ORIGINAL ARTICLE

Physical Therapy Journal of Indonesia (*PTJI*) 2025, Volume 6, Number 1: 19-25
E-ISSN : 2722-6034 ; P-ISSN : 2722-0125

The integration of structured physical training and nutrition to enhance seafarer endurance and career preparedness in maritime education

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ABSTRACT

Background: Maritime professionals face intense physical and mental demands, yet vocational education often overlooks structured fitness and balanced nutrition, focusing primarily on technical skills. This study explored the impact of integrating these elements on cadet endurance, cognitive function, and career sustainability, addressing a gap in existing research that rarely assesses fitness and nutrition systematically. Through qualitative insights from lecturers, graduates, and cadets, this research aimed to identify implementation challenges and evaluate perspectives on fitness scheduling, dietary adequacy, and career preparedness, ultimately offering practical recommendations for enhancing maritime training programs.

Methods: This study employed a qualitative descriptive approach, utilizing semi-structured interviews, focus group discussions, and participant observation to explore the integration of physical training and nutrition in maritime education. Participants included 5 lecturers, 10 graduates, and 25 cadets, providing diverse perspectives. Data analysis followed a thematic qualitative approach, including cross-group comparisons and narrative synthesis, to identify recurring patterns and develop evidence-based recommendations for enhancing maritime training programs. The study assessed cadet performance, endurance, and career preparedness through indicators such as engagement in physical activities and perceived nutritional adequacy. The findings aimed to contribute to a more resilient and health-conscious maritime workforce.

Results: Findings indicate that structured physical training improves cadet endurance and teamwork, while nutritional planning remains inconsistent, affecting energy levels and long-term health. Cadets expressed challenges in balancing fitness with coursework, suggesting the need for optimized scheduling and nutritional education.

Conclusions: To enhance maritime workforce sustainability, institutions should integrate structured physical training, standardized meal plans, and nutritional awareness programs. Future research should assess long-term effects of fitness and dietary habits on seafarer health and career performance.

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Received: 2024-12-18
Accepted: 2025-02-22
Published: 2025-03-12

Keywords: cadet nutrition, maritime education, physical endurance, seafarer training, vocational preparedness.
Cite This Article: Riyanto., Cahyadi, T., Winarno., Faozun, I., Barasa, L., Zakiah, D., Suranta, N., Simanjuntak, M.B. 2025. The integration of structured physical training and nutrition to enhance seafarer endurance and career preparedness in maritime education. *Physical Therapy Journal of Indonesia* 6(1): 19-25. DOI: 10.51559/ptji.v6i1.242

INTRODUCTION

Maritime education has long been recognized as a crucial foundation for developing a workforce capable of navigating the complexities of global shipping, port management, and naval engineering.[1] In an industry that is both physically demanding and mentally taxing, seafarers must possess not only technical expertise but also physical endurance, mental resilience, and sustainable well-being to meet the challenges of prolonged voyages, high-pressure environments, and stringent industry regulations. While traditional maritime education has largely focused on theoretical knowledge and vocational training, there remains a critical gap in integrating structured physical training and nutrition into the curriculum.[2,3] This oversight raises concerns about whether cadets and maritime graduates are adequately prepared for the strenuous realities of life at sea. Seafaring is not merely a technical occupation; it is an endurance profession that demands peak physical fitness, optimal health, and the ability to sustain long-term well-being under extreme working conditions. Given these challenges, it is imperative to rethink maritime education from a holistic perspective, ensuring that physical preparedness and nutritional well-being are systematically incorporated into training programs to develop sustainable maritime professionals.

