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A Comparative Study of Some Biomechanical Variables According to Physical Biorhythm Curve Among Young High Jumpers

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ABSTRACT

This study aimed to identify some biomechanical variables in high jump performance of young athletes according to positive and negative biorhythm curve. It also aimed to identify differences in some biomechanical variables during positive and negative biorhythm cycles. The researcher hypothesized existence of statistically significant differences in some biomechanical variables during high jump performance of young athletes, favoring positive biorhythm cycle. The researcher used descriptive method, as it was suitable for study outcome. Four high jumpers from specialized schools participating in Southern Region Championship were selected to perform youth high jump. These athletes had achieved top rankings after homogenization of some variables. Athletes were photographed according to their positive and negative biorhythm cycles, calculated for each athlete based on their birth date and date of test. The researcher used appropriate statistical methods for outcome of study, including mean, standard deviation, t -test for paired samples, and simple correlation coefficient, to extract differences among values of biomechanical variables according to biomechanical rhythm curve. The most important conclusions of research revealed statistically significant differences in some biomechanical variables between positive and negative phases of physical cycle, favoring positive phase. No significant differences were found in angle of support and time of stand-up between positive and negative phases of physical cycle. Statistically significant differences were found in following kinematic variables stand-up knee angle, stand-up angle, and vertical speed, favoring positive phase of biomechanical rhythm cycle. The most important recommendations adoption of a systematic scientific record for recording data for each player, along with periodic monitoring of phases of biomechanical rhythm and identifying rise and fall of cycle. This will enable coaches to diagnose fluctuations in physical abilities according to cycle variables. It is necessary for trainers to pay attention to physical biorhythm cycle when preparing and implementing training programs by taking into account positive and negative phases, which contributes to regulating training loads to improve level of performance and achievement.

Keywords: Biomechanics; Biomechanical variables; Biorhythm; Physical Biorhythm; High jump.

ABSTRAK

Penelitian ini bertujuan untuk mengidentifikasi beberapa variabel biomekanik dalam performa lompat tinggi atlet muda sesuai kurva bioritme positif dan negatif. Ini juga bertujuan untuk mengidentifikasi perbedaan dalam beberapa variabel biomekanik selama siklus bioritme positif dan negatif. Peneliti berhipotesis adanya perbedaan yang signifikan secara statistik dalam beberapa variabel biomekanik selama kinerja lompat tinggi atlet muda, mendukung siklus bioritme positif. Peneliti menggunakan metode deskriptif, karena sesuai dengan hasil penelitian. Empat pelompat tinggi dari sekolah khusus yang berpartisipasi dalam Kejuaraan Wilayah Selatan dipilih untuk melakukan lompat tinggi remaja. Para atlet ini telah mencapai peringkat teratas setelah homogenisasi beberapa variabel. Atlet difoto sesuai dengan siklus bioritme positif dan negatif mereka, dihitung untuk setiap atlet berdasarkan tanggal lahir dan tanggal tes mereka. Peneliti menggunakan metode statistik yang tepat untuk hasil penelitian, termasuk rata-rata, standar deviasi, uji t untuk sampel berpasangan, dan koefisien korelasi sederhana, untuk mengekstrak perbedaan antara nilai variabel biomekanik menurut kurva ritme biomekanik. Kesimpulan penelitian yang paling penting mengungkapkan perbedaan yang signifikan secara statistik dalam beberapa variabel biomekanik antara fase positif dan negatif siklus fisik, mendukung fase positif. Tidak ada perbedaan signifikan yang ditemukan dalam sudut dukungan dan waktu stand-up antara fase positif dan negatif siklus fisik. Perbedaan yang signifikan secara statistik ditemukan dalam variabel kinematik berikut: sudut lutut berdiri, sudut berdiri, dan kecepatan vertikal, mendukung fase positif dari siklus ritme biomekanik. Rekomendasi yang paling penting adopsi catatan ilmiah sistematis untuk merekam data untuk setiap pemain, bersama dengan pemantauan berkala fase ritme biomekanik dan mengidentifikasi naik turunnya siklus. Ini akan memungkinkan pelatih untuk mendiagnosis fluktuasi kemampuan fisik sesuai dengan variabel siklus. Pelatih perlu memperhatikan siklus bioritme fisik saat mempersiapkan dan melaksanakan program pelatihan dengan memperhitungkan fase positif dan negatif, yang berkontribusi untuk mengatur beban latihan untuk meningkatkan tingkat kinerja dan prestasi.

