# THE EFFECT OF ONE SESSION OF PROGRESSIVE EXHAUSTIVE RUN ON THE RAPID RESPONSE OF SERUM CORTISOL AND IMMUNOGLOBULIN A IN ELITE ATHLETES OF FARS PROVINCE

**Pooyan Sabet[1]*, Dr. Mahdi Soleimani Farrokh[2], Dr. Vahideh Razmi[3], Dr. Rakesh Bharti[4], Dr. Sunny Ramdas Kanekar[5]**

## Abstract

The present study was designed and conducted to study the rapid response of serum cortisol and immunoglobulin A to one session of the progressive exhaustive run. The participants in the study were 45 athletes, including those in the super league handball team (21 men) and first-division basketball league and second-division football league (23 women) in Fars province who took part in the study voluntarily. To perform the exercise, each participant used a treadmill in one session of the progressive exhaustive run, starting from the speed of four miles per hour. Then, the speed of the machine was increased by one mile per hour every two minutes until the participant was not able to continue the activity. For measuring the density of cortisol and IgA, serum samples were collected at the time of rest and immediately after the activity. The statistic t-test for correlated groups was used for comparing the density of cortisol and IgA before and after the activity, and the statistic t-test for independent groups was used for comparing women and men. The findings showed that the density of serum cortisol increased significantly in both women and men after one session of maximum progressive activity. On the other hand, the density of serum IgA ($P > 0.05$) did not change significantly in either group of women and men with the maximum progressive activity. The findings of this research showed that one session of maximum progressive exercise results in remarkable changes in the density of serum cortisol in elite athletes and causes a significant increase in its density. It can be concluded that the response of cortisol to physical activity is quicker than that of IgA.

**Keywords:** maximum progressive activity, cortisol density, immunoglobulin A, serum, elite athlete

[1]*Department of Physical Education, Faculty of Human Sciences, Islamic Azad University, Larestan Branch, Fars, Iran, E-mail:- pooyansabet@yahoo.com
[2]Assistant Professor and Director of Sports, FLAME University, Pune, India
E-mail mahdi.farrokh@flame.edu.in
[3]Assistant Professor and Director of Student Affairs, FLAME University, Pune, India
E-mail vahideh.razmi@flame.edu.in
[4]Assistant Professor, Lovely Professional University, Phagwara Punjab, India
E-mail dr.raakeesh@gmail.com
[5]College Director of Physical Education and Sports, Vidya Prabodhini College of Commerce Education Computer and Management, Parvari Goa, Goa University, Goa India
E-mail sunny4213@gmail.com

*__Corresponding author__: Dr. Rakesh Bharti
*Department of Physical Education, Lovely Professional University, Phagwara Punjab, India
E-mail:- dr.raakeesh@gmail.com

**DOI:** 10.48047/ecb/2023.12.si10.00412

## Introduction

The world around us is full of infectious agents which threaten humans everywhere. However, the human body is endowed with the required defence mechanisms to fight these elements off. Physical fatigue as a result of physical activity (especially after sports activities) is among the factors which can affect the functioning of defence mechanisms of the body. Therefore, if the volume and intensity of the exercise exceed the physiological capacity of the athlete, they can disrupt many physiological processes and cause hormonal and immunological disorders. These changes can have unfavourable consequences; therefore, they should be controlled.

Cortisol is the most important catabolic hormone in the body. Cortisol is a steroid hormone which is released from the Adrenal cortical part and its effects are mostly catabolic. The response of cortisol to stress has always been regarded as an indicator of work pressure. Numerous findings show the relationship between cortisol and work pressure. This stress can be induced by psychological stressors such as daily work pressure or physical activities (24, 8) which can result in a decrease in performance during work or competition.

The most long-term response of cortisol to the stress-inducing factor was seen 24 hours after the effect of the factor (14); but the suppression of the immune system is one of the effects of cortisol and the serum, plasma and salivary levels of this hormone increase during and after physical activities; therefore, the decrease in the levels of IgA is also attributed to the increase of the levels of cortisol because the increase in the levels of cortisol affects B lymphocytes and prevent the production of antibodies and decrease the production of immunoglobulins (18, 26).

