Received: 9 August 2024 | Revised: 29 October 2024 | Accepted: 22 November 2024

DOI: 10.1002/dad2.70054

Alzheimer's & Dementia
Diagnosis, Assessment & Disease Monitoring

REVIEW ARTICLE

A systematic review and meta-analysis of dual-task outcomes in subjective cognitive decline

Talia Salzman[1] | **Erica Laurin**[2] | **Chloe Thibault**[2] | **Peter Farrell**[3] | **Sarah Fraser**[2]

[1]Faculty of Health Sciences, School of Human Kinetics, University of Ottawa, Ottawa, Ontario, Canada

[2]Faculty of Health Sciences, Interdisciplinary School of Health Sciences, University of Ottawa, Ottawa, Ontario, Canada

[3]Research Services, University of Ottawa Library, Ottawa, Ontario, Canada

Correspondence
Talia Salzman, Faculty of Health Sciences, School of Human Kinetics, University of Ottawa, 200 Lees Avenue, Ottawa, Ontario, Canada, K1N 6N5.
Email: tsalz084@uottawa.ca

Abstract

Subjective cognitive decline (SCD) may represent a preclinical manifestation of objective cognitive impairment. This review consolidated existing findings to determine if dual-tasks objectively differentiate between individuals with SCD, motoric cognitive risk syndrome (MCR), mild cognitive impairment (MCI), and dementia. MEDLINE, Embase, PsycINFO, CENTRAL, AgeLine, and CINAHL were systematically searched for dual-task studies examining older adults with SCD and analyzed using random-effects meta-analyses. Thirteen studies met the inclusion criteria. Within the SCD group, faster gait speed (SMD, 1.35; 95% CI, 0.57–2.13; $p = .0007$) and longer step length (SMD, 0.85; 95% CI, 0.44–1.26; $p < .0001$) favored the single compared to dual-task condition. Faster gait speed was observed in the SCD group compared to MCI (SMD, 0.48; 95% CI, 0.28–0.67; $p = .0001$). A standardized dual-task approach is needed to track gait parameters longitudinally, beginning with changes occurring at the SCD stage as these may precede future cognitive impairments.

KEYWORDS
dementia, dual task, gait, mild cognitive impairment, neuroimaging, subjective cognitive decline

Highlights

- Evidence demonstrates that SCD may be a precursor to dementia.
- Faster dual-task gait speed was observed in the SCD group compared to MCI.
- Slower dual-task gait speed and shorter step length were observed within the SCD group.
- Dual-tasks may help differentiate between preclinical and clinical cognitive decline.
- Dual-tasks should be standardized and changes should be tracked longitudinally.

1 | INTRODUCTION

Dementia has been recognized as a major contributor to mortality and disability among older adults and the prevalence of dementia is projected to nearly triple from 57 million cases in 2019 to 152 million cases in 2050.[1] Since dementia treatments remain limited, increasing attention is being paid to the transitional period between healthy cognition and cognitive impairment as it may present a critical window for interventions that help maintain cognitive health.[2,3] This includes the stages of subjective cognitive decline (SCD) or motor cognitive risk syndrome

(MCR) as well as mild cognitive impairment (MCI), which has been identified as a potential precursor to dementia in a subset of diagnosed individuals.[4]

MCI is characterized by the presence of subjective cognitive complaints (SCC), objective deficits compared to age-related norms, and the absence of dementia and functional deficits related to cognition.[3,5] SCD, a distinct stage that may precede MCI, is characterized by persistent, self-perceived declines in memory or other cognitive domains that are not associated with an underlying disease.[6] Others have further adapted the criteria to diagnose MCI by highlighting evidence of a relationship between gait and cognition.[7] This preclinical stage, known as MCR, is comparable to SCD in that cognitive complaints are based on self-reports.[8] However, MCR also requires a clinical gait assessment, which may serve as a predictor of future cognitive decline on its own. SCD and MCR are, therefore, treated as distinct groups in the literature.

Unlike MCI and dementia, the manifestation of SCD symptoms remains unclear but many are exploring other objective measures such as declines in gait speed to help identify cognitive impairments.[9,10] Furthermore, there are several terms used synonymously with SCD, including subjective memory complaints (SMC), subjective cognitive complaints (SCC), subjective cognitive impairment (SCI), and subjective memory impairment (SMI), that have yet to be standardized.[11] For clarity, SCD will be used to encompass these terms in this review.

The importance of early identification of subtle cognitive declines has been highlighted in recent studies since SCD onset can occur up to 15 years before objective cognitive declines emerge.[12] Cognitive complaints are also frequently attributed to aging or depression but longitudinal studies on older adults with SCD demonstrate an elevated risk for conversion to MCI and dementia.[4,11] Individuals with SCD may also exhibit early pathology, similar to dementia, including compensatory cerebral mechanisms and the presence of tau and amyloid beta peptides.[13] This is supported by a recent review that demonstrated that structural and functional neuroimaging can be used to differentiate between individuals with and without SCD, highlighting the role of neural markers in SCD characterization.[14] Nevertheless, there are currently no standardized neuropsychological, self-report, or informant instruments to identify SCD.[12,15] Current SCD classification approaches rely on self-reported questionnaires of everyday functioning[16] or a single question related to memory decline (e.g., "Do you feel like your memory is declining?").[15]

Alternate approaches that have been effective at differentiating between older adults at different stages of cognitive decline include dual-task outcomes.[17] Dual-task studies examine the simultaneous performance of two tasks, which is related to one's attentional capacity.[18] Given that attention deficits often coincide with cognitive decline, older adults with objective cognitive impairment (i.e., MCI, dementia) typically exhibit worse dual-task performance and greater changes in brain activity than healthy, age-matched older adults.[19] More specifically, motor performance outcomes during dual tasks (i.e., gait speed), have been increasingly proposed as objective indicators to differentiate between those with and without SCD, MCR, MCI, and dementia.[17,19,20] Similar to neural markers, decrements in performance during dual (i.e., walking and talking) compared to single (i.e., just walking) tasks may be an important tool to characterize SCD and assist in more accurately identifying older individuals at risk of cognitive decline.[12,21,22]

The purpose of this systematic review and meta-analysis is to examine dual-task studies and determine whether dual-task outcomes can be used to identify differences within and between groups of older adults with SCD compared to controls, MCI, and dementia. Importantly, unlike previous reviews, the present review is the first to examine dual-task outcomes as a measure to differentiate within and between individuals at preclinical and clinical stages of cognitive decline. This includes measures beyond cognitive performance on traditional paper and pencil tests such as motor and neuroimaging outcomes, which have previously been used as a proxy for cognitive decline and occur as a result of increased cognitive load.[7,23] Unlike traditional paper and pencil tests, dual tasks provide a novel approach to understanding cognitive functioning and may have the potential to supplement existing classification approaches that enable timely interventions to preserve cognitive health.

2 | METHODS

2.1 | Study design

This systematic review and meta-analysis were reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[24] The protocol was registered in the International Prospective Register of Systematic Reviews (PROSPERO, CRD42023416378).

2.2 | Eligibility criteria

Inclusion and exclusion criteria were determined using the PICO (population, intervention, comparison, and outcome) model. Eligible studies examined older adults with SCD 60 years and older who performed a dual task. SCD was defined using the criteria established by the SCD-Initiative working group which includes individuals with self-reported cognitive complaints but without objective cognitive impairments.[6] This could be assessed using one or more questions such as "Do you feel like your memory is worsening?", self-report questionnaires of everyday cognitive function, or by physician assessments. Dual-task interventions were included if two tasks (i.e., any combination of cognitive and motor tasks) were performed simultaneously. Studies examining within- or between-group comparisons between SCD and controls, MCR, MCI, and dementia were included. MCI was defined using Petersen criteria, and dementia had to be diagnosed by a physician.[3] Study protocols, reviews, abstracts without full-texts, and studies specifically examining SCD with other co-occurring conditions (e.g., stroke) were excluded.

2.3 | Search strategy

A peer reviewed[25] search strategy was conducted on March 30, 2023 in MEDLINE (Ovid), Embase (Ovid), APA PsycInfo (Ovid), Cochrane Central Register of Controlled Trials (CENTRAL; Ovid), AgeLine (Ebsco), and CINAHL (Ebsco) (Table S1). The full search strategy can be found in the Open Science Framework (https://osf.io/r6h29/). No limits to language or publication date were applied. The main search concepts comprised of terms related to older adults, SCD, and dual-task paradigm. In addition, references from the included studies and those from previous systematic reviews on SCD were hand-searched for other relevant studies.

