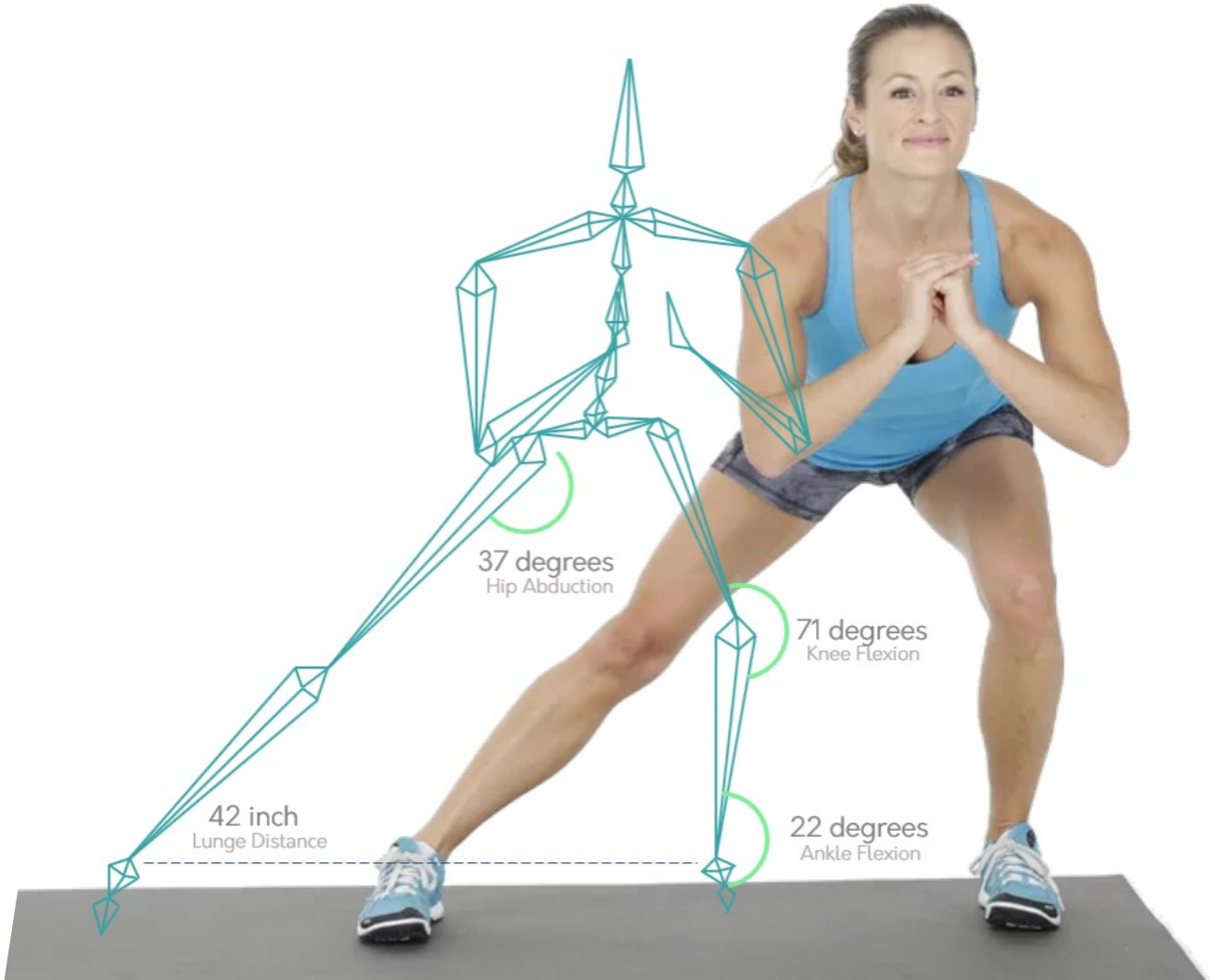
3D Markerless Motion Capture Overview

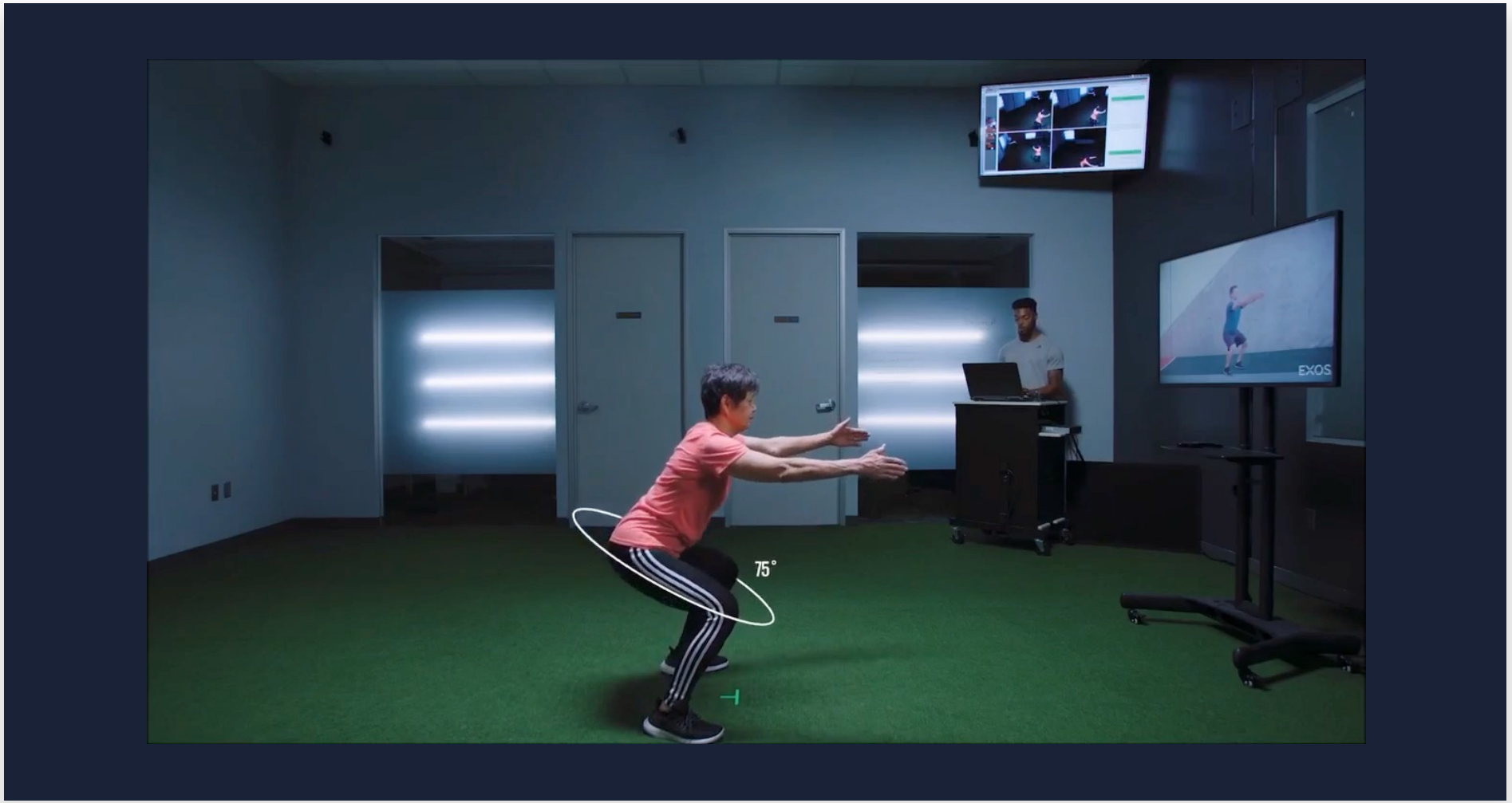
+Efficient
+High Fidelity
+FDA Cleared

Prepared for the American Medical Association



What is 3D Markerless Motion Capture?

