

CHAPTER IV

RESULTS

1. General characteristics of endurance trained athletes (ETA), resistance trained athletes (RTA) and sedentary subject (SS).

The general characteristics of the ETA, RTA and SS groups are shown in Table 3. The average age of the ETA, RTA and SS groups were 22 (1.91), 21(1.64) and 22(1.95) years, respectively. No significant differences were found among three groups of subjects in age.

The ETA group has body weight and diastolic blood pressure [56.7(5.46) kg, 69(7.88) mmHg] lower than the RTA group [66.3(14.38) kg, 75(6.02)mmHg], but no difference when compared with SS group [61.8(6.71) kg, 73(4.20)mmHg], and no difference between RTA and SS groups. However, the heart rate, systolic blood pressure and percent body fat of both RTA [65(6.92) bpm, 112(7.69) mmHg, and 17.8(4.35)%] and SS subject [68(8.79) bpm, 117(4.89) mmHg and 18.1(2.71)%] were higher than of the ETA subjects [56(8.01) bpm, 107(8.01) mmHg, and 13.9(8.15)%, respectively], but no significant difference between RTA and SS groups. On the other hand, the body height of the SS group [171.9(5.04) cm] was higher than the RTA [164.9(5.14) cm] and ETA group [166(6.79) cm], but not significant difference between ETA and RTA groups.

2. Physical fitness data at peak exercise

Physical fitness data at peak exercise including work load, heart rate, VO_2 max and exercise time of the subjects in all three groups shown in Table 4.

Workload

The workload then showed in ETA subjects [289(33.91) watt] were found to be significantly higher ($p < 0.001$) than in RTA and SS subjects [242(18.32) and 205(26.41) watt], while the RTA subjects was significantly higher ($p < 0.001$) than the SS subjects, respectively.

Heart rate

The heart rate at peak exercise of the ETA subjects [176(9.05) beat/min] was significantly less than the RTA and SS groups [183(7.96) and 189(9.95) beat/min], but not significant difference between RTA and SS groups.

VO₂max

The VO₂max of the ETA, RTA and SS subjects were 63(9.52), 40.5(4.99) and 36.4(5.45) ml/kg/min. This value of the ETA was significantly higher than those of the RTA and SS subjects with the p value less than 0.001. While the exercise time of the RTA subjects was significantly higher than the SS subjects.

Exercise time

The exercise time of the ETA group [14(1.25) min] was significantly higher than RTA [12(0.79) min] and SS group [11(1.55) min], while the exercise time of the RTA group was significantly higher than the SS group.

3. Physical fitness data at 50% VO₂max

Physical fitness data at 50%VO₂max including workload, heart rate, and VO₂ of the subjects in all 3 groups shown in Table 5

Workload

The workload of the ETA, RTA and SS groups were 147(18), 122(15) and 99(15) watt, respectively. This value of the ETA was significantly higher than of the RTA and SS groups, while RTA group was significantly higher than SS group.

Heart rate

The average heart rate of the ETA, RTA and SS groups were 130(6), 132(3) and 133(4) beat/min, shown no significant difference between three groups.

VO₂

The VO₂ of the ETA group [31.7(4.7) ml/kg/min] was significantly higher than RTA [19.1(2.5) ml/kg/min] and SS group [17.9(2.4) ml/kg/min], but no significantly between RTA and SS group.

4. Time and frequency domain analysis at sitting rest

The results from Time and Frequency domain analysis of RR interval variability at rest shown in Table 6.

Time domain analysis

The average NN interval and SDNN was significantly higher in ETA [1087(140) and 77(21) ms] than in RTA [924(89) and 58(13) ms] and SS group [886(94) and 51(10) ms]. This value of the RTA and SS groups with no significant.

Frequency domain analysis

The total power and VLF power was significantly higher in ETA [1079(170) and 34(159) ms²] than in RTA [714(199) and 205(94) ms²] and SS groups [591(137) and 173 (45) ms²], but not significant difference between RTA and SS groups.

The HF and LF power of HRV were assessed for sitting rest position, with absolute mean and normalized results shown (Table 6).

The LF power (absolute value) in ETA, RTA and SS groups were 302(82), 268(75) and 231(70) ms², shown ETA was significantly higher than SS group, but not significant difference between RTA and groups. The LF power, when expressed in normalized units, were significantly lower in ETA group [42(5)%] than in RTA [53(7)%] and SS group [53(7)%]. In case of HF power (absolute value), ETA group [421(72) ms²] showed significantly ($p < 0.001$) higher value as compared with both RTA [241(72) ms²] and SS groups [200(55) ms²], respectively. The mean normalized HF power of the ETA group [58(5)%] was significantly higher than in RTA [48(7) %] and SS group [47(7)%], but no significant difference between RTA and SS groups.

The LF/HF ratio was significantly lower in ETA [0.7(0.2)] than in RTA [1.14(0.3)] and SS groups [1.20(0.4)], but no significant difference between RTA and SS groups [0.85(0.28)].

5. Time and frequency domain analysis during exercise at 50% VO₂max

The results from time and frequency domain analysis of RR interval variability during exercise at 50% VO₂max shown in Table 7.

Time domain analysis

Mean and SD values of average NN interval and SDNN during exercise at 50% VO₂ max of ETA group were 595(55) and 19(6) ms. RTA group were 572(48) and 20(8) ms. SS groups were 562(59) and 21(5) ms, respectively. The subjects in all of three groups were not significant different ($p < 0.05$).

