

## LIST OF FIGURES

Figure		Page
1.1	Study I conceptual framework.....	11
1.2	Study II conceptual framework.....	12
2.1	Functional classification of allergic rhinitis.....	15
2.2	Nasal anatomy.....	17
2.3	Schematic representation of the nasal neuronal control. ....	18
2.4	Pathophysiology of allergic rhinitis.....	19
2.5	Characteristic of cytokine.....	25
2.6	T-helper lymphocyte differentiation to Th1 or Th2.....	32
2.7	Interaction of oxygen free radicals and antioxidants. ....	36
2.8	Steps of lipid peroxidation .....	37
2.9	Antioxidant effects of vitamins C and E on lipid peroxidation (LPO)....	44
2.10	Format of a typical aerobic exercise session. ....	49
3.1	Study I procedure.....	60
3.2	Study II procedure.....	63
	<u>Study I</u>	
4.1	The percent different between pre and post of exhaustive and moderate exercise in cytokine levels: IL-2, IL-4, IL-13, and TNF- $\alpha$ (pg/ml) in healthy (CON) and allergic rhinitis patient (AR) groups.....	71
4.2	The ratio of IL-2 and IL-4 (IL-2/IL-4) compared between exhaustive and moderate exercise in healthy (CON) and allergic rhinitis patient (AR) groups.....	72
	<u>Study II</u>	
4.1	The comparison of resting heart rate (bpm) between pre- and post-training and among three groups of subjects: control group (CON), exercise group (EX) and exercise combined vitamin C supplementation group (EX + Vit. C).....	73

Figure	Page
4.2 The comparison of systolic blood pressure (mmHg) between pre- and post-training and among three groups of subjects: control group (CON), exercise group (EX) and exercise combined vitamin C supplementation group (EX + Vit. C).....	74
4.3 The comparison of diastolic blood pressure (mmHg) between pre- and post-training and among three groups of subjects: control group (CON), exercise group (EX) and exercise combined vitamin C supplementation group (EX + Vit. C).....	75
4.4 The comparison of body weight (kg) between pre- and post-training and among three groups of subjects: control group (CON), exercise group (EX) and exercise combined vitamin C supplementation group (EX + Vit. C).....	76
4.5 The comparison of body mass index ( $\text{kg/m}^2$ ) between pre- and post-training and among three groups of subjects: control group (CON), exercise group (EX) and exercise combined vitamin C supplementation group (EX + Vit. C).....	77
4.6 The comparison of body fat (%) between pre- and post-training and among three groups of subjects: control group (CON), exercise group (EX) and exercise combined vitamin C supplementation group (EX + Vit. C).....	78
4.7 The comparison of maximum oxygen consumption; $\text{VO}_2\text{max}$ (ml/kg/min) between pre- and post-training and among three groups of subjects: control group (CON), exercise group (EX) and exercise combined vitamin C supplementation group (EX + Vit. C).....	79
4.8 The comparison of forced vital capacity forced vital capacity; FVC (liters) between pre- and post-training and among three groups of subjects: control group (CON), exercise group (EX) and exercise combined vitamin C supplementation group (EX + Vit. C).....	80

Figure	Page
4.9 The comparison of forced expiratory volume at 1 second; FEV1 (liters) between pre- and post-training and among three groups of subjects: control group (CON), exercise group (EX) and exercise combined vitamin C supplementation group (EX + Vit. C).....	81
4.10 The comparison of slow vital capacity; SVC (liters) between pre- and post-training and among three groups of subjects: control group (CON), exercise group (EX) and exercise combined vitamin C supplementation group (EX + Vit. C).....	82
4.11 The comparative between pre-test and post-test of maximum voluntary ventilation; MVV (liters/min) in control group (CON), exercise group (EX) and exercise combined vitamin C supplementation group (EX + Vit. C).....	83
4.12 The comparison of white blood cell (cells/mm <sup>3</sup> ) between pre- and post-training and among three groups of subjects: control group (CON), exercise group (EX) and exercise combined vitamin C supplementation group (EX + Vit. C).....	86
4.13 The comparison of red blood cell (mcells/mm <sup>3</sup> ) between pre- and post-training and among three groups of subjects: control group (CON), exercise group (EX) and exercise combined vitamin C supplementation group (EX + Vit. C).....	87
4.14 The comparison of hemoglobin (g/dl) between pre- and post-training and among three groups of subjects: control group (CON), exercise group (EX) and exercise combined vitamin C supplementation group (EX + Vit. C).....	88
4.15 The comparison of hematocrit (%) between pre- and post-training and among three groups of subjects: control group (CON), exercise group (EX) and exercise combined vitamin C supplementation group (EX + Vit. C).....	89

