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Comparison of vital signs in gymnastic participants in ac and non-ac rooms

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ABSTRACT

Vital signs, including heart rate, blood pressure, respiratory rate, and body temperature, are essential indicators of physiological responses to exercise. Environmental conditions such as temperature and humidity may alter these responses, yet limited evidence exists regarding their effect during indoor training in tropical climates. This study aimed to analyze differences in vital sign responses between individuals performing gymnastics-based strength training in air-conditioned (AC) and non-AC fitness centers in Medan Petisah District, Medan. A quasi-experimental pretest–posttest two-group design was applied with 100 male participants aged 18–30 years who routinely engaged in gymnastics-based exercise. Participants were divided into two groups: training in AC gyms and training in non-AC gyms. Vital signs, namely heart rate, systolic and diastolic blood pressure, respiratory rate, and body temperature, were measured before and after a standardized 30-minute session. Data analysis used the Independent t-test with a significance threshold of $p<0.05$. The findings showed no statistically significant differences in heart rate ($p=0.184$), systolic blood pressure ($p=0.263$), diastolic blood pressure ($p=0.714$), respiratory rate ($p=0.114$), and body temperature ($p=0.380$) between the AC and non-AC groups. These results indicate that short-term strength training produces similar physiological responses regardless of the presence of air conditioning. Strength training in both AC and non-AC environments demonstrated comparable impacts on vital signs. Although environmental comfort may differ, acute physiological adaptation remained stable. Further studies should involve diverse participants, longer training durations, and additional physiological variables to deepen understanding.

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INTRODUCTION

Vital signs—including blood pressure, pulse rate, respiratory rate, and body temperature—are fundamental physiological indicators that reflect the overall health status of an individual. They are objective measures that can fluctuate rapidly depending on physical activity, environmental conditions, and medical interventions. Monitoring vital signs plays a critical role in detecting early physiological changes, assessing responses to medical or physical interventions, and evaluating overall health progression (Nurochman et al., 2024; Sitorus et al., 2023). Within the context of physical exercise, vital signs are often used to evaluate how the cardiovascular, respiratory, endocrine, and nervous systems adapt to external stressors, including environmental conditions (Adjie et al., 2024; Carrick-Ranson et al., 2020).

One of the most influential external factors that modify the body's response to exercise is the surrounding environment, particularly temperature and humidity. Exercise conducted in an air-conditioned (AC) environment is generally perceived as more comfortable and safer, as it allows for better thermoregulation and reduces the risk of heat-related illnesses such as dehydration or heat stroke. Conversely, exercising in a non-AC environment increases thermal strain due to heat accumulation, accelerates fatigue, and imposes greater cardiovascular and respiratory demands on the body (Gavrielatos et al., 2022; McGlynn et al., 2022; Otani et al., 2023). Gymnastics exercises such as squats, planks, and other high-intensity movements often increase body temperature and sweating, which magnifies the influence of environmental conditions. Research has shown that training in hot and humid settings exacerbates thermoregulatory stress, elevates heart rate, and reduces metabolic efficiency, whereas cooler environments—though alleviating heat stress—may trigger respiratory discomfort due to dry air exposure (Agrawal & Devi, 2023; Seok et al., 2024; You et al., 2022).

Several recent studies emphasize the physiological implications of environmental conditions during exercise. Périard et al. (2021) demonstrated that high temperatures significantly increase cardiovascular strain, forcing the body to elevate both heart rate and respiration to maintain optimal internal balance. Cheuvront et al. (2023) further noted that exercise in non-AC environments accelerates fatigue and increases the risk of dehydration compared to regulated temperatures. Similarly, Huang et al. (2021) reported that thermoregulatory responses directly correlate with rises in core temperature, resulting in heightened cardiovascular workload. Complementary findings by Morrissey-Basler et al. (2021) showed that individuals with higher body fat experience greater thermoregulatory stress, highlighting the relevance of BMI when considering training environments. In addition, Yanovich et al. (2020) emphasized sex-based differences in thermoregulation, suggesting that environmental stressors may affect men and women differently during exercise. Collectively, these findings indicate that training environments substantially influence exercise safety and efficiency. However, most existing studies focus on endurance sports or outdoor training, with limited exploration of indoor gymnastic exercise under tropical climates such as in Indonesia. This gap provides a strong rationale for the present study.