Frequency domain analysis

Mean and SD values of total power, VLF, LF and HF power during exercise at 50% VO_2 max of ETA group were 234(120), 82(55), 72(33), and 73(39) ms^2 . RTA groups were 240(162), 87(69), 80(53) and 72(51) ms^2 . SS groups were 181(89), 80(44), 78(37) and 58(35) ms^2 , respectively. Mean and SD values of LF nu, HF nu and LF/HF ratio of ETA groups were 50(10), 49(10) % and 1.13(0.52). RTA groups were 55(9), 45(9) % and 1.37(0.51). SS groups were 55(5), 45(4) % and 1.45(0.51), respectively. These values of three groups were not significantly different ($p < 0.05$).

Table 3 General characteristics of endurance trained athletes (ETA), resistance trained athletes (RTA) and sedentary subject (SS).

Parameter	ETA (n=20)	RTA (n=20)	SS (n=20)
Age (years)	22(1.91)	21(1.64)	22(1.95)
Body weight (kg)	56.7(5.46)	66.3(14.38)	61.8(6.71)
Body height (cm)	166(6.79)	164.9(5.14)	171.9(5.04)
Heart rate (beat/min)	56(8.01)	65(6.92)	68(8.79)
Blood pressure (mmHg)			
- Systolic	107(8.01)	112(7.68)	117(4.89)
- Diastolic	69(7.88)	75(6.02)	73(4.20)
Body fat (%)	13.9(2.15)	17.8(4.35)	18.1(2.71)

Values are mean (SD)

Table 4 Physical fitness data at peak exercise of endurance trained athletes (ETA), resistance trained athletes (RTA) and sedentary subject (SS).

Parameter	ETA (n) =20	RTA (n) =20	SS (n) =20	p-value
Work load (watt)	289(33.91) ^{a,b}	242(18.32) ^c	205(26.41)	0.001
Heart rate (beat/min)	176(9.05) ^{a,b}	183(7.96)	189(9.95)	0.001
Vo2 (ml/kg/min)	63(9.52) ^{a,b}	40.5(4.99)	36.4(5.45)	0.001
Exercise time (min)	14(1.25) ^{a,b}	12(0.79) ^c	11(1.55)	0.001

Values are mean (SD)

ns=no significant, a = ETA vs RTA, b = ETA vs SS, c = RTA vs SS

Table 5 Physical fitness data at 50% VO₂max of endurance trained athletes (ETA), resistance trained athletes (RTA) and sedentary subject (SS).

Parameter	ETA (n) =20	RTA (n) =20	SS (n) =20	p-value
Work load (watt)	147(18) ^{a,b}	122(15) ^c	99(15)	0.001
Heart rate (beat/min)	130(6) ^{ns}	132(3)	133(4)	0.177
VO ₂ (ml/kg/min)	31.7(4.7) ^{a,b}	19.1(2.5)	17.9(2.4)	0.001

Values are mean (SD)

ns=no significant, a = ETA vs RTA, b = ETA vs SS, c = RTA vs SS



Table 6 Time and frequency domain measures of RR interval variability in endurance trained athletes (ETA), resistance trained athletes (RTA) and sedentary subject (SS) at rest.

Parameter	ETA (n=20)	RTA (n=20)	SS (n=20)
Time domain			
-Average NN interval (ms)	1087 (140) ^{a,b}	924(89) ^{ns}	886(94)
-SDNN (ms)	77(21) ^{a,b}	58(13) ^{ns}	51(10)
Frequency domain			
-Total power (ms ²)	1079(170) ^{a,b}	714(199) ^{ns}	591(137)
-VLF power (ms ²)	346(159) ^{a,b}	205(94) ^{ns}	173(45)
-LF power (ms ²)	302(82) ^b	268(75) ^{ns}	231(70)
-LF nu	42(5) ^{a,b}	53(7) ^{ns}	53(7)
-HF power (ms ²)	421(121) ^{a,b}	241(72) ^{ns}	200(55)
-HF nu	58(5) ^{a,b}	48(7) ^{ns}	47(7)
-LF/HF ratio	0.7(0.2) ^{a,b}	1.14(0.3) ^{ns}	1.20(0.4)

Values are mean (SD)

ns=no significant, a = ETA vs RTA, b = ETA vs SS



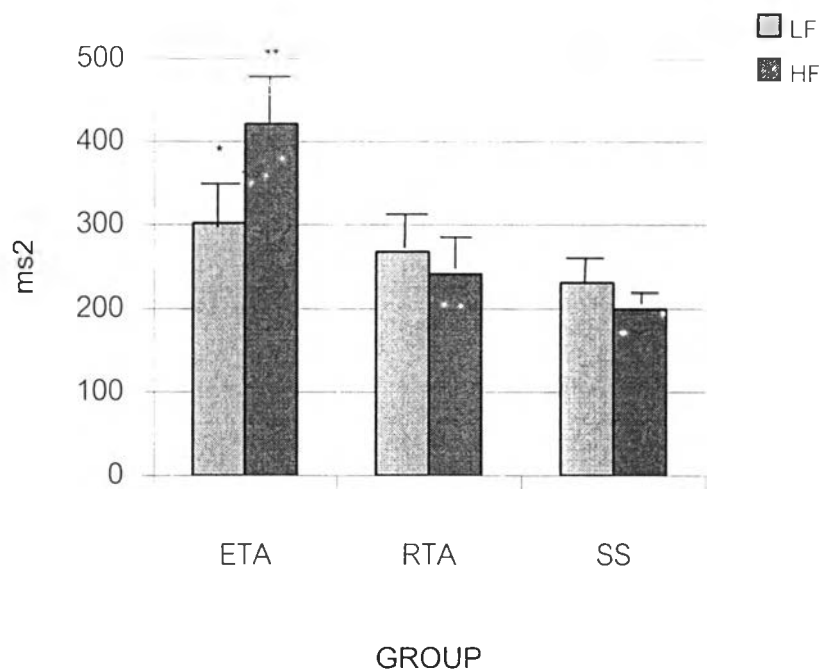
Table 7 Time and frequency domain measures of RR interval variability in endurance trained athletes (ETA), resistance trained athletes (RTA) and sedentary subject (SS) correspond steady state exercise at 50% V_{o_2max} .

