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Exploring Physiology and Body Traits of Finswimming Athletes and Trained Swimmers

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Abstract

In practical situations, athletes often face certain limitations in the transition to finswimming. Consequently, coaching procedures focus on the conversion of trained-swimmers into finswimming athletes. This study aimed to conduct a comparative analysis of the anthropometric characteristics, aerobic capacity, and respiratory capacity of athletes engaged in finswimming and those trained in traditional swimming. Fifteen male finswimming athletes and trained-swimmers aged 18-19 years participated in the study. They performed a progressive maximal treadmill test under laboratory conditions for measuring their aerobic capacities. Respiratory capacity was measured using spirometer, while body fat percentage was measured using GE Lunar Prodigy DXA. The result showed that the finswimming athletes had statistically higher values of aerobic capacity and respiratory capacity compared to trained-swimmers. Meanwhile, trained-swimmers had statistically higher values of body fat percentage compared to finswimming athletes. Based on these findings, we conclude that finswimmers exhibit a pronounced advantage in aerobic capacity, body fat, and respiratory capacity. While certain parameters, notably respiratory and aerobic capacities, demonstrated marked disparities between the two cohorts, other elements showcased a parallel nature. This conveys the potential for trained swimmers, as identified in this study, to ascend to the levels of athletes by adopting analogous structured training schedules and nutritional regimes akin to those observed in finswimmers.

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INTRODUCTION

Finswimming and swimming are aquatic sports characterized by competitive swimming in water (Stavrou & Voutselas, 2018). Nevertheless, a fundamental difference between the two sports lies in the requisite employment of specialized equipment unique to finswimming, including monofins, bifins, and snorkels, which are not integral components of traditional swimming (Stavrou et al., 2019). Furthermore, despite the swimming historical prominence as a competitive event within the Olympic Games, it is noteworthy that fin swimming, in contrast, has not attained the status of an Olympic sport.

Finswimming encounters challenges in gaining popularity due to the specialized equipment required, potentially creating financial obstacles for participation. Recent research among adolescents aged 16 to 19 across various North and South American regions shows a notable preference for traditional swimming (Eime et al., 2020; Vandermeerschen et al., 2015). In this age group, swimming holds the fourth most favored sport position in the United States and Mexico, ranking second only to football in Brazil, Peru, and Argentina (Maillane-Vanegas et al., 2018; Vandermeerschen et al., 2015, 2016). Moreover, within the European adolescent demographic, swimming is the second most favored sport, while football retains its primary preference (Hulteen et al., 2017; Maillane-Vanegas et al., 2018).

Swimming stands as a highly beneficial physical activity renowned for its positive impacts on both physical and mental well-being (Charmas & Gromisz, 2019; Fone & van den Tillaar, 2022; Roelofs et al., 2017). Furthermore, participation in swimming sports is associated with specific advantages. Numerous studies indicate that adolescents engaged in swimming sports exhibit a greater stature compared to non-participants (Kondrič et al., 2012; Santos-Silva et al., 2017). Moreover, trained-swimmers aged 16 to 18 typically manifest an average height ranging from 176 to 183 cm, weigh around 70 to 74 kg, maintain body fat percentages between 8 and 12%, and demonstrate a VO2max ranging from 48 to 56 ml/kg/min (Dassanayake, 2016; Lazovic-Popovic et al., 2016). Similarly, the professional finswimmers aged 16 to 17 typically present an average height spanning 175 to 180 cm, a weight ranging from 70 to 72 kg, body fat percentages ranging from 10 to 12%, and VO2max values ranging from 50 to 58 ml/kg/min (Kunitson et al., 2015; Wang et al., 2012).

Collectively and as per multiple prior independent research endeavors, it becomes evident that adolescent swimmers, specifically within the 16-18 age group, exhibit physiological and anthropometric attributes closely akin to those observed in finswimming athletes aged 16-19 (Fone & van den Tillaar, 2022; Kondrič et al., 2012; Kunitson et al., 2015; Wang et al., 2012). Consequently, considering the outcomes of the comprehensive body of research conducted, it becomes compelling to delve into further investigations aimed at elucidating the intricacies that underlie the relationship between traditional swimming and finswimming. Additionally, in practical situations, athletes transitioning to finswimming often face certain limitations. Consequently, coaching procedures are oriented towards the conversion of trained-swimmers into finswimming athletes.