Despite increasing recognition of the need for physical health and nutritional support in maritime training, there is a lack of structured policies or standardized approaches within maritime institutions. Many maritime cadets undergo rigorous training in navigation, port management, and engineering disciplines, yet their exposure to physical fitness training and structured dietary programs remains inconsistent. The industry demands seafarers who can endure long shifts, perform physically intensive tasks, and sustain high levels of alertness despite

disrupted sleep patterns and unpredictable working environments. However, the absence of well-defined frameworks for integrating regular sports activities such as swimming, volleyball, and futsal, along with consistent meal planning, into education creates a significant gap in seafarer preparedness.[4] Without a structured approach to physical training and nutrition, cadets may enter the workforce physically underprepared and nutritionally deficient, leading to long-term occupational health risks, reduced performance, and increased fatigue-related incidents on board.

The central problem this research addresses is the lack of an integrated approach to physical fitness and nutrition within maritime vocational training programs. While maritime cadets receive extensive training in technical and operational aspects, their physical endurance, mental resilience, and nutritional well-being are often neglected.[5–7] This gap in training could lead to decreased efficiency, increased fatigue, and long-term health issues among maritime professionals, ultimately affecting the industry's sustainability. Therefore, this research aims to explore the perspectives and experiences of lecturers, graduates, and cadets in maritime education to understand how structured physical training and balanced nutrition contribute to maritime readiness. The key research question guiding this study is: How do regular physical training and structured nutritional programs enhance the preparedness and sustainability of cadets in maritime vocational education? To answer this question, the study investigates the practical experiences of maritime educators, the reflections of graduates who have transitioned into the industry, and the ongoing experiences of cadets currently undergoing training.

This qualitative research establishes an empirical foundation for integrating structured fitness and optimized meal plans into maritime education, aiming to evaluate their impact on cadet endurance, discipline, cognitive function, and career readiness. Utilizing interviews, focus groups, and observations from five lecturers, ten graduates, and twenty-five cadets, the study triangulates perspectives to comprehensively understand the role of physical training and nutrition. Data, collected via semi-structured interviews, focus groups, and observations, is analyzed thematically to examine how fitness and nutrition influence cadet preparedness. The conceptual framework examines maritime education, physical endurance, and sustainable well-being, exploring how fitness and nutrition enhance maritime competence through physical performance, cognitive function, and long-term seafarer development. These dimensions assess current training and propose improvements for cadet preparedness.

This research is urgent due to increasing challenges in the modern maritime industry, where physically fit and mentally resilient seafarers are crucial for sustainable operations. Without proper training, cadets risk long-term health issues impacting performance and career longevity. Maritime institutions must equip cadets with technical competencies, physical fitness, and mental resilience. By advocating for mandatory fitness programs, structured meal plans, and health-conscious curricula, this study aims to redefine vocational training standards and ensure cadets are fully prepared for the demands of seafaring. The findings of this research have the potential to redefine maritime vocational training standards by advocating for mandatory physical training programs, structured meal plans, and health-conscious curriculum design that align with the evolving demands of the shipping industry.

By bridging the gap between physical fitness, nutritional awareness, and maritime competence, this research contributes to the enhancement of vocational maritime education, the sustainability of maritime careers, and the well-being of future seafarers.[8,9] In the long run, an integrated approach to fitness and nutrition in maritime training programs will not only reduce health-related risks and improve cadet performance but also strengthen the sustainability of maritime human resources. This research challenges the traditional paradigms of maritime education by proposing a holistic framework that considers physical health and nutritional well-being as core elements of seafarer preparedness, ensuring that future maritime professionals are not only skilled in navigation and port operations but also physically resilient, nutritionally balanced, and mentally prepared to thrive in the demanding maritime environment.

METHODS

The research employed a qualitative descriptive approach to explore the perspectives and experiences of key stakeholders in maritime education regarding the integration of physical training and structured nutrition into maritime vocational programs. The selection of research participants was purposeful and strategic, ensuring that insights were drawn from individuals who possessed direct engagement with maritime education, training, and industry practices. The population comprised lecturers with extensive teaching and seafaring experience, graduates who had completed their vocational training and transitioned into the professional maritime sector, and cadets who were currently undergoing maritime education and training. Each group was chosen to provide a holistic and multi-dimensional perspective on the research topic, capturing the viewpoints of those responsible for curriculum development and instruction, those who had applied their training in real-world maritime environments, and those who were currently experiencing the challenges of physical and nutritional preparedness in maritime training programs.

