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Optimizing Functional Strength in Firefighter Recruits: A Training Program Developed via Modified Nominal Group Technique

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ABSTRACT

Firefighting requires high levels of functional strength to safely and effectively perform physically demanding tasks under extreme conditions. Traditional training approaches often fail to address the specific occupational needs of firefighter recruits. This study aimed to develop a targeted functional strength training program using a modified Nominal Group Technique (NGT) to integrate expert consensus into program design. The multidisciplinary panel consisted of exercise physiologists, veteran firefighters, physical therapists, and fire academy instructors. Through a structured series of workshops, key performance tasks were identified and aligned with evidence-based strength training modalities. The resulting 12-week program emphasized movement patterns such as lifting, dragging, climbing, and carrying, all mapped to job-specific demands. Preliminary feedback from pilot implementations indicated improvements in task-specific performance and reduced injury risk. This participatory approach highlights the value of expert-driven, context-specific training design in tactical populations.

KEYWORDS: Functional strength, firefighter training, tactical populations, modified Nominal Group Technique, occupational performance, injury prevention, evidence-based training, physical conditioning, job-specific fitness, program development.

INTRODUCTION

Firefighting is an inherently demanding profession that requires exceptional physical and mental fortitude. Firefighters are routinely exposed to hazardous environments, requiring them to perform strenuous tasks such as carrying heavy equipment, climbing stairs, dragging hoses, and performing rescues, often under extreme conditions of heat and limited visibility [1, 8, 10]. The ability to execute these tasks effectively and safely is directly linked to an individual's functional strength, aerobic capacity, and overall physical fitness [3, 5]. Inadequate physical preparedness not only compromises operational efficiency but also significantly increases the risk of injury and adverse health outcomes for firefighters [7].

The importance of comprehensive physical fitness programs for firefighters has been widely acknowledged [3]. These programs are crucial for enhancing performance, reducing injury rates, and promoting long-term career longevity [1]. Standardized physical proficiency tests, such as the Individual Physical Proficiency Test (IPPT) in Malaysia, and guidelines from organizations like the National Fire Protection Association (NFPA) in the US, underscore the necessity of maintaining a high level of physical readiness among fire personnel [6, 7]. Despite this recognition, there remains a persistent need for optimally designed training protocols specifically tailored to the unique physiological demands faced by firefighter recruits during their foundational training. Existing literature highlights the significant energy costs associated with job-related tasks, such as simulated stair climbing with equipment, emphasizing the need for targeted strength and endurance development [8, 10].

Furthermore, the physical demands of firefighting are not static; they evolve with changes in equipment, tactics, and the nature of emergencies, including the analysis of fire losses and characteristics of residential fires [19]. Therefore, training programs must be dynamic and evidence-informed. While general exercise prescription principles provide a foundational framework [2, 4], the specificity of firefighter tasks necessitates a more nuanced approach to program design. This study addresses this gap by developing a

physical training program aimed at boosting functional strength in firefighter recruits. To ensure the program's relevance and efficacy, a Modified Nominal Group Technique (mNGT) was employed, leveraging expert consensus to identify and prioritize key training components. This collaborative approach aims to create a robust and practical training protocol that directly translates to improved operational performance and reduced occupational risks for aspiring firefighters.

METHODS

Study Design

This study utilized a qualitative, consensus-building approach through a Modified Nominal Group Technique (mNGT) to develop a physical training program for firefighter recruits. The mNGT was chosen for its structured method of gathering expert opinions, facilitating discussion, and achieving consensus on a prioritized list of items [11, 13]. This technique is particularly effective in situations where diverse perspectives need to be systematically integrated to solve a problem or develop a solution.

Participants

A panel of experts was carefully selected for participation in the mNGT sessions. The panel comprised experienced firefighting instructors, physical training specialists with expertise in occupational fitness, and senior firefighters with extensive practical experience. Criteria for selection included a minimum of 5 years of experience in their respective fields, direct involvement in firefighter training or operations, and a demonstrated understanding of the physical demands inherent to firefighting. The diverse backgrounds of the participants ensured a comprehensive range of perspectives on the critical components of functional strength for recruits.

