Sport Specific Muscle Imbalances

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Assessing individual athletes in their strengths and weaknesses can have a near infinite amount of perspectives and possibilities. Because of this, it is time consuming and inefficient to take an athlete one by one from their individual sport and analyze their physical strengths and limitations. Especially when trying to collect a large amount of data from an entire athletic population, one must come up with a simpler and more efficient way of assessment.

In our collective data, we decided to take a class filled with student athletes and underwent with a series of exercises and flexibility assessments. The purpose of this data gathering was to record the results and performance of very basic exercises in a variety of sports. By making the data analysis sport specific, it allows us to break down and compare numbers that stand out for an indication of muscle imbalances.

Muscle imbalance is a leading theory behind what causes injuries in their specific sport. For example, ACL sprains and tears are fairly common injuries in "Stop and Go" sports like soccer and basketball. As where in "Strength and Power" sports like baseball and football have more upper body injuries to the back and shoulders. In our experiments and data gathering, our idea was to find a trend or common pattern to flexibility and muscle imbalance in comparison to the athletes' specific sport movements.

Our purpose was to compare information among teammates in their perspective sport to analyze what movements their sport cause injuries. In doing so, we seek to find new information that can lead to better programming from a Strength and Conditioning perspective along with prevention and rehabilitation from an Athletic Training perspective.

The research and experiments were conducted in a class of 28 (22 Male, 6 Female) Avila University student athletes along with data gathering of 12 Golf players (7 Male, 5 Female). The data was separated between Males and Females in their perspective category.

The study took place inside the Maybee Fieldhouse at Avila University on a Tuesday morning Measurement and Evaluation class that runs from 9:00 – 10:00. The measurements were taken by groups of students at different set up stations throughout the gymnasium.

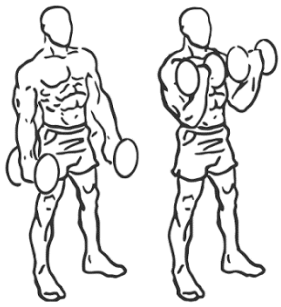
The procedures that took place during the class portion of the data gathering involved splitting into groups of 4-6 people with each individual partnering to observe the exercise and record the results. The order of performing the exercises were not of great importance, rather just emphasizing pairing the synergistic muscle groups. Such pairings involve performing the Right side Bridge (RSB) with the Left Side Bridge (LSB) as well as the Trunk flexor endurance (TFE) with the Trunk extensor endurance (TEE).

R/L Side Bridge

Trunk Extensor

Trunk Flexor

The remaining exercises involved performing a One-repetition Maximum (1RM) Bicep Curl with proper technique of not swinging the curling arm. The other was a simple measurement of a Sit and Reach (S&R) pushing a marker measuring in inches.



Data collecting consisted of tracking the endurance exercise times along with the quantitative results of the 1RM and S&R exercises.

Data analysis consisted of an Excel Spreadsheet tracking and utilizing ratios between opposing sides (Left-Right & Extensor-Flexor). Imbalances were determined by researched differentials corresponding with the specific muscle groups based off of the endurance exercises. Such comparisons were made with:

- RSB/LSB 1.0 ± .05
- TFE/TEE > 1.0
- RSB/TEE > 0.75
- LSB/TEE > 0.75

The first data provided in the study shows a correlation between back troubles and muscle imbalances. With the numbers below, the only subjects that tested out with an imbalance were ones with a history of back problems. Such information can indicate how having a source of pain and/or weakness in the posterior regions of the kinetic chain impact how the rest of the body can function. Because the subjects who had back pain had a significant amount of differentials with their oblique and trunk extensor/flexors, a muscle imbalance gives us a good indicator for what the individual's specific needs are.

Table 1. Normative Data for Trunk Stabilization Endurance

		Flexibility	*Strength*	*Muscle Endurance*				*Endurance Ratios*			
NORMATIVE STUDIES	**Sex**	**S&R**	**1RM BiCurl**	**RSB**	**LSB**	**TFE**	**TEE**	**RSB:LSB**	**TFE:TEE**	**RSB:TEE**	**LSB:TEE**
Females - No back troubles (21 y.o.)	F			75	78	134	**185**	0.96	0.72	0.40	0.42
Males - No back troubles (21 y.o.)	M			95	99	136	161	0.96	0.84	0.58	0.61
Males - No Back Troubles (34 y.o.)	M			54	54	66	103	1.05	0.71	0.57	0.58
History of Disabling Back Troubles (34 y.o.)	M			58	65	84	90	**0.93**	**1.15**	**0.97**	**1.03**

