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IMMUNOGLOBULIN (IGG) RESPONSE TO PHYSICAL STRESS AND COMBAT IN TAEKWONDO PLAYERS

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ABSTRACT

This research aims to identify the effect of moderate and high-intensity physical training on the immunoglobulin G (IgG) response to physical stress and competition in taekwondo athletes, to identify the effect of competition duration on the IgG response to physical stress and competition in taekwondo athletes, and to study the differences between the effect of moderate and high-intensity physical training and competition duration on IgG levels in taekwondo athletes.

The researchers used a single-group experimental design with pre- and post-testing. The research sample, consisting of ten players from the North Gas Taekwondo Club team, was selected purposively. After collecting the data through the specified measurements, it was statistically analyzed. A number of conclusions were reached: high-intensity physical training has an effect on increasing immunoglobulin G (IgG) levels, comparable to the effect of competitive training in taekwondo players. A significant increase in IgG levels was observed as a result of competitive training, exceeding the effect of moderate-intensity training. Among the most important recommendations reached by the researchers are: regulating high-intensity training loads, which have an effect on increasing IgG levels; evaluating and developing training programs and planning physical conditioning for taekwondo players; and the necessity of considering measurements of the immune system, particularly IgG levels, in monitoring and evaluating the health and physiological status of taekwondo players and those participating in similar sports and activities with comparable energy production systems.

KEYWORDS: *Immunoglobulin (IgG), training loads, Taekwondo.*

INTRODUCTION

The impact of athletic training on the immune system is a key factor to consider when planning and regulating athletes' physical training loads. This is due to the vital role the immune system plays in resisting diseases, responding to injuries, and accelerating recovery processes—factors that become increasingly important during periods of intensive training and competition. Athletic training represents a form of physical activity that places complex physiological stresses on the athlete's body, particularly the immune system, which is the first line of defense against foreign substances, including viruses and bacteria. The intensity of these stresses is determined by several factors, most notably the intensity and duration of the training load, as well as the surrounding environmental conditions.

Immunity is considered one of the most vital functions in the human body, not only for its defensive role in protecting tissues and organs from pathogens, but also for its close connection to regulating the body's responses to various external stimuli, including physical exertion, thus ensuring the maintenance of homeostasis. The immune system is highly complex, consisting of an integrated system that includes multiple lines of defense, including cells that are stationary in specific locations and others that are mobile and capable of rapid deployment to confront any threat. It also contains specialized antibodies with immunological memory, capable of recognizing previously encountered pathogens, in addition to a range of proteins and enzymes, such as components of the complement system, which contribute to destroying pathogens and enhancing the efficiency of the immune response.

Antibodies (immunoglobulins) are among the most important components of acquired immunity, playing a crucial role in resisting infections and diseases. These proteins are found in varying proportions in blood serum and mucous fluids, such as tears, saliva, and secretions from the respiratory and reproductive systems. The variation in their concentrations reflects the nature of the immune response depending on the type of challenges the body faces. It is worth noting that the responses of these proteins are not always identical between blood serum and mucous membranes, indicating the unique way each immune system deals with different stressors.

In this context, Taekwondo stands out as one of the modern martial arts that has witnessed widespread global popularity, due to its competitive nature, which combines high-level skill with advanced physical demands. Taekwondo has become an Olympic sport demanding high levels of physical and functional fitness, as well as motor coordination and precision in executing offensive and defensive skills. This sport relies on a mixed energy system combining aerobic and anaerobic activity. Matches require rapid, powerful, and repetitive movements within short timeframes with limited recovery periods, placing significant physiological stress on various bodily systems, particularly the circulatory and respiratory systems, in addition to its direct impact on the immune system.

Although numerous previous studies have examined the effects of varying training loads on the immune system in athletes and non-athletes across different age groups, there is a lack of research specifically focusing on immunoglobulin responses in taekwondo athletes. To the best of the researchers' knowledge, the effects of physical exertion and competition on immunoglobulin G (IgG) levels in this group of athletes have not been adequately explored, especially given that many of them undergo unregulated training programs that may negatively or positively affect the efficiency of their immune systems. Accordingly, the importance of conducting a scientific study aimed at identifying the response of immunoglobulin (IgG) to the stresses of physical loads and fights in Taekwondo players is highlighted, which contributes to establishing standardized scientific training foundations that ensure a balance between developing physical performance and maintaining the efficiency of the immune system, in order to achieve the desired competitive levels.

