

## MORPHOLOGIE ET PERFORMANCE SELON LA MATURATION SEXUELLE ET SQUELETTIQUE CHEZ LES NAGEUSES VÉNÉZUÉLIENNES

### MORPHOLOGY AND PERFORMANCE IN WATER PHYSICAL FITNESS TESTS ACCORDING TO SEXUAL AND SKELETAL MATURITY IN A GROUP OF VENEZUELAN SWIMMERS

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#### RÉSUMÉ

Le but de ce travail était d'étudier quelques relations entre les dimensions biométriques, la performance dans l'eau (vélocité 50 mt et résistance 400 mt pour les enfants de moins de 13 ans et 800 mt pour ceux de plus de 13 ans) et la maturation sexuelle et squelettique (age osseux). Pour cela, une cohorte de 41 garçons et filles nageurs entre 9 à 17 ans (étude pilote) a été divisée en 3 groupes selon leur état de maturation. La maturation sexuelle a été évaluée selon les stades de développement de Tanner. D'autre part, pour la maturation squelettique on a suivi la méthode de Tanner-Whitehouse (TW2). Afin de décrire la typologie morphologique, nous avons relevé les mesures de taille, poids ainsi que 8 plis cutanés. Dans ce premier rapport descriptif on a trouvé une corpulence plus élevée pour les filles au début de la maturation ainsi que des valeurs plus hautes pour les plis cutanés dans tous les groupes de la maturation pubertaire. Pour les garçons pubères la maturation squelettique était plus avancée que l'âge chronologique presque 1.5 ans. Les résultats obtenus montrent qu'il y a des différences entre les deux sexes en la performance de la résistance selon l'état de la maturation qui est meilleure chez les filles.

**Mots-clés :** Sport juvénile, natation, maturation squelettique, croissance, maturation sexuelle Vénézuéla.

#### ABSTRACT

Swimming is one of the team sports that provides a way for health and better quality of life. However, few studies are commonly reported in young Latin American athletes, in which the knowledge is addressed to the structure and function of the human body in relation to athletic performance. This study comprises the pilot sample of 41 male and female young swimmers at competitive levels. Age ranged between 9 to 17 years of age. The aim was to explore anthropometric variables (weight, height and sum of 8 skinfolds) and water physical fitness test (sprint and long distance events) according to stage of maturation. Descriptive analysis included box-plot diagrams to look for dispersion of variables and Student t test to study sexual dimorphism. Groups were partitioned into categories of prepuberty, initial puberty (stages 2 and 3) and late puberty (stages 4 and 5), according to Tanner-Marshall method. Skeletal maturation was assessed with Tanner-Whitehouse (TW2) method. Results showed that girls were only taller and heavier than boys at the initial stage of maturation, with a higher sum of skinfolds values in all groups. In boys at the late stage of puberty, skeletal maturation was more advanced than chronological age in almost 1.5 years differences between ages. Very low differences were attained for boys and girls in short and middle distance events at the prepubescent stage. At the onset of puberty the differences are marked only for middle distance events that favors boys. At late puberty boys perform better than girls in short distance, whilst girls do better in middle to long distance events.

**Keywords :** Youth sports, swimming, skeletal maturity, growth, sexual maturity, Venezuela.

#### INTRODUCTION

Swimming is one of the team sports that provide many young people a way for healthy exercise and is a classic feature of childhood and youth all the world over. In fact injury rates are not commonly reported, and is believed by many to have favorable influences on the organism during growth [NAUGHTON et al., 2000] specially those related to reduction of morbidity caused by asthma [BAR-Or O, INBAR O, 1992], and to develop a wide range of skills. As in others sports like figure skating and gymnastics, swimming shares the characteristics to train year-round and

to begin training and compete on an "elite" level at younger ages. Hence a knowledge of the process and variation of

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growth and biological maturation offers a significant contribution for the well-being of the youngsters, and to avoid an early drop-out of the sport, before they can express its genetic potential [MALINA et al., 1982]. On the other hand, provides the coach a few basic guide lines to monitoring and quantify the amount and intensity of physical training, and criteria for the identification of the many factors that act upon the physical performance of a child.

It has been emphasized by many that maturity is a related issue to growth and exercise performance characteristics. The studies done by MALINA [1994] and KATZMARZYK et al. (1997), among others, revealed that in most cases, skeletal maturity and chronological age although generally related, nevertheless proceed at the same speed. This is to say that at a given chronological age group, there is a considerable variation in maturity status that on the other hand, will act as an important factor in the performance of young athletes.

