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Effect of Combined Feedback and Verbal Encouragement on Anaerobic Performance, Technical and Physiological Aspects During Small-Sided Basketball Games for Students' Girls

Rim Mekni[1], Mohamed Ali Hammami[1, 2], Faten Sahli[3], Okba Selmi[1], Gabriel Stanica[4], Adelina Elena Panaet[5], Cristina Ioana Alexe[5], Omar Trabelsi[1*], Lamia Ben Ezzeddine[3]

[1] High Institute of Sports and Physical Education of Kef, University of Jendouba, El Kef 7100, Tunisia
[2] Research Unit, Sportive Performance and Physical Rehabilitation, High Institute of Sports and Physical Education of Kef, University of Jendouba, EI Kef 7100, Tunisia
[3] L'Institut Supérieur du Sport et de l'Éducation Physique de Ksar Said, Université de la Manouba, Manouba, Tunisia
[4] Faculty of Movement, Sports and Health, Sciences, "Vasile Alecsandri" University of Bacau, 600001 Bacau, Romania
[5] Vasile Alecsandri" University of Bacau, 600115, Romania

*** Corresponding author email address**: omar.trabelsi@issepk.rnu.tn

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A B S T R A C T

Objective: The aim of this research is to determine the effect of combined feedback and verbal encouragement on anaerobic performance, technical and physiological aspects during small-sided Basketball games for adolescent schoolgirls.

Material and Methods: Sixty schoolgirls were divided into 3 groups of 20 girls: control group (G1) (mean ± standard deviation (M±SD); age:15.45 ± 0.41years), verbal encouragement group (G2) (M±SD; age:15.65 ± 0.61years) and combined feedback and verbal encouragement group (G3) (M±SD; age:15.55 ± 0.51 years). Muscle power (countermovement jump (CMJ); 5-Jump-Test (5JT)), agility (Illinois-test), sprint speed (10 and 30 m)]; technical skill and heart rate (HR) responses during 3 vs. 3 small sided basketball game (SSBG) were measured. Additionally, HR was continuously recorded and video analysis was used to quantify technical actions during SSBG.

Results: The results showed greater improvements in muscle power of CMJ and 5JT for G3 compared to G2 (P<0.001, ES=1.21, moderate, p<0.001, ES= 4.74, large, respectively) and for G3 compared to G1 (P<0.001, ES= 1.72 large; p=0.001, ES =6.86 large respectively). The time in the 10 m, 30 m sprints and agility decreased more profoundly for G3 compared to G2 (p<0.001, ES=4.93, large; p<0.001, ES=3.27, large, p<0.001, ES=1.14, large, respectively).For technical skill, the ball contacts, successful balls, number of shots and successful shots were higher in G2compared with G1 (p<0.001, ES=1.48 moderate; p<0.001, ES=3.83, large; p<0.001, ES=1.99, large; p=0.001, ES=2.41, large respectively), higher in G3 compared with G2 (p<0.001,ES=-0.89, large, p=0.001, ES=-1.48 moderate; p=0.001, ES= 3.97, large; p<0.001, ES=4.93, large, respectively). Furthermore, average heart rate was higher in G3 compared

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with G2 and G1 ($p<0.001$, ES = 1.06, large; $p<0.001$, ES=4.64, large, respectively).

Conclusion: These findings indicate that the combination of feedback and verbal encouragement are more effective for achieving better results in physical fitness and technical skill than verbal encouragement group and control group.

Keywords: *Motivation, Performance, Physical education, Intervention, Students.*

1. Introduction

hysical education (PE) instructors, sports coaches, and athletes continuously explore strategies to augment skill acquisition and overall performance. Specialists in motor learning are similarly engaged, delving into the nuances that affect both performance enhancement and the learning process. PE classes within schools serve as a cornerstone for holistic child development, offering avenues for physical, psychological, and social enrichment (1). The supportive milieu of a school and enriching PE experiences contribute significantly to fostering healthy lifestyle choices and structured physical engagement (2). Contemporary pedagogical approaches stress the adoption of innovative teaching techniques aimed at bolstering communication skills, speech, and personal development. It's imperative to identify and understand the factors that influence engagement in physical activities to devise impactful intervention strategies (3).