Video Overview



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Overview

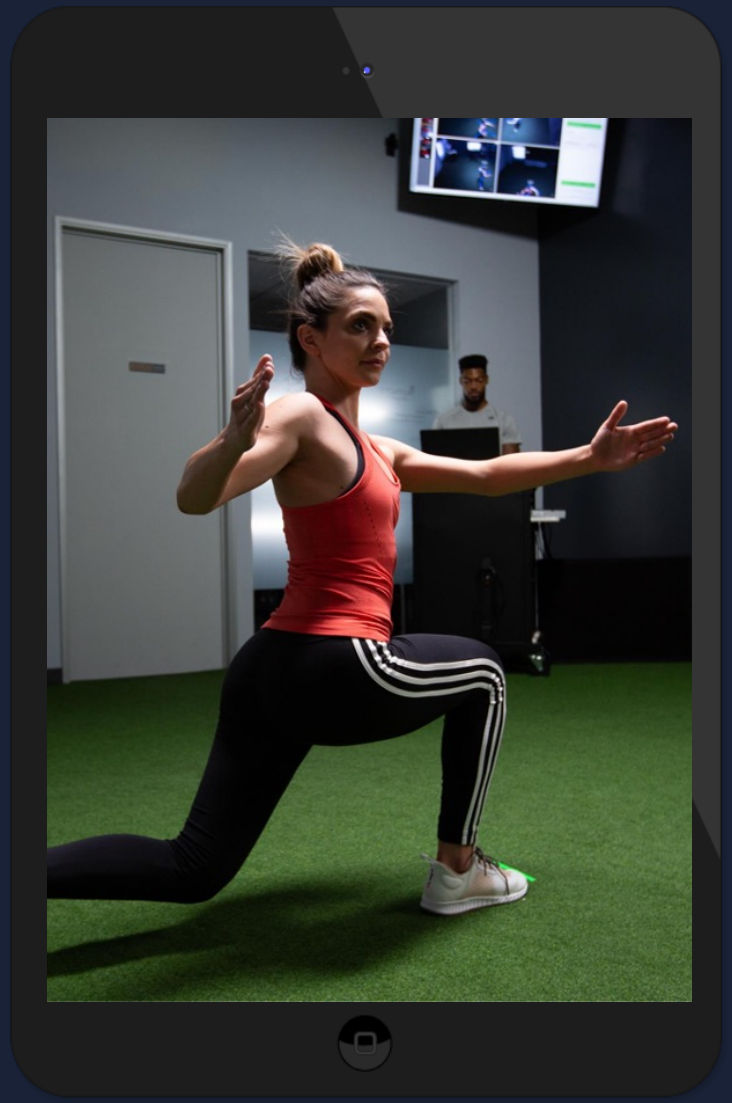
3D Markerless Motion Scan (3DMMS) is a new function first imaging modality that measures a patient's motion health.

800,000+
Data Points Per Scan

400,000+
Reference Scans

+3D Analysis & Time Domain Measures Function Directly
+High Fidelity and Repeatable Objective Measurement
+Full Body Imaging – Simultaneous Multi-Joint Measurement
+Expert System Utilizing AI & Machine Learning
+Population-Based Data Aggregation
+Data Visualization to Enhance Clinical Insights
+FDA Cleared & Validated

+Longitudinal Patient Tracking
+Individualized Treatment Planning
+Enhanced Patient Education & Engagement
+Enhanced Communication Across Clinical Team
+Measures and Quantifies Patient Benefit
+Clinically Practical to Enable Broad Patient Access
+Broad Application Across Specialties



3DMMS

Validated Use Cases

- Orthopedic
- Sports Medicine
- Neurology
- Preventative Medicine & Wellness

Case Study A:

Orthopedic

A 68-year-old female demonstrates moderate knee osteoarthritis. The physician has the patient undergo a 3D Markerless Motion Scan (3DMMS) which incorporates assessments of stability, gait symmetry, and loaded range of motion.

After normative comparison, the patient demonstrates the loaded range of motion of a 78-year-old. The patient lacks the ability to control their body bilaterally to the standard height of a toilet and unilaterally to the standard height of a stair. The patient undergoes total knee arthroplasty.

As the patient progresses through rehabilitation, DARI is incorporated to reassess stability, gait symmetry, and loaded range of motion. The patient's loaded range of motion slowly approaches the typical range of their age demographic and meets the demands of standard activities of daily living.

"DARI helps me analyze movement in a much more efficient time frame due to the immediate measurement of multi-joint movements. It helps me write an appropriate treatment plan by quickly gauging the patient's level of function and quantifying deficiencies which may be missed in traditional evaluations."

