PITCHING ACCURACY IN PROFFESSIONAL, HIGH SCHOOL AND JUNIOR HIGH SCHOOL PITCHERS

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The purpose of this study was to investigate the differences in pitching accuracy among three different age groups. Professional (n=5), high school (n=8), and junior high school (n=11) pitchers were tested. To determine pitching accuracy, pitch locations relative to the catcher's mitt were fitted to a bivariate normal distribution and a 90% confidence ellipse was obtained for each pitcher. Significant main effects were observed for age group in all of the parameters analysed, including: area, major radius and minor radius. There were significant differences in the minor and major radii of the 90% confidence ellipses between professional and junior high school players. The pitching accuracy of high school and professional players was also significantly greater than that of junior high school players. The superior pitching accuracy demonstrated by professional pitchers may be an important motor skill that is required to pitch at the professional level.

KEYWORDS: baseball, throwing, motor development.

INTRODUCTION: Baseball pitching is a complex motor task that requires both high velocity and accuracy. While many studies have investigated the kinematic and kinetic variables of overhand throwing and baseball pitching (Fleisig et al., 1999), little research has focused on the accuracy of pitching. The present study aimed to determine how accurately highly competitive baseball pitchers could throw a ball and to assess the extent to which pitching accuracy differs between age groups. The primary purpose was therefore to quantitatively evaluate and compare pitching accuracy among three different age groups including professional pitchers.

METHODS: Five professional baseball pitchers, 8 high school and 11 junior high school baseball pitchers participated in this study (Table 1). Overhand and sidearm pitchers were included among the participants and all were right-handed. All participants provided informed consent prior to data collection, and had no shoulder or elbow-related injuries. The pitchers were instructed to throw a ball from the pitcher's mound to the home plate. They were also instructed to aim at a mitt being held by experimenter as a target. After their own warm up, each subject performed a total of 30 throws in three 10-pitch sessions. In one session, the pitchers threw only fastballs. In the other two sessions, they threw 5 fastballs and 5 breaking balls instructed to them at random by the experimenters. The typical inter-pitch interval was approximately 10-30s. A rest period of at least one minute was given between sessions.
Ball velocity was measured using a radar gun (ATLAS, BSG-1) from behind the home plate. The pitch location was recorded by a digital video camera (Panasonic HC-V100M, Japan). The camera was set at a position of 5~8 m ahead from the home plate. In this paper, we regarded the position of the catcher's mitt before each pitch as the target. To visualize and quantify pitching accuracy, pitch location relative to the catcher's mitt was fitted to a bivariate normal distribution and a 90% confidence ellipse was drawn (Figure 1). Major and minor radii of the ellipses were compared between age groups using an ANOVA and Tukey's post-hoc test.

Table1 Physical characteristics of subjects

	Professional (n = 5)	High school (n = 8)	Junior high school (n = 11)
Age (years)	26.2±2.7	17.0±0.0	13.3±0.7
Body height (cm)	184.6±1.5	178.2±5.7	167.6±6.5
Body weight (kg)	84.0±10.1	73.9±4.3	55.8±9.1
Ball velocity (km/h)	136.0±1.87	126.5±6.7	105.4±9.3
Pitching experience	Professional leagues	National tournaments	National tournaments

RESULTS: Our analysis of the 90% confidence ellipses showed a clear difference in pitching accuracy between the groups (shown in Figure 1). Age group was found to have significant main effects for all parameters analysed, including: area, major radius and minor radius. The results of the post-hoc analysis (shown in Figure 2), revealed that professional and high school players were significantly more accurate than those in junior high school. Professional players exhibited remarkable precision (the minor radius for the group measured only 27cm, which is roughly the size of a baseball glove), however they were not found to be significantly more accurate than high school players. This was possibly due to the small number of participants in this group (n=5).