The comparative analysis undertaken here serves not only to enrich the corpus of sports science but also to provide a scientific basis for tailoring training methodologies, optimizing athletic performance, and mitigating the risk of sports-related injuries in these athletes. This research initiative embarks on a comprehensive examination aimed at unraveling the intricate tapestry of physiological and anthropometric attributes that distinguish finswimming athletes from their counterparts, trained-swimmers. Finswimming and traditional swimming, while both aquatic disciplines, present athletes with distinct challenges, necessitating specialized physiological adaptations (E. Z. Campos et al., 2017; Fone & van den Tillaar, 2022; Stavrou et al., 2018).

The high level of competition in traditional swimming classes tends to cause athletes to switch to finswimming. However, in practical situations, traditional swimming athletes who switch to finswimming often face limitations in the use of their equipment. Hence, given the existing limited research that scrutinizes the distinctions between trained-swimmers and finswimming athletes, this study was aimed to conduct a comparative analysis of the anthropometric characteristics, aerobic capacity, and respiratory capacity of athletes engaged in finswimming and those trained in the traditional swimming. Ultimately, this investigation aimed to provide a comprehensive understanding of the specialized characteristics of finswimming and traditional swimming and their implications for athlete performance and development.

METHODS

Participants

The research encompassed a cohort of 30 participants, consisting of 15 male finswimming athletes and 15 trained-swimmers aged 18 and 19 years. The finswimming athletes involved in this study were distinguished as elite athletes who dedicated an average of 12 hours per week to training, harbored 7 years of expertise in finswimming, and boasted participation in numerous national and international level tournaments. In contrast, the trained-swimmers were affiliated with a local swimming club, devoting an average of 6 hours per week to training, possessing 4 years of swimming experience, and not having partaken in national or international level competitions. All participants were confirmed to be in a good health and devoid of cardiovascular disease, asthma, or smoking habits. The tests were administered at the Cibubur National Sports Hospital's Sports Laboratory, commencing at 9 am. The laboratory maintained a temperature ranging between 22-26°C, alongside an approximate humidity of 60-80%. An hour before the tests, the research subjects consumed snacks and dressed appropriately in sports gear and footwear.

Ethical

Each participant was subjected to thorough verbal and written elucidations concerning the study objectives, methodologies, and conceivable risks. Following this, they were required to furnish informed consent through the formal endorsement of a consent document if they willingly concurred with participation. The research protocol underwent a rigorous appraisal and secured approval from the Research Ethics Commission at the Bandung Polytechnic of Health.

Procedures

Anthropometric Measurement

The assessment in this investigation employed the GE Lunar Prodigy DXA apparatus for the determination of body fat percentage. The subject particulars, comprising height, weight, gender, and age, were documented and entered a computer system connected to the GE Lunar Prodigy DXA device. Following this, the subjects were positioned in a supine posture on the GE Lunar Prodigy DXA equipment to enable a detailed full -body scan. Post-scanning, the data derived from the measurement procedure were displayed on the computer monitor for subsequent analysis and comprehension (Esco et al., 2018).

Aerobic Capacity Measurement (VO2max)

In this investigation, the assessment of aerobic capacity involved the use of a laboratory method in line with the recommended testing protocol established by the British Association of Sport Science (BASS). The measurement process was facilitated by a Cosmed CPET device combined with a computerized treadmill. The protocol for determining VO2max via the Cosmed CPET entailed an initial treadmill setting ranging from 4-7 km/h for 4 minutes, with varying speeds each minute. Following this, the speed increased by 1 km/h per minute, accompanied by adjustments in the treadmill incline every two minutes. The test concluded once the subjects could no longer maintain their pace or reached a point of exhaustion, with the VO2max data displayed on the computer screen after the test completion (Durstenfeld et al., 2022).

