

## CHAPTER 5

### Discussion

This study assessed peripheral sudomotor function by quantitative sudomotor axon reflex test (QSART) and directly stimulation in eccrine sweat gland function (DIR) at forearm and thigh between in the high physical fitness and sedentary prepubertal boys. ACh-induced sweating responses can be measured from the DIR (sweating activity mediated by the muscarinic receptor of the eccrine sweat gland) and AXR (sweating activity mediated by the sudomotor axon reflex via the nicotine receptor) separately by using iontophoresis method. Hilz and Dutsch [2006] have reported that ACh-induced DIR and AXR sweating may reflect the elements of the sweat gland itself (cholinergic sensitivity and size of eccrine glands) and of postganglionic sympathetic axons.

#### **1. Physical fitness related difference effect to sweating responses**

The results showed that prepubertal subjects with high physical fitness had higher sweat gland function at both forearm and thigh than that of sedentary group when measured using AXR method suggesting a different cholinergic sensitivity of sudomotor nerves responsible for the axon reflex. Thus, physical training or exercise may modify of the function of postganglionic sympathetic axons. Unlike the results from a study in trained young men where the ACh-induced AXR sweating was not enhanced markedly by physical training [Inoue et al., 2009b], results from current study demonstrated that the activity of postganglionic sympathetic axons of sweat glands was enhanced by physical activity in prepubertal boys although their sweat glands were underdeveloped. Moreover, acclimatization may contribute to the lower volume of evaporative heat loss through lower sweat gland output of AXR in young men [Lee, 2008].

Similar to sweat response through AXR, prepubertal subjects with high physical fitness had higher sweat gland function at both forearm and thigh than that of sedentary group when measured using DIR method. Thus, physical training could also directly improve

sweat gland response. Results from this study were similar to results from a previous study that showed sweat gland hypertrophy in prepubertal children with high physical fitness which could lead to increased sweating rate [Ichinose-Kuwahara et al., 2010]. Another study showed that the physically trained male group had significantly higher mean sweat rate than the untrained male group at 50 and 65%  $VO_{2max}$  and that the enhancement of sweat gland function in young men by long-term physical training was due to the enhanced DIR rather than AXR. The effect could be observed even in people acclimated to a tropical climate [Inoue et al, 2009b].

An increased sweat rate could be due to an increased density of active sweat glands (ASG), increased sweat output per gland (SGO), or a combination of both factors. The active sweat gland density (ASG) and single sweat gland output volume (SGO) as well as the evaporated quantity are quantitative parameters for evaluating sweat gland function [Shibasaki et al., 2006].

In the current study, both ASG and SGO may contribute to the higher forearm and thigh DIR output in high physical fitness group when compared to the sedentary group. These results suggested that exercise training improved sweating function in prepubertal boys by recruiting more sweat glands to become more active in producing sweat as indicated by an increased ASG and by promoting sweat production from individual gland as indicated by an increased SGO. In contrast to previous study in young men that showed the enhancement of sweat rate by long-term physical training was mainly attributable to changes SGO of and not to changes in the number of ASG [Inoue et al., 2009b], this study demonstrated that both ASG and SGO were involved in prepubertal subjects. Because the number of eccrine sweat glands were determined at birth and no new glands were developed after birth but decreased with age [Low, 2012], it is conceivable that a portion of sweat glands were inactive in sedentary subjects and were later recruited into action by aerobic physical training as shown by an increased in ASG in high physical fitness group.

## **2. Regional related difference effect to sweating responses**

The regional skin evaporation can significantly affect the heat released from each body part, the pattern of skin temperature distribution and the thermoregulation. In the present study, DIR sweat rates measured at forearm were significantly higher than the rates obtained from thigh in high physical fitness group. In addition, active sweat gland densities (ASG) in high physical fitness and sedentary groups were significantly higher in forearm than in thigh suggesting that the difference in sweating rates between 2 locations was a result of higher active sweat gland density in the upper limb.

The difference in sweat rates between the upper and lower limb was confirmed by a previous study that found variation of regional sweat rates among different body sites [Ueda and Inoue, 2013]. However, the differences in sweat regulation depending on physical fitness may be the result of different local or peripheral mechanisms underlying thermoregulation [Inoue et al., 1999]. Moreover, previous study reported that local sweat rates on the back and thigh during the last 30 min of heat exposure was significantly lower for the older men but not on the forearm leading to the conclusion that successive decrements may develop sequentially from the lower limbs to the upper body, and head [Inoue and Shibasaki, 1996].

In conclusion, prepubertal boys with high physical fitness have higher sweat gland function at both forearm and thigh areas as determined by DIR and AXR. The increased sweat rate at both locations is likely due to a recruitment of sweat glands that were inactive in sedentary subjects. Additionally, an increased sweat production by individual gland is another contributing factor for the enhanced response in forearm. Thus, aerobic physical training can improve eccrine sweat gland function in prepubertal boys through a peripheral mechanism involving postganglionic sympathetic axons and the regulation of sweat glands activity.