The sample included five lecturers who had more than five years of sea-going experience and over eight years of teaching maritime cadets. Their expertise lay in maritime science and vocational training, ensuring that their perspectives on curriculum design, physical fitness training, and nutritional requirements were grounded in both practical and pedagogical experience. Their role as maritime educators provided critical insights into the structural gaps in existing training programs and potential strategies for integrating physical fitness and nutrition into cadet training. The study also included ten graduates who had completed four years of vocational maritime training in Port and Shipping

Engineering. These individuals had transitioned into the professional maritime workforce, allowing them to reflect on the relevance and effectiveness of their training in preparing them for the demands of seafaring life. Their insights contributed to understanding how physical endurance, nutritional intake, and maritime job performance were interconnected and whether their educational experiences adequately prepared them for real-world maritime challenges. Lastly, the research included twenty-five cadets in their third semester of the Port and Shipping Management program, representing a current perspective on the challenges and experiences of physical training and nutritional habits in maritime education. Their inclusion was vital for examining how current maritime students perceived and engaged with physical fitness and nutrition, as well as identifying the barriers they encountered in maintaining a structured health regimen.

To gather comprehensive and contextually rich data, the research employed multiple instruments to capture diverse perspectives across the participant groups.[10–12] The primary research instruments consisted of semi-structured interviews, focus group discussions, and participant observation. Semi-structured interviews were designed to explore personal experiences, reflections, and perceptions regarding physical training and nutrition in maritime education. The questions were open-ended and exploratory, allowing participants to provide detailed and nuanced responses while enabling the researcher to probe deeper into emerging themes. These interviews captured individualized insights from lecturers, graduates, and cadets, ensuring that both pedagogical and practical perspectives were represented.

Focus group discussions were employed to facilitate collective reflection and interactive dialogue among participants, particularly graduates and cadets, to explore shared experiences, challenges, and proposed solutions regarding fitness training and nutrition in maritime education. These discussions encouraged collaborative knowledge-building and allowed for comparative insights across different participant groups, revealing patterns of agreement and divergence regarding training effectiveness. Participant observation served as an additional instrument, allowing for direct assessment of cadets' engagement in structured physical activities, their dietary habits, and the implementation of health-related policies within their educational environment. Through systematic and structured observation, the research gathered empirical data on how physical training was conducted, the frequency and intensity of participation, and the actual dietary provisions offered to cadets in maritime institutions.

The study's independent variable was the integration of structured physical training and balanced nutrition into maritime vocational education, while the dependent variables included cadet performance, endurance, cognitive function, and perceived readiness for maritime careers. The research identified three key indicators for assessing the effectiveness of physical and nutritional integration in maritime education. The first indicator was physical endurance and fitness, which measured cadets' engagement in regular sports activities such as swimming, volleyball, and futsal, as well as their perceived stamina, agility, and overall fitness levels. The second indicator was nutritional adequacy and health sustainability, which examined the composition, frequency, and perceived effectiveness of cadets' meal plans in maintaining energy levels, cognitive alertness, and physical well-being. The third indicator was maritime career preparedness, which explored how graduates reflected on their training experience in relation to their job performance, resilience, and ability to sustain long-term maritime careers.

Data collection followed a systematic and iterative process to ensure depth, validity, and contextual richness in the findings.[13] The initial phase involves preliminary interviews with lecturers to establish baseline knowledge on the role of physical fitness and nutrition in maritime training. These insights guide the refinement of interview questions and discussion topics for the next phase. The second phase focuses on in-depth individual interviews and focus group discussions with graduates and cadets, exploring their experiences with physical training and nutrition in their education and how these aspects have impacted their readiness for maritime careers. The final phase involves participant observation and data triangulation, ensuring that findings from interviews and discussions align with empirical observations in real-time training environments. This phase includes documenting cadets' participation in structured sports, assessing meal consumption patterns, and analyzing the availability and quality of nutritious food options in their institutions.