2.4 | Study selection

Search results were exported to Covidence (Veritas Health Innovation, Melbourne, Australia), and duplicates were eliminated using the platform's duplicate identification feature. The titles and abstracts were then independently screened in pairs, by two of four authors (S.F., T.S., C.T., and E.L.) followed by the full-text review. Conflicts were resolved by a discussion until a consensus was reached.

2.5 | Data extraction and synthesis

Data extraction of study characteristics and outcomes was independently conducted by two reviewers (T.S. and E.L.) using a custom extraction form. When there was insufficient information in an included study (i.e., missing or unclear data), study authors were contacted for the information. A random effects meta-analysis was conducted using Review Manager 5.4 to compare single and dual-task outcomes within the SCD group and between the SCD group and controls, MCI, and dementia populations. Meta-analyses were conducted when there were at least three studies with dual-task outcomes. The random effects model was chosen to account for variability between dual-task study designs. Dual-task outcomes were pooled, and Hedges' g statistic was used as a measure of the standardized mean difference and 95% confidence intervals (CIs).[26] Data were transformed for outcomes when a larger change indicated worse performance as opposed to better performance to ensure consistency between outcomes. Small ($d = 0.20$), medium ($d = 0.50$), and large ($d = 0.80$) effect sizes were used, and $p < .05$ was considered statistically significant.[27] I^2 statistic was used to evaluate statistical heterogeneity and was classified into small (<25%), medium (26%–74%), and large (>75%) groups.[28] Subgroup analyses were only conducted when there were at least three similar studies. When an insufficient number of studies were reported for a particular outcome, findings were described narratively.

2.6 | Risk of bias

The risk of bias and methodological quality was assessed using the Joanna Briggs Institute Critical Appraisal tools.[29] This included seven criteria that were rated by two reviewers (T.S. and E.L.) as yes, no, unclear, or not applicable. Disagreements were resolved by a consensus between both reviewers.

3 | RESULTS

3.1 | Search results

Database searches yielded 7644 studies and 3814 remained after duplicate removal (Figure 1). A further 3768 records that did not meet the eligibility criteria were excluded at the title and abstract screening stage. Forty-six studies were then reviewed at the full-text stage and 33 studies were excluded for examining the wrong population ($n = 16$), study design ($n = 11$), comparator ($n = 2$), intervention ($n = 2$), and outcomes ($n = 2$). Thirteen studies met the eligibility criteria and were included in the meta-analysis.[17,30–41]

3.2 | Study characteristics and demographics

Study demographics and baseline neuropsychological test scores are reported in Tables 1 and 2, respectively. The publication period ranged from 2011 to 2022 and of 1598 participants, the majority were categorized as SCD ($n = 748$), followed by MCI ($n = 389$), controls ($n = 284$), and dementia ($n = 175$). Six studies recruited participants from memory clinics, and seven recruited from the community. The proportion of female to male participants was approximately equal across studies except for two which predominantly examined female participants.[32,34] The mean age of SCD participants ranged from 63.3 to 73.5 years compared to 66.4–71.9 years in controls, 70.1–73.0 years in MCI, and 76.0–87.2 years in dementia.

All studies compared SCD to controls, MCI, or dementia groups. Specifically, four studies compared SCD exclusively to controls[34,39] or MCI,[36,37] two compared SCD to controls and dementia,[38,40] one compared SCD to MCI and dementia,[35] one compared SCD to controls and MCI,[30] one compared SCD to controls, MCI, and dementia,[17] and three studies conducted within-group SCD analyses.[32,33] Single and dual-tasks outcomes were reported in seven studies,[17,30,31,36–38,40] whereas six studies only reported dual-task outcomes.[32–35,39,41]

Walking with a cognitive task was the dual-task selected across eight studies.[30–32,35–38,40,41] Other motor tasks included the Timed Up and Go (TUG) test,[17] knee extensions,[30] or standing balance[34] tasks, respectively. The cognitive tasks included serial seven subtractions[30,32,35,38,40] in five studies, animal or month naming in three studies,[17,30,35] counting backwards[31,35] or spelling words backwards[36,37] in two studies, and story or words recall,[30] verbal fluency,[32] and reciting alternating letters of the alphabet[41] in one study. Two studies used an auditory-visual dual task with a button response,[33,39] and one study varied sensory conditions during standing balance.[34]

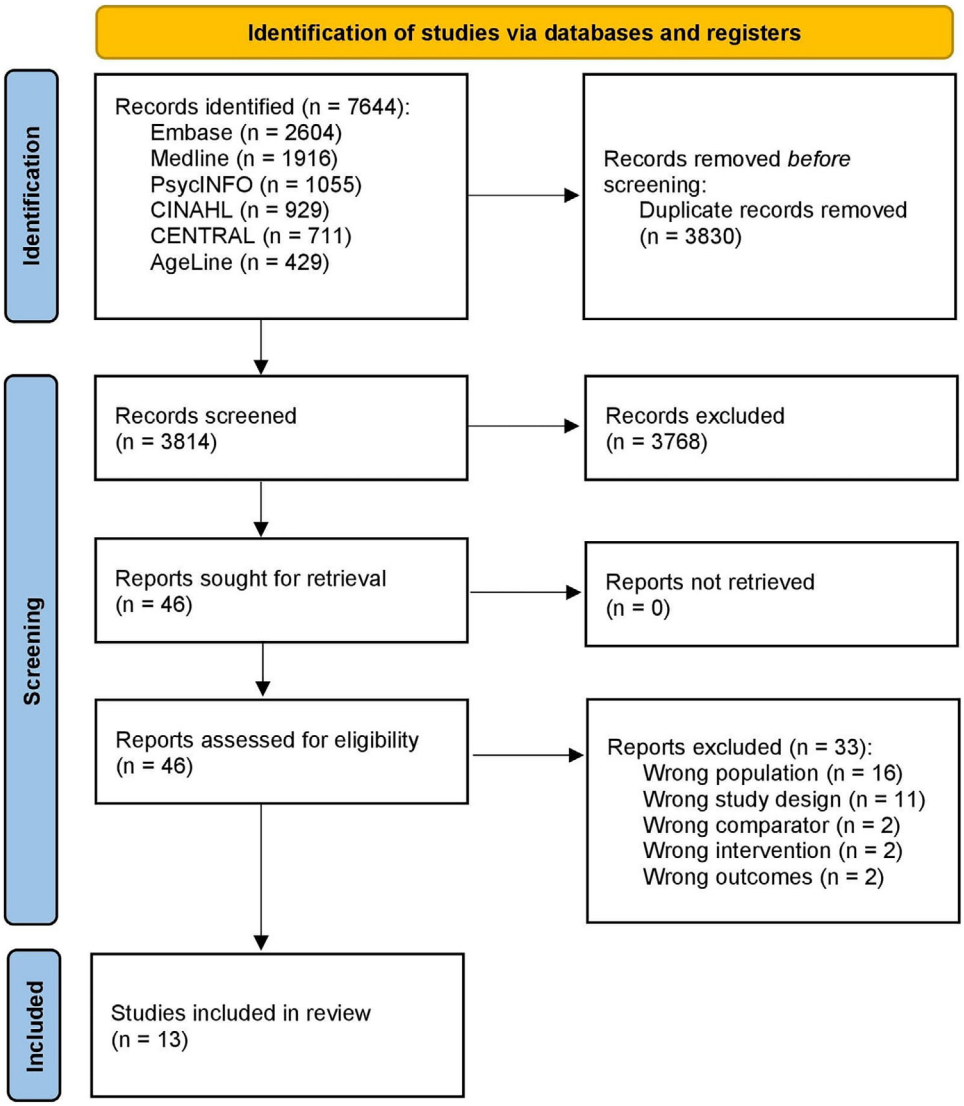

FIGURE 1 PRISMA flow diagram of study selection. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

