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Dual task function differences in chronic low back pain: a narrative review

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Chronic low back pain (CLBP) presents complex challenges, with traditional treatments offering only moderate relief. Emerging evidence suggests that impairments in dual task performance—simultaneous cognitive and motor processing—may contribute to CLBP persistence. This narrative review examined 10 studies comparing individuals with CLBP to healthy controls using various dual task paradigms. Findings indicated consistent deficits in gait variability, balance control, and muscle activation patterns among CLBP participants, especially under cognitive load. Neurocognitive impairments, including delayed anticipatory postural adjustments and altered trunk control, were also observed. These deficits likely reflect

Différences de fonction à double tâche dans la douleur lombaire chronique: une revue narrative

La douleur lombaire chronique (DLC) présente des défis complexes, les traitements traditionnels n'offrant qu'un soulagement modéré. Des preuves émergentes suggèrent que des déficits dans la performance de double tâche—traitement cognitif et moteur simultané—peuvent contribuer à la persistance des DLC. Cette revue narrative a examiné 10 études comparant des individus souffrant de lombalgie chronique à des témoins en santé en utilisant divers paradigmes de double tâche. Les résultats ont indiqué des déficits constants dans la variabilité de la démarche, le contrôle de l'équilibre et les schémas d'activation musculaire chez les participants souffrant de lombalgie chronique, en particulier sous charge cognitive. Des déficits neurocognitifs, y compris des ajustements posturaux anticipés retardés et un contrôle du tronc altéré, ont également été observés. Ces déficits reflètent probablement une intégration sensorimotrice perturbée et une compétition pour les

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disrupted sensorimotor integration and resource competition within the central nervous system due to chronic pain. Incorporating dual task interventions into rehabilitation may enhance outcomes by addressing both cognitive and motor domains. Future research should focus on standardized assessments, pain-related cognitive interactions, and neuroimaging methods to further explore these mechanisms and support targeted treatment strategies for CLBP.

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KEY WORDS: chronic low back pain, CLBP, dual-task, neurocognitive, somatosensory, chiropractic

ressources au sein du système nerveux central en raison de la douleur chronique. L'incorporation d'interventions à double tâche dans la réhabilitation peut améliorer les résultats en s'attaquant à la fois aux domaines cognitif et moteur. Les recherches futures devraient être axées sur des évaluations standardisées, les interactions cognitives liées à la douleur et les méthodes d'imagerie cérébrale afin d'explorer davantage ces mécanismes et de soutenir des stratégies de traitement ciblées de la DLC.

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MOTS CLÉS : douleur lombaire chronique, DLC, double tâche, neurocognitif, somatosensoriel, chiropratique

Introduction

Low back pain (LBP) is a leading cause of disability, and the number of workdays lost worldwide with rates between 60-84% for onset at any point in life.[1,2] The rate of LBP has steadily increased by an estimated 54% since 1990 to a point prevalence of 7.3% worldwide in the last decade.[3] Recurrence of LBP episodes is common with an estimated 33% of LBP patients experiencing chronic low back pain (CLBP).[1,4] With nearly 1 in 5 episodes of LBP resulting in sick leave and 30% of all sick leave of 6 months or longer being associated with CLBP, the economic impact of LBP is immense.[1] In the United States alone, LBP is estimated to cost at least 100 billion USD per year in both direct and indirect costs with the average CLBP patient spending $3,622 ($1,383-$8784) in direct medical expenses per year.[5,6]

The treatment for CLBP has historically resulted in relatively weak outcomes. Spinal surgery is reported to have up to 40% of patients not achieving a minimally clinically important difference in pain and nearly 20% of patients continuing to experience similar or worse pain following surgery.[7–9] Conservative treatments, including exercise and manual therapies, often have low to moderate effects on pain and function that are temporary in nature.[10] Prevention methods for LBP have also been underwhelming in their results as models centered around biomechanics, muscle strength and size, and lifestyle factors have shown little or no success in reducing or preventing LBP.[10–12]

One such area of interest in overall chronic pain research has been neurocognitive tasking. Neurocognitive tasking aims to manipulate nervous system pathways by providing an input that requires cognitive processing.[13,14] One popular and easy method to assess neurocognitive abilities in generalized musculoskeletal and CLBP research is dual tasking.[15–17] Dual tasking is a process where the participant is performing a cognitive processing task while performing a motor action. The performance of this task is then compared to the single task condition. Any deficits seen between these conditions are thought to be related to the processing limits of the nervous system.[18,19] Pain is theorized to result in decay of the ability to effectively integrate the required sensory and motor functions in both feedforward and feedback pathways due to it also requiring processing resources.[20,21] As pain often alters movement patterns, we also expect to also see altered cortical function. Individuals experiencing pain are therefore theorized to show a further decrease in task performance. This altered sensorimotor integration is likely a contributor to the chronicity of pain in many conditions, including CLBP. Targeting this integration as a rehabilitation strategy has been shown to be effective for conditions like complex regional pain syndrome and other pain syndromes. For a detailed discussion of the proposed physiology, see the paper by Vittersø and colleagues.[20] Few studies on dual-task function in the context of CLBP have been performed. Due to this, this literature review's purpose is to identify differences in dual task function in individuals with CLBP compared to those without CLBP.

