

First Responder Injury Prevention

Initial Findings and Implications



Ascension



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THERE'S AN **AT** FOR THAT.

I have no financial disclosures or
conflicts of interest related to the
material in this presentation

- **24 Years as an athletic trainer**
 - 21 with Ascension Health
- **Former Indiana Athletic Trainers' Association President and GLATA Treasurer**
- **High School, sports medicine physician practice, public safety settings**
- **Currently with Ascension Public Safety Medical in Indianapolis, IN**
 - Perform movement assessments as part of an injury prevention component of annual wellness exams
 - Work Performance Evaluation(WPE) validation coordinator

About Me

- **Founded in 1990**
- **One of the Largest practices of its kind in the country**
- **Provide full wellness and special services exclusively to the public safety/first responder community**
- **Nearly 10,000 encounters annually from over 300 agencies**

About Ascension Public Safety Medical

- Understand the trends of musculoskeletal injuries with first responders
- Understand the role of movement quality in injury prevention
- Identify methods of assessing movement quality
- Identify relationships between movement quality and overall health
- Understand the components of an effective injury prevention program

Learning Objectives

Designing an Injury Prevention Program

What components?

- **Define your problem**
 - What's the problem that exists? (*Too many non-contact injuries*)
- **Create your hypothesis**
 - What are your assumptions? (*Poor movements, Culture, Training*)
- **Choose your method of data collection**
 - What tools/equipment/technology?
- **Data analysis**
 - Correlation does not equal causation
- **Solution**
 - What is needed to address the answers that you've discovered?

National Fire Protection Agency(NFPA)

Where do we start?

