

The effect of the 40mm diameter ball on table tennis rallies by elite players

Toshiko TAKEUCHI¹, Yoshio KOBAYASHI¹, Shuichi HIRUTA²
and Nobuo YUZA³

¹Chukyo University, Japan; ²Nagoya University, Japan and ³Chukyo Women's University, Japan

Abstract This study dealt with the influence of the ball's mass and size on the number of hits per point (rally hit counts) in table tennis matches. The difference was studied between the conventional 38mm diameter ball that is 2.5 grams in weight, and the currently adopted 40mm diameter ball that is 2.7 grams in weight. Rally hit counts for the 38mm ball were conducted in the All Japan Championships in 1993 and those for the 40mm ball in the same tournament in 2000. The rally hit counts for the 38mm ball were taken from the quarterfinals and the semifinals in both men's and women's singles. The rally hit counts for the 40mm ball were taken from the quarterfinals and the semifinals in both men's and women's singles and from the quarterfinals and the semifinals in both junior men's and junior women's singles. The defensive players' matches have been excluded. The mean of rally hits per point for 38mm and 40mm balls respectively was 3.1 vs. 4.1 in men, and 3.8 vs. 4.6 in women. The same counts were 3.0 vs. 3.3 in junior men and 3.6 vs. 4.6 in junior women. The combined means for men and junior men, and women and junior women were 3.1 vs. 3.8 and 3.7 vs. 4.6 for 38mm and 40mm balls, respectively. The frequency distribution for the rally hit counts in all groups for both the 38mm and 40mm balls were concentrated toward the low end of the scale. In conclusion, the rallies in elite players during table tennis matches are lengthened with a 40mm ball, which may result from slower flight and spin characteristics of the larger ball.

1 40mm diameter ball and rally hit counts in All Japan Table Tennis Championships

In recent years, competitive table tennis has been criticized as not producing longer rallies because of over-reliance on advancement in rubber technology, which yields more spin and speed. Longer rallies during table tennis matches are consequently more attractive to not only spectators but also TV viewers.

In February, 2000, The International Table Tennis Federation (ITTF) officially adopted a larger ball of which the diameter is 40mm, and weight is 2.7 g, hoping

to decrease the ball speed compared to the traditional 38mm ball (2.5 g) and consequently increasing the length of time of rallies.

The purpose of the present study was to compare the newly adopted 40mm large ball to the conventional 38mm ball to determine whether diameter differences cause differences in number of hits per point (rally hit counts).

2 Methods and materials

The rally hit counts for this study for the 38mm ball were conducted in the All Japan Table Tennis Championships held in 1993, and those for the 40mm ball in the same tournament in 2000. The method for rally hit counts was identical for both 38 and 40mm balls. Several investigators sat down behind the court and recorded the number of hits per point during each match. The first ball served by the server was counted as 1 (one) if the service was successful, and the second hit by the receiver was counted as 2 (two) if the return was successful, and so forth on. The net-in and edge-in balls were counted as rally hit counts but a swing wide and net-in ball by service were not counted.

The rally hit counts for the 38mm ball were taken from the quarterfinals and semifinals in both men's and women's singles and from the semifinals in both junior men's and junior women's singles. On the other hand, the rally hit counts for the 40mm ball were taken from the quarterfinals and the semifinals in both men's and women's singles and from the quarterfinals, semifinals and the finals in both junior men's and junior women's singles. However, defensive player's matches were excluded.

In addition to the rally hit counts investigation, a questionnaire was distributed to all participating players in the tournament in 2000 to subjectively evaluate differences in spin, speed, resistance and so forth of the 40mm ball as compared to the 38mm ball. The questionnaires were returned during the tournaments. Furthermore, another questionnaire was given to the spectators who came to watch the games on the final day of the tournaments. However, the spectators who were asked to fill out the questionnaire were limited to those who had previously watched the 1993 All Japan Table Tennis Championships and its equivalents.

