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Research article

RELATIVE TOTAL BODY FAT AND SKINFOLD PATTERNING IN FILIPINO NATIONAL COMBAT SPORT ATHLETES

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ABSTRACT

The purpose of this study was to assess relative total body fat and skinfold patterning in Filipino national karate and pencak silat athletes. Participants were members of the Philippine men's and women's national teams in karate (12 males, 5 females) and pencak silat (17 males and 5 females). In addition to age, the following anthropometric measurements were taken: height, body mass, triceps, subscapular, supraspinale, umbilical, anterior thigh and medial calf skinfolds. Relative total body fat was expressed as sum of six skinfolds. Sum of skinfolds and each individual skinfold were also expressed relative to Phantom height. A two-way (Sport*Gender) ANOVA was used to determine the differences between men and women in total body fat and skinfold patterning. A Bonferroni-adjusted α was employed for all analyses. The women had a higher proportional sum of skinfolds (80.19 ± 25.31 mm vs. 51.77 ± 21.13 mm, $p = 0.001$, $\eta^2 = 0.275$). The men had a lower proportional triceps skinfolds (-1.72 ± 0.71 versus -0.35 ± 0.75 , $p < 0.001$). Collapsed over gender, the karate athletes (-2.18 ± 0.66) had a lower proportional anterior thigh skinfold than their pencak silat colleagues (-1.71 ± 0.74 , $p = 0.001$). Differences in competition requirements between sports may account for some of the disparity in anthropometric measurements.

KEY WORDS: Fat, skinfold, Filipino, karate, pencak silat.

INTRODUCTION

In general, elite athletes may be characterized by optimal endurance and strength as well as a physique conducive to high performance. For instance, long distance runners will have an excellent cardiorespiratory endurance, and shot putters will show a well-developed strength profile. Artistic gymnasts are generally shorter than swimmers or basketball players. Regardless of the sport discipline and on average, athletes are less fat and more muscular than non-athletes (McDougall et al., 1991).

Similar to athletes in other sports, those in combat sports have also been profiled. However, only limited information is available on them. For instance, Pieter and Taaffe (1990) tested the isokinetic strength of elite American taekwondo athletes and found their hamstrings to quadriceps (H/Q) ratios to be lower than expected. Their aerobic endurance was characteristic of intermittent-activity athletes with a relatively well-developed anaerobic endurance level (Taaffe and Pieter, 1990).

Structural features of judo athletes were described by Maas (1974) and Carter (1982), who concluded that elite male judo athletes were heavy for their height. For instance, the male judo athletes

competing in the 1976 Olympic Games recorded a reciprocal ponderal index (RPI) of $40.86 \text{ cm/kg}^{0.333}$ (Carter, 1982).

In terms of body composition, the Canadian national men's judo team was assessed as having 12.27% of fat (Taylor and Brassard 1981) and 9.3% in a follow-up study (Thomas et al., 1989). As expected, American elite male judo athletes (judoka) had less fat than their female counterparts (Callister et al., 1991). Tumilty et al. (1986) found Australian elite Junior judoka to have a higher sum of eight skinfolds than their Senior counterparts. Claessens, et al. (1986a) used the sum of three skinfolds (tricipital, subscapular and suprailiac) and reported that the lighter elite Belgian male judoka (< 71 kg) had a sum of 19.3 mm, while the heavier athletes (71 - 86 kg) recorded 18.9 mm. Similarly, international elite male judoka recorded higher sums of three skinfolds with increasing weight division (Claessens et al., 1987).

Pieter et al. (1998a) studied adult elite Filipino female judoka competing for the national team in terms of their body fat and proportional skinfold patterning. The judoka were statistically compared with a sample of elite American female taekwondo athletes (taekwondo-in). The judo group as a whole had a larger sum of six skinfolds than the taekwondo-in. The lightweight (< 60 kg) judoka were proportionally relatively similar to the taekwondo groups, but the heavyweight (≥ 60 kg) judoka recorded higher proportional values for all skinfolds.

