**Supplemental Table 1. Associations Between Pitching Biomechanics at Foot Contact and Lead- and Back-Hip Strength**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Lead-Hip Strength | | | | | | | | | | | |
|  | Flexion | | Extension | | Abduction | | Adduction | | Internal Rotation | | External Rotation | |
|  | *r* Value | *P* Value | *r* Value | *P* Value | *r* Value | *P* Value | *r* Value | *P* Value | *r* Value | *P* Value | *r* Value | *P* Value |
| Shoulder |  |  |  |  |  |  |  |  |  |  |  |  |
| Horizontal abduction | 0.152 | .46 | −0.027 | .90 | −0.085 | .68 | 0.224 | .27 | −0.240 | .24 | −0.062 | .76 |
| Abduction | 0.170 | .41 | −0.058 | .78 | 0.006 | .98 | 0.228 | .26 | −0.158 | .44 | −0.078 | .70 |
| Internal/external rotation | −0.250 | .22 | −0.200 | .33 | −0.234 | .25 | −0.351 | .08 | 0.012 | .96 | 0.013 | .95 |
| Elbow flexion | 0.111 | .59 | 0.109 | .60 | 0.039 | .85 | −0.197 | .34 | 0.224 | .27 | 0.112 | .59 |
| Pelvic rotation | −0.108 | .60 | 0.340 | .09 | −0.069 | .74 | −0.078 | .71 | 0.238 | .24 | 0.135 | .51 |
| Torso rotation | −0.141 | .49 | 0.158 | .44 | −0.132 | .52 | −0.113 | .58 | 0.172 | .40 | 0.036 | .86 |
| Hip-to-shoulder separation | 0.078 | .71 | 0.492 | .01a | 0.091 | .66 | 0.108 | .60 | 0.207 | .31 | 0.265 | .19 |
| Lead-hip |  |  |  |  |  |  |  |  |  |  |  |  |
| Flexion | −0.239 | .24 | 0.098 | .64 | 0.053 | .80 | −0.118 | .57 | 0.089 | .67 | −0.130 | .53 |
| Abduction | −0.012 | .95 | −0.188 | .36 | −0.138 | .50 | −0.373 | .06 | −0.017 | .94 | −0.080 | .70 |
| Internal/external rotation | −0.158 | .44 | 0.154 | .45 | 0.002 | .99 | 0.121 | .56 | 0.067 | .74 | 0.166 | .42 |
| Back-hip |  |  |  |  |  |  |  |  |  |  |  |  |
| Flexion | 0.151 | .46 | −0.201 | .33 | 0.300 | .14 | 0.163 | .43 | −0.248 | .22 | −0.056 | .79 |
| Abduction | 0.016 | .94 | 0.147 | .48 | −0.038 | .85 | −0.072 | .73 | 0.069 | .74 | 0.026 | .90 |
| Internal/external rotation | 0.059 | .78 | −0.337 | .09 | 0.047 | .82 | −0.284 | .16 | 0.048 | .82 | −0.038 | .85 |

Continued on next page.

