

Proposal for a protocol-based approach to a pre-competitive mésocycle focused on the development of PMAN and its impact on performance during the U18 African Championship of men's taekwondo

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Abstract:

This article examines the impact of a protocol-based approach to a pre-competitive training mésocycle based on the development of PMAN spread over 2x20 days, as two mésocycle before the African U18 Taekwondo Championships in Abidjan, which will take place on 20/08/2025, in order to consolidate the technical performance of the junior men's national taekwondo team. Thirty athletes (aged between 18 and 24), were adjusted using ACNOVA covariance and then divided into two groups: an experimental group EG, n=15 following a training protocol mainly based on the development of PMAN, and a control group CG, n=15 following a standard training programme. The results show a significant improvement in technical performance ($p<0.05$) and PMAN in favour of the EG compared to the CG.

Key words: Anaerobic A-lactic Power (PMAN), (A-lactic AP), cyclic protocol, Taekwondo,

المخلص:

نتقترح من خلال هاذ المقال مقارنة بروتوكولية حلقة تدريبية متوسطة المدى لي ما قبل المنافسة مبنية اساسا على تطوير خصلة ال PMAN موزعة على مدار 20 يوما بوتيرة 2 x 20 يوما، لحلقتان متوسطتان قبل فعاليات بطولة أفريقيا للتايكوندو تحت 18 سنة في أبيدجان، والتي ستقام في 20/08/2025. من أجل تعزيز الأداء الفني للمنتخب الوطني. تم اختيار ثلاثين رياضيا (تتراوح أعمارهم بين 18 و 24 سنة)، استخدمنا التباين ACNOVA. تم تقسيم العينة إلى مجموعتين: مجموعة تجريبية (EG)، العدد = 15 تتبع بروتوكول تدريبي يعتمد بشكل أساسي على تطوير PMAN، ومجموعة ضابطة (CG)، العدد = 15 تتبع برنامج تدريب اعتيادي. أظهرت النتائج تحسنا ملحوظا في الأداء الفني ($p<0.05$) وقياسات PMAN لصالح EG مقارنة ب CG

الكلمات المفتاحية: القدرة اللاهوائية الغير لاكتية (PMAN)، بروتوكول حلقي، تايكوندو،

1-Introduction:

Protocol-based approaches in sports training refer to structured and systematic methods used to plan, organize, and execute training programs to optimize athletes' performance. These approaches are based on scientific principles and well-defined protocols that take into account the specific needs of the athlete, the sport practiced, and the objectives to be achieved (competition, physical development, injury prevention, etc.). They include concepts such as periodization, training load management, recovery, and adaptation to the physiological and psychological demands of the sport.

Taekwondo, an Olympic martial art, requires a combination of power, speed, and technical precision. It is also characterized by a specific physiological nature that is developed through the demands of the discipline itself. The PMAn, characterized by rapid and explosive muscle contractions, involves dynamic strikes based on very powerful kicks Roosen & all, 2007. The technical-tactical arsenal that a competitor must possess, along with the speed and strength of the attack, are both important factors for succeeding in competition and ensuring the effectiveness of offensives directed at the opponent Jidovtseff &all, 2005. It is essential to optimize performance in this sport.

Most often, these two qualities are evaluated in high-level taekwondo to assess the level of preparation, in order to develop appropriate training protocols. To do this, coaches responsible for physical preparation use various laboratory and/or field tests. For the assessment of maximum anaerobic strength and power (MASP), the isotonic or even isokinetic mode of concentration has been the subject of multiple research studies Larrat & all, 2007, examining the relationship between isokinetic strength and the different types of leg strikes (the tchagui) for various specialties Jidovtseff & all, 2005, However, the analysis of the discipline of Taekwondo shows that it requires power qualities to execute brief and intense attacks but also endurance qualities for the repetition of attacks at the same strength and speed in the sequence of fights despite the observed only short periods of rest Barker, L. & All 2018.

Our work is to try to find the relationship that may exist between these two qualities of strength for elite national competitors in Algerian taekwondo, in other words, to find the correlations that might appear between the parameters of PMAn and absolute and

relative performances via BMI and horizontal jump, measured by PTO-JUMP. In this context, we can pose the following question: can a cyclic pre-competition protocol based on PMAn in taekwondo improve power in junior taekwondo athletes on the day of the African Championship in Abidjan 2025?

