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Comparison of Pitching Kinematics between Normal-Weight and Overweight Group in High School Baseball Pitchers

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Abstract

This study compared differences in pitching kinematics between normal-weight and overweight high school baseball pitchers. Twenty male pitchers were included in the study. According to the 2020 guidelines on the Body Mass Index (BMI) standard for children and adolescents by the Korean Society for the Study of Obesity, 10 participants with BMI below the 85% percentile were assigned to the normal-weight group, and 10 participants with BMI above the 85% percentile were assigned to the overweight group. The two groups threw 10 trials for a fastball with maximum effort. Out of 10 trials, three pitches thrown in the strike zone with the fastest velocity were extracted. The mean ball velocity was measured, and the mean and maximum angle and angular velocity of the knee, pelvis, trunk, shoulder, and elbow joints were calculated. The differences in the ball velocity, angle, and angular velocity between the two groups were compared using an independent t-test ($p<0.05$). There were no differences in mean ball velocity between the two groups. However, compared with the normal-weight group, the overweight group showed smaller knee flexion, trunk forward tilt, trunk rotation, maximum trunk angular velocity, shoulder external rotation and maximum shoulder external rotation, while shoulder abduction and maximum elbow flexion were greater. These results suggest that the overweight group may have a high risk of soft tissue damage in the knee, shoulder, and elbow joints caused by limited movement of the trunk and inefficient movement between the extremities during power pitching.

Key words: fastball, pitching kinematics, ball velocity, body mass index, overweight

Introduction

Pitchers play an essential part in a baseball game, as encapsulated in an old saying that "Baseball is a battle of pitchers". Excellent pitching by pitchers is an important factor that determines approximately 80% of a win, and fastball velocity is an essential factor in retiring a batter (Matsuo et al., 2001; Yang et al., 2013). A pitch at a speed of approximately 145 km/h reaches the home plate in about 450ms, and during this short

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period of time, the batter must judge the ball and elect whether to swing or not for an accurate hit. Notably, the increments in the fastball velocity cause a reduction in the reaction time of batters by about 1% with a 1.6km/h increment of ball speed (Caldwell et al., 2019). As a result, the faster the ball velocity, the more challenging it is for batters to identify the pitch and determine to swing within a shorter reaction time (Crotin et al., 2015; Kishita et al., 2020).

The pitching motion of baseball players consists of a series of instantaneous movements of the knee, pelvis, trunk, shoulder, elbow, and wrist segments. Coordination between each segment is essential to increase the ball velocity. Accordingly, previous studies divided the pitching motion into the foot contact (FC) event when the lifted foot during windup touches the ground, the ball release (BR) event when the ball is released, and the FC-BR phase for the acceleration period between the two events to analyze the relationship between ball velocity and kinetic/kinematic elements of each body segment at each event and phase. As a result, at the FC event, a greater vertical ground reaction force applied to the stepping foot and a greater flexion angle of the knee and elbow joints increased the pitching velocity (McNally et al., 2015; Werner et al., 2008). At the BR event, a greater extension angle of the knee joint and forward tilt angle of the trunk as well as a greater linear velocity of the wrist increased the ball velocity (MacWilliams et al., 1998; Mercier et al., 2020). In the FC-BR phase, the acceleration period between the two events, the maximum external rotation and abduction angle of the shoulder joint and angular velocity of the trunk was positively correlated with ball velocity (Nicholson et al., 2022; Stodden et al., 2001; Wang et al., 1995). In summary, to increase the ball velocity, the ground reaction force generated during the FC event must be efficiently transferred to the ball during the BR event. This can be achieved by maximizing the range of motion (ROM) of each body segment at each event and phase and establishing coordination between each body segment.

In baseball, tall and heavy pitchers tend to have a higher ball velocity. In a study that analyzed the effects of body composition of elite players playing different positions on baseball performance, pitchers showed higher height, weight, and muscle mass than players in other positions, which were positively correlated with ball velocity (Carvajal et al., 2009). Additionally, in another study on the relationship between physical performance and pitching velocity of pitchers in a professional baseball team tryout, pitchers with higher muscle strength and power had a faster pitching velocity (Huang et al., 2022). Based on these findings, the physical characteristics of pitchers were significantly correlated with ball velocity, suggesting the importance of muscle strength and power improvement training of the trunk and extremities to increase ball velocity (Stodden et al., 2005; Wong et al., 2022; Yamada et al., 2013).

