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Effect of Modifying Net Height and Court Size on Children's Badminton Performance

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Abstract It may be possible for children to acquire motor skills more successfully and effectively if they are given equipment that is the right size for their physical characteristics. The study aims to examine the effect of modifying court size and net height on children's badminton performance. Sixteen children aged 7 to 9 years (M_{age} = 8.3 years ± 1.4) participated in the study. They competed in a mini-match under four different situations where the court size or net height was modified. Children's match-play performances in all conditions were notated and analyzed via video replay. The results from a repeated measure of two-way ANOVA showed that there was a significant interaction between court and net height on winning strokes, unforced errors, and strokes struck, $p < .05$. Nevertheless, there was no significant interaction between court and net height on rally length, hitting opportunities, and successful strokes, $p > .05$. The findings demonstrated that reducing court size and lowering net height led to an offensive playstyle where children recorded higher winning shots with fewer shots struck and unforced errors. Lowering net height also resulted in a shorter rally length and decreases in hitting opportunities. The current findings suggested that by reducing net height and court-size, skill acquisition can be enhanced among junior badminton players in match-play performance as the condition has improved children's success experience by producing more successful strokes during a match. These factors can be apart from being motivating factors that encourage decision-making in a realistic environment.

Keywords Modified Equipment, Scaling, Skill Acquisition, Badminton

1. Introduction

The constraints-led approach explains that the idea of skill acquisition is influenced by the interaction of three different constraints, which are task (e.g., modified equipment), environment (e.g., court surfaces), and individual (skill level or player's experience) [1]. Newell [2] stated that constraints or boundaries are the limitations or restrictions faced by the individual while acquiring motor skills. These constraints can be manipulated by reducing the task constraints, which may influence the outcome of skill production and enhance skill acquisition among children [1]. The use of adult equipment gives more constraints for children to play sports which might decrease their opportunities to learn the skills due to the lack of physical capabilities. Previous studies have shown that the modification of sports equipment gives benefits for children to acquire the skills in sports more effectively [3-5]. Providing the appropriate size of equipment in the

early stage of learning can be useful for a learner to perform the skills with more desirable movement patterns [5, 21].

Modified or scaling equipment has been studied as manipulation of the task constraints, which could facilitate a learner to acquire the skills with greater success that could lead to greater enjoyment and engagement among children [5-7]. Moreover, altering the equipment size is one of the best ways to improve children's skills performance in sports in which children can also enhance the accuracy of the techniques during practice [3, 5, 8, 9]. The use of a lighter ball in basketball also increased shot frequency and success rates among children [3, 9]. The use of modified equipment might reduce the task constraint which has been beneficial for children to get adequate skills and find various solutions to the task given [5, 10].

In general, many sports still use the standard equipment for children to practice and play without considering their age, capabilities, and stage of development. In badminton, children still use the standard equipment (e.g., racket and court-size, net height) to practice and compete in the official tournament at an early age. The use of standard equipment increases the constraints for children to control the equipment during hitting tasks as their physical capabilities are not the same as adults [11]. Consequently, it could affect children's learning skills during practice in which they might have fewer hitting opportunities, lesser engagement, and satisfaction during activities [5]. Evidence from previous studies has shown that modifying the racket and court size in badminton has facilitated the children to produce a higher number of hitting opportunities and successful strokes in a mini-tournament compared to standard equipment [12].

Net height is also considered as a task constraint that can be manipulated for children to play in sports. In tennis, research has been studied on the effect of scaling net height on children's performance [10, 13]. They found that lowering net height encouraged children to play in an aggressive way in which they tend to perform an offensive play that resembles the adult's play style. Like tennis, badminton should provide an appropriate playing environment (suitable net height and court-size) for children where it might give them opportunities to play like the adult style and may encourage them to learn the skills more effectively. The use of standard net height and court-size might decrease the chances for children to acquire the skills which can affect their enjoyment of the game. Therefore, the current study aimed to investigate the effect of reducing net height and court-size on children's performance in badminton. We hypothesize that children will produce more winning shots, fewer shots struck, and shorter rally lengths when using a lower net height and smaller court-size.

