



Original Contribution

MODELLING AND OPTIMISING THE STRENGTH POTENTIAL OF STUDENTS DURING SPORTS ACTIVITIES

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ABSTRACT

Strength training in sports has long been a topic of debate. It is also examined with regard to concepts giving it additional characteristics, particularly dynamic (explosive) strength, which is manifested in the shortest time. Testing according to the indices that characterize objectively dynamic strength level was conducted with 50 randomly selected students, engaged in various motor activities. The model we developed by applying the MARTIN method (successfully used in sports and pedagogic investigations) involves mathematically and statistically processed and analysed results, based on variable parameters, logarithmic, correlation, and interrelation dependencies. The model attempts to determine the level of the dynamic strength momentum state as part of the motor potential of students by objective evaluation, allowing optimal impact exerted in a particular direction.

Keywords: strength, strength potential, model, students

INTRODUCTION

Dynamic strength, defined as the ability to exert force rapidly and repetitively, is fundamental in most sports (1). Unlike static strength, dynamic strength encompasses neuromuscular coordination, muscular endurance, and explosive power (2, 3). Among students, optimising dynamic strength not only enhances sports performance, but also supports overall physical health and injury prevention (4-6). In contemporary sports practice, the concept of strength is commonly interpreted from multiple perspectives, generally depending on the context of the motor activity being performed, or its mechanical characteristics (7). Strength may be viewed either as a physiological capacity to perform movement or as a mechanical force measurable in biomechanical terms. From a physiological standpoint, strength is defined as the capacity to exert force on external objects

through muscle contractions in order to perform physical work (8, 9). In this sense, strength is closely associated with neuromuscular activation and the body's ability to generate force against resistance during movement (10-13). Alternatively, from a mechanical perspective, strength is treated as a vector quantity, characterised by magnitude, direction, and point of application (14). In this perspective, it becomes a subject of biomechanical analysis, where the efficiency and direction of force application are fundamental to understanding athletic performance (15). The functional characteristics of strength as a physical quality in student sports activities further necessitate the integration of sport-specific variables (16-18). These include the demands of different disciplines taught in physical education curricula, which significantly influence the planning and methodological structure of strength development programs. Thus, training interventions must align with both the physiological and biomechanical dimensions of strength, tailored to the practiced sports (19-21).

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This paper introduces a multi-component model that assesses and enhances dynamic strength in students through practical, evidence-based interventions. Our model was developed with consideration for educational constraints, age-appropriate adaptations, and integration into school sports programs.

METHODOLOGY

1. The present study *aims* at optimising the strength potential of students by establishing the current state of this element and developing a model to assess and improve the dynamic strength and the impacts applied in the educational process.

2. *Participants*: The proposed model comprises three core components: evaluation module, training intervention, and monitoring & feedback. The participants included thirty public university students (25 males, 25 females; aged 18–25) who gave their informed consent to take part in the study. The local educational board granted its ethical approval. The criteria for inclusion were absence of chronic health conditions and willingness to participate in bi-weekly sports sessions.

3. *Intervention*: The experimental group received 60-minutes athletic sessions twice a week for 18 weeks, involving strength component and the impacts applied in the training process. The control group did not receive any structured sports intervention and simply joined the regular physical education sessions.

4. *Method applied*: We decided to apply the MARTIN method, that focuses on the optimal regulation of training load through a combination of heart rate monitoring, interval-based training, and aerobic/anaerobic control. We used it to build aerobic endurance and improve cardiovascular efficiency in a controlled, progressive way.

5. *Key principles of the MARTIN method*: This is an interval-based endurance training that we structured into intervals (periods of activity and rest) to systematically build endurance, and monitor physiological response and performance within specific heart rate zones, commonly: zone 1: recovery; zone 2: aerobic base; zone 3: tempo/threshold; zone 4: anaerobic; zone 5: maximum effort.

6. *Adaptation and progression*: Training loads were progressively increased to adapt the body's cardiovascular and muscular systems without overtraining.

RESULTS

Dynamic strength is a critical component of athletic performance, particularly in youth development and physical education. This study proposes a novel model for evaluating and optimizing dynamic strength in students during sports activities. By integrating biomechanical analysis, physiological measurements, and tailored training protocols, the model offers a comprehensive approach to improve dynamic strength systematically. **Table 1** shows the comparative performance metrics pre- and post-intervention.