• **Problematic:**

A taekwondo athlete prepares for a competitive season with a main objective, such as national championships or opens, in order to qualify for the Olympic Games. The mésocycle is divided into phases: general preparation (basic strength, endurance), specific preparation (combat techniques, explosiveness), competition (sharpening), and recovery.

In my capacity as DTN of the Algerian Taekwondo Federation “ministerial decree 15/03/2024 Ref: 12-2024 we have noted that the achievement of a “sporting performance“ is the result of the integration of several parameters, of several determining factors, because nowadays, this approach is considered to be “multifactorial”. Despite encouraging performances (bronze medals at the All-Africa Games 2023 and the Egyptian Open), Algeria is struggling to compete with nations such as Egypt and Tunisia on the international stage. The problem highlights the need to boost competitiveness through better training, early talent detection and increased participation in international tournaments.

The issue is broad enough to encompass the key dimensions of taekwondo development in Algeria, yet precise enough to guide in-depth reflection and study.

• **Hypotheses :**

In this problem, we can assume that:

General hypothesis:

An 8-week PMAn program significantly improves the technical performance and plyometric abilities of senior male taekwondo players compared with standard training.

In this context, it can be assumed that:

≥ The judicious choice of training methods and a more specific content based on a strength training program will contribute to the improvement of PMAn in taekwondo.

≥ The means and methods of training as well as specific content based on a strength training program will not improve power in taekwondo.

2- General objective of the study:

The aim of our article is to study the effect of a specific weight training program aimed at developing PMAn quality and to evaluate its impact on the physical and technical development of senior Algerian taekwondo athletes over a training mesocycle.

• **study tasks:**

In order to achieve the objectives of our present study, we have attempted to solve the following tasks:

- Bibliographical analysis of the scientific literature on power.
- Development of a program based on power quality.
- Determination of the effect of bodybuilding programs on power.
- Sample design.
- General and special physical tests.

• **Research methods used:**

Experimental method: This consists of developing a specific taekwondo strength training programme to develop the quality of power in a mesocycle. The results obtained by the experimental group will confirm or invalidate the effectiveness of this work.

• **Presentation of the Protocol for the tests used:**

Evaluating an athlete is essential if a training plan is to make sense. In fact, the first stage in the training process is the diagnostic evaluation, to find out where we are starting from in order to achieve an objective. After the stages of training design and implementation, the last stage is regulation and the correction of any errors. Progress must therefore be assessed to validate the coach's choices

We used the following protocols to carry out the various tests:

3- Procedural definition of the concepts mentioned in the research:

3-1- Maximum Anaerobic Power PMAn:

General definition (exercise physiology):

Maximum Anaerobic Power (PMAn) refers to the maximum capacity of an individual to produce energy by anaerobic metabolic pathways (mainly anaerobic glycolysis and the ATP-PC system) over a very short duration, generally between 5 and 10 seconds. It represents the maximum power that muscles can generate without a significant supply of oxygen, often measured during explosive efforts such as sprinting or jumping Jack H Wilmore, David L Costill, Larry Kenney. 2017.

3-2- Definition in sports training:

PMAn corresponds to the maximum mechanical power that an athlete can develop during a very high-intensity, short-duration effort, mainly

by mobilizing immediate energy reserves (ATP and phosphocreatine). It is often assessed using tests such as the Wingate test or sprints on a cycle ergometer, expressed in watts (W) or watts per kilogram of body weight (W/kg) Véronique Billat 2017.

3-3- Protocol approach:

Periodization is a protocol approach which divides training into temporal cycles (macrocycles, mesocycles, microcycles) to optimize progression and reach peak performance at competition time. It helps structure the development of physical (strength, endurance, speed) and technical qualities, while avoiding overtraining Olivier Bernard · 2016.

4- The methodological procedures used in the study:

Experimental method: This consists of developing a specific taekwondo strength training programme to develop the quality of power in a mesocycle. The results obtained by the experimental group will confirm or invalidate the effectiveness of this work.