However, increased weight due to excessive muscle strength and power is associated with a high risk of serious injuries to each body segment. Especially, as the power pitching involves rapid execution of flexion, extension, and rotation of the trunk and extremities, pitchers with greater body inertia parameter such as body weight accumulate more stress on each body segment due to internal and external forces. Major League Baseball (MLB) statistics from 2010 to 2016 show that pitchers had significantly more elbow and shoulder injuries than fielders and catchers. Similarly, in a study on injuries in MLB pitchers, pitchers with greater body weight had a higher risk of injury when pitching fastballs than those with normal body weight (Fares et al., 2020).

In particular, elbow, shoulder, and knee injuries were more prevalent in middle and high school baseball pitchers than in professional pitchers (Hartnett et al., 2022; Sekiguchi et al., 2018). Previous studies have suggested the possibility that such injuries in middle and high school pitchers may be related to the deformation of bones and soft tissues to adapt to fast and repetitive pitching motions (Sabick et al., 2005;

Table 1. Participant characteristics (n=20)

Variables	Normal-weight	Overweight	t	*p*-value
Age (years)	15.80±0.29	16.30±0.34	-1.13	.274
Career (years)	7.90±0.57	7.90±0.72	0.00	1.00
Height (cm)	184.40±1.85	182.10±1.89	0.87	.396
Weight (kg)	76.96±2.49	92.68±2.18	-4.76	.001*
BMI (%)	22.65±0.69	27.93±0.38	-6.71	.001*

Statistical significance: *$p<0.05$

Shanley & Thigpen, 2013). Compared to professional pitchers, middle and high school pitchers who are in their rapid growth period have immature skeletons and unevenly developed muscles. As a result, middle and high school pitchers are likely to have risks of injuries because of excessive weight to increase ball velocity.

This study aimed to compare and analyze the differences in kinematic variables (angle, angular velocity) of the knee, pelvis, trunk, shoulder, and elbow joints during power pitching between normal-weight and overweight groups of high school pitchers and identify the potential risk of injury in the overweight group.

Methods

Participants

Twenty male high school baseball pitchers were recruited from 6 high schools in the pre-season. All participants were regarded as overhand type pitchers. The participants were divided into two groups according to the Body Mass Index (BMI) standard for children and adolescents defined in the revised 2020 Obesity Treatment Guidelines by the Korean Society for the Study of Obesity. Ten participants with BMI below the 85% percentile were assigned to the normal-weight group, and the remaining 10 participants with BMI above the 85% percentile were assigned to the overweight group. All participants and their parents received explanation regarding the purposes and procedures of the study and signed an informed consent approved by the Seoul National University Institutional Review Board (IRB No. 1907/003-015).

All participants had no musculoskeletal injuries related to pitching motion and expressed subjective opinions that they had no abnormality in pitching. The mean age, mean baseball experience, mean height, mean weight, and mean BMI of high school baseball pitchers in the two groups are shown in Table 1.

Experimental Procedure

The two groups performed a pitching task using an official ball (KA-100, Big Line Sports, Korea) on a stepped mound manufactured to the same specifications indicated in the official baseball rules. Prior to measuring the pitching task, each participant conducted 10 practice pitches to perform consistent pitching motions within the experimental environment. Then, in the strike zone 18.44m away from the pitcher's plate, each participant threw 10 trials for a fastball as in actual baseball games (Figure 1-A). To prevent fatigue during the pitching task, rest time was provided as much as needed between each pitch. A Full Body Plug in Gait model marker set was used to calculate the angle and angular velocity of the knee, pelvis, trunk, shoulder, and elbow joints involved in the pitching motion, and a total of 40 reflection markers were used for the whole body (4 yellow markers: head, 6 gray markers: trunk, 7 orange markers: right arm, 7 purple markers: left arm, 4 black markers: pelvis, 4 pink markers: right leg, 4

