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RESEARCH ARTICLE

A pragmatic strength and conditioning intervention for firefighters: Feasibility of the Tactical Athlete Resilience Program (TARP)

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Abstract

Issue Addressed: Firefighting is physically and mentally taxing and recruits are expected to have optimal health and fitness. However, physical fitness tends to decline following initial training, placing firefighters at an increased risk for stress and injury. Efforts are needed to engage and support firefighters in maintaining adequate health and fitness to withstand the rigorous demands of their occupation. This study examined the feasibility of TARP, a pragmatic strength and conditioning intervention for metropolitan-based firefighters, delivered in collaboration with a professional National Rugby League club.

Methods: A mixed-methods approach was utilised to examine program implementation, recruitment and sample characteristics, intervention satisfaction and acceptability, and participants' response to the intervention. Evaluation measures included field notes taken during steering committee meetings, participant flow data, baseline and follow-up outcome measures, self-report questionnaires, and telephone interviews with a sample of participants.

Results: Participants (N = 113) were predominantly men (82%) with a mean age of 43 ± 9.3 years and BMI of 26.6 ± 2.9 kg/m^2. Program satisfaction was high (95% very satisfied or somewhat satisfied) among program completers (42% retention). Key strengths of the program included delivery through the professional sports club, quality of facilities and equipment, and scheduling flexibility. Future programs should consider incorporating education or training to support behaviour change maintenance and strategies to retain participants at follow-up.

Conclusions: Results provide valuable insights into the design and delivery of interventions for firefighters and demonstrate the importance of strong partnerships between community stakeholders.

KEYWORDS
exercise, firefighters, health promotion, intervention, resistance training, stakeholder engagement

1 | INTRODUCTION

Australian firefighters enter the workforce through a recruitment process bound by physical, tactical, and psychological parameters (eg, psychometric assessments, fitness and medical tests, as well as other merit-based processes). Due to the physicality of entry-level testing, firefighters typically begin employment with an adequate level of strength and endurance to meet the inherent requirements of firefighting. It is expected that they maintain good physical fitness in order to work in the dynamic and unpredictable environments that are commonly associated with the firefighter role.[1,2] However, research indicates that in the years following entry, the physical fitness of firefighters declines, impacting their abilities to respond to the high physical demands of firefighting and leaving them more susceptible to short and long term physical and psychological stress and injury.[3–5] Changes over time that may impact a firefighters' performance have been observed including decreased aerobic capacity, muscle strength, and endurance, all of which have been associated with increased cardiovascular disease risk and decreased job performance.[6–8] In addition, continual exposure to hazardous environments that cause psychological trauma can have long-term detrimental effects on firefighters' mental health, emotional fatigue, employment burnout and post-traumatic distress.[9,10] As such, there has been a call from researchers and fire agencies alike for increased action surrounding the potential benefits of health interventions and training programs which could encourage firefighters to maintain their health and fitness.[2,11,12] Moreover, it is important that these programs consider how to best empower individuals to increase their control over, and improve, their physical and mental well-being.

Finding innovative ways to promote, engage, and support the health and fitness of firefighters can be difficult for fire agencies alone, especially given the dynamic and unpredictable nature of the profession. Borrowing from health promotion research and practice, creating partnerships with relevant community stakeholders can improve engagement in health promotion programs and has the potential to positively impact physical and mental health outcomes.[13–15] For example, The Healthy Eating Activity and Lifestyle (HEAL[16]) program is an Australian lifestyle modification program aimed at improving lifelong healthy eating and physical activity. It was designed and implemented by a collaboration of stakeholders from local government health districts, national health and exercise accreditation organisations, local government councils, and researchers from academic institutions. Process evaluation and feasibility results of the HEAL program indicated that partnerships were vital to the success of local implementation and are necessary to reach and engage community members in preventative health promotion programs.[13] Similarly, the Canadian Harmonization Program[17] was a collaborative effort amongst health professionals, cancer care professionals, academics and community members to advance cancer prevention approaches through smoking cessation, healthy eating and physical activity in rural communities. Like HEAL, they highlighted that these partnerships were integral to engaging and reaching community members. Moreover, they also reported the interventions utilised as part of the Harmonisation program had positive impacts on smoking and physical activity behaviours.[18–20] Although these programs are not specifically centred on firefighters, the learnings reported are highly transferable to programs with similar objectives (eg, improve program uptake and fitness related outcomes), and with a focus on stakeholder collaborations in program design, delivery, and evaluation.