- **Presentation of the Protocol for the tests used:**

Evaluating an athlete is essential if a training plan is to make sense. In fact, the first stage in the training process is the diagnostic evaluation, to find out where we are starting from in order to achieve an objective. After the stages of training design and implementation, the last stage is regulation and the correction of any errors. Progress must therefore be assessed to validate the coach's choices

We used the following protocols to carry out the various tests:

- **Protocol for general tests :**
- **Protocol for performing a SJ:**

The Squat Jump (SJ) test is generally used to measure an athlete's lower body explosive power (i.e., speed-strength capacity) (2, 3). It is also less commonly used in conjunction with a CMJ to identify an athlete's reactive strength capabilities during a slow stretch and low stretch load cycle (2). This provides new insights as they can be compared to their performances during reactive strength tests at fast stretch cycle/high stretch load such as the progressive jump test (2). There are two common variations of the SJ test:

A. Static SJ test

B. Dynamic SJ test.

The static SJ test requires the athlete to make a "pause" in a bent and semi-squat position for several seconds before initiating the ascending/concentric phase and jumping. The dynamic SJ test, on the other hand, allows the athlete to descend and ascend through the

countermovement in a continuous and quick motion without any stops or pauses. Strength and conditioning coaches often measure an athlete's SJ capabilities using various loads in order to identify their power production abilities. For example, a coach may ask the athlete to perform a series of SJs—whether static or dynamic—using loads such as 20%, 40%, and 60% of the athlete's back squat one-repetition maximum (1RM). The athlete's back squat 1RM is typically used to determine the SJ loads solely due to its biomechanical similarities and its relationship with back squat strength Slinde, F., Suber, C., Suber, L., Edwén, C. E., & Svantesson, U. (2008).

- Dynamic SJ test: When instructed by the test administrator, the athlete must simply jump as high as possible and attempt to land in the same location on the platform as they took off from.
- Static SJ test: When instructed by the test administrator, the athlete must lower themselves into a semi-squat position (depth dictated by the test administrator) and pause for 2-3 seconds. After the 2-3 second pause, the athlete is then free to jump explosively as high as possible but must attempt to land in the same location on the platform as they took off from.
- The athlete must perform a minimum of three jumps so that performance averages or their best score can be calculated.
- With the help of various loads, the coach is able to chart the athlete's performance on a graph, known as the 'power load curve', and identify at what load the athlete expressed their maximum output power (Figure 1).

- **Protocol for performing a CMJ:**

Stand upright and completely still with feet hip-width to shoulder-width apart and hands on hips.

- Keeping the chest up and looking forward, begin the countermovement by dropping into a squat position at a self-selected depth.
- Without pausing, spring back up into a maximal-effort vertical jump.
- Land in a safe and controlled manner.
- Reassume the starting position and repeat for as many repetitions as desired. Three reps are the most common protocol.

- **Common Mistakes or Poor Technique of CMJ? :**

- Shifting weight, talking or otherwise moving during weighing and/or immediately prior to start of movement. Both of these periods require complete stillness to ensure accurate readings.

- Releasing hands from hips can create excess momentum, making the test less reliable.
- Performing a slow countermovement can reduce the effect of the SSC.
- Excessively bringing knees up or feet forward in the air can affect landing.
- Landing with knees bent can artificially exaggerate the jump height measurement for jump mats and force plates.
- Losing balance on landing can artificially exaggerate asymmetry measurements.

Some force plates (such as ForceDecks) can calculate jump height using the “Impulse-Momentum equation.” This calculates jump height based on specific impulse metrics prior to take-off, reducing variability in the measure due to flight time or landing errors.

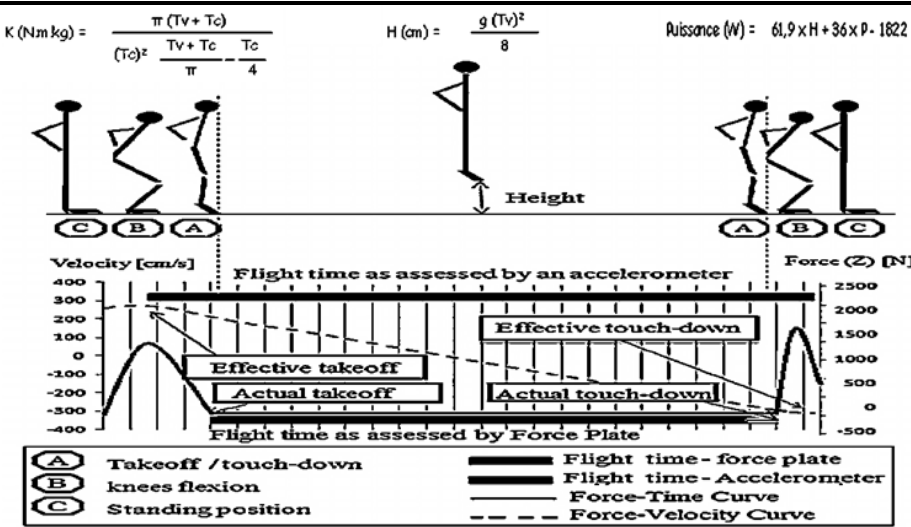
Varieties of a CMJ exist, however, a CMJ with hands on hips is the most common test as it removes the influence of the upper body. Although a CMJ with arm swing (also known as an “Abalakov jump”) can result in a more than 10% increase in jump height, it also has the potential to add variability to the jump and “hide” deficits when athletes are fatigued. Svantesson, U. & All (2008).