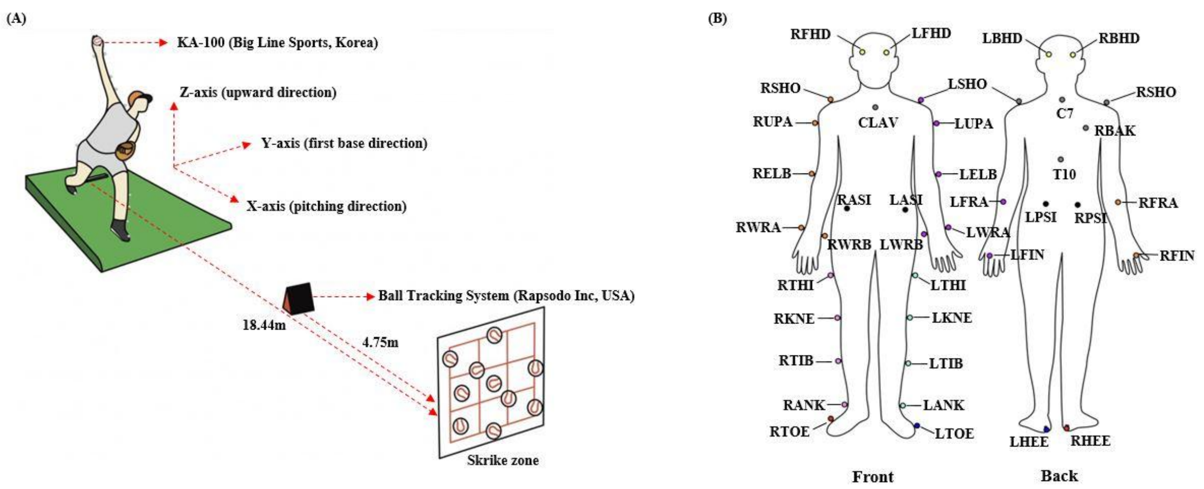

Figure 1. *The pitching task is shown in this figure. The pitcher threw the fastball from the pitching mount to the catcher located 18.44m away. The coordinate system for pitching motion analysis is as follow: the X-axis represents the pitching direction, the Y-axis represents the first base direction, and the Z-axis represents the upward direction, respectively (A). Full body plug in gait model marker set for the pitching motion analysis. 40 reflective markers (25 mm) were attached bilaterally by the same experimenter onto the participant's skin over standardized bony landmarks (B).*

mint markers: left leg, 2 red markers: right foot, and 2 blue markers: left foot). The detailed placement of each marker is shown in Figure 1-B. The pitches were measured using a total of 11 three-dimensional infrared cameras (Vero v2.2, VICON Motion Systems Ltd., UK), and pitching motion data were collected at 300 Hz per second. The pitching velocity was measured using One Ball Tracking System (Rapsodo Baseball System, Rapsodo Inc, USA).

Data Analysis

The pitching motion data measured 10 trials were stored in a motion analysis software (Nexus 2.11.0, VICON Motion Systems Ltd., UK). Of the collected data, three pitches thrown in the strike zone with the fastest velocity were extracted. Then, a Butterworth 4th-order low-pass filter set at a cut-off frequency of 10 Hz was applied to the extracted data to reduce noise generated during measurement. Python 3.7.3 (Python Software Foundation, www.python.org) was used to calculate the angle and angular velocity of each body segment. All kinematic variables were measured at FC and BR events to calculate the mean value at each event and the mean maximum value at FC~BR phase (Figure 2). Table 2 shows explanation of kinematics calculated in the process of analyzing the pitching motion of high school baseball pitchers.

Statistics

The measured velocity and kinematic variables of pitching motion were expressed with descriptive statistics (mean ± standard error). The mean and standard error of all variables were statistically analyzed using SPSS 24.0 (IBM, Armonk, NY). Levene's test for equality of variance was conducted to verify homogeneity between the normal-weight and overweight groups. The independent t-test was conducted at the FC event, BR event, and FC-BR phase to compare differences in the angle and angular velocity of each body segment between the two groups. A p-value less than 0.05 was considered statistically significant.