**Supplemental Table 1. Associations Between Pitching Biomechanics at Foot Contact and Lead- and Back-Hip Strength (continued from previous page)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Back-Hip Strength | | | | | | | | | | | |
|  | Flexion | | Extension | | Abduction | | Adduction | | Internal Rotation | | External Rotation | |
|  | *r* Value | *P* Value | *r* Value | *P* Value | *r* Value | *P* Value | *r* Value | *P* Value | *r* Value | *P* Value | *r* Value | *P* Value |
| Shoulder |  |  |  |  |  |  |  |  |  |  |  |  |
| Horizontal abduction | −0.025 | .90 | −0.059 | .78 | −0.028 | .89 | 0.266 | .19 | −0.144 | .48 | −0.068 | .74 |
| Abduction | 0.092 | .65 | −0.049 | .81 | 0.004 | .99 | 0.208 | .31 | −0.131 | .52 | 0.010 | .96 |
| Internal/external rotation | −0.101 | .63 | −0.183 | .37 | −0.227 | .26 | −0.316 | .12 | −0.063 | .76 | 0.157 | .44 |
| Elbow flexion | 0.067 | .74 | 0.077 | .71 | 0.031 | .88 | −0.170 | .41 | 0.062 | .77 | 0.174 | .39 |
| Pelvic rotation | −0.005 | .98 | 0.403 | .041a | 0.074 | .72 | −0.078 | .71 | 0.076 | .71 | −0.016 | .94 |
| Torso rotation | 0.022 | .92 | 0.243 | .23 | −0.016 | .94 | −0.237 | .24 | 0.025 | .90 | −0.089 | .66 |
| Hip-to-shoulder separation | −0.011 | .96 | 0.444 | .02a | 0.182 | .37 | 0.382 | .054 | 0.165 | .42 | 0.189 | .36 |
| Lead-hip |  |  |  |  |  |  |  |  |  |  |  |  |
| Flexion | −0.143 | .49 | 0.225 | .27 | 0.099 | .63 | −0.318 | .11 | −0.119 | .56 | −0.262 | .20 |
| Abduction | −0.052 | .80 | −0.167 | .42 | −0.215 | .29 | −0.192 | .35 | −0.124 | .55 | −0.003 | .99 |
| Internal/external rotation | −0.133 | .52 | 0.052 | .80 | 0.000 | >.99 | 0.144 | .48 | −0.029 | .89 | 0.274 | .18 |
| Back-hip |  |  |  |  |  |  |  |  |  |  |  |  |
| Flexion | −0.002 | .99 | −0.233 | .25 | 0.228 | .26 | 0.116 | .57 | −0.109 | .60 | −0.098 | .63 |
| Abduction | 0.164 | .42 | 0.169 | .41 | 0.067 | .75 | −0.108 | .60 | 0.011 | .96 | −0.138 | .50 |
| Internal/external rotation | 0.143 | .49 | −0.305 | .13 | −0.041 | .84 | −0.078 | .71 | 0.082 | .69 | 0.019 | .93 |

**a Correlation at the .05 level (2-tailed).**

**Supplemental Table 2. Associations Between Pitching Biomechanics at Maximum External Rotation and Lead- and Back-Hip Strength**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Lead-Hip Strength | | | | | | | | | | | |
|  | Flexion | | Extension | | Abduction | | Adduction | | Internal Rotation | | External Rotation | |
|  | *r* Value | *P* Value | *r* Value | *P* Value | *r* Value | *P* Value | *r* Value | *P* Value | *r* Value | *P* Value | *r* Value | *P* Value |
| Shoulder |  |  |  |  |  |  |  |  |  |  |  |  |
| Horizontal abduction | −0.163 | .43 | −0.314 | .12 | −0.123 | .55 | −0.318 | .11 | −0.564 | .003a | −0.419 | .03b |
| Abduction | 0.044 | .83 | −0.115 | .58 | −0.255 | .21 | −0.055 | .79 | −0.015 | .94 | −0.111 | .59 |
| Internal/external rotation | −0.098 | .63 | −0.082 | .69 | −0.163 | .43 | 0.047 | .82 | 0.163 | .43 | 0.080 | .70 |
| Elbow flexion | 0.422 | .03b | 0.118 | .57 | 0.366 | .07 | 0.155 | .45 | 0.087 | .67 | 0.342 | .09 |
| Pelvic rotation | 0.186 | .36 | 0.203 | .32 | 0.051 | .81 | 0.110 | .59 | 0.362 | .07 | 0.304 | .13 |
| 0.268 | 0.116 | .57 | 0.068 | .74 | 0.059 | .77 | 0.086 | .68 | 0.284 | .16 | 0.257 | .20 |
| Hip-to-shoulder separation | 0.235 | .25 | 0.335 | .09 | 0.075 | .71 | 0.157 | .44 | 0.383 | .054 | 0.299 | .14 |
| Lead-hip |  |  |  |  |  |  |  |  |  |  |  |  |
| Flexion | −0.024 | .91 | 0.158 | .44 | 0.110 | .59 | 0.193 | .35 | 0.324 | .12 | 0.097 | .64 |
| Abduction | 0.104 | .62 | −0.112 | .59 | 0.086 | .68 | −0.321 | .11 | 0.180 | .38 | 0.071 | .73 |
| Internal/external rotation | 0.042 | .84 | 0.219 | .28 | 0.257 | .21 | 0.156 | .45 | −0.007 | .97 | 0.294 | .15 |
| Back-hip |  |  |  |  |  |  |  |  |  |  |  |  |
| Flexion | −0.021 | .92 | 0.178 | .38 | 0.057 | .78 | −0.119 | .56 | −0.060 | .77 | −0.124 | .55 |
| Abduction | 0.095 | .65 | 0.244 | .23 | 0.096 | .64 | 0.251 | .22 | 0.462 | .02b | 0.349 | .08 |
| Internal/external rotation | −0.218 | .29 | −0.026 | .90 | −0.271 | .18 | −0.282 | .16 | 0.123 | .55 | −0.138 | .50 |