Methods

Research question

A focused research question was formed: do patients with chronic low back pain exhibit differences in dual task functioning compared to healthy, non-pain experiencing controls?

Procedure – literature search

A search for experimental trials related to CLBP and dual task function was completed via PubMed, Scopus, and CINAHL. Dates of publication were limited to January 2014 through 2024 to ensure relevance to contemporary clinical practice and evolving methodologies. The search terms used were the following:

> "Low Back Pain"[MeSH] AND ("dual task" OR "dual-tasking" OR "cognitive-motor task" OR "concurrent task performance")

Included articles required a comparison of CLBP patients with healthy controls and at least 1 dual task paradigm used. This search produced 38 results. 19 results were removed as duplicates. Of the remaining 19, 9 were removed via abstract screening for not meeting the inclusion criteria with the papers being reviews, commentary, or trial proposals. Each of the remaining 10 studies were fully reviewed and included in this review without further exclusion (Figure 1). Each study was evaluated using National Institutes of Health (NIH) quality assessment criteria with summaries of the articles in Table 1. All articles were screened and evaluated by a single reviewer.

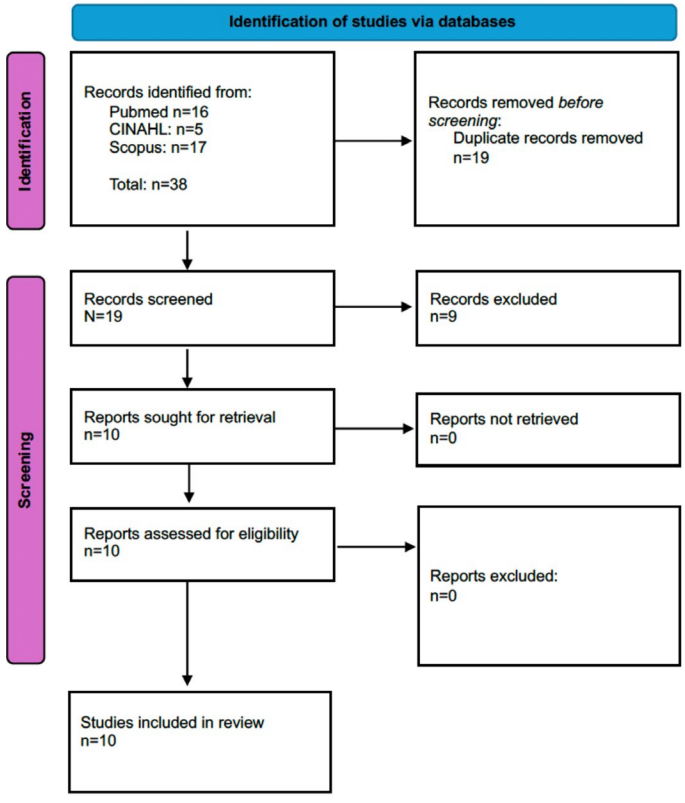

Figure 1.
Search strategy

Results

Gait

Hamacher *et al*. reported an increase in gait stride-to-stride variability for CLBP participants compared to healthy controls ($F(1,22) = 11.506$, $p = 0.003$, $\eta^2 = 0.343$) and a greater dual task cost for CLBP participants ($F(1,22) = 4.583$, $p = 0.044$, $\eta^2 = 0.172$).[22] In a follow-up study, Hamacher *et al*. found increased stride time variability in both single ($Z = -1.963$, $p = 0.050$) and dual task conditions ($Z = -2.540$, $p = 0.010$) for CLBP patients compared to healthy participants. This study also noted that stride length ($Z = -2.824$, $p = 0.005$) and stride time variability ($Z = -2.903$, $p = 0.004$) increased in the CLBP group between task conditions, while only stride time variability increased in controls ($Z = -3.059$, $p = 0.002$). No significant differences in this study's primary outcome, min-

Table 1.
Study summaries

Authors	Title	Participants	Inclusion and Exclusion	Outcome Measure(s)	Results	NIH Quality Assessment
Assessment Hamacher, Hamacher, Schega (2014)	A cognitive dual task affects gait variability in patients suffering from chronic low back pain	12 healthy, 12 CLBP	Inclusion: CLBP = >3 months of self-reported low back pain	Stride-to-stride gait variability, trunk angular velocity, Regensburger word fluency test (RWT) for both single- and dual-task exposures	Gait variability group by condition effect: F 1, 22 = 11.506, p = 0.003, n^2 = 0.343; Dual-tasking group effect: F1,22 = 4.583, p = .044; η2 = 0.172; Trunk velocity dual-task costs higher for CLBP (p=0.001); Condition effect single vs. dual-tasking for CLBP: F1,11 = 16.041, p = .002, η2 = 0.593; No effect on RWT performance.	Fair

