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# Influence of Hip and Shoulder Range of Motion on Shoulder Function

Alison Reddick  
*Grand Valley State University*

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GRAND VALLEY STATE UNIVERSITY

**HUMAN RESEARCH REVIEW COMMITTEE**

Principal Investigator(s): Faculty Advisor: Brian Hatzel, PhD, ATC  
Undergraduate Student: Alison Reddick

Contact email address: hatzelb@gvsu.edu  
reddicka@mail.gvsu.edu

Address and Telephone

Number of Principal Investigator(s):

Faculty Advisor:  
Brian Hatzel, PhD, AT, ATC  
Department of Movement Science  
B2-218 Mackinac  
Grand Valley State University  
(616) 331-8538

Undergraduate Student:  
Alison Reddick  
Athletic Training Student  
Grand Valley State University  
(248) 915-8926

**GVSU Department or School:** Movement Science

**Title of the Project:** Influence of Hip and Shoulder Range of Motion on Shoulder Function

**Date(s) and Location(s) of Subject Enrollment:**

March 2011-December 2011, Grand Valley State University Athletic Training Research Laboratory, Allendale, MI, or other college athletic training rooms as necessary.

**Summary of Project:**

Introduction:

Overhead throwing involves synchronized motion of the hip, trunk, and upper extremity.<sup>5</sup> The throwing motion produces stress on a baseball players' arm that often reaches near the point of tissue failure in highly-skilled athletes.<sup>3</sup> Previous studies have correlated hip and shoulder range of motion and rates of shoulder injury or level of performance in professional baseball players. These investigations identified relationships between injury or performance and differences in trail leg hip extension and adduction + abduction, throwing shoulder internal and external rotation, and lead leg internal and external rotation.<sup>10,11</sup> Szymanski et al. (2007) also demonstrated the positive relationship between core strength and bat velocity, which further supports the association between lower body activity and shoulder ability during throwing.

**Specific Aims:**

This study seeks to investigate the presence of correlations within ranges of motion of the hips of the lead and trail legs (non-dominant and dominant, respectively), ranges of motion of the

throwing shoulder, and the presence of previous shoulder injury. This investigation will expand the demographic previously investigated through the inclusion of collegiate softball and baseball players; earlier investigations have only investigated professional baseball players. The following ranges of motion will be measured:

- a. Internal and External Rotation of both shoulders at 90 degrees of humeral abduction.
- b. Horizontal Abduction and Horizontal Adduction of the throwing shoulder
- c. Flexion and Extension of the dominant (trail) and non-dominant (lead) hips
- d. Adduction and Abduction of the trail and lead hips
- e. Internal and External rotation of both hips

From these direct measurements, we will also assess glenohumeral internal rotation deficit (GIRD) compared bilaterally within each subject and calculate the total arc of motion through adduction + abduction, external rotation + internal rotation, and horizontal adduction + horizontal abduction to fully assess function of the upper and lower extremity limbs.

These measurements will be taken with a handheld goniometer or digital inclinometer. The goniometer has been shown to have high intertester and intratester reliability and validity and high intratester reliability for passive range of motion in a wide range of studies, as reviewed by Gajdosik and Bohannon (1987).

Use of human subjects:

**Research Plan:**

Patient Eligibility:

Inclusion –

Subjects included in this investigation will be softball and baseball players from college athletic programs that currently are not experiencing shoulder discomfort. The investigators selected a sample size of 40 based on the power analysis and effect size estimation.<sup>8</sup> Mullaney et al. (2005) were the sources of information to estimate the effect size (ES). The means for the control and experimental groups identified in each of these studies were  $M_c = 74.4, 120.8$ ;  $M_e = 63.5, 137.3$  and the  $S_c = 9.8, 11.9$ . Where  $ES = (M_e - M_c) / S_c$ , where  $M_c$  = mean of the control group,  $M_e$  = Mean of the experimental group and  $S_c$  = Standard Deviation of the control group. Therefore the ES was calculated to equal 1.1. Thomas et al. (1997) has rationalized that a more accurate ES can be estimated by taking multiple means from different but yet similar investigations. The alpha was set at  $\alpha = 0.5$ , and using Cohen's suggestion of  $\beta$ , an alpha: beta ratio of 4:1 was chosen, therefore the  $\beta = 0.2$ , with power =  $1 - \beta$ , power = 0.8. Utilizing the effect size curve for the above information the appropriate sample size is  $>12.5$ , therefore keeping consistent with the power calculation and past research conducted we choose to maintain a sample size of 40. A subject population of 40 will give our study the greatest chance of reporting significant differences, while decreasing the chance of statistical error. If appropriate subject numbers are not achieved within the current protocol, athletes from surrounding colleges may be considered. Currently the PI's have relationships with Davenport University and Calvin College. It is obvious that if this were needed that proper Institutional review would necessitate inclusion from each additional enrolled site. Additionally, a change of protocol form would be filed with the HRRC at GVSU.

Exclusion –

Human subjects not currently participating in collegiate baseball or softball programs will be excluded from the investigation. Those with current injuries of the hip or shoulder that prevent full participation in their athletic programs or as evidenced on the Shoulder Dysfunction Questionnaire will also be excluded from this investigation. One “yes” on the Shoulder Dysfunction Questionnaire that indicates current discomfort will warrant exclusion from the investigation.

The coaching staff of all teams from which subjects are recruited will be notified of the procedures and aims of the study but will not be used in the recruitment process or informed of which athletes choose to participate in the study.

Analysis: An analysis of variance followed by appropriate post-hoc assessment will be used to identify any statistical significance in range of motion and injury history.

### **Protocol (Methods)**

1. Subjects who agree to participation will be informed of where and when to report for the investigation. Subjects will be asked to complete the informed consent form approved by the Human Research Review Committee at GVSU. Any participant questions will be encouraged and answered. Subjects will be given a coded number to match questionnaire data with passive range of motion data. Names and personal identifiers will not be used on the data collection sheets, and the sheets matching the subject and their number code will be secured in the faculty PI's office for a minimum of three years.
2. The questionnaire completed by participants will include demographic information (age, height, weight), playing history (length of time playing sport, position played), and the Shoulder Dysfunction Questionnaire (see Appendix A).
3. Measurements will be taken once subjects have gone through an appropriate warm up. The warm up will be consistent throughout the investigation and will include the following: ride a bicycle for ten minutes OR run on the treadmill for ten minutes AND ten minutes of upper extremity ergometry OR ten throws. Investigators will measure the following passive ranges of motion using a handheld goniometer or digital inclinometer: internal and external rotation of both shoulders at 90 degrees of humeral abduction; horizontal abduction and horizontal adduction of the throwing shoulder; flexion and extension of both hips; adduction and abduction of the trail and lead hips; internal and external rotation of both hips. Measurement methods will be based on the investigation by Scher et al. (2010) and procedures described by Norkin & White (2009).
  - a. Shoulder internal and external rotation: measured at 90 degrees of abduction and 90 degrees of elbow flexion with the patient supine to stabilize the scapula. The anterior portion of the shoulder will be stabilized during internal rotation measurement. Rotation will be measured in reference to an axis perpendicular to the floor.
  - b. Shoulder horizontal adduction and abduction: measured at 90 degrees of abduction and 90 degrees of elbow flexion with the forearm parallel to the ground. The arm will be horizontally abducted and adducted relative to a vertical axis through the glenohumeral joint. The axis parallel to the body in the frontal plane will be considered the starting point.