Case Study B:

Sports Medicine

A 24-year-old male athlete undergoes an arthroscopic knee procedure and 3D Markerless Motion Scans (3DMMS) are used to assess functional competence during rehabilitation at 6 weeks, 3 months, 6 months, and 9 months post op.

The physical therapist that conducts the screening uses the objective data to document the patient's response to treatment, and also uses the data to educate the patient. The functional measures are leveraged both to guide progression to more-complex movements and to delay progression until competence is exhibited in less-complex movements.

In late stages of rehab, performance testing is incorporated to assess the patient's readiness for clearance. The patient demonstrates symmetrical jump distances and jump heights, but exhibits kinematic asymmetries in loading and landing knee flexion. The clinician communicates the findings with the surgeon to ensure landing competence prior to clearance.

"With DARI's data, we can individualize programs, treat root causes, communicate with physicians on RTP decision making, and test/retest to make sure our programs are effective."

Case Study C:

Neurology

A 72-year-old male begins to show signs of neurological disease. The physician has the patient undergo a 3D Markerless Motion Scan (3DMMS) to establish a baseline.

As measures such as physical therapy are incorporated to slow the rate of disease progression, 3DMMS is routinely performed to document deficiencies and deterioration in motor function.

Gait assessments are performed to detect variations in the patient's speed, step length, postural control, asymmetry, and balance.

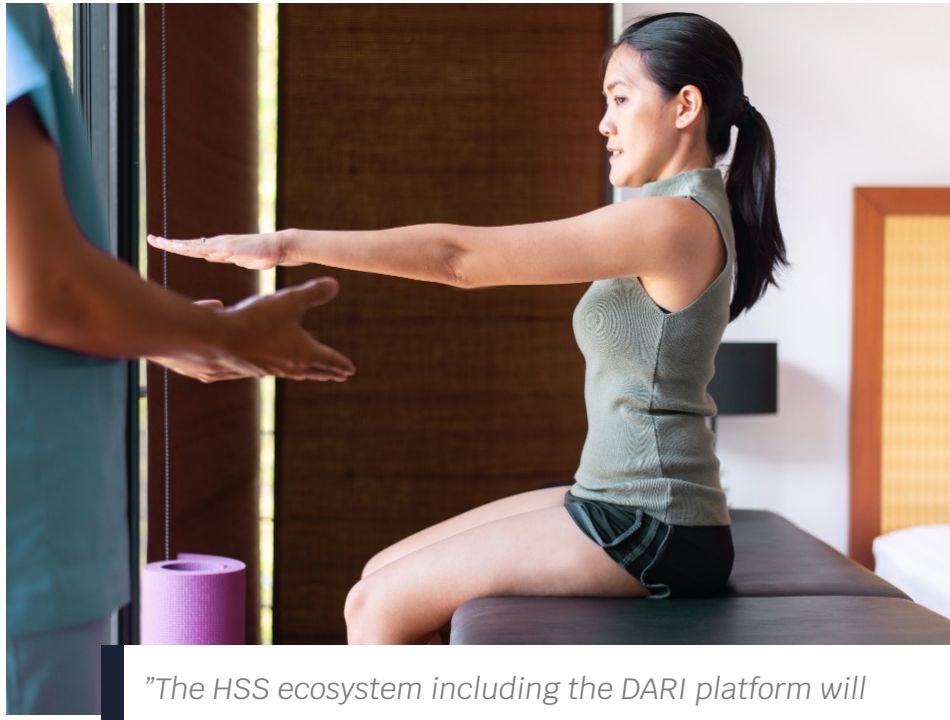
"DARI has helped us create hyper-specific individualized programs for patients, influenced by data points that cannot be seen with the human eye."

Case Study D:

Preventative Medicine & Wellness

A 45-year-old female has a BMI of 32. Prior to going through dietary modification, she undergoes a 3D Markerless Motion Scan (3DMMS) screen that shows her loaded range of motion resembles that of a 55-year-old, based on normative analysis.

As her BMI improves, her loaded range of motion slowly improves and more closely resembles that of her chronological age. The patient notes it's easier to get in and out of her car, and her lingering knee pain has significantly improved.