Parameter	ETA (n=20)	RTA (n=20)	SS (n=20)
Time domain			
-Average NN interval (ms)	595 (55) ^{ns}	572(48)	562(60)
-SDNN (ms)	19(6) ^{ns}	20(8)	21(5)
Frequency domain			
-Total power (ms ²)	234(120) ^{ns}	240(162)	181(89)
-VLF power (ms ²)	82(55) ^{ns}	87(69)	80(44)
-LF power (ms ²)	72(33) ^{ns}	80(54)	77(37)
-LF nu	51(10) ^{ns}	55(9)	55(5)
-HF power (ms ²)	73(39) ^{ns}	72(51)	58(35)
-HF nu	49(10) ^{ns}	45(9)	45(4)
-LF/HF ratio	1.13(0.52) ^{ns}	1.37(0.51)	1.45(0.51)

Values are mean (SD)

ns = no significant between groups.

Fig 11 Effect of rest on the absolute value in low and high frequency power



LF = low frequency power, HF = high frequency power,

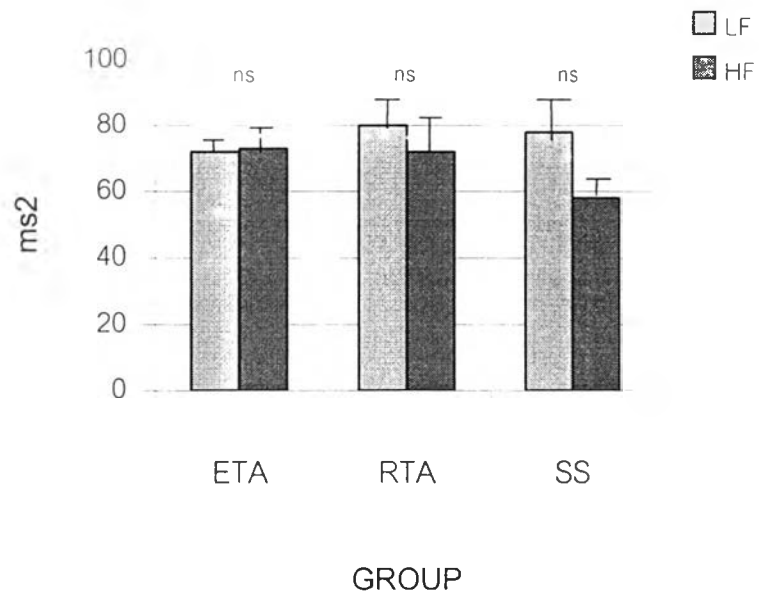
ETA = endurance trained athletes, RTA = resistance trained athletes,

SS = sedentary subject.

* = ETA>SS

** = ETA>RTA and SS ($p < 0.01$)

Fig 12 Effect of steady state exercise at 50% Vo_2max on the absolute value in low and high frequency power



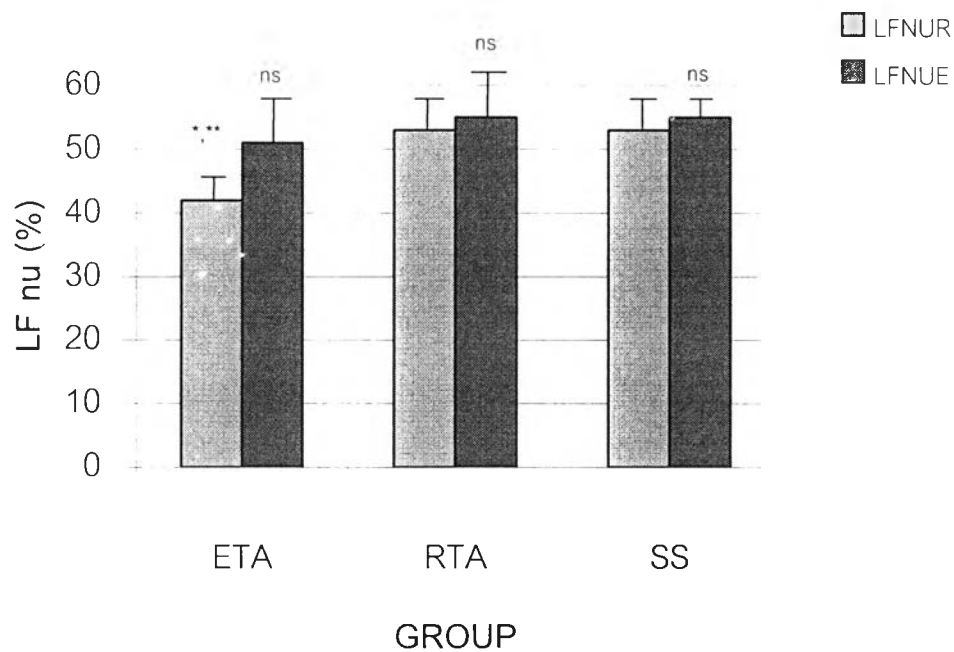
LF = low frequency power, HF = high frequency power,

ETA = endurance trained athletes, RTA = resistance trained athletes,

SS = sedentary subject.

ns = no significantly

Fig 13. Effect of rest and steady state exercise at 50% V_{O_2max} on the normalized unit in the low frequency power (LF nu).