Guided by the success of previous stakeholder partnerships, Fire and Rescue New South Wales (FRNSW; Australia's busiest, and one of the world's largest, state-level urban fire and rescue services), iCare (the workplace insurance and care services agency for New South Wales Government agencies), and the South Sydney Football Club (SSFC; a professional National Rugby League club in Sydney, Australia), collaborated to co-design and develop a health and fitness program for firefighters. Similar stakeholder partnerships (ie, health agencies, community organisations, academic institutions, sporting teams, etc) aimed at developing and delivering health promotion programs have been highlighted in general populations[21,22]; however utilising this approach with firefighters is a new endeavour.

The Tactical Athlete Resilience Program (TARP) was developed as a pragmatic strength and conditioning intervention for metropolitan-based firefighters aimed at improving physical and mental health. Delivered in collaboration with the SSFC, the 10-session program was delivered on site in the club's training facilities and led by professional performance staff (eg, strength and training coaches, physiotherapists), utilising the high-performance sport context as a draw to program participation. To accommodate firefighters varied schedules, participants were given the flexibility to choose from several available options each week and self-nominate the frequency that they attended sessions (eg, weekly, bi-weekly, varied). Up to six participants could register for each session, providing an opportunity for social interaction with other firefighters, often from other stations across the city. Each session lasted approximately 1.5 to 2 hours and included a warm-up (ie, foam rolling, stretching, movement patterns), gym-based exercises (eg, weights, stationary bike), and mobility training (indoors). SSFC coaches utilised participants' baseline measures to create an individually-tailored experience and participants were encouraged to engage in additional, unsupervised sessions outside of the program. While previous initiatives for fire and rescue services have concentrated on physical health and fitness outcomes,[2,6] few studies have explored program feasibility. Understanding the processes of program implementation is necessary to inform future research and support program sustainability and dissemination.[23] Thus, the aim of this study was to determine the feasibility of the

TARP related to program implementation, recruitment and sample characteristics, intervention satisfaction and acceptability, and participants' response to intervention.

2 | METHODS

Program development, delivery, and evaluation were guided by the TARP steering committee, which included organisational stakeholders from FRNSW, SSFC, and iCare, and researchers from the University of Technology Sydney (UTS). The focus of the committee was to define the scope and objectives of the program, to monitor program progress, and provide a forum for feedback and joint decision making across stakeholders. All ethical procedures were approved by the institutional Human Research Ethics Committee (ETH19-3632) and registered with the Australian and New Zealand Clinical Trials Registry (ACTRN12619001116112).

2.1 | Study design

TARP was evaluated using a pre-post quasi-experimental design. Program feasibility was based on evaluation objectives identified by the TARP steering committee and guiding questions for health promotion programs using mixed methods.[24] In line with Orsmond & Cohn (2015), feasibility objectives were operationalised as an evaluation of (1) recruitment capability and sample characteristics, (2) acceptability and suitability of intervention and study procedures, and (3) preliminary evaluation of participant responses to intervention. Data were collected from participants at baseline and post intervention (ie, completion of 10 TARP sessions) including self-reported questionnaires of health-related behaviours and psychosocial outcomes, objective measures of health and fitness, and semi-structured telephone interviews. Process data regarding recruitment, intervention fidelity, and attendance records were obtained from program facilitators.

2.2 | Participants and recruitment

Participants were firefighters (18-65 years) from FRNSW platoons with no history of illness or injury that would contraindicate participation in a strength and conditioning program. Recruitment occurred between August 2019 to March 2020 and September 2020 to April 2021 and was facilitated by FRNSW using a combination of induction events at SSFC and informational emails to targeted stations and crews. Interested individuals were encouraged to contact a member from SSFC and the research team to determine eligibility, register participation, and schedule baseline measurements. To maintain participant confidentiality, FRNSW did not have access to recruitment records or data. All participants provided written informed consent and completed an exercise pre-screening tool (PAR-Q) prior to data collection.

