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Fitness of Firefighters in Qatar and Indonesia: A Systematic Review

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[*Abstract*]

Firefighting is a strenuous occupation that requires firefighters to be in peak physical condition. However, there is a limited study focusing on firefighters' fitness assessment, especially in association with fitness for duty. The aim of this paper is to review the existing literature on firefighter fitness for duty. The review was taken from various literature taken from various electronic databases such as PubMed, SCOPUS, and Web of Science. Publications and grey literature between the years 2000 to present were used. The study found that existing literature have indicated that there is a lack of studies focusing on firefighter's fitness for duty evaluation and availability of proper tools with similar standards globally to assess firefighter's fitness-for duty, including in the contexts of Indonesia and Qatar which have different unique characteristics in terms of the importance of fire incident prevention-protection and firefighter's fitness

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status. Significant gaps remain in the literature and could be opportunities for further studies.

Keywords: Systematic review, firefighter, fitness for duty, Indonesia-Qatar

Ⅰ. Introduction

Firefighting is dangerous work. Each year, in the US, approximately 80,000 firefighters are injured and about 100 firefighters lose their lives in the line of duty (Smith 2011). Firefighters labor in a chaotic atmosphere and are exposed to toxic gases, hazardous combustion products, high radiant heat loads, and other risks (Campbell and Evarts 2021). Despite the numerous risks, abrupt cardiac events which account for around 45% of duty deaths are the most common cause of death for firefighters while they are on the job in the US (Divingian 2019). Data indicate that many firefighters do not have high levels of aerobic fitness, anaerobic ability, physical strength and endurance, which are all necessary for fighting fires. In addition, a lot of firefighters are overweight and have one or more cardiovascular disease risk factors that can be changed. If firefighters followed well-designed exercise programs to boost general health and fitness, both the public's safety and their own would be improved (Smith 2022).

There have been very few studies investigating fitness for duty assessment for firefighters, especially in Indonesia and Qatar, which both countries have different unique characteristics. Petroleum and natural gas are the cornerstones of Qatar's economy and Qatar has the world's third largest proven natural gas reserve and is the second-largest exporter of natural gas (United Nations 2022). According to this condition, the Fire Department and firefighters in this state have the critical and essential roles in guarding the companies and national assets. However, it is a contradictory condition that the proper standard system to evaluate firefighter’s fitness for duty is still not available (Civil Defense-State of Qatar 2022). Besides that, Indonesia with almost 300 million population and 13,000 islands, and being geographically located in the tropics,

has a high average fire incident rate, especially in densely populated areas such as Jakarta, the capital city that yields 3-4 fire incidents per day (Lestari 2017). Moreover, similar to Qatar, the fitness evaluation standard for firefighters is still not available as required for duty readiness of this high risk job.

Therefore, this systematic review will examine the existing literature on firefighters and their fitness evaluation from several studies worldwide, especially in these two countries. The paper will also highlight gaps in the literature for future research.

Ⅱ. Methodology

2.1. Review Method

To review the literature on the selected topic, a methodical approach was used. In the realm of public health, systematic literature reviews (SLR) have become a standard review technique.

2.2. Search Strategy

The list of digital databases consulted is provided below:

<Table 1> Digital Database

Databases
Google Scholar
Springer (springerlink.com)
Scopus (scopus.com)

The following keywords were used to search the literature:

a. Firefighter assessment in Indonesia
b. Firefighter assessment in Qatar
c. Fitness firefighters in Indonesia
d. Fitness firefighters in Qatar
e. Health assessment for firefighters in Indonesia
f. Health assessment for firefighters in Qatar

2.3. Study Selection

The primary studies were chosen based on the inclusion and exclusion standards.

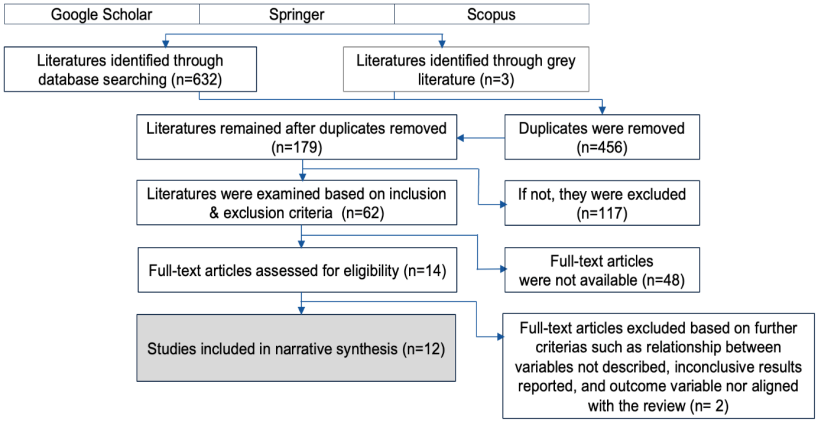
<Table 2> Inclusion-Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Studies involving firefighters	Studies that do not include firefighters only (other emergency services and population are excluded)
Studies examining the linkages between physical fitness assessments, occupational performance, disorders/sickness	Review studies
English-language publications	Non-English-language publications
Open-access articles	Articles where full texts were not available
Studies published after the year 2000	Studies published before the year 2000

31 primary studies made up the final list of those chosen for the first round.

