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The Impact of Gender Dynamics on Technical, Physiological, and Psychological Performance in Small-Sided Games

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Abstract: This study examined the effects of gender composition in small-sided games (SSGs) on the tech-nical, physiological, and psychological responses of adolescent students in physical education (PE). Thirty-two high school students (16 girls, 16 boys; 16.73 ± 0.37 years) participated in 4v4 SSGs performed in single-gender and mixed-gender formats. Heart rate, perceived exertion, mood states, enjoyment, and technical performance were assessed.The results showed significant gender × condition × time effects on psychological, physiological and technical variables. Boys consistently reported lower negative mood states, anger (ES = 2.53), confusion (ES = 2.56), and depression (ES = 1.19) and higher vigor (ES = 1.61) compared with girls. They also experienced greater enjoyment (PACES, ES = 1.59) and lower perceived exertion (RPE, ES = 1.28), with higher peak heart rates during single-gender games (ES = 3.33). Girls demonstrated significant reduc-tions in negative mood across both session types ($p < 0.0001$), indicating mood improvement af-ter gameplay.Technically, boys performed better in successful passes (ES = 2.28), ball possessions (ES = 2.81), and interceptions (ES = 1.36). Nevertheless, both genders improved in mixed sessions, particularly in successful passes (boys: ES = 0.83; girls: ES = 1.42), duels (boys: ES = 0.99; girls: ES = 1.81), and overall ball involvement ($p < 0.01$), highlighting the benefits of mixed-gender formats for skill execution and engagement. These findings indicate that group composition meaningful-ly influences adolescents' affective responses, perceived effort, and skill execution in PE. Inte-grating both mixed- and single-gender SSGs may enhance engagement, support skill develop-ment, and promote inclusive learning environments in school physical education.

Keywords: adolescents, gender differences, mixed-gender education, small-sided games, mood states, physical education, football, psychophysiology, enjoyment, performance

1. Introduction

Physical education (PE) is a basis of global student development, extending far beyond ordinary physical fitness to reach crucial social and psychological dimen-sions [1]. PE teachers can manipulate various variables to enhance learning outcomes, including the type of activities, learning strategies, and group dynamics [2]. Among

these variables, gender composition is critical in PE settings [3]. Gender, as a complex social construct [4], is essential in shaping students' experiences and outcomes in educational settings, particularly in PE [5]. For instance, boys tend to be more physically active than girls, yet schools can encourage health-focused physical activity among all students [14]. The thoughtful manipulation of gender composition in PE classes represents a powerful pedagogical tool for educators [6]. By strategically alternating between single-gender and mixed-gender groupings, PE teachers can create diverse learning environments that potentially enhance student engagement [7, 8], skill development, and social interaction [9]. Moreover, the ability to adjust gender groups provides teachers with a unique opportunity to address and challenge gender stereotypes, promote equity, and cultivate a more inclusive atmosphere in PE [10]. As students navigate these varied group compositions, they may develop greater adaptability, empathy, and cross-gender communication skills, which become increasingly valued in today's diverse society [11].

Small-sided games (SSGs), a popular teaching and training method in PE [12], offer a microcosm for examining the complex interplay of gender dynamics in physical activities [13]. These games, which involve fewer players on reduced playing areas [12], have been shown to effectively develop technical skills, physical fitness, and decision-making abilities [14]. Football, in particular, constitutes an ideal framework for this investigation due to its widespread popularity among adolescents, its collective nature that fosters gender interactions, and its technical and physiological richness, which allows the assessment of multiple performance and psychological variables. However, the majority of research on SSGs has focused on single-gender environments, leaving a significant gap in understanding how gender composition affects student outcomes [15].

The transition from single-gender to mixed-gender group activities in PE classes introduces unique opportunities that affect social dynamics [9]. While some studies suggest that mixed-gender activities can promote gender equality and improve social interactions [16], others highlight potential issues such as reduced participation of female students or reinforcement of gender stereotypes [17, 18]. The impact of this transition on students' technical performance, physical engagement, and psychological responses remains largely unexplored, particularly in team sports. Furthermore, the psychological aspects of participating in single-gender versus mixed-gender groups warrant careful examination. Factors such as self-efficacy, motivation, and enjoyment can significantly influence students' engagement and learning outcomes in PE [19, 20]. The shift from a single-gender to a mixed-gender environment may alter these psychological factors in ways that are not yet fully understood.

The present study aims to investigate the effects of transitioning from single-gender to mixed-gender groups on the technical, physical, and psychological aspects of both female and male students. By utilizing SSGs as a standardized activity, the impact of gender composition on these key variables is sought to be isolated.