It is appropriate at this point to highlight the fact that success on an athletic competition is a very complex issue, on which psychological and socio-cultural factors play an important role, into the complex matrix of factors that influence successful performance and activity pursuits. [MALINA, 1983]. Hence, this paper will focus only on the biological aspect of this rather complex phenomenon during the adolescent period of growth.

Over the past decades several reports have been made with regard to the anthropometric, and body composition of young Venezuelan athletes [PÉREZ, 1980, BRIEF, 1986, GARCÍA 1996, 1998, GARCÍA and SALAZAR, 2000] yet focusing on maturity-associated variation in performance, (both sexual and skeletal) instead of chronological age, are not extensive. To address these critical needs a project is actually been carried out by a multidisciplinary group, starting with a pilot sample, which constitutes the base of this report. At the present moment, this study sought to make performance and sexual and skeletal maturity status related comparison.

## METHODS

The tests for the pilot sample were administered from March through May 2001 to 41 young swimmers, 9-17 years of age, recruited from the Association of Aquatic Sports of the Miranda State of Venezuela. The athletes described in this study are part of a larger sample who fulfilled the criteria of being included within this association, with a systematic training and time attained, which allow them to take part in competitions of national and international levels. Measurements were made at the middle of the training season.

Participation was voluntary, parents were provided with written and oral information of the study, and parental consent for participation was sought with the written consent of the parents. The testing protocol comprised 38 anthropometric measurements indicative of skinfolds, girths, lengths, breadth/lengths, in accordance with the standards set by the International Society for the

Advancement of Kinanthropometry (ISAK) [NORTON and OLDS, 1996]. Information on demographic data, clinical, nutrition, socioeconomics and epidemiological aspects was collected as well. Trained anthropometrists and medical doctors collected the anthropometric information and maturity development. Criterion anthropometrist, landmarking and quality controls were provided in order to diminished measurements errors.

For the purpose of this study, only data of weight and height, as indices of overall body size; sum of 8 skinfolds, as indicative of subcutaneous fatness and development of secondary sex characteristics and skeletal maturity will enter into consideration. Body weight was measured to the nearest 0.05 kg with a Detecto balance. Standing height was measured with a portable Harpenden stadiometer to the nearest 0.1 cm, and the sum of eight skinfold thicknesses (biceps, triceps, subscapular, iliac crest, supraspinale, abdominal, front thigh, and medial calf), was measured with a Holtain caliper which permits reading to the nearest 0.2 mm.

The development of secondary sex characteristics such as breast and genitalia development and pubic hair has been summarized into five-stage scales of TANNER [1962], MARSHALL and TANNER method [1969, 1970]. Hence, groups were partitioned into categories of prepuberty, (stage 1), characterized for the absence of breast development and pubic hair with male genitalia as the same size as in early childhood. Initial puberty (stages 2 and 3) to indicate initial and continued development of each trait; and late puberty (stages 4 and 5), as indicative of continued and adult or terminal attainment of these characteristics [NICOLETTI, 1992].

Skeletal maturity was assessed by means of dorso-palmar X-rays of the left hand-wrist according to TANNER-WHITEHOUSE-20 bone (TW2) method. [TANNER et al., 1983]. Percentage of attainment of skeletal maturity was considered as well.

Performance taken as the time required to swim a prescribed event, was measured on the base of distances freestyle events, referred to as short distance (SD= 50 m), whereas 400 m for children under 13 years of age and 800m for youths aged equal or more than 13 years, were both labeled middle-to-long distance (ML). [CARTER and ACKLAND, 1994].

Results are presented according with sexual development as previously described, not by chronological age.

Continuous variables were summarized as means with standard deviation. Student's t tests or analysis of variance were used for the categorical variables. Statistical analysis was performed with SPSS version 8.0 for windows. A p value < 0.05 was considered statistically significant.

## RESULTS

Table 1 depicts mean ages for attaining different sexual maturity traits that were at initial puberty (stages 2 and 3 breast/genitalia) 12.24 years and 12.86 years for boys and girls respectively. Late puberty (4 and 5 breast/genitalia)



were on the average attained for boys at 14.52 years whilst for girls, these traits were reached at 13.74 years.