Kata Kunci: Biomekanik; Variabel biomekanika; Bioritma; Bioritme Fisik; Lompat tinggi.

INTRODUCTION

High jump is a complex athletics event that relies on organized interaction between physical and biomechanical abilities to achieve optimal performance. Success in this event is not limited to possessing strength or speed alone but is largely related to the efficiency of motor performance during the different phases of the jump, from the approach to the landing. With the scientific advancement in the field of kinematic analysis, attention has focused on studying biomechanical variables as an accurate indicator for evaluating performance. These variables reflect the nature of the movement in terms of speed and angles and help determine the efficiency of skill execution. On the other hand, the importance of internal physiological factors has emerged, including the biophysical rhythm, which expresses the periodic changes in the

body's efficiency level. These changes may have a direct impact on the athlete's ability to perform, as levels of physical efficiency vary according to the phases of this rhythm. Based on the integration between the kinetic and physiological aspects, this study aims to highlight the nature of the difference in some biomechanical variables among young high jumpers in light of the biophysical rhythm curve.

Importance of the research lies in its treatment of a topic that combines kinematic analysis and the physiological aspect. It is a modern trend in the science of sports education, and its importance is highlighted in providing a scientific vision about the effect of the physical biorhythm on motor performance, helping coaches to choose the optimal timing for training units and supporting the performance evaluation process using accurate biomechanical indicators to contribute to the development of the level of young players, as they are the foundation of future athletic achievement.

Despite coaches relying on similar training programs, the performance level of young high jumpers is not consistent, exhibiting noticeable fluctuations from one period to another. This variation may not be solely due to individual differences or training effort but may also be related to internal factors affecting performance efficiency. Among these factors is the biomechanical rhythm, which likely plays a role in determining the athlete's physical readiness. However, the relationship between this rhythm and biomechanical variables has not been sufficiently researched, raising the following question: Does the biomechanical performance of high jumpers differ young people at different stages of their physical biorhythm?

This research aims to identify some biomechanical variables in high jump performance among young athletes, based on positive and negative biomechanical cycles. It also aims to identify differences in certain biomechanical variables during the positive and negative biomechanical cycles in high jump performance among young athletes, and to determine the nature of the relationship between the biomechanical cycle of the study variables and performance level.

The researcher hypothesizes that there are significant differences in some biomechanical variables depending on the physiological rhythm, favoring the positive phase. Athletes achieve their best performance during the positive phase of the biomechanical rhythm. A significant correlation exists between the physiological biomechanical rhythm in some study variables and the level of achievement in the high jump.

Study terms

Biological rhythm: The biological rhythm is an internal periodic system that regulates the time changes in the functions of the human body, such as physical activity, psychological state and mental abilities, according to regular cycles that affect the efficiency of the individual's daily performance (Abu Al-Ala Abdel Fattah, 2003, p. 85). It is also defined as "regular biological changes of short and long range during which physical, mental and emotional activity increases or decreases in a person" (Ali Al-Beik and Sabri Omar, 1994, p. 15).

The physical cycle: It is one of the cycles of the biological rhythm, and it represents the periodic change in the level of physical efficiency of an individual, as it fluctuates between high and low over a period of (23) days. (Muhammad Hassan Alawi, 1992, p. 174) It is also defined as "the cycle related to physical abilities such as strength,

speed and endurance, which goes through positive and negative phases that affect the level of athletic achievement." (Mufti Ibrahim, 2001, p. 96)

METHODS

The researcher employed the descriptive method with its comparative approach, as it was well-suited to the nature of the research problem. This method is among the most commonly used in studies that analyze and accurately describe kinetic and athletic phenomena, then compare them according to specific variables, thereby enabling the resolution of the research problem. The research sample consisted of four high jumpers from specialized schools participating in the Southern Region Youth High Jump Championship, held at Al-Shatra Sports Stadium in Dhi Qar Governorate on December 1, 2025. These athletes achieved top rankings, and homogeneity was established for certain variables. Table (1) details the characteristics of the research sample.