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**Supplemental Table 2. Associations Between Pitching Biomechanics at Maximum External Rotation and Lead- and Back-Hip Strength (continued from previous page)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Back-Hip Strength | | | | | | | | | | | |
|  | Flexion | | Extension | | Abduction | | Adduction | | Internal Rotation | | External Rotation | |
|  | *r* Value | *P* Value | *r* Value | *P* Value | *r* Value | *P* Value | *r* Value | *P* Value | *r* Value | *P* Value | *r* Value | *P* Value |
| Shoulder |  |  |  |  |  |  |  |  |  |  |  |  |
| Horizontal abduction | −0.325 | .11 | −0.407 | .04b | −0.228 | .26 | −0.354 | .08 | −0.528 | .006a | −0.501 | .009a |
| Abduction | 0.201 | .32 | −0.029 | .89 | −0.195 | .34 | −0.094 | .65 | −0.015 | .94 | 0.017 | .93 |
| Internal/external rotation | −0.025 | .90 | 0.049 | .81 | −0.140 | .50 | 0.098 | .63 | 0.056 | .78 | 0.216 | .29 |
| Elbow flexion | 0.381 | .06 | 0.055 | .79 | 0.322 | .11 | 0.314 | .12 | 0.138 | .50 | 0.336 | .09 |
| Pelvic rotation | 0.268 | .19 | 0.348 | .08 | 0.154 | .45 | 0.325 | .11 | 0.435 | .03b | 0.259 | .20 |
| Torso rotation | 0.249 | .22 | 0.112 | .59 | 0.098 | .63 | 0.238 | .24 | 0.442 | .02b | 0.271 | .18 |
| Hip-to-shoulder separation | 0.242 | .23 | 0.538 | .005a | 0.233 | .25 | 0.317 | .11 | 0.247 | .22 | 0.201 | .33 |
| Lead-hip |  |  |  |  |  |  |  |  |  |  |  |  |
| Flexion | 0.128 | .53 | 0.338 | .09 | 0.207 | .31 | 0.034 | .87 | 0.141 | .49 | 0.008 | .97 |
| Abduction | 0.152 | .46 | 0.002 | >.99 | 0.007 | .97 | −0.010 | .96 | 0.240 | .24 | 0.154 | .45 |
| Internal/external rotation | 0.017 | .93 | −0.005 | .98 | 0.215 | .29 | 0.283 | .16 | 0.052 | .80 | 0.318 | .11 |
| Back-hip |  |  |  |  |  |  |  |  |  |  |  |  |
| Flexion | 0.031 | .88 | 0.184 | .37 | 0.155 | .45 | −0.075 | .72 | −0.001 | >.99 | −0.321 | .11 |
| Abduction | 0.335 | .10 | 0.362 | .07 | 0.215 | .29 | 0.316 | .12 | 0.459 | .02b | 0.279 | .17 |
| Internal/external rotation | −0.108 | .60 | 0.061 | .77 | −0.227 | .26 | −0.145 | .48 | 0.101 | .62 | −0.147 | .47 |