Authors	Title	Participants	Inclusion and Exclusion	Outcome Measure(s)	Results	NIH Quality Assessment
Hamacher, et al. (2016)	Are there differences in the dual-task walking variability of minimum toe clearance in chronic low back pain patients and healthy controls?	12 healthy, 12 CLBP	Inclusion: Healthy = VAS 0, no self-reported LBP >3mo duration CLBP = VAS at least 4, duration of pain 3mos or longer, participating in "back therapy training course"	Minimum toe clearnace, stride length, stride time under single and dual-tasking	Stride length ($Z = -2.824$; $p = 0.005$) and time variability ($Z = -2.903$; $p = 0.004$) increased in CLBP group between task conditions. Time variability increased in controls ($Z = -3.059$; $p = 0.002$) between task conditions. No change in MTC for CLBP ($Z = -1.177$; $p = 0.239$) or controls ($Z = -0.628$; $p = 0.530$). CLBP patients experienced higher stride time variability than controls in both single ($Z = -1.963$; $p = 0.050$) and dual-task ($Z = -2.540$; $p = 0.010$). No difference in MTC in single or dual-task between groups ($p>0.050$).	Fair
Shanbehzadeh, et. al. (2018)	Attention demands of postural control in non-specific chronic low back pain subjects with low and high pain-related anxiety	20 healthy, 19 low pain-related CLBP, 19 high pain-related anxiety CLBP	Inclusion: CLBP = patients experience low back pain >6mos or at least 3 self-recurrent pain episodes in the previous year. CLBP patients only tested if pain less than 30mm of 100mm on VAS. Exclusion: CLBP = no specific diagnosis (nsLBP), no medications related to postural control or cognition.	Anticated and actual pain, postural performance assessed via center of pressure (COP) for single and dual task conditions, cognitive performance via single and dual task conditions.	CLBP patients with high pain-related anxiety significantly anticipated greater pain than what they felt during testing ($p < 0.05$). Significant main effects of group for COP area ($F2,55 = 10.57$, $P < 0.05$, $\eta2 = 0.28$) and mean velocity ($F2,55 = 7.67$, $P < 0.05$, $\eta2 = 0.22$). Significant interaction of group by cognitive load was found for COP sway area ($F2,55 = 3.27$, $P = 0.04$, $\eta2 = 0.1$). Post hoc analyses by paired t-tests showed that CLBP participants with high pain-related anxiety and control subjects significantly reduced their sway area during the dual-task conditions. Interactions of group by postural task difficulty by cognitive load were significant for A–P range ($F2,55 = 3.46$, $P < 0.05$, $\eta2 = 0.11$). Significant main effects of postural task condition on reaction time (RT) ($F4,208 = 13.36$, $P < 0.05$, $\eta2 = 0.27$). The interaction between group and postural task condition was significant for RT ($F8,208 = 2.155$, $P < 0.05$, $\eta2 = 0.07$). CLBP subjects with high pain-related anxiety showed significantly slower reactions with increased difficulty of postural tasks ($p<0.05$).	Fair
Bianchi, et al. (2022)	Cognitive dual-task cost depends on the complexity of the cognitive task, but not on age and disease	19 in Younger healthy, 16 in Older healthy, 19 in Parkinson's, 9 in actue (<4 weeks) stroke, 16 in Multiple Sclerosis, 5 in CLBP	Inclusion: >18 years old (18-45 for younger, >60 for older), ability to independently walk. Exclusion: Montreal Cognitive Assessment score <15, other movement disorder affecting mobility	Dual task cost (DTC) from simple reaction time (SRT) while performing stroop numerical test under 3 conditions of congruent, neutral, and incongruent while standing (single task) and walking with turns (dual task)	Significant effect of factor "task" ($F3, 177 = 48.630$; $p < 0.001$; $\eta2p = 0.452$). Post-hoc analysis reveals higher DTC between SRT and stroop conditions ($p<0.001$) with CLBP being statistically different from other groups. Disease state not linked to differences in DTC.	Poor
