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CURRENT STATUS OF SELECTED MORPHOLOGICAL INDICES, BODY COMPOSITION, AND PHYSIOLOGICAL FUNCTIONS IN FEMALE U15 SWIMMERS OF THE VIETNAM NATIONAL YOUTH TEAM

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Abstract:

Background: Swimming is a highly specialized sport requiring comprehensive development in morphology, physical fitness, and physiological function. For U15 athletes, this developmental stage coincides with the pubertal growth spurt in females, characterized by accelerated skeletal growth, substantial increases in muscle mass, and heightened sensitivity to training stimuli (Mirwald et al., 2002; Lätt et al., 2010).

Objective: This study aimed to determine the baseline status of morphological characteristics, body composition, somatotype, and physiological functions of female U15 swimmers from the Vietnam National Youth Team, thereby providing a foundation for establishing reference thresholds for individualized monitoring throughout training cycles.

Methods: Seven female swimmers (mean age: 12.9 ± 0.8 years; height: 154.0 ± 5.23 cm; body mass: 47.06 ± 3.62 kg) underwent comprehensive assessment in January 2023. The evaluation included: 12 anthropometric variables measured according to ISAK standards; 06 body composition indices assessed using the InBody 570 analyzer; Somatotype analysis using the Heath–Carter method; 04 physiological function indices, including lactate threshold parameters and vital capacity.

Results: Most anthropometric and body composition variables demonstrated coefficients of variation (CV) below 10%, indicating relative homogeneity within the group. Somatotype analysis revealed a predominant meso-ectomorphic tendency, consistent with the physical profile typical of young competitive swimmers. Lactate threshold variables exhibited very low variability (CV < 7%), whereas vital capacity showed a CV of 16.20%, reflecting substantial inter-individual differences in pulmonary function.

Conclusion: The baseline findings provide a set of reference percentiles (P25/P50/P75) and smallest worthwhile change thresholds (SWC = 0.2 × SD) for individualized athlete monitoring across training cycles. These results contribute to improving the effectiveness of longitudinal athlete surveillance and evidence-based training adjustment.

Keywords: swimming, youth athletes, morphology, body composition, lactate threshold, periodized assessment.

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1.INTRODUCTION

Swimming is a highly specialized sport that requires comprehensive development in morphology, physical fitness, and physiological function. In U15 athletes, this developmental stage coincides with the pubertal growth acceleration phase in females, characterized by rapid skeletal growth, substantial increases in lean body mass, and heightened responsiveness to training stimuli (Mirwald et al., 2002; Lätt et al., 2010). This phase presents an important opportunity for athletic development; however, it simultaneously necessitates rigorous scientific monitoring to distinguish training-induced adaptations from changes attributable to natural growth and maturation.

In the context of youth athlete monitoring, establishing baseline status constitutes an essential prerequisite before implementing any athlete assessment programme. Baseline data provide individualized reference thresholds that enable coaches to evaluate the magnitude of change following each training cycle using the smallest worthwhile change criterion (SWC = 0.2 × SD; Hopkins, 2004), rather than relying solely on subjective judgment.

In Vietnam, studies investigating the multidimensional status of female swimmers aged 12–14 years remain limited, and training decisions are still largely experience-based. This paper presents the results of baseline assessments regarding morphology, body composition, somatotype, and physiological function in female U15 swimmers of the Vietnam National Youth Team in January 2023. The study forms part of a two-year longitudinal doctoral research project conducted from 2023 to 2024.

2. RESEARCH METHODS

Participants

Seven female swimmers from the Vietnam National Youth Team (National Sports Training Center, Ho Chi Minh City) participated in the baseline assessment conducted in January 2023. The athletes had a mean age of 12.9 ± 0.8 years, mean height of 154.0 ± 5.23 cm, and mean body mass of 47.06 ± 3.62 kg. All athletes completed the full testing battery and provided valid datasets. Written informed consent was obtained from both the athletes and their parents/legal guardians prior to participation.