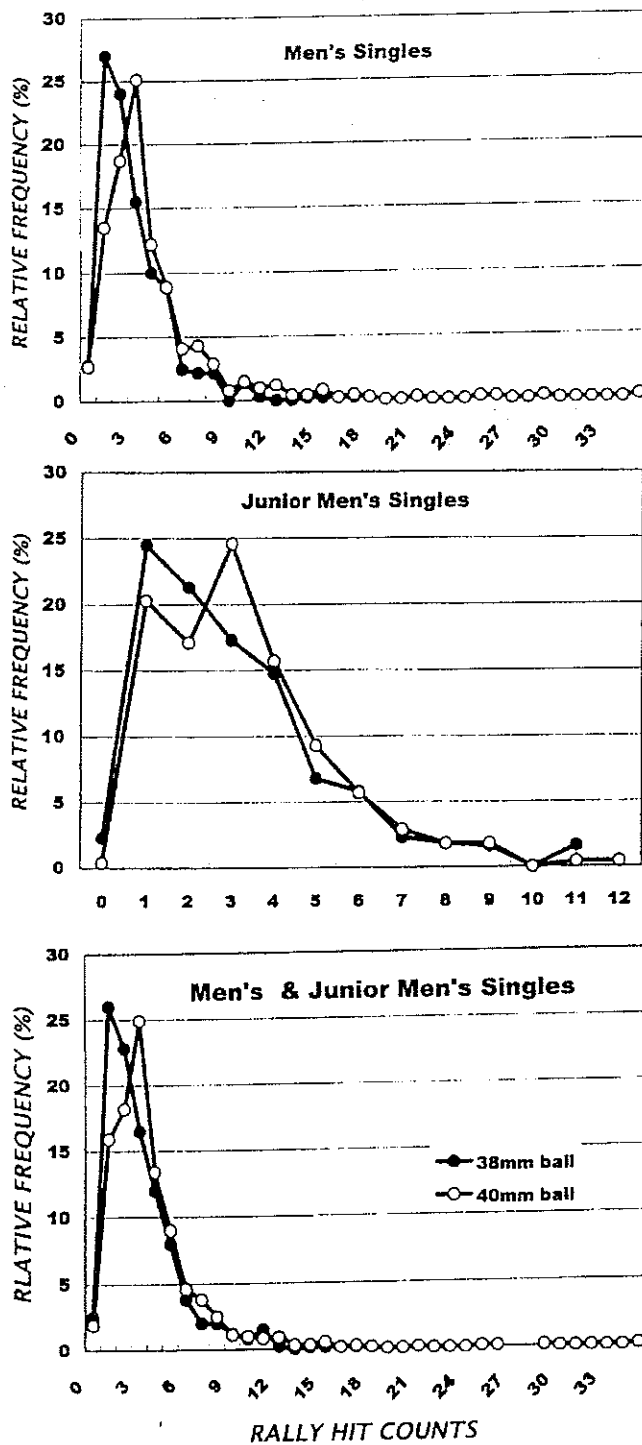


Figure 1. Comparison of relative frequency distribution of rally hit counts during matches between 38mm and 40mm balls in men's and junior men's singles, and in their combined scores; ●=38mm ball, ○=40mm ball.