The city of Medan, characterized by its hot and humid tropical climate, presents an ideal case for examining how indoor training conditions, specifically AC versus non-AC rooms, affect physiological responses. Unlike previous research conducted in temperate regions, this study uniquely addresses the effects of tropical environments, where humidity levels and heat exposure differ significantly (Seok et al., 2024; Soraya et al., 2020). The choice of gymnastics as the focus is particularly urgent, as strength training produces different cardiovascular and metabolic responses compared to endurance-based activities. Unlike endurance exercise that emphasizes sustained aerobic demand, gymnastics-based strength training involves intermittent, high-intensity, and resistance-focused movements, which elicit acute spikes in blood pressure, heart rate, and respiratory activity. These characteristics make strength training a more sensitive context for evaluating how environmental stressors, such as AC versus non-AC conditions, directly influence both cardiovascular and thermoregulatory responses. Thus, prioritizing gymnastics-based strength training as the research model not only fills the gap in the literature but also provides contextually relevant insights into exercise physiology in tropical indoor environments (Rios et al., 2024; Salagas et al., 2020). This provides an opportunity to expand the literature by analyzing how different indoor environments influence vital signs during such exercise.

Therefore, the present study aims to investigate the differences in vital signs—specifically pulse rate, respiratory rate, blood pressure, and body temperature—among individuals performing gymnastics in AC and non-AC environments in Medan Petisah District, Medan. The specific objectives are: (1) to compare heart rate responses during gymnastics in AC and non-AC rooms, (2) to examine differences in blood pressure across the two environments, (3) to assess variations in respiratory rate, and (4) to evaluate changes in body temperature.

The contribution of this study lies in its practical and theoretical significance. Theoretically, it enriches existing literature by providing empirical evidence on how environmental conditions shape physiological responses in gymnastics, particularly in a tropical context (Araujo & Tou, 2024; Cramer et al., 2022). Practically, the findings will inform health professionals, fitness trainers, and gym operators in designing safer and more effective training environments. Recommendations derived from this research may help minimize health risks such as dehydration, heat stroke, or excessive cardiovascular strain, while optimizing comfort and performance for individuals engaging in indoor physical activities (Hanum et al., 2020; Ihenacho, 2020).

In summary, while prior studies have highlighted the influence of temperature and humidity on vital signs during exercise, limited research has addressed the comparison of AC versus non-AC indoor settings in tropical climates, particularly within the scope of gymnastics. This study seeks to fill that gap by offering context-specific insights and evidence-based recommendations, thereby contributing both to academic discourse and to practical health and fitness strategies. Therefore, the present study aims to investigate the differences in vital signs specifically pulse rate, respiratory rate, blood pressure, and body temperature among individuals performing gymnastics in AC and non-AC environments in Medan Petisah District, Medan. The research seeks to compare heart rate responses, examine variations in blood pressure, assess differences in respiratory rate, and evaluate changes in body temperature between the two environmental settings. In addition to these physiological outcomes, the study also intends to explore subjective comfort indicators such as perceived exertion, fatigue, and thermal comfort. The inclusion of these perceptual measures is expected to provide complementary insights that enrich the interpretation of objective vital sign data, offering a more holistic understanding of how environmental conditions influence both physiological and psychological responses during gymnastics training.

