The hidden impact of injuries: a case study of Christian Yelich

In the world of Major League Baseball, a player's journey can be like a rollercoaster ride. Christian Yelich, a former MVP, found himself facing an unforeseen challenge starting from 2020. Yelich's hitting performance seemed to hit a roadblock that defied explanation.

In this article, I delve into Christian Yelich's hitting journey, discussing the potential impact of his 2019 knee injury on his subsequent performances at the plate. With a blend of statistical analysis and a compassionate observation, I endeavor to shed light on the underlying factors that may have contributed to the decline of his hitting performance, and how the effects of that injury persist even to this day.

As we navigate the highs and lows of Yelich's hitting journey, we strive to find the potential keys to reigniting his hitting ability once more.

OBP, SLG and OPS analysis

A player's performance can be influenced by various elements. Christian Yelich's performance decline first happened in a unique 2020 season, that was shortened to 60 games due to the COVID-19 pandemic. The pandemic impacted everyone's life in one way or another and could have an impact on player's performance due to the special circumstances. In this changed environment it was hard to get answers about his struggles and find the real elements that influenced his performance.

It is also not uncommon for players to have slightly lower numbers following a peak performance. Yelich had an exceptional 2018 and 2019 season. This could be attributed to the concept of regression to the mean, where exceptionally high performance is likely to normalize over time. Is this decline a common occurrence among players, or is it an unusual event, particularly for someone of his caliber?

To answer this question, I looked at the largest changes in players' OBP, SLG and OPS separately for players who had at least one season with .400 OBP, .590 SLG or 1.000 OPS. I only looked at players between 2015 and 2022 (excluding the 2020 season due to its small sample size) where the playing environment was similar and players with more than 300 ABs to only look at core players with large sample size.

Slugging Percentage (SLG) and On Base Plus Slugging Percentage (OPS)

SLG and OPS shows a very similar trend for Yelich (see Table 1 and Table 2). He had the second highest SLG and 3rd highest OPS both in his 2019 season after Aaron Judge's spectacular season in 2022 and Bryce Harper's 2016 season. Looking at the largest changes, Yelich ranks 3rd in both lists after Cody Bellinger and Nelson Cruz. He ranks 4th in both lists when we look at the largest percentage drop compared to their highest. He had a drop of 44% in SLG and 33% in OPS compared to his peak of .671 and 1.100. The smallest drop in SLG belongs to Fernando Tatis Jr., David Ortiz, Mike Trout, Shohei Ohtani and Yordan Alvarez and in OPS to Mike Trout, David Ortiz, Paul Goldschmidt, Yordan Alvarez and Aaron Judge.

| Player Name | SLG | | | | | | Largest Change | | | |
	max	year	ranking	min	year	ranking	SLG Change	ranking	Percentage Change comapred to maximum	ranking
Cody Bellinger	0,629	2019	11th	0,302	2021	1st	0,327	1st	52,1%	1st
Nelson Cruz	0,639	2019	7th	0,337	2022	3rd	0,302	2nd	47,2%	2nd
Christian Yelich	0,671	2019	2nd	0,373	2021	5th	0,297	3rd	44,3%	4th
Ketel Marte	0,592	2019	19th	0,323	2016	2nd	0,270	4th	45,5%	3rd
Anthony Rendon	0,598	2019	16th	0,363	2015	4th	0,235	5th	39,3%	5th
Mitchell Garver	0,630	2019	9th	0,414	2018	8th	0,216	6th	34,3%	6th
Bryce Harper	0,649	2015	4th	0,441	2016	12th	0,208	7th	32,1%	8th
Brandon Belt	0,597	2021	17th	0,403	2019	6th	0,194	8th	32,5%	7th
Charlie Blackmon	0,601	2017	15th	0,411	2021	7th	0,190	9th	31,7%	9th
Mookie Betts	0,640	2018	6th	0,459	2017	15th	0,182	10th	28,4%	12th
Julio Martinez	0,629	2018	10th	0,448	2022	13th	0,181	11th	28,7%	10th
Alex Bregman	0,592	2019	21st	0,422	2021	9th	0,170	12th	28,7%	11th
Giancarlo Stanton	0,631	2017	8th	0,462	2022	16th	0,169	13th	26,8%	14th
Vladimir Guerrero Jr.	0,601	2021	14th	0,433	2019	10th	0,168	14th	27,9%	13th
Aaron Judge	0,686	2022	1st	0,528	2018	18th	0,158	15th	23,1%	17th
George Springer	0,591	2019	22nd	0,434	2018	11th	0,157	16th	26,6%	15th
Daniel Murphy	0,595	2016	18th	0,449	2015	14th	0,146	17th	24,6%	16th
Yordan Alvarez	0,655	2019	3rd	0,531	2021	19th	0,124	18th	19,0%	18th
Mike Trout	0,645	2019	5th	0,550	2016	20th	0,095	19th	14,7%	20th
Shohei Ohtani	0,592	2021	20th	0,505	2019	17th	0,087	20th	14,7%	19th
David Ortiz	0,620	2016	12th	0,553	2015	21st	0,067	21st	10,8%	21st
Fernando Tatis Jr.	0,611	2021	13th	0,590	2019	22nd	0,021	22nd	3,4%	22nd

