Ontology of measures of **postural sway**

CORE MEASURES *of*
PHYSICAL ACTIVITY

Digital Measures Development

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Concepts	Properties	Values *(or nested properties)*	Examples *(Sources: 1 2 3 4)*

Postural sway

Definition
Movement or oscillations away from a "desired body position," which prevent an individual from "maintaining this position in any static or dynamic situation."

Concepts	Properties	Values *(or nested properties)*	Examples
Posture	Center of Mass	Meters (center of mass is usually a reference point for other measurements)	Documentation of foot position may include distance between anatomical landmarks, footprint borders, and foot opening or progression angle
	Base of Support	Meters^2, centimeters^2 (area); meters, centimeters (distance); degrees (angle)	
	Static Postures	Standing, sitting, tandem, single leg, Romberg	
	Dynamic Movement	Walking, turning, reaching, transferring	
Spatial properties of sway	Displacement	Meters, centimeters, millimeters	**Statistics**: Distance/excursion, path length, range/amplitude
	Area	Meters^2, centimeters^2	**Statistics**: Mean area, 95% ellipse
	Direction	Anterior/posterior, medial/lateral, degrees (angle)	
Spatiotemporal properties of sway	Velocity	Meters/second, centimeters/second, millimeters/second	**Statistics**: Peak velocity, mean velocity
	Acceleration	Meters/s^2, centimeters/s^2, millimeters/s^2	**Statistics**: Root-mean-square (RMS), range
	Jerk	Meters^2/second^5	
Temporal properties of sway	Frequency	Hertz	**Statistics**: Power, dispersion
Metadata	Individual-specific Variables	Height, age, body mass index (BMI), gender/sex, age, use of walking aid, etc.	
	Environmental Variables	Surface of walking, location, indoor vs. outdoor and transitions, weather, etc.	
	Context-of-use Dependent	Baseline health status, condition or therapeutic area (if relevant); typical comorbidities, visual/auditory/vestibular/lower body sensory impairment	
	Measurement Modality	Technology type and model; sensors (e.g., accelerometer, gyroscope, pressure); duration of measurement and time of day (clock time); wear location (if wearable); evaluation algorithm; form factor	Accelerometers calculate velocity by taking the integral of acceleration signals. Force plates calculate acceleration by dividing force by mass of the subject.

Postural sway

Postural sway represents the meaningful aspect of health, "balance-dependent activities," which has been shown to be clinically relevant for various therapeutic areas. However, whereas other measures in the core set have been frequently measured using digital sensor technologies, further development in defining measures of postural sway is needed. To fill this gap, we have conducted a search of the literature to define ontologies for measures of postural sway, to further promote innovation and adoption of postural sway measures.

Measure considerations (assumptions & limitations):

- The center of mass (COM) is the average position in 3D space of all body segment positions according to their specific masses.
  - In humans, the COM is often located at the navel, lumbar ~L3-L5.
- Balance is defined as the ability to maintain center of mass (COM) over base of support (BOS).
  - Contact area based on pose: standing = feet, sitting = buttocks/thighs; borders define edge limit for loss of balance/falls.
- For assessment of postural sway during dynamic movements, such as walking:
  - The minimum number of steps and days' worth of data should be captured to estimate sway at the slice in time.
  - May need to assume the walking aid is used consistently for all bouts.
- May need to account for whether a particular side of body detects more sway (or both sides).
- Postural sway is traditionally measured using force plates in lab settings, but there is potential for further development in technologies (e.g., inertial measurement units, insoles, etc.) capable of capturing measures of postural sway more accurately.