Based on this, we hypothesized that There will be significant main and interaction effects of gender (boys vs. girls) and group composition (single-gender vs. mixed-gender) on psychological and physiological responses during small-sided games. Specifically, boys are expected to report lower negative mood states (anger, confusion, depression, fatigue, tension), higher vigor and enjoyment (PACES), lower perceived exertion (RPE), and higher heart rate responses (%HRmaxTheo) compared with girls, with these effects varying according to group composition. Also, Group composition will significantly influence technical performance indicators during small-sided games. Mixed-gender formats are expected to elicit higher levels of technical involvement (successful passes, ball possessions, duels, and interceptions) compared with single-gender formats, with potential moderation by gender.

2. Materials and Methods

2.1. Participants

This study involved 32 high school students (16 girls, 16 boys) from a single institution in Tunisia (age: 16.73 ± 0.37 years; physical education experience: 10.2 ± 0.7 years; height: 171.5 ± 2.7 cm; body mass: 66.3 ± 5.2 kg). All participants were enrolled in the same grade level (3rd year of secondary education) and attended PE classes taught by the same physical education teacher. Inclusion criteria were: (i) current enrollment in the 3rd year of secondary education; (ii) absence of injury before and during the study period; and (iii) no reported physical or cognitive impairments. Exclusion criteria included: (i) high absenteeism rates from physical education sessions; and (ii) the onset of illness during the study period. The sample size was calculated using G-Power software (version 3.1.9.6). The analysis considered an effect size of f = 0.50, a power of 0.8, and an alpha level of 0.05. The minimum required sample size was 30 participants, which justified the inclusion of 32 eligible participants [21].

2.2. Ethical approval

The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. The research protocol was reviewed and approved by the Local Ethics Committee of the High Institute of Sport and Physical Education of Kef, University of Jendouba (approval code: ISSEPK-002/2022). Before study participation, written informed consent was obtained from all participants and their legal guardians.

2.3. Procedures

This study was conducted during the mid-year of 2022–2023 and comprised three consecutive phases spanning two weeks. The first week was dedicated to participant familiarization with all testing procedures and comprehensive instruction on using the assessment instruments. These included the Profile of Mood States (POMS), the Rating of Perceived Exertion (RPE) scale, and the Physical Activity Enjoyment Scale (PACES). This familiarization phase aimed to ensure that all participants clearly understood the purpose and application of each tool, thereby promoting reliable self-reporting and minimizing measurement bias.

During the second week, participants engaged in small-sided games (SSGs), each lasting 29 minutes and structured into four 5-minute active periods interspersed with 3-minute passive recovery intervals. Before this phase, participants were randomly assigned to four groups using a computer-generated randomization procedure. The structure of the SSG groups is presented in Table 1. Grouping was matched based on theoretical maximum heart rate and applied consistently to form mixed-gender and single-gender groups. This process ensured a balanced distribution of males and females, preventing gender clustering and minimizing potential confounding effects related to group composition. The sessions were conducted under standardized conditions to ensure consistency in the physical and environmental parameters.

Heart rate peak (HRpeak) was monitored throughout the SSGs as an objective physiological measure. Subjective mood states were assessed using the POMS immediately before and after each session. At the same time, RPE was collected at the end of each 5-minute game to capture perceived exertion in real time. Physical activity enjoyment was evaluated after each SSG using the PACES. Additionally, technical performance was quantified through systematic video analysis of each SSG using a GoPro 4 camera (San Mateo, California, USA) at a resolution of 1.080 pixels (1.920 × 1.080 × 16:9), 48 frames per second (FPS), and a 2.4 GHz frequency. All experimental sessions were conducted on a standardized playing area (a 25 m × 35 m synthetic turf field) during consistent time periods (between 09:00 and 10:30 hours) to minimize potential confounding effects of environmental and circadian variations.

Table1. The SSG group compositions

The experimental period		
Time 1	**Time 2**	**Time 3**
(SSG)	(SSG)	(SSG)
Familiarization with the experimental protocol	(single-gender groups)	(mixed groups)
	4 B v 4 B	
	4 B v 4 B	(2 G+2 G) v (2 B+2B)
	4 G v 4 G	(2 G+2 G) v (2 B+2B)
	4 G v 4 G	(2 G+2 G) v (2 B+2B)
		(2 G+2 G) v (2 B+2B)

Note: SSG: Small Sided Games; B: boys; G: girls

2.3. Measurement

2.3.1. Heart Rate Response

Heart rate was monitored during small-sided games using portable HR sensors (Polar Team Sport System, Polar Electro Oy, Kempele, Finland). Recovery periods were excluded from the analysis, with the focus on HRpeak, defined as the highest heart rate recorded during each SSG session. HR values were expressed as a percentage of theoretical maximum heart rate to standardize exercise intensity across participants, calculated as HRmaxTheo = 208 − (0.7 × age) [22].