Figure	Page
4.16 The comparison of cholesterol (mg/dl) between pre- and post-training and among three groups of subjects: control group (CON), exercise group (EX) and exercise combined vitamin C supplementation group (EX + Vit. C).....	90
4.17 The comparison of triglyceride (mg/dl) between pre- and post-training and among three groups of subjects: control group (CON), exercise group (EX) and exercise combined vitamin C supplementation group (EX + Vit. C).....	91
4.18 The comparison of high density lipoprotein cholesterol; HDL-C (mg/dl) between pre- and post-training and among three groups of subjects: control group (CON), exercise group (EX) and exercise combined vitamin C supplementation group (EX + Vit. C).....	92
4.19 The comparison of low density lipoprotein cholesterol; LDL-C (mg/dl) between pre- and post-training and among three groups of subjects: control group (CON), exercise group (EX) and exercise combined vitamin C supplementation group (EX + Vit. C).....	93
4.20 The comparison of total Immunoglobulin E; Total IgE (IU/ml) between pre- and post-training and among three groups of subjects: control group (CON), exercise group (EX) and exercise combined vitamin C supplementation group (EX + Vit. C).....	94
4.21 The comparison of specific immunoglobulin E; Specific IgE ( <i>D.pteronyssinus</i> ) (kUA/L) between pre- and post-training and among three groups of subjects: control group (CON), exercise group (EX) and exercise combined vitamin C supplementation group (EX + Vit. C).....	95
4.22 The comparison of plasma Vit C (mg/dl) between pre- and post-training and among three groups of subjects: control group (CON), exercise group (EX) and exercise combined vitamin C supplementation group (EX + Vit. C).....	96

Figure	Page
4.23 The comparison of malondialdehyde; MDA ( $\mu\text{mol/L}$ ) between pre- and post-training and among three groups of subjects: control group (CON), exercise group (EX) and exercise combined vitamin C supplementation group (EX + Vit. C).....	97
4.24 The comparison of interleukin-2 (pg/ml) between pre- and post-training in three groups of subjects: control group (CON), exercise group (EX) and exercise combined vitamin C supplementation group (EX + Vit. C).....	100
4.25 The comparison of interleukin-2 after 5 minutes nasal challenge by house dust mite ( <i>D.pteronyssinus</i> ) between pre- and post-training in control group (CON).....	102
4.26 The comparison of interleukin-2 after 5 minutes nasal challenge by house dust mite ( <i>D.pteronyssinus</i> ) between pre- and post-training in exercise group (EX).....	102
4.27 The comparison of interleukin-2 after 5 minutes nasal challenge by house dust mite ( <i>D.pteronyssinus</i> ) between pre- and post-training in exercise combined vitamin C supplementation group (EX + Vit. C).....	103
4.28 The comparison of interleukin-4 (pg/ml) between pre- and post-training in three groups of subjects: control group (CON), exercise group (EX) and exercise combined vitamin C supplementation group (EX + Vit. C).....	104
4.29 The comparison of interleukin-4 after 5 minutes nasal challenge by house dust mite ( <i>D.pteronyssinus</i> ) between pre- and post-training in control group (CON).....	106
4.30 The comparison of interleukin-4 after 5 minutes nasal challenge by house dust mite ( <i>D.pteronyssinus</i> ) between pre- and post-training in exercise group (EX).....	107

Figure	Page
4.31 The comparison of interleukin-4 after 5 minutes nasal challenge by house dust mite ( <i>D.pteronyssinus</i> ) between pre- and post-training in exercise combined vitamin C supplementation group (EX + Vit. C).....	107
4.32 The comparison of interleukin-13 (pg/ml) between pre- and post-training in three groups of subjects: control group (CON), exercise group (EX) and exercise combined vitamin C supplementation group (EX + Vit. C).....	108
4.33 The comparison of interleukin-13 after 5 minutes nasal challenge by house dust mite ( <i>D.pteronyssinus</i> ) between pre- and post-training in control group (CON).....	110
4.34 The comparison of interleukin-13 after 5 minutes nasal challenge by house dust mite ( <i>D.pteronyssinus</i> ) between pre- and post-training in exercise group (EX).....	111
4.35 The comparison of interleukin-13 after 5 minutes nasal challenge by house dust mite ( <i>D.pteronyssinus</i> ) between pre- and post-training in exercise combined vitamin C supplementation group (EX + Vit. C).....	111
4.36 The comparison of peak nasal inspiratory flow; PNIF (liter/sec) between pre- and post-training and among three groups of subjects: control group (CON), exercise group (EX) and exercise combined vitamin C supplementation group (EX + Vit. C).....	114
4.37 The comparison of PNIF after nasal challenge on 5, 15, 30, 45 and 60 minutes between pre- and post-training in control group (CON).....	116
4.38 The comparison of PNIF after nasal challenge on 5, 15, 30, 45 and 60 minutes between pre- and post-training in the exercise group (EX).....	116
4.39 The comparison of PNIF after nasal challenge on 5, 15, 30, 45 and 60 minutes between pre- and post-training in the exercise combined vitamin C supplementation group (EX + Vit. C).....	117