Jacks et. al. (2017) in a study entitled "Effect of Exercise at Three Exercise Intensities on Salivary Cortisol" concluded that low- and medium-intensity exercise cannot change the density of cortisol but high-intensity exercise results in a significant increase of the density of cortisol (13). On the other hand, the immune system is one of the important systems of the body which protects the body against foreign and pathogenic agents. The human body is always in contact with bacteria, viruses, fungi and parasites; therefore, without the immune system or even its weakening, life becomes very hard or even impossible (12). IgA is one of the most important immunoglobulins in various body secretions. Tear, milk (especially cholesterol), nasal secretions, mucous secretions of the respiratory system, mucous secretions of the digestive system (saliva and bile) and genital system secretions are among the most important secretions in which a great amount of IgA is found. IgA is the most essential antibody in the external secretions and has an important biological function in this area. During the primary immunological defence of the body against local infections in areas such as the respiratory system, this antibody is of great importance. In addition to its protective role against local infections, IgA acts as a bactericide against gram-negative organisms. But this activity happens only in the presence of lysosome which exists in secretions which contain secretory IgA (4). Some studies have shown that in athletes, Upper Respiratory Tract Infection (URTI) increases after intense physical exercises and competitions. Gleeson et. al. (2016) believe that changes in the density of cortisol after sports activities are dependent on the intensity and duration of the physical activity of the athletes (11). Ring et. al. (2015) studied the effects of competition, sport and mental pressure on the secretion of the immune system in 62 young active men. The participants were placed in one of the four conditions of 8-minute tasks: mental calculations, cycling with a workload of 60 to 120 watts, competitive cycling, and mental calculations during cycling. The results showed that mental calculations result in a significant increase in the density and secretion of IgA in comparison with the state of rest, but competitive sports alone cannot affect the amount of secretion and the density of IgA (21). Theories say that as a result of participating in competitive sports, mental pressures decrease the secretion of IgA and make the individual more exposed to infection (21). Demtitriou et. al. (2017) studied the densities of secretory IgAnd salivary cortisol in elite swimmers and

observed that exercise does not have a significant effect on the density of secretory immunoglobulin, but there was a significant difference between the density of cortisol before and after the exercise (6). Other findings, though, concluded that as a result of physical activity, both the density and the secretion of IgA decrease or remain unchanged (17, 25).

Regarding such contradictory results, the researchers found it necessary to study the effect of one session of progressive activity on the density of serum cortisol and IgA in elite female and male athletes to find suitable solutions for the improvement of sports championships in Iran from the perspective of the sports community, hoping that with the implementation of these solutions, our athletes be more successful in their performances.

| General characteristics | Unit | All athletes N = 45 | Male athletes N = 21 | Female athletes N = 23 |
|---|---|---|---|---|
| Age | year | 22.47 +/- 3.375 | 21.41+/- 45.156 | 23.32 +/- 2.394 |
| Weight | kilogram | 71.02 +/- 13.606 | 80.81 +/- 9.978 | 61.05 +/- 6.05 |
| Height | centimeter | 175.53 +/- 8.683 | 182.37 +/- 7.173 | 169.78 +/- 4.781 |
| Body fat | percent | 55.87 +/- 5.78 | 13.94 +/- 4.687 | 17.78 +/- 6.879 |
| Maximum oxygen consumption | ml/kg.min | 55.15 +/- 7.396 | 57.15 +/- 9.798 | 53.13 +/- 4.994 |

**Table 1** – General characteristics of participants. Information based on mean and standard deviation

**Research Methodology**

The participants in the study were 45 athletes, including those in the super league handball team (21 men) and first-division basketball league and second-division football league (23 women) in Fars province who took part in the study voluntarily. None of the participants had a history of hormonal disorders or was under medical treatment at the time of the study. the general characteristics of the participants are presented in Table 1.

**Physiological measurements:** The present research was conducted in two separate sessions with a 48-hour interval but at similar hours of the day (to minimize the effects of circadian rhythms) in the Championship Site Salon of Shiraz. The procedure in each session was as follows: in the first session, the participants filled out a medical questionnaire and a consent form created by the researchers and got familiar with the way the protocol would be carried out. Their personal information was also recorded. In the second session, each participant performed a maximum progressive activity on the electronic treadmill model HC1200 of the Technogym brand made in Italy. For evaluating and measuring the maximum oxygen consumed by the participants, the 1600-meter run test on the treadmill was used. For measuring the participants' subcutaneous fat, the calliper was used in seven areas of the stomach, thighs, subscapular, supraclavicular, triceps brachial, armpit, and chest was used; and for the percentage of body fat, Jackson & Pulak formula was used.