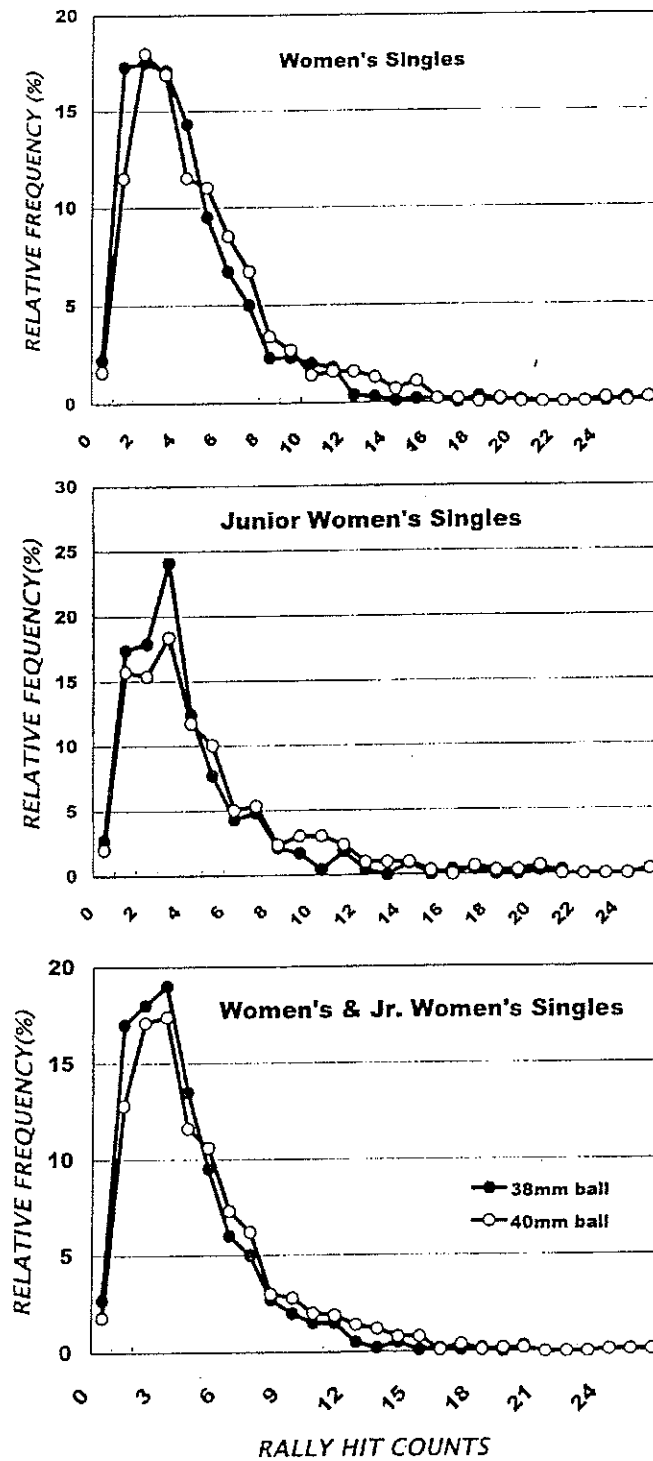


Figure 2. Comparison of relative frequency distribution of rally hit count during matches between 38mm and 40mm balls in women's and junior women's singles, and in their combined scores; ● =38mm ball, ○=40mm ball.

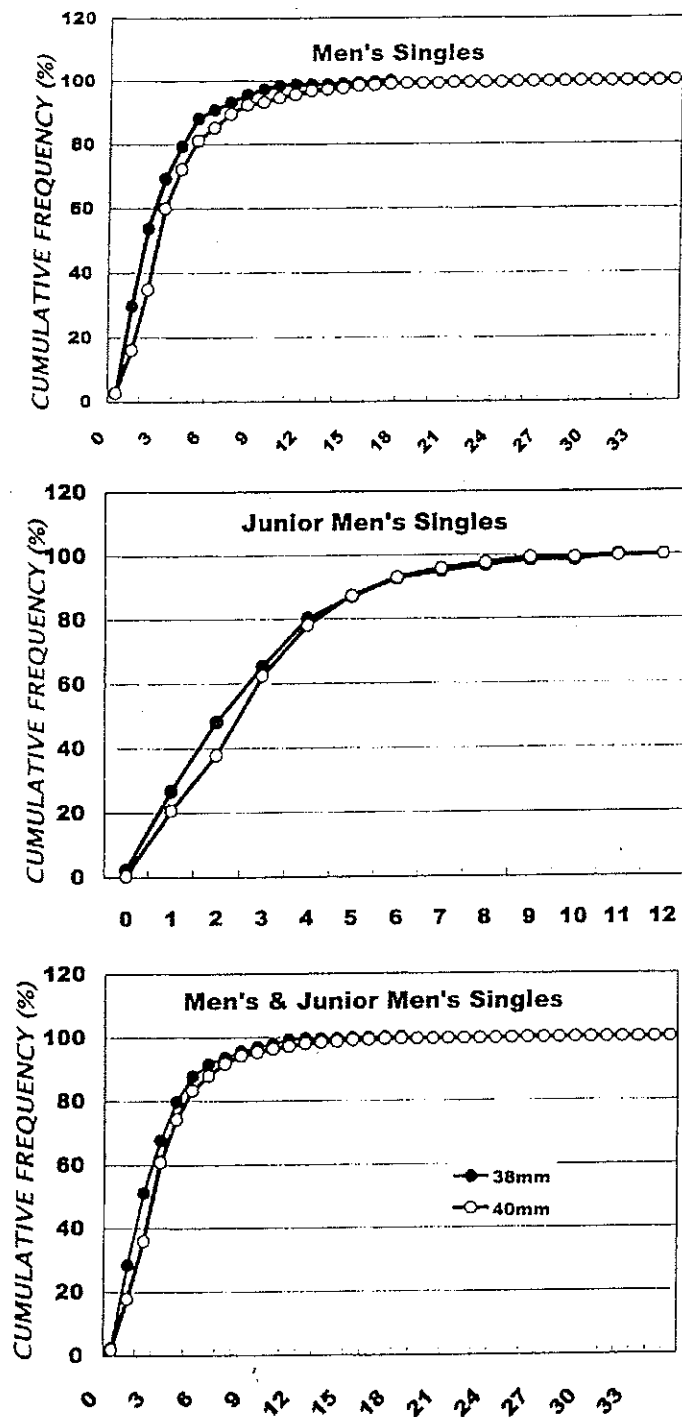


Figure 3. Comparison of cumulative frequency distribution of rally hit counts during matches between 38mm and 40mm balls in men's and junior men's singles, and their combined scores; ●=38mm ball, ○=40mm ball.