2.3 | Measurements

2.3.1 | Self-report questionnaires

Valid and reliable self-report questionnaires were completed online by participants and emailed to research staff prior to baseline assessments. Psychological well-being was assessed using the single item Cantril ladder.[25] Self-esteem was assessed using the 10-item Rosenberg self-esteem questionnaire.[26] Psychological resilience was assessed using the abbreviated version (2-item) of the Connors-Davidson Resilience Scale.[27] Health related quality of life was assessed using the EuroQoL questionnaire.[28] Overall health was assessed using the EuroQol visual analogue scale.[28] Physical activity was assessed using two previously validated questions relating to the number of days participants engaged in physical activity over the past week and over the past month.[29] Post intervention, questionnaires were completed again at the commencement of the follow-up measurement session and included additional Likert-scale questions to assess program satisfaction and acceptability (eg, *How likely are you to tell other firefighters about the TARP program?*)

2.3.2 | Health and fitness measures

Participants completed a battery of health and fitness measures at baseline and post intervention to determine the feasibility of the assessment protocol, determine effectiveness of recruitment for engaging individuals that would benefit from participating, and to provide an indication of intervention effect. Body weight and height were measured without shoes or heavy clothing using an electronic flat scale to 2 decimal places. Resting systolic and diastolic blood pressure was measured on participant's nondominant arm with a blood pressure monitor (Omron 705-CPII) after sitting at rest for 5 minutes. Grip strength was assessed by maximal isometric hand grip strength using a Harpenden Handheld Dynamometer. Participants completed three alternating attempts per hand and peak values were retained for analysis. The Knee-to-Wall (KTW) test was used to assess ankle mobility and the range of ankle dorsiflexion.[30] The Apley Test was used to assess shoulder mobility, particularly around the glenohumeral joint.[31] The Sit-and-Reach Test (SRT) was used to assess hamstring and lower back flexibility,[32] balance was assessed using the Y-balance Test (YBT[33]), whilst lower body power was assessed using the Standing Broad Jump (ie, farthest of 3 jumps recorded in centimetres). Upper body strength was assessed using the 3RM (3-repetition maximum) bench press (kg). Aerobic capacity was assessed using the 3-Minute Mean Maximal Power cycling test on a Wattbike Pro (Wattbike, Nottingham, UK) and average power output (Watts) was retained for analysis. All measures were collected on site at SSFC by trained performance staff and research assistants using standardised procedures, including a period of familiarisation prior to assessment. Further detail about the health and fitness measures and procedures are available with the TARP evaluation report.[34]

2.3.3 | Follow-up interviews

Post intervention, a sub-sample of participants (50%; n = 24) were invited to participate in a one-on-one telephone interview to gain a deeper understanding of program satisfaction and acceptability. Participants invited to complete an interview were randomly selected following completion of the program. A semi-structured interview guide was developed to explore participants' perceptions and experiences with program implementation, delivery, content, and recommendations for improvement (Appendix A). Interviews were audio recorded and lasted approximately 10 to 20 minutes.

2.3.4 | Field notes and process data

Field notes were taken during TARP steering committee meetings from a member of the research team and any deviations or interruptions in the intervention protocol were recorded. Intervention dose was collected from registration and attendance records kept by SSFC staff.

2.4 | Data analysis

Quantitative data analysis (ie, self-reported questionnaires, health and fitness measures) was performed using IBM SPSS version 25. Descriptive data are reported as mean (SD) and/or percentages where appropriate. Independent *t* tests were conducted to identify potential differences between baseline measures of completers and non-completers. Differences in outcomes from baseline to post intervention were tested using repeated measures ANOVAs and reported with 95% confidence intervals (CIs).

Qualitative data (ie, telephone interviews, field notes) were transcribed and managed using Nvivo 12. For the purposes of feasibility testing, transcribed data were content analysed by one of the researchers (PS) and a trained research assistant (GB). A coding framework was developed inductively using low inference codes to enable a descriptive summary of the data.[35] All transcripts were independently coded by both researchers and regular checks on consistency of coding were conducted. Codes were reviewed for similarities and grouped under the following categories: recruitment and sample characteristics; program implementation and engagement; acceptability and satisfaction; and, participants' responses to intervention. According to best practices,[24] results from the quantitative analysis were integrated with the qualitative findings to provide a rich report of program feasibility.

3 | RESULTS

Results are presented under four topics as they relate to the feasibility of TARP: (1) program implementation; (2) recruitment and sample characteristics; (3) intervention satisfaction and acceptability; and, (4) participants' responses to the intervention.

