Cognitive Assessment and Wearable Sensor-Based Gait and Balance Assessment in Studies of Alzheimer's Disease and Mild Cognitive Impairment: A Preliminary Review.

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Background

Gait and balance deficits are present in patients with diminished cognitive function as a result of overlapping cortical networks in the central nervous system [1, 2]. Given the interplay between gait and cognition, quantitative gait measures show potential as clinical measures of cognitive impairment and dementia [3, 4, 5]. Wearable sensor-based gait assessment offers a feasible approach to monitor gait impairment in large scale studies, however a better understanding of the concurrent use of sensor-based gait assessment with traditional measures of cognitive function in mild cognitive impairment (MCI) and Alzheimer's Disease (AD) populations is important for determining utility for clinical trials.

Methods

A literature review was conducted in the PubMed database to assess studies that incorporated cognitive assessment and wearable sensor-based gait or balance assessment in AD and MCI populations. A PubMed search was conducted using the following inclusion criteria: 1) MCI or AD populations. 2) Cognitive assessment (i.e. Mini-Mental Status Examination: MMSE, Montreal Cognitive Assessment: MoCA). 3) Wearable sensor. 4) Gait or balance assessment.

Results

Out of 56 unique publications, a total of 17 studies were included in the analysis. The indications of these studies included AD (1), MCI (12), and both (4) [Fig. 1]. Cognitive assessments reported include MMSE (11), MoCA (9), and both (3) [Fig. 2]. The most common instrumented tests were walk tests (13: 6 MMSE, 5 MoCA, 2 Both) and Timed Up and Go (TUG) (4: 1 MMSE, 2 MoCA, 1 Both), in addition to daily monitoring (2: 1 MMSE, 1 MoCA) and balance (1: 1 MoCA) [Fig. 3]. Sensor location included lumbar (7: 5 MMSE, 2 MoCA), wrist/arms (2: 1 MMSE, 1 Both), feet/ankles (3: 1 MMSE, 1 MoCA, 1 Both), and multiple sensor configurations (5: 1 MMSE, 3 MoCA, 1 Both) [Fig. 4]. Inertial measurement units (IMUs) were implemented most frequently (13: 6 MMSE, 4 MoCA, 3 Both), followed by accelerometers (4: 2 MMSE, 2 MoCA) [Fig. 5]. Two studies reported a significant association between gait parameters and MoCA scores.