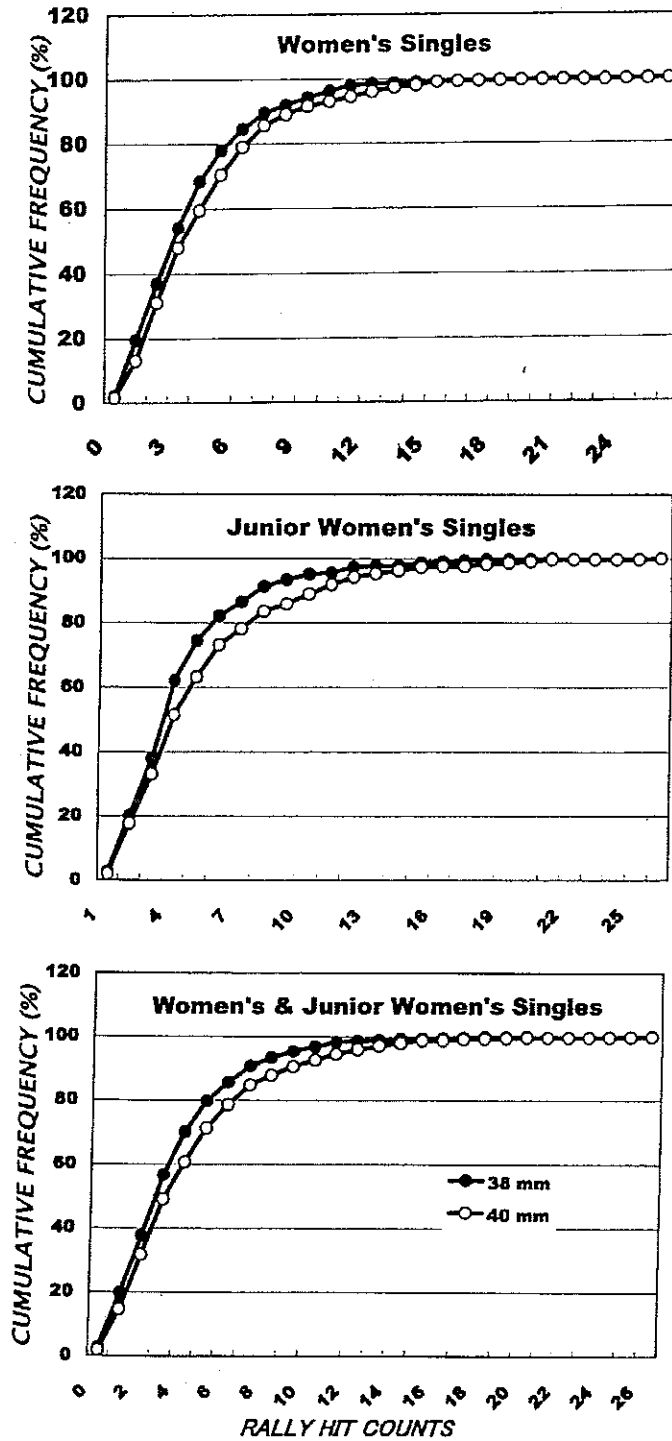


Figure 4. Comparison of cumulative frequency distribution of rally hit counts during matches between 38mm and 40mm balls in women's and junior women's singles, and their combined scores; ●=38mm ball, ○=40mm ball.

