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Yoga for firefighters: Evaluation of a quality improvement program in California fire departments

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ABSTRACT

Background: Firefighters experience high levels of physical and mental challenges. Yoga interventions have suggested benefits for firefighters.
Methods: This study reports results from a quality improvement assessment at fire departments with a 10-class yoga program. Main outcome is the total score on the Functional Movement Scale (FMS), an observer-based objective performance measure. A score of at least 14 [range 0–20] is considered as protective against injury. Secondary outcome is the score on the Multidimensional Assessment of Interoceptive Awareness (MAIA) questionnaire, a self-report measure for interoceptive bodily awareness as a parameter for a mechanism of action with yoga. We used descriptive statistics and regression analyses.
Results: Both total FMS and MAIA scores improved statistically significantly. The strongest performance improvement was seen in trunk stability. The mean FMS score improved from below 14 to 14 and higher indicating a decrease in the risk for injury. Changes in FMS and MAIA did not appear to be correlated.
Discussion: Despite the limitation of the study design, the findings support the potential benefits from a yoga program for firefighters.

1. Introduction

Firefighters are emergency responders who provide invaluable societal services in a fast-paced manner. They engage in firefighting and related activities for the saving of life and property, administer first responder treatment including first aid, and respond to a variety of emergency situations involving public safety and medical care. They are required to work 24-h shifts, including weekends and holidays(Department, 2021). Firefighting is one of the most dangerous jobs in the US.(Bryant and Harvey, 1996) Firefighters face a number of physical and mental challenges and collectively report more than 58,000 injuries in a year, with about 42% happening at the scene of a fire and the rest happening during events like rescues, vehicle extrications, hazardous materials incidents and, most prevalent, emergency medical calls.(U. S. F. Administration, 2019) The most common injuries include overexertion, strains, sprains, burns, and wounds(Bryant and Harvey, 1996). More than 10,000 incidents per year (17%) required time off, translating to annual cost estimates between $1.6 billion and $8.4 billion(Butry et al., 2018). Approximately 30 percent of first responders develop behavioral health conditions, including depression and PTSD.(S. A. a. M. h. S. Administration, 2018; Bryant and Harvey, 1996; Lebeaut et al., 2020). Almost a quarter suffer from work-related depression with suicidal thoughts, a rate more than double the general population, and nearly half can't stop looking for threats even in their own homes, a common symptom for those who have been exposed to trauma(Carson et al., 2019). However, firefighters often believe getting mental health support could derail their careers(Park et al., 2020).

There is growing interest in exploring ways to optimize the health of firefighters, prevent burnout, increase resilience and to reduce the elevated risks of injury and death. Numerous research studies have shown how mindfulness supports firefighters (Chen

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et al., 2019; Counson et al., 2019; Lebeaut et al., 2020; Lee et al., 2020; Smith et al., 2011; Stanley et al., 2019); however, data regarding how yoga may improve firefighters' outcomes are scarce(Cohen, 2010). Yoga, originating from Indian tradition and widely practiced today in the Western world, denotes a posture-based physical fitness, stress-relief and relaxation technique, consisting largely of mindful movements or postures(Feuerstein, 2001). The practice of yoga has been widely studied for its health benefits with both mental and physical conditions(Elwy et al., 2014; Groessl et al., 2015). As yoga is much more physical than the brief yoga elements within mindfulness activities, such as Mindfulness-Based Stress Reduction, further exploration on how this modality may optimize firefighters' physical and mental health, work performance, and overall quality of life may benefit these emergency responders, their communities, and our society as a whole.

As yoga has been shown to improve stress resilience and body awareness (Park et al., 2020), some fire departments have begun offering this modality to their employees(Cohen, 2010). Due to the high-urgency, physically-taxing nature of their work, improving stress resilience and body awareness may lead to improved performance and/or health (Emerson and Hopper, 2011). In this quality improvement program, we evaluated how offering the manualized program of FireFlex Yoga classes to firefighter emergency responders in the San Francisco Bay Area affects their physical mobility function and their bodily awareness. The study was approved by the Institutional Review Board of the University of California San Francisco (# 19–29367) and classified as a quality improvement project rather than a trial.