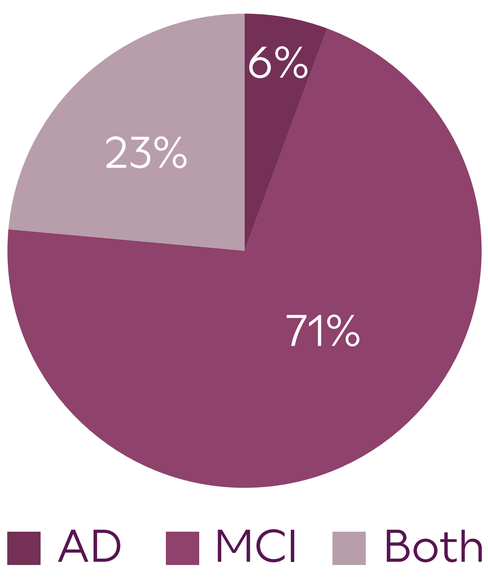

Figure 1: Study Indications

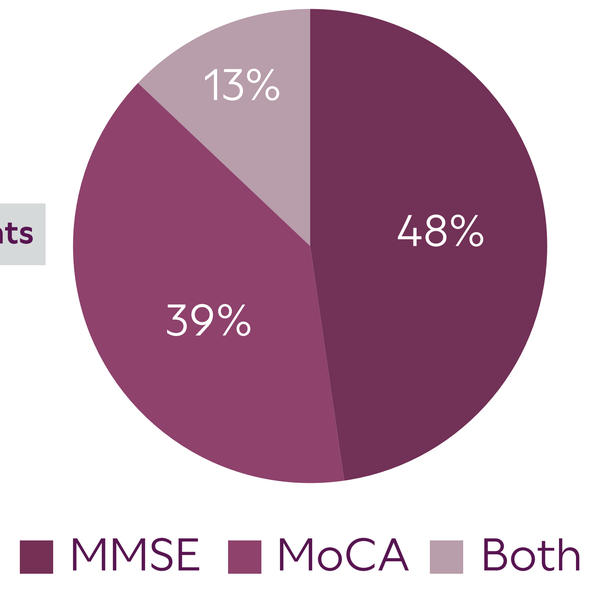

Figure 2: Cognitive Assessments

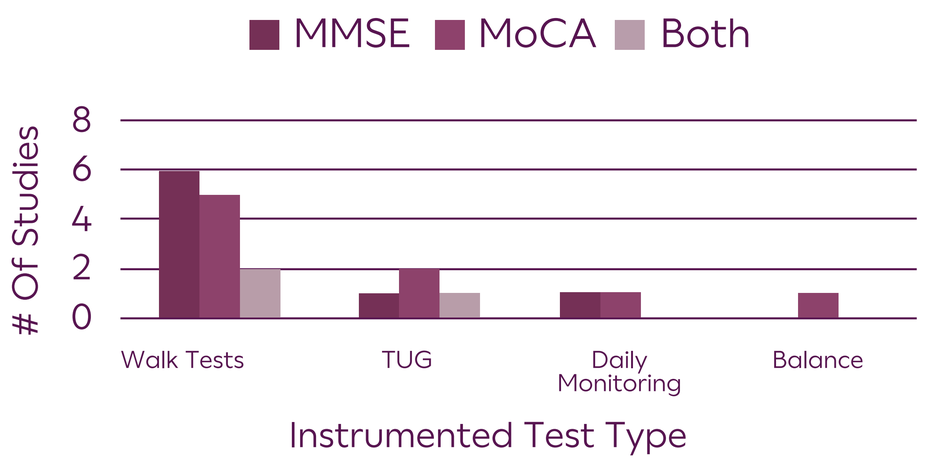

Figure 3: Instrumented Tests included in analysis

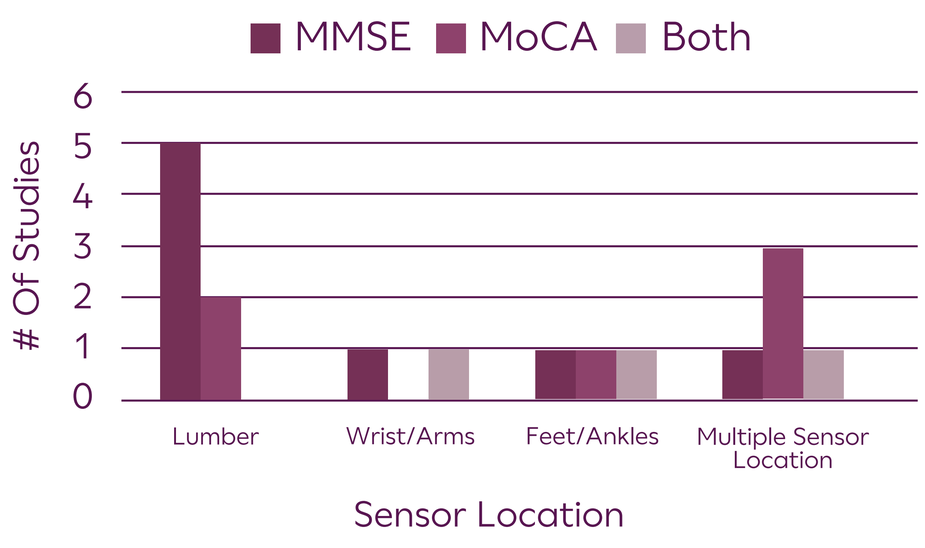

Figure 4: Sensor Locations included in analysis

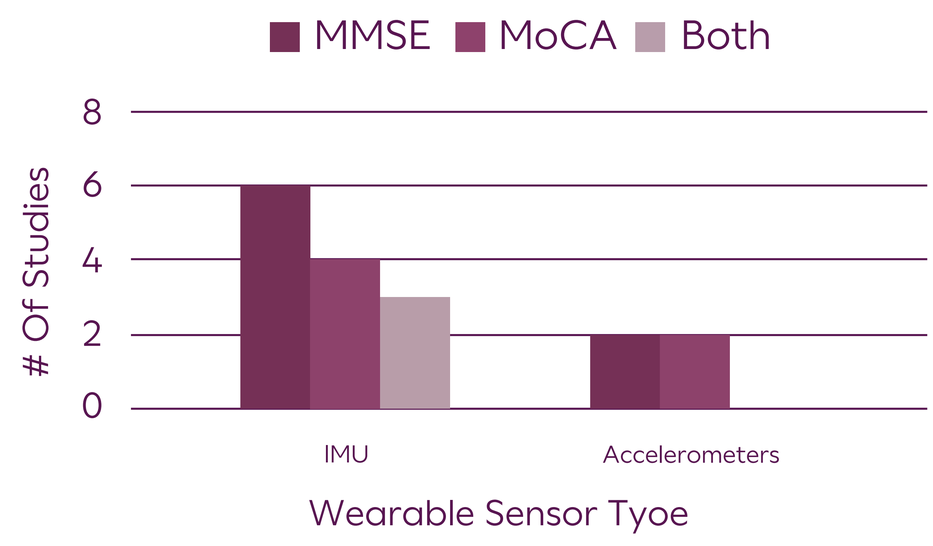

Figure 5: Sensor Type included in analysis

Conclusion

In AD and MCI studies using both wearable sensors and cognitive assessments, gait was most commonly measured using a single IMU or accelerometer on the lumbar region, although multi-sensor configurations were also implemented to assess movement in the extremities. Walk tests were the most common form of instrumented gait assessment used together with cognitive assessments, followed by the instrumented TUG. Only two studies implemented daily monitoring, and one study assessed balance. There was no major distinction between use of MoCA and MMSE when considering the sensor location, wearable sensor type, and instrumented test. This review provides insights into concurrent implementation of cognitive assessment and wearable sensor-based gait/balance measurement in AD and MCI studies. Further investigation is needed to explore the interrelationship between cognitive assessments and wearable sensor-based gait outcomes, as well as implications for test selection and sensor placement.