2.3.2. Rating Exertion Perceived RPE (CR-10)

The Borg CR-10 RPE scale assessed subjective exertion levels immediately following each small-sided game (SSG). This scale, which ranges from 0 (rest) to 10 (maximal effort), provides a validated measure of perceived physical strain [23].

2.3.3. Profile of Mood States (POMS)

Participants' mood states were assessed using the Arabic version of the modified Brunel Mood Scale (BRUMS) [24], validated by Sahli & al. [25]. This 24-item instrument evaluates six mood dimensions: fatigue, anger, vigor, confusion, depression, and tension. Immediately following each session, participants responded to the prompt "How do you feel right now?" on a 5-point Likert-type scale ranging from 0 (not at all) to 4 (extremely). Each subscale comprises four items, yielding scores from 0 to 16. For instance, anger is assessed with statements such as "I feel easily annoyed or frustrated today," while vigor is evaluated with items such as "I feel full of energy today." The Arabic BRUMS has demonstrated satisfactory psychometric properties, with Cronbach's alpha values exceeding 0.70 for all subscales except vigor ($\alpha = 0.749$), which still falls within an acceptable range [26]. This indicates good internal consistency reliability, supporting its use for mood assessment in Arabic-speaking populations, particularly in physical education contexts.

2.3.4. The Physical Activity Enjoyment Scale (PACES)

The 8-item Physical Activity Enjoyment Scale (PACES) [27] was used to assess participants' enjoyment of physical activity. Immediately following each session, participants were prompted to rate "how you feel right now compared to the physical training you've been through" on a 7-point Likert scale, ranging from 1 (not fun at all) to 7 (very pleasant). The total enjoyment score was calculated by summing the responses to all eight items, yielding a possible range of 8 to 56 points, with higher scores indicating greater enjoyment. Participants completed the PACES questionnaire individually to minimize peer influence on responses [28].

2.4. The small-sided games

The small-sided games (SSGs) were conducted as 4v4 matches on an outdoor synthetic grass field measuring 25 m × 35 m. Each SSG session consis

ted of 5-minute playing periods interspersed with 3-minute passive recovery intervals [29]. Participants were instructed to exert maximum effort during the games, emphasizing maintaining possession of the ball for as long as possible. To optimize playing time and minimize interruptions, four student volunteers were positioned around the field to rapidly supply new balls when needed. All SSGs were played without goalkeepers to encourage continuous play and maximize player involvement.

2.5. Statistical analysis

Descriptive data were presented as means ± standard deviation (SD). Shapiro-Wilk and Levene's tests were used to test the distribution's normality and homogeneity of variance for all variables before inferential statistics. Three-way analysis of variance with repeated measures-ANOVA [Time (T1 and T2) × Condition (same-gender and mixed) × Gender (boys and girls)] and 2-way ANOVA univariate [Condition (same-gender and mixed) × Gender (boys and girls)] were performed to test condition and gender effects on the dependent variable values. Bonferroni post hoc analyses were conducted to identify pairwise differences when significant main effects or interactions were observed. Effect sizes (ES) were determined by converting the partial eta squared to Cohen's d (Cohen et al., 1988). The magnitude of effect size was classified as trivial (< 0.20), small (0.20–0.49), medium (0.50–0.79), and large (0.80 and greater) (Cohen et al., 1988). The analyses were performed using SPSS version 29 for Windows (IBM Corp, Armonk, N.Y., USA), and the significance level (p) was set at 0.05.

3. Results

Normality of the data and homogeneity of variance were confirmed.

For anger scores, there were no significant gender × condition or gender × condition × time interaction effects (Table 2). However, significant gender × time and condition × time interactions were found (Table 2). Boys had significantly lower anger scores than girls in both the mixed ($p < 0.0001$; ES = 2.531) and same-gender ($p = 0.003$; ES = 1.133) settings at T1. When girls were pooled across conditions, scores at T1 were significantly higher than at T2 (mixed: $p < 0.0001$; ES = 1.334; same-gender: $p < 0.0001$; ES = 1.433). Within the female group, anger scores were higher in the same-gender setting compared to the mixed setting at T1 ($p = 0.019$; ES = 0.689).

