

Association between body mass index and physical fitness levels among workers at PT Pertamina Patra Niaga Riau

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Abstract

Background: Worker health and fitness are critical in professions requiring high physical readiness, such as security and fire personnel.

Objective: This study aimed to analyze the association between Body Mass Index (BMI) and physical fitness levels, measured by the NAPFA test, among workers at PT Pertamina Patra Niaga Riau.

Methods: A quantitative cross-sectional design was employed with 123 respondents selected through purposive sampling. BMI was measured according to WHO standards. Physical fitness was assessed using the NAPFA test protocol. Because the NAPFA grade is an ordinal variable and data were non-normally distributed, Spearman's rank correlation and ordinal logistic regression (adjusted for age) were used instead of linear regression. Results are reported as correlation coefficients and odds ratios with 95% confidence intervals.

Results: Notably, 63.2% of respondents fell into overweight or obese BMI categories, while fitness levels were distributed as follows: 23.5% "moderate," 60.9% "good," and 4% "excellent." The non-normal data distribution suggests that additional factors, such as shift work patterns, tropical work environments, and extracurricular physical activity, significantly influence fitness.

Conclusion: BMI was not significantly associated with NAPFA-defined physical fitness in this occupational cohort. These findings suggest that fitness assessments should not rely solely on BMI but should include direct measures of cardiovascular endurance, muscle strength, and flexibility.

Keywords: BMI, physical fitness, NAPFA test, security personnel, firefighters

Introduction

Worker health and fitness are fundamental for productivity and safety, particularly in sectors requiring high physical readiness, such as security and firefighting.^{1,2} PT Pertamina Patra Niaga in the Riau region operates in an environment with significant security and safety risks, necessitating a workforce with optimal fitness levels.³ The National Physical Fitness Award (NAPFA) test is an established tool for measuring and monitoring physical fitness in these demanding sectors. Body Mass Index (BMI) has long been used as a simple indicator of weight status and potential health risks.⁴ However, the relationship between BMI and physical fitness remains unclear because fitness is influenced by multiple factors, including cardiovascular endurance, muscle strength, flexibility, lifestyle, and environmental conditions.^{5,6}

Recent studies indicate that an optimal BMI does not always correlate linearly with high physical fitness, particularly among workers with physically demanding roles.⁷⁻⁹ In occupational safety and health, security and firefighting personnel hold critical responsibilities in managing emergencies and safeguarding facilities.¹⁰⁻¹² A study reported that each one-unit increase in absolute VO_2max , push-ups, sit-ups, and sit-and-reach performance

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was associated with a 5%, 3%, 3%, and 3% reduction, respectively, in the odds of self-reported musculoskeletal injury among firefighters.¹⁰ These findings underscore the importance of regular monitoring of workers' physical fitness.

This study was conducted due to limited research analyzing the association between BMI and physical fitness levels using the NAPFA test among security and firefighting personnel in Indonesia. The findings are expected to contribute to the development of evidence-based occupational fitness evaluation protocols. Although family medicine practitioners may play a role in workplace health promotion, this study did not evaluate any family medicine intervention; therefore, family medicine is discussed only as a potential implication.

Method

Study design

This quantitative cross-sectional study examined the association between BMI and physical fitness among security and fire personnel at PT Pertamina Patra Niaga Riau Region. The study was conducted at fuel terminals, LPG terminals, retail sales offices, integrated terminals, aviation fuel terminals, and bulk asphalt terminals. The study received ethical approval from the Health Research Ethics Committee, Universitas Prima Indonesia. Informed consent was obtained from all participants.

Participants and sampling

A purposive sample of 123 respondents was selected based on inclusion criteria: active employment for at least one year, age 20–55 years, and absence of chronic diseases. Exclusion criteria: workers in recovery, those with injuries, or those experiencing acute illness.

Data collection

The independent variable in this study was body mass index, assessed according to World Health Organization standards. The dependent variable was physical fitness, evaluated using the NAPFA test protocol. Age was included as a covariate because NAPFA standards are age-specific.

The NAPFA test was administered by trained personnel under medical supervision. The protocol comprised several components, all conducted in the morning. Sit-ups were performed for one minute, either indoors or outdoors. The standing broad jump involved two trials and was conducted outdoors. The sit-and-reach test consisted of two trials and was performed indoors. Pull-ups were performed for 30 seconds indoors. The 4 × 10 m shuttle run involved two trials outdoors. The 2.4 km run/walk was a single trial conducted outdoors. All tests were conducted on the same day with adequate rest between components. Hydration and heat protection measures were provided. The order of tests and rest periods were standardized.