- **Key Aspects in the CMJ:**

- **Stretching of Muscles:** The initial dip phase stretches the muscles, priming them for a forceful contraction.
- **Stretch-Shortening Cycle (SSC):** This refers to the fast transition from the eccentric pre-stretch to the concentric action, crucial for generating maximum force.
- **Neuromuscular Strategy:** Efficient motor unit recruitment and speed of muscle contractions are essential for optimal performance in the CMJ.
- **Joint Kinematics:** The CMJ involves multiple joints, including the ankles, knees and hips, each playing a pivotal role in the movement execution Cohen, D. & All (2020).

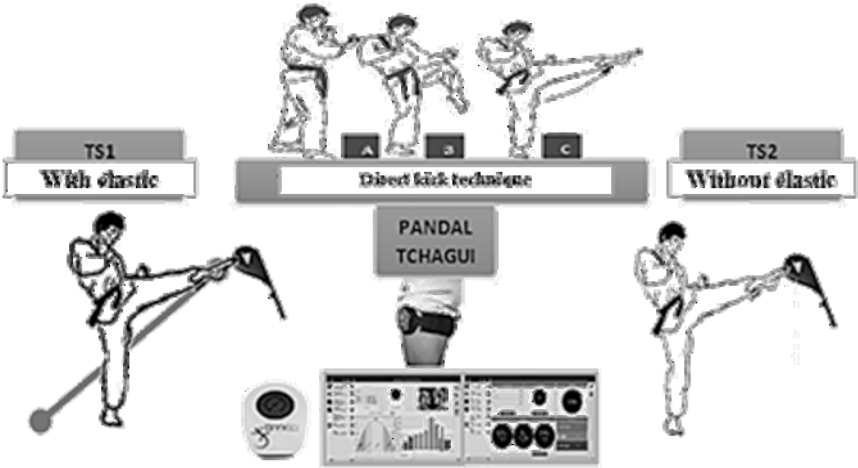
4-1 Method and tools: the following elements are mentioned:

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• **Protocol for the special tests:**

Score the highest number of hits on the racket in PANDAL TCHAGUI for 10 seconds. - The player is allowed only one attempt. - He chooses his objective from the three listed below. If the support foot leaves the hoop, the countdown and the event stop.



- **Human resources :**
- **The study sample:**

In our study, we will evaluate (30) athletes from the senior men's national taekwondo team who will be divided into two groups (15), the experimental group (EG=15) and the control group (TG=15).

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- **Material resources :**
- **Impudence meters the Z-METRIX;**



<https://www.bioparhom.com/impedancemetre->

- **gyko sport ;**



<https://training.microgate.it/sites/default/files/manuali/optojump/Manual-EN.pdf>