2.4. Data Extraction

The data needed to answer the research issues raised by this review are taken from the chosen primary studies. The data extraction form was finished for every one of the 31 primary studies that were chosen. The primary studies that provided the information required to address the study questions were the focus of the data extraction form. From 31 primary studies, 12 final papers were selected for this research. These literatures were included based on the closeness of the topic and the robustness of the methodology. Studies which are far from the main topic or with poor methodological quality are excluded. The complete texts of 12 primary papers were carefully examined. The standard of the original studies, their relevance to the research topics, and study similarity were considered in addition to the further inclusion and exclusion criteria such as when the relationship between variables not described, inconclusive results reported, or outcome variable nor aligned with the review. Identical papers by the same authors published in different journals were omitted. After excluding papers based on the full text selection, 12 primary studies were included.



<Figure 1> Screening Paper Flowchart

2.5. Study Quality Assessment and Data Synthesis

The interpretation of the synthesis findings and the level of support for the elaborated inferences can both be determined using the research quality evaluation. Data synthesis is to compile evidence from the chosen studies to respond to the research questions. A single piece of evidence could have minimal evidence force, but the aggregation of several of them can make a claim stronger. Both quantitative and qualitative data were gathered for this review. To synthesize the gathered data related to various study issues, various methodologies were used. The narrative synthesis method was typically applied.

Ⅲ. Results

Firefighting is a physically demanding and hazardous profession. Sufficient levels of cardiorespiratory fitness thru VO2 max test are necessary to perform fireground tasks safely and maintain cardiovascular health. Specifically, several essential fireground tasks require an energy expenditure of at least 42 mL/kg/min (i.e., 12 metabolic equivalents [METs]), and another research shows the minimum requirement levels of an aerobic capacity of at least 39.9 to 45 mL/kg/min (Glenhill and Jamnik 1992; Lusa 1993).

However, firefighters spend much of their working shift on standby, with long sedentary periods. On short notice, firefighters respond to high-intensity emergency situations in heavy protective clothing while wearing a self-contained breathing apparatus (SCBA), operating at near maximal capacities. Combined with situational unpredictability and high ambient temperatures, these stressors may lead to firefighters facing potentially dangerous levels of thermoregulatory and cardiovascular strain. To ameliorate this risk and ensure operational effectiveness and safety, firefighters should maintain high levels of physical fitness (Walker 2014). According to this condition, simulated physical capacity training and evaluation through fireground functional fitness activities and tests should be conducted on a regular basis to maintain a readiness status of firefighter's fitness for duty.

The fitness for duty evaluation parameters for firefighters should be based on information generated from a needs analysis that provides the occupational physician practitioners with critical information regarding physiological and biomechanical demands of job tasks, and an assessment of the firefighter's physical ability (Schmit and DeBeliso 2019).

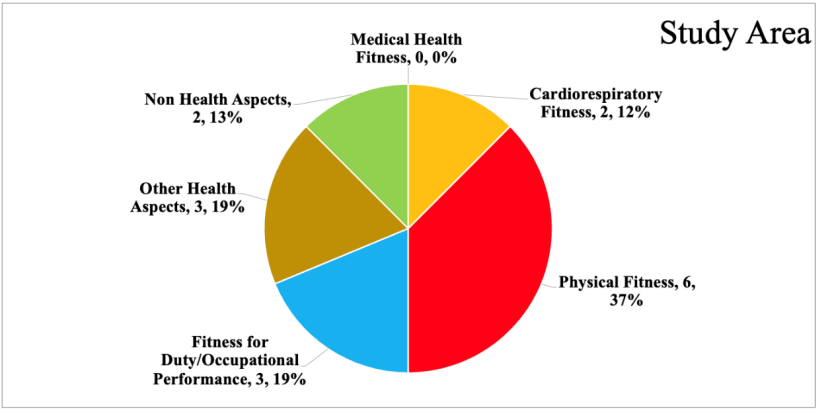
Prospective firefighters must pass all key parameters of assessment prior to service. Several different methods currently assess the fitness condition; however, there are no comprehensive & universally accepted standards across all organizations worldwide. NFPA publishes several codes and standards by which many organizations abide by. NFPA provides fitness guidelines that incorporate measures of medical fitness, aerobic capacity, flexibility, muscular and endurance, and body composition testing as part of a regular fitness regimen. The physical functional fitness test is a widely used simulation test for which contains some main points of firefighting tasks that mimic real life scenarios (Nfpa.org 2020).