Table 1. Results from the comparative performance metrics pre- and post-interventions

Test	Pre-Intervention	Post-Intervention	Improvement
Vertical Jump (cm)	32.10	35.70	11.21
Medicine Ball Throw (m)	4.50	4.90	8.89
Movement Efficiency (1-10)	5.80	7.10	22.41
Motivation Score (1-10)	6.00	7.30	21.67

We conducted a study to establish the baseline level of strength potential through specialised tests that provide objective information on the level of dynamic strength. We illustrated the

comparative analysis of the dynamic strength metrics during pre- and post-intervention in **Figure 1**.

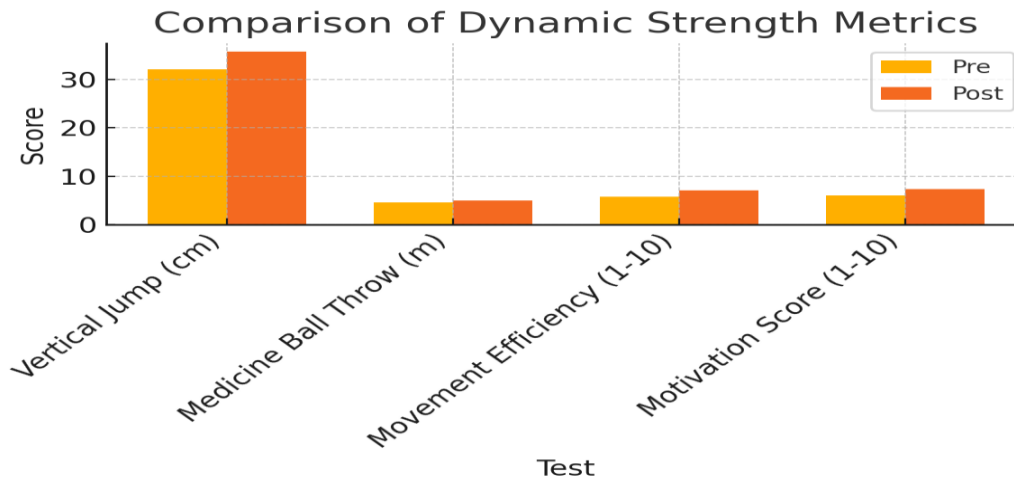


Figure 1. Comparative analysis of dynamic strength metrics pre- and post-intervention.

These included: standing long jump with both legs, vertical jump, standing triple jump, timed platform jumps, and timed jumps over 8 solid balls with both legs. Our expectations were focused on determining the performance levels of individuals in this category and whether these

levels could serve as a foundation for developing a model to assess and optimise this component (dynamic strength) of students' motor potential. **Table 2** presents values from the variation analysis of the obtained results, which give us an understanding of the variability of the indicators.

Table 2. Variation table of the research results

Test	Unit	N	Xmin	Xmax	Mean	Range	Sd
Standing Long Jump	cm	30	202	258	235.6	56	14.6
Vertical Jump	cm	30	28	48	38	20	4.5
Standing Triple Jump	cm	30	545	740	659.3	195	53.02
Platform Jumps (in time)	no.	30	9	19	15.8	10	2.08
Jumps Over 8 Solid Balls	sec	30	3.56	5.56	4.63	2.05	0.53

The paper outlines the model's structure, implementation strategies, and validation through a pilot study involving university students. Results demonstrate measurable improvements in strength and performance,

suggesting the model's effectiveness and applicability in educational settings. **Table 3** presents values from the assessment levels that allow us to classify the indicators and strength capabilities of students.

Table 3. Model for assessing the current level of dynamic strength

Test	Very High	High	Average	Low	Very Low
Standing Long Jump (cm)	> 249	240–248	233–239	224–232	< 223
Vertical Jump (cm)	> 42	41–38	38–40	35–37	< 34
Standing Triple Jump (cm)	> 706	674–705	647–673	615–646	< 614
Platform Jumps (number)	> 19	18	16–17	15	< 14
8-Ball Jumps (seconds)	< 4.18	4.19–4.5	4.51–4.78	4.78–5.1	> 5.11

Table 4 shows structured presentation of heart rate (HR) data based on the applied MARTIN method for training endurance. We have

included HR values, typical zones and structure in endurance training contexts.