LFNUR = normalized unit of low frequency at rest

LFNUE = normalized unit of low frequency corresponded steady state exercise at 50% V_{O_2max} .

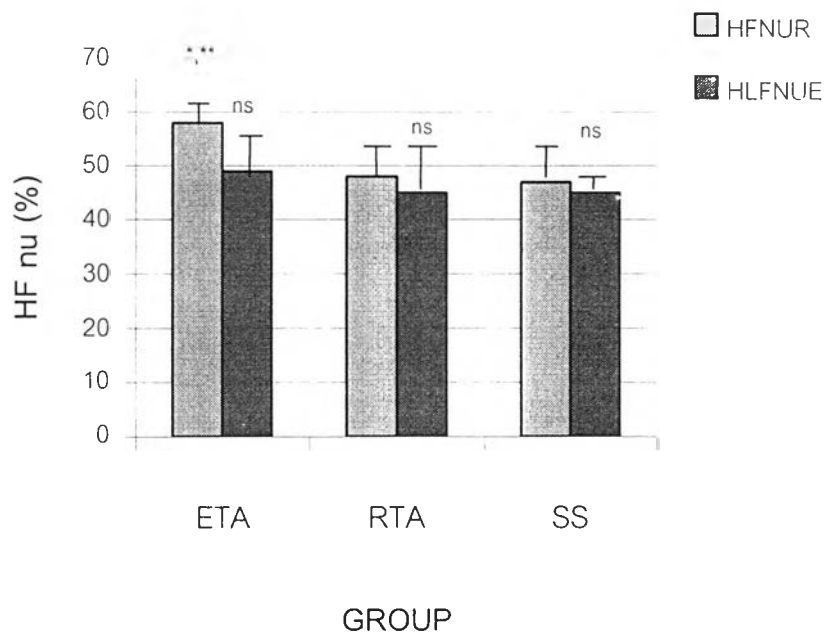
ETA = endurance trained athletes, RTA = resistance trained athletes, SS = sedentary subject.

* = Significant between rest and steady stat exercise at 50% V_{O_2max} within group.

** = ETA < RTA and SS group.

ns = no significant between groups of rest and steady stat exercise at 50% V_{O_2max} .

Fig 14. Effect of rest and steady state exercise at 50% V_{O_2max} on the normalized unit in the high frequency power (HF nu).



HFNUR = normalized unit of high frequency at rest

HLFNUE = normalized unit of high frequency corresponded steady state exercise at 50% V_{O_2max} .

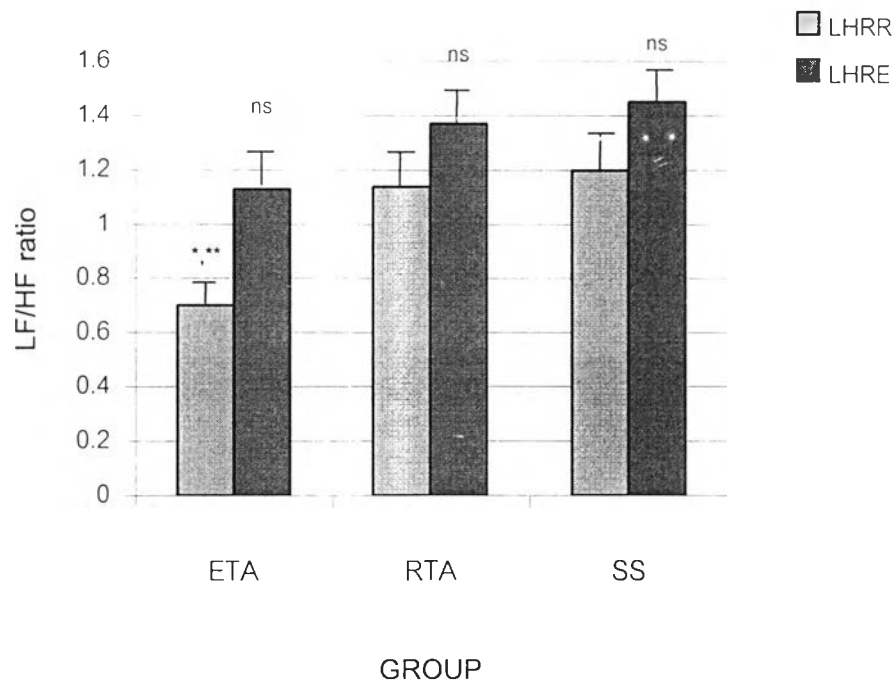
ETA = endurance trained athletes, RTA = resistance trained athletes, SS = sedentary subject.

* = Significant between rest and steady stat exercise at 50% V_{O_2max} within group.

** = ETA >RTA and SS group at rest.

ns = no significant between groups of rest and steady stat exercise at 50% V_{O_2max} .

Fig 15. Effect of rest (site) and steady state exercise at 50% Vo_{2max} on the ratio of the low (LF) to high (HF) frequency.