The dynamics of interaction between educators and students can significantly shape the outcomes and experiences of sports activities (4-6). An educator's approach is characterized by their application of methodological, communicative, and integrative tactics (7, 8). Motivation plays a pivotal role during PE sessions, as it directly influences students' efforts and, consequently, their performance outcomes. Verbal encouragement has been recognized as a vital motivator, with its significance in sports pedagogy being extensively studied (9, 10). Feedback represents another motivational tool in PE, where positive reinforcement can spark intrinsic motivation, encouraging students to sustain or escalate their efforts during exercises or assessments. Exercise testing protocols frequently recommend positive reinforcement as a strategy to boost performance (11). Through feedback, educators can both motivate and inform students about their performance, utilizing verbal, visual, or written mediums (12, 13). For feedback to exert its full effect, it must be received positively by students (14), as those with favorable feedback perceptions often exhibit heightened self-efficacy and confidence in accomplishing tasks (15, 16).

Research by Badami et al. (17) distinguishes between intrinsic feedback and augmented feedback, noting that employing both types synergistically can elevate performance in both educational and athletic contexts (18). Miller et al. (19) further evidenced that a mix of stimuli could enhance strength parameters more effectively than mere verbal encouragement. Yet, the literature is scant regarding the combined effects of verbal encouragement and feedback on physiological and technical aspects during PE sessions tailored for young females (19, 20). Thus, investigating how synergistic verbal encouragement and feedback impact student performance at both a physical and technical level can significantly enrich the teaching-learning continuum. Particularly for young females engaged in basketball within a school setting, such encouragement and feedback can be viewed as enhanced practice conditions. This study endeavors to scrutinize the impact of this combined approach on physical fitness assessments, technical proficiency, and physiological responses within the context of small-sided basketball games among adolescent girls. Our hypothesis posits that the integration of verbal encouragement and feedback from educators will yield superior outcomes in physical fitness evaluations, technical skills, and physiological responses during these games, compared to the effects of each strategy used in isolation.

2. Materials and Methods

2.1 Participants

Sixty adolescent school girls, aged 15.50 ± 0.51 years, were divided into three groups: control (G1), verbal encouragement (G2), and combined feedback and verbal encouragement (G3), each with 20 girls. Random selection and assignment were conducted based on a single sequence to designate subjects into the groups. No significant age or anthropometric differences were found among groups. Participants regularly engaged in physical education classes, including two weekly sessions of team sports (e.g., handball, football, basketball, and volleyball) and individual sports (e.g., athletics and gymnastics). Before the study, written informed consent was obtained from each participant and their parents or guardians, and the study was approved by the Institutional Ethics Committee of the Higher Institute of Sport and Physical Education of Kef, Tunisia. In this study, conducted according to the Declaration of Helsinki, girls

provided written consent, were familiarized with the experimental protocol, and the main purpose of each test. Proper execution was explained, and trial attempts were performed. The physical education teacher, who had been with the students for 7 months, programmed and conducted the study, behaving normally as usual.

2.2 Experimental Procedures

The research was conducted at the end of the 2022 school season. Tests were conducted by groups (G1, G2, and G3) on different days of the same week at the same time (between 8:00 and 10:00) and place. Before the experimental testing, anthropometric measurements were taken. All participants underwent a standardized 15-minute warm-up across the three testing sessions. In the first session, participants performed a countermovement jump (CMJ), 10m, and 30m sprints. During the second session, they did a 5-jump test (5JT) and the Illinois Agility Test. In the third session, in addition to the standardized warm-up, the girls performed simple basketball technical tasks and a 3 vs 3 small-sided game (SSG) on a half basketball court. In each testing protocol, G3 performed all tests with the PE teacher's verbal encouragement and feedback during recovery time.The G2 group underwent all tests with the PE teacher's verbal encouragement (VE) but without feedback. The G1 group underwent all tests without VE or feedback. The PE teacher provided verbal encouragement using specific instructions (e.g., "Go Go Go," "Well done," "Again Again," "Great," "Courage," "Go ahead," "Try again," "Come on," "You will get there," "Trust yourself," and "You can") (1, 21). Feedback mainly focused on proper execution of gestures in tests, whether physical or technical-tactical in basketball. For combined VE and verbal feedback, the teacher emphasized VE during each set to motivate students, interspersed with technical-tactical instructions during recovery periods. In the technical instruction condition, only instructions were given during recovery. The control condition involved students performing the exercise without any instruction or encouragement.