3.3 | Dual-task outcomes

3.3.1 | Neuroimaging outcomes

Four studies examined brain imaging using functional near-infrared spectroscopy (fNIRS),[40,41] magnetic resonance imaging (MRI),[33] and functional MRI (fMRI),[39] respectively. The fNIRS findings demonstrated oxyhemoglobin changes (ΔHbO2) in the left prefrontal cortex were greater during the dual task compared to a single task in the SCD group while deoxyhemoglobin changes were reduced (ΔHHb).[40] In addition, the SCD group demonstrated greater ΔHbO2 during the dual task compared to the control,[40,41] whereas reduced ΔHbO2 was observed in the dementia group compared to SCD.[40] When examining the blood oxygenation level dependent (BOLD) signal in fMRI, greater bilateral thalamus (predominantly pulvinar), caudate and posterior cingulate, left hippocampus, and parahippocampal gyrus changes were observed in the SCD group compared to control without any differences between single- and dual-task activations.[39] Using MRI, decreased brain volume was observed in an SCD group with hypertension compared to without but the effects of hypertension on SCD were not clearly established.[33]

3.3.2 | Motor outcomes

Several dual-task motor outcomes were examined but the most common was gait performance. This includes gait speed,[30–32,35–38] step length,[32,38,40] step duration,[38] step velocity,[40] stride time,[31] and gait cycle time variability.[32] The remaining studies measured peak knee extension[30] and postural control.[34]

When comparing gait speed in the SCD and dementia groups, gait speed was slower in the dementia group during the dual tasks.[35,38] The dementia groups also had a reduced step length[38,40] and velocity compared to the SCD group.[40] Comparisons between SCD, control,

TABLE 1 SCD classification and summary of study characteristics.

Study	Country	Study design	Recruitment source	SCD term	SCD identification criteria	Dual task	Results
Åhman et al. (2020)	Sweden	Cross sectional	Clinic	SCI	Geriatrician's assessment	TUG + naming animals or months in reverse order	TUG DT outcomes animals/10 s and months/10 s (words named per unit time) discriminated significantly between dementia, MCI, SCI, and healthy controls ($p < .001$).
Ali et al. (2022)	China	Cross sectional	Community	SCD	Self-reported questionnaire and SCD-Initiative working group recommendations	Walking + serial seven subtraction, naming, story recall, or words recall	DT calculation ($p = .013$) and story recall ($p = .04$) gait speed slower in MCI than SCD. Larger DT knee peak extension angle during animal naming ($p = .037$) in MCI compared to SCD and DT story recall in SCD compared to control ($p = .037$).
Beauchet et al. (2017)	France	Cross sectional	Clinic	SMI	Self-administered questionnaire on memory complaints expressed by the participants and/or an informant	Walking + counting backward	Informant-reported SMI was significantly associated with greater DT CoV of stride time ($p = .038$).
Boa Sorte Silva et al. (2018)[a]	Canada	Cross sectional	Community	SCC	Single question about memory and thinking abilities	Walking + serial sevens subtractions or phonemic verbal fluency	Trend for increased DT cognitive accuracy at 52 weeks compared to baseline ($p = .052$). Gait velocity, step length, and cycle time variability not significantly different from baseline.
Cai et al. (2022)[a]	China	Cross sectional	Community	SCD	SCD-Initiative working group recommendations	Visual-auditory divided attention task	Increased visual reaction time in SCD with hypertension compared to without hypertension ($p < .001$).
Carr et al. (2019)[a]	Canada	Cross sectional	Community	SCD	Single question about memory and thinking abilities	Standing balance and auditory task under increasingly challenging sensory, cognitive, and motor conditions	Longer COP path lengths in control than SCD group when standing on a compliant surface ($p < .001$). Longer COP path length during eyes closed compared to eyes open in SCD ($p < .001$). Response accuracy similar between control and SCD across all conditions.
Cullen et al. (2019)[a]	Canada	Cross sectional	Clinic	SCI	Geriatrician's assessment	Walking + counting, serial seven subtractions or counting backwards	DT gait speed slower than ST in SCI. Slower gait speed for each walking condition between SCI, MCI, and dementia groups with increasing cognitive impairment (counting gait $p < .001$; naming animals $p < .001$; serial sevens $p = .004$).
Lowe et al. (2020)	United States	Cross sectional	Clinic	SCC	Neuropsychological test performance, medical chart review, and clinical interview with patient and informant (when available). Final diagnostic decisions were made by a licensed clinical neuropsychologist	Walking + spelling five-letter words backward	Slower DT gait speed ($p < .001$) and gait time ($p < .001$) in MCI compared to SCC.

(Continues)

TABLE 1 (Continued)

Study	Country	Study design	Recruitment source	SCD term	SCD identification criteria	Dual task	Results
MacAulay et al. (2017)	United States	Cross sectional	Clinic	Normal aging group	Participants presented to a clinic with subjective cognitive/memory complaints and were evaluated by a licensed clinical neuropsychologist and/or advanced neuropsychology trainees	Walking + spelling five-letter words backward	Slower DT gait speed ($p = .006$) and decreased accuracy in ($p = .002$) in MCI compared to normal aging group.
Rantalainen et al. (2020)	Australia	Cross sectional	Community	SMC	Single question about memory and participants were required to provide three examples of day-to-day memory issues	Walking + serial seven subtractions	DT gait speed slower than ST in SMC ($p < .001$). DT gait speed, step duration, step length not significantly different between SMC and controls. DT gait speed, step duration, and step length were worse in dementia group compared to SMC ($p < .001$).
Rodda et al. (2011)[a]	United Kingdom	Cross sectional	Clinic	SCI	SCD-Initiative working group recommendations	Visual (letters) and auditory (spoken numbers) with button press response	DT reaction time and correct recognition rate were not significantly different between SCI and controls. Increased bilateral thalamus (predominantly pulvinar), caudate and posterior cingulate, left hippocampus, parahippocampal gyrus activation in SCI compared to control.
Teo et al. (2021)	Australia	Cross sectional	Community	SMC	Single question about memory and participants were required to provide three examples of day-to-day memory issues	Walking + serial seven subtractions	Dementia group significantly worse than SMC in DT step length ($p < .001$), gait speed ($p < .001$), and number of counting responses ($p < .001$). Number of counting responses not significantly different between SMC and healthy control. Increased left PFC ΔHbO2 in SMC between ST and DT ($p < .001$). Decreased DT ΔHHb compared to ST in SMC ($p < .001$).
Udina et al. (2021)[a]	United States	Cross sectional	Community	MCR	Single question about memory, question from the Geriatric Depression Scale about thinking clearly, score ≥ 1 on the AD-8 dementia screener, presence of cognitive symptoms assessed by study clinician	Walking + reciting alternating letters of the alphabet	Slower gait speed and smaller decrement between single and dual tasks in MCR group compared to no MCR ($p < .001$). Lower cognitive accuracy in MCR compared to no MCR during the dual task ($p < .001$).

Abbreviations: AD-8, Eight-item Informant Interview to Differentiate Aging and Dementia; CoV, coefficient of variation; COP, center of pressure; DT, dual task; MCR, motoric cognitive risk syndrome; PFC, prefrontal cortex; SCC, subjective cognitive complaints; SCD, subjective cognitive decline; SCI, subjective cognitive impairment; SMC, subjective memory complaints; SMI, subjective memory impairment; ST, single task; TUG, Timed Up and Go test.

[a] Between-group analyses were only conducted for dual-task outcomes rather than single and dual tasks.

TABLE 2 Baseline participant characteristics of included studies.