3.1 | Program implementation

Significant external factors that impacted program delivery included the 2019 to 2020 Australian bushfires, the COVID-19 pandemic, and the 2020 flood events. Notably, public health orders implemented to control the spread of COVID-19 caused a pause in program delivery between April and August 2020. Significant "in-program" learnings and pivots were made, driven primarily through stakeholder collaboration across 5 steering committee meetings. Deviations in the registered trial protocol as a result of these disruptions include an extended recruitment and study period and modified recruitment target from 300 to 100 firefighters. All stakeholders (iCare, SSFC, UTS, FRNSW) agreed there was a clear commitment to adapt and see the program through, particularly through the work of key operational staff in all organisations, and that recruitment and delivery challenges were negotiated through strong community stakeholder collaborations.

3.2 | Recruitment and sample characteristics

Recruitment efforts focused on firefighters within the Metro East and South Commands,[36] encompassing approximately 1449 firefighters within the target catchment area. A total of 129 participants registered for TARP, and 113 completed baseline assessments. Telephone interviews revealed that the most common method of recruitment was by word-of-mouth, and that knowing others that were participating in TARP, and/or hearing positive experiences from past participants, encouraged participants to join. Participants' motivations for program participation varied, yet most reported an interest in getting more active, increasing fitness, and/or improving exercise technique. Potential deterrents to program participation included concerns about the confidentiality of physical measurements and their potential impact on employment, as well as a general lack of confidence, interest, or experience with structured exercise programs.

Participants (N = 113) were predominantly men (82%) and had a mean age of 43 ± 9.3 years, and BMI of 26.6 ± 2.9 kg/m^2 (Table 1). Post intervention, 48 participants completed follow-up measures (43% retention). Differences in baseline characteristics between program completers and non-completers (ie, lost to follow-up) were examined (Table 1). Non-completers were younger (45.7 ± 9.2 vs. 39.5 ± 8.3 years; $P = .002$) and reported a lower initial overall health rating (80.9 ± 8.8 vs. 75.6 ± 12.8; $P = .016$). There were no other differences in participant characteristics or program outcomes at baseline between completers and non-completers.

3.3 | Intervention satisfaction and acceptability

Satisfaction and acceptability were examined using process data (ie, attendance records), a self-report questionnaire (n = 39), and telephone interviews (n = 24) with a subsample of participants. Throughout the 20-month program period, registered participants collectively completed a total of 1,037 supervised sessions, with only 59 recorded

TABLE 1 Baseline characteristics of study participants

	All (N = 113)	Completers (n = 48)	Non-completers (n = 65)	*P* value
Age (years)	43 (9.3)	45.7 (9.2)	39.5 (8.3)	**.002***
Sex (M/F)	93/20	39/9	55/11	—
Height (cm)	176.6 (7.6)	175.1 (7.6)	177.7 (7.3)	.072
Body weight (kg)	82.6 (12.3)	80.9 (12.6)	84.1 (12.0)	.234
BMI (kg/m^2)	26.6 (2.9)	26.5 (3.0)	26.7 (2.8)	.693
SBP (mm Hg)	140 (14)	140 (14)	139 (14)	.720
DBP (mm Hg)	85 (10)	87 (10)	84 (10)	.178
Grip strength R (kg)	49 (9)	49 (9)	50 (8)	.649
Grip strength L (kg)	47 (9)	47 (10)	47 (8)	.946
Perceived wellbeing	6.0 (0.9)	6.1 (0.9)	5.9 (0.9)	.302
Self-esteem	32.8 (4.2)	33.1 (4.2)	32.6 (4.3)	.557
Psychological resilience	6.5 (1.7)	6.8 (1.5)	6.3 (1.8)	.131
Quality of life	0.89 (0.12)	0.90 (0.11)	0.87 (.012)	.177
Health rating	77.7 (11.6)	80.9 (8.8)	75.6 (12.8)	**.016***
Physical activity (days/wk)	4.2 (2.0)	4.6 (1.6)	4.0 (2.2)	.199
Physical activity (days/mo)	17.2 (8.2)	18.6 (6.9)	16.2 (8.8)	.119

Abbreviations: BMI, body mass index; DBP, diastolic blood pressure; L, left; R, right; SBP, systolic blood pressure.
*$P < .05$.