**One session of progressive running:** To warm up, the participants started running on the treadmill at a zero-degree slope and a speed of four miles per hour. After three minutes, the speed of the treadmill was raised by one mile per hour; and after this, the speed of the machine was increased by one mile per hour every two minutes without taking any rest. Running continued until the participant was not able to continue the activity and announced his/her physical exhaustion.

**Collecting Serum:** For studying the rapid response of cortisol and IgA, serum samples were collected in two stages, before and after the activity. Four millilitres of blood were collected from each of the participants before and immediately after the activity. The samples were centrifuged on the spot to prevent coagulation. All collected samples were stored at the temperature of minus 20 degrees centigrade to be used later for measuring cortisol and IgA. Because the

secretion of cortisol follows a circadian rhythm, all blood samples were collected between 8 to 12:30 a.m. Also, to eliminate any disruptive effect, collecting samples from the participants was carried out in identical situations.

**Measuring Cortisol and IgA.** The density of serum cortisol was measured by Monopole Kit with the use of the Elisa method by a kit made by Radim company in Italy with a sensitivity of 5 nanograms/ml. Also, the kit made by Binding Site company in England, the nephlimetry method and also the Minineph device were used for measuring the amount of IgA.

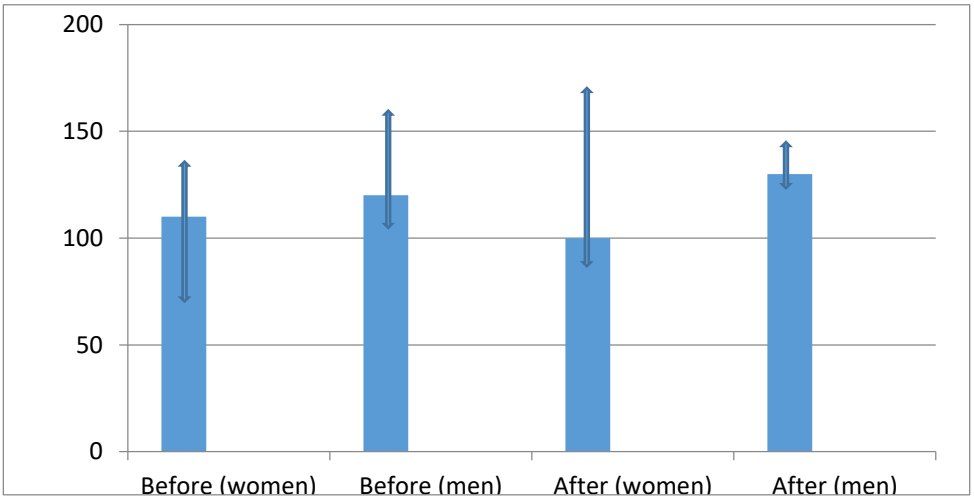


**Chart 1:** The response of cortisol (Nanograms per milliliter) to one session of activity for women and men (information according to mean and standard deviation)