Study	Participants (*N*)	Age[a]	Female (%)	Education[a]	Cognitive test score[a]
Åhman et al. (2020)	SCD: $n = 77$ Control: $n = 166$ MCI: $n = 135$ Dementia: $n = 86$	SCD: 67.0 ± 9 Control: 70.0 ± 11 MCI: 73.0 ± 9 Dementia: 76.0 ± 8	SCD: 47.0 Control: 51.0 MCI: 44.0 Dementia: 43.0	University educated (%): SCD: 43 Control: 73 MCI: 41 Dementia: 37	**MMSE** SCD: 29(28–30) Control: 29(29–30) MCI: 26(24–28) Dementia: 22(0–25)
Ali et al. (2022)	SCD: $n = 33$ Control: $n = 26$ MCI: $n = 24$	SCD: 72.7 ± 5.3 Control: 71.9 ± 5.1 MCI: 71.0 ± 6.4	SCD: 54.5 Control: 42.5 MCI: 50.0	SCD: 13.2 ± 2.4 Control: 12.9 ± 2.5 MCI: 11.8 ± 2.9	**MMSE** SCD: 27.0 ± 2.0 Control: 28.3 ± 1.6 MCI: 26.6 ± 1.7 **MoCA** SCD: 23.2 ± 3.1 Control: 27.0 ± 2.1 MCI: 22.4 ± 3.1
Beauchet et al. (2017)	Self-reported SCD: $n = 69$ Informant-reported SCD: $n = 10$ Self- & informant-reported SCD: $n = 32$ Control: $n = 15$	Self-reported SCD: 70.1 ± 3.7 Informant-reported SCD: 68.9 ± 3.6 Self- & informant-reported SCD: 70.6 ± 2.6 Control: 70.9 ± 3.1	Self-reported SCD: 56.5 Informant-reported SCD: 40.0 Self- & informant-reported SCD: 34.4 Control: 40	Not reported	**MMSE** Self-reported SCD: 28.6 ± 1.2 Informant-reported SCD: 29.5 ± 0.7 Self- & informant-Reported SCD: 28.0 ± 2.0 Control: 29.1 ± 0.8
Boa Sorte Silva et al. (2018)	SCD[b]: $n = 64$ SCD[c]: $n = 63$	SCD[b]: 67.4 ± 7.2 SCD[c]: 67.6 ± 7.5	SCD[b]: 71.9 SCD[c]: 69.8	SCD[b] : 13.8 ± 3.0 SCD[c] : 13.3 ± 2.7	**MMSE** SCD[b]: 29.2 ± 1.0 SCD[c]: 29.0 ± 1.2 **MoCA** SCD[b]: 25.6 ± 2.4 SCD[c]: 25.3 ± 2.7
Cai et al. (2022)	SCD[d]: $n = 75$ SCD[e]: $n = 45$	SCD[d]: 66.1 ± 4.8 SCD[e]: 66.3 ± 5.0	SCD[d]: 46.7 SCD[e]: 64.4	SCD[d]: 12.0 (11.0–14.0) SCD[e]: 12.0 (9.5–15.0)	**MoCA** SCD[d]: 27.00 (27.00–28.00) SCD[e]: 28.0 (27.0–28.0)

(Continues)

TABLE 2 (Continued)

Study	Participants (*N*)	Age[a]	Female (%)	Education[a]	Cognitive test score[a]
Carr et al. (2019)	SCD: $n = 16$ Control: $n = 14$	SCD: 70.6 ± 7.0 Control: 66.34 ± 4.8	SCD: 81.3 Control: 64.3	SCD: 16.5 ± 3.4 Control: 15.4 ± 2.2	**MoCA** SCD: 26.9 ± 2.1 Control: 28.2 ± 1.1
Cullen et al. (2019)	SCD: $n = 46$ MCI: $n = 77$ Dementia: $n = 71$	Total: 72.1 ± 10.8 SCD: 65.2 ± 11.0 MCI: 71.2 ± 10.4 Dementia: 77.6 ± 8	Total: 52 SCD: 59 MCI: 51	Total: 12.8 ± 3.7 SCD: 14.0 ± 3.4 MCI: 12.6 ± 3.7 Dementia: 12.2 ± 3.7	**MMSE** SCD: 29.0 ± 1.4 MCI: 26.8 ± 2.7 Dementia: 22.5 ± 4.9 **MoCA** SCD: 27.0 ± 2.2 MCI: 21.3 ± 3.8 Dementia: 17.2 ± 4.4
Lowe et al. (2020)	SCD: $n = 133$ MCI: $n = 119$	SCD: 62.29 ± 9.6 MCI: 70.16 ± 9.8	SCD: 64.7 MCI: 49.6	SCD: 15.0 ± 2.6 MCI: 14.5 ± 2.9	**MMSE** SCD: 28.4 ± 1.8 MCI: 25.7 ± 2.5
MacAulay et al. (2017)	SCD: $n = 27$ MCI: $n = 34$	SCD: 63.3 ± 9.9 MCI: 73.1 ± 8.1	SCD: 51.9 MCI: 47.1	SCD: 14.6 ± 3.0 MCI: 14.3 ± 2.4	**MMSE** SCD: 28.7 ± 1.3 MCI: 24.8 ± 2.9
Rantalainen et al. (2020)	SCD: n = M: 11; F: 13 Control: n = M: 14; F: 13 Dementia: n = M: 4; F: 5	SCD: M: 75.5 ± 6.5; F: 71.8 ± 6 Control: M: 71.5 ± 4.5; F:70.2 ± 4 Dementia: M: 87.2 ± 8.5; F:86 ± 6.5	SCD: 54.2 Control: 48.1 Dementia: 55.6	Not reported	**MoCA** SCD: M: 27 ± 1.8; F: 28.6 ± 1.3 Control: M: 28.4 ± 1.3; F: 27.8 ± 1.5 Dementia: M: 19.8 ± 3.8; F: 21 ± 5
Rodda et al. (2011)	Total: $n = 21$ SCD: $n = 11$ Control: $n = 10$	SCD: 64.0(59.0–66.0) Control: 73.5(52.3–80.0)	SCD: 45.5 Control: 60.0	SCD: 11.0(10.0–13.0) Control: 9.0(9.0–11.3)	**MMSE** SCD: 29(28–30) Control: 9.0(27.8–30.0)
Teo et al. (2021)	SCD: $n = 23$ Control: $n = 26$ Dementia: $n = 9$	SCD: 73.5 ± 6.7 Control: 71.1 ± 4.2 Dementia: 86.1 ± 7	SCD: 56.5 Control: 46.2 Dementia: 44.4	SCD: 14.6 ± 3.5 Control: 14.5 ± 4.3 Dementia: 12.5 ± 3.0	**MoCA** SCD: 27.8 ± 1.9 Control: 28.1 ± 1.6 Dementia: 20.3 ± 3.5
Udina et al. (2021)	Total: $n = 538$ MCR: $n = 60$ Control: $n = 478$	Total: 76.6 ± 6.5 MCR: 78.2 ± 7.3 Control: 76.4 ± 6.3	Total: 55 MCR: 55 Control: 55	Total: 14.6 ± 3.0 MCR: 13.7 ± 3.1 Control: 14.7 ± 2.9	Not reported

Abbreviations: SCD, subjective cognitive deline; MCI, mild cognitive impairment; MCR, mild cognitive risk syndrome; MMSE, Mini-Mental State Examination; MoCA, Montreal Cognitive Assessment.

Note: M: male and F: female.

[a]Data were presented as mean ± standard deviation or median (interquartile range).

[b]Multiple-modality SCD group.

[c]Multiple-modality and mind-motor SCD group.

[d]SCD without hypertension.

[e]SCD with hypertension.

and MCI groups also demonstrate worse outcomes in the MCI group such that the knee peak extension angle was larger in the MCI group compared to SCD and in the SCD group compared to the control.[30] The SCD group also demonstrated longer center of pressure (COP) path lengths than the control group when standing on a compliant surface.[34] Within-group comparisons in the SCD group revealed longer COP path lengths during the eyes-closed condition compared to an open condition.[34] Similarly, informant-reported SCD was associated with a greater dual-task coefficient of variation (CoV) of stride time than non-informant based SCD.[31]

Comparisons between single and dual tasks in the SCD group demonstrated that gait cycle time variability was greater during the dual task compared to walking alone.[32] Shorter step length[32,40] and slower velocity[40] were also reported in the dual- compared to single-task conditions. In contrast, dual-task step length and duration were similar between SCD and controls when comparing between groups.[38]

3.3.3 | Cognitive outcomes

Cognitive accuracy was measured in five studies[17,32,34,37,40] and compared to MCI and dementia groups. Cognitive accuracy was greater in the SCD group during verbal fluency, serial seven subtractions, and spelling words backward while walking.[17,37,40] One study reported that cognitive accuracy was greater in the SCD group compared to the control during the serial seven subtractions and walking dual task.[40] Within group manipulations of difficulty, revealed no differences in cognitive accuracy based on the difficulty of the dual-task condition in the SCD group.[34] One study examining two different SCD group interventions only demonstrated a trend for increased cognitive accuracy post-intervention in the dual-task intervention group at 52 weeks.[32]

3.3.4 | Other outcomes

Two studies examined motor reaction time via button press in response to a stimulus.[33,39] Of these studies, one did not find any differences between the SCD and controls,[39] whereas the second study only compared reaction times within the SCD group and demonstrated slower reaction times in an SCD group with hypertension compared to those no hypertension.[33]

Three studies demonstrated greater dual-task costs (i.e., DTC = [single task – dual task/single task] ×100) in the MCI group compared to SCD, but these interactions did not reach significance.[17,30,35] In contrast, when the SCD and dementia groups were compared, the dementia group had significantly higher dual-task costs than the SCD group.[35] Comparisons between SCD and controls prove to be more variable with dual-task costs favoring both groups.[17,30,35] However, these interactions did not reach significance.