		Muscle Imbalances			
NORMATIVE STUDIES	**Sex**	**RSB/LSB 1.0 ± .05**	**TFE/TEE > 1.0**	**RSB/TEE > 0.75**	**LSB/TEE > 0.75**
Females - No back troubles (21 y.o.)	F	no	no	no	no
Males - No back troubles (21 y.o.)	M	no	no	no	no
Males - No Back Troubles (34 y.o.)	M	no	no	no	no
History of Disabling Back Troubles (34 y.o.)	M	**yes**	**yes**	**yes**	**yes**

When analyzing the data of our study's Non-Golf female athletes, 6 subjects provided a sample of multiple female sports. 4/6 female athletes showed at least one type of muscle imbalance. The majority of the subjects managed to perform the S&R with above average flexibility. Despite the notion of lower injury probabilities by having greater flexibility, there was still a significant amount of female athletes with a muscle imbalance. Such inferences provide support towards the significance of muscle imbalances over flexibility causes.

		Flexibility	*Strength*	*Muscle Endurance*				*Endurance Ratios*			
FEMALES (all sports/activities)	**Sex**	**S&R**	**1RM BiCurl**	**RSB**	**LSB**	**TFE**	**TEE**	**RSB:LSB**	**TFE:TEE**	**RSB:TEE**	**LSB:TEE**
1	F	5	25	65	65	97	90	1.00	1.08	0.72	0.72
2	F	16	12	19	20	36	43	0.95	0.84	0.44	0.47
3	F	15	25	71	71	75	41	1.00	1.83	1.73	1.73
4	F	18	20	31	45	69	104	0.69	0.66	0.29	0.43
5	F	17	25	60	61	NA	90	0.98	NA	0.67	0.68
6	F	12	35	67	70	69	64	0.96	1.08	1.04	1.09
		14	**24**								

	Muscle Imbalances			
	RSB/LSB 1.0 ± .05	**TFE/TEE > 1.0**	**RSB/TEE > 0.75**	**LSB/TEE > 0.75**
1	no	yes	no	no
2	no	no	no	no
3	no	yes	yes	yes
4	yes	no	no	no
5	no	no	no	no
6	no	yes	yes	yes

Baseball consisted of a sample size of 7 subjects during their competitive Fall Pre-season. In this point of a season, they are in a semi-in season form undergoing scrimmages and a Strength and Conditioning program. The data collected showed all subjects to have at least 1 form of muscle imbalance with the obliques and/or trunk extensor/flexors. Being a Strength-Power sport, there is no surprise in having 3/7 subjects scoring below average on the S&R. While flexibility isn't an overall strength in a baseball population, it is common to see a dominant side on an oblique as well as a stronger/overused back. The subjects showed to have 5/7 stronger TFE than TEE, showing better endurance on TFE due the constant sport specific movement of overhead throwing and swinging a bat. Considering that all baseball players were right handed, there are no abnormalities in having 6/7 subjects scoring a stronger RSB, showing an imbalance with the RSB and LSB. 5/7 also showed a significant imbalance between the LSB and TEE, imbalances that had mixed ratios for what side was stronger. Such variability goes to show how specific movements cause variances in how muscle imbalances take place in a baseball population.

STRENGTH-POWER SPORT (baseball)	Sex	S&R	1RM BiCurl	RSB	LSB	TFE	TEE	RSB:LSB	TFE:TEE	RSB:TEE	LSB:TEE
7	M	11	50	25	26	59	38	0.96	1.55	0.66	0.68
8	M	9	30	62	65	96	68	0.95	1.41	0.91	0.96
9	M	10	50	65	95	60	70	0.68	0.86	0.93	1.36
10	M	17	20	45	43	57	17	1.05	3.35	2.70	2.53
11	M	9	45	26	18	23	33	1.44	0.70	0.79	0.55
12	M	9	35	39	67	75	32	0.58	2.34	1.22	2.09
13	M	14	50	66	65	69	60	1.02	1.15	1.10	1.08
		11	40								

	Muscle Imbalances			
	RSB/LSB 1.0 ± .05	TFE/TEE > 1.0	RSB/TEE > 0.75	LSB/TEE > 0.75
7	no	yes	no	no
8	no	yes	yes	yes
9	yes	no	yes	yes
10	no	yes	yes	yes
11	yes	no	yes	no
12	yes	yes	yes	yes
13	no	yes	yes	yes

Another Strength-Power sport is Football, which consisted of a sample size of 7 subjects all in the middle of their regular season. In-season along with a Strength and Conditioning program, these subjects are the ideal study in terms of studying their imbalances while in current competition. The data showed having 6/7 football players having at least 1 muscle imbalance. Keeping in mind of the nature of strength and aggressiveness of their sport, it is completely normal to find multiple imbalances amongst the majority of its subjects. In having only 3/7 subjects with RSB-LSB imbalances, those are fairly good numbers for the population. Further studies with a greater sample size could provide more data analysis, especially if combined with both current and past injuries. 5/7 subjects displayed a TFE-TEE imbalance showing a stronger mixed results of either side being more significantly dominant. As before, further studies showing injury history as well information on the individuals' sport specific position needs could provide a better subject background to determine causes and effects of their considered muscle imbalance(s).