Data analysis followed a thematic qualitative approach to identify recurring patterns, conceptual linkages, and emergent insights from the collected data. Thematic analysis involved categorizing data into key themes, such as competency development through physical training, sustainability of cadet well-being through nutrition, and institutional policies on maritime health and fitness.[5,7,14] This stage allowed for a comprehensive examination of the relationship between physical training, nutrition, and cadet readiness. The next phase, cross-group comparisons, involved analyzing responses from lecturers, graduates, and cadets to identify commonalities, distinctions, and areas of divergence in their perspectives. By comparing and contrasting these viewpoints, the study developed a more holistic understanding of how maritime education could be enhanced through integrated fitness and nutrition programs. Finally, the narrative synthesis stage constructed a cohesive interpretation of the findings, contextualizing them within the broader framework of maritime vocational education, sustainable workforce development, and long-term seafarer well-being. This synthesis enabled the formulation of evidence-based recommendations for maritime institutions to implement structured physical training and nutritional strategies that aligned with industry demands and seafarer health requirements.

By integrating perspectives from lecturers, industry-experienced graduates, and active cadets, this research offered a multi-faceted exploration of the role of physical training and nutrition in

Table 1. Physical endurance and fitness evaluation

Group	Effectiveness Score (1-5)	Observational Insights
Lecturers	5 (Excellent)	Lecturers confirm that structured physical training is crucial for cadet endurance and seafaring resilience.
Graduates	4 (Very Good)	Graduates acknowledge that physical training in their cadet years significantly improved their endurance at sea.
Cadets	4 (Very Good)	Cadets find physical training beneficial but challenging to manage alongside coursework.

Table 2. Nutritional adequacy and health sustainability evaluation

Group	Effectiveness Score (1-5)	Observational Insights
Lecturers	4 (Very Good)	Lecturers support the need for structured meal planning to maintain cadets' energy and endurance.
Graduates	4 (Very Good)	Graduates feel their training lacked consistent nutritional guidance, impacting their long-term seafaring readiness.
Cadets	3 (Good)	Cadets report inconsistencies in meal planning, with some meals lacking nutrient density.

Table 3. Maritime career preparedness evaluation

Group	Effectiveness Score (1-5)	Observational Insights
Lecturers	5 (Excellent)	Lecturers believe that integrating physical training and nutrition significantly enhances cadets' career readiness.
Graduates	5 (Excellent)	Graduates affirm that structured fitness and proper nutrition are crucial for long-term success in the maritime profession.
Cadets	4 (Very Good)	Cadets acknowledge that training supports career readiness but suggest improvements in balancing workload.

maritime education. The analysis not only identified existing gaps in curricular design and implementation but also presented practical insights into how these gaps could be addressed to enhance cadet performance, sustainability, and career longevity. The findings contributed to the development of a more resilient, health-conscious, and physically prepared maritime workforce, reinforcing the necessity of incorporating structured fitness and nutrition programs as core components of maritime vocational education.

RESULTS

The research findings strongly demonstrate the effectiveness of integrating structured physical endurance training and balanced nutrition into maritime education. Lecturers, graduates, and cadets provided comprehensive perspectives on how these elements enhance cadet performance, resilience, and long-term career sustainability. Qualitative thematic analysis identified critical insights across three key areas: physical endurance and fitness, nutritional adequacy and health sustainability, and maritime career preparedness. These findings highlight both the strengths and areas maritime vocational training programs must improve.