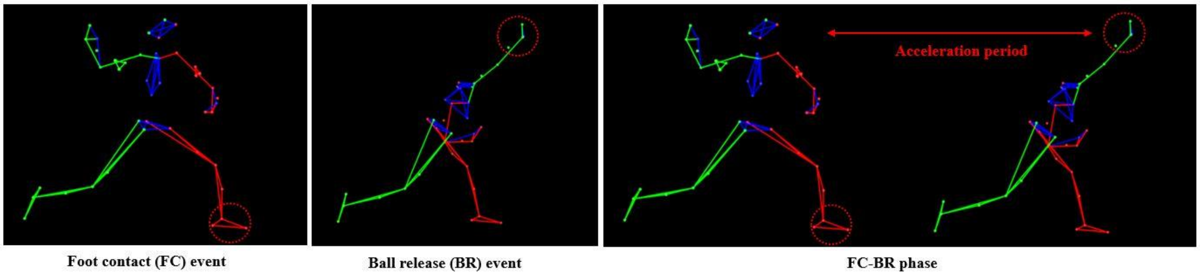

Figure 2. *Setting the 2 event and 1 phase for pitching motion analysis. The FC event refers to the event at which the stepping foot touches on the ground, and the BR event means the event at which the ball is released from the hand (red dotted circles). The FC-BR phase indicates an acceleration period between two events of the fastball pitching motion.*

Table 2. *Definition for kinematic variables*

Kinematic variables		
Angle (degree)	Elbow flexion	The angle between the distal directions of the upper arm and forearm.
	Shoulder external rotation	The angle between the anterior direction of the trunk and the distal direction of the forearm in a plane perpendicular to the upper arm.
	Shoulder abduction	The distal direction of the upper arm and the inferior direction of the trunk in the trunk frontal plane.
	Shoulder horizontal abduction	The angle between the distal direction of the upper arm and the upper torso vector in the transverse plane.
	Trunk forward tilt	The angle between the superior direction of the trunk and the global Z direction in the global XZ plane.
	Trunk lateral tilt	The angle between the superior direction of the trunk and the global Z direction in the global YZ plane.
	Trunk rotation	The angle between the trunk and the global Y direction in the global XY plane.
	Pelvis rotation	The angle between the pelvis and the global Y direction in the global XY plane.
	Hip-shoulder separation	The angle between the pelvis rotation and shoulder external rotation in the transverse plane.
	Knee flexion	The angle between the distal directions of the thigh and leg.
Maximum Angle (degree)	Elbow flexion	Maximum elbow flexion angle at the FC-BR phase
	Shoulder external rotation	Maximum shoulder external rotation angle at the FC-BR phase
	Shoulder horizontal abduction	Maximum shoulder horizontal abduction angle at the FC-BR phase
	Shoulder abduction	Maximum shoulder abduction angle at the FC-BR phase
Maximum angular velocity (degree/s)	Elbow	Maximum elbow extension velocity at the FC-BR phase
	Shoulder	Maximum shoulder internal rotation velocity at the FC-BR phase
	Trunk	Maximum trunk angular velocity at the FC-BR phase
	Pelvis	Maximum pelvis angular velocity at the FC-BR phase
	Knee	Maximum knee extension angular velocity at the FC-BR phase

Results

The mean ball velocity was 126.99 ± 1.33 km/h in the normal-weight group and 127.72 ± 2.13 km/h in the overweight group. The independent t-test showed no significant difference in the mean pitching velocity between the two groups (Table 4). The results of statistical analysis of kinematic variables between the two groups at FC event and BR event and in FC-BR phase were as follows.

Foot Contact (FC) Event

Table 3 shows the results of the independent t-test for differences in the angle of each segment between the normal-weight and overweight groups at the FC event, which means the moment when the lifted foot during windup touches the ground.

Compared with the normal-weight group, the overweight group showed greater elbow flexion angle and smaller trunk forward tilt angle, trunk rotation angle, and knee flexion angle at the FC event (elbow flexion angle: t=-2.56, p=0.021; trunk forward tilt angle: t=2.42, p=0.026; trunk rotation angle: t=-3.14, p=0.006; knee flexion angle: t=2.50, p=0.023).