Table 1: Players with a minimum of 300 ABs and .590 SLG between 2015 and 2022 (excl. 2020) ordered by largest SLG change.

| Player Name | OPS | | | | | | Largest Change | | | |
	max	year	ranking	min	year	ranking	OPS Change	ranking	Percentage Change comapred to maximum	ranking
Cody Bellinger	1,035	2019	7th	0,542	2021	1st	0,494	1st	47,7%	1st
Nelson Cruz	1,031	2019	10th	0,651	2022	2nd	0,381	2nd	36,9%	2nd
Christian Yelich	1,100	2019	3rd	0,736	2021	5th	0,365	3rd	33,1%	4th
Joey Votto	1,032	2017	8th	0,689	2022	3rd	0,343	4th	33,3%	3rd
Anthony Rendon	1,010	2019	13th	0,707	2015	4th	0,303	5th	30,0%	5th
Bryce Harper	1,109	2015	2nd	0,814	2016	11th	0,295	6th	26,6%	6th
Mookie Betts	1,078	2018	5th	0,803	2017	10th	0,276	7th	25,6%	7th
Giancarlo Stanton	1,007	2017	14th	0,759	2022	6th	0,248	8th	24,6%	8th
J.D. Martinez	1,031	2018	9th	0,790	2022	9th	0,242	9th	23,4%	9th
Alex Bregman	1,015	2019	12th	0,777	2021	8th	0,238	10th	23,4%	10th
Vladimir Guerrero Jr.	1,002	2021	16th	0,772	2019	7th	0,230	11th	23,0%	11th
Aaron Judge	1,111	2022	1st	0,916	2021	15th	0,194	12th	17,5%	14th
Yordan Alvarez	1,067	2019	6th	0,877	2021	13th	0,190	13th	17,8%	13th
Paul Goldschmidt	1,005	2015	15th	0,821	2019	12th	0,184	14th	18,3%	12th
David Ortiz	1,021	2016	11th	0,913	2015	14th	0,108	15th	10,6%	15th
Mike Trout	1,088	2018	4th	0,991	2016	16th	0,097	16th	9,0%	16th

Table 2: Players with a minimum of 300 ABs and 1.000 OPS between 2015 and 2022 (excl. 2020) ordered by largest OPS change.

On Base Percentage (OBP):

OBP looks a little better for Yelich (see Table 3). He had the 7th highest OBP again in his 2019 season. He ranks 13th in the list both largest change and the largest percentage drop compared to his peak that puts him to the middle of the list. Brandon Nimmo, Freddy Freeman, David Ortiz, Kris Bryant, and Aaron Judge have the smallest changes in OBP.

Player Name	OBP						Largest Change			
	max	year	ranking	min	year	ranking	OBP Change	ranking	Percentage Change comapred to maximum	ranking
Cody Bellinger	0,406	2019	19th	0,240	2021	1st	0,166	1st	40,9%	1st
Joey Votto	0,459	2015	4th	0,319	2022	5th	0,140	2nd	30,5%	3rd
Jose Cabrera	0,440	2015	5th	0,305	2022	2nd	0,135	3rd	30,8%	2nd
Mookie Betts	0,438	2018	6th	0,340	2022	11th	0,099	4th	22,5%	6th
Bryce Harper	0,460	2015	2nd	0,364	2022	22nd	0,096	5th	20,9%	9th
Josh Donaldson	0,404	2016	21st	0,308	2022	3rd	0,096	6th	23,8%	4th
DJ LeMahieu	0,416	2016	11th	0,321	2018	7th	0,095	7th	22,8%	5th
Mike Trout	0,460	2018	3rd	0,369	2022	24th	0,091	8th	19,8%	11th
Tommy Pham	0,411	2017	15th	0,320	2022	6th	0,091	9th	22,0%	7th
Paul Goldschmidt	0,435	2015	7th	0,346	2019	15th	0,090	10th	20,6%	10th
Andrew McCutchen	0,401	2015	24th	0,316	2022	4th	0,086	11th	21,4%	8th
Justin Turner	0,415	2017	12th	0,339	2016	10th	0,076	12th	18,3%	12th
Christian Yelich	0,429	2019	8th	0,355	2022	19th	0,074	13th	17,3%	13th
Alex Bregman	0,423	2019	10th	0,352	2017	18th	0,071	14th	16,8%	14th
Anthony Rendon	0,412	2019	14th	0,344	2015	14th	0,068	15th	16,5%	16th
Anthony Rizzo	0,405	2019	20th	0,338	2022	8th	0,067	16th	16,6%	15th
Yordan Alvarez	0,412	2019	13th	0,346	2021	16th	0,066	17th	16,0%	17th
Juan Soto	0,465	2021	1st	0,401	2019	27th	0,064	18th	13,8%	22nd
Vladimir Guerrero Jr.	0,401	2021	26th	0,339	2019	9th	0,063	19th	15,6%	18th
Yandy Diaz	0,401	2022	25th	0,340	2019	12th	0,061	20th	15,3%	19th
J.D. Martinez	0,402	2018	23rd	0,341	2022	13th	0,061	21st	15,2%	20th
Jose Altuve	0,410	2017	16th	0,350	2021	17th	0,060	22nd	14,6%	21st
Aaron Judge	0,425	2022	9th	0,373	2021	26th	0,052	23rd	12,2%	24th
Kris Bryant	0,409	2017	17th	0,358	2021	20th	0,051	24th	12,4%	23rd
David Ortiz	0,401	2016	27th	0,360	2015	21st	0,041	25th	10,2%	25th
Freddie Freeman	0,407	2022	18th	0,370	2015	25th	0,037	26th	9,0%	27th
Brandon Nimmo	0,404	2018	22nd	0,367	2022	23rd	0,037	27th	9,1%	26th