3.3.5 | Motoric cognitive risk syndrome

One study examined dual-task performance in MCR during walking while reciting alternating letters of the alphabet task.[41] Gait speed and stride velocity were slower and cognitive accuracy decreased during the dual task in the MCR group compared to the controls. Dual-task costs, however, were not significantly different between groups.

3.4 | Meta-analyses

3.4.1 | Single- and dual-task outcomes in SCD

Gait speed

Seven studies, encompassing 392 participants with SCD, compared gait speed during dual-task walking to walking alone. One study[37] which demonstrated faster gait speed during the single compared to dual-task condition was excluded from the meta-analysis due to an overlapping participant sample with another study.[36] The remaining four studies[30,32,35–38] demonstrated faster gait speeds during the single compared to dual tasks, whereas one study found the opposite effect.[31] This is supported by the results of the meta-analysis which revealed a large, pooled effect size favoring the single-task condition (SMD, 1.35; 95% CI, 0.57–2.13; $p = .0007$) (Figure 2). A high level of heterogeneity ($I^2 = 95\%$) was obtained.

Step length

Three studies examined step length.[32,38,40] All studies demonstrated longer step lengths when participants walked alone compared to walking with a cognitive task. The meta-analysis findings support this such that a large, pooled effect was obtained that favored the single-task condition (SMD, 0.85; 95% CI, 0.44–1.26; $p < .0001$) (Figure 3). A medium level of heterogeneity ($I^2 = 45\%$) was obtained.

3.5 | Dual-task outcomes in SCD and controls

Three studies compared dual-task outcomes in the SCD group and controls. When examining gait speed, two studies reported faster gait speeds in the control compared to the SCD group,[31,38] and one study found the opposite interaction.[30] Meta-analysis findings were not significant.

3.6 | Dual-task outcomes in SCD and MCI

Four studies examined dual-task outcomes in the SCD group compared to MCI.[30,35–37] All studies observed faster gait speeds in the SCD group compared to MCI. However, one study[37] was excluded from the meta-analysis due to an overlapping participant sample with another study.[36] The meta-analysis findings demonstrated a medium effect size favoring the SCD group (SMD, 0.48; 95% CI, 0.28–0.67; $p = .0001$) but with a low level of heterogeneity ($I^2 = 0\%$) (Figure 4).

3.7 | Risk of bias

A summary of all risk of bias criteria is presented in Table S2. All studies clearly outlined the inclusion and exclusion criteria and described the

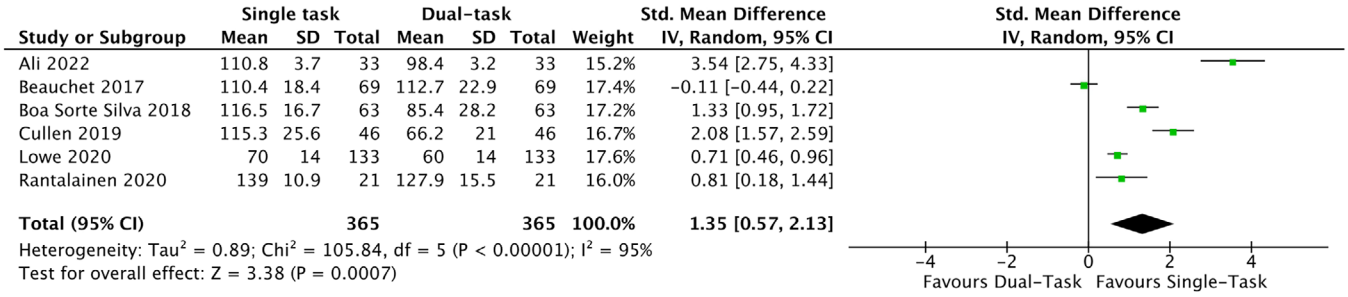

FIGURE 2 Meta-analysis of gait speed within the SCD group in the dual- compared to single-task condition. SCD, subjective cognitive decline; SD, standard deviation.

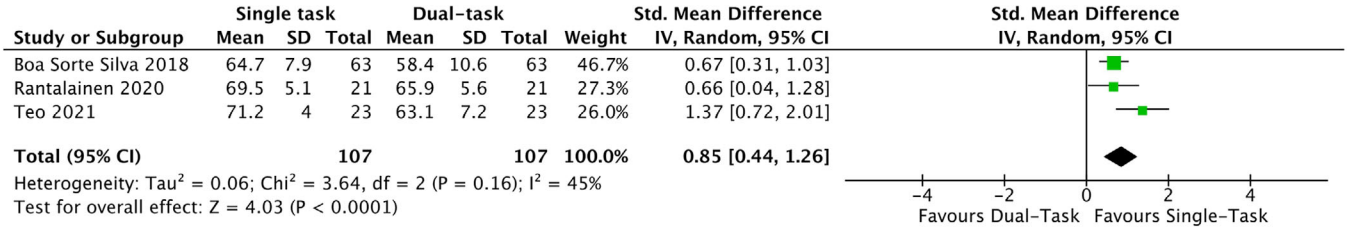

FIGURE 3 Meta-analysis of step length within the SCD group in the dual- compared to single-task condition. SD, standard deviation; SCD, subjective cognitive decline.

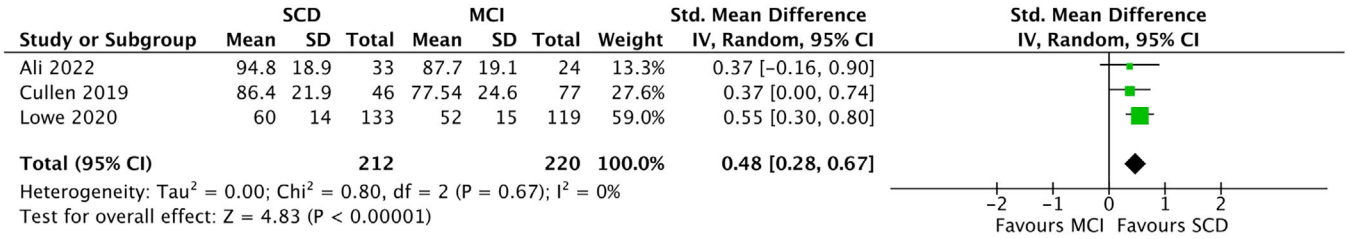

FIGURE 4 Meta-analysis of dual-task gait speed in the SCD group compared to MCI. MCI, mild cognitive impairment; SCD, subjective cognitive decline; SD, standard deviation.

study participants and setting. SCD was identified using a self-report question or questionnaire in six studies,[31,32,34,38,40,41] by a physician or specialist in four studies,[17,35–37] and by the SCD-Initiative working group criteria in three studies.[30,33,39] The individual components of the dual tasks were also clearly reported and measured in a valid and reliable way. For example, gait parameters were measured using a gait mat or by delineating start and stop points for walking trials.[31,36,37,40] Dual-task outcomes were analyzed using appropriate statistical methods, suggesting a low risk of bias for these criteria. Two studies did not identify confounding factors[33,40] and two studies did not clearly describe the strategies used to manage confounders.[32,39] Due to the small number of studies omitting this criterion, it is unlikely to have affected the overall analysis.

4 | DISCUSSION

This review examined whether dual-task outcomes could be used to discriminate between individuals with SCD, healthy controls, and those diagnosed with cognitive impairment such as MCI and dementia. Findings revealed that dual-task performance was worse than single-task performance within the SCD group, which is consistent with changes observed in the literature.[20] When comparing SCD to other groups, dual-task gait speed was slower in the MCI group compared to SCD, but findings were mixed when comparing SCD to controls. Functional imaging findings show promise for delineating SCD from controls, but the limited number of studies preclude meta-analyses in these groups. Few studies directly compared individuals with dementia with SCD thus preventing meta-analyses with these groups.