2. Methods

2.1. Participants

Participants were a convenient sample of firefighters from 8 fire departments in 5 counties of the San Francisco Bay Area, who were invited to participate in a quality improvement program initiated by their department between September 2018 and December 2019. Those whose work schedule overlapped with the FireFlex yoga sessions were eligible to participate.

2.2. Intervention

FireFlex Yoga is a manualized, structured yoga program developed specifically for firefighters by one of the authors (SMQ) in 2014. Classes consist of 10 h-long sessions that occur on an approximately weekly basis and were designed to address the most common physical and behavioral health challenges firefighters face by providing targeted postures and mindfulness exercises to support functional movement and resilience, and to mitigate stress. FireFlex Yoga trains firefighters to consciously bring awareness to the sensations of the body, gradually increasing the capacity to experience and understand physical sensation (Emerson and Hopper, 2011). Over time, with its focus on the breath and movements coordinated with the breath rhythm, yoga aims at supporting firefighters to build trust in the sensory messages they receive from their bodies. They learn how to adjust to pain sensations, to identify where stress is manifesting, how to calm down, and to notice when it's time to seek support. Developing this kind of bodily sensation-based insight is crucial for modern firefighters, who must manage a highly stressful, often dangerous environment where they are required to perform at optimal physical and mental capacity.

FireFlex classes are conducted by specially trained (see below) yoga instructors and follow a 5-element arc structure: Initiate the Yogic Process, Warm the Body, Create a Pathway to the Peak Pose, Explore the Peak Pose, and Integrate.(Stephens, accessed October 6, 2021) Additionally, classes apply the following general principles: moving from simple to complex; moving into stillness; cultivating energetic balance; integrating the effects of action; and cultivating sustainable self-transformation. Every class concludes with 3–5 min in Savasana or Resting Corpse Pose. The course includes sequences for four movement categories: shoulder and hip mobility, trunk stability and balance. All FireFlex Yoga classes include a combination of breathing practices; mindful meditation techniques, such as body-scan practices; physical postures; and deep relaxation. Mindful meditation practices include the body scan, controlled breathing and breath awareness practices to help first responders increase situational awareness, focus, and concentration; to deescalate stress response; and to boost resiliency.(L. Haase et al., 2015a,b; Haase et al., 2016) Breathing practices, such as controlled slow and deep breathing, are adapted from pranayama, a key element in traditional yoga, which have been used to help manage emotions and regulate stress, as well as increase energy and maintain optimal arousal needed for greater focus and performance(Melnychuk et al., 2018). All sessions took place at the firefighters' particular fire house stations while they were on duty. Participants were encouraged to complete as many of the ten sessions as possible.

FireFlex instructors are yoga teachers who have undergone additional training in a 3-day, 20-h course. The FireFlex yoga training focuses on the role of mind and body practices to address the most common injuries (e.g., strains and sprains), the daily stress of firefighters that can escalate from mundane to life-threatening in moments, and the impact of experiences of trauma. It covers the role of mindfulness and breathing exercises to decrease the impact of chronic stress and to improve self-awareness, and it includes instruction in the assessment tools applied in this study (FMS, MAIA; see below). Assessments allow the instructors to customize the program to fit individual fire departments.

2.3. Measures

The following individual in-person pre- and post-assessments were conducted by FireFlex Yoga instructors before the first yoga session and after completing the final one:

1) the Functional Movement Screen™ (FMS) (Cook et al., 2014; FMS Manual, Functional Movement Screen, 2015): The FMS is an observer-based objective performance assessment tool that captures fundamental movements, motor control within movement patterns, and competence of basic movements uncomplicated by specific skills. It is a tool that is widely used by sports medicine, athletic, and sports associations, and by fitness professionals. The FMS identifies movement dysfunction by grading the quality of movement patterns rather than measuring isolated joint movement and takes about 15 min to administer. Using a 95-page instruction manual and providing precise instructions, the trained observer assesses seven precisely guided movements: Deep Squat, Hurdle Step, Inline Lunge, Shoulder Mobility, Active Straight-Leg Raise, Trunk Stability Push-Up and Rotary Stability. The right shoulder and hip are tested separately from the left to check for asymmetries, as these have been found to increase the likelihood of an injury. The data collected from the FMS screen provide immediate information on the following: (1) pain and location of pain; (2) level of mobility in shoulders, hips, pelvis, and ankles; (3) core and pelvic stability; (4) preference for spinal extension versus spinal flexion; and (5) compensatory movement patterns and motor control.