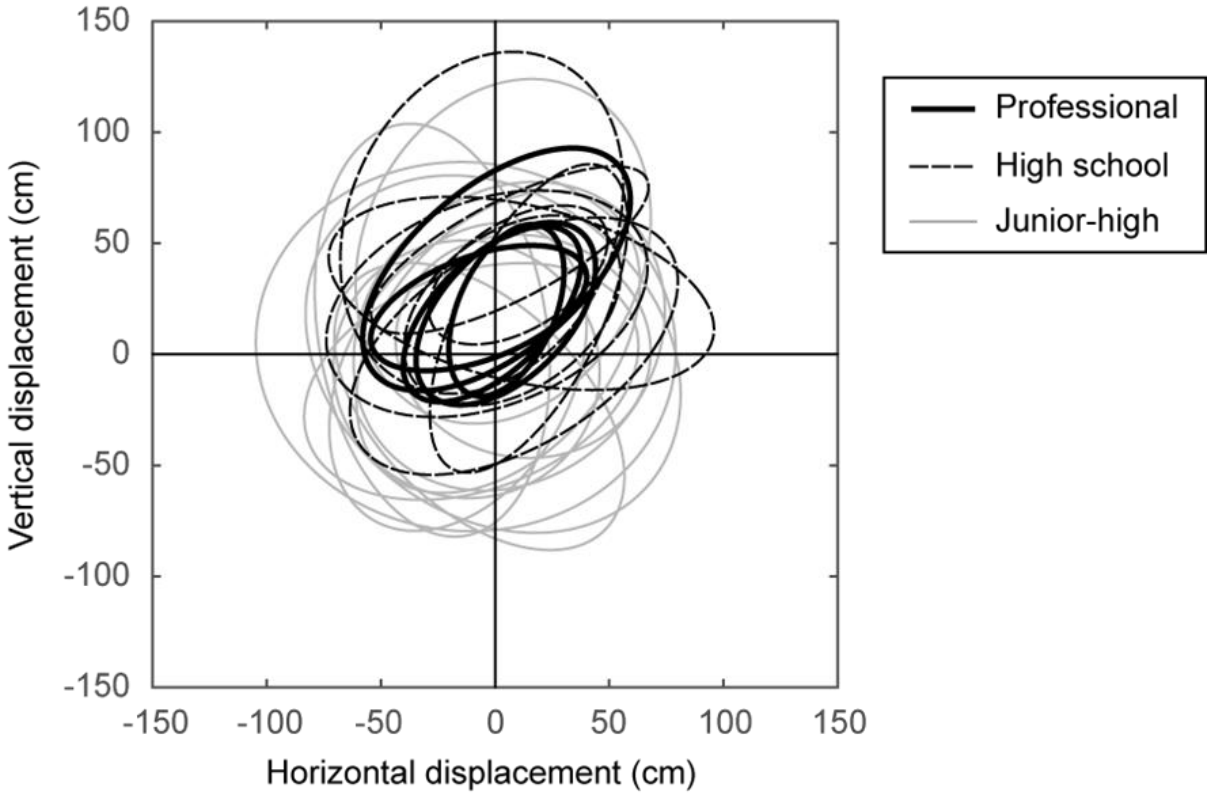

Figure 1: Ninety percent confidence ellipses showing pitching accuracy.