Figure	Page	
4.40	The comparison of nasal blood flow (AU) between pre- and post-training and among three groups of subjects: control group (CON), exercise group (EX) and exercise combined vitamin C supplementation group (EX + Vit. C).....	118
4.41	The comparison of NBF after nasal challenge on 5, 15, 30, 45 and 60 minutes between pre- and post-training in the control group (CON)....	121
4.42	The comparison of NBF after nasal challenge on 5, 15, 30, 45 and 60 minutes between pre- and post-training in the exercise group (EX).....	121
4.43	The comparison of NBF after nasal challenge on 5, 15, 30, 45 and 60 minutes between pre- and post-training in the exercise combined vitamin C supplementation group (EX + Vit. C).....	122
4.44	The comparison of nasal congestion (level) between pre- and post-training and among three groups of subjects: control group (CON), exercise group (EX) and exercise combined vitamin C supplementation group (EX + Vit. C).....	123
4.45	The comparison of itching (level) between pre- and post-training and among three groups of subjects: control group (CON), exercise group (EX) and exercise combined vitamin C supplementation group (EX + Vit. C).....	124
4.46	The comparison of sneezing (level) between pre- and post-training and among three groups of subjects: control group (CON), exercise group (EX) and exercise combined vitamin C supplementation group (EX + Vit. C).....	125
4.47	The comparison of rhinorrhea (level) between pre- and post-training and among three groups of subjects: control group (CON), exercise group (EX) and exercise combined vitamin C supplementation group (EX + Vit. C).....	126

Figure	Page
4.48 The comparison of total rhinitis symptoms (level) between pre- and post-training and among three groups of subjects: control group (CON), exercise group (EX) and exercise combined vitamin C supplementation group (EX + Vit. C).....	127
4.49 The comparison of nasal congestion after nasal challenge on 5, 15, 30, 45 and 60 minutes between pre- and post-training in the control group (CON).....	131
4.50 The comparison of nasal congestion after nasal challenge on 5, 15, 30, 45 and 60 minutes between pre- and post-training in the exercise group (EX).....	131
4.51 The comparison of nasal congestion after nasal challenge on 5, 15, 30, 45 and 60 minutes between pre- and post-training in the exercise combined vitamin C group (EX + Vit. C).....	132
4.52 The comparison of itching after nasal challenge on 5, 15, 30, 45 and 60 minutes between pre- and post-training in the control group (CON).....	134
4.53 The comparison of itching after nasal challenge on 5, 15, 30, 45 and 60 minutes between pre- and post-training in the exercise group (EX).	134
4.54 The comparison of itching after nasal challenge on 5, 15, 30, 45 and 60 minutes between pre- and post-training in the exercise combined vitamin C group (EX + Vit. C).....	135
4.55 The comparison of sneezing after nasal challenge on 5, 15, 30, 45 and 60 minutes between pre- and post-training in the control group (CON).....	137
4.56 The comparison of sneezing after nasal challenge on 5, 15, 30, 45 and 60 minutes between pre- and post-training in the exercise group (EX).....	137

Figure	Page
4.57 The comparison of sneezing after nasal challenge on 0, 15, 30, 45 and 60 minutes between pre- and post-training in the exercise combined vitamin C group (EX + Vit. C).....	138
4.58 The comparison of rhinorrhea after nasal challenge on 5, 15, 30, 45 and 60 minutes between pre- and post-training in the control group (CON).....	140
4.59 The comparison of rhinorrhea after nasal challenge on 5, 15, 30, 45 and 60 minutes between pre- and post-training in the exercise group (EX).....	140
4.60 The comparison of rhinorrhea after nasal challenge on 5, 15, 30, 45 and 60 minutes between pre- and post-training in the exercise combined vitamin C group (EX + Vit. C).....	141
4.61 The comparison of total rhinitis symptoms after nasal challenge on 5, 15, 30, 45 and 60 minutes between pre- and post-training in the control group (CON).....	143
4.62 The comparison of total rhinitis symptoms after nasal challenge on 5, 15, 30, 45 and 60 minutes between pre- and post-training in the exercise group (EX).....	143
4.63 The comparison of total rhinitis symptoms after nasal challenge on 5, 15, 30, 45 and 60 minutes between pre- and post-training in the exercise combined vitamin C group (EX + Vit. C).....	144
5.1 The conclusion of study.....	159