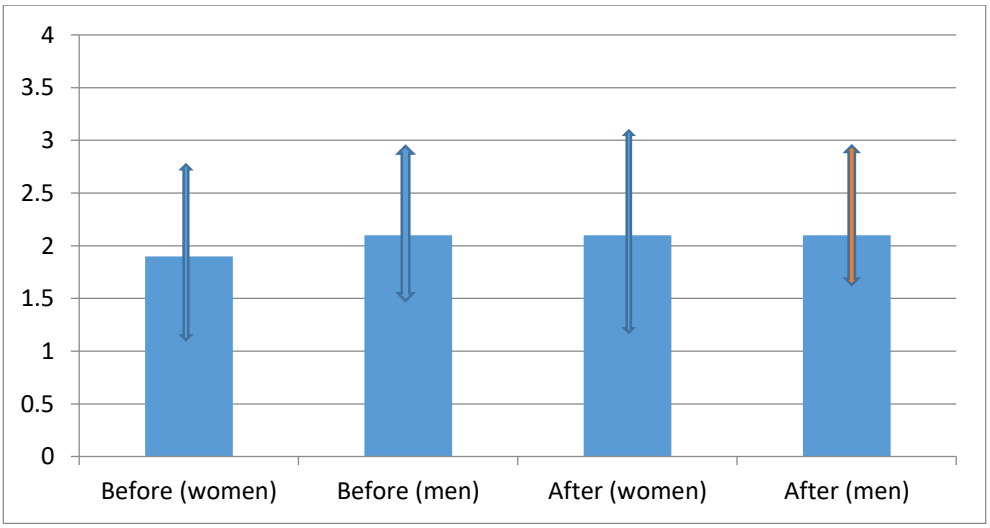


**Chart 2:** The response of immunoglobulin (Nanograms per milliliter) to one session of activity for women and men (information according to mean and standard deviation)

**Statistical Method**

All data is reported based on mean and standard deviation. The statistic t-test for correlated groups was used for comparing the density of salivary cortisol and IgA before and after one session of exhaustive activity, and the statistic t-test for independent groups was used for comparing women and men. All statistical computations were done by the use of SPSS16 software and the level of significance was considered $P < 0.05$ for all computations.

Findings of the study: There was no significant difference in the resting levels of cortisol between women and men ($P > 0.05$). Performing one session of activity to the level of exhaustion resulted in a significant

increase in the density of serum cortisol in both women and men ($P < 0.05$). There was no significant difference between the levels of density of cortisol after exercise for women and men. In other words, there was no significant difference in the response of cortisol to physical activity between the two groups. The density of IgA was not influenced by one session of progressive exercise, either in women or in men ($P > 0/05$). Also, there was no significant difference between the amounts of IgA before and after exercise among men and women.

**Discussion**

According to the first finding of the present study, after one session of progressive activity, the density of serum cortisol increased significantly. This finding is in contrast with the findings of Moya and Salvador (2013) and Rimmele and Zellweger (2017); while it is consistent with the findings of Dimitriou et. al. (2017), Jacks et. al. (2017) and Filaire et. al. (2008) (6, 9, 13). It is suggested that the measurement of cortisol is one of the important hormonal factors in determining the physiological pressure caused by exercise. In many studies, the researchers concluded that a change in the density of cortisol is dependent on the intensity and type of the exercise and also its environment and the level of preparation of the participants and their psychological pressure (16). The intensity of the sport has the most important role in comparison with other factors such as the duration of the sport (27).

There are different mechanisms which explain the reason for the increase in cortisol density after sports activities. The first suggested mechanism is the increase of hormone secretion from the adrenal cortical part, and the role of the liver in reducing metabolic clearance during physical activity does not have an important role in the increase in the density of the hormone, and the amount of hormonal secretion is more important than the amount of its metabolization (15). The stimulation of the Hypothalamic- Pituitary- Adrenocortical (HPA) axis and the increase in the secretion of ACTH from the pituitary gland is considered the most important factor in stimulating the secretion of cortisol (15, 2). Therefore, the most important nervous and psychological system attacked by stress is the pituitary gland-hypothalamus axis (2); as such, during physical activity, the Hypothalamic- Pituitary- Adrenocortical (HPA) axis is activated and the secretion of the hormone increases (3). The HPA axis is stimulated by anaerobic metabolism products such as accumulated lactate, PH drop and hypoxia.

Previous studies had shown that running on the treadmill for 8 to 12 minutes increases the density of ATCH up to 10 times. In this situation, the density of cortisol increases parallel to the increase in ATCH (3). In the present study, the participants ran for an average of 11 minutes on the treadmill. Although the density of ATCH was not measured, we can expect a remarkable increase in the density of ATCH according to the findings of the previous studies. Therefore, the increase in cortisol density can be attributed to the increase in ATCH density.

The increase in core temperature and the decrease in PH are other mechanisms for increasing the density of cortisol, especially free cortisol (5). Filaire et. al. (2008) researched the comparison between the density of cortisol in swimmers and handball players and concluded that cortisol levels increased significantly in handball players but did not have a significant increase in swimmers (9). Because the participants of the present study are male handball players, the findings of the two studies are consistent.