RESEARCH METHOD

This study employed a quantitative comparative approach using a quasi-experimental design with a pretest–posttest two-group structure. Such a design is frequently used in sports and health sciences to compare physiological responses between different intervention settings while maintaining ecological validity (Creswell & Creswell, 2018). The research compared two groups: individuals performing strength training in air-conditioned (AC) rooms and those training in non-AC rooms. The study was conducted in four selected gyms in Medan Petisah District, consisting of two AC gyms (Vizta Gym and New Life Gym) and two non-AC gyms (Spartan Gym and Agi Gym). Data collection was carried out over three months, encompassing preparation, execution, and analysis stages.

The study population included all individuals engaged in gymnastics-based strength training within Medan Petisah. Sampling was determined using the Federer formula $(n-1)(t-1) \geq 15$, which indicated a minimum of 16 participants per group, resulting in a total sample of 32. Participants were recruited based on inclusion criteria: male, aged 18–30 years, physically healthy without cardiovascular or respiratory disorders, having performed regular strength training at least three times per week in the past month, and willing to sign informed consent. Exclusion criteria included recent consumption of caffeine, stimulants, or alcohol within 24 hours, medical contraindications, failure to complete training sessions, or withdrawal of consent. This sampling procedure aligns with recommendations for experimental sports research to ensure homogeneity and reliability.

The research instruments included a sphygmomanometer to measure blood pressure, a pulse oximeter to assess heart rate, a stopwatch to calculate respiratory rate and training duration, and a digital thermometer to measure body temperature. These tools are widely validated in exercise physiology research for accuracy and reliability in monitoring vital signs.

The procedure was conducted in three stages. First, the preparation stage included obtaining permission from gym facilities, calibrating instruments, and conducting participant briefing to ensure procedural clarity. Second, during the implementation stage, participants were assigned to AC and non-AC groups, each undergoing a standardized 30-minute gymnastics-based strength training session. Pretest vital signs (blood pressure, heart rate, respiratory rate, and body temperature) were measured before the exercise, while posttest measurements were taken immediately after the session. Third, the analysis stage involved comparing physiological responses between the two groups to evaluate the influence of environmental conditions on vital signs.

Data were processed through univariate and bivariate analyses. Univariate analysis was applied to describe the distribution of vital sign variables for both AC and non-AC groups. Bivariate analysis was conducted to test differences between groups, using the Independent t-test for normally distributed data or the Mann–Whitney test for non-normally distributed data. Statistical significance was determined at $\alpha = 0.05$, with $p < 0.05$ considered significant. This analytical framework is consistent with established guidelines for evaluating exercise interventions in controlled experimental designs.

In operational terms, the independent variable was the training environment (AC vs. non-AC), while the dependent variables were pulse rate, blood pressure, respiratory rate, and body temperature. All outcomes were measured on ratio scales, except training environment, which was nominal. This operationalization allowed for direct comparison of physiological changes attributable to environmental conditions during exercise.

RESULTS AND DISCUSSIONS

Univariate Analysis

The study on comparing vital signs of gymnastics participants performing strength training in air-conditioned (AC) and non-AC rooms in Medan Petisah was conducted between May and August 2025. The sample was selected using purposive sampling, resulting in 100 subjects who met the inclusion criteria.

The distribution of the age of subjects in the study is as follows:

Table 1. Age frequency distribution

Age	N	%
18	8	8
19	10	10
20	6	6
21	3	3
22	7	7
23	10	10
24	15	15
25	6	6
26	10	10
27	13	13
28	6	6
29	6	6
Total	100	100

Additionally, the degree of hypertension among the subjects was as follows:

Table 2. Hypertension degree

Degree of Hypertension	N	%
Normal	62	62
Pre-hypertension	19	19
Hypertension Stage 1	13	13
Hypertension Stage 2	6	6
Total	100	100

Next, the data regarding vital signs, including heart rate, systolic blood pressure, diastolic blood pressure, respiratory rate, and body temperature, was analyzed for normal distribution. The results are summarized in the following table:

Table 3. Distribution of vital signs (heart rate, blood pressure, respiratory rate, and temperature) in ac and non-ac rooms

