future research should include adequate sample sizes and must be combined with myoelectric and neural electrical activity and gait analyses to evaluate dynamic-static equilibrium and reactive balance, which could better reflect the effect of the central nervous system on peripheral control.

### **Study limitations**

This review included only case-control and RCTs. Furthermore, the present review did not incorporate non-English studies. This may limit the validity of our findings and must be taken

into consideration when interpreting its overall generalizability. The limited number of case-control studies did not allow a subgroup meta-analysis, and we did not include RCTs in the meta-analysis. However, we achieved the main aim of our review, which was to estimate the effect of LBP on motor performance in elderly people and provide comprehensive information for the design of future studies.

### **Conclusion**

In summary, the study results indicate evidence in favour of a negative effect of LBP on motor performance. However, further studies are required before a broad conclusive statement on this subject can be made.

# Declarations

Notes

## Ethics approval and consent to participate

Not applicable

## Consent for publication

All authors approved the final version to be published

## Availability of data and materials

Not applicable.

## Competing interests

The authors declare that they have no competing interests

## Funding

Not applicable

## Authors' contributions

All authors were involved in drafting the article or revising it critically for important intellectual content and all authors approved the final version to be published

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# Figures

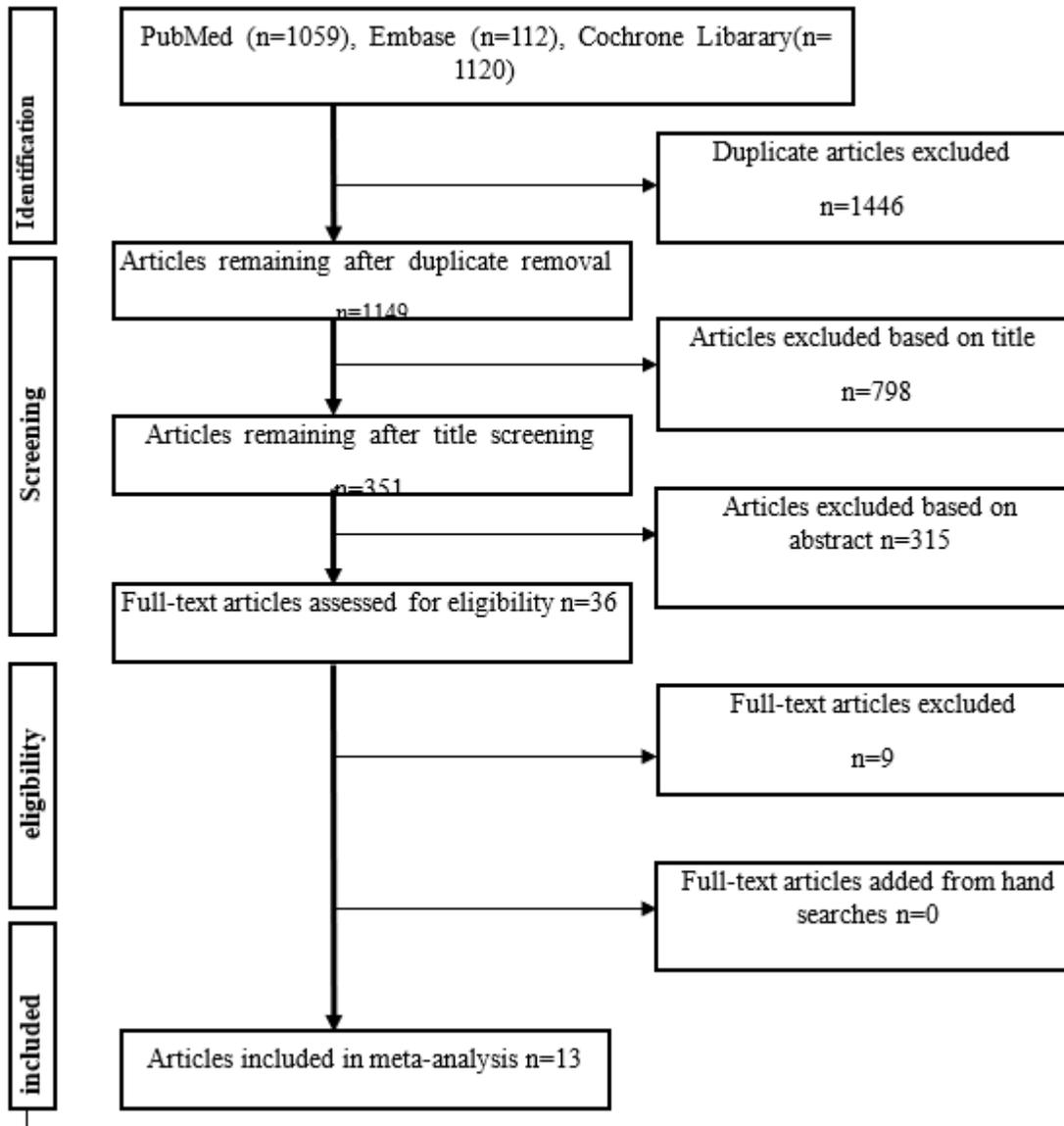


Figure 1

PRISMA flow chart of the article screening and selection process

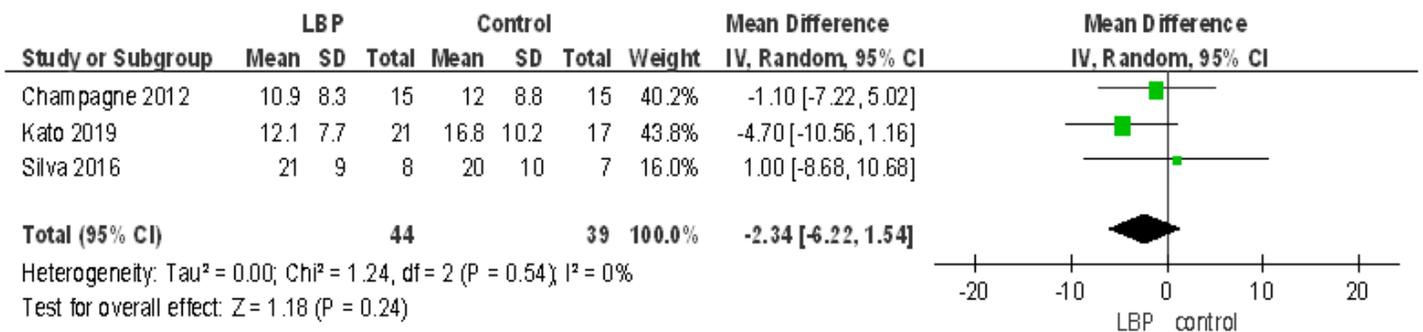