3 Results

The frequency distribution curves of rally hit counts for the 4 groups and two combined groups are depicted in Figures 1 and 2. The curves for both 38mm and 40mm balls were concentrated toward the low end of the scale with the curve trailing off to the right (high end of the scale). We observed that the curve of the 40mm ball tended to be on the right of the curve of the 38mm ball. This right shift of the 40mm ball curve was associated with the reduction in the relative frequency ratio (%) of 1 hit and 2 hit rallies when compared to those of the 38mm ball. The ratio of 1 hit and 2 hit rallies in men's singles was 13.5% and 18.7% of the total, respectively for the 40mm ball while 27% and 24%, respectively for the 38mm ball. The same statistics in women's singles were 11.5 % and 18% of the total for the 40mm ball while 17.3% and 18% for the 38mm ball. When we compared these ratios in junior players, 20.3% and 17.1% were observed for 1 hit rally and 2 hit rallies, respectively for the men's 40mm ball while 24.5% and 21.3%, respectively for the men's 38mm ball; and 15.7% and 15.4%, respectively for the women's 40mm ball while 17.4% and 17.9%, respectively for the women's 38mm ball. The cumulative frequency distribution curves of the 38mm and 40mm balls in men and women are illustrated in Figures 3 and 4, respectively. It is also obvious from these figures that the total percentages demonstrated in 1 through 3 hit rallies were smaller for the 40mm ball than the 38mm ball in any groups.

Table 1. The means and ranges of rally hit count scores for 38 and 40mm balls in men's singles, women's singles, junior men's singles, junior women's singles, a combination of men's and junior men's singles and a combination of women's and junior women's singles.

		Men	Women	Jr. Men	Jr. Wom.	Men/Jr.men	Wom./Jr.wom.
38 mm	Mean	3.1	3.8	3	3.6	3.1	3.7
	Range	0-18	0-25	0-11	0-21	0-18	0-20
	Samples	411	948	248	254	659	1202
40 mm	Mean	4.1	4.6	3.3	4.6	3.8	4.6
	Range	0-35	0-26	0-12	0-25	0-35	0-26
	Samples	518	556	281	299	799	855

Table 1 presents the mean rally hit counts per point in the six groups. The mean values for the 40mm ball in men, women, junior men, junior women, the combination of men and junior men and the combination of women and junior women were 4.1, 4.6, 3.3, 4.6, 3.8 and 4.6 rallies, respectively, while the respective values for the 38mm ball were 3.1, 3.8, 3.0, 3.6, 3.1 and 3.7 rallies. The 40mm ball averaged approximately 0.8 hit per point as compared to the 38mm ball. Since standard deviation (SD) values in the investigation of the 38mm ball were not available, unfortunately, we could not express a statistical significance for the increase in the mean of rally hit counts for the 40mm ball.

Table 2. Results of the questionnaire to the players who participated in the tournaments. "How have you felt about the 40mm ball comparing with 38mm ball?"

1 Speed of 40 mm ball	slower	79.60%
	no difference	18.30%
	others	2.20%
2 Movement of the ball	easier to anticipate	51.60%
	harder to anticipate	11.80%
	no difference	34.40%
3 Spin of the ball	easier to develop	11.80%
	harder to develop	78.50%
	no difference	9.70%
4 Weight of the ball	heavier	73.10%
	lighter	6.50%
	no difference	18.30%
5 Feeling of physical discomfort	Yes	68.80%
	None	31.20%
	others	0%
6 Your game strategy	must change	30.10%
	no need to change	62.40%
	others	7.50%
7 physical fatigue after the games	fairly fatigued	21.50%
	a little ftigued	40.90%
	not different	35.50%
8 Necessity of a new racket	Yes	50.50%
	No	28.00%
	don't know	17.20%

Number of returned questionnaires

Results of the questionnaire distributed to the players who participated in the tournaments are summarized in Table 2. The number of responses was 93 as a result of an 8.5% return ratio ($93/1100 \times 100$). When asked to compare the 40mm ball to the 38mm ball, the players responded thus; 1) the speed of opponents' ball seemed to be slower (80%), 2) it was easier to anticipate the opponents' ball movements (52%), 3) it was harder to spin the 40mm ball (79%), 4) the ball mass seemed to be heavier (73%), 5) physical discomfort was felt (69%), 6) a modification in the game strategy and tactics is needed (62%), 7) physical fatigue was felt after the game (62%), and 8) a new and different racket is needed to adjust effectively to the larger ball (51%).

Table 3. Results of the questionnaire to the spectators who have previously watched the All Japan Table Tennis Championship and its equivalents.

"How did you feel about the games using the 40 mm ball as compared to those of the 38 mm ball?"