Figure 1. Total Firefighter Injuries by Year: 1981–2021

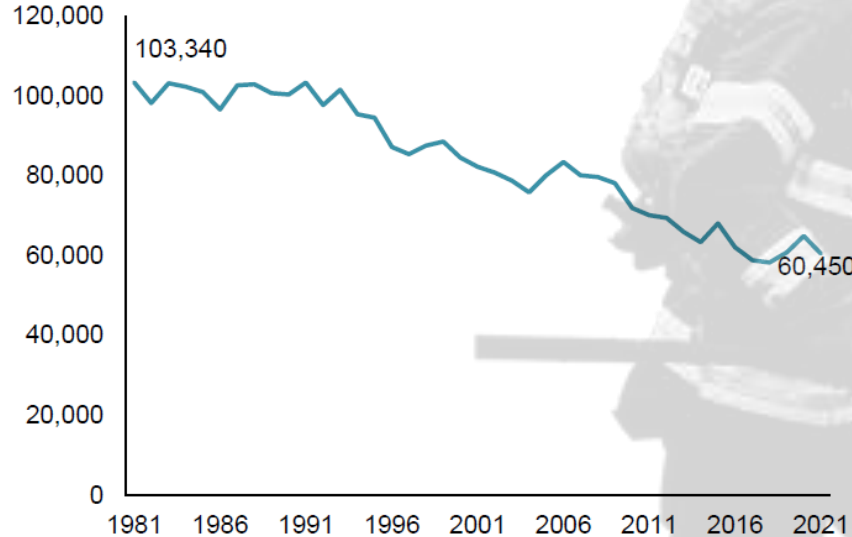


Figure 3. Fireground Injuries by Year: 1981–2021

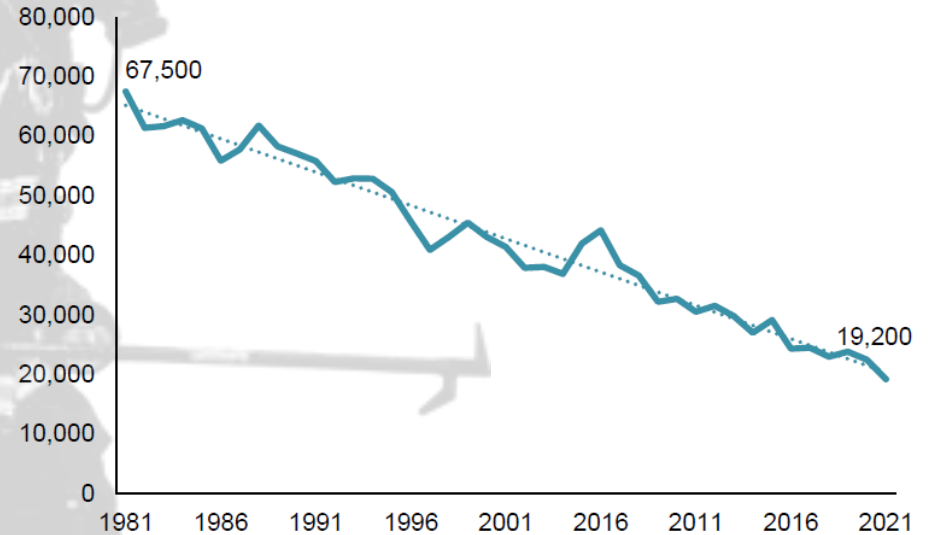


Figure 1 & 3. Adapted from "United States Firefighter Injuries in 2021." By R. Campbell & S. Hall. 2022.

National Fire Protection Agency(NFPA)

Where do we start?

Figure 5. Fireground Injuries by **Nature of Injury**: 2021

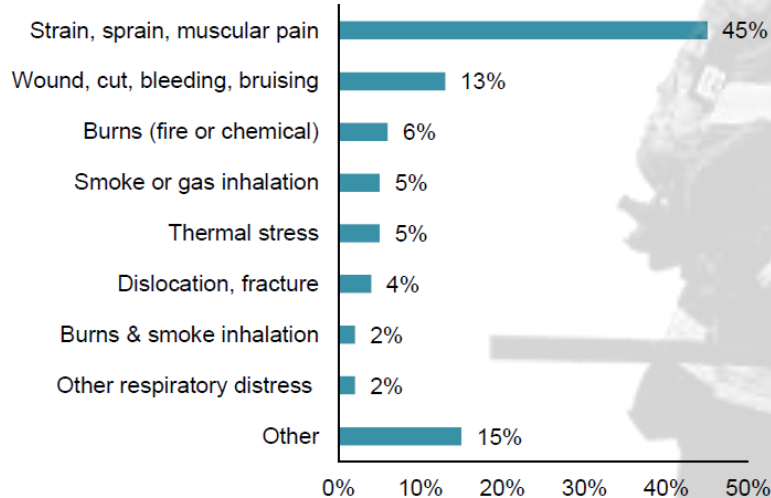


Figure 5. Adapted from "United States Firefighter Injuries in 2021." By R. Campbell & S. Hall. 2022.

28% of total injuries resulted in lost time. ("United States Firefighter Injuries in 2021." R. Campbell & S. Hall. December 2022.)

Table ES-1. Total annual cost of firefighter injuries normalized on a per-unit basis.

Unit	Number	Total Firefighter Injury Cost Per Unit	
		Low Estimate (\$1.6 Billion)	High Estimate (\$5.9 Billion)
Fire Departments ^a	29 819	\$53 657	\$197 860
Firefighter Injuries ^b	62 085	\$25 771	\$95 031
Firefighters ^a	1 090 100	\$1468	\$5412
Total Calls ^c	34 683 500	\$46	\$170

Sources: ^a Evarts and Stein (2019), ^b Haynes and Molis (2017), ^c NFPA (2019)

National Fire Protection Agency(NFPA)

Additional Injury Details

Table A. Factors Contributing to Injuries, 2016–2020

Injury Factor	Percent
Fire development	28%
Fire progress, including smoky conditions	24%
Slippery or uneven surfaces	14%
Uneven surface, including holes in the ground	5%
Icy surface	3%
Wet surface	2%
Loose material on surface	2%
Collapse or falling object	7%
Falling objects	2%
Ceiling collapse	2%
Holes	2%
Lost, caught, trapped, or confined	1%
Unclassified factor	9%
None	17%

Table A. Adapted from "Firefighter Injuries on the Fireground." By R. Campbell. October 2022.