Significant gender × condition and gender × time interactions were observed (Table 2) for confusion scores, but no gender × condition × time interaction was found. Boys had significantly lower confusion scores than girls in both the mixed (T1: $p < 0.0001$; ES = 2.562; T2: $p < 0.0001$; ES = 2.096) and same-gender (T1: $p < 0.0001$; ES = 1.884) conditions. Among girls, confusion scores at T1 were higher than at T2 in both conditions (mixed: $p < 0.0001$; ES = 1.143; same-gender: $p < 0.0001$; ES = 1.646). At T2, girls were less confused in the same-gender condition than in the mixed condition ($p < 0.0001$; ES = 1.1).

For depression scores, a significant gender × condition interaction was observed, with boys reporting lower depression scores than girls at T1 in both mixed ($p = 0.002$; ES = 1.192) and same-gender ($p = 0.002$; ES = 1.212) settings (Table 2). Additionally, significant condition × time and gender × time interactions were noted. Among girls, depression scores decreased from T1 to T2 in both settings (mixed: $p = 0.004$; ES = 1.192; same-gender: $p < 0.0001$; ES = 1.358). Within the female group, same-gender scores were higher than mixed scores at T1 ($p < 0.0001$; ES = 0.976).

A gender × time interaction was found for fatigue scores, with boys reporting lower scores than girls at T1 and T2 in the mixed (T1: $p < 0.0001$; ES = 1.823; T2: $p = 0.047$; ES = 0.734) and same-gender (T1: $p < 0.0001$; ES = 1.469) conditions (Table 2).

For tension scores, significant gender × condition and gender × time interactions were identified (Table 2). Among girls, tension scores were higher at T1 than at T2 in both the mixed ($p = 0.044$; ES = 0.602) and same-gender ($p = 0.007$; ES = 1.017) settings. Among boys, scores decreased from T1 to T2 only in the same-gender condition ($p = 0.001$; ES = 1.101), and were higher in the same-gender condition than in the mixed condition at T1 ($p < 0.0001$; ES = 1.368).

For vigour scores, a condition × time interaction was observed (Table 2). Boys had higher vigour scores at T1 than at T2 in the mixed condition ($p < 0.0001$; ES = 1.605), while girls had higher scores at T2 than at T1 in the same-gender condition ($p < 0.0001$; ES = 1.017). A gender × time interaction was also found. At T2, vigour scores were higher in the same-gender than in the mixed condition for both boys ($p = 0.046$; ES = 0.614) and girls ($p < 0.0001$; ES = 1.512). However, within boys, scores were higher in the mixed than in the same-gender condition at T1 ($p = 0.016$; ES = 1.042) (Figue 1).