RESEARCH PROBLEM

Human beings are the true wealth of any society, and athletes represent the productive elite and the active force that reflects the image of society in various sporting arenas, serving as its unofficial ambassadors. Therefore, preserving this human capital is a fundamental pillar with both economic and humanitarian dimensions. Any deterioration in the health or immunity of athletes not only impacts their physical and mental well-being but also constitutes an economic loss due to the loss of talent and the disruption of athletic achievement.

The importance of studying the immune system in the sports field has increased due to its close relationship with physical performance efficiency and the athlete's ability to resist injuries and adapt to training loads. With the significant advancements in sports training science, training loads have witnessed a remarkable increase in intensity and volume, especially since the late 1990s, reaching, in some cases, their maximum limits. In this context, any disruption in the regulation of these training loads, whether in terms of intensity or volume, may not lead to the expected improvement in athletic performance. On the contrary, it may result in chronic fatigue, an increased likelihood of injuries, and a negative impact on the efficiency of the immune system by suppressing some of its components, thus weakening the body's ability to resist disease.

With the scientific advancements in the field of sports training, the focus is no longer limited to developing technical and physical aspects alone, but has expanded to include the study of the physiological and immunological responses resulting from different training loads. The immune system is among the systems most affected by these loads. Scientific literature indicates that moderate training contributes to enhancing the efficiency of the immune system, while high loads or intense competitive pressures may lead to temporary suppression of some of its components.

Despite the growing interest in what is known as sports immunology, a research gap remains regarding the study of immunoglobulin G (IgG) responses to physical loads and competitive pressures in combat sports, particularly taekwondo. Hence the importance of this study, which aims to identify the nature of the physiological and immunological responses resulting from training loads at varying intensity levels, whether moderate or high, as well as during competition periods. This will contribute to building a precise scientific basis for regulating training and achieving a balance between performance development and maintaining the athlete's health.

This is where the importance of this study lies. The practical importance of this study lies in the potential for using immunoglobulins, particularly IgG, as physiological indicators that can be relied upon when planning and regulating training loads. This allows coaches and specialists to monitor athletes' immune responses and avoid reaching states of stress or functional decline, thus contributing to maintaining the health of athletes, especially at advanced levels characterized by high training and competition demands.

RESEARCH OBJECTIVES

1. To identify the effect of moderate-intensity physical training on the immunoglobulin (IgG) response to the stresses of physical loads and matches in taekwondo athletes.
2. To identify the effect of high-intensity physical training on the immunoglobulin (IgG) response to the stresses of physical loads and matches in taekwondo athletes.
3. To identify the effect of the competition period on the immunoglobulin (IgG) response to the stresses of physical loads and matches in taekwondo athletes.
4. To study the differences between the effects of moderate and high-intensity physical training. Intensity and Duration of Competition on Immunoglobulin G (IgG) Levels in Taekwondo Athletes

RESEARCH HYPOTHESES

1. There are statistically significant differences in IgG levels at rest and at moderate intensity physical training levels in Taekwondo athletes.
2. There are statistically significant differences in IgG levels at rest and at high intensity physical training levels in Taekwondo athletes.
3. There are statistically significant differences in IgG levels before and after competition in Taekwondo athletes.
4. There are statistically significant differences in IgG levels at rest and at moderate and high intensity physical training levels, as well as before and after competition in Taekwondo athletes.

RESEARCH AREAS

- Human Area:The research was conducted on a sample of Taekwondo players from the North Gas Sports Club.
- Time Area:

The research procedures were implemented from December 11, 2025 to April 2, 2026, through:

A. A pilot study was conducted from December 11, 2025 to December 20, 2026.

B. The main study was conducted from February 2, 2026 to April 2, 2026.

Spatial Area:

- Anthropometric measurements were taken of the research sample in the North Gas Sports Club gymnasium.
- Physical training (moderate and high-intensity loads) was conducted in the North Gas Sports Club gymnasium.
- Blood was drawn before and after the competition in the sports activity hall belonging to the Kirkuk Governorate Directorate of Education. • Laboratory analyses for measuring immunoglobulin (IgG) were performed on blood samples at Ibn Al-Nafis Laboratory under the supervision of Professor Dr. Yahya Jirjis Muhammad.