Heart Rate Measurement

The maximal heart rate was assessed through a 12-lead ECG, utilizing the COSMED CPET system in conjunction with the Tanaka Equation (208 - (0.7 * age)) (Luo et al., 2021). During the evaluation of VO2max, participants were equipped with chest electrodes to facilitate the automatic monitoring and display of their heart rate on the computer screen.

Respiratory Capacity Measurement (FVC)

The evaluation of FVC (forced vital capacity) was carried out employing the Spirometer SP10 apparatus. The participant anthropometric data, encompassing parameters such as height, weight, and age, were inputted into the device. Subsequently, subjects assumed a seated position and were instructed to execute maximal inhalation followed by maximal exhalation into the Spirometer device. The determination of FVC was made after the subjects successfully completed the measurement (Yasmeen et al., 2020).

Lactic Acid Measurement

The quantification of lactic acid concentrations was carried out through the application of a meticulously calibrated portable device known as the Accutrend

Plus. Following the completion of the VO2max assessment, a minor blood sample was extracted from the subject fingertip. This blood specimen was subsequently subjected to analysis employing the portable Accutrend Plus lactate meter to ascertain the precise lactate concentration (Cole et al., 2017).

Design or Data Analysis

The examination of variable normality was conducted through the application of the Kolmogorov-Smirnov Test. Furthermore, data presentation was displayed in the form of average values and standard deviation. One-way analysis or One-way Anova test was used to compare variables between trained swimmers and finswimming athletes. The statistical analysis was performed utilizing SPSS v22 software, with the significance level established at $p < 0.05$.

RESULT

Following the Kolmogorov-Smirnov test, it was confirmed that the collected data for all variables in this study exhibited normal distribution. Table 1 displays the mean values for age, weight, height, BMI, and body fat percentage among finswimmers, which were recorded as 17.33 ± 1.75 years, 172.17 ± 5.85 centimeters, 63.33 ± 4.09 kilograms, 21.30 ± 2.51 kg/cm², and 11.2 ± 2.1 percent, respectively. Conversely, the mean values for these variables in trained-swimmers were 16.83 ± 1.82 years, 170.83 ± 4.17 centimeters, 68.17 ± 8.33 kilograms, 22.84 ± 3.62 kg/cm², and 19.4 ± 3.5 percent, respectively. Upon conducting statistical analysis to compare the two groups, it was revealed that while there were no significant differences in age, weight, height, or Body Mass Index, a notable distinction existed in body fat percentage between the finswimmers and trained-swimmers, demonstrating a p-value < 0.05.

Table 1. Participants characteristics

Variables	Finswimmers (N=15)	Trained-swimmers (N=15)	p-Value
Age (years)	17,33 ± 1,75	16,83 ± 1,82	0.187
Height (cm)	172,17 ± 5,85	170,83 ± 4,17	0.124
Weight (kg)	63,33 ± 4,09	65,17 ± 8,33	0.185
BMI (kg/cm^2)	21,30 ± 2,51	22,84 ± 3,62	0.232
Body Fat (kg)	11,2 % ± 2,1	16,4 % ± 3,5*	0.024

Note: Results are means ± SD; SD = Standard deviation. Significant difference between finswimmers and trained-swimmers, * at P<0.05.

Table 2 displays the mean values and standard deviations for heart rate, maximum heart rate, lactic acid concentration, VO2max, and FVC among finswimmers and trained-swimmers. The heart rate mean for finswimmers stood at 168.21 ± 8.51 (beats per minute), whereas for trained-swimmers, it registered at 178.67 ± 7.20 (beats per minute). In terms of maximum heart rate, finswimmers exhibited a mean of 191.17 ± 9.32 (beats per minute), while trained-swimmers showed 195.67 ± 7.97 (beats per minute). Comparatively, the lactic acid concentration averaged 10.10 ± 0.86 (mmol·L-1) for finswimmers and 11.81 ± 0.39 (mmol·L-1) for trained-swimmers.

Figure 1. Body compotition measurements

Figure 2. Aerobic capacity measurements

Concerning VO2max, finswimmers had an average value of 52.72 ± 2.11 (ml·kg-1·min-1) and trained-swimmers exhibited 46.26 ± 6.31 (ml·kg-1·min-1). Lastly, the FVC values were noted as 4.12 ± 0.29 for finswimmers and 3.85 ± 0.29 for trained-swimmers. Upon statistical analysis to compare the two groups, it was revealed that while there were no significant differences in maximum heart rate, notable differences existed in maximum heart rate, lactic acid concentration, VO2max, and FVC levels, demonstrating a p-value < 0.05.