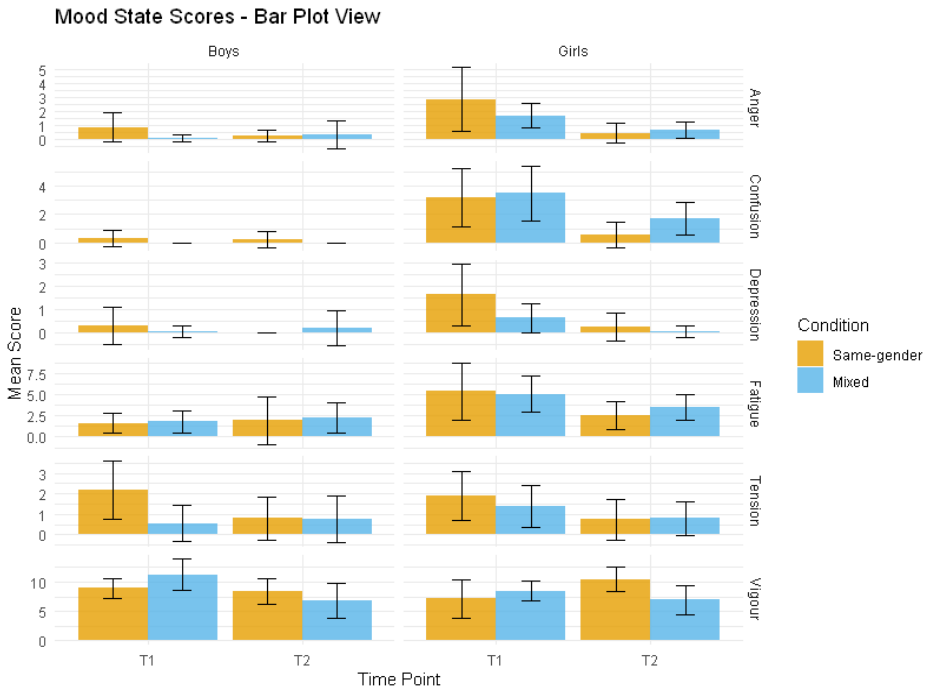

Figure1. Mood states of girls, boys and same gender group

There was a significant gender effect, with boys reporting higher enjoyment and lower RPE than girls in both the mixed ($p = 0.003$ and $p < 0.0001$; ES = 1.135 and 1.382, respectively) and same-gender ($p < 0.0001$ and $p = 0.001$; ES = 1.590 and 1.280, respectively) conditions (Table 3). A main effect for condition was also observed, with higher HRpeak values recorded in the same-gender condition compared to the mixed condition ($p < 0.0001$; ES = 1.008) (Table 3).

Boys outperformed girls in all technical performance indicators in both mixed (successful passes: $p < 0.0001$ and ES = 2.28; ball possessions: $p < 0.0001$ and ES = 2.807; interceptions: $p = 0.001$ and ES = 1.359) and same-gender (successful passes: $p < 0.0001$ and ES = 1.986; ball possessions: $p < 0.0001$ and ES = 1.959; duels: $p = 0.014$ and ES = 0.922; interceptions: $p = 0.032$ and ES = 0.795) conditions (Table 4). Additionally, a main effect of condition was found for technical performance in both genders (Table 4). In the mixed condition, the number of successful passes ($p < 0.0001$; ES = 0.828 for boys, ES = 1.415 for girls), lost balls ($p = 0.007$; ES = 0.978 and 0.627), ball possessions ($p = 0.003$ and 0.001; ES = 0.893 and 1.768), and duels ($p < 0.0001$; ES = 0.988 and 1.806) were significantly higher.

Table 2. Descriptive data for mood state scores in boys (n=16) and girls (n=16) before (T1) and after (T2) small-sided games in same-gender and mixed conditions.

Variables	Gender	Time	Condition		ANOVA
			Same-gender	Mixed	
Anger	Boys	T1	0.88±1.02	0.06±0.25	Time: F(1,30) = 36.457; p<0.0001; d = 1.052 Cond: F(1,30) = 5.028; p = 0.032; d = 0.355 Gender: F(1,30) = 22.215; p<0.0001; d = 0.814 Time×Cond: F(1,30) = 9.896; p = 0.004; d = 0.527 Time×Gender: F(1,30) = 23.524; p<0.0001; d = 0.839 Cond×Gender: F(1,30) = 0.062; p = 0.805; d = 0 Time×Cond×Gender: F(1,30) = 0.586; p = 0.450; d = 0
		T2	0.25±0.45	0.31±1.01	
	Girls	T1	2.88±2.28†‡§	1.69±0.87†‡	
		T2	0.44±0.73	0.69±0.60	
Confusion	Boys	T1	0.31±0.60	0.0±0.0	Time: F(1,30) = 40.207; p<0.0001; d = 1.107 Cond: F(1,30) = 1.260; p = 0.271; d = 0.090 Gender: F(1,30) = 67.639; p<0.0001; d = 1.443 Time×Cond: F(1,30) = 1.378; p = 0.250; d = 0.109 Time×Gender: F(1,30) = 38.004; p<0.0001; d = 1.075 Cond×Gender: F(1,30) = 6.581; p = 0.016; d = 0.418 Time×Cond×Gender: F(1,30) = 1.012; p = 0.322; d = 0019
		T2	0.25±0.58	0.0±0.0	
	Girls	T1	3.19±2.07†‡	3.50±1.93†‡	
		T2	0.56±0.89	1.69±1.14‖¥	
Depres-sion	Boys	T1	0.31±0.79	0.06±0.25	Time: F(1,30) = 12.403; p = 0.001; d = 0.597 Cond: F(1,30) = 10.033; p = 0.004; d = 0.531 Gender: F(1,30) = 13.739; p = 0.001; d = 0.631 Time×Cond: F(1,30) = 12.346; p = 0.001; d = 0.595 Time×Gender: F(1,30) = 8.412; p = 0.007; d = 0.481 Cond×Gender: F(1,30) = 8.127; p = 0.008; d = 0.472 Time×Cond×Gender: F(1,30) = 1.111; p = 0.300; d = 0.059
		T2	0.0±0.0	0.19±0.75	
	Girls	T1	1.63±1.31†‡§	0.63±0.62†‡	
		T2	0.25±0.58	0.06±0.25	
Fatigue	Boys	T1	1.63±1.20	1.81±1.28	Time: F(1,30) = 3.672; p = 0.065; d = 0.289 Cond: F(1,30) = 0.987; p = 0.328; d = 0 Gender: F(1,30) = 29.005; p <0.0001; d = 0.935 Time×Cond: F(1,30) = 1.380; p = 0.249; d = 0.109 Time×Gender: F(1,30) = 7.341; p = 0.011; d = 0.445 Cond×Gender: F(1,30) = 0.012; p = 0.913; d = 0 Time×Cond×Gender: F(1,30) = 0.924; p = 0.344; d = 0
		T2	1.94±2.79	2.25±1.84	
	Girls	T1	5.38±3.40†§	5.06±2.17†§	
		T2	2.56±1.67	3.50±1.55‖	
Tension	Boys	T1	2.19±1.42¢£	0.56±0.89	Time: F(1,30) = 17.420; p<0.0001; d = 0.716 Cond: F(1,30) = 12.694; p = 0.001; d = 0.604 Gender: F(1,30) = 0.229; p = 0.636; d = 0 Time×Cond: F(1,30) = 10.638; p = 0.003; d = 0.549 Time×Gender: F(1,30) = 0.527; p = 0.474; d = 0 Cond×Gender: F(1,30) = 4.392; p = 0.045; d = 0.325 Time×Cond×Gender: F(1,30) = 2.356; p = 0.135; d = 0.206
		T2	0.81±1.05	0.75±1.13	
	Girls	T1	1.88±1.20‡	1.38±1.02‡	
		T2	0.75±1.00	0.81±0.83	
Vigour	Boys	T1	8.94±1.73	11.25±2.62øω	Time: F(1,30) = 5.101; p = 0.031; d = 0.358 Cond: F(1,30) = 0.699; p = 0.410; d = 0 Gender: F(1,30) = 1.333; p = 0.257; d = 0.102 Time×Cond: F(1,30) = 26.963; p<0.0001; d = 0.900 Time×Gender: F(1,30) = 22.002; p<0.0001; d = 0.810 Cond×Gender: F(1,30) = 3.058; p = 0.091; d = 0.253 Time×Cond×Gender: F(1,30) = 0.352; p = 0.557; d = 0
		T2	8.38±2.13Δ	6.81±2.90	
	Girls	T1	7.13±3.28	8.50±1.75	
		T2	10.44±2.13ϕψ	6.94±2.49	