A score of 1, 2 or 3 is assigned to the best of three movement trials based on observation and exact metric measurements unless the tested individual reports any pain during the test movements. If any of the test movements cause pain the score goes automatically to 0.

Following are two examples for FMS test movements: Trunk stability is assessed with a push-up test. This test is similar to a traditional push-up and is designed to tease out weak links in the anterior core and muscles that support the spine by observing reflexive anterior core stability during an upper body pressing motion. The goal of this test is to assess motor control over the anterior core to inhibit extension and rotation in the core and hips with a push-up movement. During the push-up, the anterior core should prevent excess lumbar extension and spinal rotation: the chest and hips should leave the floor simultaneously. *Rotary stability* is assessed as multi-plane stability in the pelvis, shoulders, and core. This test is done on hands and knees. A perfect score of 3 on each side of the body is given if you are able to start with your knees and thumbs touching a board running lengthwise underneath the body, extend your arm and leg out on the same side, then touch elbow to knee, extend back out, and then touch back down to the floor, maintaining alignment of the body over the board below for the entire movement. A score of 2 is given for being able to extend opposite arm and leg out, touching opposite knee to elbow, and then touching back down to the starting position. A score of 1 is given if a person can only get into the start position but is not able to maintain stability enough to do the movement of opposite arm and leg being raised and extended.

For most of these movement assessments an additional so-called "clearing" test is performed that adds extra strain and potentially provoking pain designed to surface compensatory body mechanics, which many have formed as a result of an injury and/or muscle and joint stiffness. This clearing test is unscored when passed without pain (documented with a "+" sign next to the 1 to 3 functional score) but would bring the score of the main test down to 0 with any pain irrespective of the movement function score. A systematic literature review of 12 studies found a 'moderate' level of evidence in favor of 'acceptable' inter-rater and intra-rater reliability for composite scores derived from live scoring (intraclass correlation coefficient $\geq$0.6)(Moran et al., 2016). The Total FMS is a composite summary score of all partial scores, ranging from 0 to 21. Despite its complexity it is treated here as a continuous variable and is our primary outcome. In 2020, after this study was completed, an updated manual with minor changes was published.

2) Multidimensional Assessment of Interoceptive Awareness (MAIA)(Mehling et al., 2012). The MAIA assesses the capacity for self-regulation, a proxy measure for resilience, such as the ability to deal with distractions, set goals, and manage emotions–key firefighter competencies(Khoury et al., 2018). It is a self-report measure developed to capture changes in interoception associated with mind–body interventions. The MAIA is a 32-item self-report instrument comprised of eight scales: Noticing, Not-Distracting, Not-Worrying, Attention Regulation, Emotional Awareness, Self-Regulation, Body Listening, and Trusting. Participants rated the items on a 6-point Likert scale, with higher scores indicating higher interoceptive awareness. The MAIA assesses regulatory aspects of interoceptive processing and is able to differentiate between clinically relevant attention styles toward bodily symptoms: anxiety and hypervigilance-driven versus acceptance and mindful attention(Bornemann et al., 2014; Mehling, 2016). It has been validated in numerous languages (see https://osher.ucsf.edu/maia/) and shown to have adequate psychometric properties including sensitivity to change(Mehling et al., 2018). The MAIA total score is our co-primary outcome. In addition, we explored differential changes in the eight scales of the multidimensional construct.