Measurement Methods and Instruments

Anthropometric Assessment

Twelve anthropometric variables were measured according to ISAK standards (Marfell-Jones et al., 2006), including:

Standing height;

Sitting height;

Body mass;

Arm span;

Upper arm length;

Hand length;

Foot length;

Biacromial breadth;

Biiliac breadth;

Hand breadth;

Foot breadth;

Chest circumference during maximal inspiration.

A Martin anthropometer (precision: 0.1 cm) and Tanita MC-780 scale (precision: 0.1 kg) were used for measurements.

Body Composition Assessment

Multi-frequency segmental bioelectrical impedance analysis (InBody 570, Biospace, Korea) was employed to determine:

Body mass index (BMI);

Body fat percentage;

Fat mass;

Basal metabolic rate (BMR);

Skeletal muscle mass;

Fat-free mass.

Athletes fasted for at least four hours and refrained from alcohol consumption and high-intensity exercise for 24 hours prior to testing.

Somatotype Assessment

Somatotype was calculated using the Heath–Carter method (1990), based on skinfold measurements (triceps, thigh, calf), bone breadths (humerus and femur), and girth measurements (flexed arm and calf circumference). Results were plotted on the two-dimensional Heath–Carter somatochart (X, Y coordinates).

Physiological Function Assessment

Lactate threshold (LT) was determined using a 5 × 200 m incremental swimming protocol tailored to each athlete's specialty stroke. Swimming velocity increased by approximately 0.05 m/s at each stage, with 60 seconds of passive recovery between stages. Heart rate was continuously monitored using the Polar H10 system.

Capillary blood samples (5 µL) were collected from the fingertip and immediately analyzed using a portable lactate analyzer (Lactate Pro 2, Arkray, Japan; CV < 3%). LT was identified using the D-max method. Vital capacity was assessed using spirometry.

Statistical Analysis

Data were analyzed using SPSS version 26.0. Descriptive statistics included mean (M), standard deviation (SD), minimum, maximum, and coefficient of variation (CV%). Group homogeneity was interpreted according to the following criteria:

CV < 10%: homogeneous;

CV ≥ 10%: heterogeneous.

The smallest worthwhile change was calculated using the formula: $SWC=0.2\times SD$

3. RESULTS

3.1 Current Morphological Status of Female U15 Swimmers of the Vietnam National Youth Team

Table 1. Morphological Characteristics of Female U15 Swimmers of the Vietnam National Youth Team (n = 7)

Variable	Min	Max	Mean ± SD	CV%	Evaluation
Standing height (cm)	146	160	154.0 ± 5.23	3.39	Homogeneous
Body mass (kg)	42	51	47.06 ± 3.62	7.69	Homogeneous
Sitting height (cm)	77	84	81.29 ± 2.14	2.63	Homogeneous
Arm span (cm)	151	165	159.0 ± 5.23	3.29	Homogeneous
Upper arm length (cm)	60	68	65.0 ± 2.71	4.17	Homogeneous

Foot length (cm)	20.5	23.5	21.93 ± 1.02	4.64	Homogeneous
Hand length (cm)	15.6	17	16.36 ± 0.55	3.38	Homogeneous
Shoulder breadth (cm)	28	38	34.07 ± 3.06	8.98	Homogeneous
Hip breadth (cm)	21.5	26	23.21 ± 1.78	7.65	Homogeneous
Hand breadth (cm)	6.2	8.5	7.10 ± 0.78	11.03	Heterogeneous
Foot breadth (cm)	7.5	8.8	8.11 ± 0.39	4.85	Homogeneous
Chest circumference during inspiration (cm)	78	88	83.71 ± 3.20	3.82	Homogeneous

The results in Table 1 indicate that 11 out of 12 anthropometric variables demonstrated CV values below 10%, reflecting relatively high morphological homogeneity within the athlete group. Mean standing height (154.0 ± 5.23 cm) and arm span (159.0 ± 5.23 cm) were comparable to anthropometric standards reported for female swimmers aged 12–13 years in the region (Lätt et al., 2010).

