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UNIVERSITAT DE BARCELONA
Càtedra de Malalties Rares

Duchenne Parent Project España

ArmTracker: Augmenting Clinical Assessment in Neuromuscular Diseases by means of Advanced Motion Analysis

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MOTIVATION

Recent therapeutic advancements for Duchenne Muscular Dystrophy (DMD) underscore the importance of precise clinical outcome metrics. Traditionally, the **Performance of Upper Limb (PUL)** scale for DMD is used to evaluate clinical outcomes.

However, the PUL scale relies solely on the physiotherapist's **interpretation** and lacks refinement. Therefore, instrumented analysis, particularly with **Inertial Measurement Units (IMUs)**, has gained popularity providing **objective data** to complement specialist assessments
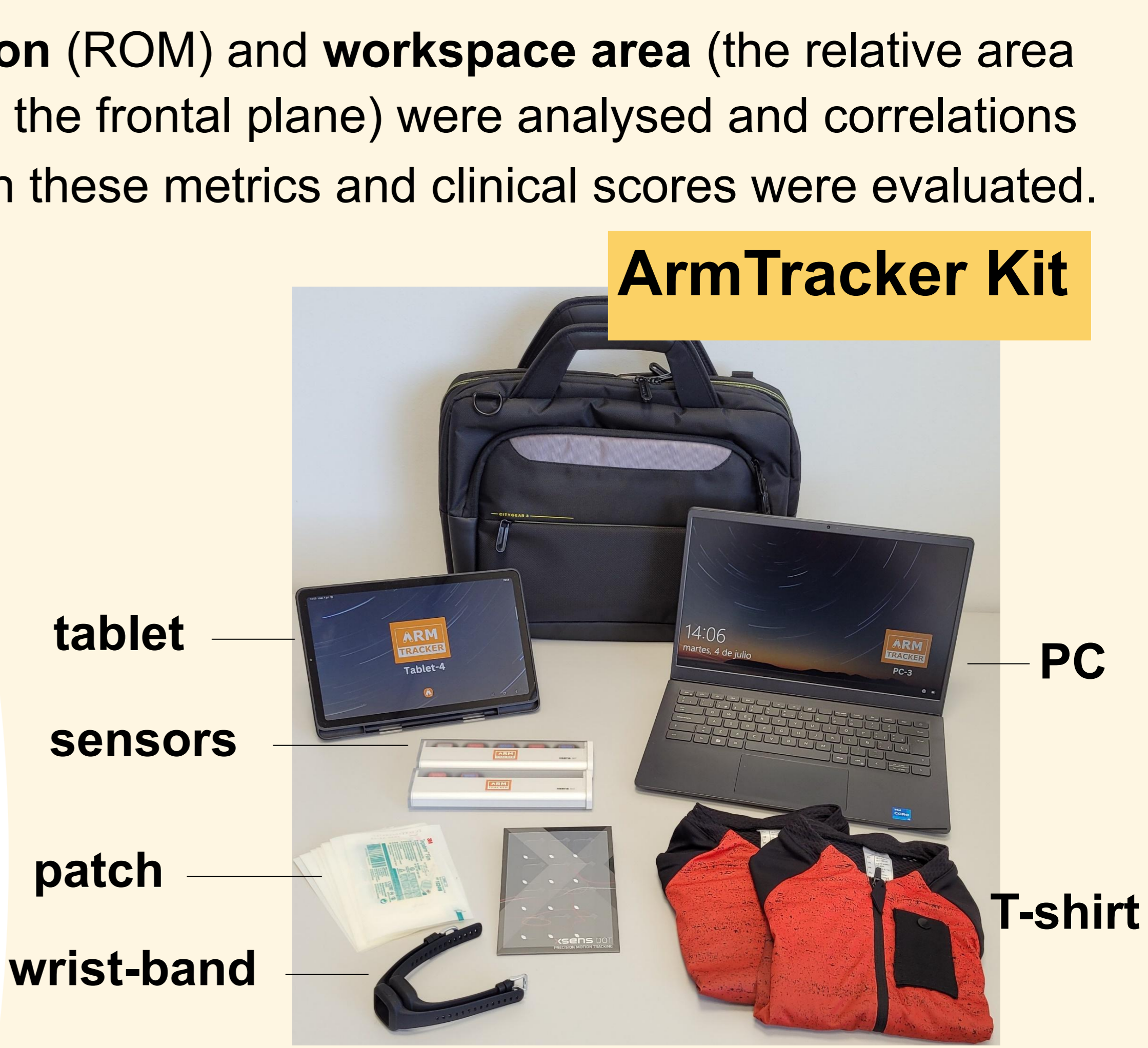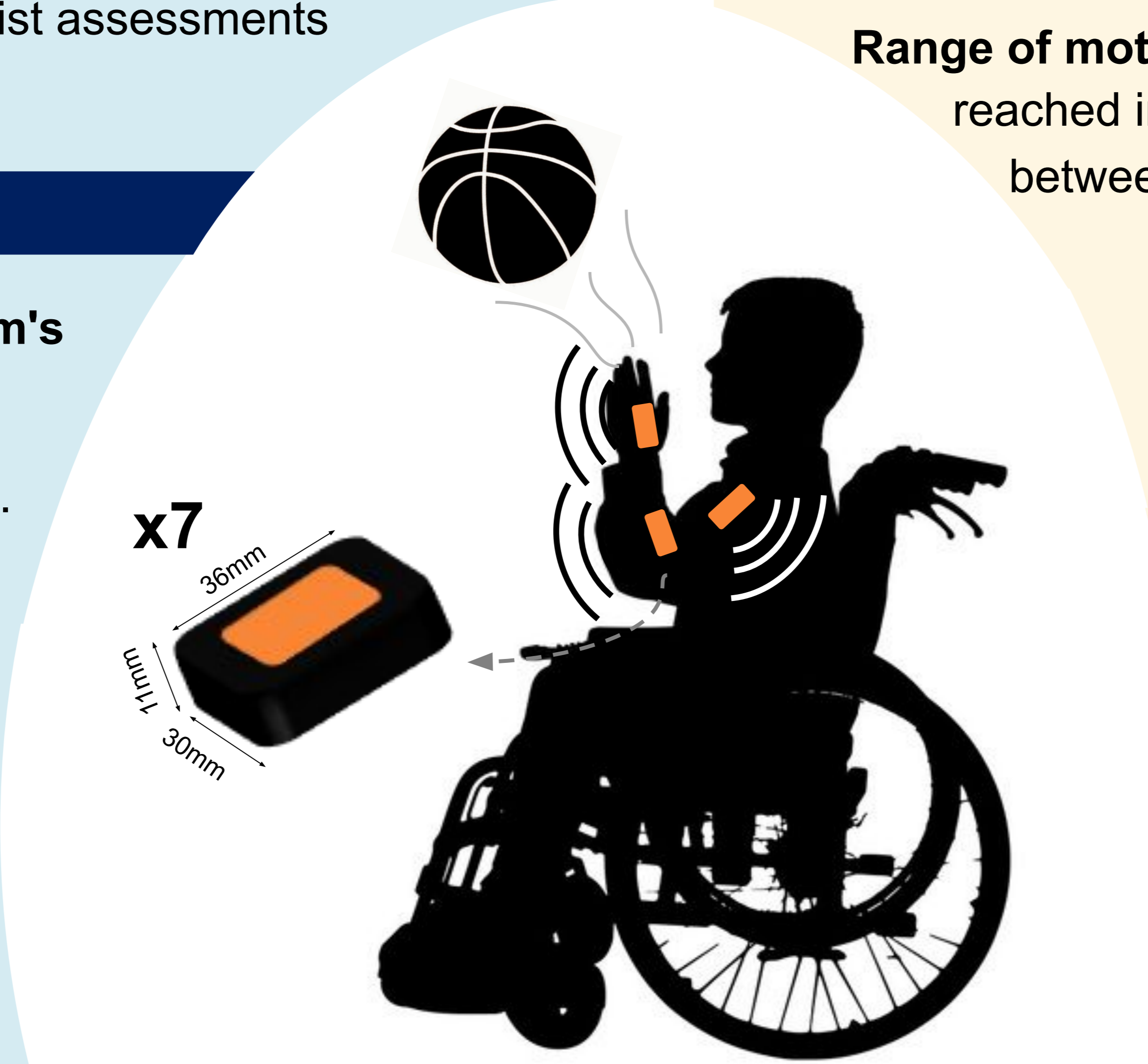
OBJECTIVE