”The HSS ecosystem including the DARI platform will help set new standards in the quality and availability of musculoskeletal wellness, assessment, devices, and solutions”

– *Louis A. Shapiro, President and CEO of HSS*

SHOULDER REVIEW

SHOULDER MOBILITY

Shoulder Angle	Left (Index)	Right (Index)	Delta	Target
Abduction	182.7° (81%)	176.0° (38%)	6.7°	> 179.0°
Horizontal Abduction	46.8° (62%)	35.4° (18%)	11.3°	> 47.0°
Internal Rotation	69.5° (45%)	59.7° (12%)	9.8°	> 73.0°
External Rotation	-106.1° (99%)	-102.2° (95%)	3.9°	< -92.0°
Flexion	197.3° (99%)	167.1° (9%)	30.2°	> 181.0°
Extension	-67.4° (98%)	-43.9° (15%)	23.5°	< -55.0°
Total Index	78	30		

SHOULDER ALIGNMENT

Shoulder Angle	Left (Index)	Right (Index)	Delta	Target
Abduction - Anterior Deviation	3.7°	19.1° (15%)	15.4°	< 14.0°
Abduction - Elbow Flexion	33.4° (20%)	36.3° (13%)	2.9°	< 24.0°
Abduction - Posterior Deviation	-17.5° (4%)	-1.0°	16.5°	> -14.0°
Horiz Abd - Inferior Deviation	-12.4° (100%)	-19.0° (95%)	6.6°	> -31.0°
Horiz Abd - Superior Deviation	1.2°	-6.4°	7.5°	< 0.0°
Rotation - Anterior Deviation	4.4°	17.3° (66%)	12.9°	< 12.0°
Rotation - Posterior Deviation	-26.8° (54%)	-11.2°	15.6°	> -28.0°
Rotation - Superior Deviation	4.7° (100%)	-5.3° (100%)	10.0°	< 5.0°
Rotation - Inferior Deviation	-15.1°	-18.5°	3.4°	> -33.0°
Flexion - Elbow Flexion	36.0° (24%)	39.9° (12%)	3.9°	< 28.0°
Extension - Elbow Flexion	17.0° (42%)	5.7° (100%)	11.3°	< 15.0°
Total Index	55	62		

3DMMS

Demonstrative Case Study Literature

Orthopedic

Ekanayake CD, DeMik DE, Glass NA, Kotseos C, Callaghan JJ, Ratigan B. **Comparison of patient reported outcomes and functional assessment using a marker-less image capture system in end-stage knee arthritis.** The Journal of Arthroplasty. 2022. doi:10.1016/j.arth.2022.05.039

Sports Medicine

Daggett MC, Witte KA, Cabarkapa D, Cabarkapa DV, Fry AC. **Evidence-based data models for return-to-play criteria after Anterior Cruciate Ligament Reconstruction.** Healthcare. 2022;10(5):929. doi:10.3390/healthcare10050929