Yang, et. al. (2023)	Effect of Cognitive Load on Anticipatory Postural Adjustment Latency and its Relationship with PainRelated Dysfunction in Non-specific Chronic Low Back Pain: A Cross-Sectional Study	30 healthy controls and 30 non-specific CLBP participants	Inclusion: 18-50 years old, pain located between the 12th rib and hip, pain duration >3 months, VAS of at least 3, one recurrent LBP pain episode within the past 3-15 months, right handed. Exclusion: Pelvic or spine surgery in the previous 2 years, presence of any identified lumbar pathology, radicular symptoms, BMI >30 kg/m2, LBP treatment within the last 3 months, pregnant or preparing for pregnancy, dysfunction of vital organ(s), visual/auditory/cognitive impairement	Anticipatory postural adjustment (APA) of transverse ab./internal oblique (TrA/IO), and multifidus (MF) during single and dual-task postural perturbations, Roland-Morris Disability Questionnaire (RMDQ)	APA latency of the right TrA/IO was significantly delayed compared with that of the left TrA/IO in the NCLBP group (mean 29.15, 95% confidence interval (CI) 18.81 to 39.50 versus mean 3.69, 95% CI - 6.81 to 14.18, $p = 0.0363$). APA latency of the right MF under cognitive load was significantly delayed compared with that on the left side in patients with NCLBP (mean 25.38, 95% CI 13.41–37.35 versus means - 3.03, 95% CI - 15.18 to 9.13, $p = 0.0220$) and right side in patients with NCLBP without cognitive load (mean 25.38, 95% CI 13.41–37.35 versus means - 5.88, 95% CI - 22.56 to 10.80, $p = 0.0092$). During the dual task, the APA latency of right MF was significantly delayed than that on the right side compared to the control group (mean 25.38, 95% CI 13.41–37.35 versus mean - 5.80, 95% CI - 19.28 to 7.68, $p = 0.0416$) APA latency delay in the right MF ($r = 0.5560$, $p = 0.0017$) and left MF ($r = 0.4010$, $p = 0.0311$) during the dual task in the NCLBP group were positively correlated with RMDQ scores.	Fair
Hemmati, Piroozi, Rojhani-Shirazi (2018)	Effect of dual tasking on anticipatory and compensatory postural adjustments in response to external perturbations in individuals with nonspecific chronic low back pain: Electromyographic analysis	25 female healthy controls, 25 female non-specific CLBP	Inclusion: CLBP = no MRI identified abnormalities, minimum of 3 month duration of LBP, NRS pain between 3 and 5 out of 10, pain of 3 or less at the time of testing, Hospital Anxiety and Depression scale (HADS) score of <=7. Exclusion: Radicular pain, uncorrected vision impairment, vestibular or auditory deficits, diabetes, spinal surgery within previous 3 months, BMI >=30, infection or tumor of the spinal cord, deformity of spine or lower extremity, previous joint or skin conditions, medication that can influence balance, pregnancy.	EMG onsent for lateral gastrocnemius, tibialis anterior, rectus femoris, bicep femoris, rectus abdominus, erector spinae with predictable and unpredictable pertubations during single and dual-task exposures, RMDQ	Tibialis anterior EMG onset activity delayed in patients with CLBP during dual-task compared to single task ($F=5.57$, $p=0.02$). During unpredictable pertubation, there was a statistically significant difference for the condition comparison for gastrocnemius ($F=4.63$, $p=0.03$), rectus femoris ($F=4.58$, $p=0.03$), and for group by condition for gastrocnemius ($F=5.74$, $p=0.02$).	Fair