Values are given as mean ± SD; Cond: condition. †: a significant difference when comparing girls to boys at T1 in the same condition. ‡: a significant difference when comparing T1 to T2 within girls in both conditions. §: a significant difference when comparing the same-gender to mixed condition within girls at T1. ‖: a significant difference when comparing girls to boys in mixed condition at T2. ¥: a significant difference when comparing the mixed to same-gender condition within girls at T2. ¢: a significant difference when comparing T1 to T2 within boys in same-gender condition. £: a significant difference when comparing the same-gender to mixed condition within boys at T1. ø: a significant difference when comparing T1 to T2 within boys in mixed condition. ϕ: a significant difference when comparing T2 to T1 within girls in the same-gender condition. ω: a significant difference when comparing the mixed to same-gender condition within boys at T1. Δ: a significant difference when comparing the same-gender to mixed condition at T1. Ψ: a significant difference when comparing the same-gender to mixed condition within girls at T2. χ: a significant difference when comparing T2 to T1 within boys in the mixed condition. The statistical signficance level was set at $p \leq 0.05$.

Table 3. Descriptive data for enjoyment, perceived exertion, and heart rate scores in boys (n=16) and girls (n=16) in same-gender and mixed conditions.

Variables	Gender	Condition		ANOVA
		Same-gender	Mixed	
PACES (AU)	Boys	26.1±4.5†	25.5±3.9†	Condition: F(1,30) = 2.265; p = 0.143; d = 0.199 Gender: F(1,30) = 20.871; p<0.0001; d = 0.788 Condition×Gender: F(1,30) = 5.097; p = 0.031; d = 0.358
	Girls	18.8±4.7	21.6±3.0	
RPE (AU)	Boys	4.8±0.8	4.3±0.9	Condition: F(1,30) = 1.045; p = 0.315; d = 0.037 Gender: F(1,30) = 23.757; p<0.0001; d = 0.843 Condition×Gender: F(1,30) = 0.376; p = 0.544; d = 0
	Girls	6.4±1.6‡	6.3±1.8‡	
HRpeak (%HRmaxTheo)	Boys	163.0±2.2§	155.1±2.5	Condition: F(1,30) = 61.268; p<0.0001; d = 1.372 Gender: F(1,30) = 2.056; p = 0.162; d = 0.182 Condition×Gender: F(1,30) = 74.798; p<0.0001; d = 1.519
	Girls	160.4±3.9	160.8±2.7	

Values are given as mean ± SD; PACES: physical activity enjoyment scale; RPE: rating perceived exertion; HRpeak: heart rate peak; %HRmaxTheo: percentage of the theoretical maximum heart rate. AU: arbitrary unit; †: a significant difference when comparing boys to girls in both conditions. ‡: a significant difference when comparing girls to boys in both conditions. §: a significant difference when comparing the same-gender to mixed condition within boys. The statistical significance level was set at $p \leq 0.05$.