		Flexibility	*Strength*	*Muscle Endurance*				*Endurance Ratios*			
STRENGTH-POWER SPORT (football)	Sex	S&R	1RM BiCurl	RSB	LSB	TFE	TEE	RSB:LSB	TFE:TEE	RSB:TEE	LSB:TEE
14	M	13	50	60	60	90	90	1.00	1.00	0.67	0.67
15	M	15	40	60	NA	100	95	NA	1.05	0.63	NA
16	M	11	45	39	26	34	109	1.50	0.31	0.36	0.24
17	M	16	50	56	40	60	34	1.40	1.76	1.65	1.18
18	M	7	50	90	90	90	90	1.00	1.00	1.00	1.00
19	M	14	50	60	62	90	90	0.97	1.00	0.67	0.69
20	M	10	45	23	20	19	33	1.15	0.58	0.70	0.61

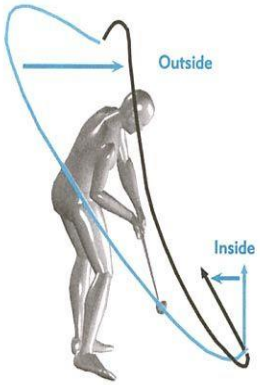
	Muscle Imbalances			
	RSB/LSB 1.0 ± .05	TFE/TEE > 1.0	RSB/TEE > 0.75	LSB/TEE > 0.75
14	no	yes	no	no
15	NA	yes	no	NA
16	yes	no	no	yes
17	yes	yes	yes	yes
18	no	yes	yes	no
19	no	no	no	no
20	yes	no	no	no

Stop and Go Sports such as Basketball and Soccer provide a different field of study in the perspective of their sport specific movements. Basketball and Soccer tend to have more injuries related to knees and ankle-joint mobility due to the constant sprinting and movement change. Our study involved a sample size of 8 subjects, all of which are in or near their regular season competition. Considering their level of current play as well both undergoing a Strength and Conditioning program, these subjects provide another good perspective on muscle imbalances with their given sport. The data combined with Basketball and Soccer players showed 6/7 subjects with at least 1 muscle imbalance. The majority of imbalances came from the ratios of RSB-LSB, indicating two possibilities considering their specific sport movements. In soccer, it is expected to have a stronger Left-to-Right side due to the constant running and kicking. With one leg planting to produce force with a hard kick, one oblique will typically undergo more force production than the other. In terms of a basketball population, RSB-LSB imbalances could be due to the constant running and jumping of the sport. Considering the explosiveness and change of direction that takes place on the floor, an oblique dominance can be due to any part of the lower extremity kinetic chain involving the ankles, knees, and hips.

		Flexibility	Strength	Muscle Endurance				Endurance Ratios			
STOP AND GO SPORT (basketball/sc	Sex	S&R	1RM BiCurl	RSB	LSB	TFE	TEE	RSB:LSB	TFE:TEE	RSB:TEE	LSB:TEE
21	M	7	45	45	44	50	65	1.02	0.77	0.69	0.68
22	M	11	40	38	43	NA	65	0.88	NA	0.80	0.66
23	M	8	50	47	52	NA	63	0.90	NA	0.75	0.83
24	M	9	35	45	50	65	60	0.90	1.08	0.75	0.83
25	M	8	50	NA	NA	NA	NA	NA	NA	NA	NA
26	M	7	35	46	51	50	72	0.90	0.69	0.64	0.71
27	M	8	35	25	48	59	10	0.52	5.90	2.50	0.79
28	M	7	40	73	78	78	92	0.94	0.85	0.79	0.85
		8	**41**								

	Muscle Imbalances			
	RSB/LSB 1.0 ± .05	TFE/TEE > 1.0	RSB/TEE > 0.75	LSB/TEE > 0.75
21	no	no	no	no
22	yes	no	yes	no
23	yes	no	no	yes
24	yes	no	no	no
25	NA	NA	NA	NA
26	yes	no	no	no
27	yes	yes	yes	yes
28	yes	no	yes	yes

To provide our study with a completely different perspective on sport specific movements, Golf is a sport that has a different background in terms of exertion. Despite the notion that Golf is a relaxed and easy going sport, there are still movements in a golfer's swing that requires a specific side or body region to generate a more forceful swing. In a study conducted by Dr. Gerald Larson at Avila University, data was gathered from the Golf team consisting of 12 players (7 Male and 5 Female).



The data showed all female subjects to have at least one form of muscle imbalance, that of it mostly being contributed to either a RSB or LSB. 4/5 displayed a RSB-LSB imbalance along with imbalances between RSB/LSB-TEE. Such data shows how much the upper extremities of the back and obliques come into play with a golf swing.