2.3 Anthropometry Characteristics

Body height and weight were measured to the nearest 0.1 cm and 0.1 kg, respectively. Skinfold thickness was measured at four sites on the left side of the body (triceps, biceps, subscapular, and suprailiac) using a Harpenden skinfold caliper for calculation of the percentage of body fat according to equations by During and Webster (22). All measurements were taken by the same investigator.

2.4 Physical Fitness Characteristics

2.4.1 Vertical Jumping

Each participant performed counter-movement-jump (CMJ), starting from a standing position allowing for counter movement with the intention of reaching knee bending angles of around 90° just before propulsion. The ground reaction forces generated during these vertical jumps were estimated with an ergo jump (Opto Jump Microgate, Italy). In addition, the participants performed a five jump-test (5JT). Each player per-formed 3 CMJ and 5JT interspersed with 2-min rest in between, and the jump performance average was used for analysis (23).

2.4.2 Running Speed Test

The time taken to cover 10 and 30 meters was measured using an infrared photoelectric cell (Cell Kit Speed, Brower, USA). Participants ran as fast as possible, completing three trials in total, with a 3-minute recovery period between each trial. The average sprint performance (10 and 30 meters) was used for analysis. All tests were conducted by the same investigators, at the same time of day, in the same order, and using the same equipment.

2.4.3 Illinois Agility Test (IAT)

The Illinois agility test evaluates acceleration, deceleration, directional changes, and running angles (24). It was chosen due to its established criteria for both males and females, as well as its reported validity and reproducibility (25, 26). Dynamic balance and agility are crucial for success in basketball, contributing significantly to high sports performance (27, 28).Before testing, each participant did four submaximal-intensity warm-up attempts. They then completed three agility attempts, with 3 minutes of rest between each. The average performance in the Illinois agility test was used for analysis. Time in each attempt was measured using photocells (Cell Kit Speed, Brower, USA). Participants began in the supine position, with their feet 1 meter behind the first beam. They then completed the course as quickly as possible. Relative and absolute reliability were established with ICC and CV values of 0.94 and 2.7%, respectively.

2.4.4 Small-Sided Games

The testing game involved 3-a-side SSBG on a 15×14 m pitch (half basketball court ~35 m2 per player). The game lasted 18 minutes, divided into 4 bouts of 3 minutes each with 2 minutes of passive recovery between bouts. The PE teacher continuously adjusted the court perimeter and provided impromptu encouragement using specific terminology such as “Again, Again”, “Attack the ball”, “Go, Go, Go”, “Intercept the ball”, “Keep the ball”, “Move”, and “Seek the ball”. The girls were instructed to play with maximum effort, maintain possession of the ball, and shoot only after holding the ball for as long as possible. During the control group (CG) game, the PE teacher did not provide verbal encouragement during the game or feedback during recovery, but only provided new balls when necessary.

2.4.5 Physiological and Technical Evaluations

HR was continuously monitored during the SSBG using a Polar Team Sport System. The average HR for each SSG was calculated and further averaged to obtain the overall average HR (HR average). All players were filmed throughout the entire 18-minute match using a Sony HDR-CX240E video camera attached to a tripod positioned in front and to the right side of the participant along a 45-degree angle. The tripod height was set to 1.5 meters from the bottom of the camera to capture student movement in the playground. Players were unaware they were being recorded. The number of technical actions performed by each player was recorded and cumulated for the entire 20-minute game period, including the total number of balls played, successful balls, total shoots, and successful shoots. To assess the reliability of the analysis, SSG videos were examined twice by the same expert researcher to establish the intra-observer agreement using the kappa coefficient, which ranged from 0.86 to 0.95, indicating a high level of reproducibility.

2.5 Statistical Analyses

The data were presented as means and standard deviations (SD) for each variable. Normality of all variables was tested using Jarque-Bera tests. Group comparisons (G1, G2, and G3) were analyzed using one-way ANOVA. Post-hoc Bonferroni tests were conducted to determine differences between groups when the ANOVA test was significant (29). Effect size (ES) was calculated to provide information about the size and direction of the effect, using Cohen's d (30). ES values were interpreted as trivial (0 to 0.20), small (>0.20 to 0.50), medium (>0.50 to 0.80), and large (>0.80) (29). Descriptive statistics for physical performances and technical skills between groups were analyzed using SPSS for Windows (version 23.0), with a significance level set at $p < 0.001$.