Table 4. Descriptive data for technical performances in boys (n=16) and girls (n=16) in same-gender and mixed conditions.

Variables	**Gender**	**Condition**		**ANOVA**
		Same-gender	**Mixed**	
SP (n)	Boys	8.31±2.63†	10.31±2.18†§	Condition: F(1,30) = 128.62; p<0.0001; d = 1.997 Gender: F(1,30) = 38.236; p<0.0001; d = 1.079 Condition×Gender: F(1,30) = 0.118; p = 0.733; d = 0
	Girls	4.0±1.59	6.13±1.41§	
LB (n)	Boys	4.0±1.46	5.13±0.72§	Condition: F(1,30) = 16.531; p<0.0001; d = 0.697 Gender: F(1,30) = 0.075; p = 786; d = 0 Condition×Gender: F(1,30) = 0.00; p = 1.00; d = 0
	Girls	4.13±2.16	5.25±1.34§	
Interception (n)	Boys	3.63±1.50†	4.25±1.13†	Condition: F(1,30) = 2.265; p = 0.143; d = 0.251 Gender: F(1,30) = 14.138; p = 0.001; d = 0.641 Condition×Gender: F(1,30) = 0.556; p = 0.462; d = 0
	Girls	2.63±0.96	2.88±0.89	
BP (n)	Boys	3.69±1.40†	4.75±0.93†§	Condition: F(1,30) = 24.711; p<0.0001; d = 0.860 Gender: F(1,30) = 66.867; p<0.0001; d = 1.434 Condition×Gender: F(1,30) = 0.162; p = 0.690; d = 0
	Girls	1.50±0.73	2.75±0.68§	
Duels (n)	Boys	2.25±1.57‡	3.56±1.03§	Condition: F(1,30) = 2.265; p = 0.143; d = 0.199 Gender: F(1,30) = 20.871; p<0.0001; d = 0.788 Condition×Gender: F(1,30) = 5.097; p = 0.031; d = 0.358
	Girls	1.13±0.72	2.81±1.11§	

Values are given as mean ± SD. SP: successful passes; LB: lost balls; BP: ball possessions; †: a significant difference when comparing boys to girls in both conditions. ‡: a significant difference when comparing boys to girls in same-gender conditions. §: a significant difference when comparing the mixed to same-gender condition in boys and girls. The statistical significance level was set at $p \leq 0.05$.

4. Discussion

This study examined how mixed-gender and single-gender small-sided games (SSGs) affect adolescent PE students' mood states, enjoyment, perceived exertion, heart rate, and technical performance. Results indicate that gender, game type, and time interact in complex ways, influencing psychological and physiological responses in PE settings.

4.1. Gender Differences in Mood States

A key finding of this study was the consistent gender difference in mood states, particularly at the beginning of SSG sessions (T1). Across multiple dimensions of mood (anger, confusion, depression, fatigue, and tension), girls generally reported higher negative mood scores than boys, regardless of the mixed-gender or same-gender condition. This gender discrepancy in mood states aligns with previous research, which has consistently found higher levels of negative affect and lower levels of self-confidence among adolescent girls in PE settings [30, 31, 65].

Several factors may contribute to these gender differences. Firstly, socialization processes and gender stereotypes in sports and physical activity may play a role, with girls potentially feeling less confident or more anxious about their performance in competitive settings [32]. Secondly, biological factors related to puberty and hormonal changes could influence mood variability in adolescent girls [33, 34]. During puberty, girls experience dramatic fluctuations in hormone levels, particularly estrogen and progesterone, which can affect mood regulation through interactions with neurotransmitters like serotonin [35]. The beginning of menstrual cycles introduces cyclical hormonal changes that may contribute to mood swings [36]. Lastly, the nature of SSGs, which involve direct competition and physical contact, may be perceived differently by girls and boys, potentially leading to intensified emotional responses in girls [37]. Interestingly, our results showed that girls' negative mood states generally improved from T1 to T2 in both mixed-gender and same-gender conditions. This finding suggests that engagement in SSGs may positively affect girls' mood over time, possibly due to increased comfort with the activity, improved self-efficacy, or the mood-enhancing effects of physical activity itself [38].