RESEARCH METHODOLOGY

The researchers used a single-group experimental design with a pre-test/post-test method.

RESEARCH POPULATION AND SAMPLE

The research population consisted of 23 taekwondo players from the North Gas Sports Club in Kirkuk Governorate. The research sample was selected purposively from these taekwondo players. The sample size was (10) players with an average age of (21.20 ± 2.35 years), an average height of (160.30 ± 14.00 cm), an average weight of (66.40 ± 7.11 kg), and an average body mass index (BMI) of (26.08 ± 3.71 kg/m²). The skewness values for these variables ranged between (-0.557 and 0.673), i.e., within ±3, indicating the normality of the data and the homogeneity of the research sample in these variables. The researchers ensured homogeneity among the research sample members in the main variables (age, height, weight, and BMI).

Table 1: Shows the homogeneity of the research sample in the variables: age, body height, body weight, and body mass index

Key variables	Units	Mean	Std	Skewness
Age	Year	21.20	2.35	0.557
Height	Centimeter	160.30	14.00	0.383
Weight	Kilogram	66.40	7.11	0.673
Body Mass Index (BMI)	Kilogram .m²	26.08	3.71	0.624

Table (1) shows that the means for the descriptive variables of the research sample were: age 21.20 ± 2.35 years, height 160.30 ± 14.00 cm, body weight 66.40 ± 7.11 kg, and body mass index 26.08 ± 3.7 kg/m². The skewness coefficients for these variables ranged between -0.383 and 0.673, i.e., within a range of ±3, indicating the normality of the data and the homogeneity of the research sample in these variables.

RESEARCH METHODS, TOOLS, AND EQUIPMENT

1. Data Collection Methods: Arabic and foreign sources, the internet, personal interviews, tests and measurements, observation and experimentation.
2. Research Tools and Equipment: A set of sterile plastic syringes (5 cm) for single use only, a tourniquet, medical cotton, antiseptic solution, sterile blood collection tubes containing EDTA (an anticoagulant) and labeled with the player's number and the blood draw timing code, adhesive bandages, a special tube rack, an ice box for storing blood samples until they are transported to the laboratory, and special reagents (kits) for detecting immunoglobulin G (IgG). A restameter (for measuring body length in meters), a medical scale (for measuring body weight in kilograms), a blood pressure monitor, a treadmill, a centrifuge (for separating blood samples), and a video camera.

IDENTIFICATION OF IMMUNOGLOBULIN G (IGG) UNDER STUDY

IgG is a protein substance secreted by B lymphocytes. Its production depends on the gamma globulin group. It is found attached to the walls of blood vessels in the interstitial fluid and is the most abundant immunoglobulin in the blood, constituting more than 75% of the body's total immunoglobulin. This protein is produced upon exposure to a foreign substance and is responsible for activity against bacteria and viruses. It is transferred through the umbilical cord and contributes to early immunity in newborns. (Abdel Fattah Abu Al-Ala, 1999, p. 14)

PHYSIOLOGICAL MEASUREMENTS

- Pulse Rate Measurement
- Blood Pressure Measurement

IMPLEMENTATION STEPS FOR CONDUCTING THE RESEARCH
PRELIMINARY PROCEDURES BEFORE THE RESEARCH

The researchers undertook several preliminary procedures before commencing the main research experiment, including:

1. Meeting with the Taekwondo coach of the North Gas Sports Club to explain the research, its objectives, and its significance, as well as obtaining his consent to conduct the experiment on the research sample, and to schedule a date for conducting the research.
2. Coordinating with a medical analysis laboratory to conduct the immunoglobulin G (IgG) level tests.
3. Arranging for a medical laboratory specialist to collect blood samples and provide the necessary equipment.