- c. Hip flexion: measured with the subject supine and the knees extended. The hip is flexed and the knee allowed to passively bend without rotation or lateral motion. The investigator simultaneously stabilizes the pelvis and ensures that the opposite limb remains on the table. Goniometric measurements are taken using the greater trochanter as the axis reference point.
  - d. Hip extension: measured with the subject prone and both limbs extended. The investigator lifts the limb from the table without flexing the knee until further pressure causes lumbar extension or an anterior pelvic tilt. The greater trochanter is the axis of reference.
  - e. Hip adduction: measured with the subject supine and knees extended. The investigator abducts the contralateral limb to allow motion of the limb being measured. While stabilizing the pelvis, the limb is adducted until further motion causes motion of the pelvis or lateral trunk flexion. The reference point is the anterior superior iliac spine (ASIS). The arms align from one ASIS to the other and from the ASIS through the midline of the femur.
  - f. Hip abduction: measured with the subject supine and both limbs in neutral (0 degrees of flexion, extension, and rotation). The investigator stabilizes the pelvis with one hand and abducts the limb with the opposite hand until pressure causes pelvic motion or trunk lateral flexion. The ASIS is the reference point for the goniometer fulcrum. The arms of the goniometer align from one ASIS to the other and from the ASIS through the midline of the femur.
  - g. Hip internal and external rotation: measured while patient sits at the edge of the table with the legs hanging down and the popliteal space several inches from the end of the table. The leg will then be internally or externally rotated until the iliac crest begins to move. Measurements will be in reference to the axis perpendicular to the floor.
4. Subjects will be given contact information for the PIs if they have any follow-up questions or concerns.

### **Potential Health Risks:**

The potential health risks are minimal. The protocol involves movement of limbs within normal, passive ranges of motion and completion of a written survey. No injuries have been documented in similar research studies.<sup>2,7,10,11</sup>

### **Potential Health Benefits:**

The subjects will not receive direct health benefit from this study. The study seeks to explore correlations between passive range of motion of the hip and shoulder coupled with the presence of shoulder injury. Such an exploration will broaden our scope of knowledge and enhance our ability to recognize and intervene for softball and baseball athletes who are identified as “at risk” for shoulder injury. Any published data will not include subjects’ names or personal identifiers.

### **Potential Financial Risks:**

There are no foreseeable financial risks to participants.

**Potential Financial Benefits:**

Participants will not be compensated financially for their participation.

**Conflict of Interest:**

The investigators have no conflicts of interest in this study.

**References:**

1. Dwelly, P.M., Tripp, B.L., Tripp, P.A., Eberman, L.E., & Gorin, S. (2009). Glenohumeral rotational range of motion in collegiate overhead-throwing athletes during an athletic season. *Journal of Athletic Training* 44(6). Retrieved February 2, 2011, from the PubMed Database.
2. Ellenbecker, T.A., Roetert, E.P., Silva, R.T., Keuter, G., & Sperling, F. (2007). Descriptive profile of hip rotation range of motion in elite tennis players and professional baseball pitchers. *American Journal of Sports Medicine* 35, 1371. doi: 10.1177/0363546507300260
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5. Hong, D., Cheung, T.K., & Roberts, E.M. (2001). A three-dimensional, six-segment chain analysis of forceful overarm throwing. *Journal of Electromyography and Kinesiology* 11, 95-112. Retrieved December 5, 2010, from PubMed database.
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9. Norkin, C.C., White, D.J. (2009). *Measurement of Joint Motion: A Guide to Goniometry* (4<sup>th</sup> ed.). Philadelphia, PA: F.A. Davis Company.
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11. Scher, S., Anderson, K., Bajorek, J., & Bey, M.J. (2010). Associations among hip and shoulder range of motion and shoulder injury in professional baseball players. *Journal of Athletic Training* 45(2). Retrieved November 21, 2010, from PubMed database.
12. Szymanski, D.J., McIntyre, J.S., Szymanski, J.M., Bradford, T.J., Schade, R.L., Madsen, N.H., & Pascoe, D.D. (2007). Effect of torso rotational strength on angular hip, angular shoulder, and linear bat velocities of high school baseball players. *Journal of Strength and Conditioning Research* 21(4). Retrieved November 21, 2010, from the PubMed Database.
13. Thomas, J.R., Lochbaum, M.R., Landers, D.M., & He, C. (1997) Planning significant and meaningful research in exercise science: estimating sample size. *Research Quarterly for Exercise and Sport* 68(1). Retrieved February 7, 2011, from ProQuest Medical Library.