Notably, the mean arm span-to-height ratio reached 1.032, exceeding the threshold of 1.0 commonly regarded as a biomechanical advantage in swimming (Bond, 2015).

Shoulder breadth (34.07 ± 3.06 cm; CV = 8.98%) approached the upper limit of acceptable variability but remained below 10%, suggesting mild differentiation in shoulder girdle structure. In contrast, hand breadth (CV = 11.03%) demonstrated greater inter-individual variation, warranting longitudinal monitoring due to its association with propulsive surface area during aquatic propulsion.

3.2 Current Body Composition Status of Female U15 Swimmers of the Vietnam National Youth Team

Table 2. Body Composition Characteristics of Female U15 Swimmers of the Vietnam National Youth Team (n = 7)

Variable	Min	Max	Mean ± SD	CV%	Evaluation
BMI	18.8	21.4	19.84 ± 0.96	4.84	Homogeneous
Body fat percentage (%)	18	20	18.93 ± 0.67	3.55	Homogeneous
Fat mass (kg)	7.7	10	8.90 ± 0.82	9.22	Homogeneous
Basal metabolic rate (kcal)	1100	1300	1222.86 ± 68.49	5.6	Homogeneous
Skeletal muscle mass (kg)	27	33.3	30.51 ± 2.32	7.62	Homogeneous
Fat-free mass (kg)	33.8	41.6	38.16 ± 2.88	7.55	Homogeneous

All six body composition variables exhibited CV values below 10%, indicating relative homogeneity within the group. The mean BMI value of 19.84 ± 0.96 fell within the normal range according to WHO classification (18.5–24.9), suggesting that the athletes were neither underweight nor overweight.

Mean body fat percentage (18.93 ± 0.67%) was consistent with normative values reported for female swimmers aged 12–14 years (Stager, 1984; William, 1993).

Skeletal muscle mass (30.51 ± 2.32 kg; CV = 7.62%) and fat-free mass (38.16 ± 2.88 kg; CV = 7.55%) reflected relatively uniform muscular foundations among athletes, which may positively influence responsiveness to specialized strength-training programmes in subsequent training phases.

Fat mass demonstrated the highest CV within the group (9.22%), suggesting the necessity for individualized monitoring to prevent uncontrolled fat accumulation during pubertal growth.

3.3 Somatotype Characteristics of Female U15 Swimmers of the Vietnam National Youth Team

Table 3. Somatotype Characteristics of Female U15 Swimmers of the Vietnam National Youth Team (n = 7)

Athlete	Endomorphy	Mesomorphy	Ectomorphy	X	Y
Athlete 01	2.5	3.5	2.5	0	2
Athlete 02	2.5	3.5	1.5	-1	3
Athlete 03	3.5	4	2	-1.5	2.5
Athlete 04	2.5	5	3	0.5	4.5
Athlete 05	2.5	3	2.5	0	1
Athlete 06	2.5	3	3	0.5	0.5
Athlete 07	3	3.5	3.5	0.5	0.5