1 Rally:	
seemed to be lengthened	72.10%
seemed to be shortened	5.60%
seemed to be not different	20.80%
others	1.50%
2 Movements of the ball:	
easier to see	62.90%
harder to see	1.50%
no difference	34.50%
others	1.00%
3 Comments on the games using the 40 mm ball:	
The games were highly exciting	48.70%
The games were not exciting	5.10%
could not find any difference from 38 mm ball games	41.10%
others	5.10%

Number of returned questionnaires: 355

Results of the questionnaire distributed to the spectators are illustrated in Table 3. All respondents were spectators who came to watch the games on the final day of the tournament, and moreover, had previous experience watching the same tournament or its equivalents when the 38mm ball was used. They responded as follows; 1) the rally during the matches seemed to be lengthened (72%), 2) it was easier to see the ball movements (63%), and 3) the games became highly exciting from the very beginning (49%).

4 Discussion

The aim of this study was to determine whether diameter differences in the table tennis ball cause differences in the number of hits per point (rally hit counts) during table tennis matches. The present investigation demonstrated that the mean values for the rally hit counts per point in the above groups were significantly higher for the 40mm ball than the 38mm ball (Table 1). The increase in the mean values for the 40mm ball were clearly associated with the smaller percentage of the total for short rallies of 1 hit and 2 hits as shown in Figures 1~4. This may be due to the fact that the service power was reduced and therefore,

the mistakes in receiving were reduced for the 40mm ball. Since the ball became larger and heavier, it became harder to spin it. Consequently the spin and speed of the server's ball is reduced and the response for receiving the ball became easier to control. Such an idea can be applied in any situation throughout the matches. This is supported by the players' responses in the questionnaire (Table 2), in which approximately 80% of the players responded that the speed and spin of his or her opponents were reduced. The lowered power of the spin and speed of the 40mm ball observed in the present study is in accordance with the study reported by Tang *et al.* (2001) in which the researchers report that the initial speed and the spin of the 40mm ball, calculated by using a serving machine and a speed measurement system, were 1-2% and 5-20% respectively, less than those of the 38mm ball. Santelices (2001) also reported that the speed of the 40mm ball is slower and therefore, anticipation is easier as compared with the 38mm ball.

Due to the larger diameter and mass of the 40mm ball, physiological effects may be present and technical adjustments may be required. About 63% of the respondents for our questionnaire reported more physical fatigue (22% of them fairly fatigued, and 41% of them a little fatigued) after the games using the 40mm ball (see Table 2). Therefore, a high level of physical fitness, especially speed endurance should be enhanced in order to overcome the physical challenges resulting from the larger mass of ball and the longer rallies. Furthermore, about 51% of the respondents pointed out a need for a different racket for the 40mm ball. Ishigaki (2001) has pointed out that the increased ball mass requires the players to hit the 40mm ball at a point closer to the racket center to overcome the increased ball pressure.

The longer rallies with the 40mm diameter ball observed in the present investigation agreed with the results of the questionnaire returned by the spectators. As shown in Table 3, more than two thirds of the respondents supported our results. It is worthy of note to see in the questionnaire that 50% of the respondents expressed that the matches using the 40mm ball were highly exciting. Therefore, the decision of adopting a large ball with 40mm diameter in size was successful in terms of more enjoyable table tennis games for spectators or TV viewers.

In conclusion, the number of hits per point (rally hit counts) in the newly adopted large ball (40mm diameter, 2.7 g) was increased as compared to the conventional 38mm ball of 2.5 g. This longer rally was mainly because the spin and speed of the ball was reduced and consequently controlling or anticipating the ball has become easier. The results of the present investigation can presumably be assumed to benefit spectators and television viewers who would be able to follow the play easier. Therefore, a 40mm large ball is beneficial to increase interest for both the players, especially beginners, as well as spectators.

5 Acknowledgements

The authors express their appreciation to Japan Table Tennis Federation and Aichi Prefecture Table Tennis Association for their positive support in this study. In addition, the authors are indebted to students of Chukyo University, Aichi

Institute of Technology and Chukyo Women's University for their valuable assistance.

6 References

- Tang H, Mizoguchi M, Matsumoto I, Satoh K, Shimizu S and Toyoshima S (2001) Characteristics of rallies in table tennis with 40mm diameter ball. Proceedings of the seventh ITTF Sports Science Congress, p16.
- Santelices OY (2001) The use of 40mm table tennis ball by the University of Philippines varsity table tennis team. Proceedings of the seventh ITTF Sports Science Congress, p 20.
- Ishigaki H (2001) Distribution of contact points on the racket with 40mm balls. Proceedings of the seventh ITTF Sports Science Congress, p 14.