Ball Release (BR) Event

Table 4 shows the results of the independent t-test for differences in the angle of each segment between the normal-weight and overweight groups at the BR event, which refers to the moment when the ball is released.

Compared with the normal-weight group, overweight group showed smaller shoulder external rotation angle and greater shoulder abduction angle at the BR event (shoulder external rotation angle: t=2.30, p=0.033; shoulder abduction angle: t=-3.17, p=0.005).

FC-BR Phase

Table 5 shows the results of the independent t-test for differences in the maximum angle and maximum angular velocity of each segment between the two groups in FC-BR phase, meaning the acceleration period between the FC and BR events.

Compared with the normal-weight group, the overweight group showed greater maximum elbow flexion angle, and smaller maximum shoulder external rotation angle and maximum trunk angular velocity (maximum elbow flexion angle: t=-3.20, p=0.005;

Table 3. *Comparison of kinematic variables (mean ± standard error) between the normal-weight and the overweight group at the FC event*

Foot contact event (FC event)					
Variables		**Normal-weight**	**Overweight**	**t**	***p*-value**
Angle (degree)	Elbow flexion	108.67±4.27	122.57±3.36	-2.56	.021*
	Shoulder external rotation	22.49±8.00	36.60±14.04	-0.87	.394
	Shoulder abduction	98.91±4.69	105.91±5.83	-0.94	.362
	Shoulder horizontal abduction	36.16±5.13	31.42±6.10	0.60	.560
	Trunk forward tilt	-0.86±1.60	-7.77±2.37	2.42	.026*
	Trunk lateral tilt	1.42±5.49	3.14±3.67	-0.26	.798
	Trunk rotation	3.79±3.75	-11.80±3.25	-3.14	.006*
	Pelvis rotation	34.77±4.05	42.77±3.15	-1.56	.136
	Hip-shoulder separation	36.74±2.86	28.77±3.21	1.85	.082
	Knee flexion	43.77±2.25	36.07±2.11	2.50	.023*

Statistical significance: *p<.05

Table 4. Comparison of kinematic variables (mean ± standard error) between the normal-weight and the overweight group at the BR event

Ball release event (BR event)					
Variables		Normal-weight	Overweight	t	*p*-value
Angle (degree)	Elbow flexion	29.16 ±0.63	29.55±1.90	-0.20	.846
	Shoulder external rotation	95.24±5.34	80.97±3.13	2.30	.033*
	Shoulder abduction	96.60±1.69	104.17±1.70	-3.17	.005*
	Shoulder horizontal abduction	-2.88±2.28	-0.86±3.69	-0.47	.647
	Trunk forward tilt	30.92±2.81	26.05±2.47	1.30	.210
	Trunk lateral tilt	29.27±6.05	25.38±4.44	0.52	.611
	Trunk rotation	111.54±2.43	112.74±1.65	-0.41	.687
	Pelvis rotation	109.43±2.10	108.68±0.70	0.34	.740
	Knee flexion	34.20±2.54	23.72±5.23	1.80	.095
Velocity (km/h)	Ball	126.99±1.33	127.72±2.13	-0.29	.776

Statistical significance: *p<0.05

Table 5. Comparison of kinematic variables (mean ± standard error) between the normal-weight and the overweight group at the FC-BR phase

FC-BR phase					
Variables		Normal-weight	Overweight	t	p-value
Maximum Angle (degree)	Elbow flexion	111.06±2.82	124.60±3.16	-3.20	.005*
	Shoulder external rotation	174.80±2.97	162.57±3.45	2.70	.015*
	Shoulder horizontal abduction	36.67±5.18	36.32±6.19	0.04	.996
	Shoulder abduction	106.81±2.94	112.66±3.69	-1.24	.231
Maximum angular velocity (degree/s)	Elbow extension	2278.62±44.22	2211.00±105.44	0.59	.565
	Shoulder internal rotation	5616.77±65.65	5368.26±207.49	1.14	.278
	Trunk	1095.09±28.25	971.01±26.06	3.23	.005*
	Pelvis	743.10±36.12	708.13±34.23	0.70	.491
	Knee extension	308.38±47.74	384.59±42.90	-1.19	.250

Statistical significance: *p<0.05

maximum shoulder external rotation angle: t=2.70, p=0.015; maximum trunk angular velocity: t=3.23, p=0.005).