Physical endurance and fitness in maritime training

Physical endurance plays a crucial role in seafaring professions, as maritime professionals must handle physically demanding tasks, irregular sleep patterns, and extreme environmental conditions. The effectiveness of structured physical training was assessed through insights from lecturers, graduates, and cadets, with findings showing high effectiveness across all groups. The in Table 1 indicates that lecturers rated physical training as essential (5/5), while graduates (4/5) and cadets (4/5) also found it beneficial. Lecturers emphasized that regular physical training helps cadets build stamina, teamwork, and mental resilience, all of which are critical for maritime operations.

Graduates reflected on how early exposure to structured fitness programs positively influenced their seafaring endurance, helping them adapt to long shifts and physically intense maritime tasks. However, cadets raised concerns about the balance between physical training and academic coursework, noting that training schedules should be optimized to accommodate both effectively. These findings suggest that while physical fitness training is highly effective, its implementation should be refined to avoid overwhelming cadets.

Nutritional adequacy and health sustainability

Nutrition plays an integral role in maritime education, as a well-balanced diet directly affects energy levels, cognitive function, and overall endurance. The research assessed the quality and consistency of nutritional provisions available to cadets and how well these support their training and future maritime careers. The data in Table 2 reflects a strong need for structured meal planning in maritime institutions. While lecturers (4/5) and graduates (4/5) acknowledge the importance of balanced nutrition, cadets rate nutritional adequacy slightly lower at 3/5, highlighting concerns about the consistency and nutritional quality of their meals.

Lecturers emphasized that proper

nutrition should be systematically integrated into maritime training to enhance physical endurance and mental sharpness. Graduates reflected on their lack of nutritional awareness during training, noting that they often struggled to maintain energy levels at sea due to inadequate dietary habits established during their cadet years. This suggests a gap in nutritional education that should be addressed within maritime institutions. Cadets currently undergoing training reported limited access to nutrient-dense meal options, leading to concerns about sustaining energy levels during rigorous physical training. This reinforces the need for standardized meal plans and nutritional education programs to ensure that cadets develop healthy eating habits that support their long-term careers in maritime professions.

Maritime career preparedness

A key aspect of this research was assessing how physical training and nutrition contribute to maritime career preparedness. The study explored whether cadets feel adequately prepared for the physical and mental demands of seafaring, whether graduates reflect positively on their training, and how lecturers perceive the effectiveness of these programs in shaping future maritime professionals. The findings in Table 3 indicate that lecturers and graduates (5/5) overwhelmingly support the role of physical training and nutrition in career preparedness, while cadets rate it slightly lower at 4/5 due to concerns about managing their academic and physical workload.

Lecturers emphasized that seafaring is an endurance profession, where physical resilience and well-balanced nutrition directly impact job performance, safety, and long-term career sustainability. They noted that cadets who maintain physical training and proper nutrition throughout their education transition more smoothly into the professional maritime sector. Graduates reflected on how their preparedness for physically intensive maritime work was significantly enhanced by structured fitness programs, although they expressed a need for better nutritional education during their cadet years. Many struggled with dietary discipline in their first years at sea, highlighting the importance of integrating nutritional awareness into maritime training curricula. Cadets agreed that their training programs provide a good foundation for seafaring careers but suggested improvements in balancing coursework, training, and structured meal plans. They recommended flexible scheduling and more dietary guidance to help them manage their physical and mental well-being more effectively.

DISCUSSION

The findings of this research offer compelling evidence supporting the integration of structured physical training and balanced nutrition into maritime vocational education as a means of enhancing cadet endurance, cognitive function, and career readiness. The results provide critical insights into how these factors contribute to the sustainability of maritime professionals and their ability to adapt to the physically and mentally demanding nature of seafaring. By analyzing the qualitative perspectives of lecturers, graduates, and cadets, this study directly addresses the research questions concerning the role of fitness and nutrition in maritime training programs, the perceptions of stakeholders, and the potential gaps in the current curriculum. The discussion connects the findings to these original research questions, interprets their significance, and situates them within the broader landscape of maritime education and workforce sustainability.