2. Materials and Methods

2.1. Participants

A priori power analysis for an ANOVA repeated measure indicated a minimal sample size of 12 participants ($\alpha = 0.05$, $1\text{-}\beta = 0.95$, $f = 0.50$). Therefore, a total of 16 beginners in badminton (16 boys; *mean age* = 8.3 years ± 1.4; *mean height* = 1.28 m ± 3.1; *mean weight* = 31.3 kg ± 2.7) volunteered to participate in the study. All participants were beginners who were training in the badminton academy program conducted by a certified coach from the Badminton Association of Malaysia (BAM). Players who have had training for more than 12 months were not included in the study. All the participants' guardians were informed through a consent form allowing their children to participate in the study. The Ministry of Education in Malaysia (KPM) (KPM.600-3/2/3-eras (97)) and the Research Ethics Committee of the University Malaysia Sabah (JKEtika 4/17(13)) both gave their approval to the study.

2.2. Quasi-experimental Design

Before the study, participants were ranked by their coach based on their performance during the skill test (i.e., short serve). The participants were divided into eight pairs. Each pair was against the same opposition in all matches. They were required to play using standard racquets. All participants completed four matches, each matching with different sizes of the court (see Table 1). The regular net height is about 87% of the average adult player's (1.8 meters), and the best net height for a modified court may likewise be close to that ratio. Before the first match, participants did a regular 10-minute warm-up. Following the warm-up session, all participants spent five minutes on each court to become comfortable with the court size and net height. Participants played a match that consisted of two sets of 11 points where they continued to play with a different condition for the next day. The study took four days to complete the matches in all conditions. Participants were distributed evenly (counterbalanced) among the four conditions' sequences where they used the same protocol from warm-up till the finish of the match. The current study used the protocol from badminton and tennis studies where they examined the effect of modified equipment among children in real match-play situations [10, 12].

Participants completed four playing conditions as follows:

1. Standard court, standard net (SCSN)
2. Standard court, modified net (SCMN)
3. Modified court, standard net (MCSN)
4. Modified court, modified net (MCMN)

Table 1. Participants playing condition

	Standard court		Modified court	
	Standard net (m)	**Modified net(m)**	**Standard net(m)**	**Modified net(m)**
Net height (m)	1.55	1.24	1.55	1.24
Court length (m)	13.4	13.4	6.1	6.1
Court width (m)	6.1	6.1	4.7	4.7

2.3. Test Procedures

During the matches, participants played against the same opponent in all four different conditions. Participants' rally length, hitting opportunities, successful strokes, winning strokes, unforced error, and strokes struck were calculated manually via video replay post-match (see Table 2). Two video cameras were used to record all the matches where it was located 5 meters in rear court at both sides.

2.4. Data Analysis

To evaluate if the data were normally distributed, a Shapiro-Wilk test was used. The results showed that the data were normally distributed, with $p > .05$. The main effects of net height and court size on the performance variables were evaluated using repeated measures of two-way analysis of variance (ANOVA). The differences between net height and court size situations were assessed using a t-test with Bonferroni correction. The mean and standard deviation of the data were presented. Cohens'*d* was also used to estimate effect sizes (ES). Rhea [14] proposed a modified scale with ES values of 0.25 trivial, 0.25-0.5 small, 0.5-1.0 medium, and > 1.0 large. The statistical program SPSS version 22.0 was used to execute all statistical tests. The statistical significance level was set at $p < .05$.

3. Results and Discussion

3.1. Result

Table 3 projects the descriptive statistics (means and standard deviation) on parameters measure conducted among participants.

3.1.1. Rally Length

Analysis showed that there was no significant interaction between the court and net on rally length, $F (3, 28) = 2.260$, $p > .05$, $\eta 2 = 0.211$. Analysis also showed that there was no significant main effect for court, $F (3, 28) = .224$, $p > .05$, but there was a significant main effect for net, $F (3, 28) = 8.800$, $p < .05$. It demonstrated that the use of the standard net height was significantly greater than modified net on rally length, $p < .05$.

3.1.2. Hitting Opportunities

Analysis showed that there was no significant interaction between the court and net on hitting opportunities, $F (3, 28) = 1.806$, $p > .05$, $\eta 2 = 0.208$. There was no significant main effect for court, $F (3, 28) = .015$, $p > .05$, but there was a significant main effect for net, $F (3, 28) = 9.328$, $p < .05$. It revealed that the used standard net height was significantly higher than modified net height on hitting opportunities, $p < .05$.

3.1.3. Successful Strokes

Analysis showed that there was no significant interaction between the court and net on successful strokes, $F (3, 28) = 2.739$, $p < .05$, $\eta 2 = .270$. A significant main effect was found for net height on the successful strokes F, $(3, 28) = 11.699$, $p < .05$, but there was no significant main effect for court, $F (3, 28) = .012$, $p > .05$. It indicated that the used modified net height was significantly larger than standard net height condition on successful strokes, $p < .05$.