2.4. Analyses

We conducted paired *t* tests using Stata 17.1 (StataCorp LLC, College Station, TX, www.stata.com) to compare the pre-post Total FMS and Total MAIA survey results. In addition, for both Total FMS and Total MAIA scores, our key outcomes, we report the scores of the second-order component variables as an exploration into which elements of the total composite summary score are most salient. Pre-post changes in the eight individual MAIA scale scores were analyzed by paired *t* tests. Scores of the individual FMS test parameters were analyzed in a different way, as these are complex composite measures scored between 0 and 3, but with a score of 0 assigned when the participant experiences pain with the movement test and/or associated clearing test movement irrespective of her/his level of physical function, which is otherwise scored between 1 and 3. We treated these individual FMS sub-scores as ordinal variables and report results from the more robust Stuart–Maxwell test.

We used linear regression models to assess for potential associations between pre-post change in Total FMS and change in Total MAIA scores, or baseline values of one on change in the other, and explored potential effects of age, sex and class attendance.

3. Results

$N = 76$ firefighters participated in the study. Mean age was 40.8 ± 9.6 years, with the youngest being 25 and the oldest 63 years old. Seventy (92%) were male and 6 were female. They attended an average of 6.8 ± 2.6 out of 10 classes [observed range 0–11; we included one observation with an add-on class].

The Total FMS score improved during the intervention from a mean score below 14 before classes to a mean score above 14 after classes, which is a clinically meaningful change ($p = 0.0014$; Table 1). All mean FMS sub-scores improved from before to after classes (except inline lunges). The statistically significant improvement in the FMS Total score was driven by significant changes in Trunk Stability, which changed from a baseline mean score of 2.0 to 2.5 after the classes (95% CI: +0.24 to +0.74; $p = 0.0006$; Table 1).

All 8 MAIA scale scores and the total MAIA score improved during the intervention (Table 2). These changes were statistically significant for both the Total MAIA score (our co-primary outcome) and the individual MAIA scales (as exploratory analysis), except for the Non-Distracting and Not-Worrying scales (Table 2).

All twenty participants who had a Total FMS score below 14 at baseline improved their score to above 14 at the end of the class series, representing clinically meaningful improvement. However, a separate group of $n = 5$ participants experienced a decrease from a pre-class score of $\geq$14 to a score below 14 post-class. In regression analyses, changes in Total FMS were not related to changes in Total MAIA ($p = 0.41$), to baseline Total MAIA ($p = 0.81$), sex ($p = 0.97$), age ($p = 0.77$), or attendance ($p = 0.32$). Similarly, changes in Total MAIA scores were not related to baseline Total FMS ($p = 0.19$), age ($p = 0.14$), sex ($p = 0.64$), or attendance ($p = 0.91$).

4. Discussion

Firefighters are at increased risk for on-the-job fatality and injuries, and mental health conditions such as PTSD, depression, and burn-out. The results of our quality improvement study indicate that the firefighters enrolled in these classes improved their overall

Table 1
Functional Movement Scale (FMS) pre (baseline, BL) and post (follow up, FU) scores and mean differences in paired results with 95% Confidence Interval (CI); ($N = 76$).

FMS Scale	BL Mean (SD)	FU Mean (SD)	Mean Diff. (95% CI)	*P*
Deep Squat	1.93 (0.70)	2.04 (0.64)	0.11 (−0.27, 0.06)	0.59
Hurdle Step (incl Clearing Test)	1.93 (0.44)	2.01 (0.42)	0.08 (−0.05, 0.21)	0.66
Inline Lunge (incl Clearing Test)	2.03 (0.43)	1.91 (0.68)	−0.12 (−0.27, 0.04)	0.13
Combined Shoulder Mobility (right + left)	1.84 (0.80)	2.01 (0.84)	0.17 (0.04, 0.31)	0.023
Total Shoulder (incl Clearing Test)	1.54 (1.00)	1.83 (0.97)	0.29 (0.03, 0.55)	0.062
Active Straight-Leg Raise (right + left)	2.00 (0.73)	2.09 (0.68)	0.09 (−0.06, 0.24)	0.36
Trunk Stability Pushup (raw)	2.31 (0.82)	2.65 (0.63)	0.35 (0.13, 0.56)	0.0030
Trunk (incl Clearing Test)	2.03 (1.00)	2.53 (0.88)	0.49 (0.24, 0.74)	0.0006
Combined Rotary Stability (right + left)	1.91 (0.44)	2.03 (0.46)	0.12 (0.01, 0.22)	0.062
Total FMS	**13.43 (2.78)**	**14.30 (2.81)**	**0.87 (0.35, 1.39)**	**0.0014**

[Individual Score Range: 1–3; with pain: 0; Total Score Range: 0–21].
all P values by Stewart Maxwell test, except Total FMS by paired *t*-test.