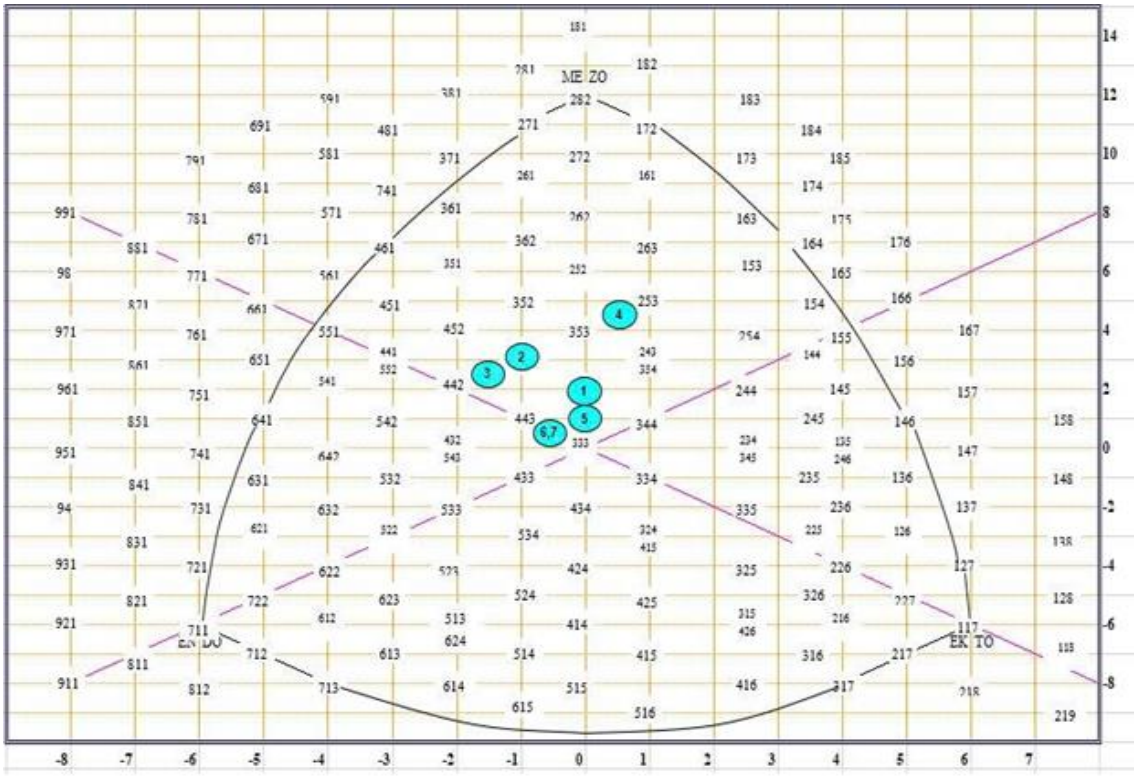

Figure 1. Individual Somatotype Profiles of Female U15 Swimmers of the Vietnam National Youth Team on the Heath–Carter Somatochart

Somatotype analysis revealed that most athletes exhibited a meso-ectomorphic profile characterized by well-developed musculature combined with low body fat and a relatively linear physique. This somatotype aligns with the biomechanical requirements of swimming, which favor high propulsive force generation and reduced hydrodynamic resistance.

Athlete 04 stood out with a Mesomorphy score of 5.0 and a Y-coordinate of 4.5 on the Heath–Carter somatochart, indicating superior muscular development relative to the group. Athlete 07 demonstrated the highest Ectomorphy score (3.5), corresponding to a physique considered advantageous for long-distance breaststroke performance.

Compared with findings reported by Kewei Zhao et al. (2020) in Chinese youth swimmers of similar age, the athletes in the present study demonstrated slightly lower Mesomorphy values. This difference may reflect the influence of ethnic background and variations in training specialization. Longitudinal monitoring is therefore required to evaluate somatotype development over the course of training.

3.4 Current Physiological Function Status of Female U15 Swimmers of the Vietnam National Youth Team

Table 4. Physiological Function Characteristics of Female U15 Swimmers of the Vietnam National Youth Team (n = 7)

Variable	Min	Max	Mean ± SD	CV%	Evaluation
Velocity at lactate threshold (m/s)	1.44	1.48	1.46 ± 0.01	0.98	Homogeneous
Heart rate at LT (beats/min)	161	169	164.86 ± 2.79	1.7	Homogeneous
Lactate concentration at LT (mmol/L)	5.2	6.3	5.80 ± 0.38	6.6	Homogeneous
Vital capacity (L)	2.28	3.72	3.07 ± 0.50	16.2	Heterogeneous

Velocity at lactate threshold (1.46 ± 0.01 m/s; CV = 0.98%) and heart rate at LT (164.86 ± 2.79 beats/min; CV = 1.70%) both demonstrated extremely low variability, reflecting high aerobic homogeneity within the group.