Figure 6. Fireground Injuries by Cause: 2021

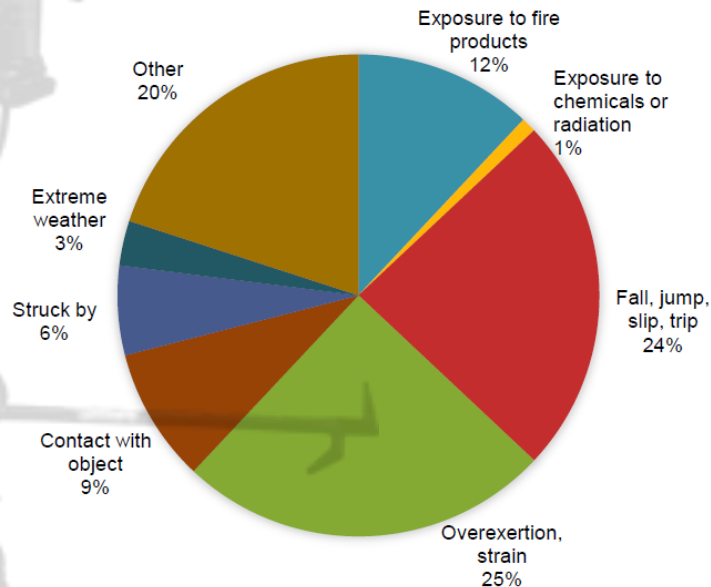


Figure 6. Adapted from "United States Firefighter Injuries in 2021." By R. Campbell & S. Hall. 2022.

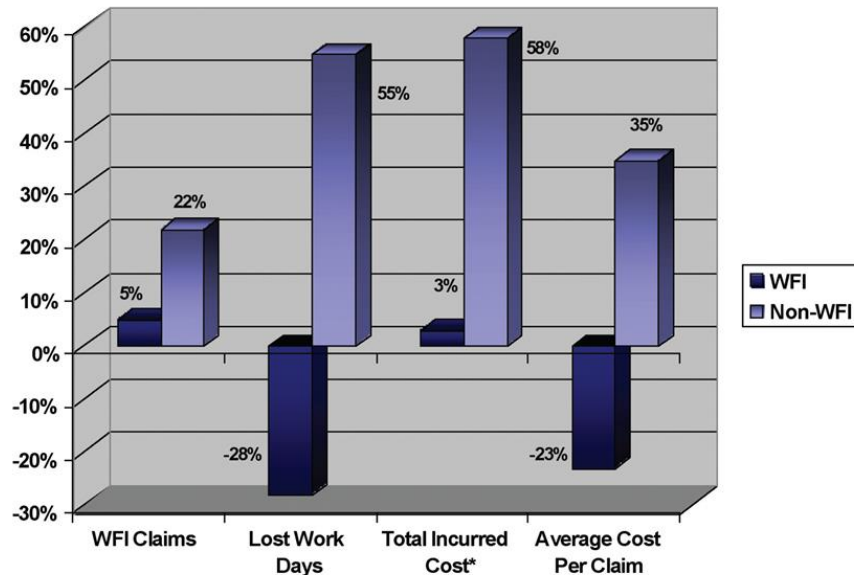
International Association of Fire Fighters(IAFF) and the Wellness Fitness Initiative(WFI)

Why the WFI?

Fire department wellness programs make economic sense and by adopting and implementing an occupational wellness program, such as the WFI, fire departments can reduce occupational claims and costs while simultaneously improving the quality and longevity of a fire fighter's life



Figure 6-1: Percent change in Claims, Lost hours, Costs and Average claim cost between WFI and Non WFI departments 7 years pre and post implementation.



**Adapted from the 4th Edition WFI Manual. IAFF, 2018*

IAFF-WFI

International Association of Fire Fighters(IAFF) and the Wellness Fitness Initiative(WFI)

Components of the WFI

- Medical Physical Examination
- Physical Fitness
- Medical/Fitness/Injury Rehabilitation
- Behavioral Health
- Data Collection and Reporting

Components of Physical Fitness

- Body Composition
- Aerobic Capacity
- Power
- Muscular Strength & Endurance
- Mobility and Flexibility

Initial Movement Assessment and Intervention Pilot

Our First Steps*(in conjunction with Ascension St. Vincent Sports Performance)*

- Local fire department went through Functional Movement Screening(FMS) and tracked all injuries(on and off-duty)
- Rehabilitation and interventional strategies implemented
- Workers Compensation claims evaluated

Movement Assessment

Functional Movement Screen(FMS)



7 Basic movement combinations evaluated on a 3 point scale(21 point maximum)

- Deep Squat
- Hurdle Step
- In-line Lunge
- Shoulder Mobility
- Active Straight Leg Raise
- Trunk Stability Push-up
- Rotary Stability



Prior research indicates scores below 14 place an individual at an increased risk of injury

Butler, R., et al. "Modifiable risk factors predict injuries in firefighters during training academies." Work. 2013.