Check one:

This is a request for exemption from HRRC approval requirements as specified by 46.101 of the Federal Register 4616:8336, January 26, 1981. (Refer to instructions on the reverse of this form.)

This is a request for expedited review as described in 46.110 of the Federal Register 46(16):8336, January 26, 1981. (Refer to instructions on the reverse of this form.)

This is a request for full review. (Refer to instructions on the reverse of this form.)

Subject ID:

Age:

Height:

Weight:

## Appendix A

### Shoulder Dysfunction Questionnaire

#### Instructions

When your shoulder hurts, you may find it difficult to do certain things you normally do. This list contains 16 sentences that people have used to describe themselves when they have shoulder pain. When you read the sentences, you may find that some stand out because they describe you currently (last 1 month). As you read the list, think of yourself currently (last month). Ask yourself if you performed the activity.

#### Examples for completion

+ You have not performed the activity, for example: you have not lain on your shoulder: put a check mark in the box for NA (not applicable).

My shoulder hurts when I lie on it. 

N/A	YES	NO
/		

+ You did perform the activity, for example: you opened or closed a door in the last month. If your shoulder was painful during opening or closing a door; put a check mark in the box for YES.

My shoulder hurts when I open or close a door. 

N/A	YES	NO
	/	

+ You did perform the activity, for example: you did lean on your elbow or hand. If your shoulder did not hurt during leaning on your elbow or hand; put a check mark in the box for NO.

My shoulder hurts when I lean on my elbow or hand. 

