

Effects of 2 Types of Resistance Training, Pyramid and Reverse pyramid training, on IL-4, IL-6, and IFN- γ in Young women

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ABSTRACT

Based on insufficient research on effects of different types of resistance training, the purpose of this study was to investigate effects of pyramid and reverse pyramid training on levels of rest of IL-4, IL-6, and IFN- γ in young women. Thirty participants were accidentally assigned into 3 groups: pyramid, reverse pyramid, and control group. Pyramid and reverse pyramid training groups took increasing resistance training for 8 weeks. Before (24 hours before training) and after training (48 hours after training), blood samples were taken from participants. Analysis of Variance (ANOVA) with repeated measures was employed to examine and compare changes of variables. Resistance training resulted in increase of IL-4 and IL-6 and reduction of IFN- γ ($p < 0.05$). However, there was no difference between pyramid and reverse pyramid training ($p > 0.05$). Perhaps resistance training reduces cellular immune response and increases humoral and inflammatory response in young women through reduction of IFN- α and increase of IL-4 and IL-6. It is possible that the training has been too intensive for participants. Further research on this issue is required.

Key words: IL-6, pyramid resistance training, reverse pyramid resistance training, inflammation, cytokines.

INTRODUCTION

Resistance training is popular with many people, especially women to improve and maintain their health. Resistance training has different types which may have common and unique effects on physiological systems, especially immune system. Focusing on cytokines can help explain complex issues of immune response to training. Immune system has a role in inflammatory responses, increased sensitivity, and defending body against pathogens (virus and bacterium) (Blotta M et al., 1997; Bruunsgaard, 2005).

Inflammatory responses are accompanied by production of cytokines including IL-4 and IFN- γ . Cytokines produced by T lymphocytes play a role in development and increase of immune system function against

pathogens. Differentiation of T lymphocytes to Th1/Tc1 (type I) is identified by production of IFN- α (Maria N et al., 2003). Extracellular pathogens produce humoral immune response which results in differentiation of T lymphocytes to Th2/Tc2 (type II) and production of IL-4 (Hernberg M et al., 1997; Ibfelt T et al., 2002). Another cytokine is IL-6 which has a variety of actions. IL-6 induces acute phase proteins synthesis which improves innate immune and plays a role during systemic inflammation (acute phase). Also, during acquired immune, IL-6 stimulates growth of B lymphocytes which differentiate to antibody producer cells (Kamimura D et al., 2003; Abul K et al., 2007). IL-6 is significantly increased in response to physical activities (up to 100 times) and then decreases (Suzuki K et al., 2002). IL-6 can increase lipolysis and induce production of cortisol and other regulatory cytokines such as IL-10 and IL-1ra.

Moreover, it suppresses production of pre-inflammatory cytokine, TNF- γ . Therefore, it reduces resistance to insulin which is an advantage of exercise (Pedersen B et al., 2007). On exercising, IL-6 is increased in muscle fibers. Based on its pre-inflammatory and anti-inflammatory role and due to being known as a myokine, its increase after exercise can be related to its anti-inflammatory function (Baum M et al., 1999; Suzuki K et al., 2002). The effects of moderate training on increase of levels of muscular have been reported (Fehrenbach E et al., 2005). reported that regular training for 12 weeks results in decrease of production and circulating level of IL-6 (Timmerman K et al., 2008). Generally, the results revealed that regular exercise influences several factors of immune system. In fact, it improves function and number of components of immune system. (Timmerman K et al., 2008; Adam S et al., 2001; Lancaster G et al., 2005).

In years past, it was believed that women cannot benefit much from resistance training due to their hormone differences. Recently, it has been proved that women can benefit from resistance training as men. Nowadays, due to women's tendency to improve their health and keep themselves in shape, they show an interest in resistance training. According to the characteristics of cytokines and effects of resistance training, the purpose of this study was to compare the effects of pyramid resistance training and reverse pyramid resistance training on serum levels of IL-4, IL-6, and IFN- γ in non-athlete young women.