PILOT STUDY

The researchers conducted two pilot studies. The first, a moderate-load study, was conducted on Thursday, December 11, 2025, and the second, a heavy-load study, was conducted on Saturday, December 20, 2026. These studies involved a sample of three athletes outside the main research sample. The objectives of these pilot studies were:

1. To verify the functionality of the treadmill and its operation.
2. To determine the starting point for physical exertion on the treadmill.
3. To determine how to increase physical exertion during performance.
4. To learn about measurement methods and how to record data using photography.
5. To identify potential difficulties that the researchers or the participants might encounter during the main study and to determine how to overcome them.

FIELD RESEARCH PROCEDURES

The main experiment was conducted from February 2, 2026, to April 2, 2026, and was implemented in three phases:

- Phase One: Moderate-Intensity Physical Training:

The moderate-intensity physical training and its associated pre-test (A) and post-test (B) measurements included the following implementation steps:

1. The research sample gathered on Monday, February 2, 2026, at 10:00 AM in the hall of the North Gas Sports Club.
2. The researchers distributed a registration form to the medical laboratory specialist, including (player number – player name – test code – blood sample collection status).
3. The pre-test measurements were taken during rest before the start of the experiment and the moderate-intensity training. These measurements included the following, in the following order:

- Heart rate measurement.
- Blood pressure measurement.
- Venous blood sample (3 cm^3) (A).
- The researchers calculated the target heart rate for moderate-intensity exercise for each participant using the Target Heart Rate (THR) equation: THR = Resting Heart Rate + [Intensity Ratio of Exercise / 100 (Maximum Heart Rate – Resting Heart Rate)]. (Al-Beik Abu Zaid Khalil, 2009, p. 127)
- A sensor device was attached to the athlete's body and connected to a treadmill. This device accurately monitored the heart rate to ensure that each athlete's heart rate reached their target heart rate for moderate-intensity exercise.
- The research experiment was conducted by performing moderate-intensity exercise based on the calculated target heart rate for each participant. When the athlete's heart rate reached the target, the safety button was released, stopping the treadmill.
- The first post-test (B) was performed for each participant immediately after the completion of the moderate-intensity exercise, and a venous blood sample (3 cm^3) was drawn. - The blood samples were collected in an icebox and transported to the Ibn Al-Nafis Medical Laboratory for blood sample separation in preparation for immunoglobulin (IgG) measurements.
- Phase Two: High-Intensity Workout:

The high-intensity physical activity and its post-test (C) measurements included the following steps:

- The research participants gathered on Sunday, February 8, 2026, at 10:00 AM in the hall of the North Gas Sports Club.
- The researchers submitted a registration form to the medical laboratory specialist, indicating (player number – player name – test code – blood sample collection status).
- Pre-test measurements were taken during rest before the start of the experiment and the high-intensity activity. These measurements included, in the following order:

1. Heart rate measurement.
2. Blood pressure measurement. - The researchers determined the target heart rate for high-intensity training for each participant in the study using the formula: Target Heart Rate for High-Intensity Training (THR) = Resting Heart Rate + [Intensity Percentage of Training / 100 (Maximum Heart Rate - Resting Heart Rate)]. (Al-Beik Abu Zaid Khalil, 2009, p. 127)

- A sensor device was attached to the athlete's body and connected to a treadmill. This device accurately monitored the heart rate to ensure that each athlete's heart rate reached their target heart rate for high-intensity physical training.
- The study experiment involved performing high-intensity training based on the calculated target heart rate for each participant. When the athlete's heart rate reached the target, the safety button was released, stopping the treadmill.
- A post-test (C) was performed for each participant immediately after the high-intensity training session, and a venous blood sample (3 ml) was drawn.
- The blood samples that were drawn were collected inside an ice box and transported to the laboratory to separate the blood samples in preparation for conducting the measurements of immunoglobulin (IgG) at Ibn Al-Nafis Laboratories.

PHASE THREE: THE COMPETITION PHASE

Pre- and post-competition measurements were conducted during the competition phase of the research sample's participation in championships organized by the Iraqi Central Taekwondo Federation. The research sample participated in the Iraqi Championship on Thursday, May 2, 2015, held in Kirkuk Governorate at the Sports Activity Hall. The following steps were implemented:

- The research sample arrived at the Sports Activity Hall at 10:00 AM.
- The researchers submitted a registration form to the lab technician, including the player's number, name, test code, and the date and time of blood sample collection.
- Blood samples were collected before the competition (D) from the research sample and stored in an icebox.
- Blood samples were collected after the final competition (E) from the research sample and stored in an icebox. These samples were then transported to the Ibn Al-Nafis Medical Laboratory for blood sample separation in preparation for immunoglobulin (IgG) measurements.