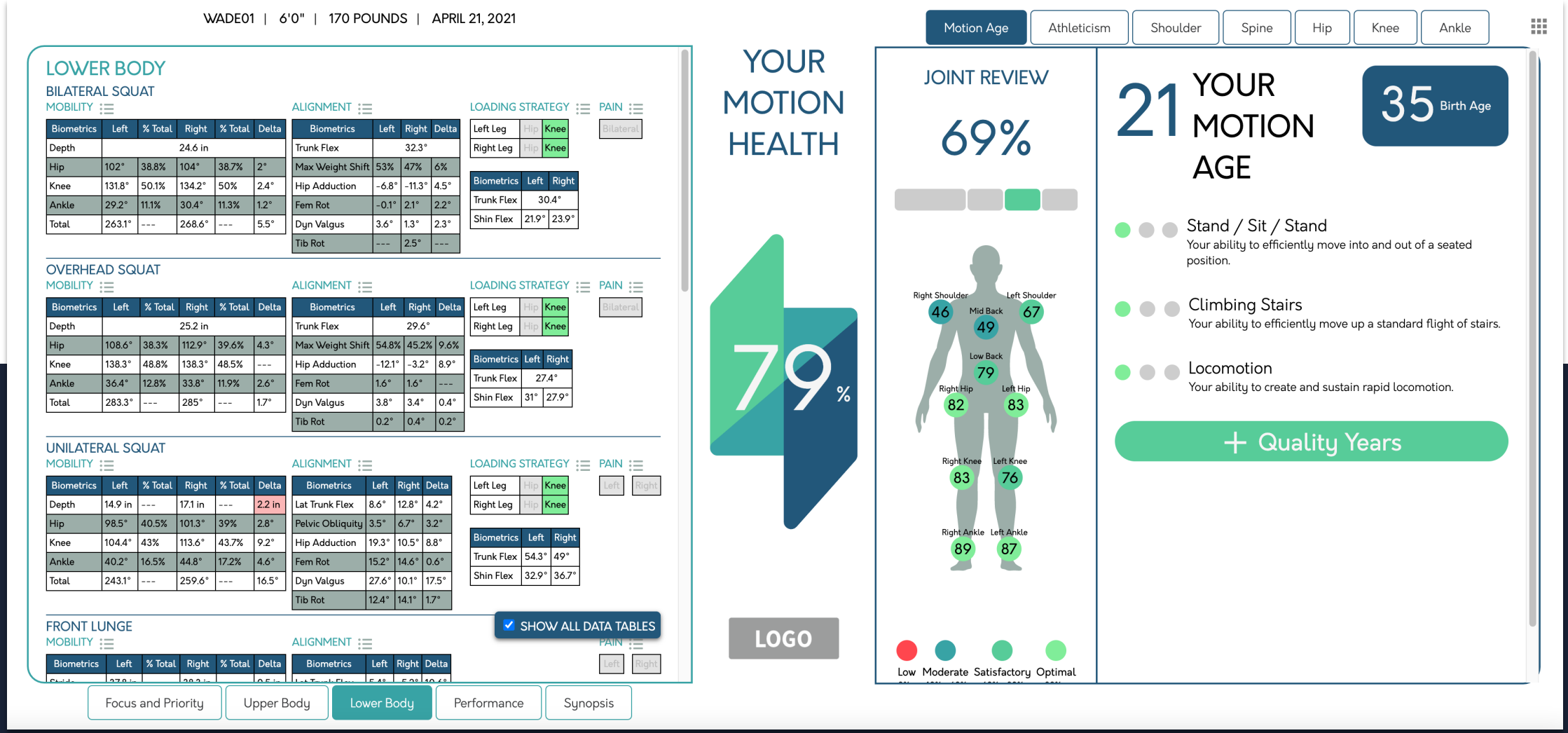
Neurology

Kuhner A, Schubert T, Maurer C, Burgard W. **An online system for tracking the performance of parkinson's patients.** 2017 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS). 2017. doi:10.1109/iros.2017.8205977

Preventative Medicine & Wellness

Cabarkapa D, Whetstone JM, Patterson AM, Mosier EM, Cabarkapa DV, Fry AC. **Relationship between health-related physical fitness parameters and functional movement screening scores acquired from a three-dimensional markerless motion capture system.** International Journal of Environmental Research and Public Health. 2022;19(8):4551. doi:10.3390/ijerph19084551

Sample Data



3DMMS presents both detailed data reviews of each movement and also higher-level visualizations where normative data is applied to contextualize the data.

Detailed Overview of 3DMMS

3D Markerless Motion Scan (3DMMS) is a hardware and software-based solution consisting of a computer, 8 cameras, and a cloud where data is processed, stored and analyzed.

Using computer vision techniques, artificial intelligence, and machine learning, 3DMMS is able to track a patient's joints, body segments, and trunk as they move through space. This is without the use of any sensors, markers, or special clothing.

Clinicians have patients complete tasks such as squatting, walking, and jumping to assess the patient's musculoskeletal function. Typically, clinicians will incorporate standardized screens for different patient populations.

Once a screen is completed, the patient's data is automatically uploaded and processed by a dedicated cloud instance in which the clinician can assess the patient's biomechanical data for individualized treatment, decision making, and clinical communication.

This data includes loaded and unloaded joint ranges of motion, secondary plane deviations, asymmetries, ground reaction forces, joint torques, and many additional data points such as velocities and joint trajectories.

3DMMS is FDA cleared, has been 3rd party validated through comparison to historical marker-based solutions, and has extensive internal data on datapoint repeatability to ensure changes that occur in patient movement over time are not due to machine artifact. 3DMMS has been implemented in rehabilitation, wellness, performance and is the motion capture solution for entities such as Hospital for Special Surgery, and the NFL.

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