Discussion

BMI, which was used as a criterion for classification of groups in this study, must be carefully used depending on the suitability of the participants. BMI is a simple ratio obtained by dividing body inertia parameter such as body weight by height squared. In adolescents who are rapidly growing as well as in athletes with specific body composition, BMI obesity standards may have a low reliability (Jonnalagadda et al., 2004; Karchynskaya et al., 2020). To overcome these limitations, we minimized the differences in the mean age and height between the normal-weight and overweight groups (Table 1). Additionally, considering that the participants of this study were athletes whose muscles were developed through long-term physical training, participants defined as obese according to BMI were also included in the overweight group. Although the difference between the two groups in skeletal muscle and body fat ratios that constitute the body weight could not be quantitatively compared, previous studies have demonstrated that overweight to improve muscle power is the main cause of injury in professional pitchers (Fares, 2020; Garner, 2011). Therefore, in this study, body inertia parameter such as body weight was treated as the main independent variable to identify differences in the kinematic variables of pitching motion between the normal-weight and overweight groups and the resulting risk of injury.

Knee Joint Injury

To increase the ball velocity, the ground reaction force applied to the stepping foot at the FC event must be used efficiently. At this time, the muscles of the lower limbs need strong muscle strength and power that can be converted into breaking force and push-off force of each body segment while minimizing the loss of ground reaction force (Campbell et al., 2010; Kageyama et al., 2014). As previously described, the knee flexion angle of the stepping foot plays an important role in this process, with an ideal flexion angle of 40°–49° (Fehr et al., 2016).

In our study, the normal-weight group maintained the ideal knee flexion angle of the stepping foot. In contrast, the overweight group showed a smaller knee flexion angle of the stepping foot than that in the normal-weight group. These findings suggest that the overweight group does not efficiently use the ground reaction force at the FC event. As a result, the overweight group performs an inefficient pitching motion of reducing the push-off force by decreasing the trunk forward tilt angle to compensate for the loss of breaking force caused by small knee flexion angle.

Such inefficient pitching motion in the overweight group increases the risk of knee joint injury. In previous studies, knee joint injuries were related to the knee flexion angle and load applied to the knee. Essentially, small knee flexion angle reduces the contact area between the femur and tibia, thereby increasing the compressive force applied to the cartilage. In this process, a greater load applied to the front of the knee joint increases the shear force between the femur and tibia, increasing the risk of damage to the anterior cruciate ligament (Li et al., 2005; Yu & Garrett, 2007). Therefore, it was considered that the overweight group had a higher risk of knee injury on the stepping foot at the FC event compared with the normal-weight group.

Shoulder Joint Injury

The shoulder external rotation angle in pitching motion is positively correlated with ball velocity. According to previous studies, as the shoulder external rotation angle increases, the effects of elastic energy and stretch reflex due to the eccentric contraction of the internal rotator muscle increases. This results in strong concentric contraction of the internal rotator muscle in the FC-BR phase (Bosco et al., 1982; Escamilla et al., 2002). Additionally, while the shoulder rotates externally, the trunk and shoulder joint muscles contract eccentrically. As the shoulder external rotation angle increases, the maximum angular velocity of the trunk increases (Katsumata et al., 2022; Seroyer et al., 2010). Therefore, the pitcher must secure sufficient rotational mobility of the shoulder during pitching motion to increase the ball velocity.

In our study, compared with the overweight group, the normal-weight group showed a greater maximum shoulder external rotation angle and maximum trunk angular velocity in the FC-BR phase as well as a larger shoulder external rotation angle at the BR event. Conversely, the overweight group showed a larger shoulder abduction angle at the BR event than the normal-weight group. These findings indicate that the overweight group induces an excessive abduction angle of the shoulders as they fail to fully utilize the rotational mobility of the trunk and shoulder.