- **Statistical tools used in this study:**
- **SPSS 2023**

La moyenne : **Ecart type :** **T-Student :** **ANCOVA**

$$\bar{A} = \frac{1}{n} \sum_{i=1}^n a_i$$

$$\sigma = \sqrt{\frac{\sum (x_i - m)^2}{n-1}}$$

$$s = \sqrt{\frac{(s_1)^2}{n_1} + \frac{(s_2)^2}{n_2}}$$

$$s^2 = \frac{\sum (x_i - \bar{X})^2}{n-1}$$

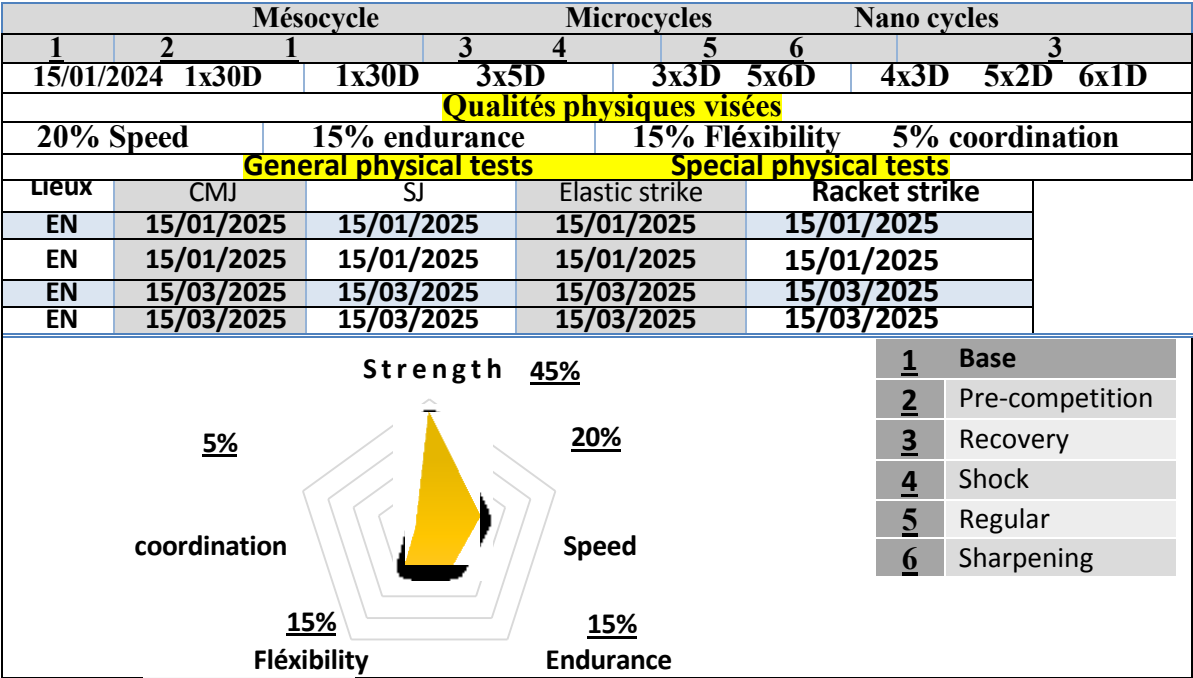
- **ANCOVA covariance :**

Like ANOVA, the ANCOVA procedure aims to determine the effect of a categorical (independent) variable on a continuous (dependent)

variable. The aim of ANCOVA is to test the initial relationship by statistically removing the indirect effect of the covariate. This amounts to testing the effect of the independent (categorical) variable on the dependent (continuous) variable, once the effect of the covariate on the dependent variable has been removed Arthur Griffith 2007. & Robert Stevens · 2023 .

❑ Study process and intervals

Three training programs were set up: one with supra-maximal intensity, one with submaximal intensity and a daily technical program. The duration of these programs was 8 weeks, since power training 3 times a week can produce changes after 6 weeks (Chawachi et all 2005). A battery of tests is carried out at the beginning of the experimental period and again at the end of the same season. The groups continue with their regular training programs, consisting of 9 sessions per week, with the exception of 4 morning sessions to work on the proposed program.



-Approach used.

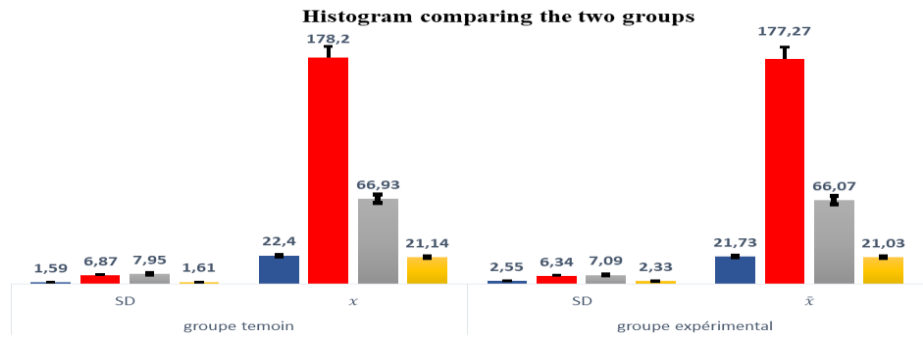
-4-2 Presentation and Analysis of Results:

1- Analysis of the homogeneity of the two groups (control and experimental) before application of the training program:

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Experimental and control group statistics on structural variables								
variables	Expérimental -G		Control -G		C -T	S -T	SIG	Décision
	$\bar{x}$	SD	x	SD				
Age	21,73	2,55	22,40	1,59	0.859	2.048	0.398	NS
Size / cm	177,27	6,34	178,20	6,87	0.387		0.702	NS
Body weight / kg	66,07	7,09	66,93	7,95	0.315		0.755	NS
BMI = P/T ²	21,03	2,33	21,14	1,61	0.146		0.885	NS

T1: Statistical comparison table between experimental and control groups for demographic and physiological variables



- **Analysis:**

An independent-samples T-test was performed to verify the homogeneity of the two groups (control and experimental) according to several baseline variables likely to influence the results of the training program, namely: age, height, weight and body mass index (BMI).