MATERIALS AND METHODS

Participants

Thirty active and healthy women (age: 25.43 ± 3.23 ; height: 166.77 ± 3.71) were purposefully collected and accidently and equally assigned into 3 groups: pyramid resistance training, reverse pyramid resistance training, and control group. Participants had no surgery or illness, took no medicine, were non-smokers and physically healthy, and took training once a week.

Data collection

Study protocol was explained to participants a week before study. Resistance training was introduced to participants. General

characteristic of participants were examined. Blood samples were taken from 3 groups. Then participants of pyramid and reverse pyramid resistance training groups performed resistance training for 8 weeks. Control group performed no regular training and had their daily routine. Blood samples were taken from 3 groups 48 hours after last training session.

Training program

Training program included 3 sessions per week, each session lasting 45 minutes. The first 10 minutes in each session was for warm up, then the next 30 minutes for exercise and the last 5 minutes for cooling down. Resistance training was planned in a circular path and pyramid and reverse pyramid. Trainings were performed in 6 stations: chest press, foot press, front of arms, front of feet, back of arms, and back of feet. Each exercise included 3 sets of 10 repetitions. After each set and between exercises they had a break of 1 and 2 minutes, respectively. Each session included a circuit. The pyramid group performed their first set of ten repetitions at 50% of 10 RM, the second set of ten at 75% of 10 RM, and the third set of ten at the 100% of 10 RM. Also, the reverse pyramid group performed their sets the reverse: 100% of 10 RM, 75% of 10 RM, and 50% of 10 RM.

Blood sampling and analysis of cytokines

Blood samples of 5 cc were taken from basilic vein. Collected samples were placed in sterilized tubes containing K3EDTR. Heparin and EDTR tubes were placed in ice and kept in ambient temperature for a few minutes. Then they were centrifuged for 10 minutes at RPM 3500. All frozen samples were kept in -20 p C until being test at laboratory. IL-4, IL-6, and IFN- γ were assayed through ELISA kits from eBioscience.

Statistical methods

Values of variables were described using mean and standard deviation. To investigate normal distribution and use of parametric and non-parametric tests, Kolmogorv-Smirnov test was employed. The results revealed that data distribution was normal. To compare changes of variables in 3 groups, Analysis of Variance (ANOVA) with repeated measures was used in a 3x2 plan (3

groups and 2 times)(P=0.05). SPSS (version 16) was used to do statistical calculations.

RESULTS AND DISCUSSION

Statistical description of weight, BMI, and serum level of IL-4, IL-6, and IFN-γ are represented in table 1. The values are reported using mean and standard deviation. Also, the results of ANOVA with repeated measures were used to compare variables changes in 3 groups (Table2, 3, 4, 5, and 6). There was no significant difference among 3 groups in weight changes and BMI (respectively P=0.18 and P=0.087). Also, no significant difference was observed among 3 groups in IL-4 and IL-6 changes

(respectively P=0.12 and P=0.10). However, there was a significant difference among these 3 groups in pattern of changes of IFN-γ (P=0.02); IFN-γ decreased in pyramid and reverse pyramid resistance training groups but increased slightly in control group. The results of Tukey's test revealed that only the difference between control and reverse pyramid resistance training group was significant (Table 7)(P=0.024).

DISCUSSION

The results revealed that there was not a significant difference among these 3 groups in pattern of changes of IL-4 and IL-6. IL-4 and IL-6

Table 1: Statistical description of variables (standard deviation± mean)

Control Groups	Oxford Groups	Delorme Groups	Sampling Times	Variables
64.50 ± 4.37	66 ± 3.77	68 ± 2.94	Before Training	Weight (kg)
64.90 ± 4.79	65.20 ± 3.76	67.30± 2.66	After Training	
23.45 ± 0.84	23.78 ± 0.43	24.32 ± 0.55	Before Training	BMI (kg/m2)
23.56 ± 0.94	23.50 ± 0.58	24.08 ± 0.47	After Training	
4.73 ± 1.36	4.63 ± 0.91	4.5 ± 1.04	Before Training	IL-4 (pg/ml)
4.79 ± 1.38	6.21 ± 1.69	5.77 ± 1.52	After Training	
3.73 ± 0.59	3.36 ± 1.12	3.68± 0.84	Before Training	IL-6 (pg/ml)
3.65 ± 0.94	4.31 ± 0.72	4.34 ± 0.87	After Training	
14.95 ± 1.48	17.91 ± 3.41	16.37 ± 2.21	Before Training	IFN-α (pg/ml)
15.60 ± 2.06	14.45 ± 2.25	14.01 ± 1.49	After Training	

