A Review Evaluating the Validity of Smartphone Sensors and Components to Measure Clinical Outcomes in Clinical Research

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OBJECTIVES: Smartphones incorporate multiple inertial sensors to enhance user experience and provide other features. More recently, novel application of these inertial sensors has enabled new and inventive uses for the smartphone in clinical research. We reviewed published validation studies performed that compare clinical outcomes assessments derived from smartphone data to gold standard approaches.

METHODS: We categorized studies in our review into the areas of application and summarised validation findings. We eliminated studies validating PRD instruments and those using external sensors or adapters connected to smartphones.

RESULTS: Eight validation studies reported the use of the smartphone accelerometer and gyroscope to measure joint angles and range of motion including shoulder, knee and spine, compared to goniometer, scoliometer and other approaches. Correlations varied between methods and outcomes measured: range of motion (ROM), function (F), correlation coefficient (r) and ICC. One study showed good correlation and in the measurement of knee flexion and shoulder ROM, the accelerometer sensor was used with the phone manually held in place on the patient's body [2] or in an arm band [6]. Rib hump measurement in scoliosis was measured in studies using the in-built smartphone camera and light-emitting diode in comparison to the goniometer [8] or the iPhone [1]. Two studies measuring Timed-up-and-go test parameters [9,10] using the smartphone with an acrylic sleeve versus the Scoliometer for hump measurement in scoliosis. Scoliosis: ICC 0.819-0.987.

CONCLUSIONS: Smartphone inertial sensors and components may offer a convenient and low-cost approach to measurement of performance outcomes. Variability between approaches is inherent due to methodology and algorithm differences. Some approaches provide positive indications in comparison to gold-standard methods, but more research in larger studies is encouraged for wider scale utility.

References

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