The mean LT velocity of 1.46 m/s corresponds approximately to a 200 m freestyle performance time of 2 minutes 16 seconds, which is consistent with the expected competitive level of female U15 national youth swimmers at the beginning of the annual training cycle.

Lactate concentration at threshold (5.80 ± 0.38 mmol/L; CV = 6.60%) fell within the physiological LT range of 4–6 mmol/L and was comparable to findings reported by Oliveira et al. (2012) in youth swimmers.

Vital capacity demonstrated the highest variability (CV = 16.20%), indicating substantial inter-individual differences in pulmonary capacity, likely associated with asynchronous respiratory development during puberty.

Based on these baseline data, smallest worthwhile change thresholds were calculated for each variable using: (SWC=0.2×SD) These thresholds provide a scientific criterion for interpreting athlete monitoring outcomes at subsequent assessment points. This evidence-based approach replaces subjective evaluation methods and aligns with contemporary trends in evidence-based training management (Bompa & Buzzichelli, 2019; Issurin, 2019).

4. DISCUSSION

Anthropometric assessment revealed a mean arm span-to-height ratio of 1.032, exceeding the threshold of 1.0 generally considered advantageous for swimming biomechanics and comparable to normative values reported in female swimmers aged 12–13 years (Lätt et al., 2010). The high degree of homogeneity observed across 11 of the 12 anthropometric variables (CV < 10%) likely reflects effective morphology-oriented talent selection procedures.

Hand breadth (CV = 11.03%) demonstrated variability exceeding the accepted threshold and should therefore be monitored longitudinally, as hand surface area has been identified as a meaningful predictor of swimming performance in youth athletes (Bond et al., 2015; Price et al., 2024).

Body fat percentage (18.93 ± 0.67%) was consistent with normative values reported in previous studies involving young female swimmers (Lätt et al., 2010; Morais et al., 2021). Both body fat percentage and absolute fat mass should be monitored concurrently because these variables may diverge during rapid growth phases, potentially leading to inaccurate interpretations if only a single indicator is considered (Mirwald et al., 2002).

Somatotype analysis confirmed a meso-ectomorphic tendency consistent with the biomechanical characteristics typically observed in young competitive swimmers (Price et al., 2024; Alves et al., 2022). The pronounced differences in Mesomorphy and Ectomorphy among individuals may indicate the potential for early stroke specialization based on body-type characteristics.

Lactate threshold variables exhibited high homogeneity (CV < 7%), consistent with findings in similarly aged youth swimmers reported by Oliveira et al. (2012). In contrast, vital capacity demonstrated substantial variability (CV = 16.20%), likely reflecting asynchronous pulmonary maturation during puberty rather than training effects (Mirwald et al., 2002). Consequently, respiratory development programmes should be individualized.

The principal limitation of this study was the small sample size (n = 7) and the absence of direct biological maturation assessment (Mirwald et al., 2002). Future studies should incorporate larger samples and integrate maturity indicators such as peak height velocity (PHV) or Tanner staging.

5. CONCLUSION

The baseline assessment of seven female U15 swimmers from the Vietnam National Youth Team demonstrated that:

1. Most anthropometric variables (11/12) and all body composition variables exhibited CV values below 10%, indicating relative homogeneity within the selected athlete group;
2. Somatotype analysis revealed a predominant meso-ectomorphic tendency consistent with the physical characteristics of young competitive swimmers;
3. Lactate threshold variables demonstrated high homogeneity (CV < 7%), whereas vital capacity exhibited substantial inter-individual variation (CV = 16.20%), suggesting the necessity for individualized monitoring and intervention regarding respiratory capacity.

This baseline dataset, together with the corresponding SWC thresholds, forms an individualized reference framework (P25/P50/P75) for periodic athlete monitoring throughout the four-phase Periodic Assessment Cycle (PAC). The findings contribute an important scientific foundation for the management and training supervision of female youth swimmers in Vietnam.

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