Table 3: Players with a minimum of 300 ABs and .400 OBP between 2015 and 2022 (excl. 2020) ordered by largest OBP change.

Total seasons

To have a sense what these numbers really mean I looked at players with at least 300 ABs who ever had a season with .590 SLG, 1.000 OPS and .400 OBP combined between the years of 2010 and 2022 (excl. 2020). Results are shown in Table 4. There are only 20 players who meets all three criteria covering a total of 29 seasons which is 1% of the MLB players. Only 7 players could make it in more than 1 seasons: Mike Trout (3), Bryce Harper (3), Yordan Alvarez (2), David Ortiz (2), Miguel Cabrera (2), Aaron Judge (2) and Christian Yelich (2).

Player Name	# of season
Bryce Harper	3
Mike Trout	3
Aaron Judge	2
Christian Yelich	2
David Ortiz	2
Miguel Cabrera	2
Yordan Alvarez	2
Albert Pujols	1
Alex Bregman	1
Anthony Rendon	1
Cody Bellinger	1
Hanley Ramirez	1
J. D. Martinez	1
Joey Votto	1
Jose Bautista	1
Josh Hamilton	1
Mike Napoli	1
Mookie Betts	1
Troy Tulowitzki	1
Vladimir Guerrero Jr.	1

Table 4. Players with a minimum of 300 ABs and .400 OBP, .590 SLG and 1.000 OPS between 2010 and 2022 (excl. 2020) and the number of seasons.

When we look at the names in Table 1, Table 2, Table 3 and Table 4, it already suggests that Yelich belongs to an elite group and have reached numbers that cannot be accounted for luck. He is one of the five players who had a season with more than .590 SLG, .400 OBP and 1.000 OPS combined between 2010 and 2022. These results suggests that Yelich belongs to an elite group of players, has exceptional skills and his true talent level is well above average.

In terms of SLG and OPS, Yelich holds one of the top positions in both the overall rankings and the rankings for the largest drop, while he experiences only an average decrease in his OBP. This implies that his ability to reach base has not been impacted as significantly as his power.

Good and Bad posture and its impact on hitting

Hitting a baseball requires a combination of proper mechanics, balance, and power generation, and any postural or biomechanical issues can affect the player's ability to perform optimally. Bad posture refers to the improper alignment of the body's building blocks – the spine, shoulders, hips, and head. This misalignment does not only impact a player hitting mechanics but the way they hold their body while standing, sitting, or moving. Picture your body as a stack of block – when they're in line, everything works smoothly. However, bad posture occurs when some of these blocks are out of alignment.

Anterior Pelvic Tilt

Figure 1 shows an example of a good and bad posture and how the body alignment changes with an anterior pelvic tilt. Anterior pelvic tilt is a postural disorder where your pelvis is tilted forward which forces an excessive curve in the lower back. Pelvis helps you walk, run, and lift weight off the ground and it also contributes to proper posture as pelvic muscles are part of core muscles.