3. Results

Table 1 presents the three groups of the study in terms of anthropometric variables. No significant intergroup difference in age, height, weight, and % body fat was found.

Table 1. Anthropometric characteristics of control group (G1); verbal encouragement group (G2), and combined feedback and verbal encouragement group (G3).

	G1 (n=20)	G2 (n=20)	G3 (n=20)
Ages(years)	15.45 ± 0.41	15.65 ± 0.61	15.55 ± 0.51
Height(cm)	166.43 ± 7.17	165.79 ± 6.9	166.4 ± 6.5
Weight(kg)	68.15 ± 7.2	66.35 ± 6.99	66.45 ± 7.35
BF (%)	23.83 ± 2.14	23.82 ± 2.11	24.6 ± 1.48

Data are presented as average± standard deviations. BF: Body Fat; G1: Control group; G2: Verbal Encouragement Group and G3: Combined Feedback and verbal encouragement group

Regarding ball interactions and successful passes, Group 3 exhibited a markedly superior performance compared to both Group 1 and Group 2 ($p < 0.001$; effect size (ES) = 2.31, indicating a large difference; ES = -1.48; and ES = 0.89, also signifying a large difference, respectively). In the context of shot attempts and accurate shots, a pronounced difference was discerned between Group 1 and Group 2 ($p < 0.001$, ES = 1.99, large difference; $p < 0.001$, ES = 2.41, large difference, respectively), between Group 2 and Group 3 ($p < 0.001$, ES = 3.97, large difference; $p < 0.001$, ES = 4.93, large difference, respectively), and between Group 1 and Group 3 ($p < 0.001$, ES = 6.02, large difference; $p < 0.001$, ES = 6.64, large difference, respectively), as delineated in Table 2.

Table 2. Sprinting and agility for control group (G1), verbal encouragement group (G2) and combined feedback and verbal encouragement group (G3).

	G1 (n=20)	G2 (n=20)	G3 (n=20)
S10m (s)	2.89 ± 0.19	2.82 ± 0.18¥¥¥	2.13 ± 0.09§§§
S30m (s)	6.32 ± 0.28	6.22 ± 0.23¥¥¥	5.29 ± 0.33§§§
IT (s)	22.34 ± 0.91***	21.33 ± 0.97¥¥¥	20.25 ± 0.93§§§

Data are presented as average ± standard deviations. G1: Control Group; G2: Verbal Encouragement Group; G3: Combined Feedback and verbal encouragement group; S10: speed 10 m; S30: speed 30m; IT: Illinois test; s: second; ES: effect size; ***Significant difference (P <0.001) between Groupe 1 and Groupe 2; ¥¥¥Significant difference (P <0.001) between Groupe 2 and Groupe 3; §§§Significant difference (P <0.001) between Groupe 1 and Groupe 3.

The CMJ performance indices were displayed in Figure 1. The results show a significant difference between G1 and G2 ($p < 0.001$; ES= 0.97, large), G2 and G3 ($p < 0.001$; ES= 1.21, large) and a significant difference between G1 and G3 ($p < 0.001$; ES= 1.72, large).