Table 1. Shows specifications of sample

Chronological age	Mass	Height	Achievement	Players names
19 years old	77 kg	180cm	185cm	Emad
20 years	79 kg	189cm	190cm	Hussein
18 years old	73 kg	179 cm	180cm	Maytham
19 years old	78 kg	188cm	190cm	Salah
19	76.75	184cm	186.25	Mean
0.71	2.28	4.53	4.15	Standard deviation

Exploratory experiment

The researcher conducted the pilot experiment on Thursday, December 4, 2025, on a sample of two jumpers from the research population who were selected from outside the main sample and with specifications close to their characteristics. The experiment aimed to test the suitability of the tools and devices used in measuring biomechanical variables, especially the high-speed imaging system and motion analysis programs, as well as to verify the accuracy of the field work procedures, their sequence, and the extent to which they could be implemented according to the actual conditions of the main experiment. The results of the pilot experiment showed the validity of the devices used, the suitability of the imaging sites and angles, and the efficiency of the assisting team. Based on this, the final procedures were adopted in implementing the main experiment with minor modifications to improve some imaging settings and camera angles.

Main Experience

The main experiment was conducted on a purposive sample of four high jumpers from specialized schools participating in the Southern Region Youth High Jump Championship. These jumpers had achieved top rankings and exhibited similar physical and skill levels. The experiment took place at Al-Shatra Sports Stadium during December 2025 at a uniform morning time to control the effect of daily rhythms. Each athlete was trained on the same day of the week to maintain a consistent weekly rhythm. The researcher used a 23-day biological rhythm cycle and determined the two performance phases (positive and negative) for each jumper individually, based on their birth date and avoiding critical days. The Natural Biorhythms software was used to ensure

measurement accuracy and avoid generalizing a single timing to the entire sample. Homogeneity was also maintained for certain variables, and the tests were conducted in two phases. The first phase was during the positive part of the cycle, and the second phase was during the negative part of the cycle. For the purpose of achieving experimental control, two tests were conducted for each jumper, separated by approximately half a cycle, with all surrounding experimental conditions being kept constant.

The researcher ensured that the time periods chosen for each jumper were precisely in line with their biorhythm curve, which enhances the validity of the results and contributes to explaining the differences in performance on a scientific physiological basis. The dates of the tests were as follows: Jumper 1: positive phase on Saturday 6/12 and negative phase on Saturday 20/12; Jumper 2: positive phase on Monday 8/12 and negative phase on Monday 22/12; Jumper 3: positive phase on Wednesday 10/12 and negative phase on Wednesday 24/12; Jumper 4: positive phase on Friday 12/12 and negative phase on Friday 26/12. Each player was given three attempts, and the best successful attempt was adopted. Then the performance was analyzed using the Kinovea kinematic analysis program, and the data was processed to extract the kinematic values with high accuracy.

Statistical methods

The researcher performed the statistical analyses using the statistical package. SPSS 22 uses the following statistical methods: arithmetic mean, standard deviation, simple correlation coefficient (Pearson's), t- test, and percentage.

RESEARCH RESULTS

Presentation and analysis of the results of the biomechanical variables for the two phases of the physical biorhythm cycle (positive and negative).

Table 2. Shows mean, standard deviation, and tabulated and calculated t-value for the two phases of the biorhythm cycle (positive and negative) of biomechanical variables

No.	Variables	Positive phase		Negative phase		Calculated (t) value	Tabular (t) value	Sig.
		M.	St.d	M.	St.d			
1	Take-off knee angle	142,500	3,210	137,800	2,850	3.41	3,182	Sig.
2	Plant angle	45,250	2,754	41,250	1,980	2.33		Insig.
3	Take-off time	0.152 seconds	0.008	0.171 seconds	0.010	2.98		Insig.
4	Take-off angle	51,850	1.920	47,643	1,580	3.39		Sig.
5	Vertical speed	3.82 m/s	0.21	3.34 m/s	0.18	3.47		Sig.

Significant at degrees of freedom (3) and significance level (0.05)

Presentation and analysis of the performance variables results for the two phases of the physical biorhythm cycle (positive and negative).

Table 3. Shows mean, standard deviation, and tabulated and calculated t-value for achievement variable for the two phases of physical biorhythm

Variable	Positive phase		Negative phase		Calculated (t) value	Tabular (t) value	Sig.
	M.	St.d	M.	St.d			
Achievement	1.91 m	0.022	1.82 m	0.025	5.47	3,182	Sig.