In the present study, after one session of progressive activity, the response of cortisol showed a significant increase which suggests that the participants of the study have endured extreme physical pressure. It is completely known that the quality of the exercise and the stressful stimuli in addition to the duration and intensity of the exercise have significant effects on the response of cortisol secretion. Therefore, it can be argued that one of the most important stimulants for the secretion of

cortisol is intense physical activity (13). Considering the findings of the study, it can be noted that there are differences between the findings of this study and the previous studies because there are differences in the type of sport, the exercise environment, the intensity and duration of the exercise, the level of physical preparation of the participants, the participant's age and gender, their nutrition and their psychological pressure.

The other finding of the study showed that the density of serum IgA after one session of progressive activity did not change in either male or female groups. This finding is consistent with the findings of Ring (2015) and Dimitriou et. al. (2017); but is in contrast with the findings of Gleeson (2016), Fahlman and Engels (2015) and Tharp and Barnes (2010) (25, 11, 7). The most abundant and frequent IgA is produced locally and has a short lifespan and can selectively attach to antigens (such as microbes) and in this way, prevent antigens from attacking or penetrating the mucosal surface (1). Researchers have proposed different mechanisms for explaining the changes in the density of IgA: the amount of the secretion of suppressive hormones of the immune system such as cortisol, epinephrine, and Enkephalin, the activity of The sympathetic nervous system, physical and psychological stress and the decrease in the flow of saliva (10). Gleeson et. al. (2016) believe that performing intense exercises results in the weakening of IgA, or other words, the weakening of the immune system (11). However, in the present study, the intensity of the exercise did not have a significant effect on the density of IgA. Rimmele and Zellweger (2017) argued that the change in the immune system and the sensitivity to infection in sports events are the results of psychological demands on the athletes rather than physical demands (21). Considering these findings, it can be noted that the reason for the difference between the findings of the present study and the previous studies lies in the difference between the intensity and duration of activity and the participant's level of physical preparation. Therefore, while designing training programs, holding preparatory camps and preparing competition schedules, it is necessary to take care of minimizing their negative effects on cortisol secretion and athletes' immune systems.

## Conclusion

The findings of the present study showed that one session of maximum progressive activity by elite athletes results in a significant increase in the density of serum cortisol but does not change the levels of IgA. Accordingly, it can be concluded that progressive activity may not affect the immune system, but it increases cortisol density. It can be argued based on the findings of the study, the response of cortisol to physical activity is quicker than that of IgA. In other words, this hormone is more sensitive to sub-minimal activity than IgA.

## References:

1. Brandtzaeg, P. Farastad, I.N. Johanson, F.E. et al. (2019). The bcell system of human mucosae and exocrine glands. Immunology Revieus, 171: 45-87.
2. Bullinger, A.H. Hemmeter, U.M. Stefani, O. Angehrn, I. Mueller-Spahn, F. Bekiaris, E. Wiederhold, B.K. Sulzenbacher, H. & Mager, R. (2005). Stimulation of cortisol during mental task performancein a provocative virtual environment. Applied Psychophysiology & Biofeedback. 30(3): 10484-005.
3. Buono, M.J. Yeager, J.E. Hodgdon, J.A. (2013). Plasma adrenocorticotropine and cortisol responses to brief high intensity exercise in human. J Appl Physiol, 64: 1337-1339.
4. Daniel, K. D.Grathwohl. CH, Weinstoch. H, Northff. & et al. (2010). Respiratory tract infection in athletes: Influence of litestyle, type of sport and immunos-timulant intake. Exercise Immunology review. 6.
5. Deligiannis, A. Karamouzis, M.K. Oudi, E. Mougios, V. Kallars, C. (2014). Plasma TSH, T3, T4 and cortisol responses to swimming at water temperature. Br J Sports, Med. 27: 247-250.
6. Demtitriou, L. Sharp, N.C. Doherty, M. (2017). Circadian effects on the acute