LHRR = LF:HF ratio at rest

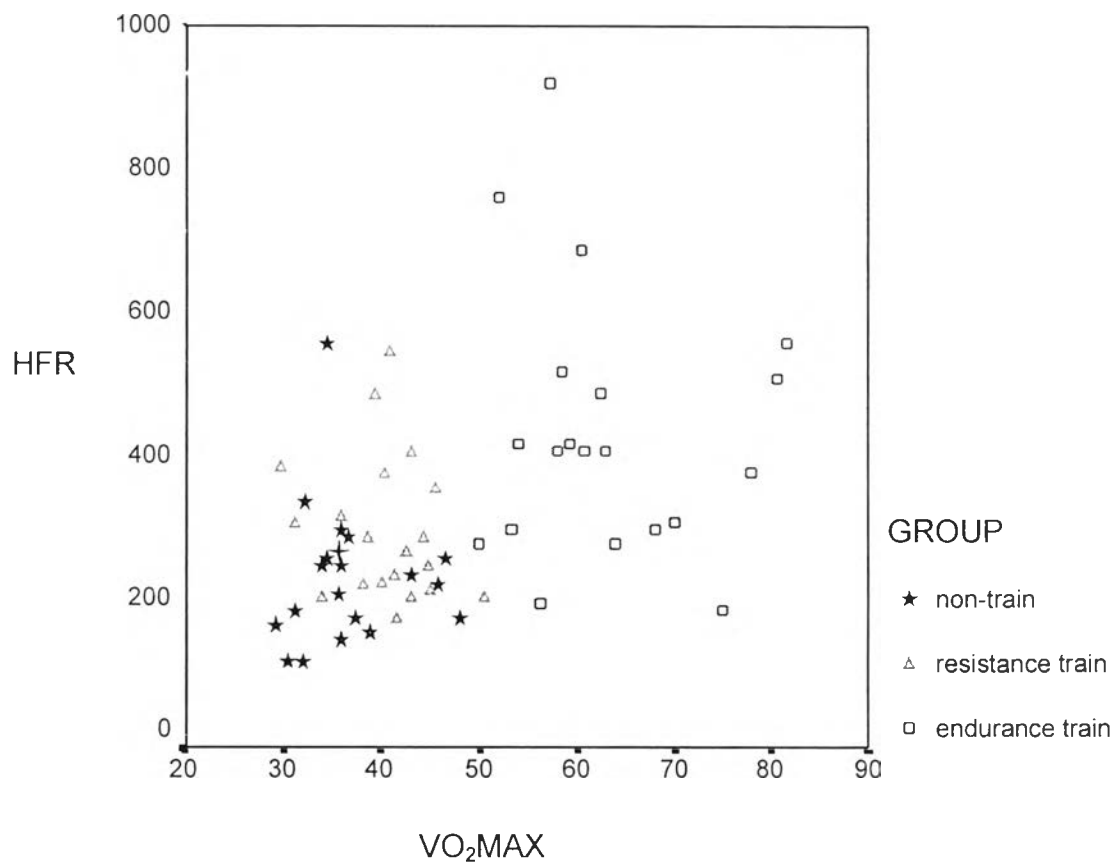
LHRE = LF:HF ratio corresponded steady stat exercise at 50% Vo_{2max} .

ETA = endurance trained athletes, RTA = resistance trained athletes, SS = sedentary subject.

* = Significant between rest and steady stat exercise at 50% Vo_{2max} within group.

** = ETA < RTA and SS groups at rest.

ns = no significant between groups of rest and steady stat exercise at 50% Vo_{2max} .

Fig 16. Scatter Plot between HFR and VO₂ Max

HFR = high frequency power at rest

VO₂max = maximum oxygen consumption

Fig 17. Example of time and frequency domain at rest (A) and steady state exercise at 50% VO_2 max (B) in Sedentary subject