This study aims to assess an **IMU-based system's** effectiveness in enhancing standard clinical evaluation by acquiring **quantitative metrics** to evaluate the **motor status** of children with DMD.
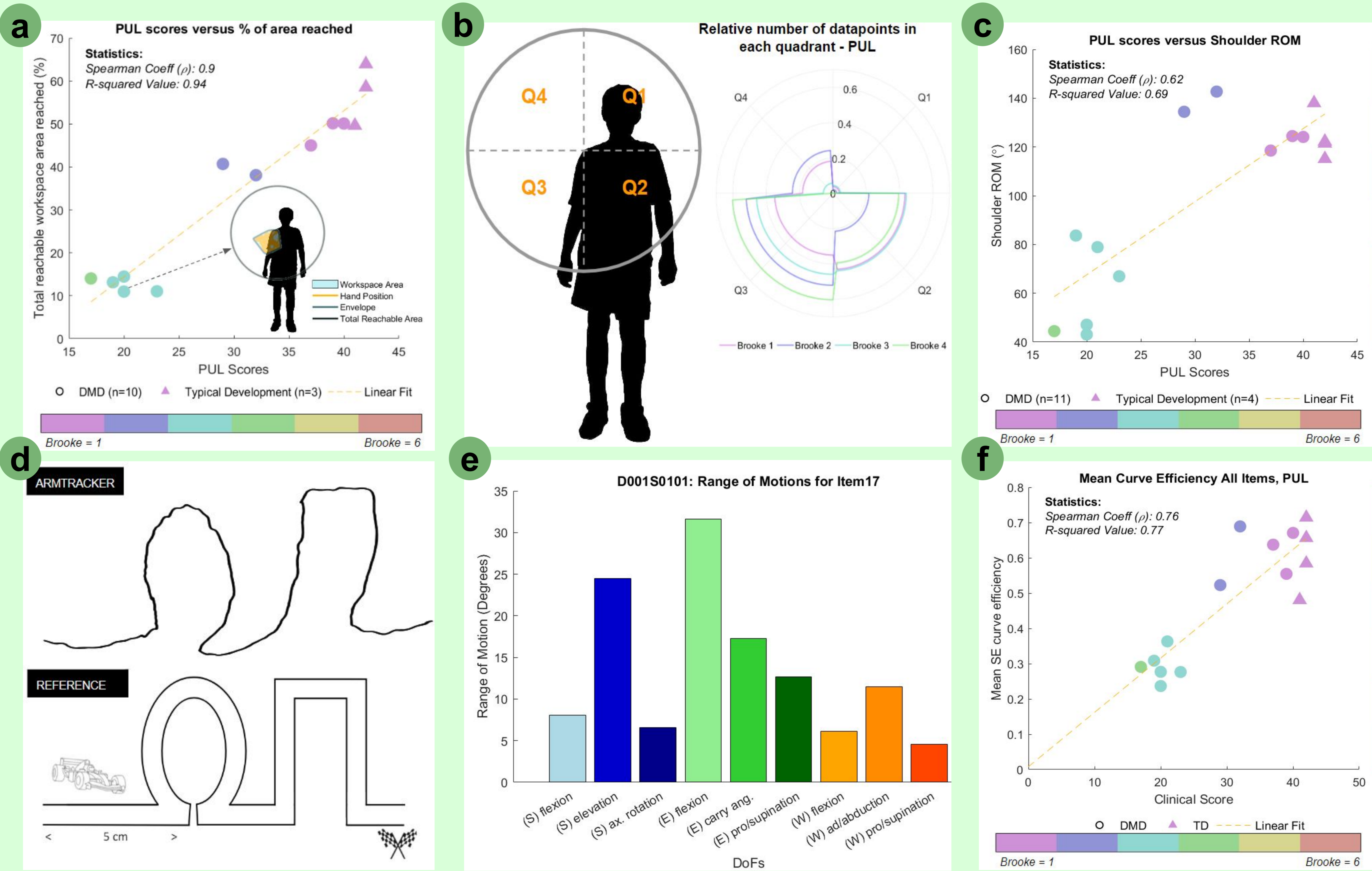
METHODS