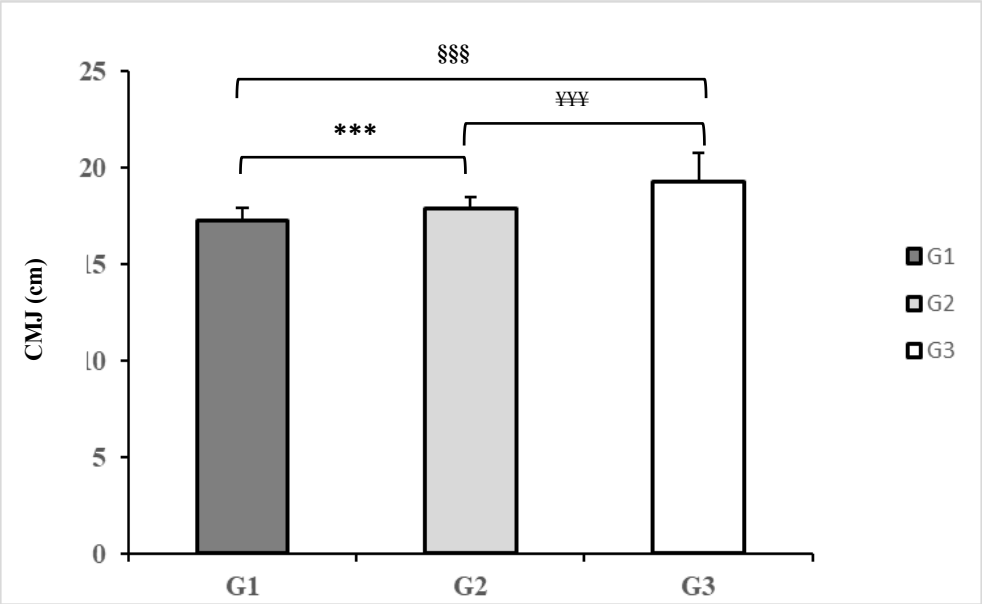

Figure 1. Comparison of jumping measurements between control group (G1), verbal encouragement group (G2) and combined feedback and verbal encouragement group. G1: control group; G2: verbal encouragement group; G3: Combined Feedback and verbal encouragement group; CMJ: countermovement jump; Mean ± SD, ***Significant difference (P <0.001) between Groupe 1 and Groupe 2; ¥¥¥Significant difference (P <0.001) between Groupe 2 and Groupe 3; §§§ Significant difference (P <0.001) between Groupe 1 and Groupe 3.

Figure 2 showed a significant difference of 5JT performance between G1 and G2 ($p < 0.001$; ES= 2.6, large), G2 and G3 ($p < 0.001$, ES= 4.74, large) and between G1 and G3 (ES= 6.86, large).

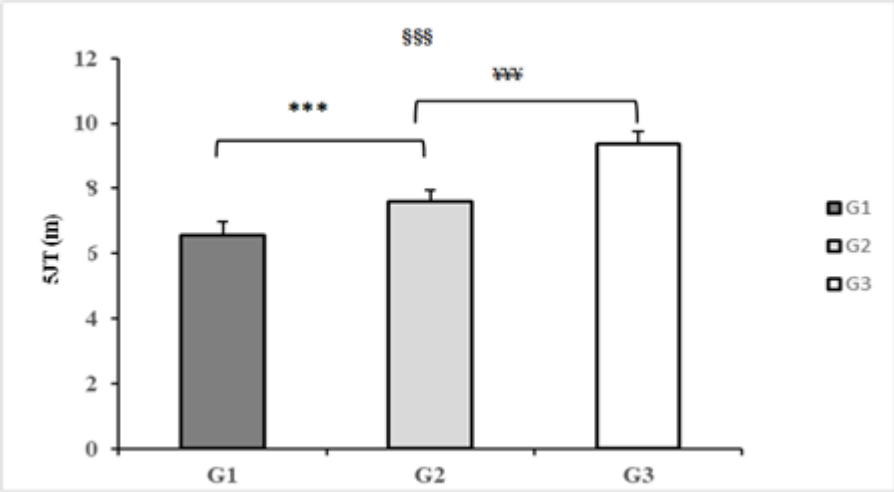

Figure 2. Comparison of jumping measurements between control group, verbal encouragement group and combined feedback and verbal encouragement group. G1: control group; G2: verbal encouragement group; G3: Combined Feedback and verbal encouragement group; CMJ: countermovement jump; Mean ± SD, ***Significant difference (P <0.001) between Groupe 1 and Groupe 2; ¥¥¥Significant difference (P <0.001) between Groupe 2 and Groupe 3; §§§ Significant difference (P <0.001) between Groupe 1 and Groupe 3

For Ball contacts and successful balls, a significant difference was significantly higher for G3 compared to G1 and G2 ($p < 0.001$; ES= 2.31, large; ES= -1.48; ES= 0.89, large, respectively). Similarly, for number of shots and successful shots, a significant difference was observed between G1 and G2 ($p < 0.001$, ES=1.99, large; $p < 0.001$, ES=2.41, large, respectively), G2 and G3 ($p < 0.001$, ES=3.97, large; $p < 0.001$, ES=4.93, large, respectively), and between G1 and G3 ($p < 0.001$, ES=6.02, large; $p < 0.001$, ES=6.64, large, respectively) (Table 3).

Table 3. Number of contacts and successful ball and number of shots and successful shots for 3vs. 3 small-sided games for control group, verbal encouragement group and combined feedback and verbal encouragement group.