Table 4. Heart rate (HR) response during endurance training using the MARTIN method

Phase	Training Load Characteristics	HR Zone (bpm)	% of HRmax	Duration	Training Effect
Warm-up	Low intensity, dynamic movement	100–120	50–60%	10–15 min	Increase blood flow, prepare muscles
Basic Endurance Block 1	Steady-state aerobic running	130–150	65–75%	10–20 min	Aerobic base development
Interval Block 1	Repeated tempo bouts (e.g., 4x3 min)	150–165	75–85%	12–16 min total	Improve VO ₂ max, cardiovascular efficiency
Recovery Phase 1	Active rest (light jogging or walking)	110–125	55–65%	3–5 min	Lactate clearance
Basic Endurance Block 2	Slightly increased tempo, steady effort	140–160	70–80%	10–15 min	Improve aerobic threshold
Interval Block 2	Sprint intervals (e.g., 6x1 min)	160–175	80–90%	6–8 min total	Anaerobic capacity boost
Recovery Phase 2	Walking or very light jog	100–115	50–60%	5 min	Return HR to baseline
Cool-down	Static walking/stretching	<100	<50%	5–10 min	HR normalization, flexibility

Our method emphasises systematic HR-based training using intervals, tempo runs, and recovery periods. It targets different HR zones to optimise aerobic and anaerobic development. It also alternates intensity phases to stimulate adaptation and recovery. **Figure 2** presents a theoretical-practical model for determining the current level of dynamic strength, developed using the Martin method. This model is intended to fulfil the following functions: 1. Determine the current condition; 2. Evaluate the

effectiveness of applied interventions; 3. Manage and plan strength potential on a semester basis; 4. Optimise training load based on the current level for each test. The practical application of the model is carried out as follows: during rapid testing using the full test set or a selected test, the obtained result or the closest value is located in the assessment table. In **Figure 2** we present the graphical visualization of heart rate over a training session using the MARTIN method:

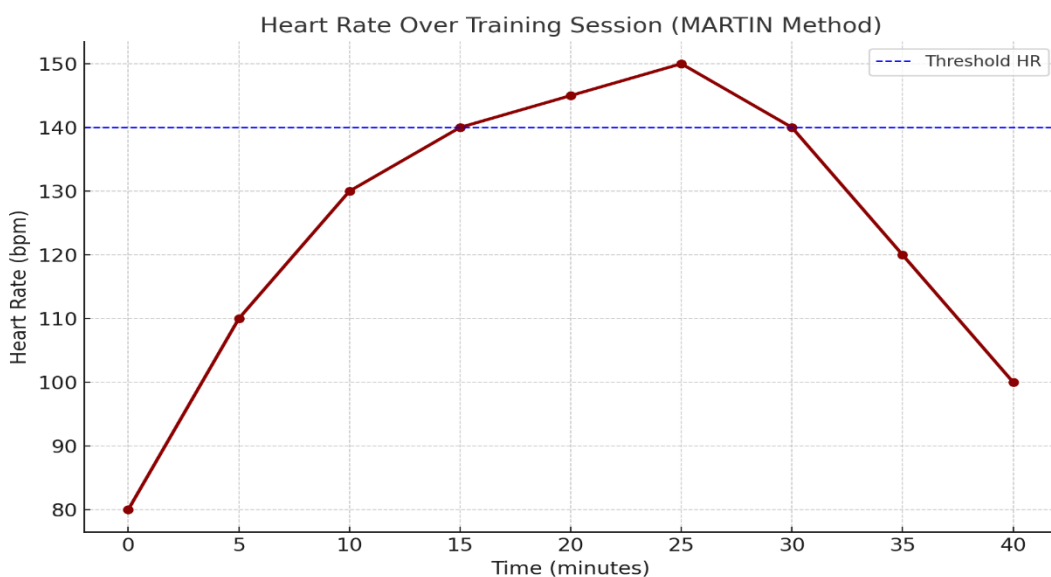


Figure 2. Heart rate curve graph after applying MARTIN method

A result trending upward or downward provides grounds to determine the effect of the applied interventions. A rapid improvement in the test result suggests that the student possesses an adaptive potential that could ensure good development of dynamic strength. The findings

and theoretical perspectives presented in this study reinforce the crucial role of dynamic strength as a fundamental component of athletic performance, particularly in student sports activities (**Figure 3**).