These samples were then transported to the laboratory for further analysis. 2-8 Statistical Methods:

Data were collected through pre- and post-tests and entered into comprehensive registration forms in preparation for statistical analysis.

- Mean.
- Standard deviation.
- Skewness coefficient.
- Analysis of variance (ANOVA).
- Least significant difference (LSD).

RESULTS

- Presentation of pre- and post-test results for immunoglobulin (IgG) used in the study:

Table 2: means, standard deviations, and skewness coefficients for IgG immunoglobulin protein variants at rest for the research sample. n = 10

Variables	Units	Mean	Std	Skewness
IGG	mg/Di	965.30	178.11	1.719

Table 2 shows that the skewness values for the resting IGG immunoglobulin variants in the research sample ranged between 0.601 and 1.719, i.e., within ±3, indicating the equivalence of the research sample in these variants.

Table 3: presents the means, standard deviations, and skewness values for the IGG immunoglobulin variants in the pre-competition period for the research sample. n = 10

Variables	Units	Mean	Std	Skewness
IGG	mg/Di	823.40	74.43	0.747

Table 3 shows that the skewness values for IGG immunoglobulin variables in the pre-competition period for the research sample ranged between 0.294 and 1.488, i.e., within ±3, indicating the equivalence of the research sample in these variables.

Table 4: shows the results of the significant differences between IGG immunoglobulin measurements in the resting and pre-competition states for the research sample. n = 10

Variables	Units	Rest		Pre-competition		Value "T"	Significance
		Mean	Std	Mean	Std		
IGG	mg/dI	965.30	178.20	823.40	74.43	2.62 *	Sig.

* Statistically significant.

Table t-value at the 0.05 level = (2.26)

Table 4 shows a statistically significant difference at the < 0.05 level between the IgG immunoglobulin measurements in the resting and pre-competition states of the research sample, with a t-value of 2.62.

Table 5: shows the analysis of variance between the IgG immunoglobulin measurements in the following states: resting, moderate load, high load, pre-competition, and post-competition for the research sample of players (n = 10)

Variables	Source of variation	Sum of squares	df	Average sum of squares	Value of F
IGG mg/Di	Between groups	4050211.480	4	1012552.870	*15.550
	Within groups	2930135.500	45	65114.122	
	Total	6980346.980	49		
	Within groups	11914.300	45	264.762	
	Total	15297.620	49		

* Statistically significant

Tabular F-value at the 0.05 level = 2.58

Table 5 shows that the F-value was statistically significant at the 0.05 level between the results of IGG immunoglobulin measurements in the following conditions: rest, moderate load, high load, pre-competition, and post-competition for the athletes in the research sample. Therefore, the researchers used the Least Significant Difference (LSD) test to determine the significance of these differences.

Table 6: shows the significance of the differences using the LSD test for IGG immunoglobulin measurements in the following conditions: rest, moderate load, high load, pre-competition, and post-competition. n = 10

Variables	Mean	Groups	Rest	Medium load	High load	Pre-competition	After the competition
IGG mg/dI	965.30	**Rest**		*230.50-	*557.20-	141.90	*557.60-
	1195.80	**Medium load**	*230.50		*326.70-	*372.40	*327.10-
	1522.50	**High load**	*557.20	*326.70		*699.10	0.400-
	823.40	**Pre-competition**	141.90-	*372.40-	*699.10-		*699.50-
	1522.90	**After the competition**	*557.60	*327.10	0.400	*699.50	

Table 6 shows statistically significant differences in the mean IgG immunoglobulin levels between the resting state and the other measurements, favoring the other measurements, except for the pre-competition measurement where the differences were not statistically significant. Similarly, statistically significant differences were found between the mean IgG levels at the moderate training load and all other measurements, favoring the latter. Furthermore, statistically significant differences were found between the high-training levels and the other measurements, favoring the latter, except for the post-competition measurement. Additionally, statistically significant differences were found between the pre-competition measurements and the other measurements, except for the resting level, and between the post-competition measurements and the other measurements, except for the high-training level.