Figure 2

## One-leg stance

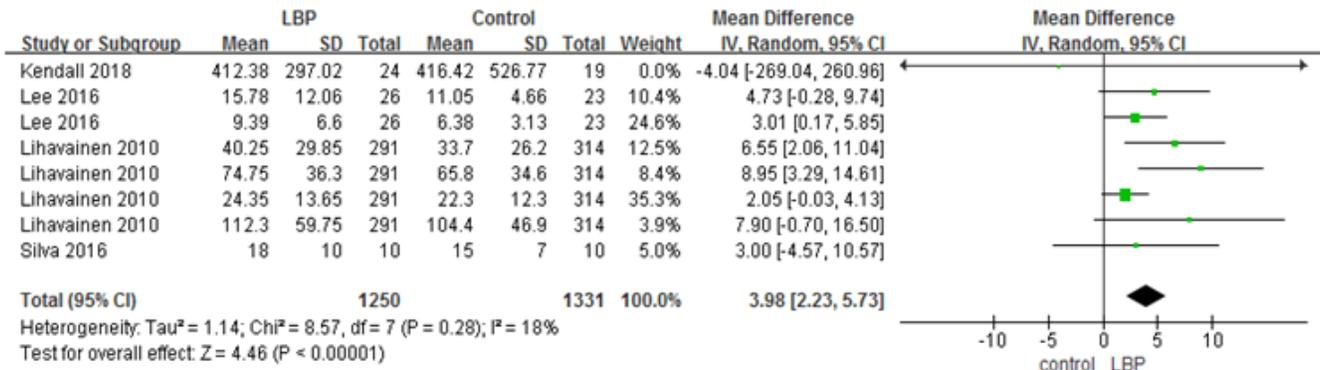


Figure 3

## Centre of pressure area

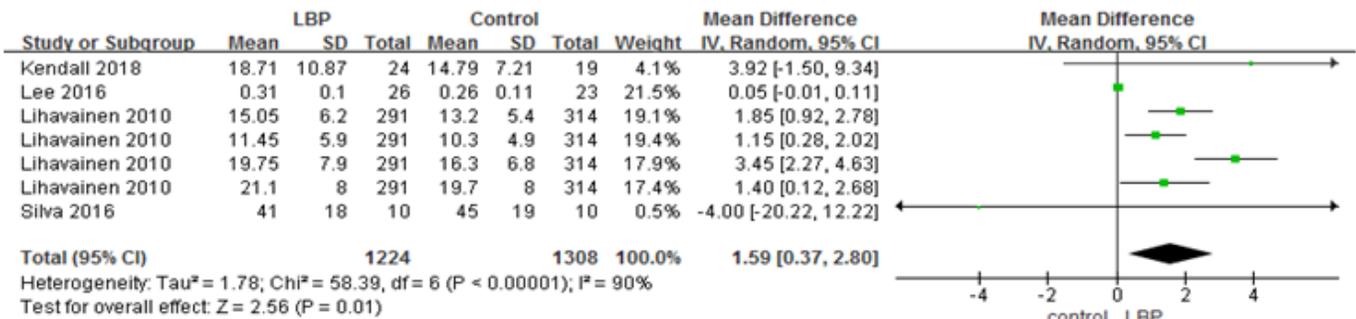


Figure 4

## Centre of pressure, anteroposterior velocity

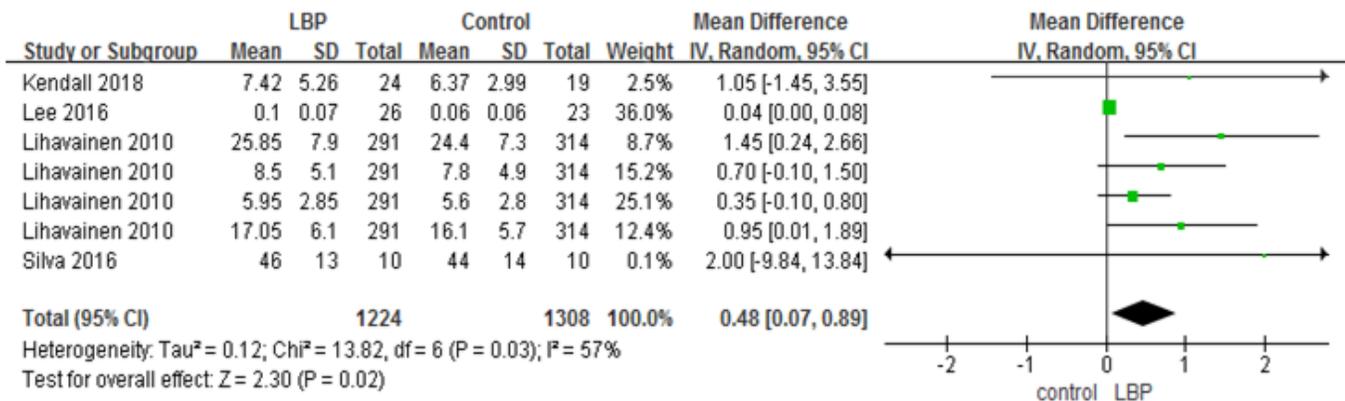


Figure 5

## Centre of pressure, mediolateral velocity

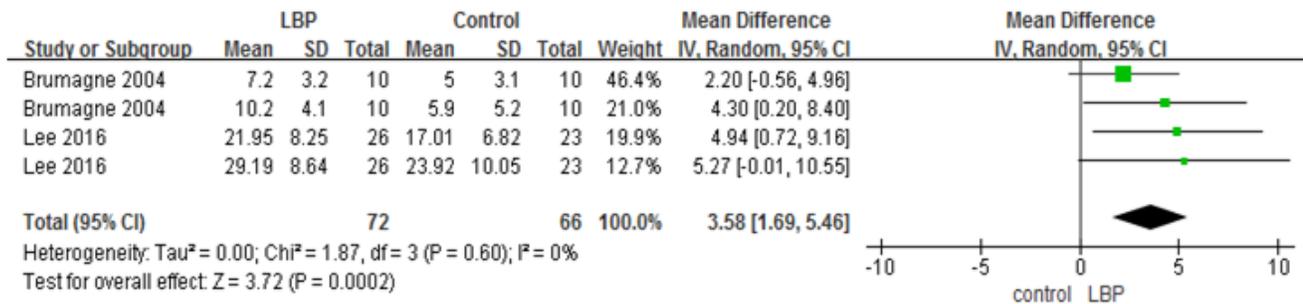


Figure 6

Centre of pressure, anteroposterior range

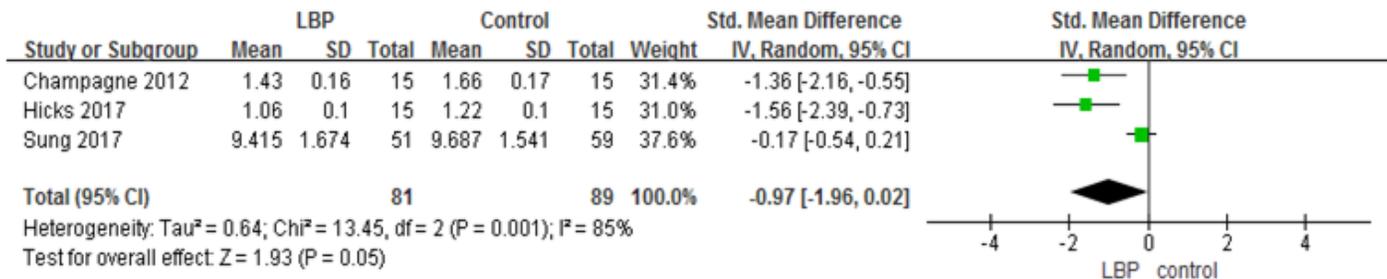


Figure 7

Gait speed

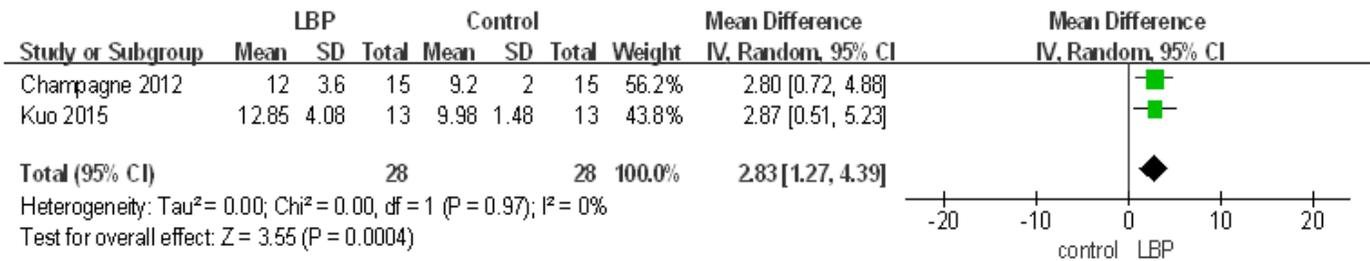
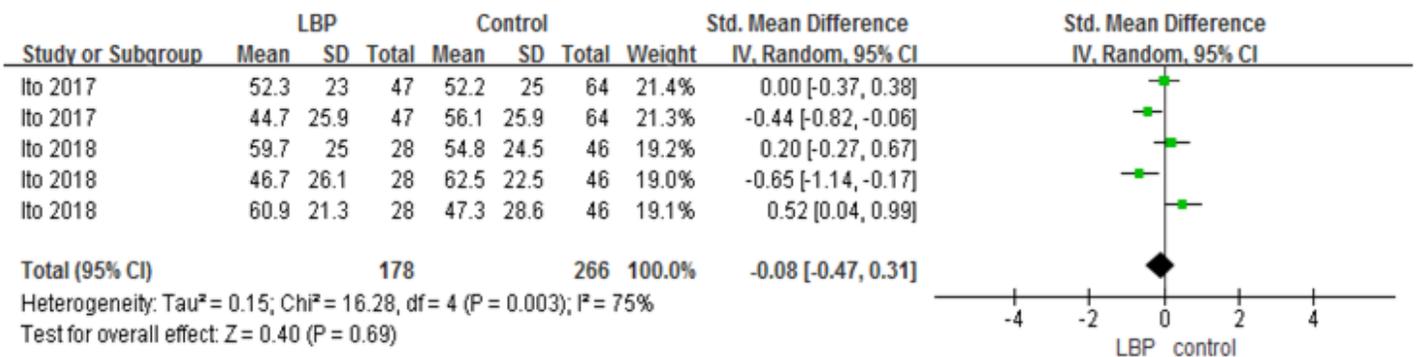


Figure 8

Timed up and go test



## Figure 9

Relative proprioceptive weighting