Authors	Title	Participants	Inclusion and Exclusion	Outcome Measure(s)	Results	NIH Quality Assessment
Sherafat, et. al.(2014)	Effect of Dual-Tasking on Dyanmic Postural Control in Individuals With and Without Nonspecific Low Back Pain	15 CLBP, 15 healthy	Inclusion: CLBP = episodic LBP for at least 12 months, pain at 40/100mm on VAS at time of testing. Exclusion: nerve root pain, history of spinal surgery, spinal pathology/deformities, uncorrected visual impairment, vestibular or respiratory disorders, auditory or cognitive deficits, diabetes, recent lower limb injury, pregnancy, or the use of any medication that interferes with the ability to maintain balance	Postural stability in anterior-posterior, medial- lateral, and overall. Verbal reaction time and error ratio during auditory Stroop task.	3-way ANOVAs showed that the interactions of group by postural task difficulty by cognitive task difficulty were significant for APSI ($F2,56 = 4.66$, $P = .013$), MLSI ($F2,56 = 9.70$, $P < .001$), and OSI ($F2,56 = 11.14$, $P < .001$). Post-hoc 2x2 interaction of group by cognitive task difficulty was significant only in the stability level of 5, eyes-closed condition for APSI ($F1,28 = 18.31$, $P < .001$), MLSI ($F1,28 = 10.65$, $P = .003$), and OSI ($F1,28 = 19.77$, $P < .001$). Concurrent cognitive task in stability level 5, eyes-closed condition significantly increased stability indices compared with single task only in participants with CLBP (APSI; $P < .001$, MLSI; $P = .02$, OSI; $P < .001$) and for APSI ($P = .01$) in the level 3 eyes-closed condition. Interaction between group and postural task difficulty was not significant for RT ($F2,28 = 0.35$, $P = .71$) but was significant for error rate (ER) ($F2,28 = 3.33$, $P = .04$)	Good
Hammati, et. al. (2017)	Evaluation of Static and Dynamic Balance Tests in Single and Dual Task Conditions in Participants With Nonspecific Chronic Low Back Pain	40 CLBP and 40 healthy	Inclusion: CLBP= Pain for at least 3 months with a pain score of 3-5 out of 10 NRS. Pain lower than 3 at time of testing. Hospital Anxiety and Depression Scale score <8. Exclusion: spinal surgery in the previous 3 months, uncorrected vision impairment, vestibular dysfunction, auditory deficits, nerve root compression resulting in neurologic symptoms, trunk or spinal deformity, use of medication that impacts balance, pregnancy.	Static balance during one-leg stance test. Dynamic balance during modified star excursion test via measure of distance in anterior, posteromedial, and posterolateral directions. Timed up-and-go and 10-m walk tests were assesed for dynamic balance. Dual cognitive and dual manual tasks were performed. Accuracy and response speed recorded.	2-way analysis indicates the main effect of task was significant for single-leg stance ($F=15.69$, $P<.001$), timed-up-and-go ($F=69.26$, $P<.001$), and 10-m walk ($F=35.55$, $P<.001$). No difference identified between CLBP and healthy controls.	Fair
Rowley, Winstein, Kulig (2020)	Persons in remission from recurrent low back pain alter trunk coupling under dual-task interference during a dynamic balance task	19 recurrent LBP, 19 healthy controls	Inclusion: CLBP = pain located between lower rib cage and horizontal gluteal fold, functional limitations as outlined in NIH Task Force recommendation and Oswestry Disability Index, at least two episodes of pain over previous year but pain on only about half of the days during the last six months. Pain at time of testing <1.5 out 10 on VAS. Healthy controls = no back pain in previous year. Exclusion: >45 years old, low back surgery, imaging support diagnosis of spinal stenosis, scoliosis, malignancy, infection, or radiculopathy, no previous injury or condition affecting locomotion or balance, no history of diabetes mellitus, rheumatic joint disease, blood clotting disorders, polyneuropathy, or pregnancy.	EMG mean activation amplitude of paraspinals and abdominals, trunk control, center of mass velocity, vertical force produced by spring compared to target force.	Trunk control had a significant interaction effect ($F(2,17) = 6.904$, $p = 0.006$, $!2$ $p=0.448$) but no main effects of group ($F(1,18) = 1.713$, $p = 0.207$, $!2$ $p =0.087$) or condition ($F(2,17) = 1.908$, $p = 0.179$, $!2$ $p=0.183$). CLBP group participants increased trunk coupling in both DTCognitive ($p = 0.006$) and DTBalance ($p = 0.008$). rLBP group had lower trunk coupling, or more dissociated thorax and pelvis motion ($p = 0.024$). No single muscle, muscle activation ratio, or combination of muscles predicted trunk coupling in any conditions for the back-healthy control group or in DTCognitive or DTBalance for the CLBP group. Task Prioritization had a main effect of condition ($F(2,17) = 17.957$, $p < 0.001$, $!2$ $p = 0.679$) with all conditions significantly different from one another ($p \leq 0.034$). There was a main effect of condition ($F(2,15) = 5.719$, $p = 0.014$, $!2$ $p = 0.433$), where there was significantly greater COM velocity in the DTCognitive condition. Self-reported measures of cognitive task difficulty corelated to trunk coupling (DTCognitive: $R = – 0.512$, $p = 0.025$; DTBalance: $R = – 0.522$, $p = 0.022$)	Good
Valizadeh, et. al. (2023)	Walking Performance during Concurrent Cognitive and Motor Tasks in Individuals with Nonspecific Chronic Low Back Pain: A Case- Control Study	20 non-specific CLBP, 20 healthy controls	Inclusion: LBP=18-45 years old, LBP of at least 12 weeks, pain of 4-6/10 NRS, disability on Oswestry of 21- 40%. Exclusion: Spondylolisthesis, pregnancy, radicular pain, spinal or lower limb deformity, tumor or infection, history of lower limb fracture, neurological disorders, rheumatic disease, diabetes, hearing or cognitive impairments, medication that impairs gait.	Gait parameters of cadence, swing time, stride length, step width, and double support time during self-selected and standardized walking speeds. Reaction time and error ratio of cognitive task performance.	In the NSCLBP group, the self-selected speed was slower than the healthy controls ($P = 0.004$). 2-way repeated measures ANOVA showed a significant main effect of the group for shorter swing time ($P = 0.012$) and longer double support time ($P = 0.021$) for CLBP. Significant interaction between the group and condition for lower cadence ($P = 0.004$) in CLBP. CLBP group had a lower cadence during the cognitive dual-task condition compared with the single-task condition ($P = 0.031$) and motor dual-task condition ($P = 0.021$). Stride length has no significant effect of group ($P = 0.467$), condition ($P = 0.460$), or interaction between group and condition ($P = 0.851$). Step width results also indicated no significant effect of group ($P = 0.072$), condition ($P = 0.619$), or interaction between group and condition ($P = 0.372$). Stride time variability had no significant interaction between the group and condition ($P = 0.904$). Post hoc analysis results showed that in all participants stride time variability was decreased under the cognitive dualtask walking compared with the single and motor-dual task walking conditions ($P = 0.030$).	Good