TABLE 2 Program satisfaction and training and lifestyle effects (n = 39)

	Very likely (%)	Somewhat likely (%)	Neutral (%)	Somewhat unlikely (%)	Very unlikely (%)
Tell other firefighters about TARP	87	8	0	0	5
If offered the opportunity, engage in future TARP workshops or programs	87	8	0	0	5
Engage in exercise on a regular basis	85	10	0	3	3
Engage in exercise more often than prior to completing TARP	41	26	23	8	3
Engage in exercise with other firefighters or other people	46	31	8	13	3
Continually make conscious changes to your behaviour to promote a healthy lifestyle	64	26	3	3	5

failures to attend (5.4%). Participants completed an average of 7 ± 3 training sessions, including 71% who completed at least 5 sessions, 53% who completed at least 8 sessions, and 43% who completed all 10 sessions. Among program completers, 95% of participants reported performing additional offsite sessions throughout the program, exercising an average of 3.2 ± 1.6 sessions per week in addition to their participation in TARP. Median time to complete the 10 TARP sessions was 12.6 weeks (range = 7-20 weeks). No adverse events were reported as a result of the intervention or testing procedures.

Participants' self-report questionnaire responses indicated a high level of satisfaction with TARP, with 82% reporting that they were very satisfied, 13% somewhat satisfied, and 5% neutral. None of the participants reported that they were dissatisfied with the program. Table 2 reports participants' likelihood to tell others about TARP and engage in future workshops or programs.

Through the telephone interviews, participants described the program as a straightforward fitness program targeted at strength, cardiovascular endurance, and flexibility. Participants believed that the exercises were relevant to their work and could be tailored to various levels of fitness. Working together in small groups with other firefighters was considered a strength of the program. This social support was perceived to provide accountability, motivation, and comradery. The flexible delivery and number of available sessions were also considered to be a strength of the program. Additionally, most participants identified the benefit of living near to the training facilities and noted that it may be more challenging for colleagues who lived farther away to attend session. Measurement was important as participants appreciated tracking their progress (eg, weight lifted) and seeing changes over time. Finally, the fitness trainers were perceived to be highly knowledgeable, approachable, motivating, and engaging.

TABLE 3 Strengths and recommendations for program improvements

Strengths	Example quote(s)
Free to join	*The fact that it was free, a lot more people would do it. We were very lucky to get it for free. A very good initiative by the uni, souths, and the fire brigade.* – Participant 4
Knowledgeable/experienced trainers	*To have the NRL training staff, and to have access to all of their knowledge is unbelievable… getting more education about specific training was the key to staying motivated and seeing results.* – Participant 10
Partnership with SSFC	*The fact that it's a bit of a reputable program and high-performance trainers and all that sort of stuff, so people like the idea of training with them. Separate from the employer and confidential.* – Participant 13
Easy to schedule training sessions	*They provided multiple times on multiple days and you could just fit it in around your rotating roster and your lifestyle. I thought that worked really well.* – Participant 7
Flexible delivery	*It was good that it was flexible. It wasn't that you have to attend these particular sessions. They offered sessions that you can slot into.* – Participant 15
Working together with other firefighters	*Meeting different people and training with different people from all different ranks, when you're sweating in the gym it doesn't matter if you're a commissioned officer or a firefighter. It was actually a really good social experience as well.* – Participant 22
Small group size	*I think the smaller classes worked well because all those people that hadn't been regularly training. Having the trainer there with less people to look at got more specific guidance where needed. Where you might lose that in the larger class size.* – Participant 18
Facilities and equipment	*It was quite interesting to see what they do there and how they apply their type of training techniques and to see the actual facilities, which were amazing.* – Participant 4
Recommendations	
More personalisation and individualised feedback	*No one sat me down and told me "oh wow you have improved or you really need more work here…your deficiencies lie in this area and this is how it's going to affect you in the long run, so here are some tips on what to do."* – Participant 8
Transition plan post-program	*Admittedly I wasn't too familiar with the nutrition component but I know there's a lot of programs that we can access in terms of exercise and building towards harder training. If there's nutrition options too I'll certainly look into it.* – Participant 1
Follow-up assessments	*Maybe a follow-up assessment or something down the track just to see if you have maintained your levels…if you had an annual or six-monthly test, it would give you inspiration to get back to those figures.* – Participant 4
Continuation of specialised programs	*There'd be a great opportunity to enhance the program as it is sort of an introduction and then look at having possibly a strength and conditioning program, cardiovascular program, even a mindfulness program so meditation or something like that.* – Participant 17

Participants appreciated their reputable experience and qualifications working for SSFC. Commonly identified strengths and recommendations for program improvements are summarised in Table 3 with representative quotes.