It has been suggested that gender and sport may contribute most to the variance in fatness (sum of skinfolds) in athletes (Malina et al., 1982). For instance, long distance runners typically have less fat than swimmers, regardless of the event, while female athletes in the same sport have more fat than their male counterparts (e.g., Wilmore and Costill, 2004). Excess fat is generally believed to be detrimental to performance (e.g., Sinning, 1985).

Gender was found to be the single most important contributor to fat patterning: female athletes have a higher extremity/trunk fat ratio (Malina et al., 1982; Ross and Ward, 1984). However, there is also a sport effect. For instance, male and female short distance runners were found to have more centrally located fat, while swimmers had a lower extremity/trunk fat ratio (Malina et al., 1982).

When sum of six skinfolds was used as a single indicator, it was found to be the best adiposity marker to differentiate between level and position in rugby. However, when skinfold measurements were taken into account as well, it appeared that skinfold patterning better discriminated between groups (Kieffer et al., 2000).

Since no information on fatness and fat patterning is available on Filipino combat sports athletes other than our own studies on female judoka (Pieter et al., 1998a; 1998b), the purpose of the present investigation was to assess the relative total body fat and skinfold patterning of Filipino national karate and pencak silat athletes. Anthropometric data on pencak silat athletes are scarce and female karateka (karate athletes) have hardly been studied. Information on fatness and the anatomical distribution of fat may contribute to a better understanding of the relationship between sport, athlete and anthropometric characteristics.

METHODS

Participants were members of the Philippine men's and women's national teams in karate (12 males, 5 females) and pencak silat (17 males and 5 females). Standing height was measured with a wall-mounted wooden stadiometer to the nearest 0.05 m. Body mass was assessed with a calibrated electronic digital scale to the nearest 0.01 kg.

A Slim Guide skinfold caliper was used to measure skinfold thicknesses at the triceps, subscapula, supraspinale, umbilical, anterior thigh and medial calf. Compared to the Harpenden and Lange calipers, the Slim Guide yielded technical errors of measurement of around 5% (Ross et al., 2000). The reliability correlation coefficient for a range of skinfold thicknesses using the Slim Guide against the Harpenden caliper and Echoscans 1502 Ultrasound system resulted in an $R = 0.98$ at the minimum (Anderson and Ross, 1986). All measurements, according to the specifications provided by Ross and Marfell-Jones (1991), were taken three times, unless the first two were the same, and the median used for statistical analysis.

Proportional sum of skinfolds and proportional skinfold patterning of the athletes were based on the Phantom stratagem (Ross and Marfell-Jones, 1991). Proportional sum of six skinfolds was calculated as: sum of six skinfolds \times (170.18/height). Phantom skinfold patterning was derived using the following formula that is based on a hypothetical human population (Ross and Ward, 1984):

$$z = 1/s [v (170.18/h)^d - p]$$

where z represents a proportionality value in z scores. s is the standard deviation of the Phantom value for the variable of interest. v is the observed size of that variable. 170.18 is the constant for Phantom height in cm. h refers to the observed height of the participant. d is a geometrical exponent and equals 1 for all lengths, widths, girths and skinfold thicknesses; 2 for all areas and 3 for all masses and volumes. p refers to the Phantom value for variable v .

Table 1. Means (\pm SD) of age and body composition indices in Filipino male and female karate and pencak silat athletes

	Pencak silat		Karate	
	Males (n = 17)	Females (n = 5)	Males (n = 12)	Females (n = 5)
Age (years)	24.4 (4.8)	20.4 (3.7)	24.0 (4.8)	20.3 (1.3)
Height (m)	1.68 (.05)	1.56 (.06)	1.70 (.05)	1.61 (3.6)
Body mass (kg)	63.2 (9.1)	53.3 (7.8)	64.3 (7.1)	55.8 (6.9)
RPI (cm/kg ^{0.333})	42.4 (1.7)	41.7 (.6)	42.5 (1.5)	42.3 (1.4)
$\Sigma 6$ skinfolds (mm)	53.7 (24.2)	86.2 (20.2)	48.1 (15.7)	63.6 (24.7)
Proportional $\Sigma 6$ skinfolds (mm)	54.3 (24.6)	93.4 (19.0)	48.1 (15.2)	67.0 (25.4)