imum toe clearance, was found between groups or task conditions ($Z = -1.177$, $p = 0.239$).[23]

In contrast, Valizadeh *et al*. found no differences in stride length or step width between groups or conditions. This study also reported a decrease in stride time variability for all participants during dual tasking ($p = 0.030$). Additionally, CLBP participants exhibited lower self-selected treadmill speeds ($p = 0.0004$), shorter swing times ($p = 0.012$), longer double support times ($p = 0.021$), and lower walking cadence ($p = 0.004$). Lower cadence was observed in CLBP participants during dual task ($p = 0.031$) and motor dual task conditions ($p = 0.021$) compared to single task conditions.[24]

Balance and posture

Hammati *et al*. evaluated static and dynamic balance, finding significant differences between dual cognitive and dual motor tasks compared with single task conditions for both CLBP and controls, but no differences between the groups in single-leg stance, timed up-and-go, and 10m walk test performance.[25] Hamacher *et al*. noted increased trunk variability under dual task conditions for CLBP patients ($F(1,11) = 16.041$, $p = 0.002$, $\eta^2 = 0.593$).[22] Rowley *et al*. reported reduced frontal plane trunk-pelvis coupling in the CLBP group during single-task conditions but not during dual task conditions, with no differences in center of mass velocity, EMG muscle activation, or dual task performance between groups.[26]

Sherafat *et al*. identified a three-way interaction between group, cognitive task difficulty, and postural task difficulty. As task difficulties increased, postural sway increased for CLBP patients starting at moderate difficulty levels compared to controls. Although reaction time did not differ for the CLBP group, the error rate was higher ($F(2,28) = 3.33$, $p = 0.04$) and influenced by postural task difficulty ($F(2,28) = 8.08$, $p = 0.002$).[27]

Shanbehzadeh *et al*. examined the influence of high and low levels of pain-related anxiety on postural performance. CLBP patients with high pain-related anxiety significantly anticipated greater pain than they experienced ($p < 0.05$). Significant main effects of group were found for center of pressure (COP) area ($F(2,55) = 10.57$, $p < 0.05$, $\eta^2 = 0.28$) and mean velocity ($F(2,55) = 7.67$, $p < 0.05$, $\eta^2 = 0.22$). A significant interaction of group by cognitive load was found for COP sway area ($F(2,55) = 3.27$, $p = 0.04$, $\eta^2 = 0.1$). Post hoc paired t-tests indicated that both CLBP participants with high pain-related anxiety and control subjects significantly reduced their sway area during dual task conditions [28]. This result conflicts with the results of Sherafat *et al*.[27] Additionally, interactions of group by postural task difficulty by cognitive load were significant for anterior-posterior (A–P) range ($F(2,55) = 3.46$, $p < 0.05$, $\eta^2 = 0.11$). Significant main effects of postural task condition on reaction time (RT) were observed ($F(4,208) = 13.36$, $p < 0.05$, $\eta^2 = 0.27$). The interaction between group and postural task condition was also significant for RT ($F(8,208) = 2.155$, $p < 0.05$, $\eta^2 = 0.07$), with CLBP subjects with high pain-related anxiety demonstrating significantly slower reactions as the difficulty of postural tasks increased ($p < 0.05$).[28]

Electromyography

Differences in muscle activation related to dual task performance in CLBP patients were noted in several studies. Hemmati et al. found delayed tibialis anterior EMG onset in CLBP patients during dual task conditions ($F = 5.57$, $p = 0.02$). During unexpected perturbations, early activation of the gastrocnemius ($F = 4.63$, $p = 0.03$) and rectus femoris ($F = 4.58$, $p = 0.03$) muscles was also observed in CLBP compared to healthy controls.[29]

Yang *et al*. investigated anticipatory postural adjustments (APA) in right-handed individuals with CLBP, finding that the APA latency of the right transversus abdominis/internal oblique (TrA/IO) was significantly delayed in the CLBP group compared to the left TrA/IO. The right TrA/IO latency was 29.15 ms (95% CI, 18.81 to 39.50) versus the left TrA/IO at 3.69 ms (95% CI, -6.81 to 14.18) ($p = 0.0363$). The APA latency of the right multifidus (MF) muscle under cognitive load was also significantly delayed compared to the left side in CLBP patients, with right MF latency at 25.38 ms (95% CI, 13.41 to 37.35) versus left MF at -3.03 ms (95% CI, -15.18 to 9.13) ($p = 0.0220$). This delay was also present in the right MF of CLBP patients without cognitive load (25.38 ms, 95% CI, 13.41 to 37.35) compared to -5.88 ms (95% CI, -22.56 to 10.80) ($p = 0.0092$). During dual task conditions, the APA latency of the right MF was significantly delayed compared to the control group, with means of 25.38 ms (95% CI, 13.41 to 37.35) versus -5.80 ms (95% CI, -19.28 to 7.68) ($p = 0.0416$). Additionally, there was a positive correlation between APA latency delay in the right ($r = 0.5560$, $p = 0.0017$) and left MF ($r = 0.4010$, $p = 0.0311$)

during dual task conditions to Roland-Morris Disability Questionnaire (RMDQ) scores in the CLBP group.[30]

In a study comparing those with CLBP to groups of elderly controls, young controls, and those with neurological conditions, Bianchini's analysis revealed a significant effect of the factor "task" on dual task cost (DTC) ($F(3, 177) = 48.630$; $p < 0.001$; $\eta 2p = 0.452$). Post-hoc analysis indicated that the DTC was significantly higher between simple reaction time (SRT) and Stroop task conditions ($p < 0.001$), with CLBP patients showing statistically different results compared to other groups. However, the disease state was not linked to differences in DTC, suggesting that the observed effects may be driven by the complexity of the task rather than the presence of CLBP.[31] As this study only included 5 CLBP participants, extra care should be taken when considering this result.