Table 2. Physiological variables measured in fin swimmers and trained-swimmers during a maximal treadmill test

Variables	Finswimmers (N=15)	Trained-swimmers (N=15)	P-Value
HRmean (beats. min-1)	168,21 ± 8,51	178,67 ± 7,20*	0.028
HRmax (beats. min-1)	191,17 ± 9,32	195,67 ± 7,97	0.102
[Lac]b peak (mmol· l-1)	10,10 ± 0,86	13,81 ± 0,39*	0.032
VO2max (ml.kg-1. min-1)	52,72 ± 2,11	46,26 ± 6,31*	0.022
Force Vital Capacity (FVC) (L)	4,34 ± 1,89	3,85 ± 1,31*	0.026

Note: HRmean= mean heart rate, HRmax = maximum heart rate, [Lac]b= Blood Lactate Concentration, L=Liters. Results are means ± SD; SD = Standard deviation. Significant difference between finswimmers and trained-swimmers, * at P<0.05.

DISCUSSION

The primary objective of this investigation was to assess and contrast the anthropometric, aerobic, and respiratory capacities in finswimmers and trained-swimmers. To the best of our understanding, this is the inaugural study to undertake a comparative analysis of anthropometric, aerobic, and respiratory capacities between finswimmers and trained-swimmers. Our findings indicated that no statistically significant variances existed in age, height, weight, or body mass index between the groups. Nonetheless, significant statistical distinctions were observed in body fat percentage, post-blood lactate concentration, aerobic capacity (VO2max), and respiratory capacity (FVC) between finswimmers and trained-swimmers.

The study provided a comparative assessment of various anthropometric measures between finswimmers and trained-swimmers, elucidating a nuanced divergence in body fat percentage between the two athlete groups. While similarities in age, weight, height, and Body Mass Index (BMI) were observed, a substantial difference was apparent in body fat percentage. Finswimmers displayed a body fat percentage mean of 11.2 ± 2.1 percent, contrasting notably with trained-swimmers, who averaged 19.4 ± 3.5 percent. This statistical variance underscored a significant discrepancy in body composition between the athletes of these distinct disciplines.

The discernible difference in body fat percentage is suggestive of a unique physiological attribute or adaptation linked to the specific training and participation in finswimming activities. The lower body fat percentage observed among finswimmers is an intriguing point of differentiation. It implies a probable distinct physiological response or requirement for enhanced hydrodynamics and buoyancy regulation, which could be an adaptation acquired through specialized training regimens in finswimming. The observed discrepancy could be attributed to the more systematic and consistent training regimen followed by finswimmer athletes. Findings from a previous study examining athletic and non-athletic young individuals further corroborate this observation (Dassanayake, 2016; Kondrič et al., 2012).

Our study demonstrates that trained-swimmers exhibit a relatively elevated body fat percentage in contrast to finswimming athletes. Notably, these fat percentage levels remain within the realm of a healthy range, and notably lower when compared to individuals who do not engage in a regular exercise (Charmas & Gromisz, 2019; Dopsaj et al., 2020; Santos et al., 2005). These results signify that active engagement in sports and adherence to a well-organized training regimen distinctly influence anthropometric factors, particularly the composition of body fat (Ashtary-Larky et al., 2018; Dassanayake, 2016; Toselli, 2021). These results suggest that active participations in sports and adherence to a structured training program can directly impact physical anthropometric factors, including body fat.

Differences in VO2max between finswimmers athletes and trained-swimmers were found to be statistically significant. Our investigation revealed that finswimmers athletes demonstrate a superior aerobic capacity in comparison to the trained-swimmers, primarily attributed to their extensive practice regimen of 12 hours per week and prolonged engagement in high-level competitive events. This outcome is in line with prior research, which has consistently established that discrepancies in exercise duration contribute to variations in the aerobic capacity of athletes (Baron et al., 2020; F. de S. Campos et al., 2021; Lipecki & Rutowicz, 2015). Additionally, scientific studies have proposed that athletes tend to have a higher aerobic capacity than the general populace due to disparities in competitive levels and the extent of their participation in various sporting events (Ashtary-Larky et al., 2018; Bahri et al., 2021; Charmas & Gromisz, 2019; Dassanayake, 2016).