The data were analyzed for skewness and kurtosis, while the Kolmogorov-Smirnov test was used to assess normality. A two-way (Gender*Sport) ANOVA was used to determine the differences between men and women by sport in RPI, absolute and proportional sum of skinfolds as well as proportional skinfold patterning. The L statistic (e.g., Thomas and Nelson, 2001) was employed in cases where the distributions were not normal. Due to the multiple comparisons, a Bonferroni-adjusted alpha was used for all analyses to prevent Type 1 error (e.g., Ntoumanis, 2001).

RESULTS

Table 1 shows the means and standard deviations of the body composition markers by combative sport and gender. Although there was a combative sport difference in proportional sum of six skinfolds ($p = 0.048$, $\eta^2 = 0.107$), this was not significant anymore after the Bonferroni correction. However, there was a gender effect for absolute sum of skinfolds with the females recording a higher value (74.90 ± 24.36 mm and 51.35 ± 20.97 mm for the women and men, respectively, $p = 0.004$, $\eta^2 = 0.209$). They also had a higher proportional sum of

skinfolds (80.19 ± 25.31 mm vs. 51.77 ± 21.13 mm, $p = 0.001$, $\eta^2 = 0.275$).

Figure 1 displays the proportional skinfold patterning by gender and sport. Collapsed over gender, there was a difference between karate and pencak silat in proportional anterior thigh skinfold ($p = 0.002$, $\eta^2 = 0.246$) with the former scoring lower (-2.19 ± 0.66 vs. -1.76 ± 0.75). The males had lower proportional triceps (-1.78 ± 0.62 vs. -0.35 ± 0.75 , $p < 0.001$, $\eta^2 = 0.506$), suprascapula (-1.87 ± 0.76 vs. -0.93 ± 0.96 , $p = 0.002$, $\eta^2 = 0.234$) and anterior thigh skinfolds (-2.18 ± 0.46 vs. -1.26 ± 0.95 , $p < 0.001$, $\eta^2 = 0.385$).

DISCUSSION

Body fat

Neither the men nor the women carried more weight for height as expressed by the RPI. However, the males had a lower proportional sum of skinfolds, which suggests that, although there was no difference in weight for height between gender, the females may carry more fat. Although the sample size of the women was smaller than that of the men, the findings confirm those of previous studies (e.g., Callister et al., 1991; Gualdi Russo et al., 1992).

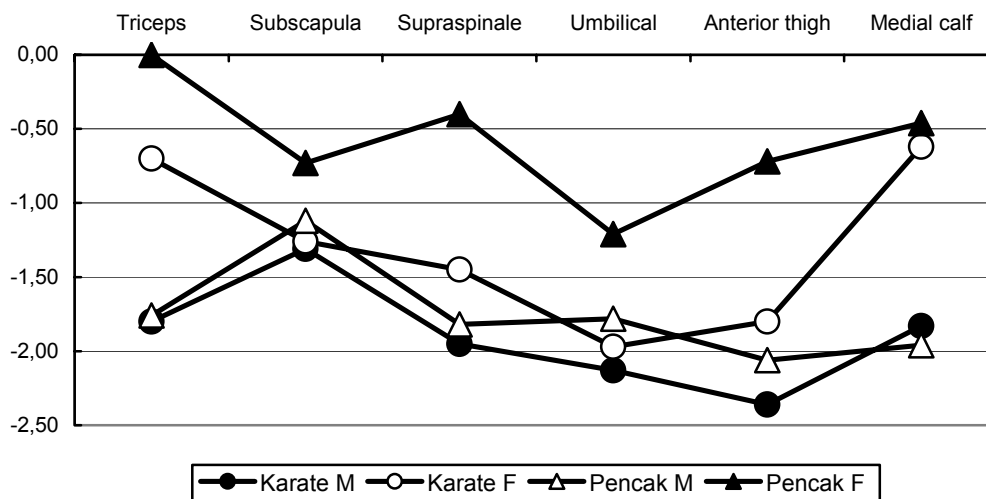
**Figure 1.** Proportional skinfold patterning in Filipino male and female karate and pencak silat athletes.