Table 7: shows the results of the follow-up measurements of IgG immunoglobulin levels during the resting period and between training loads for the research sample of athletes (n = 10)

Variables	Rest		Medium load			High load			Pre-competition			After the competition		
	Mean	Std	Mean	Std	% change	Mean	Std	% change	Mean	Std	% change	Mean	Std	% change
IgG	965.30	178.119	1195.80	252.193	23.8-%	1522.50	223.194	-27.3%	823.40	74.431	45.9%	1522.90	418.196	84.-9%

Table 7 shows a progressively increasing rate of change in immunoglobulin G (IgG) levels between the mean resting and moderate-intensity physical load measurements, and between the mean moderate-intensity and high-intensity physical load measurements. The rate of change decreased before competition compared to high-intensity physical loads, and then increased again after competition.

DISCUSSION OF RESULTS

Table 6 shows statistically significant differences between the results of immunoglobulin concentration measurements at rest and at a moderate-intensity physical load for the research sample. The change was statistically significant at the 0.05 level for the variable under investigation, immunoglobulin G (IgG). Tables (8, 9, and 10) also show statistically significant differences between IgG protein levels at rest and after moderate-intensity physical load.

IgG is the predominant immunoglobulin in blood serum, representing about 75% of the total protein concentration (Maram Jamal, 2012). Its concentration is equally distributed between the inside and outside of blood vessels. It plays a fundamental role in antibody defense mechanisms. Due to its relatively small size, it can easily pass through blood vessels, making it readily available to protect tissues and body surfaces (Maram Jamal, 2012). There are four subtypes of IgG, classified based on minor differences in their amino acid sequences: IgG1, IgG2, IgG3, and IgG4. The researchers explain the significant change in this protein following physical exertion in light of these distinctive characteristics (Fayed Maram, 2012, p. 88). The results of the current study differ from those of Maram Jamal (2012) regarding immunoglobulin G, as statistically significant differences were found. This is attributed to the different research sample. The results of the current study are consistent with those of Sandra et al. (1991), which found that moderate-intensity exercise is accompanied by a 20% increase in immunoglobulin G (IgG). (Sandra et al., 1991)

It is noted that, at rest, as well as with typical daily activity patterns, the immune system capabilities of athletes and non-athletes are similar. (Sayed Ahmed, 2013, p. 323)

Ahmed Nasr El-Din Sayed (2014) states that, compared to rest, sports and physical exertion represent an assault on the body's various systems, disrupting their normal routines. Their activity is heightened during the exercise period, followed by a relative decline in their functional state upon completion. Furthermore, intense, strenuous exercise reduces the athlete's immune capacity, making them more susceptible to infection or illness and requiring special financial support for their nutrition and overall health. (Sayed Ahmed, 2013, p. 324)

The results in Table (6) show statistically significant differences in immunoglobulin G (IgG) levels at rest and during high-intensity physical exertion. The statistical significance value for the differences in the IgG variable reached 557.20.

Ahmed Nasr El-Din Sayed (2014) explains that immunoglobulins are produced as a type of immune response known as humoral immunity. This immunity results from the formation of antibodies, which are immunoglobulins belonging to a family of proteins secreted by B lymphocytes. These antibodies are responsible for protecting the body from foreign substances and microbes that enter the bloodstream. (Sayed Ahmed, 2013, p. 323)

In the event that the player performs high-intensity physical exertion, he needs to obtain a larger volume of breathing air to avoid exposure to the accumulation of oxygen debt (Oxygen Deficiency). Therefore, he uses the mechanism of breathing through the mouth and nose together. The study by Shephard et al. (1998) indicated that during exercise, especially intense exercise, the intake of larger quantities of air through the nose and mouth together is mixed, which causes an increase in the coldness and dryness of the air in the mucus present in the respiratory tract, and increases the exposure of the trachea to pollutants. Also, the coldness and dryness reduce the movement of the cilia and increase the viscosity of the mucus, which reduces the chances of getting rid of small sensory particles and toxic particles that stick to the respiratory system. In addition, these changes weaken the secretion of immune B cells and weaken their function, and therefore reduce the production of antibiotics. (Shephard RJ, Schck PN, 1998)

The researchers believe that athletes breathing in this manner during high-intensity exertion may lead to the entry of dust and some parasites into the respiratory tract, as they pass through the mouth without being trapped by the nasal mucous membranes. Furthermore, the inhaled air is not adequately conditioned to suit the internal environment of the lungs and body, potentially causing allergic reactions.