Initial Movement Assessment and Intervention Pilot

Results

Body Site	Duty Status				Total	
	On-Duty		Off-Duty			
	n	%	n	%	n	%
Ankle	1	4.3%	5	4.2%	6	4.3%
Cervical Segment	3	13.0%	2	1.7%	5	3.5%
Elbow	3	13.0%	9	7.6%	12	8.5%
Finger	0	0.0%	1	0.8%	1	0.7%
Foot	1	4.3%	9	7.6%	10	7.1%
Hip	0	0.0%	4	3.4%	4	2.8%
Knee	4	17.4%	21	17.8%	25	17.7%
Lower Back/Lumbar Spine	5	21.7%	24	20.3	29	20.6%
Lower Leg	2	8.7%	7	5.9%	9	6.4%
Rib	0	0.0%	1	0.8%	1	0.7%
Shoulder	3	13.0%	23	19.5%	26	18.4%
Thigh	0	0.0%	6	5.1%	6	4.3%
Thoracic Spine	0	0.0%	3	2.5%	3	2.1%
Thumb	0	0.0%	2	1.7%	2	1.4%
Wrist	1	4.3%	1	0.8%	2	1.4%
Total	23	100.0%	118	100.0%	141	100.0%

Table X. 2020 Line of Duty Firefighter Injuries by Activity

Line of Duty Activity	n	%
Training grounds	11	47.8%
Responding to or returning from incidents	5	21.7%
Fireground / working a fire	4	17.4%
Non-fire emergency	2	8.7%
Running	1	4.3%
Total	23	100.0%

Initial Movement Assessment and Intervention Pilot

Takeaways

- 84% of injuries were off-duty
- Largest amount of line-of-duty injuries were during training activities (48%)
- Injuries during pilot year were about 33% less than the average of the past 3 years
 - Total injuries declined after athletic trainer interventions and functional movement assessment
- Backfill/Overtime and rehabilitation savings totalled nearly \$300,000

Injury Prevention Program

Wellness Implementation

Based on results from initial pilot program, functional movement assessments and intervention strategies were implemented into the annual wellness/physical fitness examination(PFE)

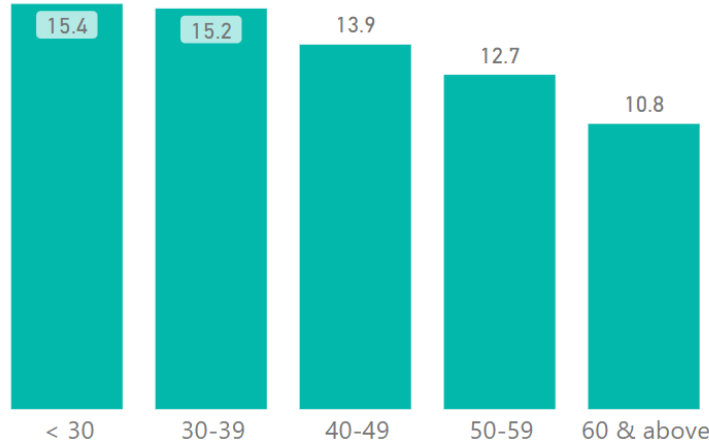
Movement Assessment Results

Functional Movement Analysis

(Entire PSM Population 1/1/2020 - 12/31/2022)

Apparatus
□ Engine
□ Ladder

Average Score by Age



725

Total Participants

Risk for Injury (FMS <= 14)