Males showed identical results in having 5/7 with a RSB-LSB muscle imbalance. When it comes to oblique comparisons to trunk extensors (TEE), only 2/7 male subjects showed a significant difference between the two body parts tested. Such results arise from several possible factors, one of them being how much stronger males are typically to females.

A useful tool to further the studies in both Male and Female Golf players could be using a biomechanics analysis to identify parts of their swing that can indicate a reason for a body part to be more dominant than another. Since Golf doesn't require as much Strength and Conditioning as other sports, this provides us with a distinct perspective on how sport specific movements can influence muscle imbalances.

Females

		Flexibility	Strength	Muscle Endurance				Endurance Ratios			
GOLF (females and males)	Sex	S&R	1RM BiCurl	RSB	LSB	TFE	TEE	RSB:LSB	TFE:TEE	RSB:TEE	LSB:TEE
29	F			4	4	46	54	1.00	0.85	0.07	0.07
30	F			27	24	11	14	1.13	0.79	1.93	1.85
31	F			69	68	62	76	1.01	0.82	0.91	0.89
32	F			72	91	90	150	0.79	0.86	0.48	0.61
33	F			116	101	49	83	1.14	0.59	1.40	1.22

	Muscle Imbalances			
	RSB/LSB 1.0 ± .05	TFE/TEE > 1.0	RSB/TEE > 0.75	LSB/TEE > 0.75
29	no	no	yes	yes
30	yes	no	yes	yes
31	yes	no	yes	yes
32	yes	no	no	no
33	yes	no	yes	yes

Males

	Sex	S&R	1RM BiCurl	RSB	LSB	TFE	TEE	RSB:LSB	TFE:TEE	RSB:TEE	LSB:TEE
34	M			38	48	20	118	0.79	0.17	0.32	0.41
35	M			147	137	192	127	1.07	1.51	1.16	1.08
36	M			105	49	102	157	2.14	0.65	0.67	0.31
37	M			71	86	120	120	0.83	1.00	0.59	0.74
38	M			60	61	21	174	0.99	0.12	0.34	0.35
39	M			69	70	68	74	0.99	0.92	0.93	0.95
40	M			52	57	47	80	0.91	0.59	0.65	0.71

	RSB/LSB 1.0 ± .05	TFE/TEE > 1.0	RSB/TEE > 0.75	LSB/TEE > 0.75
34	yes	no	no	no
35	yes	yes	yes	yes
36	yes	no	no	no
37	yes	yes	no	no
38	no	no	no	no
39	no	no	yes	yes
40	yes	no	no	no

In conclusion, there is a lot of data and information to process with this study. While we can analyze a sport's specific needs and issues, breaking the various sport types allows us to ask more questions when comparing and contrasting the results. Considering Strength-Power sports such as Baseball and Football, they have similar imbalances that can be traced to their similar movement and training patterns. But when we compare them to Stop and Go sports such as Basketball and Soccer, there are significant differences that are ultimately traced to their specific running and directional change. In contrast to the previous two categories, Golf is in a sense a different animal considering how much less exerting the sport is. Considering the Female population in a variety of sport specific categories, their general background in terms of gender equate for much of their results for muscle imbalances.

In having a fairly small sample size of 40 student athletes from various sport specific backgrounds, one must consider that each field could provide a much deeper in depth analysis with a greater population in their sport. Some sources of error could be due to the several timings of each sports' season. Considering to have more studies throughout the year could provide another perspective to the data when considering pre-season, in season, and post-season analysis for all of the sports. It is more likely to have sources of error in the data collection if certain student athletes are more fatigued than others due to the competitive nature of their perspective season.

What stood out in this data collection was the statistic of having 88% of the student athletes to have a muscle imbalance. Being in a competitive college sport is clearly more vigorous and exhausting than for athletes who play at a lower level, so there is no surprise in the numbers discovered in this research. Considering how these athletes are supposed to be trained and developed at a higher level of play and conditioning, the demands of their specific sport has a toll on their bodies. While imbalances display a red flag for a possible injury, it doesn't always indicate that the athlete is weak. Sometimes an athlete can be doing things so well in their sport that it causes an imbalance. For example, a Baseball player is likely to have an imbalance of having a stronger side to their body depending on what side they throw and swing from. As long as that differential isn't as extreme in its imbalance significance, the player can still have a good probability in getting stronger and remaining healthy.

What I found interesting in this study was how so many sport specific movements can be traced to its perspective athletes' imbalances. The numbers in the data only show what side may be stronger than the other, but when you provide an in depth analysis for what that specific athlete does on a daily basis, a lot of ideas can emerge for how to interpret that athlete's needs. Further research using more athletes and more specific measurements can open up multiple windows for new perspectives toward sport specific analysis.