As you can see in Figure 1, anterior pelvic tilt impacts lower and upper back, hips, head position and legs. In good posture all the pink lines are closer to vertical (90°) while in bad posture they have larger angles compared to the blue 0° horizontal lines.
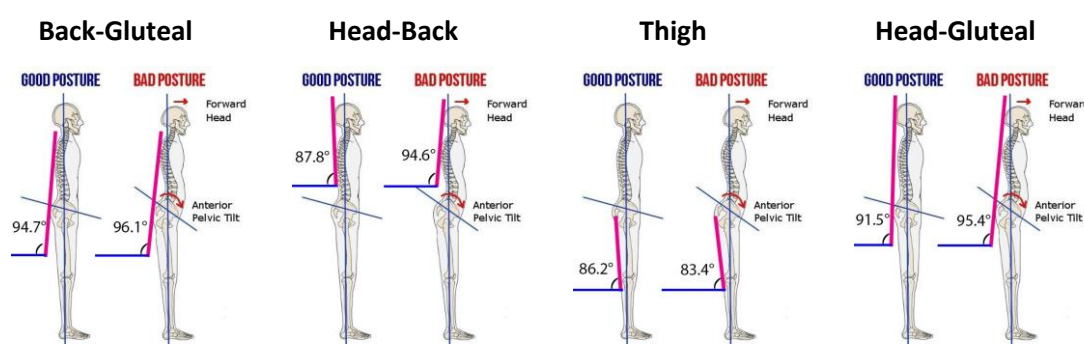

Figure 1: Change of the angles between good and bad posture: (1) Back-Gluteal: +1.4°, (2) Head-Back: +6.8°, (3) Thigh: -2.8°, (4) Head-Gluteal: +3.9°.

Impact on hitting

An anterior pelvic tilt can be symmetric when the entire pelvis tilts forward, or one-sided where one side tilts forward more than the other resulting in an uneven tilt of the pelvis. Both types can lead to

discomfort and postural problems. They have similar effects, but a one-sided tilt can cause more differences between the two sides of the body.

One-sided anterior pelvic tilt in baseball can have several negative effects, including imbalanced weight distribution, altered hip rotation, limited torso rotation, shoulder and arm misalignment, muscle imbalances, and decreased power transfer. These issues can collectively impact a player's stance, stability, making it difficult to maintain a controlled swing, reduces swing power due to inefficient swing path and decreased bat control, and affect mechanics, timing, bat speed and overall performance at the plate. Additionally, over time, this condition may increase the risk of overuse injuries, especially on the tilted side, due to excessive stress on certain muscles and joints.

The impact can vary from player to player. Some individuals may compensate well for the tilt, while others may experience more significant limitations. The severity of the pelvic tilt, the player's overall athleticism, and their ability to adapt and adjust their mechanics will also influence the extent of its impact.

Methodology

The aim of this study is to analyze any changes in Christian Yelich's body posture before and during his swing, with the goal of determining whether such changes have occurred and, if so, whether they have an influence on his performance. Based on his movements, my initial assumption is that he struggles with right-sided anterior pelvic tilt.

Hypothesis

My initial hypotheses are:

- **Hypothesis 1**: There are differences in Christian Yelich's posture between his peak years (2018-2019) and the years after his knee injury (2020-today).
- **Hypothesis 2**: There is a correlation between his body alignment and baseball hitting performance.
- **Hypothesis 3**: Christian Yelich has right-sided anterior pelvic tilt.

Procedures

To assess characteristics of Yelich's body alignment, I collected photos from his at bats using videos from baseballsavant.mlb.com. Photos were collected from the beginning of the 2018 season till August 5th and all photos were taken from games played at American Family Field, the home of the Milwaukee Brewers to have the same camera angles. Photos are taken a few seconds before the pitcher starts its pitching motion and when the batter's stance is unchanged.

I measured the position of Christian Yelich's body during his batting stance with simple lines and their angles. Lines were created manually using Photoshop and can include measurement errors due to its manual nature of fitting lines on the pictures. To lower the error and personal bias I collected 31-36 pictures from every season and added lines in a random order without knowing the date of the picture.