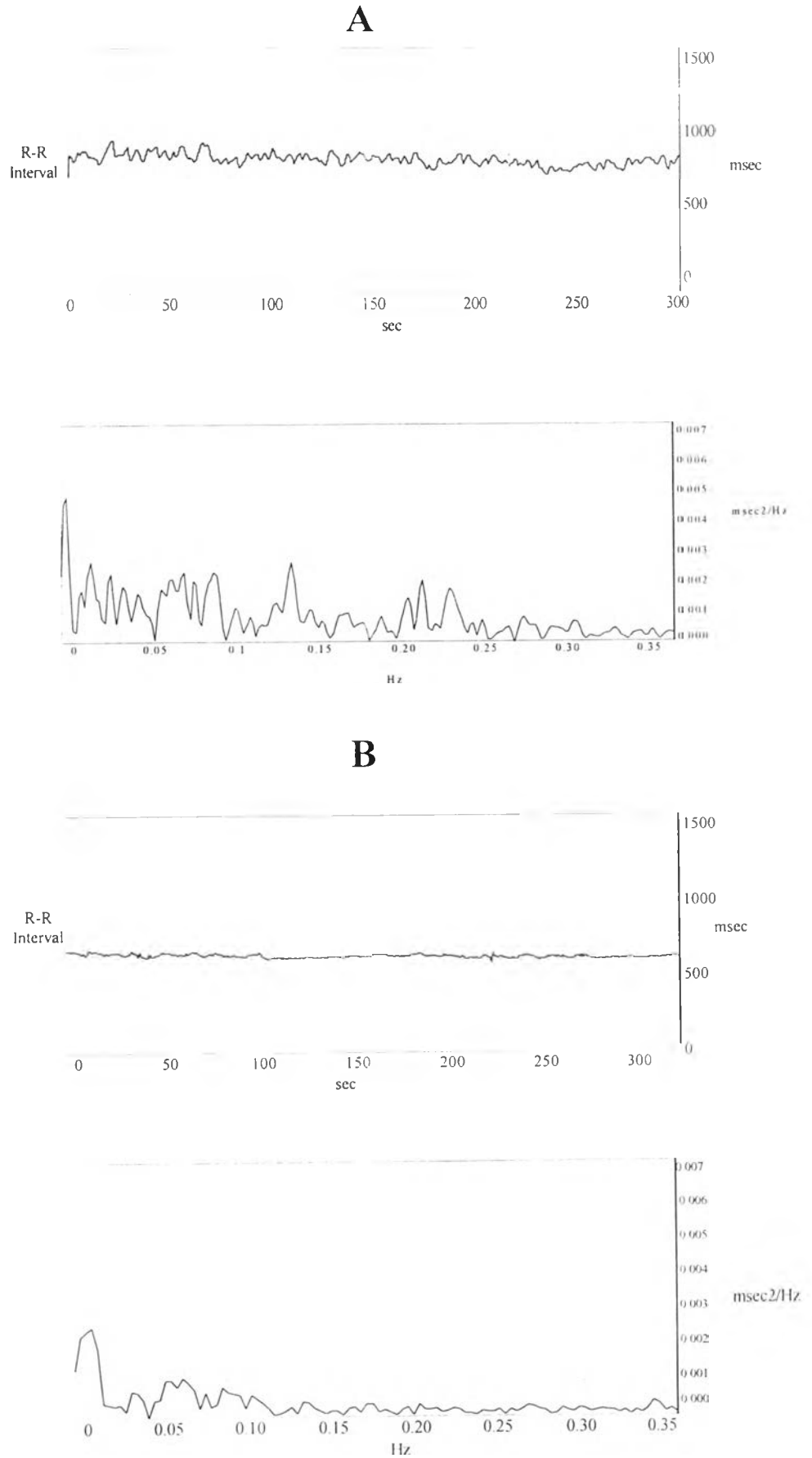


Fig 18. Example of time and frequency domain at rest (A) and steady state exercise at 50% VO_2max (B) in Resistance trained athletes.

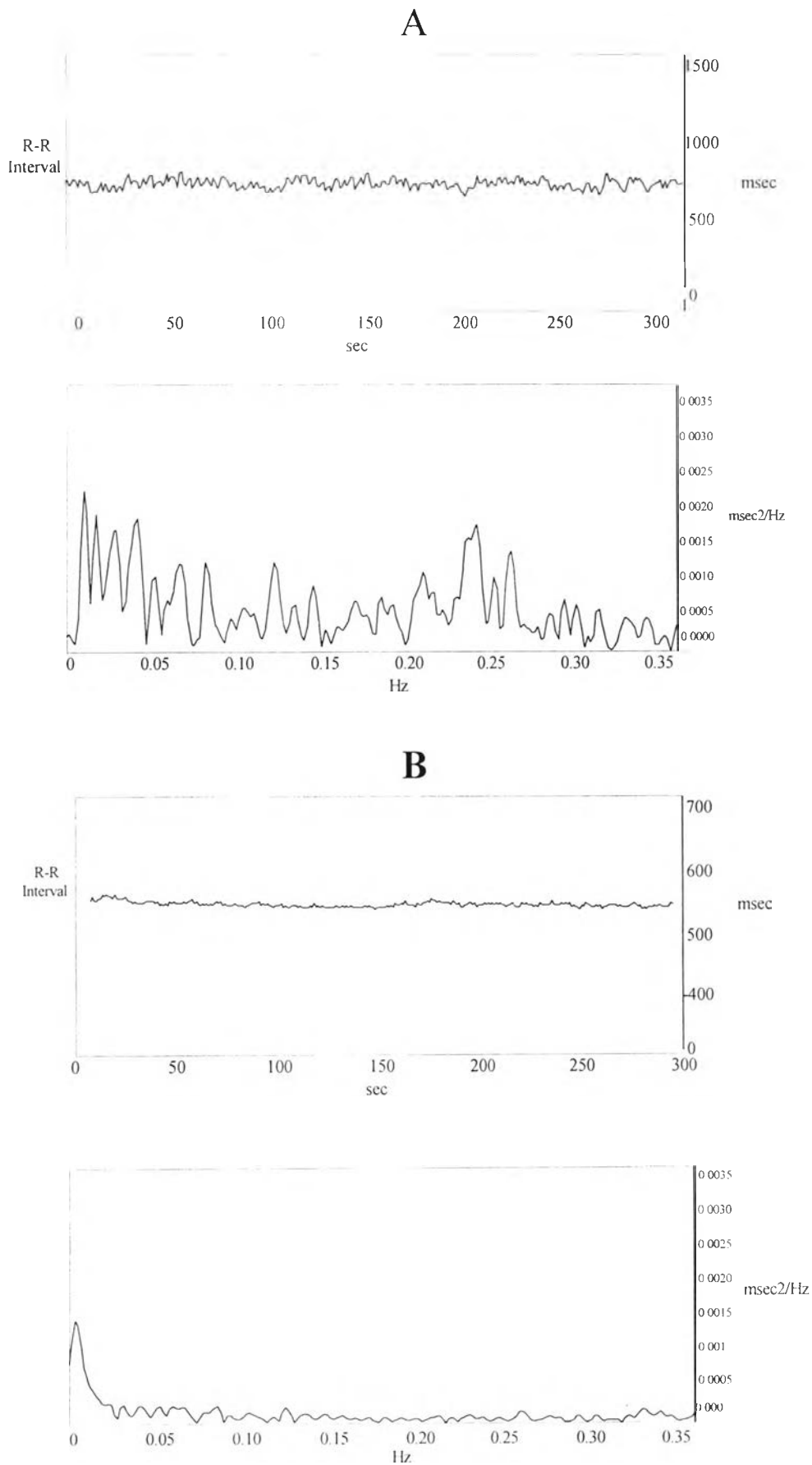


Fig 19. Example of time and frequency domain at rest (A) and steady state exercise at 50% VO_2 max (B) in endurance trained athletes.