4.2. Impact of Mixed-Gender vs. Single-Gender Conditions

The study revealed several notable differences between mixed-gender and single-gender conditions. For girls, single-gender groups initially elicited higher negative mood scores (anger, confusion, depression) at T1 compared to mixed groups. This finding contradicts previous research suggesting that girls might feel more comfortable in same-gender physical education settings [3]. Our results indicate that anticipating competition with other girls might increase negative affect, possibly due to heightened perceived pressure or social comparison within the same-gender group [39, 66].

For boys, the impact of mixed-gender vs. same-gender conditions was less pronounced for mood states. However, boys showed higher vigor scores in the mixed condition at T1, suggesting increased enthusiasm or arousal when participating with girls. This could be attributed to social factors, such as the desire to impress or compete with the opposite gender [40]. Social comparison and self-presentation motives, where boys may feel compelled to showcase their abilities to impress female peers [41, 69]. Also, gender role expectations that associate masculinity with physical prowess [42], and the heightened competence, motivation, and competitive drive in the presence of a broader, mixed-gender audience [43]. These factors may create a situation in which boys perceive increased pressure and opportunity, leading to greater arousal and engagement.

4.3. Enjoyment and Perceived Exertion

Boys consistently reported higher enjoyment (PACES) and lower perceived exertion (RPE) than girls across both mixed- and single-gender conditions, supporting evidence that boys generally experience PE more positively [44]. These differences may be explained by both physiological and psychosocial factors. Biologically, boys typically demonstrate greater muscle mass, cardiovascular fitness, and lower body fat percentages, which contribute to improved endurance and reduced perceived effort during physical tasks [45,46]. Psychologically, higher physical self-concept and

sport competence beliefs may further influence exertion perception [47], often reinforced by gender norms associating masculinity with physical competence [48]. Greater habitual engagement in leisure-time physical activity may also enhance fitness and familiarity with exertion demands [49]. Additionally, social expectations within PE contexts may contribute to lower reported exertion among boys [50], and differences in pain tolerance have also been suggested [51].

These affective and perceptual differences may influence long-term engagement. Higher enjoyment and lower exertion may reinforce boys' participation, whereas girls' lower enjoyment and higher perceived effort may contribute to reduced motivation and engagement over time [52–54]. Negative experiences may also undermine physical self-concept and self-efficacy [47], with broader social stereotypes further discouraging sustained involvement in intense physical activity [32]. Over time, this pattern may contribute to progressive disengagement and lower fitness levels among girls [55].

4.4. Technical Performance

Analysis of technical performance revealed significant gender differences, with boys outperforming girls in successful passes, ball possessions, and interceptions across both mixed- and single-gender conditions. These differences may reflect disparities in prior sport-specific experience, physical characteristics, and perceived competence, as previously reported in adolescent sport contexts [56].

Importantly, both boys and girls demonstrated improved technical involvement in the mixed-gender condition compared with the single-gender format. This suggests that mixed-gender SSGs may create a more challenging and engaging learning environment, potentially enhancing motivation and adaptive skill execution [57,58]. Exposure to peers with diverse physical and technical profiles may stimulate tactical adjustment, decision-making, and increased ball engagement [59,60]. Given the intrinsic characteristics of small-sided games—frequent ball contact, reduced space, continuous play, and pressure-based decision-making [61,62]—the integration of mixed-gender participation appears to further enrich this learning context.

Collectively, these findings support the pedagogical value of incorporating mixed-gender SSGs in physical education, as they may simultaneously promote technical development and inclusive participation [63,64].

5. Conclusions

This study demonstrates that gender and group composition significantly influence psychological, physiological, and technical responses during small-sided games in physical education. Boys reported more positive affective responses and lower perceived exertion, whereas girls exhibited higher initial negative mood states but showed improvements following participation. Moreover, mixed-gender formats enhanced technical involvement for both sexes, indicating that group composition meaningfully shapes engagement and performance outcomes.

These findings underscore the importance of considering gender dynamics when designing PE activities. Rather than privileging a single instructional format, a balanced integration of mixed- and single-gender SSGs may better address students' diverse psychological and performance needs. Strategically structured SSGs appear to offer a valuable pedagogical framework for promoting skill development, engagement, and inclusive participation within school physical education.

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Abbreviations

The following abbreviations are used in this manuscript:

PE	Physical education
SSG	Small-Sided Games
RPE	Rating Exertion Perceived
SD	standard deviation

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