**a Correlation at the .01 level (2-tailed).**

**b Correlation at the .05 level (2-tailed).**

**Supplemental Table 3. Associations Between Pitching Biomechanics at Ball Release and Lead- and Back-Hip Strength**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Lead-Hip Strength | | | | | | | | | | | |
|  | Flexion | | Extension | | Abduction | | Adduction | | Internal Rotation | | External Rotation | |
|  | *r* Value | *P* Value | *r* Value | *P* Value | *r* Value | *P* Value | *r* Value | *P* Value | *r* Value | *P* Value | *r* Value | *P* Value |
| Shoulder |  |  |  |  |  |  |  |  |  |  |  |  |
| Horizontal abduction | −0.178 | .38 | −0.378 | .06 | −0.147 | .47 | −0.367 | .07 | −0.554 | .003a | −0.441 | .02b |
| Abduction | 0.035 | .87 | 0.024 | .91 | −0.130 | .53 | 0.186 | .36 | 0.218 | .29 | 0.102 | .62 |
| Internal/external rotation | −0.285 | .16 | −0.173 | .40 | −0.060 | .77 | −0.096 | .64 | −0.115 | .58 | −0.163 | .43 |
| Elbow flexion | 0.290 | .15 | 0.092 | .66 | 0.218 | .29 | −0.071 | .73 | −0.173 | .40 | −0.012 | .96 |
| Pelvic rotation | 0.233 | .25 | 0.255 | .21 | 0.033 | .88 | 0.161 | .43 | 0.405 | .04b | 0.345 | .09 |
| Torso rotation | 0.163 | .43 | 0.022 | .92 | 0.089 | .67 | 0.120 | .56 | 0.244 | .23 | 0.260 | .20 |
| Hip-to-shoulder separation | 0.194 | .34 | 0.394 | .046b | −0.026 | .90 | 0.100 | .63 | 0.373 | .06 | 0.232 | .25 |
| Lead-hip |  |  |  |  |  |  |  |  |  |  |  |  |
| Flexion | 0.008 | .97 | 0.129 | .53 | 0.147 | .47 | 0.188 | .36 | 0.387 | .051 | 0.151 | .46 |
| Abduction | 0.143 | .49 | −0.028 | .89 | 0.031 | .88 | −0.298 | .14 | 0.244 | .23 | 0.124 | .55 |
| Internal/external rotation | 0.059 | .77 | 0.196 | .34 | 0.222 | .28 | 0.092 | .65 | 0.042 | .84 | 0.309 | .13 |
| Back-hip |  |  |  |  |  |  |  |  |  |  |  |  |
| Flexion | 0.088 | .67 | 0.168 | .41 | 0.098 | .63 | −0.130 | .53 | 0.179 | .38 | 0.007 | .97 |
| Abduction | 0.095 | .65 | 0.245 | .23 | 0.094 | .65 | 0.208 | .31 | 0.512 | .008a | 0.352 | .08 |
| Internal/external rotation | −0.181 | .38 | 0.026 | .90 | −0.253 | .21 | −0.255 | .21 | 0.201 | .33 | −0.071 | .73 |