Table 2. Comparative values for reciprocal ponderal index ($\text{cm/kg}^{0.333}$) in combat sports athletes.

Study	Men	Women
Filipino elite karateka (this study)	42.51	42.25
Filipino elite pencak silat athletes (this study)	42.10	41.66
Belgian elite judoka (< 71 kg) (Claessens et al., 1986a)	43.2	n.a.
Belgian elite judoka (71-86 kg) (Claessens et al., 1986a)	42.2	n.a.
German judoka (Amann and Weiss, 1994)	41.49	42.76
French judoka (Vidalin et al., 1988)	42.30	41.38
American elite judoka (Callister et al., 1991)	40.62	41.91
Canadian Alberta team judoka (Little, 1991)	41.20	41.87
Filipino elite judoka (< 60 kg) (Pieter et al., 1998a)	n.a.	42.0
Filipino elite judoka (\geq 60 kg) (Pieter et al., 1998a)	n.a.	37.2
Korean elite judoka (Kim et al., 1996)	40.84	40.36
Japanese elite judoka (Ebine et al., 1991)	40.19	40.37
Polish elite judoka (Janiak and Krawczyk, 1995)	40.60	n.a.
Polish international elite judoka (Krawczyk et al., 1997)	40.7	n.a.
Belgian elite karateka (Claessens et al., 1986b)	42.6	n.a.
Welsh/British elite karateka (Baker et al., 1995)	42.14	n.a.
Polish elite karateka (Janiak and Krawczyk, 1995)	41.45	n.a.
Polish international elite karateka (Krawczyk et al., 1997)	41.3	n.a.
Botswana elite karateka (Amusa and Onyewadume, 2001)	43.14	40.56
Korean elite taekwondo-in (Olds and Kang, 2000)	43.32	n.a.
American elite taekwondo-in (Pieter, 1991)	43.16	43.70

Caution is warranted, however, because the effect size for the gender effect for fatness is small.

Compared to a combined sample of Italian judo, karate and wushu college athletes, the RPI scores of the Filipinos were similar. The Italian males recorded an RPI of $41.86 \text{ cm/kg}^{0.333}$ and the females, $42.32 \text{ cm/kg}^{0.333}$ (Gualdi Russo et al., 1992). A combined sample of male Saudi national elite judoka and karateka had an RPI of $41.31 \text{ cm/kg}^{0.333}$ (Chukwuemeka et al., 1992), which is again similar to the values of the Filipinos.

Table 2 shows comparative RPI data of elite combative sport athletes from various countries. It is self-evident that RPI depends on the weight division of the athlete (e.g., Claessens et al., 1986a; Pieter et al., 1998a). However, it was not always possible to divide the samples studied into different weight categories. Nevertheless, it is instructive to compare the Filipino athletes with counterparts from other countries. The American, Japanese, Korean and Polish male judoka seem to carry more weight for height than the Filipino athletes. In the females, the Korean and Japanese judoka seem to carry more weight for height, with the Filipino heavyweight judoka having much more weight for height than any of the other groups, male or female. However, RPI is a reflection of total body weight, containing both lean and fat tissue. In other words, it may very well be that the lower RPI scores are indicative of more lean than fat mass.

Studies using sum of six skinfolds to represent body fat in combative sports athletes are scarce. Italian college combative athletes had a sum of

skinfolds of 61.1 mm (men) and 74.4 mm (females) (Gualdi Russo et al., 1992), both of which were higher than those of the Filipino male and female karateka. Only the female pencak silat athletes had more total relative body fat than their Italian counterparts. Filipino elite female judoka (< 60 kg) had a sum of six skinfolds of 76.0 mm, while their heavier colleagues recorded a value of 136.3 mm (Pieter et al., 1998a). In contrast, American elite male taekwondo-in had a sum of skinfolds of 36.14 mm and their female colleagues, 54.81 mm (Pieter, 1991), both of which were lower than those of the Filipino athletes in the present study. Russian elite male wushu taolu athletes had a sum of six skinfolds of 30.81 mm, while their recreational sanshou colleagues recorded a value of 42.19 mm (Pieter and Gagonin, 1994).