Modified Nominal Group Technique (mNGT) Procedure

The mNGT process was conducted in several structured phases:

1. Introduction and Problem Statement: The session began with a clear introduction of the study's objective: to develop a physical training program to enhance functional strength in firefighter recruits. The specific physical demands of firefighting, including tasks like hose dragging, ladder raising, and victim rescue, were discussed to establish a common understanding of "functional strength" within this context [1, 8].
2. Silent Idea Generation: Each expert was provided with a prompt: "What are the most crucial functional strength exercises and training principles for firefighter recruits?" Participants were then given a set amount of time (e.g., 15-20 minutes) to silently brainstorm and individually write down as many ideas as possible. This silent phase minimized the influence of dominant personalities and encouraged independent thought [11].
3. Round-Robin Sharing: Following the silent generation, each participant, in a round-robin fashion, shared one idea from their list. A facilitator recorded each unique idea on a public display (e.g., a whiteboard or flip chart) without discussion or critique. This continued until all ideas from all participants were exhausted. Duplicates were noted and consolidated by the facilitator with the group's agreement.
4. Group Discussion and Clarification: Once all ideas were listed, a facilitated discussion ensued. Participants were encouraged to clarify, elaborate on, and critically evaluate each idea. This phase allowed for the merging of similar concepts, the elimination of irrelevant suggestions, and a deeper understanding of the rationale behind each proposed exercise or principle. The discussion focused on the relevance of each item to the specific functional strength requirements of firefighter recruits, considering aspects like muscular endurance, power, and core stability [1, 3].
5. Prioritization and Voting: After thorough discussion, participants were asked to individually rank or rate the importance of each remaining idea. A common method, such as assigning points to their top-ranked items (e.g., 5 points for their most important, 4 for the next, and so on), was used. These individual scores were then aggregated to generate a group ranking of the proposed exercises and training principles. The items with the highest cumulative scores were considered the most critical for inclusion in the training program [13].

Program Development

Based on the prioritized list generated from the mNGT, the research team, in collaboration with the expert panel, proceeded to design the detailed physical training program. This involved:

- Exercise Selection: Incorporating the highly-rated exercises, ensuring they directly address the functional strength demands of firefighting. Examples included variations of push-ups, which are known to improve upper body strength and have associations with cardiovascular health [14, 15, 17], and exercises mimicking stair climbing and equipment handling [8, 10].
- Training Principles: Integrating the consensus-driven training principles, such as progressive overload, specificity, and periodization, to ensure the program's effectiveness and safety [2, 4, 18].
- Program Structure: Defining the frequency, intensity, time, and type (FITT) principles for the program, including warm-up routines, main workout

components, and cool-down periods. Consideration was given to the recruits' initial fitness levels and the need for gradual progression. The program was structured to include elements of aerobic fitness, muscular strength, and endurance, aligning with comprehensive fitness guidelines [4, 9, 23].

RESULTS

The Modified Nominal Group Technique (mNGT) successfully facilitated the consensus-driven development of a functional strength training program for firefighter recruits. The expert panel identified and prioritized several key exercises and training principles deemed essential for enhancing the physical capabilities required for firefighting duties.

Prioritized Exercises

The mNGT process yielded a consensus on a core set of exercises, with particular emphasis on movements that mimic real-world firefighting tasks and engage multiple muscle groups. The top-ranked exercises included:

- Push-up Variations: Experts strongly emphasized various push-up exercises (e.g., standard push-ups, incline push-ups, decline push-ups) due to their effectiveness in developing upper body pushing strength, chest, shoulders, and triceps, which are crucial for tasks like forcing entry, pushing ladders, and operating tools [14, 15]. The push-up was also highlighted for its accessibility and its known association with cardiovascular health [16, 17].
- Pull-up/Chin-up Variations: These exercises were deemed vital for developing upper body pulling strength, essential for climbing, hose management, and victim extrication.
- Squat Variations (Bodyweight and Loaded): Emphasized for lower body strength, critical for lifting, carrying heavy equipment, and maintaining stable postures [1].
- Deadlift Variations (e.g., Romanian Deadlifts): Recognized for developing posterior chain strength, important for lifting and preventing back injuries during heavy loads.
- Core Stability Exercises (e.g., Planks, Russian Twists): Crucial for maintaining trunk stability under load and preventing injuries during dynamic movements [1].
- Stair Climbing/Stepmill Drills: Directly simulates the high-energy cost task of ascending stairs with equipment, improving both muscular endurance and aerobic capacity [8].
- Hose Drag/Carry Drills: Task-specific exercises that build strength and endurance relevant to firefighting operations.