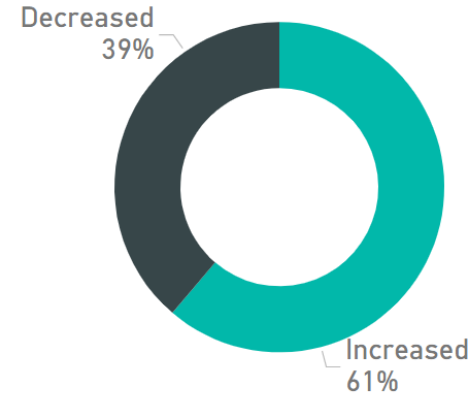
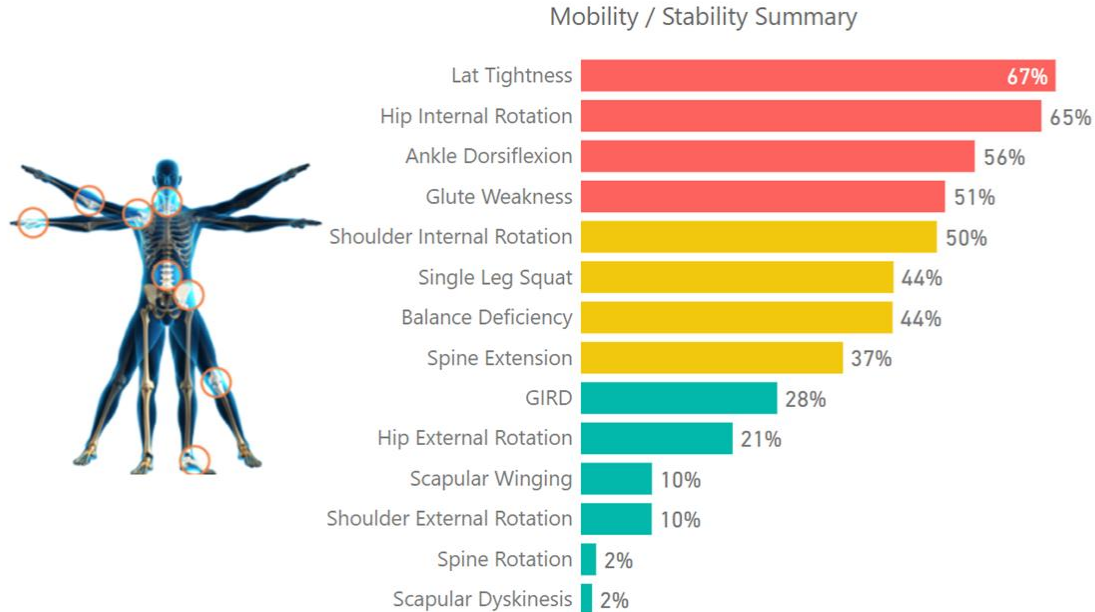


Table Musculoskeletal Exam

13 Additional Movements Evaluated in addition to FMS



Disclaimer

Movement Assessment Tools

- Only the Functional Movement Screen(FMS) and Dari Motion systems are discussed in the following slides.
- There are multiple options for assessing movement
- The selection of these tools was merely the discretion of Ascension Public Safety Medical

Next Generation Movement Assessment

DARI Motion

Customizable protocols from 36 different movements

- 3D Motion Capture
- Full body mechanics
- Sensorless, Contactless
- Full Reporting Suite
- Customizable
- FDA Approved



DARI vs FMS

Specific vs General

- FMS scores only indicate a very general observation of functional movement. It does not necessarily indicate the source.
 - Upon follow up, an individual can score the same, yet truly have improved movement quality that cannot be documented.
- DARI specifically identifies the area of movement dysfunction(which joint)



DARI vs FMS

- DARI evaluates total range of motion in addition to the alignment(quality) of those motions.
- Because DARI utilizes cameras and software to evaluate movement, it is much more reliable and consistent. Interrater reliability is virtually 100%.
- DARI takes much less time to perform with much greater accuracy and includes an extensive list of data points that FMS cannot provide.
- An additional musculoskeletal table exam is also performed, like with the FMS, but with fewer movements due to the fact DARI can identify many of those same issues.
- Cost of equipment is a significant difference. FMS is much more cost-effective and portable.

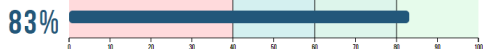
DARI Results



READINESS REVIEW

ALL MOVEMENTS | 5'6" | 120 POUNDS | JULY 15, 2021

OVERALL READINESS



STATUS: OPTIMAL

Your Overall Readiness was in the optimal zone. This means your body performance and quality of movement were exceptional! Your body is moving just how it was designed. Work to maintain your current movement level by concentrating on the focus and priority areas below.

BUILDING YOUR READINESS

QUALITY

77%

Quality ("how you did it") assesses the movement patterns for all movements completed. To improve quality, focus on the following movements:

- Bodyweight Squat
- Shoulder Internal/External Rotation
- Shoulder Horizontal Abduction

PERFORMANCE

90%

Performance ("what you did") assesses squat depth and jump heights/distances for movements completed. To improve your performance score, focus on the following movement:

- Right Lateral Bound

FOCUS & PRIORITY

LEFT ANKLE MOBILITY

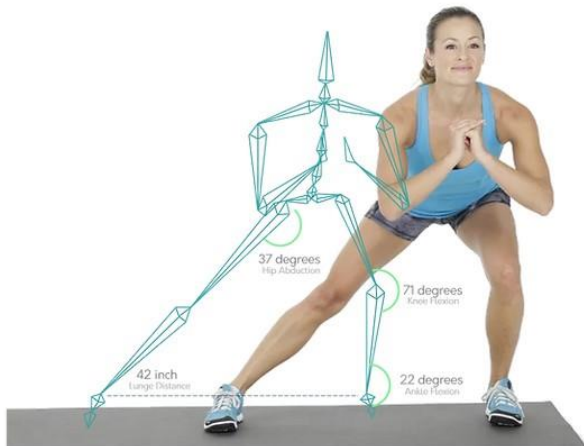
1 Your left ankle had limited flexion (toes moving toward shin) when compared to the right ankle. Decreased ankle mobility restricts lower leg movement during squatting. This could cause pain and limit performance.

LEFT SHOULDER ALIGNMENT

2 Your left shoulder had low alignment during the shoulder movements. Proper control of the musculature around the shoulder blade can help decrease the accessory motion leading to better movement.

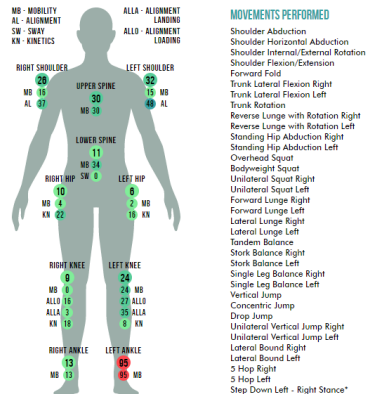
RIGHT SHOULDER ALIGNMENT

3 Your right shoulder had low alignment during the shoulder movements. Proper control of the musculature around the shoulder blade can help decrease the accessory motion leading to better movement.



JOINT VULNERABILITY

ALL MOVEMENTS | 5'6" | 120 POUNDS | JULY 15, 2021



VULNERABILITY

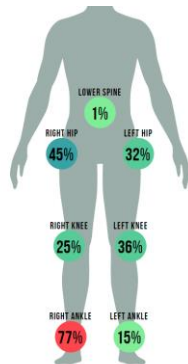
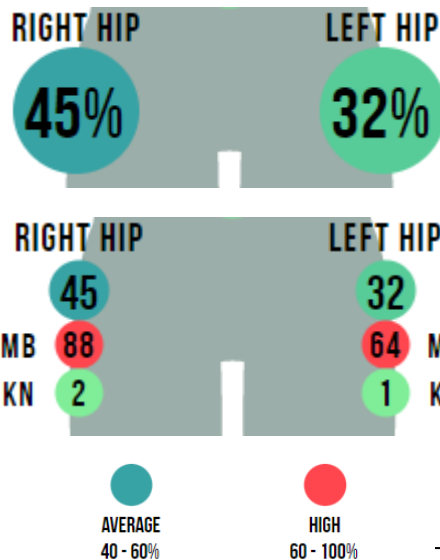
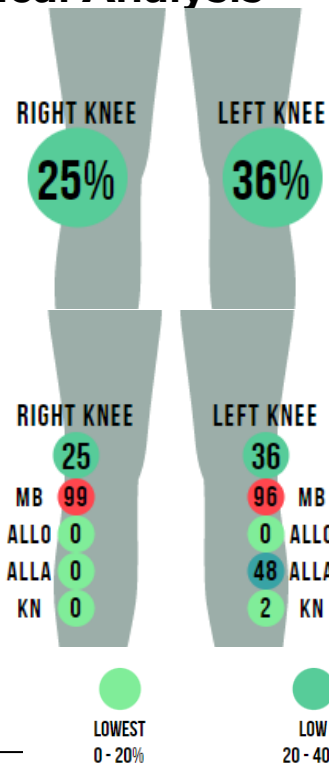


The joint assessment percentage lets you know how that joint performed across all movements completed when compared to the population. The lower the percentage, the better the quality and performance of that joint.



DARI Results

Critical Analysis



BILATERAL SQUAT

MOBILITY

BIOMETRICS	LEFT	% TOTAL	RIGHT	% TOTAL	DELTA
DEPTH	6.3 IN				
HIP	74.7°	43.1%	75.1°	44.8%	0.4°
KNEE	68.2°	39.3%	65.4°	39%	2.8°
ANKLE	30.6°	17.6%	27.2°	16.2%	3.4°
TOTAL	173.4°	---	167.7°	---	5.7°

UNILATERAL SQUAT

MOBILITY

BIOMETRICS	LEFT	% TOTAL	RIGHT	% TOTAL	DELTA
DEPTH	7.5 IN	---	1.8 IN	---	5.8 IN
HIP	93.2°	46.1%	29.9°	32.4%	63.3°
KNEE	70.6°	35%	37°	40%	33.6°
ANKLE	38.2°	18.9%	25.5°	27.6%	12.7°
TOTAL	201.9°	---	92.4°	---	109.5°

What's next?