4.1 | Single- and dual-task outcomes within the SCD group

Results from the current meta-analysis demonstrated that gait parameters differed between single and dual tasks in the SCD group. In individuals with SCD, step length was shorter and gait speed was slower during the dual-task condition which required participants to

walk while executing a cognitive task in comparison to walking alone. Consistent with the literature, dual tasks necessitate greater cognitive control compared to single tasks. As stated in the capacity sharing theory, attention is a finite resource and must be shared when two tasks are performed simultaneously.[42] Changes in step length and gait speed may, therefore, be the result of motor adaptations and changes in gait mechanics to meet the continuous attentional demands of dual-tasking. These adaptations have been further linked to several different factors including an individual's cognitive and sensorimotor capacity.[43]

A similar effect would be expected for other measures of mobility and lower limb function identified in this review such as knee extension,[30] step duration,[38] step velocity,[40] and stride time.[31] However, insufficient data prevented pooling these outcomes in meta-analyses. One reason for fewer studies examining these measures may be the emergent nature of dual-task paradigms in people with SCD. In addition, compared to other gait parameters, gait speed can be easily measured without any specialized equipment and has been used as a reliable marker of cognitive capacity in SCD and MCI.[20,44]

4.2 | Comparison of outcomes between SCD and non-SCD groups

Another important characteristic of gait speed is that decrements in this measure may precede the clinical onset of cognitive decline by a decade.[44–46] This is consistent with investigations of MCR, which specifically examine individuals with cognitive complaints and slow gait speed, given that gait changes may serve as an early marker of cognitive decline.[8] The current systematic review only identified one dual-task MCR study which found no differences overall in dual-task costs, but cognitive accuracy was worse in the MCR group compared to controls.[41] Since MCR groups inherently display slower baseline gait speeds, similar dual-task costs may reflect the MCR group's ability to adapt motorically at the expense of cognitive performance.

Udina et al.'s (2021) findings of decreased cognitive performance may reflect the posture-first strategy, which argues that healthy older adults intrinsically prioritize posture over cognitive performance to ensure stability.[47] Since this was observed in MCR, this group may be more comparable to healthy older adults than those with MCI. However, the posture-first strategy may be context-dependent, and in the case of a dual task, may depend on the difficulty of the cognitive or motor task.[37,43] The effects of different motor tasks on dual-task outcomes have not been examined in MCR, but evidence from an SCD study found that SCD groups may compensate motorically under challenging dual-task conditions.[34] Specifically, increased stability (i.e., decreased postural sway) was observed during a complex standing balance task in an SCD group compared to controls.[34] In contrast to the MCR study, the balance task did not affect cognitive accuracy as scores were similar between the SCD and non-SCD groups.

Due to variability in the choice of cognitive tasks, cognitive accuracy data could not be pooled for meta-analyses, but accuracy was generally worse in the SCD group compared to the non-SCD control group.[17,34,40] In the studies identified in this review, certain cognitive tasks may have influenced dual-task outcomes such that greater cognitive accuracy was observed during animal naming,[17] naming months backwards,[17] and serial seven subtractions[40] in the control group compared to the SCD group. In contrast, when a listening task was used, there were no differences in cognitive accuracy.[34] The authors suggested that the listening task may not have been sufficiently challenging to identify differences between groups.[34] Given these findings, it is possible that dual tasks targeting cognitive domains that are more susceptible to decline such as verbal fluency or memory may better identify declines in older adults with SCD. Furthermore, the cognitive dual-task component is not typically well learned like walking or standing balance motor tasks. It is unclear whether the cognitive tasks were practiced before being evaluated and may have thus contributed to more pronounced declines in cognitive performance.

In addition to performance measures such as gait speed and cognitive accuracy, a subset of the included studies examined brain activity in older adults with and without SCD.[33,39–41] The goal of these studies was to capture neural changes that are associated with changes in attention or "mental effort" within and between groups. For example, functional magnetic resonance imaging (fMRI), electroencephalography (EEG), and fNIRS have all been used to examine neuroimaging markers of SCD.[33,39–41] While findings point to increased brain activity, or increased mental effort being required with each successive stage of cognitive decline, the studies included in this review each used different neuroimaging methods and targeted different brain regions. These findings should thus be interpreted with caution as more studies are needed to replicate existing findings. Nonetheless, a recent review concluded that neuroimaging can be used to identify differences between individuals with and without SCD, but this was not examined in dual tasks.[14] Our lab has since investigated cerebral oxygenation outcomes using fNIRS and has identified differences between individuals with and without SCD, in alignment with the findings of the present review.[48]

Recent reviews have also identified that structural imaging such as MRI may be used to detect differences between older adults with SCD and those at different stages of cognitive decline, but these reviews have not been conducted using the dual-task paradigm.[14,49] Therefore, future studies should consider monitoring changes in brain structure and function during cognitively challenging scenarios as this may help explain the underlying cause of cognitive complaints. Nonetheless, a standardized approach is needed to determine whether these brain changes lead to an increased risk of MCI or dementia.

4.3 | Comparison of outcomes between SCD and other population groups

Dual-task outcomes were stratified across different stages of cognitive decline including MCI and dementia. Although there were no significant differences in gait speed between SCD and controls, dual-task gait speed was faster in the SCD group compared to MCI.[30,35–37] This suggests that there are detectable dual-task differences in motor performance between individuals who are clinically healthy and those

with MCI. Dual tasks have been linked to greater costs in MCI groups compared to healthy controls and demonstrate greater sensitivity in detecting cognitive deficits than walking alone.[44]

The relationship between cognition and mobility has often been linked to changes in executive function, which typically demonstrate deficits at the MCI stage.[19] This may explain why greater dual-task performance decrements are present in individuals with MCI compared to SCD.[50] In addition, changes between MCI and SCD may be more pronounced due to the existence of different MCI subtypes. One study identified that free recall is correlated with gait variables specifically in older adults with amnesic MCI (aMCI).[51] Currently, SCD subclassifications have not been identified nor explicitly compared with MCI subtypes. However, SCD plus factors such as the time since SCD onset may have a similar purpose in identifying subtypes of SCD and an increased risk of cognitive decline.[21]

There were no significant differences in other measures such as dual-task costs in the SCD compared to MCI and control groups. Dual-task costs measure any change in performance between a task performed on its own compared to simultaneously with another. They arise when dual-task performance decrements are greater than those of single tasks and are typically a result of the increased task load of performing two tasks simultaneously. Dual-task costs have thus served as an indirect measure of executive functioning and attention. However, among the three studies that examined it in the present review, findings were variable in the dual-task costs were greater in the dementia group compared to SCD but similar between SCD, MCI, and controls.[17,30,35]

Few studies have directly examined changes in dual-task performance between SCD and dementia groups.[35,38,40] One reason may be that individuals experiencing significant cognitive declines may be unable to overcome the attentional demands of dual-tasking. Nonetheless, among the three studies identified in this review, dementia group findings aligned with MCI such that gait speed was slower in the dementia group compared to MCI and SCD.[35] Other gait parameters such as step duration and step length declined in the dementia compared to the SCD group further demonstrating decreased stability in groups with objective cognitive impairments.[38,40]

4.4 | Clinical implications

The single- and dual-task changes between SCD and other groups identified in the present review shed light on a potential measure to supplement the existing characterization of SCD. In turn, this may contribute to more timely interventions to preserve cognitive outcomes and a tool to monitor changes in cognition longitudinally. Future research should consider evaluating clinically significant cutoffs of dual-task performance in SCD based on conversion rates to MCI or dementia.

On the other hand, the consequences of the overdiagnosis of SCD must be considered. The overdiagnosis of preclinical conditions may lead to misleading results and negative behavioral and psychological effects, particularly in those concerned about their cognition. While the SCD-Initiative working group suggests that SCD diagnoses should be considered on an individual basis, actively screening for SCD may be inadvisable.[21] In addition, given the broad nature of SCD, many individuals may be overreporting cognitive complaints.[52] Therefore, the SCD plus features set forth by the SCD-Initiative working group suggest additional factors including whether individuals seek medical attention, are concerned about their cognition, and report persistent of cognitive complaints, among others, that should be considered when characterizing SCD.[21] Taken together, this may help facilitate the clinical interpretation and implications of SCD.

5 | STRENGTHS AND LIMITATIONS

Significant heterogeneity was present in the meta-analyses, which may be due to several factors. First, age plays a role in SCD such that cognitive complaints reported in individuals aged less than 60 years may be related to worse cognitive performance compared to those aged greater than 60 years whose complaints may signify neurodegeneration.[53] The terminology used to classify individuals with SCD remains unstandardized and is further reflected in this review.[12] This was overcome by broadening our search terms to include more keywords based on the established criteria of the SCD-Initiative working group.[21] If SCD is to be a distinct stage within the continuum of normal cognition to cognitive decline, then it is necessary to establish a consensus on the terminology used to describe it.