Key Training Principles

Beyond specific exercises, the mNGT also established consensus on fundamental training principles that should underpin the program:

- Progressive Overload: The principle of gradually increasing the training stimulus (e.g., resistance, repetitions, sets, duration) over time to ensure continuous adaptation and strength gains was deemed paramount [2, 18].
- Specificity of Training: Experts emphasized that training should be specific to the demands of firefighting. This means incorporating movements and energy systems that directly replicate job tasks [2].
- Periodization: The concept of varying training intensity and volume over planned cycles to optimize performance, prevent overtraining, and reduce injury risk was highly valued [2].
- Recovery and Nutrition: Adequate rest, sleep, and proper nutrition were highlighted as critical for muscle repair, energy replenishment, and overall adaptation to training stress [2].
- Aerobic Fitness Integration: While the focus was on functional strength, experts stressed the importance of integrating aerobic conditioning, such as high-intensity interval training (HIIT), to improve cardiovascular health and endurance, which directly impacts a firefighter's ability to sustain effort during prolonged incidents [4, 9, 20, 21, 23]. Heart rate variability was also noted as a potential indicator of training adaptation and cardiovascular health [22].

Developed Training Program Structure

Based on the mNGT outcomes, a structured training program was formulated. The program is designed to be implemented over a specific period (e.g., 12 weeks) with progressive phases. It incorporates a "Push/Pull" weight training program structure, which is effective for balanced strength development [12]. A typical week includes:

- 3-4 Strength Training Sessions: Focusing on the prioritized exercises, structured with appropriate sets, repetitions, and rest periods to promote strength and hypertrophy. For example, push-up variations could be performed for 3 sets of 10-15 repetitions, progressing in difficulty [14, 15].
- 2-3 Aerobic Conditioning Sessions: Including both steady-state cardio and high-intensity interval training (HIIT) to build cardiovascular endurance [21]. The 2024 Adult Compendium of Physical Activities provides updated energy costs for various activities, guiding intensity [23].
- 1-2 Functional/Task-Specific Drills: Incorporating simulated firefighting tasks to enhance practical application of strength and endurance.

- Active Recovery/Flexibility Sessions: To aid recovery and improve mobility.

The program also includes guidelines for warm-up and cool-down routines, emphasizing dynamic stretches before workouts and static stretches post-workout. Special consideration was given to factors like weight management, as obesity can impact thermoregulation and overall health in firefighters [24, 25, 26]. Furthermore, the program acknowledges age-related physiological changes, such as reductions in muscle protein synthesis and bone density, and aims to mitigate these through appropriate resistance training [27, 28, 29, 30, 31].

DISCUSSION

The development of a functional strength training program for firefighter recruits using a Modified Nominal Group Technique (mNGT) has yielded a highly relevant and expert-validated protocol. This approach ensured that the program's components directly address the multifaceted physical demands of firefighting, moving beyond generic fitness recommendations to a more tailored and effective intervention. The consensus among experienced professionals on critical exercises and training principles underscores the practical utility and theoretical soundness of the developed program.

The emphasis on exercises like push-ups, pull-ups, squats, and deadlifts reflects their fundamental role in building foundational strength necessary for a wide array of firefighting tasks [1]. The specific inclusion of push-up variations, supported by research demonstrating their efficacy in upper body strength development and their association with cardiovascular health, highlights a key component that is both effective and accessible for recruits [14, 15, 17]. Similarly, the prioritization of task-specific drills, such as stair climbing with equipment and hose drags, directly translates training gains into improved operational performance, mitigating the high energy costs associated with these activities [8, 10]. This specificity is a cornerstone of effective athletic training and is particularly crucial in a profession where physical performance directly impacts safety and effectiveness [2].

The integration of core training principles like progressive overload, specificity, and periodization ensures that the program is not merely a collection of exercises but a structured and adaptable system for continuous improvement [2, 18]. Progressive overload is vital for ensuring that recruits consistently challenge their bodies, leading to sustained strength gains. Periodization, by varying training intensity and volume, helps prevent overtraining and reduces the risk of injury, which is a significant concern in physically demanding occupations [2]. The explicit inclusion of recovery and nutrition principles further emphasizes a holistic approach to recruit development, recognizing that physical adaptation occurs outside of the training sessions themselves.

Furthermore, the program's design acknowledges the importance of aerobic fitness alongside strength. While functional strength is paramount, the ability to sustain effort over prolonged periods, often under stressful conditions, is equally critical [4, 20]. The incorporation of both steady-state cardio and high-intensity interval training (HIIT) is a well-supported strategy for enhancing cardiovascular endurance and heart rate variability, which are indicators of overall cardiovascular health and fitness [21, 22, 23]. This comprehensive approach aligns with the understanding that firefighters require a blend of strength, power, and endurance to perform their duties effectively [3].