Table 2
MAIA pre (baseline, BL) and post (follow up, FU) scores, along with estimated mean differences with 95% confidence intervals (CI) and paired *t*-test p-values ($N = 76$). [Individual Scale Range 0–5; Total Scale Range 0–40, giving equal weight to each scale].

MAIA Scale	BL Mean (SD)	FU Mean (SD)	Mean Diff (95% CI)	*P* (*t*-test)
Noticing	3.40 (0.80)	3.83 (0.64)	0.43 (0.24, 0.62)	<0.0001
Non-Distracting	1.95 (0.88)	2.05 (0.93)	0.10 (−0.08, 0.27)	0.26
Not-Worrying	2.84 (0.77)	2.85 (0.73)	0.01 (−0.16, 0.17)	0.93
Attention Regulation	2.87 (0.90)	3.09 (0.61)	0.22 (0.03, 0.41)	0.026
Emotional Awareness	3.41 (0.90)	3.70 (0.72)	0.29 (0.09, 0.50)	0.0050
Self-Regulation	2.822 (1.00)	3.21 (0.81)	0.39 (0.19, 0.58)	0.0002
Body Listening	2.18 (1.05)	2.69 (0.85)	0.51 (0.30, 0.72)	<0.0001
Trusting	3.53 (0.97)	3.81 (0.87)	0.28 (0.11, 0.45)	0.0020
Total MAIA	**23.01 (4.26)**	**25.22 (3.60)**	**2.22 (1.44, 2.99)**	**<0.0001**

performance on the Functional Movement Screen, an objective observer-based functional assessment tool. Although 28% of the participating firefighters decreased their FMS scores (most of them by 1 point) and 18% did not change their score, more than half of them (54%) increased their scores by up to 7 points. Decreased FMS scores were mostly caused by participants reporting pain at follow-up during movement assessments, which decreased the score for specific test movements to 0 disregarding any score for mobility range, even if that may have improved. The statistically significant increase in Total FMS was primarily driven by improvements in trunk stability. Trunk stability is tested with a push-up movement with defined hand positioning (different for men and women) and observation of the form. Thumbs should be aligned with men's foreheads, the trunk should be rigid, and the body pushed up as one unit into push-up position. With an Extension Clearing Test, pressing the upper body up from prone position with maximal back extension, participants receive a "+" sign (uncounted for the total FMS) attached to the push-up trunk stability score, but despite range of motion they are assigned scores of 0 if they report any pain during the push-up or the clearing test. A strong improvement in this test indicates that after yoga either the push-up was performed with better form, that the maximal back extension with its compression of the lumbar facet joints did not provoke pain anymore, or that both of these test elements improved.

In general, FMS scores below 14 have been shown to correlate with a clinically meaningful increase in injury risk(Garrison et al., 2015). The mean total FMS score improved from a mean below 14 at the start, to a mean above 14 at the post-assessment, which is evidence of an overall quality improvement. However, there were individual differences—while 20 firefighters who were below this threshold in FMS score at baseline had final scores above the threshold, another 5 participants with scores of 14 or more at baseline dropped below that level at the end of the program.

The only other study of yoga with firefighters we are aware of is the one by Cohen (2010), which demonstrated similar improvements in FMS scores after an average of only 4 classes attended on-site at the fire station. This was a similar pre-post single-arm study, in which firefighters also improved mean FMS scores from below 14 to above 14. The author did not report in which functional dimension the FMS scores improved.