How do we measure success?

- As first responders return for future physicals, their measurements will be compared to analyze improvements or new dysfunction.
- In conjunction with DARI, a conversion formula was developed so we can compare an individual's FMS score with the new DARI readiness score to gauge changes from one system to another.
- Gathering data from private health insurance as well as worker compensation companies will help us evaluate the anticipated reduction in claims related to injuries and their subsequent rehabilitation.
 - What were FMS/DARI scores of those that suffered non-contact injuries?
 - Can we affect their movement enough to reduce the number of overall injuries(line-of-duty/non line-of-duty)?

What's next?

- Current research addresses DARI ratings and health metrics correlations in general population.

(Cabarkapa, et al. "Relationship Between Health-Related Physical Fitness Parameters and Functional Movement Screening Scores Acquired from Three-Dimensional Markerless Motion Capture System". *Int. J. Environ. Res. and Public Health*. 2022.)

- How do first responders differ from the general population?
 - Do they need to be significantly different/Does their job require a difference?
- Our data indicates the direct correlation of better movement with a higher VO_2 max, lower resting blood pressure, and lower BIA(body composition) as well as an overall increase in other strength and endurance measures(push-ups, pull-ups, side planks, vertical jump)

Additional Health Metrics

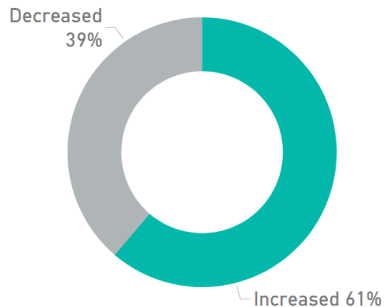
Correlations between movement dysfunction and other health metrics(FMS)

Functional Movement Analysis

(Entire PSM Population 1/1/2020 - 12/31/2022)

Apparatus
□ Engine
□ Ladder

Risk for Injury (FMS <= 14)



Population Averages:

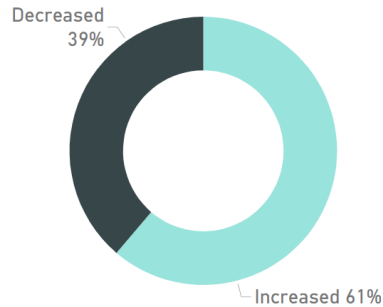
BIA Standard:	28.2
Max VO2:	39.7
Push Ups:	19.1
Resting Systolic BP:	126.4
Resting Diastolic BP:	81.6
Side Plank:	32.0
Vertical Jump:	16.2
Pull Ups:	15.8

Functional Movement Analysis

(Entire PSM Population 1/1/2020 - 12/31/2022)

Apparatus
□ Engine
□ Ladder

Risk for Injury (FMS <= 14)