3.1.4. Winning Strokes

Analysis showed that there was a significant interaction between court and net on the winning shots, $F (3, 28) = 11.738$, $p < .05$, $\eta 2 = 0.664$. A significant main effect was found for net height on the winning shots, $F (3, 28) = 49.213$, $p < .05$, but there was no significant main effect for court, $F (3, 28) = 3.222$, $p > .05$. It showed that the used modified net height was significantly greater than standard net height on winning strokes, $p < .05$.

3.1.5. Unforced Errors

For the unforced error, analysis showed that there was a statistically significant interaction between court and net, $F (3, 28) = 9.634$, $p < .05$, $\eta 2 = 0.607$. A significant main effect was found for the net, $F (3, 28) = 33.871$, $p < .05$ and court, $F (3, 28) = 7.376$, $p < .05$. It demonstrated that the used standard net was substantially higher than modified net on unforced errors, $p < .05$.

Table 2. Parameters of the study

No.	Parameter	Description
1.	Rally length (RL)	The number of shots a player takes against an opposition, beginning with a serve and finishing when the point is won (total shots regardless of the outcome).
2.	Hitting opportunities (HO)	Total shots were executed by the players regardless of the outcome.
3.	Successful strokes (SS)	The number of badminton strokes that are successful (hit over the net; hit the shuttle inside the designated playing area only).
4.	Winning strokes (WS)	The player scores a point for successful in-court shots that prevent the opponent's shuttles from being returned.
5.	Unforced error (UE)	A mistake made by a player during play results in the opponent being awarded a point.
6.	Strokes struck (SST)	The number of shots struck into the net (not over the net).

Table 3. Descriptive statistics of the experimental variables

	Standard court		Modified court		Sig.	η2
	Standard net	Modified net	Standard net	Modified net		
Rally length (RL)	50.75 ±6.63	44.25 ±2.12	49.25 ±3.77	47.13 ±2.23	.078	.211
Hitting opportunities (HO)	36.75 ±4.33	32.25 ±3.01	35.50 ±1.51	33.75 ±1.83	.108	.208
Successful strokes (SS)	25.63 ±2.39	28.50 ±2.50[a]	26.50 ±1.25	27.50 ±1.77	.008[*]	.270
Winning strokes (WS)	7.50 ±1.31	11.50 ±1.20[*]	8.13 ±.99[b]	9.50 ±1.05	.000[*]	.664
Unforced error (UE)	8.50 ±.93[*]	5.63 ±.74	6.63 ±1.06[a]	5.75 ±1.03	.002[*]	.607
Strokes struck (SST)	7.0 ±.53[b]	2.88 ±.64[c]	6.38 ±.74[d]	2.63 ±.52[a]	.001[*]	.914

Notes: [a]Significantly different from the standard court – standard net condition

[b]Significantly different from the standard court – modified net condition

[c]Significantly different from the modified court – standard net condition

[d]Significantly different from modified court – modified net condition

[*]Significantly different from all other conditions

3.1.6. Strokes Struck

Analysis of two-way ANOVA with repeated measures showed that there was a significant interaction between court and net, $F(3, 28) = .741$, $p < .05$, $\eta 2 = 0.914$. A significant main effect was found for the net height, $F(3, 28) = 3.421$, $p < .05$ but no main effect for court size, $F(3, 28) = 4.035$, $p > .05$. It revealed that the used standard net height was significantly higher than modified net height on strokes struck, $p < .05$.

3.2. Discussion

The purpose of the study was to determine how the net height and court size affected the match-play performance of badminton players between the ages of 7 and 9. We hypothesized that young children would benefit when playing badminton from a smaller court and a lower net height. Based on Table 3's findings, we may conclude that smaller courts and lower net heights produce more winning shots, fewer unforced errors, and strokes that go into the net than a normal court size and standard net height.

Results showed that modifying the net height and court size made the rally length shorter and created a faster game closely resembling the adult playing style (see Figure 1). A prior study revealed that children lack situational consciousness due to lack of disclosure to fast-paced gameplay where anticipatory skill is necessary. This circumstance may improve children's anticipatory ability [15]. As a result of the net height being decreased to enable more successful shots, children may play more fiercely and competitively [13]. However, a shorter rally length has turned children's hitting opportunities to decrease, which could give limitations for children to improve their skills development [10]. Whereas, a higher hitting opportunity would be beneficial for children to improve their strokes or hitting techniques as they can diversify their stroke preferences to create a lot of variety in tactical and technical play during a match [16].