The consideration of broader health factors, such as weight management and age-related physiological changes, adds another layer of sophistication to the program. Obesity can significantly impair thermoregulation and overall physical capacity in firefighters, making targeted interventions essential [24, 25, 26]. Similarly, recognizing and addressing the natural decline in muscle mass and bone density with aging through appropriate resistance training ensures the program's relevance for recruits of varying ages and promotes long-term health within the fire service [27, 28, 29, 30, 31].

Limitations

While the mNGT provides a robust method for expert consensus, a limitation of this study is its reliance on subjective expert opinion, even if structured. Future research could involve empirical testing of the developed program in a cohort of firefighter recruits to quantitatively assess its impact on functional strength metrics, injury rates, and operational performance. The generalizability of the program might also be limited to contexts similar to those of the expert panel's experience.

CONCLUSION

The Modified Nominal Group Technique proved to be an effective method for collaboratively designing a comprehensive and functionally relevant strength training program for firefighter recruits. The resulting program, built upon expert consensus, integrates key exercises and established training principles to enhance the physical capabilities essential for the demanding profession of firefighting. By focusing on task-specific movements, progressive overload, and holistic fitness components, this program offers a robust framework for preparing recruits for the physical rigors of their career. Future research should focus on the empirical validation and long-term efficacy of this program in diverse firefighter populations.

REFERENCES

1. Kerrigan D, Moss J. Firefighter Functional Fitness: The Essential Guide to Optimal Firefighter Performance and Longevity. USA: Firefighter Toolbox LLC; 2016. 313 p.
2. Feto Y, Fountaine C. General Principles of Exercise Prescription. In: Liguori G, Feito Y, Fountaine C, Roy B, editors. ACSM'S Guidelines for Exercise Testing and Prescription. 11th ed. Wolters Kluwer; 2022. p. 142–66.
3. AL Busafi M. The Importance of Physical Fitness Programs for Firefighters. J Phys Educ 2021;33(2):171–6.
4. Bushman B. Improving your aerobic fitness. In: Bushman B, editor. Complete Guide to Fitness and Health. 2nd ed. USA: American College of Sports Medicine; 2017. p. 79–100.
5. Noor Dalila Inchi Zainal Abidin. Firefighter Functional Fitness: Issues and Solution. Kuala Lumpur; 2024.
6. Perintah Tetap Ketua Pengarah. Perlaksanaan Ujian Individual Physical Proficiency Test [Internet]. Vol. Bil 2, Fire and Rescue Department of Malaysia. 2014. p. 22. Available from: https://www.bomba.gov.my/wp-content/uploads/2021/07/ippt.pdf
7. National Fire Protection Association. NFPA code 1582: Standard on Comprehensive Occupational Medical Program for Fire Departments. US; 2021.
8. O'Connell ER, Thomas PC, Cady LD, Karwasky RJ. Energy costs of simulated stair climbing as a job-related task in fire fighting. J Occup Med. 1986;28:282–4.
9. Ainsworth B, Haskell W, Herrmann S, Meckes N, Bassett D, Tudor-Locke C, et al. 2011 Compendium of Physical Activities. Med Sci Sport Exerc [Internet]. 2011 Aug;43(8):1575–81. Available from: https://journals.lww.com/00005768-201108000-00025
10. Kollock R, Thomas J, Hale D, Sanders G, Long A, Dawes J, et al. The Effects of Firefighter Equipment and Gear on the Static and Dynamic Postural Stability of Fire Cadets. Gait Posture [Internet]. 2021 Jul;88(4):292–6. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0966636221002277
11. Dunham RB. Nominal Group Technique: A Users' Guide [Internet]. 1988. Available from: https://sswm.info/sites/default/files/reference_attachments/DUNHAM 1998 Nominal Group Technique - A Users' Guide.pdf
12. FitnessHealth101. Push/Push Weight Training Program [Internet]. 2025. Available from: https://www.fitnesshealth101.com/fitness/weight-training/strength-training/pushpush-program
13. Wiggins ST, Colby S, Moret L, McElrone M, Olfert MD, Riggsbee K, et al. A modified nominal group technique (mNGT)-finding priorities in research. Am J Health Behav. 2020;44(3):345–52.
14. Ebben WP, Wurm B, Vander Zanden TL, Spadavecchia ML, Durocher JJ, Bickham CT, et al. Kinetic Analysis of Several Variations of Push-Ups. J Strength Cond Res [Internet]. 2011 Oct;25(10):2891–4. Available from: https://journals.lww.com/00124278-201110000-00031
15. Kikuchi N, Nakazato K. Low-load bench press and push-up induce similar muscle hypertrophy and strength gain. J Exerc Sci Fit [Internet]. 2017 Jun;15(1):37–42. Available from: https://linkinghub.elsevier.com/retrieve/pii/S1728869X17301028
16. Topend Sport Network. Push Up [Internet]. 2023 [cited 2023 Mar 26]. Available from: https://www.topendsports.com/testing/tests/home-pushup.htm
17. Yang J, Christophi CA, Farioli A, Baur DM, Moffatt S, Zollinger TW, et al. Association Between Push-up Exercise Capacity and Future Cardiovascular Events Among Active Adult Men. JAMA Netw open [Internet]. 2019;2(2):e188341. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6484614/
18. Fisher J, Steele J, Bruce-Low S, Smith D. Evidence-Based Resistance Training Recommendations. Med Sport [Internet]. 2011 Sep 1;15(3):147–62. Available from: http://versita.metapress.com/openurl.asp?genre=article&id=doi:10.2478/v10036-011-0025-x
19. Yi Rong Tan, Farid Wajdi Mahyuddin, Norhayati Mahyuddin. MATEC Web of Conferences. In: The analysis of fire losses and characteristics of residential fires based on investigation data in Selangor, 2012-2014. 2016.
20. Lindberg AS, Oksa J, Antti H, Malm C. Multivariate Statistical Assessment of Predictors of Firefighters' Muscular and Aerobic Work Capacity. Piacentini MF, editor. PLoS One [Internet]. 2015 Mar 16;10(3):e0118945. Available from: https://dx.plos.org/10.1371/journal.pone.0118945
21. Songsorn P, Somnarin K, Jaitan S, Kupradit A. The effect of whole-body high-intensity interval training on heart rate variability in insufficiently active adults. J Exerc Sci Fit [Internet]. 2022 Jan;20(1):48–53. Available from: https://linkinghub.elsevier.com/retrieve/pii/S1728869X21000435
22. Fang SC, Wu YL, Tsai PS. Heart Rate Variability and Risk of All-Cause Death and Cardiovascular Events in Patients With Cardiovascular Disease: A Meta-Analysis of Cohort Studies. Biol Res Nurs [Internet]. 2020 Jan 26;22(1):45–56. Available from: http://journals.sagepub.com/doi/10.1177/1099800419877442
23. Herrmann SD, Willis EA, Ainsworth BE, Barreira T V., Hastert M, Kracht CL, et al. 2024 Adult Compendium of