TABLE 1. — DESCRIPTIVE STATISTICS FOR MEAN AGE OF SEXUAL MATURITY STAGE, HEIGHT, WEIGHT, SUM OF SKINFOLDS AND SKELETAL AGE, IN VENEZUELAN YOUNG SWIMMERS

VARIABLES	Boys			Girls		
	Prepuberty n=8	Initial Puberty n=10	Late Puberty n=7	Prepuberty n=5	Initial Puberty n=5	Late Puberty n=4
Mean age (years)	X ± SD 10.14 ± 0.64	12.24 ± 1.58	14.52 ± 1.59	10.18 ± 0.58	12.86 ± 1.92	13.74 ± 0.44
Height (cm)	X ± SD 138.09 ± 2.60	147.54 ± 11.23	169.84 ± 14.83	138.60 ± 9.79	153.40 ± 13.30	159.23 ± 2.33
Weight (kg)	X ± SD 32.66 ± 2.74	42.45 ± 10.40	61.39 ± 13.31	33.46 ± 10.43	46.00 ± 11.67	48.55 ± 5.92
Sum of skinfolds (cm)	X ± SD 62.38 ± 8.28	78.82 ± 16.02	80.36 ± 15.59	72.40 ± 21.70	100.96 ± 27.27	95.40 ± 14.30
Skeletal age (years)	X ± SD 9.91 ± 0.77	12.48 ± 1.74	16.14 ± 1.41	10.76 ± 0.95	13.16 ± 2.38	14.88 ± 0.86

Non statistical significant differences by sex was found for the variables considered according with maturity status, as  $p > 0.05$ . Student t-test values were rather small and rejected hypothesis for equally means values among variables was not allowed. These results could be affected by the small number of the subjects within each category once the groups are partitioned. In spite of that, these results are in accordance with the biological changes that take place during puberty. On the other hand, a trend was observed for both sexes towards diminishing time

performance for short distance event as puberty stage proceed.

Variation in level of biologic maturity on overall body size is shown in figures 1 and 2. Prepubescent girls exhibited higher values in height and weight whilst boys at initial and late puberty overcome girls for both traits. Sexual dimorphism appears with 10.6 cm for height and 12.8 kg for weight. Sum of skinfolds is consistently higher in girls at all stages of maturity (Figure 3).