respomses of salivary cortisol and IgA in well trained swimmers. Br J Sports Med 36: 260-264.
7. Fahlman, M.M. Engels, H.J. (2015). Mucosal IgA and URTI in American college Football players: a year longitudinal study. Med Sci Sports Exerc, 37: 374-380.
8. Farzanaki, P. Azarbayjani, M.A. Rasaee, M.J. Jourkesh, M. Ostojic, S.M. Stannard, S. (2018). Salivary immunoglobulin A and cortisol response to training in young elite female gymnasts. Brazilian Journal of Biomatricity, 252-258.
9. Filaire, E. Duche, P. Lac, G. (2008). Effects of training for two ball games on the saliva response of adrenocortical hormones to exercise in elite sports women. Eur J Appl Physiol, 77: 452-456.
10. Gleeson, M. (2016). Mucosal immune responses and risk of respiratory illness in elite athletes. Exercise Immunology Review. 6:4-42.
11. Gleeson, M. Pyne, D.B. Austin, J.P. Lynn, J. Francis, A. Clancy, R.A. McDonald, W.A. and Fricker, P.A. (2015). Epstein-Barr virus reactivation and upper-respiratory illness in elite swimmers. Med Sci Sports Exerc, 34(3): 411-417.
12. Hoffman, G. Pederson, B.K. (2016). Exercise and the immune system: A model of the stress response. Immunol. 15: 345-392.
13. Jacks, D.E. Sowash, J. Anning, J. Mc Gloughlim, T. Andres, F. (2017). Effect of exercise at three exercise intensities on salivary cortisol. J Strengeth Cond Res, 162 286-289.
14. Koopman, CH. Sephton, S. Heather, C.A. Classen, C. Lisa, D.b. Felton, Ch.G. Borggrefe, A. Spiegel, D. (2016). Dissociative Symptoms and cortisol responses to recounting traumatic experiences among childhood sexual abuse survivors with PTSD. Journal of Trauma & Dissociation, Vol. 4(4).
15. Kuoppasalmi, K. Adlercreutz, H. (2010). Interaction between catabolic and anabolic steroid hormones in muscular exercise. In: Fotherby K Pal s b (eds) Exercise Endocrinology, de Gruyter, Berline, PP. 65-69.
16. Lovaloo, W.I. (2012). Cortisol responses to mental stress, exercise and meals following caffeine intake in men and women." Biochemistry and Behavior, 83: 441-447.
17. Mackinnon, L.T. and Hooper, S. (2010). Mucosal (Secretory) immune system responses to exercise of varying intensity and during overtraining. Int J Sports Med, 15: 179-183.
18. Mc Dowell, S. L. Hughes, R. A. Hughes, R. J. Housh, T. J. Johnson, G. O. (2015). The Effect of Exercise training on salivary Immunoglobulin A and Cortisol responses to maximal exercise. Int. Sports. Mes, 13; 577-580.
19. Moya-Lu. Albid. A. L. Salvodor. A. L. (2013). Psychophysiological responses to the stroop task ofter a maximal cycle ergometry in elite sports men & physically active subjects. International J of Psychophysiology. 40: 47-59.
20. Bharti, R., Devi, S. S., Patel, A. D., & Kholia, K. (2022). Effects of varied packages of aquatic plyometric training on leg explosive power among college male basketball players. Journal of Pharmaceutical Negative Results, 408-413.
21. Ring, C. Carroll, D.J. Horing, J. Ormerod, L. Harrison, L.K. Drayson, M. (2015). Effect of competition, exercise & mental stress on secretory immunity. J. Sport Sci. 23(5): 501-8.
22. Ropitt, I. M. Rabinson, A. (2013). Medical Immunology, first ed. Oxford: Blackwell Science Co.
23. Singh, A. Papanicolaou, D.A. Lawrence, L.L. Howell, E.A. Chrousos, G.P. Deuster, P.A. (2010). Neuroendocrine responses to running in women after zinc and vitamine e supplementation. Med Sci Sports Exerc, 31(4): 536-542.
24. Steptoe, A. Cropley, M. Griffith, J. Kirschbaum, C. (2019). Job strain and anger expression predict early morning elevations in salivary cortisol. Psychosomatic Medicine, 62: 286-292.
25. Tharp, G.D and Barnes, M.W. (2010). Reduction of saliva immunoglobulim

levels by swim trining. Eur J Appl Physiol, 6: 64-64.

26. Tiollier, E. Gomez-Merino, D. Burnat, P. Jouanin, J.C. Bourrilhon, C. Filaire, E. Guezennec, C.Y. Chennaoui, M. (2015). Intense training: mucosal immunity and incidence of respiratory infections. Eur J Apple Physiol. 93: 421-428.
27. Tremblay, MS. Copeland, J.L. Van Helder, W. (2014) Effect of training status and exercise mode on endogenous steroid hor mones in men. J Appl. Physiol. 96:531-539.-:- Joylawi