In the hitting stance evaluation 6 parameters were assessed as shown in Picture 2. The values are the angles from Photoshop of the added lines and represent the deviation of the body from the 0° horizontal line shown in the pictures in blue.
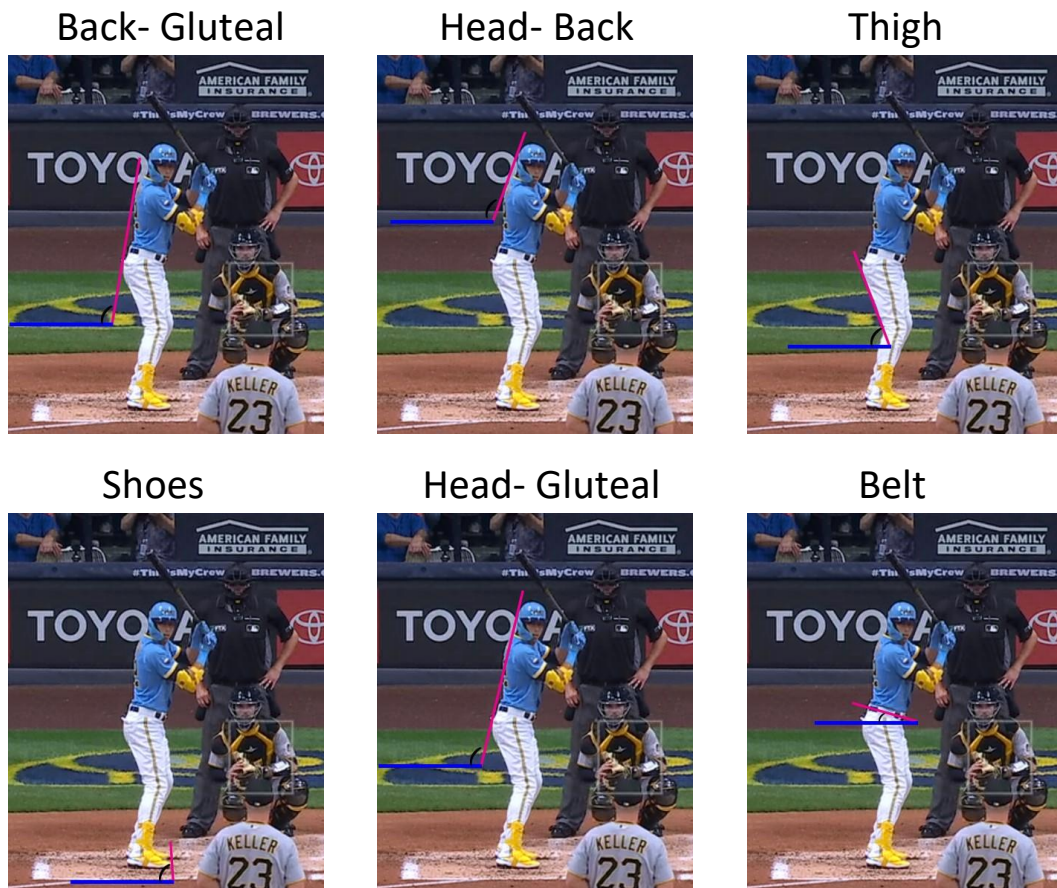
Back- Gluteal	Head- Back	Thigh
Shoes	Head- Gluteal	Belt

Figure 2: Measured angles of body posture. (1) Back-Gluteal, (2) Head-Back, (3) Thigh, (4) Shoes, (5) Head-Gluteal, (6) Belt

Data analyses

Years/Periods

The data was statistically analyzed using python. First, I looked at yearly and monthly averages for every 6 variables and looked for any differences or trends. There was a significant difference between the 1st and 2nd half in 2018 in the Back-Gluteal, Head-Back, Thigh, Shoes and Head-Gluteal results. The only line where there is no change in 2018 is the Belt line. Based on the monthly averages I decided to split the 2018 data into two parts – 1st and 2nd half. I also split the 2023 data into two parts where the month of April seems to be an outlier compared to later months. Starting from May 4th Yelich changed from a leg kick to a toe tap to find the right timing at the plate that might explain the differences in my measurements thus I analyzed May-August separately.

Relationship between assessed variables

A descriptive analysis was performed for the 6 variables to see if there is any relationship between them. Pearson correlation coefficient were calculated to establish associations between different measurements.

The correlation analysis (Figure 3) shows positive and strong relationship between the Head-Gluteal and the Back-Gluteal lines (r = 0.896), the Head-Gluteal and Head-Back lines (r = 0.732), and the Belt

and Back-Gluteal lines (r = 0.555). The relationship is statistically significant at the significance level (two-tailed) of 1% and the confidence of 99%, respectively of 5% and the confidence of 95%.
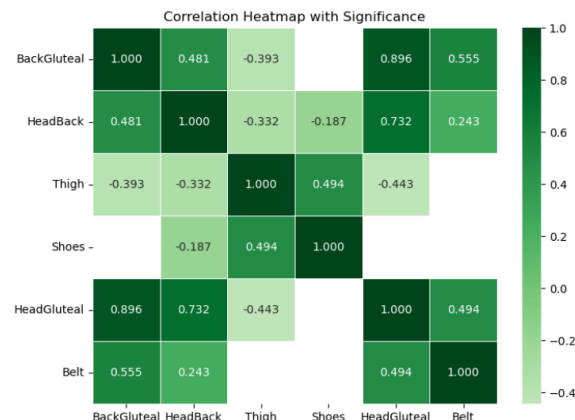
Figure 3: Correlations between variables showing only statistically significant correlations at the significance level of 1% (p-value=0.01) and confidence of 99%.

While Figure 1 showed a relatively smaller change in the Back-Gluteal line (+1.4°) compared to the more substantial changes in the Head-Back (+6.8°) and Head-Gluteal (+3.9°) lines, our statistical analysis shows that the Head-Gluteal and Back-Gluteal lines move closely together and have nearly equivalent changes in Christian Yelich's batting stance. Therefore, both lines contain similar information and can be valuable for further analysis.