Therefore, when foreign substances re-enter the body, such as when an athlete engages in similar exertion—which naturally occurs during training—the body's immune response is activated. This response includes lymphocytes called "mast cells," which, in allergic reactions, release chemicals such as histamine. Histamine is released into the bloodstream, causing the allergy symptoms experienced by the individual, such as skin allergies, hay fever, and respiratory allergies. (Spence L, Nissen MD, Sloots TPP, McCormack JG, Locke AS, Pyne DB, Fricker PA, Brown WJ, 2005)

The results of the current study are consistent with those of Alaa Mohamed Ali Nahasa's study (2010), which found statistically significant differences in some immunoglobulins (IGG, IGA, IGM) among football players aged 16-17-18 years between the pre- and post-tests, favoring the post-test. (Nahasa, Alaa, 2010)

The results of the current study are also consistent with those of Hamida Mohamed Ali Mujahid's study (2006), which found that the levels of most of the studied immunological and functional variables increased with increasing training load. (Mujahid Hamida, 2006)

The results of the current study are consistent with the study by Maram Jamal Attia (2012), which indicated statistically significant differences between the pre- and post-test results of high-intensity training in a sample of athletes regarding immunoglobulin (IgG-IgA) levels, showing an increase in their concentration. (Fayed Maram, 2012)

Nirvana Nasr El-Din's study (2007) also confirms statistically significant differences between the pre- and post-test results of high-intensity training in immunoglobulin (IgG-IgA) levels, favoring the post-test. (Ahmed Nirvana, 2007)

The results of the current study differ from those of Sobhi Hassouna's study (2006), which concluded that immunoglobulin levels decreased after high-intensity physical exertion. (Hassouna Sobhi, 2006)

The researchers believe that the reason for this difference may be due to the nature of the individuals in the research sample (Sobhi Hassouna, 2006), who are Taekwondo players. They are distinguished by their use of leg muscles, which are among the largest skeletal muscles, during play, at a rate exceeding 70%. This develops and activates the circulatory and respiratory systems and contributes to the elimination of waste products resulting from biochemical processes, thus preventing chemical imbalances in the blood.

The results of the current research differ from what Mackinnon (2000) stated, namely that strenuous training leads to a decrease in serum immunoglobulin levels, which increases the frequency of respiratory tract infections during such training. However, it was found that these symptoms appeared in players as a result of strenuous training performed for extended periods. This is attributed to the difference in the research sample. (Mackinnon, L.T., 2000, p. 9)

Table (4) also shows statistically significant differences in immunoglobulin G (IgG) concentration levels between the pre- and post-competition periods, with a statistical significance level of -699.50.

Ahmed Nasr El-Din Sayed (2014) states that, generally, a decrease in the body's immunity level among elite athletes is particularly noticeable at the end of the preparation period and during the competition period. These periods are characterized by high-intensity physical exertion, making athletes more susceptible to infectious diseases. This is attributed to decreased lymphocyte activity and a drop in blood immunoglobulin levels due to the intensity of the exertion during these periods. (Sayed Ahmed, 2014)

Ahmed Nasr El-Din (2014) adds that the acute response and impact on the immune system following exercise and training is temporary and variable, depending on the intensity and type of physical exertion and the athlete's fitness level. The types of response often manifest as a decrease in the number of lymphocytes and an increase in the concentration of immune proteins of the IgG, IgM, and IgA types. However, there is a fine line between the effect of structured, scientifically based exercise and that which is carried out without regulation, which may lead to the athlete experiencing fatigue accompanied by dysfunction of the immune system and subsequently developing illnesses. (Sayed Ahmed, 2014, p. 325)

The results of the current study, as shown in Table (7), indicate a progressively increasing rate of change in immunoglobulin G (IgG) levels between the mean resting and moderate load measurements, and between the mean moderate and high load measurements. The rate of change decreased before the competition compared to the high load, and then increased again after the competition. The physical loads under study had an effect on the selected immunoglobulin G (IgG), as the rates of change in these values indicate a variable increase in the IgG variable. The percentage change between its level at rest and at moderate load was (-23.8%), and it increased to (-27.3%) between moderate and high-intensity loads. It then decreased significantly to (45.9%) and increased again significantly to (-84.9%) between the pre- and post-competition periods.