3.4 | Participants' responses to the intervention

Data collected from questionnaires, telephone interviews, and health and fitness measures suggested that the intervention had potential to improve a range of study outcomes. During the telephone interviews, participants reported experiencing improvement in strength and flexibility as well as increased exercise frequency and confidence in performing movements properly. Participants also reported an increased knowledge of exercise technique and programming; however, some participants reported a lack of skills, knowledge or uncertainty in how to continue making lifestyle changes post-program. Some participants reported that they had incorporated the techniques and exercises they had learned into their existing training regime and/or increased the amount of exercise they were engaged in. Although many of the participants reported that they regularly engaged in exercise prior to joining TARP, their participation refreshed or expanded their understanding of exercise programming and movements. This was further supported by questionnaire data, which indicated most participants were confident that they could continue to engage in physical activity and make healthy lifestyle changes (Table 2). Finally, the intervention showed potential to improve several health and fitness outcomes, with the greatest observed changes in self-esteem (1.8, 95% CI = 0.8-2.7, $P < .001$, $d = 0.57$), flexibility (2.3 cm, 95% CI = 1.3-3.3, $P = .001$, $d = 0.68$), Y balance R (7.2%, 95% CI = 5-9.5, $P < .001$, $d = 0.99$), Y balance L (7.9%, 95% CI = 5.6-10.2, $P < .001$, $d = 1.06$), broad jump (9.3 cm, 95% CI = 5.9-12.7, $P < .001$, $d = 0.80$), bench press (7.2 kg, 95% CI = 5.4-9.1, $P < .001$, $d = 1.17$), and mean maximal power (25.6 W, 95% CI = 18.6-32.7, $P < .001$, $d = 1.06$). Changes in health and fitness measures of program completers are reported in Table 4.

4 | DISCUSSION

Firefighting is physically and mentally taxing and requires optimal health and fitness for safe and effective work – factors that tend to

TABLE 4 Changes in health and fitness measures for program completers (n = 48)

	Baseline Mean (SD)	Post score Mean (SD)	Difference Mean (95% CI)	*P* value (ES)
BMI (kg/m^2)	26.5 (3.0)	26.5 (3.1)	0 (−0.2, 0.1)	.892 (0.02)
Body weight (kg)	80.9 (12.6)	80.8 (12.5)	−0.1 (−0.5, 0.4)	.825 (0.04)
Perceived wellbeing	6.1 (0.9)	6.5 (1.1)	0.3 (0, 0.8)	**.029 (0.34)***
Self-esteem	33.1 (4.2)	34.8 (4.4)	1.8 (0.8, 2.7)	**<.001 (0.57)***
Psychological resilience	6.8 (1.5)	7.1 (1.1)	0.1 (−0.2, 0.3)	.486 (0.10)
Quality of life	0.90 (0.11)	0.91 (.10)	0 (0, 0)	.999 (0.00)
Health rating	80.9 (8.8)	83.9 (9.3)	2.9 (1, 5.7)	**.041 (0.31)***
Physical activity (d/wk)	4.6 (1.6)	4.6 (1.5)	.1 (−0.3, 0.5)	.614 (−0.08)
Physical activity (d/mo)	18.6 (6.9)	19.3 (7.2)	0.9 (−1.1, 2.8)	.368 (0.14)
SBP (mm Hg)	140 (14)	135 (15)	−5.4 (−10.0, −0.8)	**.022 (0.35)***
DBP (mm Hg)	87 (10)	84 (10)	−2.6 (−5.5, 0.3)	.080 (0.26)
Grip strength R (kg)	49 (9)	50 (10)	1.5 (−0.4, 3.3)	.116 (0.24)
Grip strength L (kg)	47 (10)	47 (11)	0 (−1.8, 1.8)	.995 (0.00)
KTW R (cm)	12.2 (3.2)	12.8 (3.1)	.6 (0.1, 1.1)	**.020 (0.36)***
KTW L (cm)	12.2 (2.9)	12.5 (2.9)	.3 (−0.1, 0.7)	.133 (0.23)
Apley test R (cm)	13.1 (7.7)	12.2 (7.0)	−.9 (−2.3, 0.4)	.167 (0.20)
Apley test L (cm)	16.4 (8.2)	15.4 (9.1)	−1.0 (−2.6, 0.5)	.184 (0.20)
Sit and reach (cm)	7.8 (12.3)	10.1 (12.2)	2.3, (1.3, 3.3)	**.001 (0.68)***
Y balance R (%)	84 (11)	91 (10)	7.2 (5, 9.5)	**<.001 (0.99)***
Y balance L (%)	84 (12)	92 (10)	7.9 (5.6, 10.2)	**<.001 (1.06)***
Broad jump (cm)	189 (27)	198 (27)	9.3 (5.9, 12.7)	**<.001 (0.80)***
Bench press (kg)	70 (20)	77 (21)	7.2 (5.4, 9.1)	**<.001 (1.17)***
3-minute MMP cycling (W)	254 (48)	280 (51)	25.6 (18.6, 32.7)	**<.001 (1.06)***