	G1 (n=20)	G2 (n=20)	G3 (n=20)
Ball C	11.45 ± 2.4***	15.15 ± 2.5¥¥¥	17.5 ± 2.7§§§
S Balls	5.2 ± 1.4***	10.55 ± 1.2¥¥¥	13.7 ± 2.7§§§
N shots	2.1 ±1.12***	4.35 ± 1.1¥¥¥	8.8 ± 1.1§§§
S shots	0.5 ± 0.6***	1.9 ± 0.5¥¥¥	5.55 ± 0.9§§§

Data are presented as average± standard deviations. G1: control group; G2: verbal encouragement group; G3: Combined Feedback and verbal encouragement group; Balls C: ball contacts; S balls: successful balls; N shots: number of shots; S shots: successful shots; ES: effect size; ***Significant difference (P <0.001) between Groupe 1 and Groupe 2; ¥¥¥Significant difference (P <0.001) between Groupe 2 and Groupe 3; §§§Significant difference (P <0.001) between Groupe 1 and Groupe 3.

The result of the present study showed that average HR was significantly higher for G3 compared to G2 and G1 ($p < 0.001$; ES= 4.64, large; ES= -1.06; ES= 3.06, large, respectively) (Figure 3).

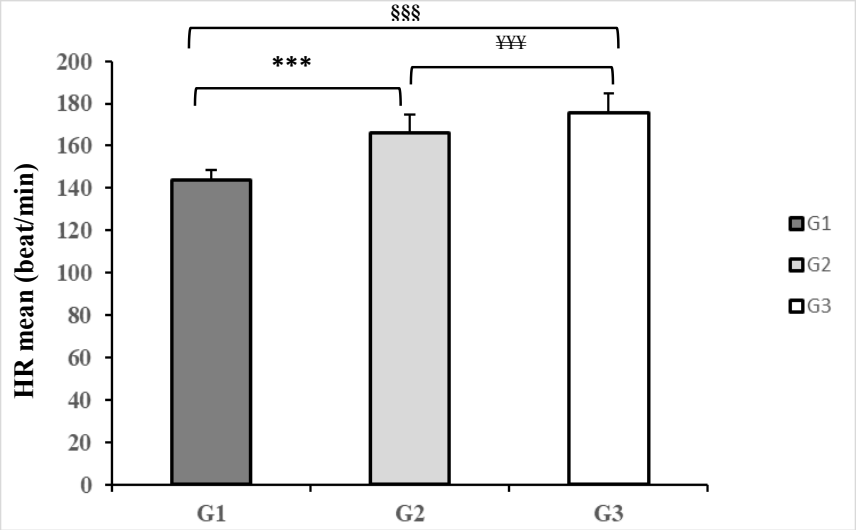

Figure 3. Comparison of average heart rate between control group, verbal encouragement group and combined feedback and verbal encouragement group. G1: control group; G2: verbal encouragement group; G3: Combined Feedback and verbal encouragement group; CMJ: countermovement jump; Mean ± SD,***Significant difference (P <0.001) between Groupe 1 and Groupe 2; ¥¥¥Significant difference (P <0.001) between Groupe 2 and Groupe 3; §§§Significant difference (P <0.001) between Groupe 1 and Groupe 3.

4. Discussion

The investigation aimed to scrutinize the effects of instructional feedback and motivational verbal encouragement by educators on the physical fitness, technical aptitude, and physiological responses within the ambit of Small-Sided Basketball Games (SSBG) for adolescent females. The empirical evidence garnered supports the presupposition that such an integrative pedagogical approach catalyzes advancements in these spheres. Specifically, the study elucidated that a regimen integrating instructional feedback and motivational verbal encouragement (Group 3) yielded significantly enhanced outcomes in a suite of evaluative metrics in comparison to solely motivational verbal encouragement (Group 2) or the absence of any intervention (Group 1). Notably, Group 3 demonstrated superior performance in short-distance sprints (10m and 30m), excelled in the Illinois agility benchmark, and showed elevated results in vertical leap measures, namely the Counter Movement Jump (CMJ) and the Five-Jump Test (5JT). Moreover, this group exhibited a higher incidence of ball interactions, successful passes, attempts, and precise shots. Additionally, the average heart rate (HR) in Group 3 was observed to be higher relative to Groups 2 and 1, suggesting that the confluence of instructional feedback and motivational verbal encouragement markedly improves performance in adolescent females, transcending the impact of motivational verbal encouragement alone.