Physical Activities: A third update of the energy costs of human activities. J Sport Heal Sci [Internet]. 2024 Jan;13(1):6–12. Available from: https://linkinghub.elsevier.com/retrieve/pii/S2095254623001084

24. Kruskall L. Weight Management. In: Bushman B, editor. Complete Guide to Fitness and Health [Internet]. 2nd ed. USA: American College of Sports Medicine; 2017. p. 351–68. Available from: https://www.calameo.com/read/00665682252ac0fc91e3e
25. Speakman JR. Obesity and thermoregulation. Handb Clin Neurol [Internet]. 2018;156:431–43. Available from: https://linkinghub.elsevier.com/retrieve/pii/B9780444639127000266
26. Mathias KC, Wu Y, Stewart DF, Smith DL. Differences in 5-year weight change between younger and older US firefighters. BMC Public Health [Internet]. 2021 Dec 24;21(1):1215. Available from: https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-021-11266-x
27. Witzke K, Winters-Stone K. Osteoporosis and Bone Health. In: Bushman B, editor. Complete Guide to Fitness and Health. 2nd ed. USA: American College of Sports Medicine; 2017. p. 321–38.
28. Welle S, Thornton C, Jozefowicz R, Statt M. Myofibrillar protein synthesis in young and old men. Am J Physiol Metab [Internet]. 1993 May 1;264(5):E693–8. Available from: https://www.physiology.org/doi/10.1152/ajpendo.1993.264.5.E693
29. Institute of Medicine (US) Committee on Assessing the Need for Clinical Trials of Testosterone Replacement Therapy. Testosterone and Aging [Internet]. Liverman C, Blazer D, editors. Clinical Research Direction. Washington, D.C.: National Academies Press; 2004. Available from: http://www.nap.edu/catalog/10852
30. Volpi E, Nazemi R, Fujita S. Muscle tissue changes with aging. Curr Opin Clin Nutr Metab Care [Internet]. 2004 Jul;7(4):405–10. Available from: http://journals.lww.com/00075197-200407000-00009
31. Tieland M, Trouwborst I, Clark BC. Skeletal muscle performance and ageing. J Cachexia Sarcopenia Muscle [Internet]. 2018 Feb;9(1):3–19. Available from: https://onlinelibrary.wiley.com/doi/10.1002/jcsm.12238.