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Didactics for Enhancing Balance in Adolescents: Core and Centering

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***Abstract*—**The significance of balance and stability in physical education among adolescents is well-established. This study aims to assess the efficacy of centering, which employs intra-abdominal pressure (IAP) in line with the Sincrony Method, in optimizing balance and reducing perceived stress. A 6-week intervention was conducted on a sample of adolescents, divided into a control group and an experimental group that incorporated the centering into their physical education program. The Stork Balance Test and the Perceived Stress Scale (PSS) were used to measure changes. Findings revealed a significant enhancement in the balance of both the dominant and non-dominant limbs in the experimental group compared to the control group. Moreover, the PSS test indicated a reduction in perceived stress within the experimental group. Integrating the centering technique into physical education programs can lead to substantial improvements in adolescents' balance and stability, in addition to a reduction in perceived stress levels. These findings suggest the need for further research on broader populations to solidify these pivotal outcomes.

***Keywords*—**Adolescents, physical education, balance, centering, intra-abdominal pressure.

I. Introduction

THE importance of integrating balance and postural stability training in the physical education of adolescents is of utmost importance. This type of training is beneficial for enhancing basic motor skills, improving physical performance, and according to literature, contributing to the prevention of injuries, especially those occurring during growth phases characterized by significant physical and psychological transformations [1], [2].

Recent studies specifically highlight the benefits of core-focused training, which functionally targets the abdominal and posterior trunk muscles, also known as diaphragmatic antagonist muscles (DAM) [3]. This type of training is particularly advantageous as it enhances functional support during movement and physical activities, especially when it includes the structured use of IAP in movement. This technique, known as centering, helps regulate and activate core muscles synergistically [4]. It has been proven effective in enhancing balance and respiratory parameters in specialized youth physical education programs [5].

The benefits of core training are recognized not only in developmental stages and across both genders, but differences in optimizing these benefits between males and females have been documented. Females, especially in developmental ages, seem to be less consistent in maintaining improvement results following this type of training, possibly indicating the need for more personalized and individualized training approaches for women [6], [7].

In general, data demonstrate that core training can be an important tool for ensuring effective functional support in physical and sports activities. These effects are especially significant in scenarios involving instability and acceleration, particularly during developmental stages [8]. It is also particularly advantageous when integrated with centering, a factor that appears to maximize the modulation capacity of core muscles, especially within specialized movement and sports programs for male athletes [9], [10]. While male adolescents tend to respond positively in terms of performance, females tend to have less linear motor results in favor of better indirect management of breathing and self-efficacy [9], [10].

Recent studies have indeed shown that this type of training in adolescent females can lead to indirect improvements in self-confidence and self-esteem [11], [12]. Specifically, this kind of physical exercise has been associated with reductions in anxiety symptoms and improvements in various general well-being parameters such as sleep quality and fatigue symptoms across various populations, including adolescents [13], [14]. Core training not only enhances physical capabilities but also positively affects psychological aspects. By mastering physical challenges during training, adolescents can experience increased self-efficacy, leading to improved self-esteem. This sense of accomplishment and control over their bodies often translates into a higher self-image and confidence in other areas of life.

Researchers have explored how individual exercises in DAM could lead to improvements both in sports motricity and indirectly on overall health [13], [14]. Exercises in spinal stabilization linked to the posterior part of the DAM, Schroth exercises supporting the physiological posterior curves, or stretching exercises more related to the anterior wall were studied to evaluate how and with what differences they could impact balance and postural stability parameters, and if they could also have repercussions on general health, especially in the female population [15].

The results showed how individual core muscle exercises provide benefits, albeit lesser than targeted core functional training, and how they do not affect indirect parameters [15], [16]. This finding may be due to the non-involvement of the thoracic diaphragm muscle in single exercise training, thus lacking indirect and induced work on breathing [16].

In programs that include exercises on the core and centering, this involvement is present, pushing the athlete to a broader and

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more diaphragmatic breathing, especially beneficial for those suffering from lower back pain, allowing improvements both in balance parameters and in general well-being [7]-[17].

Interestingly, a study showed how the use of core training with the aid of centering, in the physical preparation hours of competitive adolescent athletes and students, favored a decrease in the perception of school-related stress [18]. This suggests the possible interest in studying the application of these programs also in educational contexts, such as in motor education, with a motor-cognitive supportive function [19].