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**Supplemental Table 3. Associations Between Pitching Biomechanics at Ball Release and Lead- and Back-Hip Strength (continued from previous page)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Back-Hip Strength | | | | | | | | | | | |
|  | Flexion | | Extension | | Abduction | | Adduction | | Internal Rotation | | External Rotation | |
|  | *r* Value | *P* Value | *r* Value | *P* Value | *r* Value | *P* Value | *r* Value | *P* Value | *r* Value | *P* Value | *r* Value | *P* Value |
| Shoulder |  |  |  |  |  |  |  |  |  |  |  |  |
| Horizontal abduction | −0.355 | .08 | −0.476 | .01b | −0.292 | .15 | −0.372 | .06 | −0.520 | .006b | −0.462 | .02b |
| Abduction | 0.103 | .62 | 0.158 | .44 | −0.085 | .68 | 0.153 | .46 | 0.144 | .48 | 0.304 | .13 |
| Internal/external rotation | −0.190 | .35 | −0.102 | .62 | −0.109 | .60 | −0.037 | .86 | −0.171 | .41 | −0.019 | .93 |
| Elbow flexion | 0.177 | .39 | −0.068 | .74 | 0.107 | .60 | 0.073 | .72 | −0.083 | .69 | −0.139 | .50 |
| Pelvic rotation | 0.307 | .13 | 0.390 | .050 | 0.181 | .38 | 0.348 | .08 | 0.458 | .02b | 0.326 | .10 |
| Torso rotation | 0.249 | .22 | 0.056 | .78 | 0.127 | .54 | 0.229 | .26 | 0.398 | .044b | 0.286 | .16 |
| Hip-to-shoulder separation | 0.212 | .30 | 0.562 | .003a | 0.163 | .43 | 0.245 | .23 | 0.210 | .30 | 0.164 | .42 |
| Lead-hip | 0.184 | .37 | 0.308 | .13 | 0.209 | .31 | 0.001 | >.99 | 0.182 | .37 | 0.102 | .62 |
| Flexion |  |  |  |  |  |  |  |  |  |  |  |  |
| Abduction | 0.186 | .36 | 0.084 | .69 | 0.006 | .98 | 0.043 | .83 | 0.292 | .15 | 0.226 | .27 |
| Internal/external rotation | 0.032 | .88 | 0.001 | >.99 | 0.193 | .35 | 0.242 | .23 | 0.080 | .70 | 0.334 | .10 |
| Back-hip |  |  |  |  |  |  |  |  |  |  |  |  |
| Flexion | 0.179 | .38 | 0.249 | .22 | 0.166 | .42 | −0.078 | .71 | 0.151 | .46 | −0.093 | .65 |
| Abduction | 0.338 | .09 | 0.370 | .06 | 0.204 | .32 | 0.228 | .26 | 0.465 | .02b | 0.310 | .12 |
| Internal/external rotation | −0.100 | .63 | 0.116 | .57 | −0.191 | .35 | −0.144 | .48 | 0.142 | .49 | −0.087 | .67 |

**a Correlation at the .01 level (2-tailed).**

**b Correlation at the .05 level (2-tailed).**

**Supplemental Table 4. Associations Between Pitching Biomechanics and Lead- and Back-Hip Strength**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Lead-Hip Strength | | | | | | | | | | | |
|  | Flexion | | Extension | | Abduction | | Adduction | | Internal Rotation | | External Rotation | |
|  | *r* Value | *P* Value | *r* Value | *P* Value | *r* Value | *P* Value | *r* Value | *P* Value | *r* Value | *P* Value | *r* Value | *P* Value |
| Normalized elbow-varus torque | 0.353 | .08 | 0.329 | .10 | 0.619 | .001b | 0.283 | .16 | 0.303 | .13 | 0.381 | .055 |
| Normalized shoulder internal-rotation torque | 0.208 | .31 | 0.313 | .12 | 0.327 | .10 | 0.334 | .10 | 0.188 | .36 | 0.184 | .37 |
|  | Back-Hip Strength | | | | | | | | | | | |
|  | Flexion | | Extension | | Abduction | | Adduction | | Internal Rotation | | External Rotation | |
|  | *r* Value | *P* Value | *r* Value | *P* Value | *r* Value | *P* Value | *r* Value | *P* Value | *r* Value | *P* Value | *r* Value | *P* Value |
| Normalized elbow-varus torque | 0.337 | .09 | 0.261 | .20 | 0.565 | .003b | 0.256 | .21 | 0.210 | .30 | 0.324 | .12 |
| Normalized shoulder internal-rotation torque | 0.176 | .39 | 0.265 | .19 | 0.357 | .07 | 0.121 | .56 | −0.023 | .91 | 0.120 | .56 |

**a Correlation at the .01 level (2-tailed).**