It is important to note that differences in dual-task performance and reports of SCD may exist between males and females and may be a source of heterogeneity between studies. Although the studies included in the present review did not examine sex-based differences in SCD, females may be more likely to report cognitive complaints and have a higher incidence of Alzheimer's disease.[54,55] Evidence also suggests that females may perform better on memory and verbal fluency tests than males, which are often used to assess SCD and objective cognitive declines.[56] This further extends to dual-task walking such that women demonstrate greater dual-task gait costs and lower dual-task cognitive costs than men.[57]

Furthermore, most studies in this review included criteria or questions centralized on memory, despite various etiologies that may drive SCD.[21] To capture the complexities of SCD, other cognitive domains such as language, executive functions, or attention should be explored as they are frequently reported in a clinical setting.[12] Finally, other factors such as anxiety, depression, and comorbidities such as cardiovascular conditions may be associated with SCD but were not accounted for in this review.[58]

6 | CONCLUSION

The present review compared SCD, MCI, MCR, dementia, and control groups and identified differences in gait speed between SCD and MCI groups and worse dual compared to single-task gait and cognitive accuracy performance within the SCD group. Since there were no

differences in dual-task outcomes between SCD and control groups, gait parameters may not be effective at discriminating between individuals with and without SCD. Dual-task imaging outcomes show promise for differentiating SCD from controls, but more research is needed to determine the significance of these findings across different neuroimaging methods. In addition, dual-task outcomes must be tracked longitudinally to determine whether they can be used as a marker of cognitive decline, but a standardized approach is needed to select the appropriate dual-task paradigm and outcome measures that are sensitive enough to distinguish between individuals at different stages of cognitive decline.

ACKNOWLEDGMENTS

We thank Valentina Ly, MLIS (Research Librarian, University of Ottawa) for peer review of the MEDLINE search strategy. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest. Author disclosures are available in the Supporting information.

CONSENT STATEMENT

Human consent was not necessary for this systematic review and meta-analysis of published studies.

ORCID

Talia Salzman https://orcid.org/0000-0002-2286-055X

REFERENCES

1. Nichols E, Steinmetz JD, Vollset SE, et al. Estimation of the global prevalence of dementia in 2019 and forecasted prevalence in 2050: an analysis for the global burden of disease study 2019. *The Lancet Public Health*. 2022;7(2):e105-e125. doi:10.1016/S2468-2667(21)00249-8
2. Montero-Odasso M, Almeida QJ, Burhan AM, et al. SYNERGIC TRIAL (SYNchronizing Exercises, Remedies in Gait and Cognition) a multicentre randomized controlled double blind trial to improve gait and cognition in mild cognitive impairment. *BMC Geriatrics*. 2018;18(1):93.
3. Petersen RC. Mild cognitive impairment as a diagnostic entity. *J Intern Med*. 2004;256(3):183-194. doi:10.1111/j.1365-2796.2004.01388.x
4. Mitchell AJ, Beaumont H, Ferguson D, Yadegarfar M, Stubbs B. Risk of dementia and mild cognitive impairment in older people with subjective memory complaints: meta-analysis. *Acta Psychiatr Scand*. 2014;130(6):439-451. doi:10.1111/acps.12336
5. Gauthier S, Reisberg B, Zaudig M, et al. Mild cognitive impairment. *Lancet*. 2006;367(9518):1262-1270. doi:10.1016/S0140-6736(06)68542-5
6. Jessen F, Amariglio RE, van Boxtel M, et al. A conceptual framework for research on subjective cognitive decline in preclinical Alzheimer's disease. *Alzheimers Dement*. 2014;10(6):844-852. doi:10.1016/j.jalz.2014.01.001
7. Montero-Odasso M, Verghese J, Beauchet O, Hausdorff JM. Gait and cognition: a complementary approach to understanding brain function and the risk of falling. *J Am Geriatr Soc*. 2012;60(11):2127-2136. doi:10.1111/j.1532-5415.2012.04209.x
8. Verghese J, Wang C, Lipton RB, Holtzer R. Motoric cognitive risk syndrome and the risk of dementia. *J Gerontol A Biol Sci Med Sci*. 2013;68(4):412-418.
9. Merchant RA, Goh J, Chan YH, Lim JY, Vellas B. Slow gait, subjective cognitive decline and motoric cognitive risk syndrome: prevalence and associated factors in community dwelling older adults. *Journal Nutr, Health Aging*. 2021;25(1):48-56. doi:10.1007/s12603-020-1525-y
10. Skillbäck T, Blennow K, Zetterberg H, et al. Slowing gait speed precedes cognitive decline by several years. *Alzheimers Dement*. 2022;18(9):1667-1676. doi:10.1002/alz.12537
11. Mendonça MD, Alves L, Bugalho P. From subjective cognitive complaints to dementia: who is at risk?: a systematic review. *Am J Alzheimers Dis and Other Demen*. 2016;31(2):105-114. doi:10.1177/1533317515592331
12. Molinuevo JL, Rabin LA, Amariglio R, et al. Implementation of subjective cognitive decline criteria in research studies. *Alzheimers Dement*. 2017;13(3):296-311. doi:10.1016/j.jalz.2016.09.012
13. Si T, Xing G, Han Y. Subjective cognitive decline and related cognitive deficits. *Front Neurol*. 2020;11:247. doi:10.3389/fneur.2020.00247
14. Parker AF, Ohlhauser L, Scarapicchia V, Smart CM, Szoeke C, Gawryluk JR. A systematic review of neuroimaging studies comparing individuals with subjective cognitive decline to healthy controls. *J Alzheimers Dis*. 2022;86(4):1545-1567. doi:10.3233/JAD-215249
15. Wasef S, Laksono I, Kapoor P, et al. Screening for subjective cognitive decline in the elderly via subjective cognitive complaints and informant-reported questionnaires: a systematic review. *BMC Anesthesiol*. 2021;21(1):277. doi:10.1186/s12871-021-01493-5
16. Farias ST, Mungas D, Reed BR, et al. The measurement of everyday cognition (ECog): scale development and psychometric properties. *Neuropsychology*. 2008;22(4):531-544. doi:10.1037/0894-4105.22.4.531
17. Åhman HB, Cedervall Y, Kilander L, et al. Dual-task tests discriminate between dementia, mild cognitive impairment, subjective cognitive impairment, and healthy controls – a cross-sectional cohort study. *BMC Geriatr*. 2020;20(1):258. doi:10.1186/s12877-020-01645-1
18. Kahneman D. *Attention and Effort*. Prentice-Hall; 1973.
19. Montero-Odasso MM, Sarquis-Adamson Y, Speechley M, et al. Association of dual-task gait with incident dementia in mild cognitive impairment: results from the gait and brain study. *JAMA Neurol*. 2017;74(7):857-865. doi:10.1001/jamaneurol.2017.0643
20. Ramirez F, Gutierrez M. Dual-task gait as a predictive tool for cognitive impairment in older adults: a systematic review. *Front Aging Neurosci*. 2021;13(101525824):769462. doi:10.3389/fnagi.2021.769462
21. Jessen F, Amariglio RE, Buckley RF, et al. The characterisation of subjective cognitive decline. *Lancet Neurol*. 2020;19(3):271-278. doi:10.1016/S1474-4422(19)30368-0
22. Rabin LA, Smart CM, Amariglio RE. Subjective cognitive decline in preclinical alzheimer's disease. *Annu Rev Clin Psychol*. 2017;13(1):369-396. doi:10.1146/annurev-clinpsy-032816-045136
23. Wang Y, Yang Q, Tian C, et al. A dual-task gait test detects mild cognitive impairment with a specificity of 91.2%. *Front Neurosci*. 2023;16:1100642. doi:10.3389/fnins.2022.1100642
24. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*. 2021;372 :n71. Published online March 29. doi:10.1136/bmj.n71
25. McGowan J, Sampson M, Salzwedel DM, Cogo E, Foerster V, Lefebvre C. PRESS peer review of electronic search strategies: 2015 Guideline statement. *Journal of Clin Epidemiol*. 2016;75:40-46. doi:10.1016/j.jclinepi.2016.01.021
26. Hedges L, Olkin I. *Statistical Methods for Meta-Analysis*. Academic Press; 1985.
27. Cohen J. *Statistical Power Analysis for the Behavioral Sciences*. Routledge Academic; 1988.
28. Higgins JPT, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. *BMJ*. 2003;327(7414):557-560.
29. Ma LL, Wang YY, Yang ZH, Huang D, Weng H, Zeng XT. Methodological quality (risk of bias) assessment tools for primary and secondary