Clearly, sport-specific requirements should be considered when evaluating the athletes' relative total body fat. In karate, for instance, athletes will have to be able to propel the body through space as fast as possible, as is the case in taekwondo. Excess mass, especially in the form of fat, may be detrimental to performance because of its negative effect on the weight-to-strength ratio (Sinning, 1985). In pencak silat, however, slow and fast movements are alternated, which calls for different requirements. For instance, male taiji quan athletes had 13.9% of relative total body fat (Zhuo et al., 1984). On the other hand, American elite taekwondo-in were reported to have 7.5% (men) and 12.0% (women) of relative total body fat (Taaffe and Pieter, 1990). Although body fat will depend on

weight division, combative sports where fast movements are required may most likely call for a low fat mass to enhance the weight-to-strength ratio. Nevertheless, even if fast and slow techniques are part of one's sport, such as in pencak silat and taiji quan, a more desirable amount of fat would still be preferable: too much fat will most likely deter the athlete from achieving peak performance in her or his chosen sport (Sinning 1985).

Proportional skinfold patterning

The differences in skinfold patterning between males and females collapsed over sport were expected: men had lower skinfolds at the tricipital, supraspinale and anterior thigh sites. Sexual dimorphism in skinfold patterning was also found in other sports (e.g., Carter, 1982; Ross and Ward, 1984). However, the effect sizes for more extremity fat in the females are moderate. Future studies should use larger sample sizes for each gender by sport.

It was shown that Filipino female elite judoka had proportionally more truncal fat than American elite female taekwondo-in, who showed more fat on the extremities (Pieter et al., 1998a). It has been suggested that mechanical efficiency may be at the basis of fat patterning that may also be sport-specific (Malina et al., 1982, Mueller et al., 1982). Similar to their Filipino colleagues in judo, the pencak silat women had more truncal fat than their male counterparts or their colleagues in karate, although the differences were not statistically significant. This was also found in adolescent Mexican-American girls involved in running, volleyball and basketball (Mueller et al., 1982).

Central fat may be more advantageous in judo than in taekwondo and karate, where one has to be able to propel the body through space as fast as possible. Having proportionally low fat at various body parts will surely aid the karateka and taekwondo-in accelerating and decelerating rapidly as is required by the nature of both sports. On the other hand, judoka may benefit from a more stable body position, so as not to be thrown. Naturally, one has to weigh the advantages of a more solid positioning of the body against a more advantageous weight-to-strength ratio (Sinning 1985).

CONCLUSION

The results of the present study seem to suggest that there was no difference between combat sports in fatness (sum of skinfolds), which is contrary to what was found by others (e.g., Malina et al., 1982). Skinfold patterning was more in line with what was reported in the literature, with the males recording lower extremity fat.