T-test

The independent T-test is a parametric test used to test for a statistically significant difference in the means between two groups. There are certain conditions that need to be met for the test results to be considered reliable: population distributions are normal, samples have equal variance, and the two samples are independent.

The means of the 6 variables between two years were compared with Independent Sample t-test. The samples are random and independent samples, normality assumption was met for each variable, while homogeneity of variance assumption is fulfilled for Back-Gluteal, Head-Back, Head-Gluteal and Belt variables when looking at all groups at the same time.

The independent sample t-test shows statistically significant differences in the means between many groups (pair of years). Results are shown below in Figure 4 for Back-Gluteal, Head-Back, Head-Gluteal and Belt variables, separately for no significant differences (green) and significant differences (orange).

There is no significant difference for any measurements between 2018 2nd half and 2019, the peak times for Christian Yelich. On the other hand, Back-Gluteal line shows statistically significant difference between 2019 and every other year except 2018 2nd half that suggests that posture of the batting stance might have a real impact on Christian Yelich's performance.

Testing Hypothesis 1: There are differences in Christian Yelich's hitting stance posture for the Back-Gluteal, Head-Back, Head-Gluteal and Belt variables between his peak years (2018-2019) and the years after his knee injury (2020-today). The differences are statistically significant at the significance level of 5% (two-tailed) and the 95% confidence interval. Although there are similarities as well between the two periods, the hypothesis has been partially confirmed. Data analysis revealed changes of the body alignment in Chistian Yelich's hitting stance.
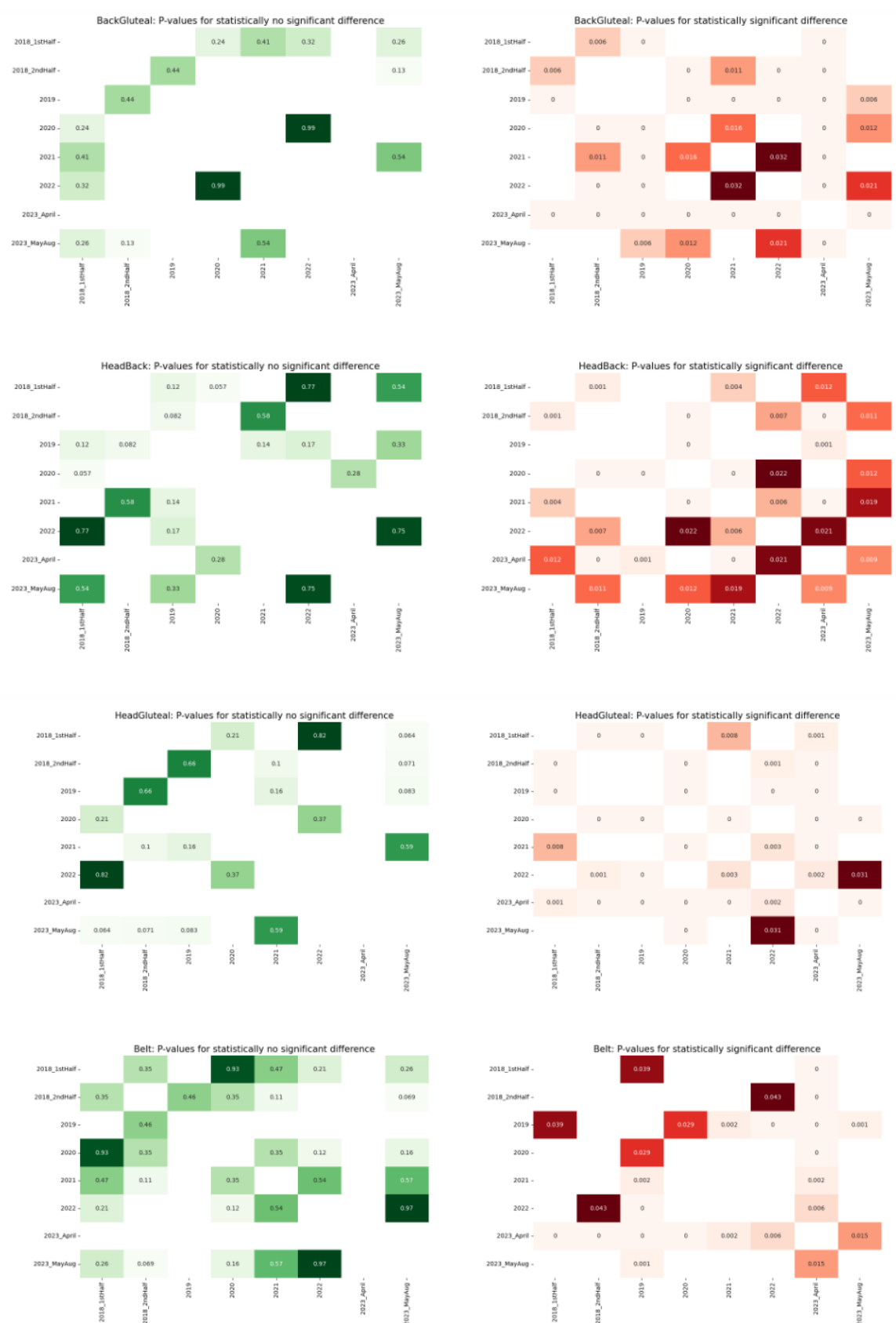
Figure 4: Back-Gluteal, Head-Back, Head-Gluteal and Belt lines T- test p-values for statistically no significant differences (green) and statistically significant differences (orange) at the significance level of 5% (two-tailed) and the 95% confidence interval