medical studies: what are they and which is better? *Military Med Res*. 2020;7(1):7. doi:10.1186/s40779-020-00238-8
30. Ali N, Liu J, Tian H, et al. A novel dual-task paradigm with story recall shows significant differences in the gait kinematics in older adults with cognitive impairment: a cross-sectional study. *Front Aging Neurosci*. 2022;14(101525824):992873. doi:10.3389/fnagi.2022.992873
31. Beauchet O, Launay CP, Chabot J, Levinoff EJ, Allali G. Subjective memory impairment and gait variability in cognitively healthy individuals: results from a cross-sectional pilot study. *J Alzheimers Dis*. 2017;55(3):965-971.
32. Boa Sorte, Silva NC, Gregory MA, Gill DP, Petrella RJ. Multiple-modality exercise and mind-motor training to improve cardiovascular health and fitness in older adults at risk for cognitive impairment: a randomized controlled trial. *Arch Gerontol Geriatr*. 2017;68 :149-160. Published online January.
33. Cai G, Wang Y, Chen R, et al. Hypertension status moderated the relationship between the hippocampal subregion of the left GC-ML-DG and cognitive performance in subjective cognitive decline. *Disease Markers*. 2022:1-11. doi:10.1155/2022/7938001
34. Carr S, Pichora-Fuller MK, Li KZH, Phillips N, Campos JL. Multisensory, multi-tasking performance of older adults with and without subjective cognitive decline. *Multisens Res*. 2019;32(8):797-829. doi:10.1163/22134808-20191426
35. Cullen S, Borrie M, Carroll S, et al. Are cognitive subtypes associated with dual-task gait performance in a clinical setting? *J Alzheimers Dis*. 2019;71:S57-S64. doi:10.3233/JAD-181196
36. Lowe DA, MacAulay RK, Szeles DM, Milano NJ, Wagner MT. Dual-task gait assessment in a clinical sample: implications for improved detection of mild cognitive impairment. *J Gerontol B Psychol Sci Soc Sci*. 2020;75(7):1372-1381.
37. MacAulay RK, Wagner MT, Szeles D, Milano NJ. Improving sensitivity to detect mild cognitive impairment: cognitive load dual-task gait speed assessment. *J Int Neuropsychol Soc*. 2017;23(6):493-501. doi:10.1017/S1355617717000261
38. Rantalainen T, Teo WP, Ridgers ND, Nuzum ND, Valente L, Macpherson H. Laboratory-based gait variability and habitual gait entropy do not differentiate community-dwelling older adults from those with subjective memory complaints. *Gait Posture*. 2020;80:20-25. doi:10.1016/j.gaitpost.2020.05.024
39. Rodda DannhauserT, Cutinha DJ, Shergill SS, Walker Z. Subjective cognitive impairment: functional MRI during a divided attention task. *Eur Psychiatry*. 2011;26(7):457-462. doi:10.1016/j.eurpsy.2010.07.003
40. Teo WP, Rantalainen T, Nuzum N, Valente L, Macpherson H. Altered prefrontal cortex responses in older adults with subjective memory complaints and dementia during dual-task gait: an fNIRS study. *Eur J Neurosci*. 2021;53(4):1324-1333. doi:10.1111/ejn.14989
41. Udina C, Ayers E, Inzitari M, Verghese J. Walking while talking and prefrontal oxygenation in motoric cognitive risk syndrome: clinical and pathophysiological aspects. *J Alzheimers Dis*. 2021;84(4):1585-1596. doi:10.3233/JAD-210239
42. Bayot M, Dujardin K, Tard C, et al. The interaction between cognition and motor control: a theoretical framework for dual-task interference effects on posture, gait initiation, gait and turning. *Neurophysiologie Clinique*. 2018;48(6):361-375. doi:10.1016/j.neucli.2018.10.003
43. Yogev-Seligmann G, Hausdorff JM, Giladi N. Do we always prioritize balance when walking? Towards an integrated model of task prioritization. *Mov Disord*. 2012;27(6):765-770. doi:10.1002/mds.24963
44. Montero-Odasso M, Speechley M, Muir-Hunter SW, et al. Dual decline in gait speed and cognition is associated with future dementia: evidence for a phenotype. *Age and Ageing*. 2020;49(6):995-1002. doi:10.1093/ageing/afaa106
45. Dumurgier J, Artaud F, Touraine C, et al. Gait speed and decline in gait speed as predictors of incident dementia. *J Gerontol A*. 2017;72(5):655-661. doi:10.1093/gerona/glw110
46. Tian Q, Resnick SM, Mielke MM, et al. Association of dual decline in memory and gait speed with risk for dementia among adults older than 60 years: a multicohort individual-level meta-analysis. *JAMA Network Open*. 2020;3(2):e1921636. doi:10.1001/jamanetworkopen.2019.21636
47. Shumway-Cook A, Woollacott M, Kerns KA, Baldwin M. The effects of two types of cognitive tasks on postural stability in older adults with and without a history of falls. *J Gerontol A Biol Sci Med Sci*. 1997;52A(4):M232-M240. doi:10.1093/gerona/52A.4.M232
48. Salzman T, Tobón DP, Perreault H, Farhat F, Fraser S. Using Cognitive-motor dual-tasks and functional near-infrared spectroscopy to characterize older adults with and without subjective cognitive decline. *J Alzheimers Dis*. 2023;95(4):1497-1508. doi:10.3233/JAD-230469
49. Viviano RP, Damoiseaux JS. Functional neuroimaging in subjective cognitive decline: current status and a research path forward. *Alz Res Therapy*. 2020;12(1):23. doi:10.1186/s13195-020-00591-9
50. Bishnoi A, Hernandez ME. Dual task walking costs in older adults with mild cognitive impairment: a systematic review and meta-analysis. *Aging Ment Health*. 2021;25(9):1618-1629. doi:10.1080/13607863.2020.1802576
51. Doi T, Shimada H, Makizako H, et al. Cognitive function and gait speed under normal and dual-task walking among older adults with mild cognitive impairment. *BMC Neurology*. 2014;14(1):67. doi:10.1186/1471-2377-14-67
52. Edmonds EC, Delano-Wood L, Galasko DR, Salmon DP, Bondi MW. Subjective cognitive complaints contribute to misdiagnosis of mild cognitive impairment. *J Int Neuropsychol Soc*. 2014;20(8):836-847. doi:10.1017/S135561771400068X
53. Cedres N, Machado A, Molina Y, et al. Subjective cognitive decline below and above the age of 60: a multivariate study on neuroimaging, cognitive, clinical, and demographic measures. *J Alzheimers Dis*. 2019;68(1):295-309. doi:10.3233/JAD-180720
54. Levine DA, Gross AL, Briceño EM, et al. Sex Differences in cognitive decline among us adults. *JAMA Network Open*. 2021;4(2):e210169. doi:10.1001/jamanetworkopen.2021.0169
55. Hirnstein M, Stuebs J, Moè A, Hausmann M. Sex/gender differences in verbal fluency and verbal-episodic memory: a meta-analysis. *Perspect Psychol Sci*. 2022;18(1):67. doi:10.1177/17456916221082116
56. Wang L, Tian T. Alzheimer's Disease Neuroimaging Initiative. Gender differences in elderly with subjective cognitive decline. *Front Aging Neurosci*. 2018;10. doi:10.3389/fnagi.2018.00166
57. Peterson DS. Effects of gender on dual-tasking and prioritization in older adults. *Gait Posture*. 2022;97(9416830, dcm):104-108. doi:10.1016/j.gaitpost.2022.07.247
58. Pedro MC, Mercedes MP, Ramón LH, Borja MR. Subjective memory complaints in elderly: relationship with health status, multimorbidity, medications, and use of services in a population-based study. *Int Psychogeriatr*. 2016;28(11):1903-1916. doi:10.1017/S104161021600106X

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Salzman T, Laurin E, Thibault C, Farrell P, Fraser S. A systematic review and meta-analysis of dual-task outcomes in subjective cognitive decline. *Alzheimer's Dement*. 2025;17:e70054. https://doi.org/10.1002/dad2.70054