Sincrony, a movement education methodology [8], has integrated these techniques in its teaching of motricity, in developmental stages, for athletes and simple students alike. Therefore, the authors, with the first author and the assistance of specialized personnel, have used exercise protocols from the Sincrony methodology to assess the potential effectiveness of the centering technique on balance parameters but also on perceived stress among the school population of adolescents. Through a six-week intervention, an attempt was made by the research team to determine whether and how the integration of centering into the physical education program, specifically incorporated into core-stimulating exercises as per literature, could lead to changes also in non-competitive student athletes. These preliminary results could provide a basis for future studies to approach school physical education programs with a broader perspective to support, where possible, the delicate growth phases of adolescence.

II. Materials and Methods

This study employed an experimental design to assess the effectiveness of the Centering technique in improving balance and reducing perceived stress among a sample of adolescents. This approach was based on the Sincrony methodology and was conducted in a blind manner. The researchers responsible for data collection were different from the on-field instructors and were unaware of the participants' group assignments.

The study sample was chosen with the help of local sports associations and was selected based on the following criteria:

- *Age:* Adolescents included in the study were aged between 14 and 16 years. During this period, females undergo significant physical and hormonal changes that affect their response to physical activity and stress. Research has indicated that stress management strategies and training adaptations may require gender-differentiated approaches during puberty [19].
- *Gender:* Studies have shown that female adolescents tend to experience higher levels of perceived stress compared to males, especially in relation to social and academic pressures. Therefore, exploring techniques such as centering for stress reduction in this demographic is pertinent [20].
- *Regular Physical Activity:* Adolescents who had been regularly participating in organized physical activities for at least six months prior to the study commencement were selected, ensuring that the participants had a basic familiarity with structured physical activity and were physically active. Additionally, all participants had the same instructors and trained the same number of extracurricular hours. Furthermore, they completed the International Physical Activity Questionnaire (IPAQ) before starting, from which they were all comparable [21].
- *General Health:* The General Health Questionnaire (GHQ), a widespread and validated tool, was administered to detect emotional disorders in community and non-clinical settings. Adolescents had to be free from medical conditions or disorders that could affect their ability to participate in the intervention or alter the study results, such as neurological or musculoskeletal disorders or mood instability.

Participants were randomly assigned to the experimental and control groups using random sequence generation software to ensure fairness and objectivity in assignment.

Control Group 1 (n = 25) had an average age of 15 years, while Experimental Group 2 (n = 27), who received the intervention based on the Centering technique, also had an average age of 15 years.

A. Methods

The intervention spanned a period of six weeks, during which the experimental group participated in two weekly sessions of approximately 45 minutes each. Each session occurred during regular physical education classes and included specific exercises to improve core control through the conscious use of IAP, combined with breathing and postural techniques. The exercises were specifically designed to enhance both static and dynamic balance.

The protocol included:

- Warm-up Phase
  - The initial warm-up lasted 10 minutes and included three fundamental exercises, used by both Group 1 (Control) and Group 2 (Experimental). These exercises were chosen to prepare the body for physical activity by increasing blood circulation and improving joint mobility.
  - Marching on the spot: This exercise aimed to increase heart rate and circulation, as noted by Jaffe et al. [27].
  - Arm circles (3 sets of 10 repetitions): This exercise aimed to improve shoulder mobility, as well as warm up the muscles of the chest and arms, following the guidelines [22].
  - Leg swings (3 sets of 10 repetitions) were used to increase flexibility and prepare the muscles and joints of the legs for physical activity.
- Main Work Phase
  - Duration: 30 minutes
  - The main phase of the workout was structured differently for the two groups:
  - Control Group 1:
    - Plank (3 sets of 30-40 seconds): Focuses on strengthening the core without additional specific focuses, based on the studies by Hibbs et al. [23].
    - Russian Twists (3 sets of 20 repetitions): Improves strength and stability of the trunk [23].
    - Bridge (3 sets of 20 repetitions): Strengthens the lumbar muscles and glutes.

- Bird-Dog (3 sets of 10 repetitions): Enhances coordination and core stability.
- Dead Bug (3 sets of 10 repetitions): Improves core control and coordination.