<Table 3> The summary of the studies

Authors – Year	**Study Summaries**	**Countries**	**Outcomes**
Chizewski et al. (2021)	Examined the linkage between physical fitness and firefighting ability/performance	US	Regular exercise may be effective for improving the ability/performance of firefighting thru:

Authors – Year	Study Summaries	Countries	Outcomes
			■ Preventing chronic diseases ■ Increasing physical fitness & cardiovascular endurance
Ras et al. (2022)	Determination of a relationship between cardiovascular disease risk factors, musculoskeletal health, physical fitness, and occupational performance	South Africa	A strong relationship between physical fitness and occupational performance of firefighters
Xu et al. (2020)	Examined relationships between various physical health parameters and performance on simulated firefighting ability tasks	China	Significant relationships among physical health parameters and performance on simulated firefighting ability tasks
Strauss et al. (2021)	Examined the association between cardiorespiratory fitness and cardiovascular risk factors in firefighters	US	Demonstrated a strong association between lower cardiovascular risk factors and higher cardiorespiratory fitness
Kinney et al. (2021)	The study aimed to address which body composition (BC) and best correlate with cardiorespiratory fitness (CRF)	US	More sophisticated measures of Body Composition (BC) and Cardiorespiratory Fitness (CRF) to evaluate firefighter fitness.
Atinah (2015)	The cross-sectional study was conducted to evaluate the physical fitness among Malaysian firefighters.	Malaysia	Physical fitness among Malaysian firefighters with low level averages.
Noh et al. (2020)	Comparative study of South Korean firefighters' physical fitness with other countries.	South Korea	Korean firefighters had relatively lower levels of physical fitness compared to different country's firefighters
Purwaningsih & Sutiari (2022)	Determine the relationship between nutritional status and smoking habits with physical fitness of firefighters in Denpasar-Bali.	Indonesia	A significant relationship between nutritional status with physical fitness, but no significant relationship between smoking habit and physical fitness
Warman (2022)	Analyzed the risk of work accidents using the HIRA (Hazard Identification and Risk Assessment) method.	Indonesia	21 potential accident risks were identified at the Mandailing Natal District Fire Department.
Hidayatun & Rodiyanto (2021)	Qualitative descriptive research with a case study approach based on the high number of work accidents among firefighters in East Jakarta Fire and Rescue Department.	Indonesia	Different levels of accident risks of firefighters, with some recommendation action points to reduce the risk of accidents.
Arfianti et al. (2011)	A cross-sectional design examined the relationship between work stressors and the incidence of insomnia in firefighters.	Indonesia	Prevalence of insomnia among firefighters is quite high. ■ Work stress, ■ Excessive qualitative workload

Authors – Year	Study Summaries	Countries	Outcomes
			■ Quantitative workload ■ Living environment with noise
Mochtar and Hooper (2012)	A cross-sectional study was conducted in Ras Laffan Industrial City, Qatar to assess the 10- year risk of coronary heart disease events for 369 Qatar Petroleum staff (firefighters and non-firefighters' groups)	Qatar	None of the firefighters was categorized as high risk. The mean risk of developing coronary heart disease in firefighters was significantly lower than in non-firefighters (Framingham Score).



<Figure 2> The Graph of Study Area

Notes: 3 Studies examined 2 areas (Physical Fitness & Occupational Performance) and 1 study examined 2 areas (Physical Fitness & Other Health Aspects)

Over the years, there have been various studies examining the most proper assessment for firefighters. 3 cross sectional studies were conducted in different Countries by Chizewski et al. (2021) in the US, Ras et al. (2022) in South Africa, and Xu et al. (2020) in China. These studies have a similar focus area on physical fitness of firefighters in relationship with firefighter task performance. The interesting findings from these 3 studies were the difference of various physical fitness parameters. Physical fitness was assessed by Chizewski et al.via 1.5 mile run time, sit-up and push-up repetitions, the Young Men's Christian Association (YMCA) bench press test, vertical jump height, and sit-and-reach flexibility. Meanwhile, Ras et al. used cardiovascular disease risk factors, musculoskeletal health,

and physical fitness. In this context, they argue that there is a strong relationship between physical fitness and occupational performance. However, the relationship between cardiovascular risk factors and musculoskeletal health in relation to occupational performance is less clear and still understudied.

In the meantime, Xu et al. study attempted to examine various physical health parameters (weight, maximum oxygen uptake, body fat percentage, upper body muscular power and lower body muscular power) and performance on simulated fire fighting ability tasks, which included a set of seven tasks (rope climb, run 200 m round trip with load, 60 m carrying a ladder, climb stairs with load, evacuation of 400 m with supplies, run 5 km with an air respirator, run 100 m with the water hose).