Hitting performance measurement

To measure Christian Yelich hitting performance I use OBP, SLG, OPS and wRC+ hitting metrics. All statistics are split apart in 2018 and 2023 the same way as earlier: 2018 1st and 2nd half and 2023 April and May-August 5th. Christian Yelich had the best performance in 2018 2nd half and 2019 followed by a significantly worse performance between 2020 and 2023 April. Starting from 2023 May there is an improvement and he got closer to his peak years again.
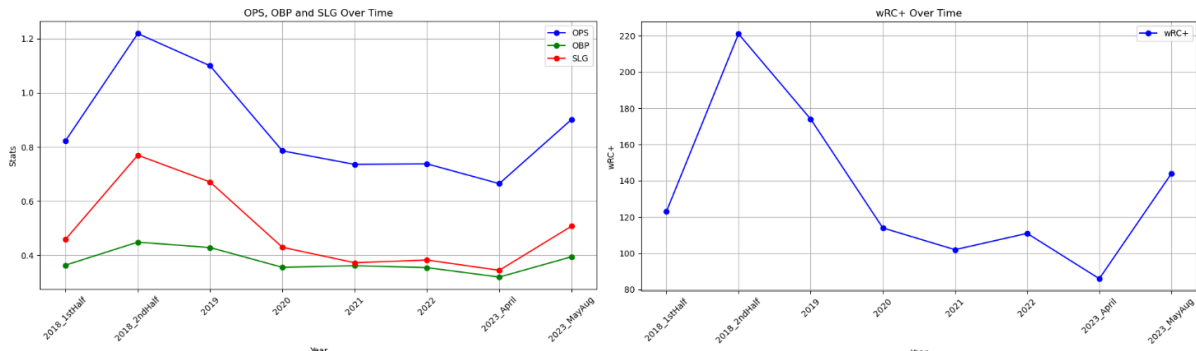
Figure 5: Christian Yelich's OPS, OBP, SLG and wRC+ over time.

Hitting performance and posture

In this section I will test our Hypothesis 2: There is a correlation between Yelich's body alignment and baseball hitting performance.

Correlations

A descriptive analysis was performed for the six variables and the four hitting statistics to see if there is any relationship between posture and performance. Pearson correlation coefficient were calculated to establish associations between different measurements.

The correlation analysis shows negative and strong relationship between the Back-Gluteal or Head-Gluteal lines and OBP, respectively r = -0.898 and r= -0.872, on 1% significance level (two-tailed) and 99% confidence.
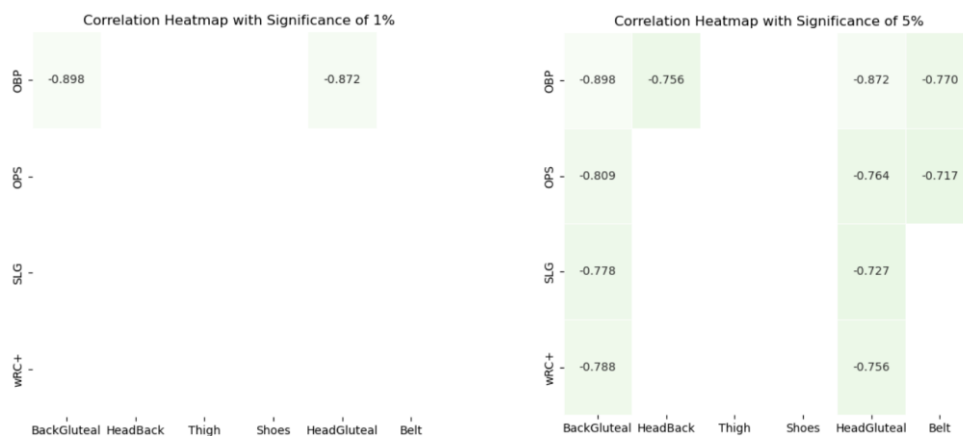
Figure 6: Correlation between hitting statistics and the yearly averages of the six variables. Both on 1% significance level (two-tailed) and 99% confidence and on 5% significance level (two-tailed) and 95% confidence.