Abbreviations: BMI, body mass index; CI, confidence intervals; DBP, diastolic blood pressure; KTW, knee-to-wall test; L, left; MMP, mean maximal power; R, right; SBP, systolic blood pressure.
Note: Significantly different from baseline (*P < .05).

decline after recruitment.[37] Previous studies have demonstrated the potential for exercise interventions to improve outcomes of health and fitness among firefighters[2,6]; however, less is known about the feasibility of implementing these interventions in the real world. Feasibility studies can provide valuable insight into the process of development and implementation of interventions and are needed to better address challenges related to engaging firefighters in health promotion programs (eg, shift system, varied schedules). The present study examined the feasibility of TARP, a pragmatic strength and conditioning intervention for metropolitan-based firefighters delivered in collaboration with the SSFC. Our findings provide direction for program refinement as well as consideration for the design and delivery of interventions aimed at increasing the health and well-being of firefighters.

It is important for programs to engage participants that would benefit most from making healthy lifestyle changes, as poor health and fitness may impact firefighters' ability to respond to the high physical demands, leaving them more susceptible to physical injury.[3] In this regard, the characteristics of participants that underwent baseline testing suggests that recruitment was effective at engaging with firefighters that varied in age (23-66 years) and weight status (20.3-34.3 BMI kg/m^2). The relatively high proportion of men (82%) is in line with that of the overall FRNSW firefighting staff (89%[38]). Participants reported several strengths of the program that may have supported engagement, notably the high-performance training environment and staff, schedule flexibility, and small peer-group setting. Community collaborations in particular, such as the partnership with SSFC, have been shown to improve engagement with exercise interventions[39] and are valuable in recruiting and retaining participants. These qualitative assessments support the feasibility of the intervention and have been previously utilised in effective interventions for firefighters[6] as well as healthy adult populations.[40] For example, social support provided in group training from trainers and other exercise participants may increase program adherence, quality of life, and social interaction.[41]

Program adherence (43%) was found to be lower than previous studies involving firefighters (50%-83%).[6] Reasons for low participant retention may be related to program design and delivery and/or external factors such as program interruptions due to COVID-19. In particular, the program was interrupted by two major environmental events (bushfires and floods) and the COVID-19 pandemic. Specifically, the 2019 to 2020 Australian bushfires resulted in the largest number of

deployed firefighters in Australian history, with over 5700 firefighters in New South Wales deployed between October 2019 and February 2020.[42] These program interruptions presented serval logistical challenges including cancelled training sessions and delays in individual program completions. Further, during the COVID-19 pandemic, the program was paused for 6 months, which likely impacted participant recruitment, retention, and satisfaction. Given the high satisfaction rating (95% satisfied; 5% neutral) by participants that completed follow-up measures, it is possible that adherence rates without these disruptions would have approached levels more in line with those reported in previous interventions. However, it can be reasonably anticipated that similar environmental or global events will continue to occur in the future, highlighting the importance of flexibility, resiliency, and creativity from researchers, stakeholders, and participants alike. In the present study, strong cross-sectoral collaboration and community partnerships likely contributed to the continued delivery of the program following these disruptions.[43] However, additional strategies (eg, incentivisation) may be required to encourage more participants to complete follow-up measures. Future research is needed to better understand the factors that contribute to low adherence and dropout.