Reducing the net height in SCMN and MCMN condition has facilitated the children to produce higher successful strokes and winning shots during a match (see Figure 2 and Figure 3). By scaling the task constraints, children can hit the shuttle with greater ease compared to full-size equipment. Low net height resulted in fewer unforced errors (see Figure 3) occurred among children as the conditions helped them to acquire the skill with minimal dependency on cognitive sources which has simplified the skills [17]. As a result, the condition has improved

children's success experience by producing more successful strokes during a match. When using a modified net height and standard court-size, it gives more advantages for children to hit the shuttle to wider locations (i.e., rear court), far from their opponent's reach. Children can try a broader range of strategies to defeat their opponents since they have a variety of possibilities for where to hit the shuttles around the court.

The constraints imposed by a standard court and standard net height may have a detrimental impact on children's learning [18] and limit their ability to experiment with and create new movement strategies, which may affect the learning possibilities available to them to improve their motor skills [19]. This condition has restricted children's movement to make court coverage and produced better strokes performance during a match. Both conditions have produced a higher number of shots struck and a fewer number of successful strokes (see Figure 2). We can see that stroke effectiveness among children is low due to the constraints of the net. It may increase the trajectory of the shuttle among children where they might aim the shuttle higher to avoid the shuttle from struck into the net. This situation might lead children to use more energy during game-play as they want to ensure the shuttle passes through over the net. Children are disadvantaged in this situation as they might experience fatigue in a shorter time due to smaller muscle mass which does not contain extra glycogen to supply more energy during match compared to adults [20].