The results of our study in firefighters confirm prior studies that showed that yoga can improve MAIA scores, but this had not been shown in firefighters before.(Roche et al., 2017) Although the scores for the MAIA scales significantly improved from before to after the yoga classes, against our *a priori* hypothesis that had never been specifically tested before and was based on the expectation that improved body awareness may improve general physical performance as suggested before (Lori Haase et al., 2015a,b), we did not find evidence that changes in FMS were associated with changes in MAIA scores. Test results were not different when using non-parametric Spearman correlations. We are not able to provide a coherent explanation for this lack of association. It should be noted that the FMS scores for individual test movements go automatically down to 0 if participants perceive any level of pain during the movement. A sensitivity analysis among participants without 0-scores did not change the results. The FMS does not assess the levels of self-reported pain intensity associated with the mobility tests. Theoretically, one may wonder whether increased bodily awareness may lead to more reports of mild pain from stretching sensations that occur with movements reaching the functional limits at the ends of the range of motion. Such sensations that firefighters may not have paid attention to before doing yoga may now possibly be more clearly perceived and then labeled as pain. In order to explore this hypothesis in future studies using the FMS, qualitative exit interviews with questions regarding the perception of pain may be useful.

Regarding attendance, 46 of the 76 participants attended at least 7 out of 10 classes, which indicates feasibility of the program and the firefighters' motivation. That the improvement in FMS or MAIA scores was not related to the rate of class attendance is somewhat unexpected. As the number of classes attended was strongly skewed towards higher attendance, we also tested attendance as

ordinal variable in quartiles or median split, which did not change the results. And as neither changes in FMS nor MAIA scores were related to the sex or age of the participants, there is no indication that the intervention would potentially be beneficial for a subgroup of firefighters based on age or sex.

There are several limitations of this study. First, this study lacks a control group, and may have enrolled a non-representative and highly motivated sample of firefighters due to self-selecting into participation. Also, while the main outcome, change in the FMS, is not based on self-report these assessments were conducted by one of the yoga teacher interventionists who was not blind to the intervention. However, the instructions for the FMS assessment do not leave any room for score manipulations, and the findings included pre-post score reductions in 21 firefighters, which would not be expected if assessors were biased. The dismissal of any functional capacity scores when participants report pain of any (unmeasured) and potentially irrelevant intensity is a limitation of the FMS. The MAIA as a self-report questionnaire is sensitive to response bias. For a more rigorous evaluation of the FireFlex Yoga program for firefighters, it would be advisable to have a control group, independent assessors blinded to group assignment and a thorough assessment of the pre-intervention injury history and potential work or off-work injuries during the time of the intervention. Nevertheless, the study findings are encouraging regarding feasibility and acceptance for firefighters despite difficulties and challenges with unpredictable work schedules, an unavoidable element of any emergency response profession, and scheduling conflicts due to other training requirements. Although the study was not set up as an efficacy trial, it provided supportive data for potential quality improvement with injury risk reduction through a yoga intervention and warrants further study.

5. Conclusion

Participation in the 10-class FireFlex yoga program designed for firefighters appeared to improve their observed movement function and self-reported bodily awareness. Although this quality improvement study was conducted without a control group and causal inferences are not possible, improvements were statistically significant and clinically meaningful. As the observed improvements may reduce the risk of injury for firefighters during their high-risk professional activities, further research is warranted. The intervention was well accepted and attended, and the inclusion of evaluative measurements, such as FMS and MAIA, has been demonstrated to be feasible.

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CRediT authorship contribution statement

Erin Floyd: Conceptualization, Methodology, Data curation, Formal analysis, Writing – original draft. **Sonia Rackelmann:** Investigation, Software, Data curation. **Shannon McQuaide:** Conceptualization, Investigation. **Wendy Hartogensis:** Methodology, Formal analysis, Writing – review & editing. **Wolf Mehling:** Conceptualization, Methodology, Formal analysis, Writing – review & editing, Supervision.

Declaration of competing interest

Erin Floyd, PhD, Wendy Hartogensis, PhD, and Wolf Mehling, MD declare no conflict of interests. Shannon McQuaide, MA is the founder and owner of FireFlex Yoga, which is part of Active Wellness, A Healthy Life Company in San Francisco, CA. Sonia Rackelmann is a yoga teacher contracted with FireFlex Yoga.

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