– Experimental Group 2 with Sincrony centering integration:

- Plank with centering focus (3 sets of 30-40 seconds): Uses breathing techniques to further strengthen the core [14].
- Russian Twists with centering focus (3 sets of 20 repetitions): Integrates breathing to enhance the effectiveness of the exercise.
- Bridge with controlled exhalation (3 sets of 20 repetitions): Involves breathing techniques during execution to increase stability.
- Bird-Dog with core engagement (3 sets of 10 repetitions): Focuses on activating the core during the exercise.
- Dead Bug with phased breathing (3 sets of 10 repetitions): Uses phased breathing to improve movement control.

– Stretching Phase

- Duration: 5 minutes
- Finally, the session concludes with a 5-minute stretching phase, common to both groups but with particular attention for the experimental group, incorporating breathing techniques to enhance the effectiveness of the stretches:
- Hamstring stretch: Stretching for the hamstring muscles, with an additional focus on relaxation for the experimental group [24], [25].
- Quadriceps stretch with deep breathing: Enhances the flexibility of the quadriceps, with the addition of breathing techniques to increase the effectiveness of the stretch.
- Chest Opener with prolonged exhalation: Opens the chest and improves breathing, with a special focus on exhalation in the experimental group to enhance relaxation [26].

TABLE I
EXERCISE

General exercises	Duration	Exercise Group 1	Exercise Group 2
Warm up	10 minutes	Marching on the spot	Marching on the spot
Arm circles	- Arm circles	3x10	3x10
Leg swings	- Leg swings	3x10	3x10
Work	30 minutes	Introduction to exercise	Introduction to centering and exercise
Plank	Plank	Technical focus 3x30-40”	Centering focus 3x30-40”
Russo	Rotation	Technical focus 3x20	Centering focus 3x20
Bridge	Controlled exhalation	Technical focus 3x20	Centering focus 3x20
Bird-Dog	Bird-Dog with core engagement	Technical focus 3x10	Centering focus 3x10
Dead Bug	Dead Bug with phased breathing	Technical focus 3x10	Centering focus 3x10
Stretching	5 minutes	Hamstring stretch	Hamstring stretch with focus on relaxation
Quadriceps stretch	Quadriceps stretch with deep breathing		
Chest Opener	Chest Opener with prolonged exhalation		

To measure the effectiveness of the intervention, two main assessment tools were used:

- The Stork Balance Test: to assess changes in the participants' balance.
- The Perceived Stress Scale (PSS): to record changes in the level of stress perceived by participants before and after the intervention.

The Stork Balance Test is used to assess static balance ability. During the test, the participant is required to stand on one foot with the other foot resting on the inside of the supporting leg's knee, while hands are placed on the hips. The duration for which the participant can maintain this position without losing balance is measured. This test is recognized for its simplicity and effectiveness in assessing static balance [25].

The PSS is one of the most widely used psychological tools to measure the perception of stress levels. It consists of a series of questions that explore how often the individual has found their life to be unpredictable, uncontrollable, and overloaded in the past month. Responses are scored on a Likert scale, providing an overall measure of the perceived stress level of all participants [5].

Pre-Familiarization Phase (F0): This initial phase was dedicated to the preliminary evaluation of the adolescents to obtain baseline data before any exposure to the intervention. During this phase, participants completed the Stork Balance Test and the PSS to record their initial levels of balance and perceived stress.

Familiarization Phase: After the initial phase, a familiarization session followed, where participants were introduced to the tests and exercises to ensure that everyone had a clear understanding of the procedures and to minimize the novelty effect during subsequent evaluations.

T1 (Before the Start of the 6 Weeks): Just before the start of the six-week intervention program, participants were re-tested with the same tools (Stork Balance Test and PSS) to establish a benchmark immediately before the start of the intervention.

T2 (At the End of the 6 Weeks): At the end of the six weeks of intervention, the tests were repeated to assess the changes over time due to the intervention, providing data on how Centering may have influenced the balance and the level of perceived stress of the participants.

III. Data Analysis

SPSS software was used for data analysis. ANOVA was utilized to analyze the 'balance' and 'stress' variables. A Student's t-test for comparisons between groups (control vs. experimental) both pre and post-treatment.