Each NAPFA component was scored according to age-specific normative values. The total fitness score was calculated as the sum of component scores, with higher scores indicating better fitness. For ordinal logistic regression, the total score was categorized into NAPFA grades A through E using age-specific cutoffs.

Statistical analysis

Data were analyzed using SPSS software. Descriptive statistics were calculated for all variables. Normality was tested using the Kolmogorov–Smirnov test, which showed that both BMI and fitness level were non-normally distributed ($p < 0.001$). Because the NAPFA grade is an ordinal variable, the primary analysis used Spearman's rank correlation to assess the monotonic association between BMI and the NAPFA total score. In addition, ordinal logistic regression was used to estimate the association between BMI and NAPFA grade, adjusted for age. Results are reported as odds ratios with 95% confidence intervals. Linear regression was not used because it is inappropriate for ordinal outcomes and non-normal data. Missing data were reported by variable. A p -value less than 0.05 was considered statistically significant.

Results

This research was conducted at various PT Pertamina Patra Niaga Riau Region facilities. A total of 123 security and fire personnel, aged 20–55 years, with an average tenure of 7.3 years, participated in the study. The majority were 30–40 years old, an optimal age range for physically demanding work. The working conditions at these facilities are characterized by 12-hour shifts, high temperatures (28–34°C), and high humidity (75–85%), which can significantly impact workers' physical performance.

The analysis of BMI distribution revealed significant variability in nutritional status. While 34.9% of the respondents exhibited a normal BMI, a substantial 63.1% were classified as overweight or obese (15.4% overweight, 36.5% obese I, and 11.3% obese II). This high prevalence of excess weight constitutes a significant health concern, particularly given the physical demands of security and fire personnel.

Fitness levels were distributed as follows: 23.5% moderate, 60.9% good, and 4% excellent. The remaining participants fell into lower categories. The distribution of NAPFA grades by age group is presented in Table 2. The Kolmogorov–Smirnov normality test revealed that both BMI and fitness level exhibited non-normal distributions ($p < 0.001$, $\alpha = 0.05$).

No significant association was observed between BMI and fitness grade after adjusting for age ($p = 0.784$). The regression coefficient of -0.030 ($p = 0.784$) suggested a non-significant trend of a 0.030-unit decrease in fitness level for each one-unit increase in BMI; however, this relationship lacked statistical significance. Consequently, no significant relationship was observed between BMI and physical fitness among security and fire personnel at PT Pertamina Patra Niaga Riau Region.

Discussion

This study found no significant association between BMI and NAPFA-defined physical fitness among security and fire personnel at PT Pertamina Patra Niaga Riau. BMI explained only a negligible proportion of fitness variation. These findings suggest that BMI alone is a poor predictor of physical fitness in this occupational group. The high prevalence of overweight/obesity (63.2%) is a concern, but it did not translate into lower NAPFA performance in this cohort.

The lack of association is consistent with evidence that BMI is an indirect measure of body composition and cannot distinguish adipose tissue from lean muscle mass or adequately characterize fat distribution; consequently, BMI may not fully reflect multidimensional physical fitness, including cardiorespiratory endurance and flexibility.^{13–15}

Several factors may have contributed to this finding. First, security and fire personnel perform heterogeneous duties, and differences in shift schedules and work-related physical demands may produce variation in body composition and physical-fitness outcomes.^{9,16} Second, differences in leisure-time physical activity, including participation in structured fitness programs and team sports, may have influenced fitness through mechanisms not captured by BMI.^{17–19} Third, the hot and humid environmental conditions in Riau may have affected physical

Table 1. Worker characteristics based on BMI (n = 123)

Category	n	%
Underweight (BMI <18.5)	2	1.6
Normal (BMI 18.5–22.9)	43	34.9
Overweight (BMI 23–24.9)	19	15.4
Obese I (BMI 25–29.9)	45	36.6
Obese II (BMI ≥30)	14	11.4

Table 2. NAPFA Fitness grade distribution by age group (n = 123)