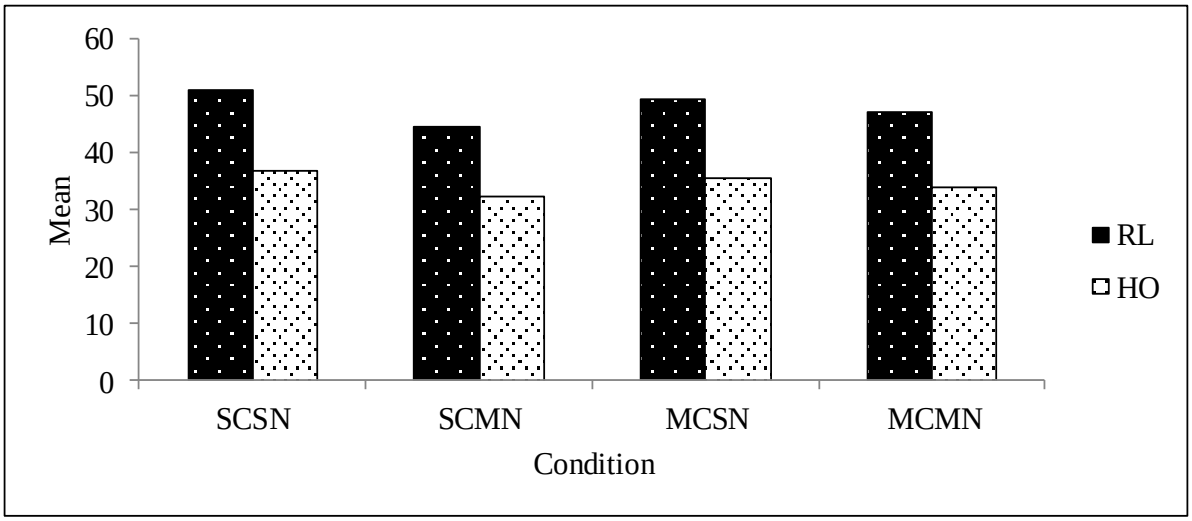

Figure 1. Mean values of rally length and hitting opportunities

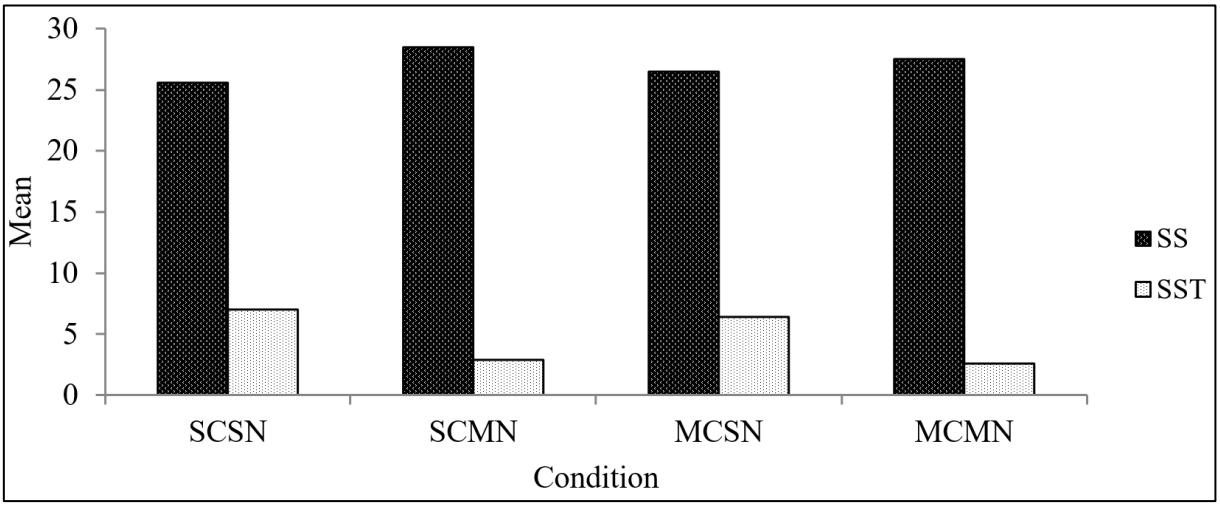

Figure 2. Mean values of successful strokes and strokes struck

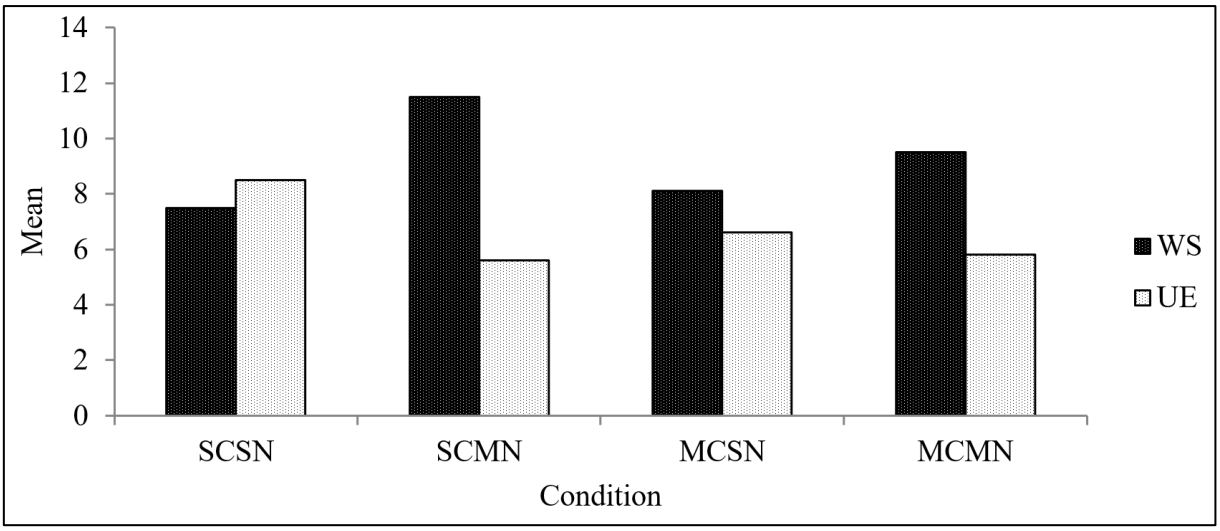

Figure 3. Mean values of winning strokes and unforced error

4. Conclusions

The current research expands on the literature on modified sports by suggesting that the use of a scaled net and court-size will facilitate children to enhance skill acquisition in badminton. Scaling both court-size and the net would be favorable for children as they can play closely like the adult style in which the play area allows them to create a more desirable movement pattern. It would make it easier for the children to practice making decisions as they get bigger and go toward adult match play. Children engaged in a more offensive stroke play and made more game-winning strokes when the net height was lowered. Further research is needed, wherein wrist kinematics and shuttle trajectory should be gathered in addition to the parameters obtained in the present study to enhance our findings. It would provide strong evidence to support the effectiveness of scaling equipment's positive effects on children's motor skills.

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