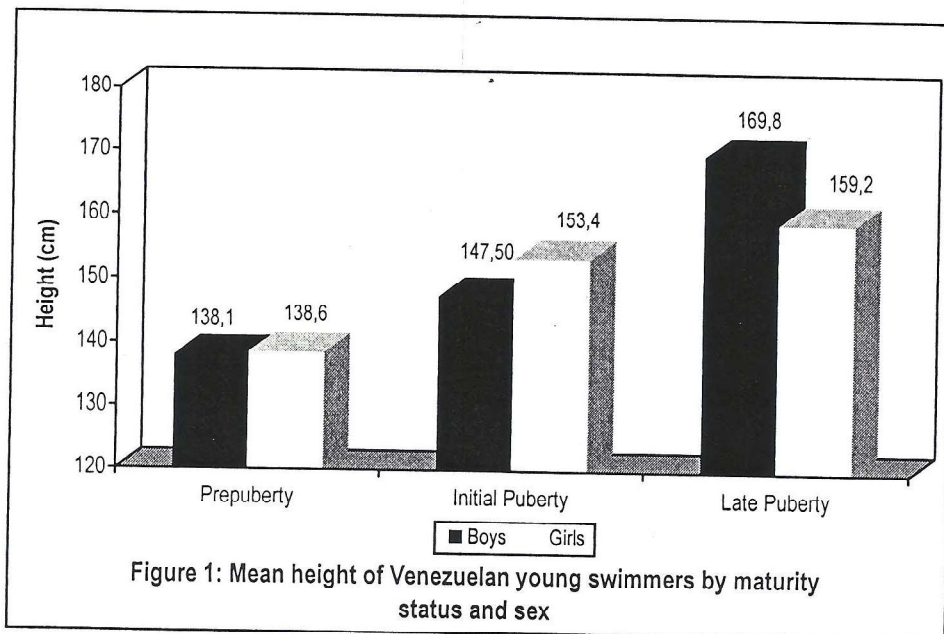
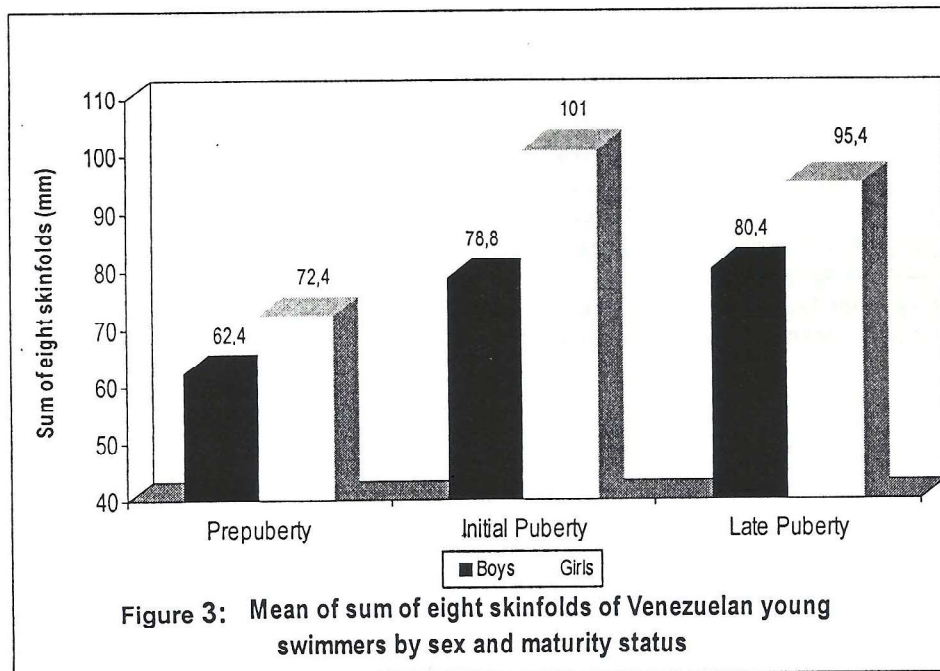
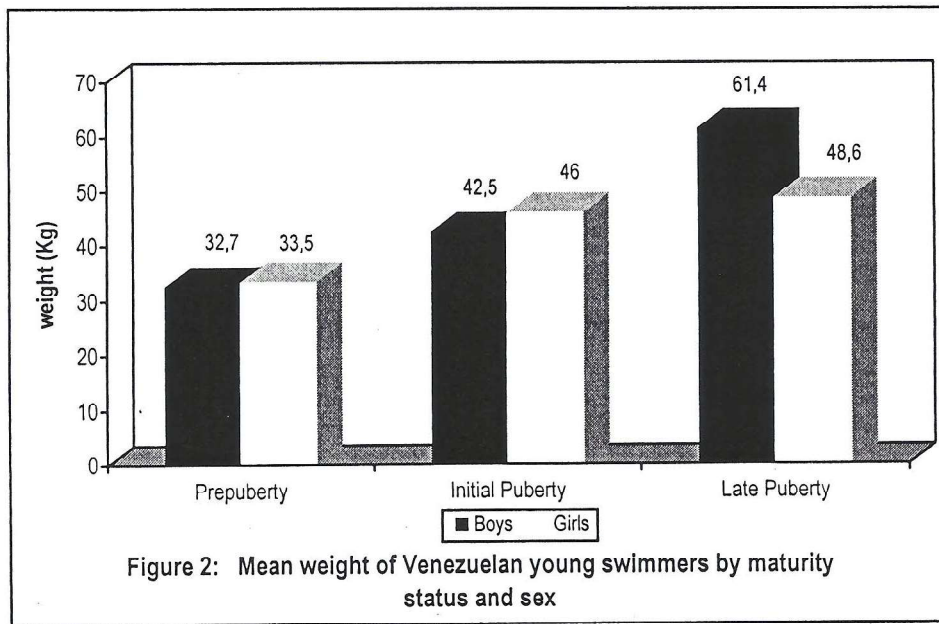


Figure 1: Mean height of Venezuelan young swimmers by maturity status and sex



Skeletal maturity as bone age estimates by sexual maturity categories, is shown in Figure 4. Girls at the prepubescent and early pubescent categories had an advanced bone age greater than chronological age,

compared with the male peers. In contrast, late puberty boys were on the average 1.3 years advanced than chronological age.