One of the core research questions posed in this study was: How do regular physical training and structured nutritional programs enhance the preparedness and sustainability of cadets in maritime vocational education? The findings strongly suggest that structured fitness programs and dietary planning significantly contribute to endurance, cognitive sharpness, and long-term career sustainability. Lecturers emphasized that physical training builds stamina, teamwork, and mental resilience, all of which are crucial in maritime work environments. Graduates reflected on how their exposure to structured fitness programs helped them transition smoothly into maritime professions, highlighting the importance of endurance and adaptability in real-world settings.

However, while graduates and lecturers recognized the value of structured nutrition, cadets expressed concerns about the quality and consistency of meal provisions. Their feedback suggests that maritime institutions have not yet fully institutionalized structured meal planning or nutritional awareness training as an essential component of maritime education. This presents a potential gap in the training framework, where cadets may develop physical endurance through training but lack proper nutritional guidance to sustain their health and energy levels. This issue partially answers the research question but also highlights a critical area for improvement in maritime education policies.

Another research question examined was: What are the perceptions of maritime educators, graduates, and cadets regarding the effectiveness of structured fitness and nutrition programs in maritime training? The findings indicate strong agreement among lecturers and graduates on the importance of these programs, with a notable difference in cadets' experiences regarding implementation challenges. While all groups acknowledged the benefits of fitness and nutrition, cadets reported that balancing physical training with academic coursework was challenging, suggesting that maritime institutions need to optimize scheduling and support mechanisms to ensure cadets can engage in both academic and fitness-related activities without excessive stress.

The findings have significant implications for the development of maritime vocational training. The overwhelming support from lecturers and graduates suggests that fitness and nutrition should not be viewed as secondary or supplementary aspects of training but as core elements of a sustainable maritime workforce. The research highlights how early exposure to structured physical fitness training improves endurance, teamwork, and mental resilience, which are essential qualities for maritime professionals facing long working hours, unpredictable weather conditions, and extended time away from land.

The findings related to nutrition and meal planning raise an essential concern about the long-term health of maritime professionals. The fact that graduates recognized deficiencies in their nutritional training suggests that early habits formed in cadet training may persist into professional life, potentially leading to higher risks of fatigue, chronic illness, and reduced work performance. This finding underscores the need for systematic meal planning and nutritional education in maritime institutions to ensure cadets develop healthy eating habits that can sustain them throughout their careers.

The research also reveals a significant challenge in balancing fitness training with academic coursework. The concerns raised by cadets about the demanding nature of physical training alongside coursework suggest that maritime institutions must reevaluate how fitness training is scheduled and supported. Institutions may need to implement flexible training schedules, adaptive fitness programs, and structured wellness support systems to ensure cadets do not experience excessive physical strain that interferes with their academic success.

The results align with existing maritime training theories, which emphasize the importance of physical fitness and endurance in preparing seafarers for demanding conditions. Prior research on seafarer health and safety has consistently highlighted fatigue, musculoskeletal strain, and stress-related illnesses as major concerns in maritime professions.[5,15–17] The current findings confirm that structured fitness programs can mitigate these risks by improving cadet endurance and resilience before they enter the workforce. Similarly, previous research on nutritional health in maritime professions has indicated that poor dietary habits contribute to long-term health risks among seafarers, such as obesity, hypertension, and reduced cognitive function. The findings of this study reinforce this concern, as cadets reported inconsistent meal planning, and graduates reflected on how their training lacked comprehensive nutritional guidance. This suggests that nutritional education should be formalized within maritime curricula to prevent long-term health risks and optimize performance.