Vital Sign	Room Type	N	P-value
Heart Rate	AC Room	50	0.267
	Non-AC Room	50	0.173
Systolic BP	AC Room	50	0.138
	Non-AC Room	50	0.058
Diastolic BP	AC Room	50	0.099
	Non-AC Room	50	0.273
Respiratory Rate	AC Room	50	0.061
	Non-AC Room	50	0.094
Temperature	AC Room	50	0.070
	Non-AC Room	50	0.066

As shown in Table 3, all vital signs were normally distributed ($P > 0.05$), suggesting that no significant deviations were found in the data regarding the normality of the distributions.

Bivariate Analysis

The next phase of analysis involved comparing the vital signs between the AC and non-AC room groups. The statistical differences were examined using an Independent t-test for each variable, and the results are summarized in the following table:

Table 4. Comparison of vital signs (heart rate, blood pressure, respiratory rate, and temperature) between ac and non-ac rooms

Vital Sign	Room Type	N	Mean	Std. Deviation	P-value
Heart Rate	AC Room	50	130.08	7.497	0.184
	Non-AC Room	50	132.42	9.831	
Systolic BP	AC Room	50	118.58	3.671	0.263
	Non-AC Room	50	119.42	3.796	
Diastolic BP	AC Room	50	84.90	3.851	0.714
	Non-AC Room	50	84.62	3.779	
Respiratory Rate	AC Room	50	24.60	2.129	0.114
	Non-AC Room	50	25.36	2.609	
Temperature	AC Room	50	36.746	0.2697	0.380
	Non-AC Room	50	36.788	0.2017	

As indicated in Table 4, the results of the Independent t-test for all five vital signs showed P-values greater than 0.05, meaning there were no significant differences between the AC and non-AC rooms in terms of heart rate, systolic blood pressure, diastolic blood pressure, respiratory rate, or body temperature.

The bivariate analysis demonstrates that environmental conditions, such as air-conditioning, do not appear to significantly affect the vital signs of individuals performing strength training in AC and non-AC rooms. The study's findings suggest that the environmental setting, whether air-conditioned or not, does not have a substantial impact on the vital sign responses of participants in this specific context.

Discussion

The findings from the current study on the comparison of vital signs between gymnastics participants performing strength training in AC and non-AC rooms indicate that environmental conditions do not have a significant impact on the physiological responses of the participants. This conclusion is drawn from the results of univariate and bivariate analyses, which show no significant differences in heart rate, blood pressure (systolic and diastolic), respiratory rate, and body temperature between the two groups (AC and non-AC rooms). The results of the Independent t-test for all variables yielded P-values greater than 0.05, suggesting that the environmental temperature did not significantly alter the participants' vital signs during the training sessions.

The lack of a significant difference in heart rate (P = 0.184) is consistent with findings by Otani et al. (2023), where the heart rate remained stable even in environments with significant temperature increases. This suggests that, despite a potential increase in body temperature, the cardiovascular load induced by the heat, particularly in non-AC environments, does not necessarily translate into a dramatic rise in heart rate during strength training. Furthermore, a systematic review by Salagas et al. (2020) noted that heat acclimatization significantly lowers heart rate during exercise, supporting the idea that participants may have adapted to the heat exposure in the non-AC rooms, leading to heart rate levels similar to those in the AC rooms.

In terms of systolic blood pressure, the study found no significant difference (P = 0.263) between the two groups, which aligns with the findings of Ihenacho (2020), who reported a similar P-value (P = 0.25). Interestingly, the study observed that constant cooling in AC rooms led to a significant increase in both systolic and diastolic blood pressure (P = 0.714), possibly due to the thermal vasoconstriction mechanism. The increase in blood pressure did not coincide with an increase in heart rate, suggesting that the observed changes were more related to hemodynamic factors rather than cardiovascular stimuli. These findings imply that an optimal approach to fitness training, particularly in terms of blood pressure management, may involve combining AC rooms (for stability and comfort) with non-AC environments (for heat acclimatization and blood pressure adaptation).