Table 2: Statistical results of ANOVA with repeated measures to compare weight changes in 3 groups

Observed Power	Effect Size	P	F	Mean Square	df	Sum of Square	Factor
0.35	0.09	0.11	2.71	2.01	1	2.01	Time
0.31	0.10	0.21	1.63	45.71	2	91.43	Group
0.53	0.18	0.06	2.98	2.21	2	4.43	Time*Group

Table 3: Statistical results of ANOVA with repeated measures to compare changes of BMI in 3 groups

Observed Power	Effect Size	P	F	Mean Square	df	Sum of Square	Factor
0.41	0.10	0.08	3.30	0.30	1	0.30	Time
0.59	0.20	0.048 *	3.41	2.72	2	5.45	Group
0.48	0.16	0.087	2.67	0.24	2	0.48	Time*Group

* The mean difference is significant at the 0.05 level

increased in pyramid and reverse pyramid resistance training groups but did not change in control group. Also, IFN- γ decreased in pyramid and reverse pyramid resistance groups but increased in control group. However, intergroup investigations showed that only the difference between reverse pyramid resistance training and control group was significant. The results of effects of pyramid and reverse pyramid resistance training on serum levels of cytokines related to inflammation are limited and we did not find any research on it. Due to the fact that there is very little literature on this subject, further research is required to reach a firm conclusion. Moreover, the intensity of training is probably the major variable of training in response to cytokines; also, duration of training is another effective, important variable. There was no difference between pyramid and reverse pyramid resistance

training groups in intensity and duration of trainings. Moreover, no significant difference was observed between these 2 groups in serum levels of IL-4 and IL-6. Due to the fact that there is not a lot of research on this subject, further studies are required to reach a firm conclusion. A study has shown that performing a period of 8 weeks gradual resistance training is related to decrease of level of IFN- γ at rest (White L et al., 2006). On the other hand, several studies reported no changes in these indicators during and after performing resistance trainings (Larsen A.I et al., 2001). Nortjaha et al. (2007) reported that a 16-week period of resistance training results in decrease of pre-inflammatory cytokines (Nurtjahja Tjendraputra E et al., 2003). Different responses of inflammatory indicators in different studies can be due to physical conditions of participants: using different plans and methods

Table 4: Statistical results of ANOVA with repeated measures to compare changes of IL-4 in 3 groups

Observed Power	Effect Size	P	F	Mean Square	df	Sum of Square	Factor
0.86	0.27	0.004*	10.01	14.14	1	14.14	Time
0.20	0.068	0.38	0.98	2.18	2	4.36	Group
0.42	0.14	0.12	2.29	3.24	2	6.49	Time*Group

* The mean difference is significant at the 0.05 level

Table 5: Statistical results of ANOVA with repeated measures to compare changes of IL-6 in 3 groups

Observed Power	Effect Size	P	F	Mean Square	df	Sum of Square	Factor
0.71	0.20	0.015	6.81	3.90	1	3.90	Time
0.13	0.04	0.57	0.55	0.51	2	1.03	Group
0.45	0.15	0.10	2.47	1.41	2	2.83	Time*Group

* The mean difference is significant at the 0.05 level

Table 6: Statistical results of ANOVA with repeated measures to compare changes of IFN- γ in 3 groups

Observed Power	Effect Size	P	F	Mean Square	df	Sum of Square	Factor
0.79	0.23	0.007 *	8.36	44.61	1	44.61	Time
0.25	0.08	0.30	1.25	6.003	2	12.006	Group
0.69	0.23	0.02 *	4.23	22.59	2	45.19	Time*Group