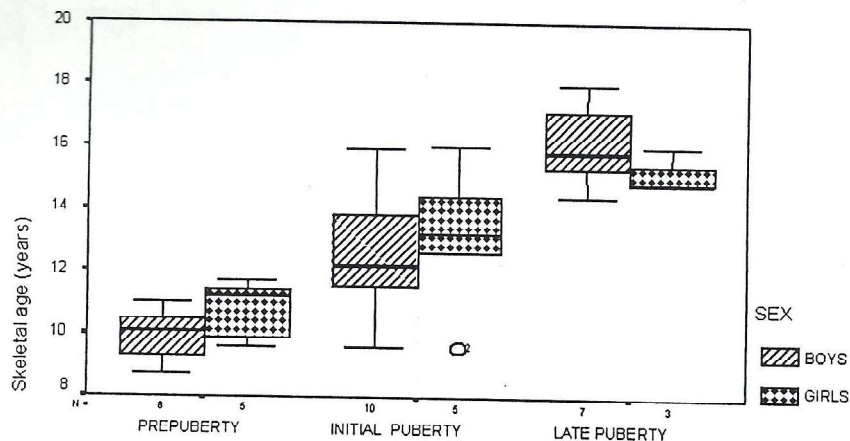


Figure 4. Mean skeletal age of the three maturity status groups of Venezuelan young swimmers

Very low differences were attained for boys and girls in short and middle distance events at the prepubescent stage. At the onset of puberty the differences are marked only for middle distance events that favors boys. At late puberty boys perform better than girls in short distance, whilst girls do better in middle distance events.

## DISCUSSION

Although literature reports data on young athletes, few studies consider the issue in the context of the kinanthropometric model, i.e. the quantitative interface between structure and function, in which the concept of growth, development, pubertal and skeletal maturation, and physical fitness performance are taken in an interrelated way. In this article selected aspects of normal growth and maturation have been considered.

Maturation as an event of adolescence, is a change in many biological characteristics that leads to adult form or function. According with BAILEY and GARN [1986] it is a "ripening" associated among others processes, with an epiphysis union in the long bones, and a sexual maturation of primary and secondary morphological characteristics such as breast or testicular development. Differences in maturity enhances the differences in size, physique and body composition, as well as in motor performance, which is age and sex associated different for boys and girls [MALINA et al., 1982].

This study that can be considered as a case report, takes into account only selected aspects of the complex sequence that characterizes normal growth and maturation. Skeletal maturity, genitalia development in boys, breast development in girls and ratings of pubic hair in both sexes, are reported. Skeletal maturity is considered in relationship with the development of secondary sexual characteristics. An analysis of other aspects and with a larger sample is intriguing and will highlights possible

areas of interest to be further explored.

Mean height and weight of swimmers vary between p10 and p50 of Venezuelan reference data. Differences between swimmers and Venezuelan population regarding the timing of pubertal development as reflected in breast, genitalia and pubic hair development, [LÓPEZ-BLANCO et al., 1995, MACÍAS-TOMEI et al., 2000] are negligible. Within this framework these results seem to support the findings of MALINA [1998] in the sense that regular training does not apparently influence growth rate and the timing and tempo of somatic, sexual and skeletal maturation, as well as those of FONTDEVILA and CARRIÓ [1992] related to the growth rates of swimmers aged 10 to 14 years of age.

Values of weight and height are similar for prepubescent swimmers boys and girls. At the onset of puberty swimmers girls are taller and heavier than boys as is commonly found in non athletic young populations. For subcutaneous fat, girls attained higher values of skinfolds at all stages of puberty, whilst boys are leaner especially at late puberty in partly related to the loss of fat experienced during normal male growth adolescence.

Sexual dimorphism in weight at the late puberty stage that favors boys suggests perhaps, the effects of training-associated changes that results in an increase in fat free mass component, and a corresponding decrease in body fat as reflected by the skinfolds thickness

As previously reported by MALINA et al., 1982, and MALINA and BIELICKI, 1996 for others swimmers samples, young female Venezuelan swimmers as a group showed a bone age slightly advanced than chronological age. In boys this pattern is found only at late puberty. This characteristic that could be responsible for the differences in overall size between the sexes, could reflect as well, the tendency towards an earlier maturation found in the Venezuelan population, more evident in girls [LÓPEZ-BLANCO et al., 1995].



Because our results were derived from a pilot study, the generalization of these findings is limited. However, for Venezuelan athletes, data dealing with the relationship of the indices of biological maturation with selected physical performance tests are limited.

Findings derived from the larger study being actually carried out, should help to distinguish the considerable variability of the physical performance according with the events of adolescent growth and maturation. Children and youths at these ages who perform intensive physical activity, have to support both genetic and environmental stress, i.e growth by itself and that one derived from training.

On the other hand, the visionary directions of the sports medicine scientist of the first quarter of the 21 st century will require awareness and understanding of the economic, demographic, environmental, social and political factors as the critical ingredients that enhances quality of life and performance of athletes [MILLER et al., 1999].

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