The results show that there were no statistically significant differences between the two groups for any of the variables studied. All p-values (sig) are above 0.05, and the calculated T-values are below the critical table value (table T = 2.048).

- **Conclusion:**

These results confirm that the two groups are statistically homogeneous in terms of the demographic and physiological characteristics studied prior to implementation of the training program. This guarantees the high internal validity of the study, enabling post-intervention effects to be attributed exclusively to the program applied.

Test préalable des échantillons indépendants					
Tests	Calculated -T	Scheduled -T	df	SL	Décision

SJ	0,74				NS
CMJ	0,22	0,05	28	2,145	NS
ES	2,35				S
RS	2,28				S

T2: Preliminary analysis table for homogeneity of independent samples (t-test)

- **Table analysis:**

The table shows the results of the independent-samples t-test applied to the pre-test data to assess homogeneity between the experimental and control groups prior to the intervention. The critical value of t (T table) at the significance level $\alpha = 0.05$ and with 28 degrees of freedom (df = 28) is 2.145

- **Interpretation of results:**

For the SJ (Squat Jump) and CMJ (Counter Movement Jump) tests, the calculated values of t are 0.741 and 0.227 respectively, which are below the critical value.

- **Decision:**

the differences are not statistically significant (NS).

- **Conclusion1:**

The two groups are homogeneous for these variables at baseline On the other hand, for the FE (hitting with rubber band) and FR (hitting without rubber band) tests, the calculated t values are 2.351 and 2.283, which is above the critical value (2.145) in absolute value. Decision: differences are statistically significant (S)

- **Conclusion2:**

The analysis shows that the initial homogeneity hypothesis is met for some variables (SJ and CMJ), but not for others (FE and FR). This justifies the use of an ANCOVA test in the post-test analysis to control for the effect of initial differences.

2- Analysis of post-test differences between the two groups after the training program:

Using analysis of covariance (ANCOVA) to compare the post-test performance of the two groups (experimental and control) while controlling for the influence of pre-test measures.

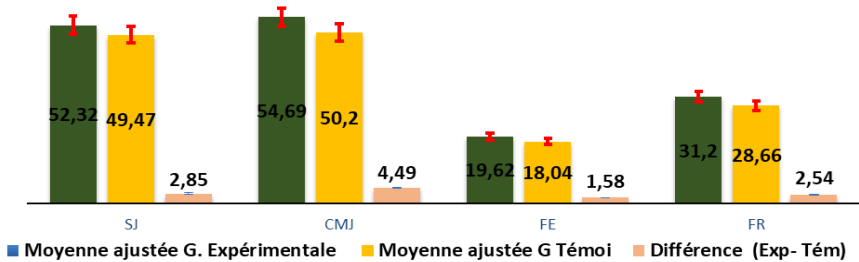
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The table below shows the Estimated Marginal Means for each test, the difference between the two groups and statistical significance.

Estimated marginal average					
Tests	Adjusted mean Experimental G	Adjusted mean Control G	Différence (Exp - Con)	F	Sig
SJ	52,32	49,47	2,85	117,39	p < 0.01
CMJ	54,69	50,2	4,49	98,14	p < 0.01
ES	19,62	18,04	1,58	22,52	p < 0.01
RS	31,2	28,66	2,54	62,78	p < 0.01

T3: Table of estimated marginal averages

Histogram of the estimated marginal means



- Table analysis:

The table shows that the experimental group obtains higher adjusted averages in all tests than the control group after controlling for initial scores. The differences are 2.85 (SJ), 4.49 (CMJ), 1.58 (FE) and 2.54 (FR), all statistically significant ($p < 0.01$).

These results indicate that the training program produced a substantial positive effect on the explosive and motor skills assessed

- Conclusion:

The program applied to the experimental group proved clearly effective, inducing significant improvements in all the tests studied compared with the control group after adjustment for initial differences.