* The mean difference is significant at the 0.05 level

of training (training protocol), training background of participants, duration and intensity of stressor stimulant, sports habits, and adjustment to training. Physical activity has a dual effect on immune system; intensive and long-term physical activities result in decrease of function of immune system so that possibility of inflammation and infection increases (Fish D et al., 2003). Inflammation of tissues is an immune response to infection or injury which includes complex reactions of immune cells and soluble proteins including cytokines (Milne K.J et al., 2002). Thus, oxidative damage and inflammation resulted from various training methods can change function of different body systems including immune system which leads to increase of inflammatory cytokines in active muscle and serum (Morton, J.P 2003). Tissue injuries resulted from physical activities intensifies inflammatory cascades. Releasing these cytokines triggers inflammatory responses and induces release of IFN- γ which increases IL-10 and IL-2 to avoid inflammation (Leick L et al., 2007). Physical activities decrease level of inflammatory cytokines (Leick L et al., 2007; Esposito K et al., 2002; Zhang YF et al. 2006). reported that IL-6 level increases after a 10-week period of training compared to pre-test (Keller C., 2005; Conraads VM., 2002). reported that a combination of strength and resistance does not have any effects on plasma level of IL-6 in people suffering from vascular disease. (Ryan AS et al., 2004) investigated effects of aerobics and resistance trainings in obese and old men and women suffering from osteoarthritis in knees. The results revealed that training did not have a significant effect on IL-6 (Nicklas BJ, 2004). However, Rine et al. reported that a losing weight plan and aerobics and resistance training result in decrease of IL-6 in obese women. Also, Haghghi et al. (2005) reported that circuit resistance trainings

result in decrease of plasma level of IL-6 in obese men (Keller C., 2005; Conraads VM., 2002). IFN- α is vital for antivirus defense and several studies have shown decrease of IFN- γ in those having tumors (Hoffman-Goetz L., 1994; Mark R., 2004). Researchers believe that suppress of production of IFN- γ is an important mechanism for increased danger of infection in those having tumors (Hoffman-Goetz L., 1994). Immunity system plays a role in inflammatory responses, increased sensitivity, and defending body against pathogens (virus and bacterium) (Blotta M et al., 1997; Bruunsgaard, 2005) [1,2]. Inflammatory responses are accompanied by production of cytokines such as IL-4, IFN- γ , and change in ratio of CD4 to CD8 lymphocyte cells. Authors believe that production of lymphocytes cells and adjustment of ratio of CD4 to CD8 is dependent on proper signals including IFN- γ . Relative increase of production of IFN- γ which activates cell immunity (increase of Th1 and Tc1 production) and decrease of production of IL-4 which activates humoral and inflammatory immunity (decrease of Th2 and Tc2 production) result in increase of cell immunity activity and have influence on CD4/CD8 (Ibfelt T et al., 2002). Findings on pyramid and reverse pyramid resistance trainings are limited and further studies are required to reach a firm conclusion. This study reported increased IL-4 and IL-6 and decreased IFN- γ in resistance trainings; however there was no difference between pyramid and reverse pyramid resistance trainings.

CONCLUSIONS

The results revealed that an eight-week period of resistance training results in increase of IL-4 and IL-6 and decrease of IFN- γ in young women. However, there was no difference between pyramid and reverse pyramid resistance trainings. Perhaps resistance trainings results in decreased cellular immune response and increased humoral and inflammatory immune response in young women through decrease of IFN- γ and increase of IL-4 and IL-6. It is possible that these trainings have been too intensive for the participants. Further studies are required to investigate the issue. Also, probably there is no difference between pyramid and reverse pyramid resistance trainings in terms of their effects on levels of cytokines.

Table 7: Results of Tukey’s test to determine point of difference of IFN- α

P	Mean differences	Compare the pair to pair
0.73	1.08	pyramid – reverse pyramid
0.11	3.01	pyramid – control
0.024 *	4.10	reverse pyramid - control

Pd^{0.05*} The mean difference is significant at the

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