Based on our study findings, trained-swimmers exhibit comparatively lower aerobic capacity when contrasted with finswimming athletes. However, it is crucial to acknowledge that the scores achieved by the trained-swimmers in our investigation remained within the superior range, particularly in comparison to non-exercising individuals within the same age group (Almeida et al., 2021; Charmas & Gromisz, 2019; Dopsaj et al., 2020; Sharifi et al., 2018). These results suggest that the active engagement in athletic activities, combined with adherence to a structured training regime, significantly influences an individual aerobic capacity (Bahri et al., 2021; Festiawan et al., 2021; Fone & van den Tillaar, 2022; Vigorito & Giallauria, 2014).

A research gap is evident in our understanding of the forced vital capacity (FVC) within the 15-18-year-old finswimmer demographics, rendering comparisons with prior studies. Nevertheless, a study from previous study, which involved a 23-year-old finswimmer, reported an FVC measurement of 5.8 liters (Vašíčková et al., 2017). In contrast, while the measured FVC value of trained-swimmers in this study was less than that of finswimming athletes, it outperformed the FVC of non-athletic peers within the identical age category (Hancox & Rasmussen, 2018; Lazovic-Popovic et al., 2016). The superior lung function commonly observed among aquatic athletes is widely accepted (Lazovic-Popovic et al., 2016; Stavrou et al., 2018; Vašíčková et al., 2017; Wylegala et al., 2007). Various factors contribute to this advantage, encompassing specialized training routines aimed at bolstering endurance and strength of respiratory muscles, decreasing resistance in the respiratory tract, and promoting both lung elasticity and expansion of the alveoli (Bahri et al., 2021; Hancox & Rasmussen, 2018; Vašíčková et al., 2017).

One significant limitation is the potential influence of confounding variables that were not addressed in this research. Factors such as dietary habits, individual training regimens, and genetic variations were not specifically controlled for and could impact the observed physiological and anthropometric differences. These unaccounted variables could introduce a level of uncertainty into the study findings and conclusions. To address this limitation, future research could consider a more comprehensive analysis that takes into account these potential confounding factors.

Our study showed that trained-swimmers possessed fundamental skills that could facilitate their transition into professional finswimming athletes. In aquatic settings, the basic swimming abilities of trained-swimmers, such as diving techniques, good lung capacity, and the ability to endure extended periods underwater, lay a solid foundation for transitioning into finswimming athletes. The diving technical skills held by swimmers, including the ability to swim efficiently and effectively as well as the capacity to navigate in water, can serve as crucial assets for becoming professional finswimmers.

Additionally, the physical aspects of trained-swimmers, such as high lung capacity and the ability to endure underwater for relatively long durations, become vital factors. In finswimming, the trained swimming endurance of these athletes represents a valuable asset aiding their adjustment to becoming finswimming athletes. This may provide them with an advantage in adapting to key elements within finswimming, such as the use of monofins, distinctive breathing techniques, and navigation in water.

CONCLUSION

The study findings presented compelling evidence that finswimmers exhibited a pronounced advantage in anthropometric measurements, aerobic capacity, and respiratory capacity when compared to their trained-swimmer counterparts. The nuances in these attributes were most likely attributed to the meticulous and tailored training regimens and dietary practices inherent to finswimming. While certain parameters, notably respiratory and aerobic capacities, demonstrated marked disparities between the two cohorts, other elements showcased a parallel nature.

This conveys the potential for trained swimmers, as identified in this study, to ascend to the levels of athletes by adopting analogous structured training schedules and nutritional regimes akin to those observed in finswimmers. Nevertheless, to comprehensively appreciate the distinct characteristics of trained swimmers and to establish the clinical relevance of these findings, further extensive investigations are warranted.

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CONFLICT OF INTEREST

The authors declared no conflict of interest.

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