3- Analysis of differences between pre- and post-experimental tests in the experimental group:

Différences entre les tests pré et post expérimentaux du groupe expérimental									
Tests	Test pré		Test post		C-T	S-T	df	LS	Décision
	$\bar{x}$	SD	$\bar{x}$	SD					

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SJ	48,64	2,22	52,01	2,52	19,27				S
CMJ	49,76	4,87	54,86	3,94	10,14	2,145	14	0,05	S
SE	17,4	1,12	19,2	1,32	16,83				S
SR	27,46	1,55	30,36	2,13	15,37				S

T4: Table of Differences between Pre- and Post-Experimental Tests for the Experimental Group

Histograme of pré and post-test résultats of the experimental group



- Analysis:

A Student's t-test for paired samples was performed to compare the mean performance of subjects before and after the intervention. The significance level chosen was $\alpha = 0.05$ with a degree of freedom (df) of 14, giving a critical value T Table = 2.145.

- Interpretation:

The results show highly significant differences between the pre- and post-test scores for the four types of tests measured. All of the calculated T values > critical T, indicating that the intervention or training had a positive and significant effect on the physical performance of the experimental group.

- Conclusion:

Statistical analysis of the experimental data revealed that the intervention applied to the experimental group generated a significant improvement in all physical tests measured (SJ, CMJ, FE, FR). These results confirm the programme's effectiveness in developing the targeted physical abilities.

4- Analysis of differences between pre- and post-experimental tests in the control group:

Differences between pre- and post-experimental tests in the control group								
Tests	Test pré		Test post		C-T	S-T	DL	LS
	$\bar{x}$	SD	$\bar{x}$	SD				
SJ	49,25	2,32	49,78	2,26	2,85			S

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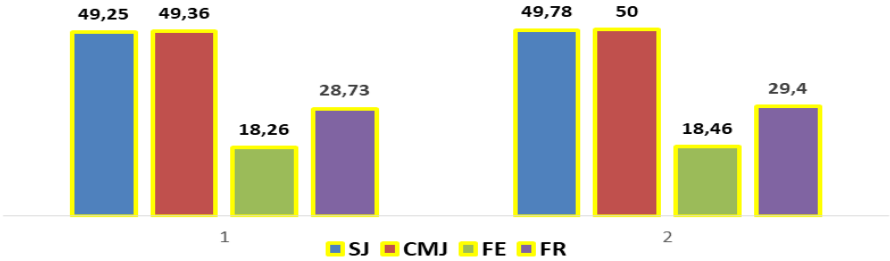
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CMJ	49,36	4,78	50	4,53	4,69	2,145	14	0,05	S
FE	18,26	0,88	18,46	1,24	0,71				NS
FR	28,73	1,48	29,4	1,72	2,87				S

T4: Table of Differences between Pre- and Post-Experimental Tests of the

Control Group

Histograme of differences between pre-and post-experimental test in the control group



- Analysis:

A Student's t-test for paired samples was used to assess whether significant changes occurred in the control group between the pre-test and post-test. The significance level was set at $\alpha = 0.05$, with $df = 14$. The critical value was $T = 2.145$.

- Interpretation:

The control group, which was not supposed to receive any specific intervention, nevertheless showed significant differences in the SJ, CMJ, and FR tests.

However, no significant difference was detected in the FE test ($T < T$ table).

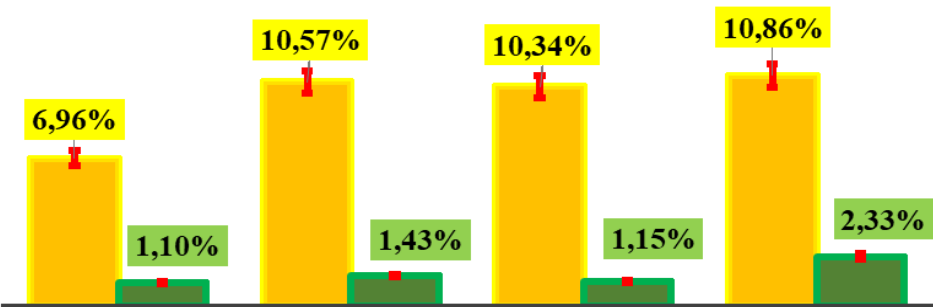
These results may be due to natural variations, measurement errors, or uncontrolled side effects of training.

- Conclusion:

The results obtained in the control group show some statistically significant improvements, even though the group did not follow a specific training programme. These variations may be attributed to external factors or inter-individual variability. However, unlike the experimental group, the extent of the changes remains limited.

5- Analysis of differences in average rates of change between the experimental group and the control group:

Histogram of the progression rates of two groups



- Analysis of results:

The results obtained show marked differences in the average rates of change between the experimental group and the control group across the four targeted physical tests.