Pitchers repeatedly lift and rotate their shoulders, which increases the risk of impingement syndrome. This is caused by impingement of the supraspinatus tendon as the gap between the subacromial part and greater humerus joint is narrowed when the arm is lifted excessively and rotated internally (Burkhart et al., 2000; Wu et al., 2022). Accordingly, the clinical guide on analysis of pitching motion reported that when the shoulder rotates externally at the BR event, the shoulder abduction angle must secure mobility of 70-94° (Diffendaffer et al., 2022; Fehr et al., 2016). This suggests that when the arm is raised higher than the shoulder during rotational movement of the shoulder, the pressure applied to the supraspinatus tendon increases, and subsequently, the risk of impingement syndrome increases. Therefore, we postulated that the overweight group had a higher risk of shoulder joint injury due to the excessive abduction angle of the shoulder during pitching motion.

Elbow Joint Injury

Pitching motion transmits strong force to the distal part of the body through a kinetic chain between the trunk and extremities (Ellenbecker & Aoki, 2020). In this process, mobility of the knee, hip, trunk, shoulder, and elbow joints, as well as the coordination between these segments, is important to increase the ball velocity (Huang et al., 2010; Takahashi et al., 2016).

Our findings showed that there was no significantly difference in the ball velocity between the normal-weight and overweight groups. However, the overweight group had a greater elbow flexion angle at the FC event and larger maximum elbow flexion angle in the FC-BR phase compared with the normal-weight group. These results are thought to be caused by excessive elbow flexion angle to compensate for the limited rotational movement of the trunk and shoulder joints.

Considering the importance of coordinating the mobility of each segment involved in the pitching motion, such pitching motion of the overweight groups increases the risk of elbow joint injury. During pitching, the elbow joint (distal part) generates a strong varus torque through extension and internal rotation (Hutchinson & Ireland, 2003; Slowik et al., 2019). Repetitive power pitching accumulates stress on the elbow joint and subsequently increases the risk of injury of the medial ulnar collateral ligament (Aguinaldo & Chambers, 2009; Anz et al., 2010). As the overweight group has heavier body segments than the normal-weight group, the inertia force caused by chain action between the segments has a great impact on distal joints (Friesen et al., 2022; Sterner, 2020). Therefore, the overweight group has an increased risk of elbow joint injury due to the configuration of excessive elbow flexion angle. In addition, the current experimental findings would be a background knowledge of training and skill acquisition in adolescents with immature musculoskeletal structures.

Conclusion

In this study, high school baseball pitchers were divided into normal-weight and overweight groups to analyze differences in the kinematic variables of pitching motion and provide implications for the mechanism of injury in the overweight group. Our results showed no significant difference in the mean ball velocity between the two groups. However, compared with the normal-weight group, the overweight group showed smaller knee flexion angle, trunk forward tilt angle, trunk rotation angle, maximum trunk angular velocity, shoulder external rotation angle, and maximum shoulder external rotation angle, while shoulder abduction and maximum elbow flexion were greater. These results suggest that the overweight group may have a high risk of soft tissue damage in the knee, shoulder, and elbow joints due to limited movement of the trunk and inefficient movement between the extremities during power pitching. In particular, as the participants of this study were adolescents with immature musculoskeletal structures, the severity and frequency of damage caused by overweight would be high. Therefore, to prevent injuries in overweight high school baseball pitchers, the importance of muscle strength and muscle power improvement training as well as conditioning training for weight control and muscle coordination enhancement must not be overlooked.

In future studies, it is necessary to accurately classify the normal-weight and obesity groups of high school baseball pitchers using body composition test, which allows for quantitative measurement of skeletal muscle mass and body fat, and compare the pitching kinematics of two groups. This will enable additional validation of the risk of injury that may occur in the fastball pitching motions of the obesity group.

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Author Contributions

Sungjune Lee: Methodology, Investigation, Data curation, Visualization, Writing-Original draft preparation. Hyeree Kim: Data curation, Investigation, Visualization. Jaebum Park: Conceptualization, Methodology, Supervision, Funding acquisition, Writing-Original draft preparation, Writing-Review & Editing.

Conflict of Interest

None.

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