However, the study also highlights some departures from previous research, particularly in the cadet perception of fitness training intensity. While previous literature often focuses on the importance of endurance training in maritime education[18], this study reveals that some cadets find physical training schedules too intense or difficult to balance with academic commitments. This discrepancy suggests that more adaptive and personalized fitness programs may be necessary to ensure cadets maintain high performance without excessive physical or mental strain.[19]

One possible reason for the observed differences between this study and prior research could be the evolving nature of maritime education and training demands. As technology, automation, and sustainability initiatives shape the modern maritime industry, the role of physical endurance may be changing, requiring a more flexible approach to fitness and well-being. Additionally, previous studies have not extensively examined the cadet experience in balancing fitness with academic coursework, which this research identifies as a significant area for improvement.[20,21]

The findings also reveal a previously underexplored gap in nutritional awareness within maritime training. While previous research has acknowledged poor dietary habits among seafarers, this study identifies a lack of early nutritional training as a contributing factor, suggesting that seafarer dietary problems may begin at the cadet stage. This highlights a crucial research gap, which future studies should explore further by evaluating the long-term impact of structured nutrition programs on seafarer health and work performance.

This research contributes to maritime education by offering a comprehensive qualitative assessment that integrates the perspectives of multiple stakeholders—lecturers, graduates, and cadets. A major strength of this study is the thoroughness of data collection, which involved semi-structured interviews, focus group discussions, and direct observations. This multi-method approach ensures credibility and depth in understanding how fitness and nutrition influence cadet development.

The practical implications of these findings are significant. Maritime institutions should consider revising curricula to integrate structured fitness programs and mandatory nutritional education. Institutions should also reassess cadet schedules to better balance fitness, coursework, and meal planning. Shipping companies and maritime employers may also benefit from this research by offering wellness programs and dietary support to seafarers, ensuring long-term health and performance.

Given the findings, future research should explore how structured fitness and nutritional programs impact seafarer performance over long-term careers. Longitudinal studies tracking cadets into their professional lives would provide valuable insights into how early physical and dietary habits influence career longevity, health outcomes, and job performance. Additionally, further research could investigate how maritime institutions in different regions approach fitness and nutrition training, allowing for comparative studies that identify best practices.

The study also suggests the need for a more personalized approach to fitness training, where cadets receive individualized fitness plans based on their physical capabilities and career goals. Research into adaptive fitness models for maritime training could improve cadet engagement and optimize training effectiveness. This research underscores the essential role of structured physical training and balanced nutrition in maritime education, confirming that these elements significantly contribute to cadet endurance, cognitive function, and career readiness. By addressing key gaps in nutritional awareness, fitness scheduling, and training balance, maritime institutions can enhance cadet preparedness and long-term workforce sustainability. The findings pave the way for policy improvements, curriculum enhancements, and future research aimed at ensuring that maritime professionals enter the workforce physically resilient, nutritionally informed, and well-equipped for the challenges of seafaring life.

CONCLUSION

This research demonstrates the critical role of structured physical training and balanced nutrition in maritime education, significantly impacting cadet endurance, cognitive function, and career preparedness. Lecturers, graduates, and cadets strongly agree on the necessity of integrating fitness and nutritional programs. Lecturers and graduates confirm fitness training enhances stamina, teamwork, and resilience; cadets request better scheduling for academic balance. The study identifies gaps in nutritional awareness and meal planning, with cadets and graduates reporting inconsistent dietary programs. Institutions must implement standardized meal plans and nutritional education to prevent fatigue and long-term health issues. They should also adapt fitness training models for greater flexibility. Future research should explore long-term impacts of fitness and nutrition training on seafarers. Addressing these areas equips maritime professionals with physical resilience and health consciousness for sustainable careers, enhancing performance and well-being at sea.

ETHICAL CONSIDERATION

Research protocol SK/STIP/75/2025 and ST//37/Puket/1/11/2025 was reviewed and approved by the Ethics Committee of Sekolah Tinggi Ilmu Pelayaran Jakarta, Indonesia, and informed consent was obtained from all participants.

CONFLICT OF INTEREST

None.

FUNDING

None.

AUTHOR CONTRIBUTIONS

RR, LB, and MBS concepted the study design, collected the data, searched the literatures, and wrote the manuscript; TC, W, IF, DZ, and NS collected the data, searhed the literature, and reviewed the manuscript.

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