Here is the detailed interpretation:

▪ **SJ test (static vertical jump):**

Experimental group: 6.94% however Control group: 1.10%

This result reflects a significant improvement in vertical explosive power in the experimental group. The programme appears to have effectively stimulated the neuromuscular capacities of the lower limbs, unlike the control group, which showed only a marginal change.

▪ **CMJ test (Counter Movement Jump):**

Experimental group: 10.57% however Control group: 1.43%

The counter-movement, which requires inter-segmental coordination and elastic recovery, clearly benefited the experimental group.

The observed difference confirms the positive effect of training on power and speed of execution.

▪ **SE test (Elastic strike):**

Experimental group: 10.34% however Control group: 1.15%

The use of elastic bands enabled the experimental group to increase their power and speed under resistance.

This significant improvement demonstrates an effective transfer of specific muscle work to technical movement.

▪ **FR test (racket strike):**

Experimental group: 10.86% however Control group: 2.33%

This test highlights motor skills without external constraints.

The experimental group showed significant improvement, suggesting that the protocol used also improved technical efficiency in free situations, through better motor control and increased speed.

Why has there been no significant progress in specific tests? While technical progress and physical progress are two essential aspects of development in many sports, technical progress can be more difficult to achieve than physical progress. Technical progress requires more in-depth physical and cognitive learning because it is a more

complex and, above all, less quantifiable process. On the other hand, physical progress, although also demanding, tends to be linear and quantifiable, which can make it easier to achieve in the short term.

❑ Conclusion:

The objective of this study was to test a protocol-based approach to the average training cycle in order to verify and monitor technical progress prior to the start of the U18 African Championships 'ABIJAN 2025' on the PMAn of taekwondo athletes. A quasi-experimental protocol design was adopted, allowing for a comparison of post-test results between the experimental group and the control group in order to evaluate the overall effectiveness of the proposed training protocol. In addition, the analysis of each group's progress between the pre-test and post-test allowed us to observe a respective improvement over time, and the study confirmed the effectiveness of the training protocol in improving PMAn in U18 taekwondo athletes.

The three-stage analysis provided comprehensive information on the initial equivalence of the groups after adjustment for ACNOVA covariance, as well as the significant impact of the protocol on the experimental group and the striking difference between progression rates, highlighting the positive impact of the proposed protocol compared to routine training.

These results validate the protocol as a key approach for developing PMAn and technical precision in U18 taekwondo athletes. The evolution of modern training highlights the growing importance of explosive qualities in combat athletes. The assessment of physical attributes is increasingly focusing on parameters such as PMAn, strength and speed.

Our working hypothesis, which proposed that a strength training programme specifically tailored to U18 taekwondo practice would improve PMAn, is confirmed by our results. These demonstrate the effectiveness of such a protocol in improving key performance parameters. The development of PMAn, particularly explosive strength and vertical jump, should be a primary objective in the training regime of every U18 taekwondo practitioner. These qualities are essential for executing dynamic and effective techniques, thereby contributing to improved competition performance.

This study reinforces the critical role of targeted training strategies in optimising athletic potential in U18 taekwondo. The results clearly demonstrate that the training protocol had a beneficial impact on the main physical qualities tested. The U18 taekwondo athletes in the

experimental group performed significantly better than those in the control group. Analysis of the rates of progress within each group, as well as comparison of post-test performances, show that the protocol significantly improved the athletic potential of the experimental group, particularly in terms of strength and endurance. This improvement represents a significant advantage, as strength endurance is a critical performance asset in U18 taekwondo, where maintaining maximum anaerobic power and explosiveness over time is essential for success in combat.

These results confirm the effectiveness of the personalised protocol in improving the physical demands required for competitive U18 taekwondo. We can affirm and conclude that developments in contemporary training highlight the growing importance of explosive qualities in combat sports. The assessment of physical demands now focuses on key parameters such as PMAn, strength and speed. Explosive strength and vertical jump training, whether conducted separately or integrated into technical preparation, has become paramount and essential in the preparation of U18 taekwondo athletes. It represents a crucial step in progressing and optimising competition performance. This study highlights the need to incorporate targeted PMAn training into modern U18 taekwondo preparation in order to meet the demands of the sport and improve the competitive advantage of athletes.

Ultimately, our study was reinforced by the very satisfactory results of the U18 national taekwondo team during its participation in the African Championships in Abidjan from 18 to 25 August 2025, in which seven athletes from the experimental group in our study and five of the selected athletes won medals .

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