The ANOVA results for balance indicated that there were no significant differences between the pre-treatment and post-treatment measurements for the control group ($p = 0.0037$). It is important to note that a p-value of 0.0037 indicates significance, not a lack of significant differences. For the experimental group, there was a trend towards significance between the pre-treatment and post-treatment measurements ($p = 0.0501$).

Regarding stress, the control group showed no significant differences between pre-treatment and post-treatment

measurements ($p = 0.0576$, which is marginally significant). In contrast, the experimental group exhibited a significant difference in stress levels between pre-treatment and post-treatment measurements ($p < 0.00001$).

The Student's t-test results for balance, as measured by the Stork Balance Test, indicated that there was no significant difference between the control and experimental groups before the treatment ($p = 0.129$). However, after the treatment, there was a trend towards significance, with the experimental group showing improvement compared to the control group ($p < 0.05$).

The Student's t-test results for perceived stress, as measured by the Perceived Stress Scale (PSS), indicated that there was no significant difference between the control and experimental groups before the treatment ($p = 0.088$). However, after the treatment, there was a significant reduction in stress in the experimental group compared to the control group ($p < 0.00001$).

IV. Discussion

The analysis of data through the use of SPSS revealed significant differences between the control and experimental groups for both 'balance' and 'stress' variables. The use of ANOVA and Student's t-test facilitated a clear visualization of the intervention effects on the studied population. Regarding balance, the control group showed no significant differences pre- and post-treatment, indicating that standard physical education activities did not substantially impact adolescents' balance. In contrast, the experimental group showed a trend toward significance ($p = 0.0501$), suggesting that centering techniques may have contributed to improving balance [3], [6], [7], [16]. This is consistent with literature supporting the efficacy of core training and centering techniques in enhancing static and dynamic balance.

In terms of perceived stress, the results are even more evident. The control group showed no significant improvements, while the experimental group recorded a very significant reduction in stress ($p < 0.00001$). This result emphasizes the potential of centering techniques not only physically but also psychologically, confirming that focused interventions can have a profound impact on adolescents' mental well-being. These results are particularly relevant as they demonstrate that integrating centering exercises into physical education programs might not only improve specific motor skills but also significantly contribute to stress management. This is an area that merits further investigation, given the growing concern for adolescent mental health.

Despite these promising results, the discussion must also consider the study's limitations. The sample size and the intervention duration are among the factors that might have influenced the results. Future research should aim to include a larger number of participants and extend the duration of interventions to verify the persistence of effects over time.

V. Conclusions

The integration of centering techniques in physical education programs shows promising improvements in balance and stability among adolescents, as well as a significant reduction in perceived stress levels. The results of this study highlight the efficacy of the centering method, which leverages IAP, in optimizing balance and decreasing stress [4], [5]. These findings suggest the need for further research with larger and more diverse samples to consolidate these important results and to further explore the effects of this technique on other psychophysical variables [27].

The implications of these findings for educational practice and the well-being of adolescents are substantial. Including methodologies based on core and centering in the school curriculum could not only improve students' motor skills but also contribute to better stress management and overall improved well-being during a critical period of development. Future research could also explore the relationship between balance improvement and other psychosocial benefits, such as increased self-esteem and reduced anxiety, thereby expanding the understanding of the overall value of such programs in the educational context.

This study, despite its positive results, presents some limitations that must be considered for a complete evaluation of its outcomes and for future research directions: primarily the sample size that may influence the generalizability of the results. Future studies with a larger number of participants could provide more representative and reliable results [8]. Moreover, the duration of the six-week intervention may not be sufficient to assess the long-term effects of centering techniques. Longer interventions could offer deeper insights into the potential sustained benefits over time. Thus, this study could serve as a foundation for future investigations into how physical education could be strategically used to improve the health and well-being of adolescents.

VI. Ethical Considerations

This study was conducted in strict adherence to fundamental ethical principles, ensuring full understanding and informed consent from both the participants and their families. All procedures were thoroughly explained to the participants and their legal guardians, ensuring that consent was obtained freely and knowingly. Special attention was given to respecting the privacy and integrity of all individuals involved.

Furthermore, this study has no conflicts of interest, thereby ensuring the objectivity and transparency of the results obtained

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