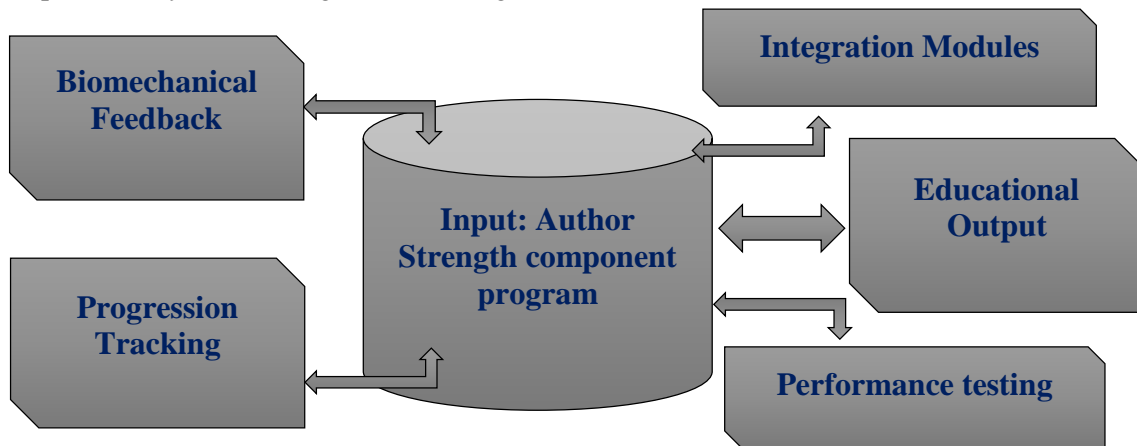


Figure 3. The theoretical and practical model for assessing dynamic strength, developed in accordance with the Martin method.

Unlike absolute strength, which is often measured in static conditions, dynamic strength reflects the capacity to produce rapid and forceful muscle contractions under varying resistance—an essential quality in sports, such as sprinting, jumping, and ball throwing (Suchomel et al., 2018; Chaabene et al., 2021). The results demonstrate and suggest long-term benefits for student health literacy and physiometrical autonomy. We postulate that following the rapid acceleration of motor development during puberty, the continued enhancement of students' motor capacity—particularly in females—requires a longer and more sustained period of targeted motor activity to produce measurable benefits in physiometrical indicators. Among these indicators, static strength of the upper limbs for example, serves as a key parameter reflecting neuromuscular adaptation and development. The study data demonstrate that static strength in the upper limbs increases steadily across the research period for both sexes. In male students, the right-hand grip strength shows a progression from an average of 16.6 kg at first stage to 22.7 kg at fourth stage. In comparison, female students, exhibit an increase from 14.2 kg to 19.7 kg across the same training stages. Notably, the difference in right-hand strength between male and female students remains relatively stable throughout the observed

period. However, when assessing left-hand strength, a consistent upward trend was observed in both groups. However, the disparity between sexes became more pronounced over time. This divergence likely reflects a developmental increase in physiometrical indicators indicating an asymmetry of the upper limbs with age, especially as right-hand dominance becomes more functionally reinforced. The same trend is observed among female students, though to a lesser degree. Analysing the comparative data between male and female participants reveals a clear pattern: as age increases, so does the absolute difference in upper limb strength, particularly for the right hand. The divergence becomes especially significant by the 3rd grade, where boys surpass girls by 3.7 kg in right-hand grip strength and 2.8 kg in left-hand grip strength. Furthermore, the analysis of the coefficient of variation (V) shows an increasing trend in both sexes, indicating growing interindividual variability with age. This variability is more pronounced among boys, particularly in right-hand strength measurements. Female students exhibit a similar trend, although the magnitude of change is generally lower compared to their male counterparts. The greater increment in the right hand compared to the left underscores the influence of dominant-limb usage and training effects (**Figure 4**).