N/A	YES	NO
		/

#### SDQ items

1 I wake up at night because of shoulder pain. <table style="float: right; border-collapse: collapse;"><tr><td style="border: none; padding-right: 5px;">N/A</td><td style="border: none; padding-right: 5px;">YES</td><td style="border: none;">NO</td></tr><tr><td style="border: 1px solid black; width: 20px; height: 20px;"></td><td style="border: 1px solid black; width: 20px; height: 20px;"></td><td style="border: 1px solid black; width: 20px; height: 20px;"></td></tr></table>	N/A	YES	NO				9 When I lift and carry something my shoulder hurts. <table style="float: right; border-collapse: collapse;"><tr><td style="border: none; padding-right: 5px;">N/A</td><td style="border: none; padding-right: 5px;">YES</td><td style="border: none;">NO</td></tr><tr><td style="border: 1px solid black; width: 20px; height: 20px;"></td><td style="border: 1px solid black; width: 20px; height: 20px;"></td><td style="border: 1px solid black; width: 20px; height: 20px;"></td></tr></table>	N/A	YES	NO			
N/A	YES	NO											
N/A	YES	NO											
2 My shoulder hurts when I lie on it. <table style="float: right; border-collapse: collapse;"><tr><td style="border: none; padding-right: 5px;">N/A</td><td style="border: none; padding-right: 5px;">YES</td><td style="border: none;">NO</td></tr><tr><td style="border: 1px solid black; width: 20px; height: 20px;"></td><td style="border: 1px solid black; width: 20px; height: 20px;"></td><td style="border: 1px solid black; width: 20px; height: 20px;"></td></tr></table>	N/A	YES	NO				10 During reaching and grasping above shoulder level my shoulder hurts. <table style="float: right; border-collapse: collapse;"><tr><td style="border: none; padding-right: 5px;">N/A</td><td style="border: none; padding-right: 5px;">YES</td><td style="border: none;">NO</td></tr><tr><td style="border: 1px solid black; width: 20px; height: 20px;"></td><td style="border: 1px solid black; width: 20px; height: 20px;"></td><td style="border: 1px solid black; width: 20px; height: 20px;"></td></tr></table>	N/A	YES	NO			
N/A	YES	NO											
N/A	YES	NO											
3 Because of pain in my shoulder it is difficult to put on a coat or a sweater. <table style="float: right; border-collapse: collapse;"><tr><td style="border: none; padding-right: 5px;">N/A</td><td style="border: none; padding-right: 5px;">YES</td><td style="border: none;">NO</td></tr><tr><td style="border: 1px solid black; width: 20px; height: 20px;"></td><td style="border: 1px solid black; width: 20px; height: 20px;"></td><td style="border: 1px solid black; width: 20px; height: 20px;"></td></tr></table>	N/A	YES	NO				11 My shoulder is painful when I open or close a door. <table style="float: right; border-collapse: collapse;"><tr><td style="border: none; padding-right: 5px;">N/A</td><td style="border: none; padding-right: 5px;">YES</td><td style="border: none;">NO</td></tr><tr><td style="border: 1px solid black; width: 20px; height: 20px;"></td><td style="border: 1px solid black; width: 20px; height: 20px;"></td><td style="border: 1px solid black; width: 20px; height: 20px;"></td></tr></table>	N/A	YES	NO			
N/A	YES	NO											
N/A	YES	NO											
4 My shoulder hurts during my usual daily activities. <table style="float: right; border-collapse: collapse;"><tr><td style="border: none; padding-right: 5px;">N/A</td><td style="border: none; padding-right: 5px;">YES</td><td style="border: none;">NO</td></tr><tr><td style="border: 1px solid black; width: 20px; height: 20px;"></td><td style="border: 1px solid black; width: 20px; height: 20px;"></td><td style="border: 1px solid black; width: 20px; height: 20px;"></td></tr></table>	N/A	YES	NO				12 My shoulder is painful when I bring my hand to the back of my head. <table style="float: right; border-collapse: collapse;"><tr><td style="border: none; padding-right: 5px;">N/A</td><td style="border: none; padding-right: 5px;">YES</td><td style="border: none;">NO</td></tr><tr><td style="border: 1px solid black; width: 20px; height: 20px;"></td><td style="border: 1px solid black; width: 20px; height: 20px;"></td><td style="border: 1px solid black; width: 20px; height: 20px;"></td></tr></table>	N/A	YES	NO			
N/A	YES	NO											
N/A	YES	NO											
5 My shoulder hurts when I lean on my elbow or hand. <table style="float: right; border-collapse: collapse;"><tr><td style="border: none; padding-right: 5px;">N/A</td><td style="border: none; padding-right: 5px;">YES</td><td style="border: none;">NO</td></tr><tr><td style="border: 1px solid black; width: 20px; height: 20px;"></td><td style="border: 1px solid black; width: 20px; height: 20px;"></td><td style="border: 1px solid black; width: 20px; height: 20px;"></td></tr></table>	N/A	YES	NO				13 My shoulder is painful when I bring my hand to my buttock. <table style="float: right; border-collapse: collapse;"><tr><td style="border: none; padding-right: 5px;">N/A</td><td style="border: none; padding-right: 5px;">YES</td><td style="border: none;">NO</td></tr><tr><td style="border: 1px solid black; width: 20px; height: 20px;"></td><td style="border: 1px solid black; width: 20px; height: 20px;"></td><td style="border: 1px solid black; width: 20px; height: 20px;"></td></tr></table>	N/A	YES	NO			
N/A	YES	NO											
N/A	YES	NO											
6 My shoulder hurts when I move my arm. <table style="float: right; border-collapse: collapse;"><tr><td style="border: none; padding-right: 5px;">N/A</td><td style="border: none; padding-right: 5px;">YES</td><td style="border: none;">NO</td></tr><tr><td style="border: 1px solid black; width: 20px; height: 20px;"></td><td style="border: 1px solid black; width: 20px; height: 20px;"></td><td style="border: 1px solid black; width: 20px; height: 20px;"></td></tr></table>	N/A	YES	NO				14 My shoulder is painful when I bring my hand to my low back. <table style="float: right; border-collapse: collapse;"><tr><td style="border: none; padding-right: 5px;">N/A</td><td style="border: none; padding-right: 5px;">YES</td><td style="border: none;">NO</td></tr><tr><td style="border: 1px solid black; width: 20px; height: 20px;"></td><td style="border: 1px solid black; width: 20px; height: 20px;"></td><td style="border: 1px solid black; width: 20px; height: 20px;"></td></tr></table>	N/A	YES	NO			
N/A	YES	NO											
N/A	YES	NO											
7 My shoulder hurts when I write or type. <table style="float: right; border-collapse: collapse;"><tr><td style="border: none; padding-right: 5px;">N/A</td><td style="border: none; padding-right: 5px;">YES</td><td style="border: none;">NO</td></tr><tr><td style="border: 1px solid black; width: 20px; height: 20px;"></td><td style="border: 1px solid black; width: 20px; height: 20px;"></td><td style="border: 1px solid black; width: 20px; height: 20px;"></td></tr></table>	N/A	YES	NO				15 I rub my painful shoulder more than once during the day. <table style="float: right; border-collapse: collapse;"><tr><td style="border: none; padding-right: 5px;">N/A</td><td style="border: none; padding-right: 5px;">YES</td><td style="border: none;">NO</td></tr><tr><td style="border: 1px solid black; width: 20px; height: 20px;"></td><td style="border: 1px solid black; width: 20px; height: 20px;"></td><td style="border: 1px solid black; width: 20px; height: 20px;"></td></tr></table>	N/A	YES	NO			
N/A	YES	NO											
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8 My shoulder is painful when I hold the driving wheel of my car or handle bars of my bike. <table style="float: right; border-collapse: collapse;"><tr><td style="border: none; padding-right: 5px;">N/A</td><td style="border: none; padding-right: 5px;">YES</td><td style="border: none;">NO</td></tr><tr><td style="border: 1px solid black; width: 20px; height: 20px;"></td><td style="border: 1px solid black; width: 20px; height: 20px;"></td><td style="border: 1px solid black; width: 20px; height: 20px;"></td></tr></table>	N/A	YES	NO				16 Because of my shoulder pain I am more irritable and bad tempered with people than usual. <table style="float: right; border-collapse: collapse;"><tr><td style="border: none; padding-right: 5px;">N/A</td><td style="border: none; padding-right: 5px;">YES</td><td style="border: none;">NO</td></tr><tr><td style="border: 1px solid black; width: 20px; height: 20px;"></td><td style="border: 1px solid black; width: 20px; height: 20px;"></td><td style="border: 1px solid black; width: 20px; height: 20px;"></td></tr></table>	N/A	YES	NO			
N/A	YES	NO											
N/A	YES	NO											