Significant at degrees of freedom (3) and significance level (0.05)

DISCUSSION

The results in Table (2) show that the calculated value for the knee rise angle (3.41) is greater than the tabulated value (3.182) and was statistically significant, indicating a significant advantage of the positive phase over the negative phase. The researcher attributes this to improved function of the knee joint extensor muscles and increased power generation during the push-off phase, where the mean value for the negative phase was (137.800) and reached (142.500) in the positive phase. This is confirmed by (Mohammed Yousef Al-Sheikh, 1986, p. 256) in "not exaggerating downward flexion of the knee joint during the rise phase, which causes an increase in the effect of the gravitational torque and requires greater force to overcome it." The results also showed no significant differences in the support angle between the two biorhythm phases, as the calculated t-value (2.33) was less than the tabulated t-value (3.182). The researcher attributes this to the fact that this variable is considered a correlated variable. The technical and kinetic style is more related to the momentary physical condition.

This is what Kamal Jamil Al-Riyadi (2003, p. 74) indicated in that the angular variables of the high jump skill are characterized by relative stability as they are related to the acquired kinetic performance pattern. As for the variable of the take-off time, the results showed a significant decrease in favor of the positive phase, as the calculated t-value reached (2.98), which is less than the tabulated t-value (3.182). The researcher believes that the reason for the decrease in the take-off time in the positive phase compared to the negative phase of the physical biorhythm cycle is the presence of a development in explosive power and the speed of the muscular response of the take-off foot, and the short time of ground contact helps to reduce the loss of horizontal speed. "All movements are synchronized at the same time, usually between (0.120 - 0.170) seconds, which is the time in which the take-off process is performed by most of the world's jumpers" (Hamed, 1997, p. 11).

In the variable of take-off angle, the results showed a statistically significant advantage for the positive phase, with the calculated t-value (3.39) being greater than the tabulated t-value (3.182). The researcher attributes this to the improved neuromuscular coordination and increased efficiency in converting horizontal velocity into a vertical component, caused by the positive phase of the biorhythmic cycle. The mean in the negative phase was (47.643), while the mean in the positive phase was (51.850). This is confirmed by Youssef Lazem Hassan (2010, p. 133), who stated that the optimal take-off angle in the high jump falls within the range of (50-55).

Approaching this range enhances the elevation of the center of gravity and performance efficiency. Similarly, the results for the vertical velocity variable showed the superiority of the positive phase over the negative phase in the biorhythmic cycle, with the calculated t-value (3.47) being greater than the tabulated t-value (3.182). The researcher explains this by noting the improved power output in the vertical direction during the moment of take-off. Jumping is a result of changes that occur in the positive phase of the physical cycle. Lennart al., 1997,2 confirms that vertical speed is the decisive factor in determining the jumper's height, as it represents the final result of converting force into effective movement.

The results in Table (3) showed a significant significance for the achievement variable and the superiority of the positive phase over the negative phase, as the calculated t value reached (5.47), which is greater than the tabulated t value (3.182). The researcher attributes this to the integration of biomechanical variables in the positive phase of the physical biorhythm cycle. It is clear from the results that the physical biorhythm cycle had a clear effect on improving the kinematic variables (vertical speed, rising time, rising time), while the angular variables were less affected and more stable, which is consistent with the nature of the technical performance of the high jump.

CONCLUSIONS AND RECOMMENDATIONS

There were statistically significant differences in some biomechanical variables between positive and negative phases of physical cycle, favoring positive phase. No significant differences were found in plant angle and take-off time between positive and negative phases of physical cycle. Statistically significant differences were found in the following kinematic variables take-off knee angle, take-off angle, and vertical speed, favoring positive phase of the biorhythmic physical cycle. Significant differences were found between the two phases of the biorhythmic physical cycle, favoring positive phase, in performance variable.

Adopting a systematic scientific record to document each player's data, along with regular monitoring of their biorhythm phases and identifying peaks and troughs of cycle, enables coaches to diagnose fluctuations in physical abilities based on cycle variables. Player selection during competition periods should be based on each player's biorhythm cycle. Scientific studies should be conducted on biorhythm cycles in individual and team sports. Coaches must pay close attention to biorhythm cycle when designing and implementing training programs, considering both positive and negative phases to optimize training loads and improve performance levels.

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