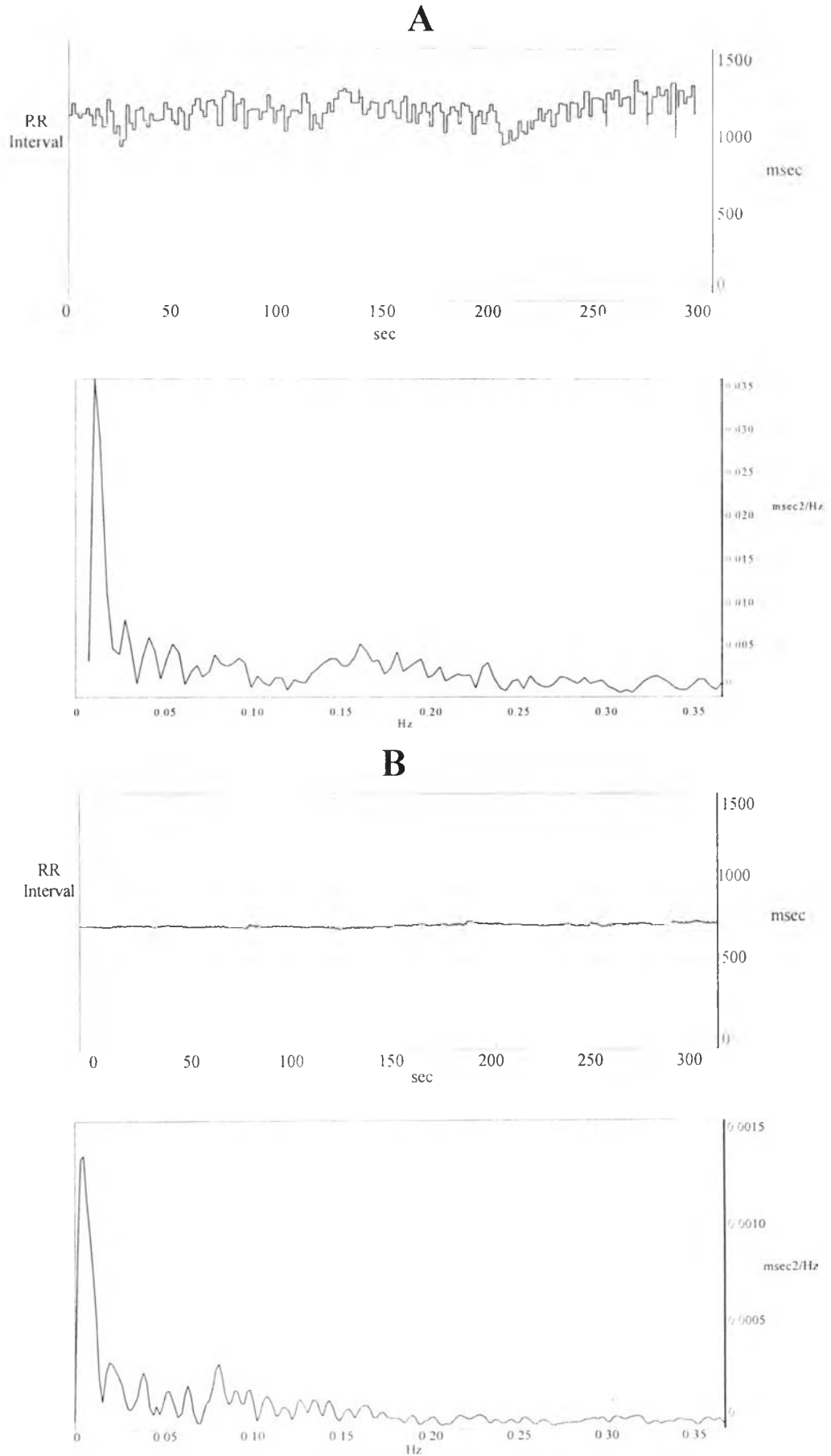


Fig 20. Comparison R-R interval variability in sedentary subjects, resistance trained athletes and endurance trained athletes at rest.