Other three cross sectional studies were also conducted in different countries by Atinah (2015) in Malaysia, Noh et al. (2020) in South Korea, and Purwaningsih and Sutiari (2022) in Indonesia. These focused on physical fitness level among firefighters without evaluating the relationship with occupational performance or firefighter's ability. Atinah used the hand grip test to evaluate hand and muscular strength was measured using a hand dynamometer and one-minute sit ups and one-minute push-ups were conducted to measure abdominal muscle endurance. The sit and reach test were carried out to measure lower back and hamstring flexibility. VO2 max was assessed by a 20-meter shuttle run test to measure cardiorespiratory fitness. Noh et al. performed a graded exercise test to measure the VO2max of the participants. Muscle strength and muscular endurance of the knees, shoulders, and trunk were measured with an isokinetic dynamometer and grip strength was measured using a grip dynamometer. DXA was utilized for body composition measurements. However, Pruwaningsih and Sutiari study did not show a clear explanation on the physical fitness parameters.

Two studies in the US were conducted by Strauss et al. and Kinney et al. in 2021. Both studies examined cardiorespiratory fitness of firefighters with different approaches. Strauss' study demonstrated a strong association between lower cardiovascular risk

factors and higher cardiorespiratory fitness, and Kinney studied more sophisticated measures of Body Composition (BC) and Cardiorespiratory Fitness (CRF) to evaluate firefighter fitness.

Otherwise, three studies in Indonesia were conducted in different years by Arfianti et al. (2011), Hidayatun and Rodiyanto (2021), as well as Warman (2022). Arfianti examined the relationship between work stressors and prevalence of insomnia among firefighters, and other two studies examined accident risks from a safety perspective. However, these 3 studies did not examine the fitness of firefighters.

In Qatar, a cross-sectional study was conducted by Mochtar and Hooper (2012) in Ras Laffan Industrial City, to assess the 10-year risk of coronary heart disease events for 369 Qatar Petroleum staff (firefighters and non-firefighters' groups). Since then, no further study has been reported in association with firefighter health or fitness issues.

Ⅳ. Discussion

Many studies have been taken on the firefighter's fitness globally, including research on the relationship between physical fitness and occupational performance of firefighters, between cardiorespiratory fitness and performance on simulated firefighting tasks, between physical fitness parameters and task performance ability. However, the studies related to the firefighter fitness evaluation parameters and association with fitness for duty are very rare and limited.

From this paper, there was only one study since 2012 in Qatar, and focused on the cardiovascular risks among general staff and firefighters without associated with fitness levels. A contradictory condition between the critical position/essential roles of firefighters in guarding the companies and Qatar national assets, and the fact of unavailability of the proper standard system in evaluating firefighter's fitness for duty. Moreover, there is no further study on firefighters in association with fitness for duty assessment /evaluation. Besides that, from 4 above studies reviewed in

Indonesia, only one study focused on the health factors (smoking & nutrition) association with physical fitness, and other studies were related to another health topic of work stress & insomnia prevalence, and incident risk factors among firefighters from safety perspective, and did not examine precisely the fitness assessment and fitness for duty of firefighters.

Different methods of fitness assessment for firefighters in many organizations worldwide, including in Qatar and Indonesia, have become a special issue in terms of fitness for duty evaluation. This lack of a standardized approach could result in firefighters being improperly assessed with different standards for their capability to safely perform firefighting duties and puts the firefighters, co-workers, and the workplace at risk. This increased risk has the potential for increased liability to business entities employing in oil & gas sectors especially in community services.

Proper tools with similar standards globally to assess firefighter's fitness-for-duty are therefore important to ensure firefighters are properly evaluated, to safely perform their full tasks and to handle the dangers of the job wherever they work.

Ⅴ. Conclusion

Overall, the research indicated that physical fitness was the most frequently studied area in firefighters and significantly related to occupational performance/task ability.

Both Countries Qatar & Indonesia, with their characteristics, maintaining a readiness status of firefighter's fitness for duty is a very critical and essential program. However, there was only one study since 2012 in Qatar, and focused on the cardiovascular risks among general staff and firefighters without associated with fitness levels. Moreover, there is no further study on firefighters in association with fitness for duty assessment /evaluation. Besides that, from 4 above studies reviewed in Indonesia, also only one study focused on the health factors (smoking & nutrition) association with physical fitness, and other studies were related to

another health topic of work stress & insomnia prevalence, and incident risk factors among firefighters from safety perspective, and did not examine precisely the determinants of firefighter's fitness for duty, and it is very rare and limited.

Furthermore, in terms of firefighter fitness for duty, studies related to fitness assessment parameters including medical-health fitness aspect, cardiorespiratory fitness, and functional capacity level in association with predicted fitness for duty or readiness of firefighter's in fireground response are required.

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