The results of the current study are consistent with what was indicated by the results of Maram Jamal Attia's study (2012), that the percentage of change in immunoglobulin (IgG) increased after the moderate intensity, which was (45.68%), and then increased when using high-intensity training, where it reached a percentage of (48.24%). (Fayed Maram, (2012))

It is also evident from the results in Table (4) and Figure (3) that there are statistically significant differences at the <0.05 level between the results of the measurements of the IgG immunoglobulin levels in the research sample players during the resting and pre-competition states, where the t-value reached 2.62. The results of the current research differ from those indicated by the study of Hamza Jaafar (2005), which showed no statistically significant difference in IgG immunoglobulin levels under the influence of the competition preparation period. This is attributed to the difference in activity; Hamza Jaafar conducted his experiment on a sample of elite handball players in the Kingdom of Bahrain, while this research experiment was conducted on a sample of taekwondo players. (Al-Asfour Hamza, 2005)

The researchers concluded that the reason for the increase in the percentage of IgG immunoglobulin after moderate and high physical loads is due to increased activation of immune system cells as a result of structured training, which leads to the formation of a strong line of defense to protect against diseases to which the player may be exposed. This is confirmed by both Farha El-Shenawy and Medhat Qassem (2002) demonstrated that structured athletic training improves, develops, and increases the activation of immune system cells, forming a strong line of defense against injuries. When the immune system is activated, the efficiency of immune proteins in destroying foreign bodies increases. (El-Shenawy, Farha, Qassem, Medhat, 2002) Regarding the decrease in the level of immunoglobulin G (IgG) before competition and its subsequent return to near-normal levels, the researchers believe this is due to the IgG protein having eliminated foreign bodies by binding to and destroying the infected body. The study's findings align with those of Abu El-Ala Abdel-Fattah and Ahmed Nasr El-Din (2003), who indicated that physical fitness leads to improved physiological and functional efficiency, which enhances quality of life and promotes health protection by improving the immune system's ability to meet the physical demands of daily life. (El-Fattah, Abu El-Ala, Sayed Ahmed, 2003, pp. 14-15) Farha El-Shenawy and

Medhat Qassem (2002) confirm that the human immune system responds to emotions, stress, and psychological tension in various ways. There are signals transmitted between the nervous system, glands, and immune system, with each responding to the other according to the psychological state associated with structured, moderate-intensity physical activity. (El-Shenawy, Farha, Qassem, Medhat, 2002, pp. 81-82)

CONCLUSIONS

In light of the research objectives and through the presentation of results within the framework of statistical data analysis, the researchers were able to reach the following conclusions:

1. High-intensity training loads have an effect on increasing immunoglobulin G (IgG) levels, equivalent to the competitive load in Taekwondo athletes.
2. There is a significant increase in immunoglobulin G (IgG) levels as a result of competitive training loads, exceeding the effect of moderate-intensity training loads.
3. The percentage change in immunoglobulin G (IgG) levels increases proportionally between the mean resting and moderate-intensity load measurements, and between the mean moderate and high-intensity load measurements.
4. The percentage change in immunoglobulin G (IgG) levels decreases before competition compared to high-intensity training loads, and increases again after competition.

RECOMMENDATIONS

In light of the research findings, the researchers recommend the following:

1. Regulating high-intensity training loads, given their effect on increasing immunoglobulin G (IgG), when evaluating and developing training programs and planning physical training for Taekwondo athletes.

2. The necessity of taking measurements of the immune system, especially immunoglobulin G (IgG), in monitoring and evaluating the health and physiological status of taekwondo athletes and those participating in similar sports and activities with comparable energy production systems.
3. Regular monitoring of immune variables in taekwondo athletes and those participating in similar sports and activities with comparable energy production systems.
4. Conducting similar studies to identify the effect of varying intensity physical loads on other immunoglobulins in taekwondo athletes and those participating in similar sports and activities with comparable energy production systems.

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