Assessing Gait Using Wearable Digital Health Technologies in Spinal Bulbar Muscular Atrophy: An Analytical validation study

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Poster # P389

Introduction

- **Spinal bulbar muscular atrophy (SBMA)** is a rare, X-linked inherited neuromuscular disease that affects males.
- **Genetic cause:** expanded CAG repeat expansion in the androgen receptor gene
- **Symptoms:** hand tremors, lower proximal muscle weakness, dysphagia and dysarthria, impaired gait
- **Physical function assessment:** 6-minute walk test (6MWT), a widely used clinical tool used to assess functional gait, aerobic capacity and endurance
- **Digital Health Technologies (DHTs)**
  - Wearable sensors can objectively record high-frequency movement data
  - DHTs can be deployed in clinical and free-living environments
  - However, their feasibility and validity in SBMA remain to be studied.

Objective

This study aims to evaluate the validity of DHT-derived measures of gait during the 6MWT in individuals with SBMA.

Methods

- **Setting:** In-clinic 6MWT
- **Device:** GT9X (ActiGraph, L.L.C. , Pensacola, FL)
- **Procedures:**
  - A physical therapist placed 5 GT9X (ActiGraph, L.L.C., Pensacola, FL) sensors on the participants: one on each wrist, one on each ankle, and one on the lumbar spine
  - Twelve participants completed the videotaped instrumented-6MWT, with four participants using assistive devices (canes, walkers, etc.)

Table 1: Demographic characteristics of study participants

Condition	n	age (years)	height (cm)	weight (kg)	sex	# participants with assistive device	Assistive device types
SBMA	12	60 (11.53)	178.83 (0.07)	95.96 (21.16)	males	4	mixed (canes, walkers etc.)

Reference Data

Step Count: Two raters annotated the steps from the video recording to provide reference data for step count and cadence.
Total Distance (m): Total distance walked was measured using a measuring wheel.
Speed (m/sec): Total distance measured was used to calculate reference walking speed by dividing it by 360 (sec).

Data processing

Algorithms specific to sensor location were applied to derive step count, cadence, distance and gait speed. For the ankle location, stride velocity 95th centile (SV95C) was also calculated.

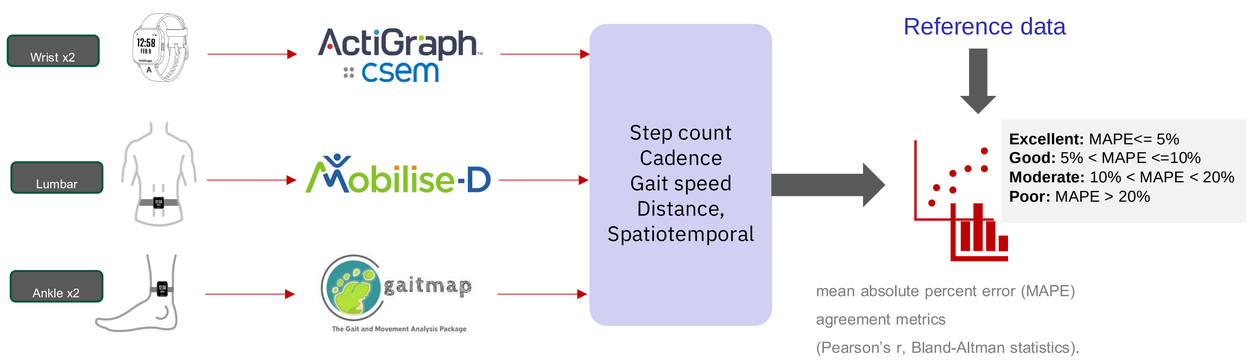

Fig 1: Algorithms used for processing raw sensor data to extract gait measures

Results

Table 2: Performance metrics of analytical validation of DHT-derived gait measures

Wear location	Assistive device	Step count		Cadence [steps/min]		Speed [m/s]		Distance [m]	
		MAPE	Bias	MAPE	Bias	MAPE	Bias	MAPE	Bias
wrist	with	44.21%	105.14	40.86%	7.43	63.43%	-0.13	85.71%	18.29
	without	5.19%	-31.13	6.56%	-6.59	19.85%	-0.18	14.08%	-48.67
	overall	**17.60%**	**12.23**	**17.48%**	**-2.13**	**33.72%**	**-0.16**	**36.67%**	**-27.36**
lumbar	with	7.74%	-32.33	13.68%	-11.2	14.59%	-0.09	12.02%	-25.01
	without	8.32%	31.62	3.76%	-4.18	14.87%	0.09	17.93%	49.44
	overall	**8.16%**	**14.18**	**4.58%**	**-2.92**	**14.80%**	**0.04**	**16.31%**	**29.13**
ankle	with	22.43%	100.3	-	-	8.82%	0.02	30.68%	67.17
	without	7.67%	53.8	-	-	4.31%	0.04	12.69%	68.88
	overall	**13.20%**	**71.3**	**-**	**-**	**6%**	**0.04**	**19.40%**	**68.23**

In addition, SV95C from ankle showed strong correlation (r(14)=0.93, p<0.05) with 6MWD, demonstrating the construct validity in given SBMA population.

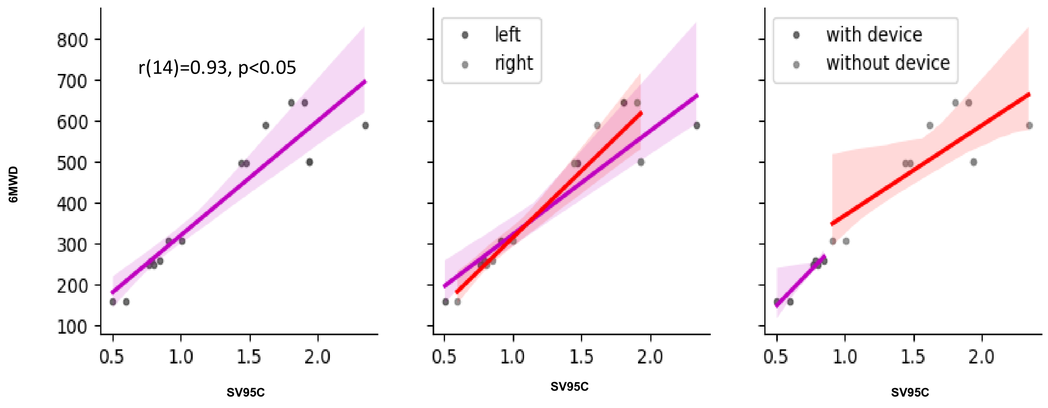

Fig. 2. Construct validity of SV95C derived from the ankle algorithm

Discussion & Conclusions

- ❑ Lumbar and ankle worn DHTs can provide gait measures at moderate to good accuracies in SBMA with 5%< MAPE <20%
- ❑ Use of assistive devices should be considered before selecting sensor-placement location for gait
  - Lower accuracy for the wrist-derived measures were observed if assistive devices were used
- ❑ Ankle-derived measures were the most accurate for estimating gait measures
- ❑ SV95C showed significant correlation with 6MWD (p<0.05) and overall walking speed (p<0.05)

Acknowledgements

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