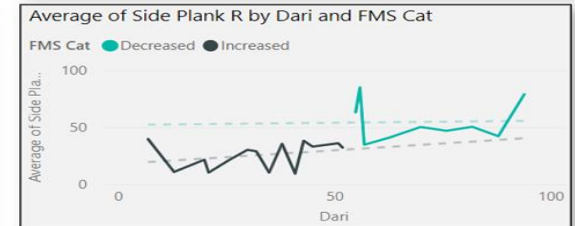
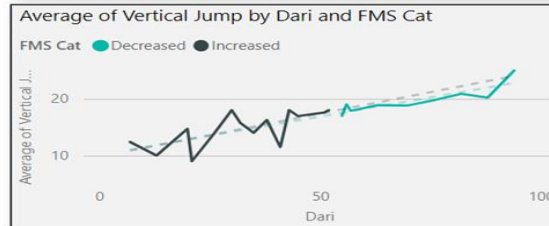
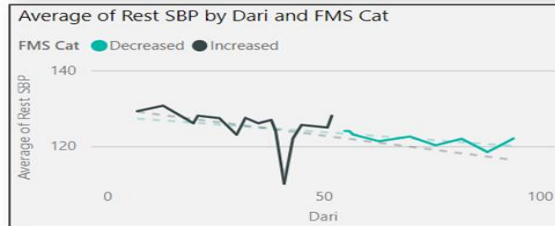
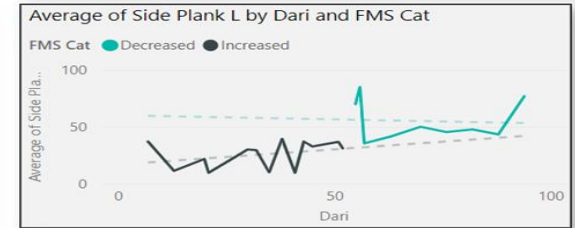
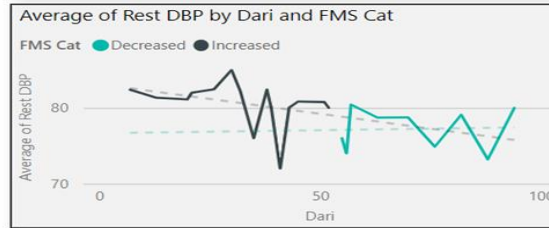
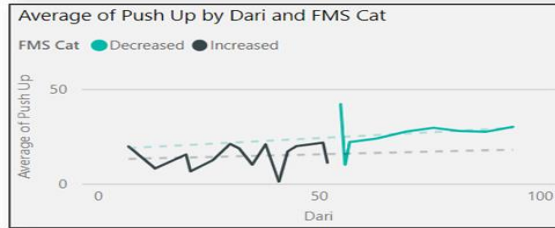
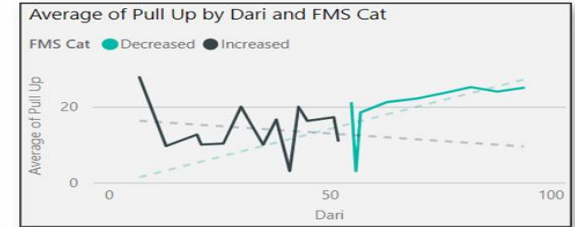
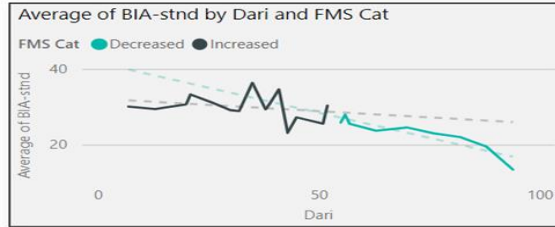


Population Averages:

BIA Standard:	24.2
Max VO2:	43.1
Push Ups:	24.9
Resting Systolic BP:	122.0
Resting Diastolic BP:	78.8
Side Plank:	42.5
Vertical Jump:	18.9
Pull Ups:	21.1

Additional Health Metrics

Correlations between movement dysfunction and other health metrics(DARI)



Advanced Connections

Work Performance Evaluations

- Annual evaluation of a first responder's ability to execute basic essential functions of the job.
 - Obstacle-type course with individual tasks selected by the department.
- What are the functional movements performed in these tasks?
- How can we tie these movements to the movement assessment and the identified dysfunctions?
- How do we compare ideal functional movement and movement required to perform the essential functions of the job?

Advanced Connections

Fit For Duty(FFD) Assessments

- A movement assessment as an applicant/incumbent provides a baseline
- In the event of a significant injury or surgery, a repeat movement assessment can be used to assess how they compare to pre-injury/surgery
- How do we know what % of baseline is adequate for return to work?
 - What do we do with traditional athletes?
- Must perform essential functions of the job (*functional progression*)
 - Perform and pass the WPE again

Finally



In Conclusion.....

- We know poor movement is correlated with an increased risk for injury as well as overall health
 - Which causes which? Does it matter? (Poor movement quality)
- We can provide interventions to address movement dysfunction with the hope of increasing the quality of functional movement, subsequently reducing injury risk and improving overall health
 - Is this program not a success if overall health is not improved, or if injuries do not decline?

Finally



In Conclusion.....

- Department buy-in and inclusion of Peer Fitness Trainers(PFTs),if applicable, is critical for long-term program success (Culture)
 - Must encourage constituent compliance
- Reduction in first responder workplace injuries ultimately provides a safer workplace, safer community, and a significant cost savings from overtime, backfill, and healthcare costs(cost avoidance)

Thank You

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