This continuity of improvement aligns with the findings of prior research by Hammami et al. (31) and Pacholek et al. (20), particularly in the context of sprint performance, reinforcing the critical value of feedback. Literature by Porter et al. (32) and further studies by Pacholek et al. (20) corroborate that external stimuli, especially when amalgamated with performance feedback, significantly amplify athletic prowess. Pertinent to basketball, where agility, dynamic equilibrium, and swift directional shifts are paramount, our analysis confirmed Group 3's ascendency in agility metrics (Table 2), echoing Hammami et al.(33) who documented the positive ramifications of verbal encouragement on agility with directional change in adolescent athletes.

In power and strength parameters, discernible disparities were observed across groups in CMJ and 5JT outcomes, with Group 3 surpassing both the control (G1) and solely verbally encouraged groups (G2), mirroring Pacholek et al.(20)'s revelations regarding feedback's potency in augmenting mean power. Contributions from Lee et al. (34) and Miller et al. (19) elucidated the roles of verbal encouragement and feedback in modulating central activation and force

generation, positing that while verbal encouragement fosters participation, feedback is quintessential for actual performance enhancement. This concept is further substantiated by Argus et al. (35), showcasing feedback's influence on peak velocity during specific exercises.

Technical skill refinement in SSBGs, as evidenced by Group 3's superior performance, underscores the efficacy of merging feedback with verbal encouragement. This insight dovetails with broader scholarly consensus, as articulated by Práxedes et al. (36) and Garcia et al.(37), advocating for the synergistic benefits of integrating instructional feedback with motivational strategies to enrich technical and tactical skills in sport-specific contexts. Such an approach not only accelerates skill development but also cultivates an educational milieu conducive to enhanced student motivation and engagement, thus facilitating a robust learning trajectory.

Within the broader landscape of physical education and sports training, the pivotal role of feedback in bolstering motor skill acquisition, technical proficiency, and overall athletic performance has been extensively affirmed. Feedback serves not merely as a corrective conduit but also as a motivational force, enriching the learner-teacher dynamic and enabling students with actionable insights to refine their technique. The preference for immediate feedback following successful trials, as highlighted by Chiviacowsky and Wulf (38, 39), underscores the strategic importance of feedback timing and context in maximizing learning outcomes.

Moreover, our study's focus on SSBGs illuminates these games' pivotal role in physical education, offering a comprehensive training modality that addresses a spectrum of developmental needs—physical, mental, tactical, and technical. The observed differential impact on average heart rate among the groups elucidates the critical function of coaching strategies, specifically the blend of verbal encouragement and instructional feedback, in modulating game intensity and effectiveness, aligning with existing scholarship that underscores the multifaceted advantages of SSBGs in educational frameworks, emphasizing their utility in fostering engaging, efficacious, and holistic training environments.

5. Conclusion

This research confirms that combining verbal encouragement with feedback improves teenage girls' performance in physical fitness tests and their physiological reactions and technical competence during small-sided basketball games at school. This suggests that physical education teachers may find it beneficial to use combined feedback and verbal encouragement in teaching. However, more studies are needed to fully support this recommendation in an evidence-based manner.

5.1 Limits and Study Perspectives

Recommendations for future studies include addressing the small sample size for better generalizability, using a range of student ages instead of just one, and exploring the use of visual feedback alongside verbal encouragement in physical education sessions. Future investigations could focus on specific sports teams to see if similar results are achieved. Incorporating technology like GPS for tracking physical aspects and emphasizing the impact of verbal encouragement and feedback on tactical abilities in basketball games across different age groups could also be beneficial. Another interesting point would be relating these responses with psychological aspects using the adapted Interpersonal Behaviors Questionnaire (IBQ) in sport such can be applied to the assessment athletes' perceptions of need-supportive and need-thwarting coaching behaviors (4-6). These factors should be checked for future studies.

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Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

All authors contributed to the original idea, study design, writing and editing the manuscript, which was approved as a final draft.

Data Availability Statement

The dataset presented in the study is available on request from the corresponding author during submission or after its publication. The data are not publicly available due to ethical considerations.

Ethical Considerations

The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the research ethics committee of the High Institute of Sports and Physical Education of Kef, Tunisia (approval no.010/ 2023).

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