Regarding respiratory rate, the analysis revealed no significant difference (P = 0.114) between the two environments. This result contrasts with findings from Agrawal and Devi (2023), where a significant increase in respiratory rate was observed during physical activities. They suggested that regular use of AC could be associated with reduced lung function, especially in lower temperature AC settings. However, in this study, no substantial changes were observed in the respiratory rate, which may indicate that the intensity of strength training exercises was not sufficient to induce a significant effect on respiratory rate in both AC and non-AC environments.

The findings on body temperature also showed no significant difference (P = 0.380) between the two groups, which is consistent with McGlynn et al. (2022), whose study reported a similar P-value (P = 0.571). The study highlighted that internal cooling mechanisms were effective in preventing excessive body temperature increases during exercise. However, the non-AC room did induce higher thermal strain compared to the AC room, which could potentially affect performance and increase the risk of heat stress, as noted by Huang et al. (2021). This finding emphasizes the importance of considering temperature control during training to minimize the risks associated with heat stress, especially in environments without AC.

Study Limitations

This study provides valuable insights but has several limitations. The sample size, while adequate, may not fully represent the broader population, particularly in terms of fitness levels and health conditions. Additionally, the study did not account for individual factors such as age, gender, or fitness level, which may influence exercise responses. Future studies should include a more diverse sample and consider these variables.

The study's geographic location in a tropical climate may also limit the generalizability of the findings to regions with different environmental conditions. Furthermore, purposive sampling may have introduced selection bias, affecting external validity.

Finally, the study focused on short-term responses to training in AC and non-AC environments. Long-term exposure, particularly acclimatization to temperature variations, could yield different results. Future research should address these limitations, explore long-term effects, and consider additional factors influencing physiological responses to exercise.

CONCLUSION

This study on the comparison of vital signs in gymnastics participants performing strength training in AC and non-AC rooms in Medan Petisah found that there were no significant differences in any of the measured vital signs. Specifically, heart rate (P = 0.184), systolic blood pressure (P = 0.263), diastolic blood pressure (P = 0.714), respiratory rate (P = 0.114), and body temperature (P = 0.380) showed no significant variation between participants in the AC and non-AC environments. The findings contribute to understanding how environmental conditions impact physiological responses during exercise, suggesting that temperature control in gym environments may not drastically alter vital signs in strength training activities.

However, the study has limitations, including its small sample size and short-term observation period, which could affect the generalizability and long-term applicability of the results. Future research should focus on longer-term studies with a more diverse sample and consider additional factors such as fitness levels, gender, and pre-existing health conditions to provide a more comprehensive understanding of the environmental effects on exercise physiology. Importantly, future investigations should expand beyond vital sign measurements to incorporate stress biomarkers as complementary indicators of physiological strain. Biomarkers such as cortisol can reflect hormonal stress responses, blood lactate levels can provide insight into anaerobic metabolism and muscular fatigue, and hydration markers (e.g., plasma osmolality, urine specific gravity) can reveal fluid balance and thermoregulatory stress. Including these parameters would allow researchers to capture a more holistic view of how the body adapts to exercise under different environmental conditions. This multidimensional approach would not only strengthen the scientific rigor of exercise physiology studies but also generate evidence that can inform practical guidelines for gym management, athlete monitoring, and preventive strategies in sports medicine.

Moreover, given the increasing global concern about climate change and its influence on human health, the exploration of exercise responses in different environmental settings carries significant public health implications. By extending the analysis beyond traditional vital signs to include biochemical and metabolic markers, future studies can bridge the gap between clinical physiology and applied sports science. Such an approach not only enhances the scientific rigor of exercise research but also provides practical recommendations for fitness centers, healthcare practitioners, and policymakers to optimize safe and effective training conditions across diverse populations.

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