As a real-world trial, the intervention delivery was adapted by facilitators and focused primarily on the delivering of a gym-based exercise program. Although originally more behaviour change strategies and personalisation were planned, the delivery did not include this aspect. While this was not identified by the Steering Committee, this may be due to program interruptions, a lack of resourcing, or non-engagement from participants. Introducing participants to a "toolbox" of behaviour change techniques (eg, setting and reviewing goals, action planning, self-monitoring, and information about health and emotional consequences of change) may encourage internalised and self-relevant motivation for the maintenance of health behaviours[44] and support program adherence and retention. Behaviour change theories (eg, Social Cognitive Theory[45]) have been utilised previously in interventions targeted at firefighters[2] and may help to inform the implementation of these techniques. Given participants reported a lack of skills/knowledge or uncertainty in how to continue making lifestyle changes post-program, these techniques would likely be beneficial in future programs. To support performance staff, additional training or guidance may also be needed to effectively incorporate these aspects of the program, as well as appropriate resourcing to effectively deliver it.

While it was not an outcome of this feasibility study nor is it appropriate to assume intervention effectiveness, it is relevant to consider if the intervention shows promise of being successful with the intended population. For feasibility studies, it has been suggested that researchers use a combination of quantitative and qualitative methods to assess if an intervention shows promise of being successful with the intended population.[24] Results from participants' interviews, survey questions, and physical outcome measures suggest the potential for several desirable improvements in modifiable risk factors, performance, and self-perception. Among program completers, participants demonstrated changes in blood pressure, unilateral leg balance, and hamstring/lower back and right ankle flexibility. Changes in upper-body strength, lower-body power, and maximal-effort work capacity were also observed, aligning with previous exercise interventions in firefighters (see Andrews, Gallagher[6] for review). Furthermore, participants reported higher perceived wellbeing and self-esteem, which highlights the potential for psychosocial benefits of training interventions. These improvements, if reproducible with an adequately-powered effectiveness study, may translate to a reduced risk of cardiovascular disease,[7,12,46] musculoskeletal injury,[47] improved overall work performance,[48] and resilience to physiological and psychological stressors and fatigue encountered during firefighting duties.[47]

Limitations of this research must be acknowledged. First, the large loss to follow-up and lack of associated data (eg, motivators/barriers to participation, reasons for dropout) limit our ability to identify potential issues with the program's design and delivery and confidently determine feasibility and acceptability. While this may have introduced a source of attrition bias, post-hoc analysis showed few differences in baseline measures between program completers and those lost to follow-up. Regardless, future research may need to account for this loss by implementing strategies that encourage participants to complete follow-up measures or allow greater flexibility in measurement schedules. Second, findings from the present study are drawn from a single urban location amid major national and international crises and may not be generalisable to other settings or contexts. These promising findings point to a need to further explore the potential for this type of program to improve firefighters' health and well-being. Future research is needed to examine the effectiveness of TARP through a fully powered randomised control trial.

5 | CONCLUSION

Understanding program feasibility is necessary to support the sustainability and dissemination of initiatives. The present study provides valuable insights into the design and delivery of interventions for firefighters. A strength of this intervention was the pragmatic delivery of a flexible training program to an active-duty workforce through the collaborative partnership of community stakeholders. In particular, delivering interventions for firefighters in collaboration with a professional sports club offers unique opportunities for recruitment and allowed firefighters to participate in an independently delivered program with the support of their employer. The sustainability and scalability of TARP, as with similar interventions, is dependent on several factors including the availability of strategic partnerships as well as the extent to which stakeholders see value (eg, reducing injury claims) in maintaining these partnerships. Strong collaborations between stakeholders such as these are critical to the development of robust and sustainable interventions.

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CONFLICT OF INTEREST

Billy Hulin and Jarrod Wade were employed by the South Sydney Rabbitohs Rugby League Football Club. Brendan Mott and Mark Gabriel were employed by Fire and Rescue NSW. Data collection, analysis, and interpretation were exclusively conducted by researchers at the University of Technology Sydney and these authors did not have access to participant data. All other authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

ETHICS STATEMENT

Ethical approval for this research was provided by the University of Technology Sydney Human Research Ethics Committee (ETH19-3632).

PATIENT CONSENT

All participates agreed to the publication of research findings in scientific journals.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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