Improvements in Physical Performance

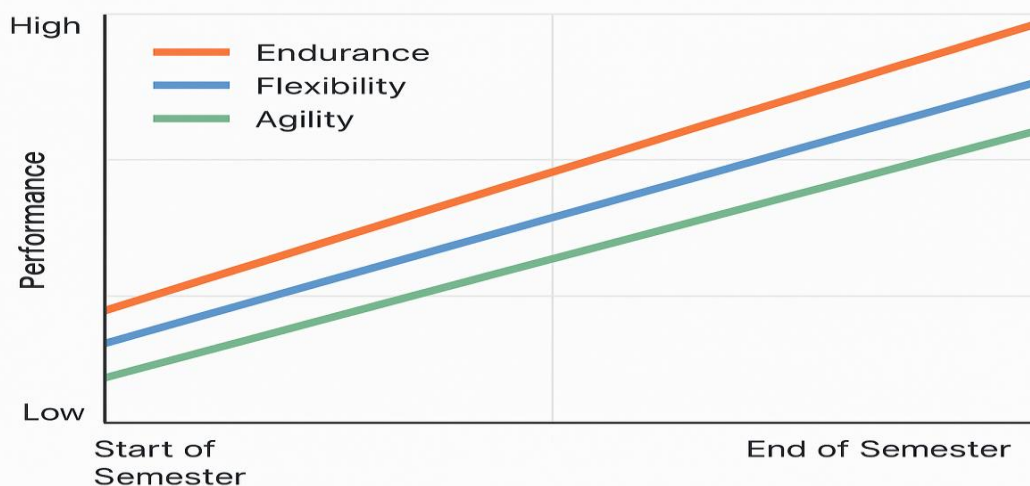


Figure 4. Improvements in Physical Performance

These findings suggest that while both sexes experience gains in static upper limb strength during this developmental window, the rate, magnitude, and asymmetry of these gains differ notably. This underscores the importance of gender-specific and individualised approaches to physical education and strength training programs during the post-pubertal years. Our research emphasises that the strength potential of students should not be viewed as a static attribute, but rather as a trainable physical quality that can be developed through structured and sport-specific interventions. The transformation of general strength into functional acceleration and power, especially under resistance, underscores the need for targeted methodological approaches in educational training programs. The distinction made in this study between maximum dynamic strength and muscular endurance also mirrors recent findings in youth strength training, where combining heavy-load resistance training with endurance-based protocols has shown synergistic effects on both performance and injury prevention (Grgic et al., 2022; Rumpf et al., 2023).

DISCUSSION

Moreover, the proposed model for monitoring and managing dynamic strength offers a systematic approach to integrating biomechanical feedback, performance testing, and progression tracking in school settings. This model not only aligns with evidence-based training principles, but also supports educators in individualising workloads based on students' evolving capabilities. Importantly, the results

suggest that improvements in dynamic strength are accompanied by increased motivation and engagement, confirming earlier work that links physical competence with psychological readiness in adolescent populations (Trowell et al., 2020). The latter highlights the dual benefit of well-designed strength training interventions: enhanced performance and greater participation. Nevertheless, certain limitations must be acknowledged. The relatively short intervention period limits our understanding of long-term adaptations, and the specific age group may not generalise across all student populations. Future research should aim to validate this model over extended durations, with diverse age groups and across different school contexts. In conclusion, the discussion affirms that dynamic strength is not only a measurable and improvable capacity, but also a central pillar in the physical education curriculum. A strategic, evidence-based focus on this parameter can lead to significant functional improvements, helping students reach their athletic potential while fostering lifelong movement competence.

CONCLUSION

This study presents a replicable, student-friendly model for evaluating and optimizing dynamic strength through a series of specialized tests tailored to assess key indicators of explosive power and motor performance. The model is grounded in objective measurements and structured according to scientifically validated criteria, making it highly suitable for consistent application in educational and athletic settings. The results demonstrate that

the model effectively captures the current status of students' dynamic strength and allows for informed planning and adjustment of training loads based on individual performance levels. Its application enables instructors and coaches to monitor progress, evaluate the effectiveness of interventions, and design targeted programs to improve strength potential. This model not only enhances immediate athletic performance but also instils foundational knowledge and habits that support long-term engagement in physical activity and health maintenance. In summary, this research offers a robust framework for evaluating and developing dynamic strength in students, with implications for both improved sports performance and the promotion of lifelong physical fitness. Optimisation is further guided by the current level of development of individual indicators, as determined through the assessment criteria applied within the proposed model.

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