We analyzed the **upper limb kinematics** of **10 children with DMD** (12-17 years old, 1-4 Brooke score) while they were performing the clinical scale. This data was compared to results from **3 children with typical development (TD)**. The study was approved by the Ethical Committee of the **Hospital Sant Joan de Déu** (HSJD), Barcelona.

Seven inertial sensors were placed on the hand, forearm, upper arm and torso

Range of motion (ROM) and **workspace area** (the relative area reached in the frontal plane) were analysed and correlations between these metrics and clinical scores were evaluated.

ArmTracker Kit

x7
36mm 11mm 30mm

tablet — PC
sensors
patch
wrist-band — T-shirt

RESULTS & DISCUSSION

The relative **workspace area** correlates well with the PUL scores that were achieved (*figure a*). A similar **strong correlation** was identified when comparing the clinical score against the **range of motion** (ROM, *figure e*) of the shoulder (*figure c*), as well as against the **efficiency of shoulder and elbow movement** (*figure f*). The differences in **division of workspace area** between subjects with differing Brooke scores was also analyzed (*figure b*).
The ArmTracker system further proved capable of accurately **reproducing hand positions** during the clinical scale (*figure d*).

a PUL scores versus % of area reached
Statistics:
Spearman Coeff (ρ): 0.9
R-squared Value: 0.94

Workspace Area / Hand Position / Envelope / Total Reachable Area
DMD (n=10) · Typical Development (n=3) · Linear Fit
Brooke = 1 ... Brooke = 6

b Relative number of datapoints in each quadrant - PUL
Q4 Q1 Q3 Q2
Brooke 1 · Brooke 2 · Brooke 3 · Brooke 4

c PUL scores versus Shoulder ROM
Statistics:
Spearman Coeff (ρ): 0.62
R-squared Value: 0.69
DMD (n=11) · Typical Development (n=4) · Linear Fit
Brooke = 1 ... Brooke = 6

d ARMTRACKER / REFERENCE
< 5 cm >

e D001S0101: Range of Motions for Item17
DoFs: (S) flexion, (S) elevation, (S) ax. rotation, (E) flexion, (E) carry ang., (E) pro/supination, (W) flexion, (W) ad/abduction, (W) pro/supination

f Mean Curve Efficiency All Items, PUL
Statistics:
Spearman Coeff (ρ): 0.76
R-squared Value: 0.77
DMD · TD · Linear Fit
Brooke = 1 ... Brooke = 6

CONCLUSIONS

The metrics obtained with inertial sensors showed a **strong correlation** with the Clinician's evaluation, confirming the potential of this technology.

Furthermore, the data collected with inertial sensors could provide clinicians with **additional information** not available through subjective observation. These data can provide a deeper insights of the motor status of children with DMD, helping the clinician to better tailor the intervention.

The current focus is on exploring the implementation of the ArmTracker system **at home**.