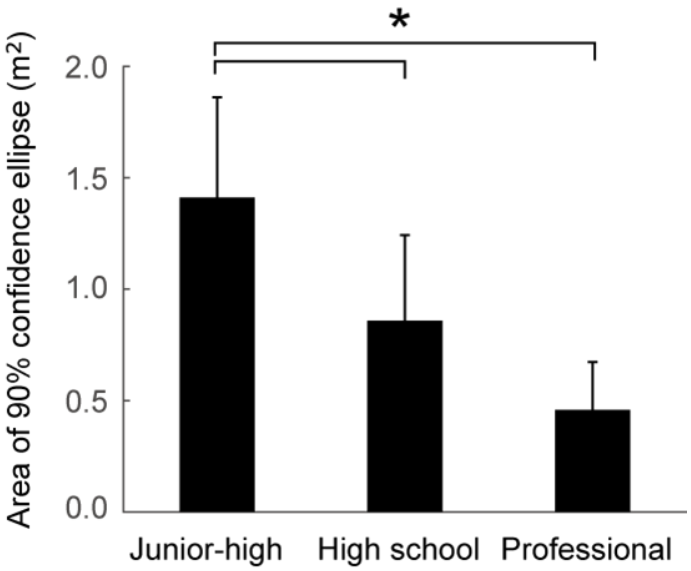

Figure 2: Area of the 90% confidence ellipse.
*** p < 0.05**

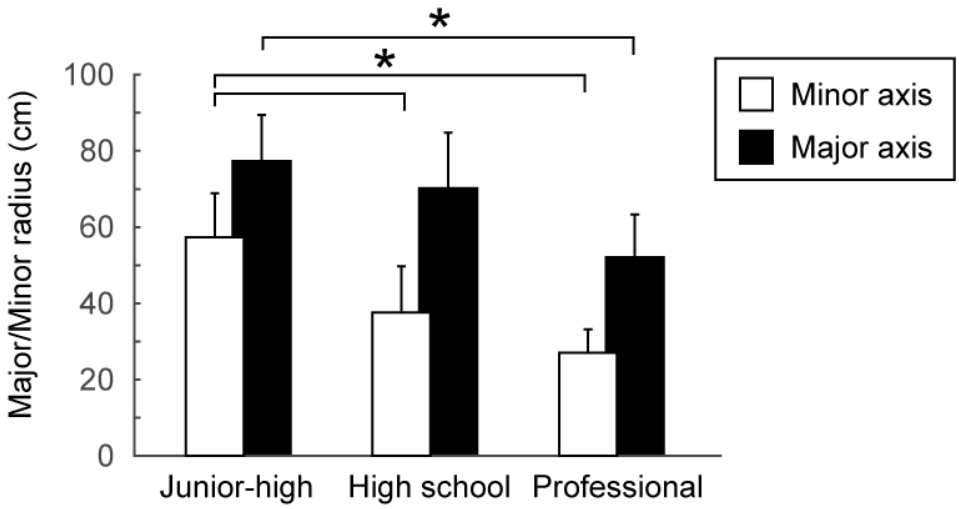

Figure 3: Minor and major radius of the 90% confidence ellipse.
*** p < 0.05**

DISCUSSION: We quantified pitching accuracy using the area and radii of the 90% confidence ellipse. The professional players were able to pitch the ball to within 30 cm * 50 cm of the area. This could be the highest possible level of performance as the participants in this study were players from the professional Japanese league. Our analysis revealed that the distribution of pitch location formed an elliptical shape, which appeared to be related to hand trajectory during pitching.

In regards to the shape of the ellipsis, there were significant differences in both the major and minor radii between junior high school and professional players (shown in Figure 3). The ellipses of professional players with more precise pitching accuracy generated narrower shapes. In the current study, none of the radii measurements were found to be statistically different between high school and professional players. While this may have been due to the small sample size in this study, the results indicate that there was no significant difference in pitching accuracy between high school and professional players. It was also worth noting that the performance of the most accurate high school participant was comparable to that of the professional pitchers (major radius: 44 cm, minor radius: 24 cm). The neural bases associated with pitching accuracy might develop faster than the musculoskeletal strength responsible for ball velocity. According to Fleisig et al. (2009), ball velocity increases throughout the teenage years. A separate study also concluded that there is a considerable difference in the kinetic variables of pitching between teenagers and professional players (Fleisig et al., 1999). The results from those studies suggest that the physical growth related to ball velocity is comparatively slow. Therefore, the developmental differences between the physical and neural factors involved in pitching may have important implications for the training of pitchers.
There are some limitations to the present study, the first of which is survival bias. Even junior high school players who will become professional players in the future, may be highly accurate. Since we only recruited players from junior high and high school teams, our samples may not have included top-level athletes for those age groups. In addition, our findings pose interesting biomechanical questions, such as: what factors determine pitching accuracy and distribution? Detailed motion analysis of more participants would help answer these questions.

CONCLUSION: The current study successfully quantified the pitching accuracy of participants and demonstrated that there were significant differences in pitching accuracy between the three age groups tested. The pitching accuracy of professional players was within 30 * 50 cm of the target, which may represent the highest possible level of precision among baseball pitchers.

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