Discussion

This narrative review examined dual task performance differences between individuals with CLBP and healthy controls. The results of this review align with recent reviews indicating that dual task performance likely is compromised in individuals with CLBP compared to healthy controls.[17] While previous reviews have identified similar findings related to dual task performance, several studies identified here have directly compared psychosocial factors, like pain-related anxiety and self-rated disability, to dual task performance metrics and found significant results indicating new, lesser explored areas.[28,30]

Increased gait variability is noted by several studies for those with CLBP.[22,23] However, conflicting evidence exists, such as Valizadeh *et al*. finding no differences in stride length or step width between groups during dual tasking compared to Hamacher *et al*.[23,24] These two studies also found contradicting results for stride time variability decreasing and increasing, respectively.[23,24] These discrepancies are likely due to variations in study methodologies, sample sizes, and the specific dual task paradigms used.

Differences in muscle activity are also noted by several studies.[25,30] These differences appear to persist beyond just the trunk and include musculature in the lower extremity. As these muscle co-activation patterns change in CLBP, it may partially explain differences in balance and postural stability that are noted previously.[25,26,30] Past studies have not always agreed with these results. Moseley *et al*. found that deep trunk muscle activation did not vary based on tasks with low attentional demands.[32] It has been further hypothesized that task type and level of attentional demand of the task explains differences in results.[27,31,33,34] One such example comes from work by Van Daele and colleagues who noted that visual-auditory stimulation and language related tasks increase postural stability in some populations.[34] Several studies noted in this review also show cognitive demands changing outcomes.

The observed dual task deficits in CLBP patients may have significant clinical implications. These findings suggest that standard rehabilitation protocols should incorporate neurocognitive tasks to address both motor and cognitive impairments. By targeting dual task performance, clinicians can potentially improve functional outcomes and reduce the chronicity of LBP. Interventions that combine physical exercises with cognitive challenges may enhance neuroplasticity and sensorimotor integration, leading to better management of CLBP.[35] A non-randomized study by Celletti and colleagues examining neurocognitive therapies for individuals with hypermobile type Ehlers-Danlos with CLBP noted improvements in pain, movement fear, and Oswestry disability index scores.[36] This population presents with a wide range of clinical challenges so the results may not extrapolate to general CLBP patients. However, no other prospective CLBP neurocognitive clinical trials have been found in the literature at the time of writing.

Several mechanisms likely explain the dual task deficits observed in CLBP patients, and three primary models have historically been used to explain this phenomenon. The cross-domain competition model theorizes there is a finite available capacity of the nervous system to execute tasks. As more tasks are completed simultaneously, the available resources allocated to the individual tasks decreases and may lead to reduced task function.[18] However, evidence exists of a U-shaped nonlinear interaction model where low demand cognitive tasks may improve a concurrent physical tasks.[17,33] A task prioritization model is also used to describe scenarios where a task is heavily prioritized at the detriment for other tasks such as what is noted in fall prevention strategies adopted in the eldery.[17] Xiao *et al*. provides an overview on the literature and further descriptions of these models.[17]

These models, as they currently exist, do not explain all differences in current research results individually and fail

to incorporate psychosocial responses. Pain is known to interfere with cognitive processing, leading to a reduction in the available resources for motor and cognitive tasks. This is supported by the sensorimotor theory of pathological pain, which suggests that chronic pain disrupts the integration of sensory and motor function.[18–21,35,37,38] Additionally, neuroplastic changes associated with chronic pain may alter cortical function and further impair dual task performance.[20,35] It is likely that while limited resources may exist for functions of the central nervous system, not all resource types will experience the same impairment from any or all experienced pain. As neurocognitive tasks are historically placed into domain classes, it is likely that these classes and their subclasses will respond to demands differently. The resources impacted will vary between person based on biopsychosocial factors as well since type, intensity, and location of pain and the attention toward or from pain is also a factor that can be influenced and will impact task performance.[39]

With the currently known information, the previously noted models of dual task interference do not adequately explain differences found in those with CLBP as they do not account for the wide array of difficulties or types of tasks and their cross-domain interactions, loss of cognitive resources to pain, or other psychosocial factors. The author of this review proposes a less rigid framework to explain dual task interference in the CLBP population. As pain is experienced, the motor systems work to dampen it by engaging the descending pain modulating pathways leading to reductions of available motor resources. Combined with pain avoidance behaviors, this has the downstream consequence of altering motor patterns that then provide different than expected proprioceptive feedback, requiring greater reliance on a wider variety of resources within the brain to handle this mismatch of feedforward and feedback pathways, leading to further reductions in resources and overall performance of concurrent tasks. However, the exact reduction in cognitive resources is likely based on the number, type, and difficulty of tasks alongside the patient's level of current and anticipated future pain. As pain increases, it is likely to reach a point of interference resulting in inhibition of task performance regardless of attention. "Automatic" processes are likely preserved at lower levels of pain while the performance of tasks can increase at higher levels of pain with greater active attention directed to the task over pain. The previously noted factors, combined with the overall biopsychosocial factors associated with CLBP, will allow for this point of interference to vary at any given time for all individuals. When pain reaches beyond this point of interference, cross-domain competition for processing resources will exceed the available resources causing reductions in all concurrent task performances regardless of adaptation strategies, producing cognitive-motor interference (Figure 2).