**Subject ID:**

Now consider your softball/baseball career. As you read the list again, think of yourself at any time that you played softball/baseball. Ask yourself if you performed the activity.

1 I woke up at night because of shoulder pain.	N/A YES NO <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	9 When I lifted and carried something my shoulder hurt.	N/A YES NO <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
2 My shoulder hurt when I lay on it.	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	10 During reaching and grasping above shoulder level my shoulder hurt.	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
3 Because of pain in my shoulder it was difficult to put on a coat or a sweater.	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	11 My shoulder was painful when I opened or closed a door	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
4 My shoulder hurt during my usual daily activities	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	12 My shoulder was painful when I brought my hand to the back of my head.	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
5 My shoulder hurt when I leaned on my elbow or hand.	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	13 My shoulder was painful when I brought my hand to my buttock.	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
6 My shoulder hurt when I moved my arm.	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	14 My shoulder was painful when I brought my hand to my low back.	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
7 My shoulder hurt when I wrote or typed.	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	15 I rubbed my painful shoulder more than once during the day.	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
8 My shoulder was painful when I held the driving wheel of my car or handle bars of my bike.	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	16 Because of my shoulder pain I was more irritable and bad tempered with people than usual.	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>

*Additional Questions*

Have you ever been diagnosed with any condition or injury involving either shoulder by a physician?

Have you had a surgery involving your throwing shoulder?

Did you play sports in high school or middle school? If yes, what sports and how long did you play?

How long have you played softball/baseball?

What position do you play? (Circle one. If not pitcher, please identify position played, i.e. first base)

Pitcher    Position

What arm do you throw with?