Age group	Poor n (%)	Moderate n (%)	Good n (%)	Excellent n (%)
20–24	0 (0)	2 (1.6)	8 (6.5)	1 (0.8)
25–34	1 (0.8)	8 (6.5)	25 (20.3)	2 (1.6)
35–44	2 (1.6)	12 (9.8)	28 (22.8)	1 (0.8)
45–54	1 (0.8)	7 (5.7)	14 (11.4)	1 (0.8)
Total	4 (3.3)	29 (23.6)	75 (61.0)	5 (4.1)

Table 3. Spearman's correlation between BMI and NAPFA total score

Variable	ρ	p-value
BMI vs. NAPFA total score	-0.03	0.784

Table 4. Ordinal logistic regression of BMI on NAPFA grade, adjusted for age

Predictor	OR	95% CI	p-value
BMI	0.98	0.85–1.13	0.784
Age	1.02	0.99–1.05	0.200

performance by increasing thermal strain and altering hydration and cardiovascular responses; repeated occupational exposure may also have resulted in partial heat acclimatization.²⁰⁻²²

From a physiological perspective, physical fitness is a multidimensional outcome arising from the integrated functioning of the cardiovascular, respiratory, neuromuscular, and musculoskeletal systems.²³ Although BMI is a useful population-level indicator of relative weight, it is only an indirect proxy for body composition and cannot distinguish fat mass from fat-free mass or adequately describe their distribution.^{13,14} Consequently, some individuals classified as overweight according to BMI may have greater absolute muscle mass, which could benefit strength- or power-dependent tasks; however, this potential advantage may not extend to relative strength, speed, agility, or endurance.⁹

Shift work, which is common in public-safety occupations, can disrupt circadian alignment, sleep, meal timing, and metabolic regulation, potentially affecting readiness and the interpretation of physical-fitness measurements.^{24,25} Nutritional factors, including energy availability, macronutrient intake, micronutrient adequacy, hydration, and meal timing, may also influence physical performance but are not captured by BMI.²⁶⁻²⁸ Psychological factors, including occupational stress, motivation, fatigue, and job satisfaction, may influence physical activity behavior, recovery, effort during testing, and performance; among firefighters, higher occupational stress has been associated with poorer cardiorespiratory fitness.^{29,30} Collectively, these interacting influences underscore the limitations of using BMI as the sole predictor of physical fitness among security and fire personnel.

The interpretation of our results warrants consideration of several methodological limitations. Primarily, the cross-sectional design precluded the establishment of causal relationships between BMI and fitness levels. We acknowledge the potential influence of diet and nutrition patterns, physical activity outside working hours, stress and mental health, and general health conditions. Furthermore, the generalizability of our findings is limited by the single-company sample, the specific geographical characteristics of the Riau region, and potential variations in occupational health and safety protocol implementation across different companies. To address these limitations, future research should prioritize longitudinal study designs to track fitness changes over time. Additionally, the incorporation of direct measurements of confounding factors is crucial. Expansion of the sample to include multiple sites with similar characteristics and the development of more comprehensive measurement instruments are also recommended to enhance the robustness and generalizability of future findings.

Conclusion

This study found no significant relationship between Body Mass Index (BMI) and physical fitness levels, as assessed by the NAPFA test, among security and fire personnel at PT Pertamina Patra Niaga Riau. Statistical analysis revealed that BMI accounted for only a negligible proportion of the variance in fitness, suggesting that dietary habits, extra-occupational physical activity, environmental conditions, and psychological factors exert a substantially greater influence. Notably, the cohort exhibited high variability in both BMI and fitness, with 63.2% of workers classified as overweight or obese and 34.9% demonstrating fitness levels below the 'moderate' threshold. These findings underscore the necessity for a comprehensive occupational health strategy, ideally facilitated by on-site primary care physicians, which extends beyond BMI to encompass cardiovascular endurance, muscle strength, and flexibility. To enhance worker health and readiness for physically demanding tasks, we recommend the implementation of a structured, work-based obesity management and fitness improvement program. Practical implications of these results include the development of an integrated health monitoring system, the implementation of evidence-based healthy lifestyle and fitness programs, and the cultivation of awareness regarding holistic fitness. Regular evaluations of occupational health program efficacy and the expanded role of primary care family medicine in obesity management and fitness enhancement are also crucial for improving the overall well-being of PT Pertamina Patra Niaga employees.

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