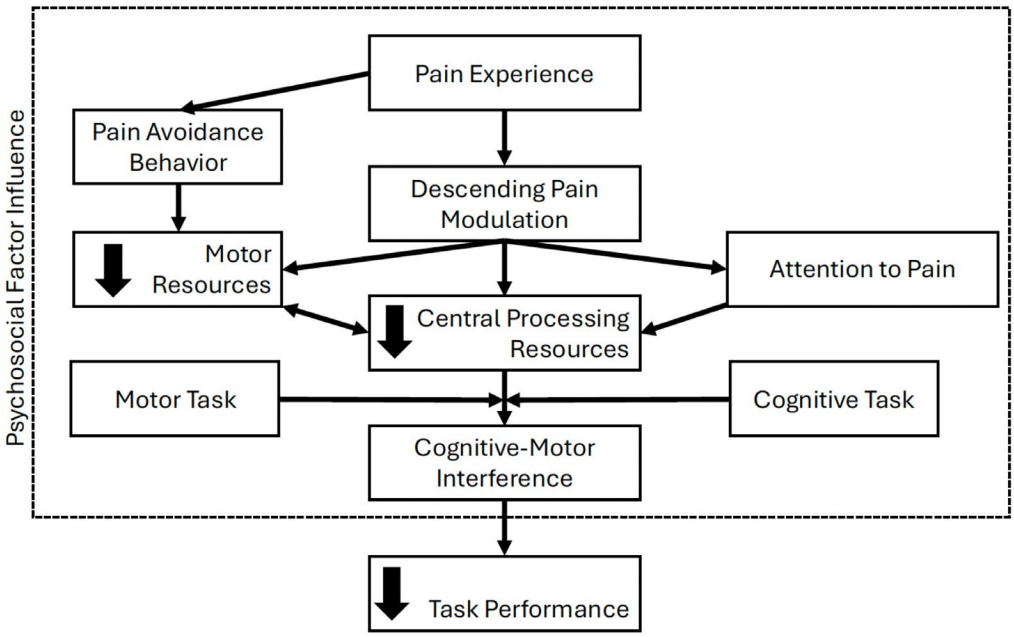

Figure 2.
Model of cognitive motor interference.

Directions for future research

Further investigation is needed to explore the mechanisms underlying dual task deficits in CLBP patients. Longitudinal studies can help determine causal relationships between chronic pain, cognitive impairment, and motor dysfunction in more diverse populations. Standardizing dual task assessment methods will also enable more consistent and comparable results across studies as changes in dual task function may vary based on demand of cognitive tasks, type of task, and number of tasks. Many cognitive tasks currently used in dual task research already utilize multi- and cross-domain resources meaning it may be worth simplifying tasks to as few domains as possible to examine the impact of pain on specific domains. Additionally, research should focus on developing and testing neurocognitive interventions that can be implemented into existing rehabilitation protocols without added strain on providers, patients, or healthcare resources.

Future measures such as event-related potentials, functional near-infrared spectroscopy, and functional MRI may be useful to attempt to measure changes in central nervous system function and locate specific regions of potential impaired function leading to deficits.[40–42] For instance, differences in somatosensory event-related potentials were identified as possible predictors of the transition from acute to chronic LBP.[43] Studies should also incorporate a greater importance on measures of pain, pain-related anxiety, and functional impairments as some correlations were noted in articles included in this review while past studies on chronic pain note the interconnected-ness of pain and motor function.[28,30,35]

Limitations

This review has several limitations. The included studies varied in their methodologies which affects the generalizability of the findings. A potential source of bias revolves around the selection of healthy controls. All studies in this review included controls without LBP but there were no statements about pain in other areas of the body which, if present, may confound results. Many studies also only included participants with low levels of pain. As higher levels of pain may correlate to greater impairment of dual task function, this population will be important to include. Studies also used individuals with "non-specific" LBP. It is currently unknown if differences in underlying pain generators in the low back influence results. As "non-specific" LBP remains a controversial diagnosis related to our current clinical limitations of diagnosis, it is worth including individuals with specific and identifiable low back disorders in future research. Most included studies did not examine how the dual task performance impacted pain and disability. The two studies that included related measures of these noted correlations between pain and performance of dual tasks.[28,30] As these are clinical outcomes stakeholders in healthcare monitor, it is important to follow-up on these factors. Additionally, this review only included articles published in English and consisted of 1 article reviewer.

Conclusions

This narrative review identified potentially significant dual task deficits in individuals with CLBP, including impaired gait, balance, and muscle activation patterns compared to healthy controls. The findings may indicate the importance of incorporating neurocognitive tasks into rehabilitation protocols for CLBP patients. Addressing both cognitive and motor impairments can potentially improve functional outcomes and reduce the chronicity of LBP. Addressing the neurocognitive aspects of CLBP is crucial for effective pain management and rehabilitation. Continued research, implementation, and refinement of dual task assessments in clinical practice are essential for advancing the treatment of CLBP.

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