REFERENCES

- Amann, K. and Weiss, M. (1994) Sports medicine profile of judo practitioners. *Leistungssport* **24**, 20-24. (In German).
- Amusa, L.O. and Onyewadume, I.U. (2001) Anthropometry, body composition and somatotypes of Botswana national karate players: A descriptive study. *Acta Kinesiologiae Universitatis Tartuensis* **6**, 7-14.
- Anderson, N.R. and Ross, W. (1986) Reliability and objectivity in skinfold-caliper and ultrasound measurement of skin and adipose tissue thickness at six sites. In: *Kinanthropometry III*. Eds: Reilly, T., Watkins, J. and Borms, J. London: E. & F.N. Spon. 15-20.
- Baker, J., Baker, T. and Bell, W. (1995) Lean leg volume and anaerobic performance in elite male karate internationals. *Journal of Human Movement Studies* **28**, 39-49.
- Callister, R., Callister, R.J., Staron, R.S., Fleck, S.J., Tesch, P. and Dudley, G.A. (1991) Physiological characteristics of elite judo athletes. *International Journal of Sports Medicine* **12**, 196-203.
- Carter, J. (1982) Body composition of Montreal Olympic athletes. In: *Physical structure of olympic athletes. Part I*. Ed: Carter, J.E.L. Basel: Karger. 107-116.
- Chukwuemeka, A. and Al-Hazzaa, H. (1992) Physiological assessment of Saudi athletes. *Journal of Sports Medicine and Physical Fitness* **32**, 164-169.
- Claessens, A.L.M., Beunen, G.P., Simons, J.M., Wellens, R.I., Geldof, D. and Nuyts, M.M. (1986a) Body structure, somatotype and motor fitness of top-class Belgian judoists. In: *Perspectives in kinanthropometry*. Ed: Day, J.A.P. Champaign, IL: Human Kinetics Publishers, Inc. 155-163.
- Claessens, A., Beunen, G., Lefevre, J., Mertens, G. and Wellens, R. (1986b) Body structure, somatotype, and motor fitness of top-class Belgian judoists and karateka. A comparative study. In: *Kinanthropometry III*. Eds: Reilly, T., Watkins, J. and Borms, J. London: E. & F.N. Spon. 53-57.
- Claessens, A., Beunen, G., Wellens, R. and Geldof, G. (1987) Somatotype and body structure of world top judoists. *Journal of Sports Medicine and Physical Fitness* **27**, 105-113.
- Ebine, K., Yoneda, I., Hase, H., Aihara, K., Aihara, M., Akaike, M., Ishida, H., Nishimoto, K., Nomura, M., Tsuda, H. and Tsuyuki, K. (1991) Physiological characteristics of exercise and findings of laboratory tests in Japanese elite judo athletes. *Médecine du Sport* **65**, 73-79.
- Gualdi-Russo, E., Gruppioni, G., Guerresi, P., Belcastro, M.G. and Marchesini, V. (1992) Skinfolds and body composition of sports participants. *Journal of Sports Medicine and Physical Fitness* **32**, 303-313.
- Janiak, J. and Krawczyk, B. (1995) Relationships between muscle force and total or lean body mass in highly experienced combat athletes. *Biology of Sport* **12**, 107-111.
- Kieffer, S., Carter, J. E. L., Held-Sturman, M., Patterson, P. and Carlson, R. (2000) Physique characteristics