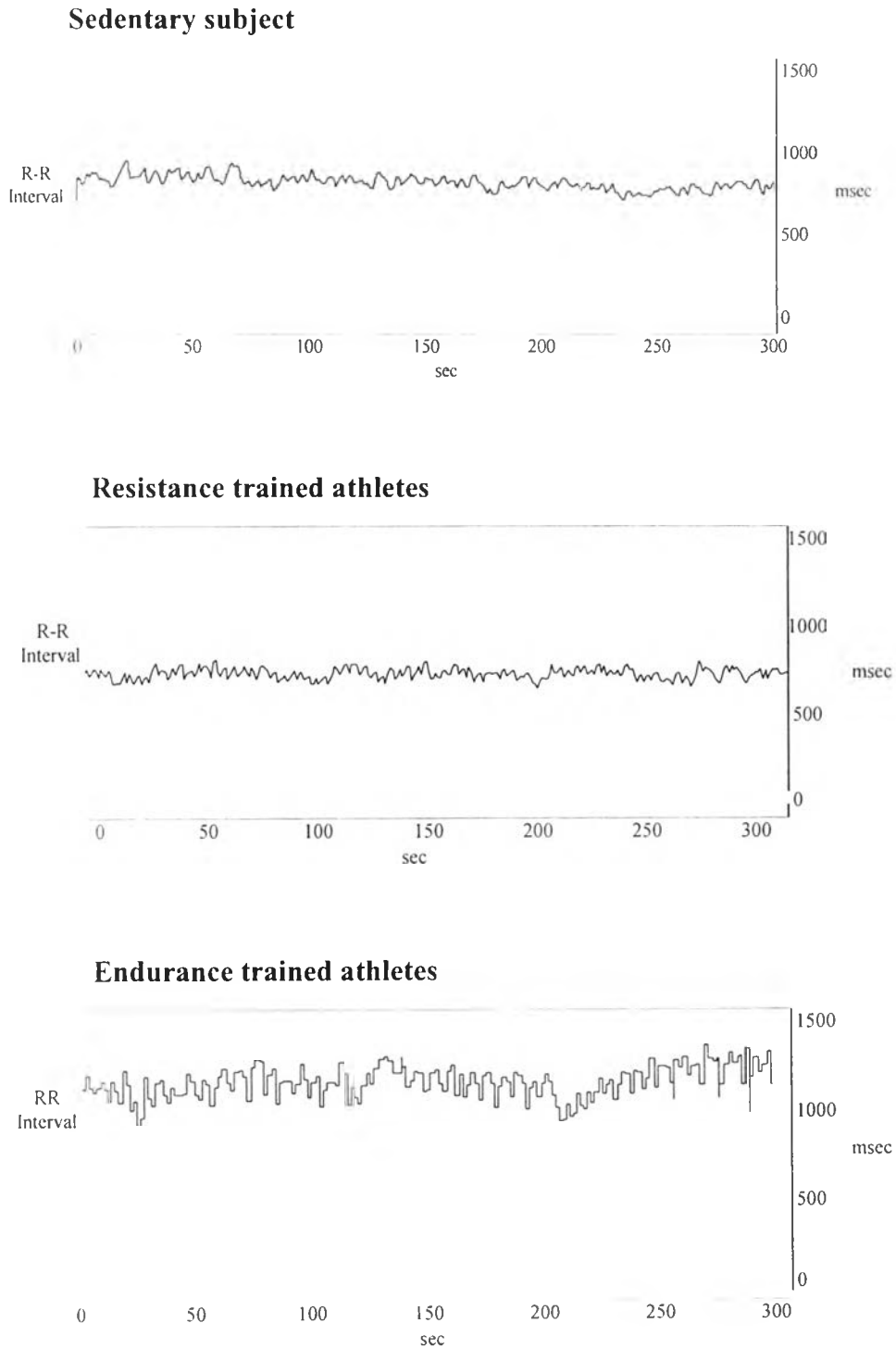
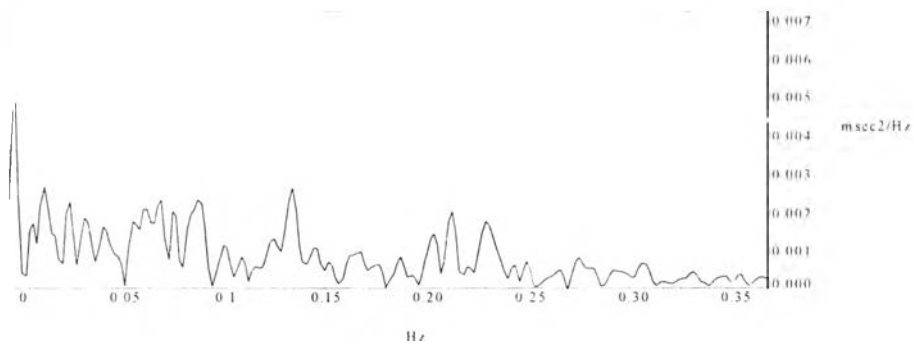
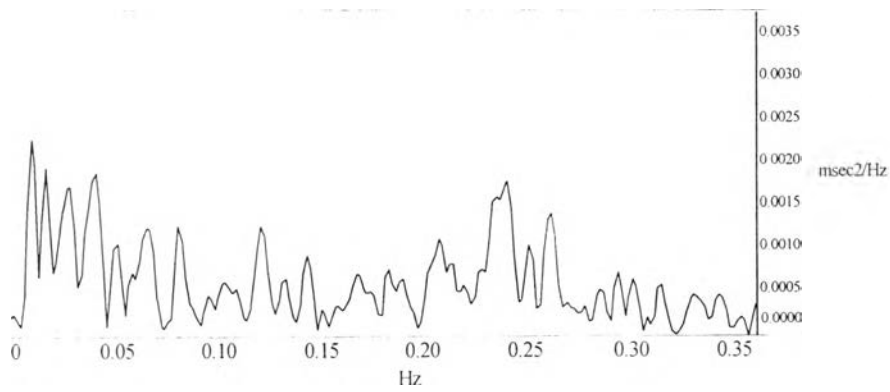


Fig 21. Comparison frequency domain in sedentary subjects, resistance trained athletes and endurance trained athletes at rest.

Sedentary subject



Resistance trained athletes



Endurance trained athletes