- of USA national and university level rugby players. In: *Kinanthropometry VI*. Eds: Norton, K., Olds, T. and Dollman, J. Underdale, Australia: International Society for the Advancement of Kinanthropometry. 53-77.
- Kim, K.J., Kim, E.H. and Han, M.W. (1996) A comparison of physiological and performance responses for analysis of the degree of judo training intensity. *Korean Journal of Sports Science* **8**, 52-64.
- Krawczyk, B., Sklad, M. and Jackiewicz, A. (1997) Heath-Carter somatotypes of athletes representing various sports. *Biology of Sport* **14**, 305-310.
- Little, N.G. (1991) Physical performance attributes of Junior and Senior women, juvenile, Junior and Senior men judokas. *Journal of Sports Medicine and Physical Fitness* **31**, 510-520.
- Maas, G.D. (1974) *The physique of athletes*. Leiden University Press, Leiden.
- MacDougall, J., Wenger, H. and Green, H. (1991) *Physiological testing of the high-performance athlete*. Human Kinetics Books, Champaign, IL.
- Malina, R.M., Mueller, W.H., Bouchard, C., Shoup, R.F. and Lariviere, G. (1982) Fatness and fat patterning among athletes at the Montreal Olympic Games, 1976. *Medicine and Science in Sports and Exercise* **14**, 445-452.
- Mueller, W.H., Shoup, R.F. and Malina, R.M. (1982) Fat patterning in athletes in relation to ethnic origin and sport. *Annals of Human Biology* **9**, 371-376.
- Ntoumanis, N. (2001) *A step-by-step guide to SPSS for sport and exercise studies*. Routledge, London.
- Olds, T. and Kang, S.J. (2000) Anthropometric characteristics of adult male Korean taekwondo players. In: *The 1st olympic taekwondo scientific congress proceedings*. Seoul: OTSC Organizing Committee and Korean National University of Physical Education. 69-75.
- Pieter, W. (1991) Performance characteristics of elite taekwondo athletes. *Korean Journal of Sport Science* **3**, 94-117.
- Pieter, W. and Gagonin, S. (1994) Body composition of elite and recreational Russian athletes. *International Conference on Current Research Into Sport Sciences, St. Petersburg Research Institute of Physical Culture, St. Petersburg, Russia*, July 28-30.
- Pieter, W., Palabrica, J. and Bercades, L. T. (1998a) Fat and skinfold patterning in national elite female Filipino judo athletes. *Biology of Sport* **15**, 87-98.
- Pieter, W., Palabrica, J. and Bercades, L.T. (1998b) Physique of national elite female Filipino judo athletes. *Acta Kinesiologiae Universitatis Tartuensis* **3**, 49-58.
- Pieter, W. and Taaffe, D. (1990) Peak torque and strength ratios of elite taekwondo athletes. In: *Commonwealth and International Conference Proceedings. Volume 3. Sport Science. Part 1*. Auckland, New Zealand: NZAHPER. 67-79.
- Ross, W.D., Carr, R.V. and Carter, J.E.L. (2000) *Anthropometry illustrated*. Turnpike Electronic Publications, Inc., Surrey, BC.
- Ross, W.D. and Marfell-Jones, M. (1991) Kinanthropometry. In: *Physiological testing of the high-performance athlete*. Eds: MacDougall, J., Wenger, H. and Green, H. Champaign, IL: Human Kinetics Books. 223-308.
- Ross, W.D. and Ward, R. (1984). Proportionality of Olympic athletes. In: *Physical structure of olympic athletes. Part II*. Ed: Carter, J.E.L. Basel: Karger. 110-143.
- Sinning, W.E. (1985) Body composition and athletic performance. In: *Limits of human performance. The academy papers #18*. Eds: Clarke, D.H. and Eckert, H.M. Champaign, IL: Human Kinetics Publishers. 45-56.
- Taaffe, D. and Pieter, W. (1990) Physical and physiological characteristics of elite taekwondo athletes. In: *Commonwealth and international conference proceedings. Volume 3. Sport science. Part 1*. Auckland, New Zealand: NZAHPER. 80-88.
- Taylor, A.W. and Brassard, L. (1981) A physiological profile of the Canadian judo team. *Journal of Sports Medicine and Physical Fitness* **21**, 160-164.
- Thomas, S.G., Cox, M.H., LeGal, Y.M., Verde, T.J. and Smith, H.K. (1989) Physiological profiles of the Canadian national judo team. *Canadian Journal of Sport Sciences* **14**, 142-147.
- Thomas, J.R. and Nelson, J.K. (2001) *Research methods in physical activity*. Third Edition. Human Kinetics Publishers: Champaign, Illinois.
- Tumilty, D., Hahn, A. and Telford, R.D. (1986) A physiological profile of well-trained male judo players, with proposals for training. *Excel* **2**, 12-14.
- Vidalin, H., Dubreuil, C. and Coudert, J. (1988) Black belt judokas. Physiological aspects: biometrics and bioenergetics. Recommendations for training. *Médecine du Sport* **62**, 184-189. (In French).
- Wilmore, J.H. and Costill, D.L. (2004) *Physiology of sport and exercise*. Human Kinetics, Champaign, IL.
- Zhuo, D., Shephard, R., Plyley, M. and Davis, G. (1984) Cardiorespiratory and metabolic responses during tai chi chuan exercise. *Canadian Journal of Applied Sport Science* **9**, 7-10.

KEY POINTS

- The purpose of the present investigation was to assess relative total body fat and skinfold patterning in Filipino national karate and pencak silat athletes.
- The results seem to suggest that there was no difference between combat sports in fatness.
- Skinfold patterning was more in line with what was reported in the literature with the males recording lower extremity fat.

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