Back-Gluteal or Head-Gluteal lines correlates with OPS, SLG and wRC+ (r= ranging between -0.717 and -0.0809), the Head-Back and Belt lines have a mid-strong negative relationship with OBP (r = -0.756 and r= -0.770). These relationships are also statistically significant at the significance level (two-tailed) of 5% and the confidence of 95%. Shoes alignment and Thigh has no or small linear relationship with performance.

Figure 7 and Figure 8 show yearly averages for Back-Gluteal angles and OBP, and Head-Gluteal angles and OBP and their correlation coefficients. Since both lines have a negative correlation with OBP, I visualized the Back-Gluteal * -1 and Head-Gluteal* -1 lines in the second plots to better see their relationships with OBP. The Back-Gluteal and Head-Gluteal averages and OBP moves together in most years, with a larger difference in 2021-2022 between the two, where based on the Back-Gluteal and Head-Gluteal angles and the correlation with OBP, a higher OBP would have been expected.
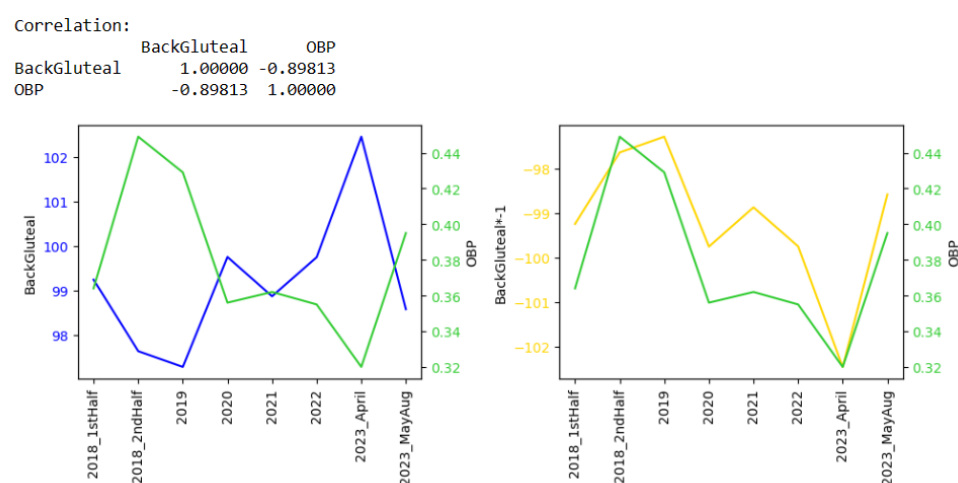
Figure 7: Correlation and yearly averages for OBP and Back-Gluteal angles and OBP and Back-Gluteal * -1.
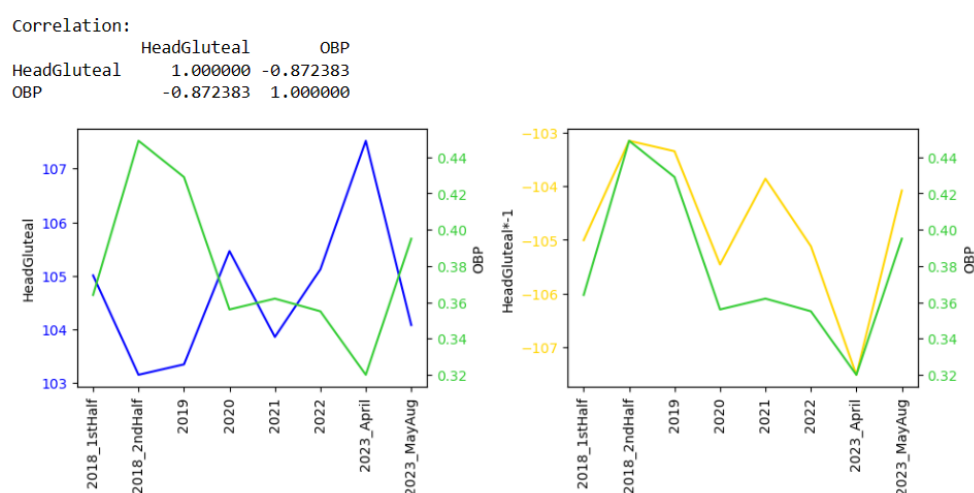

Figure 8: Correlation and yearly averages for OBP and Head-Gluteal angles and OBP and Head-Gluteal * -1.

Testing Hypothesis 2: There is a correlation between his body alignment and baseball hitting performance. The correlations are statistically significant at the significance level of 1% or 5% (two-tailed) and the 99% or 95% confidence interval. The hypothesis has been confirmed.

Yearly changes

In this section, I analyze the averages of the six measurements, examining their yearly variations and exploring their potential implications for Chirstian Yelich's performance.

A box plot is a graphical representation to display the distribution of a dataset. The box represents the interquartile range (IQR), which contains the middle 50% of the data. The median (middle value) is marked inside the box. Figure 9 shows the six measurements in a separate box plot and how they changed over time.
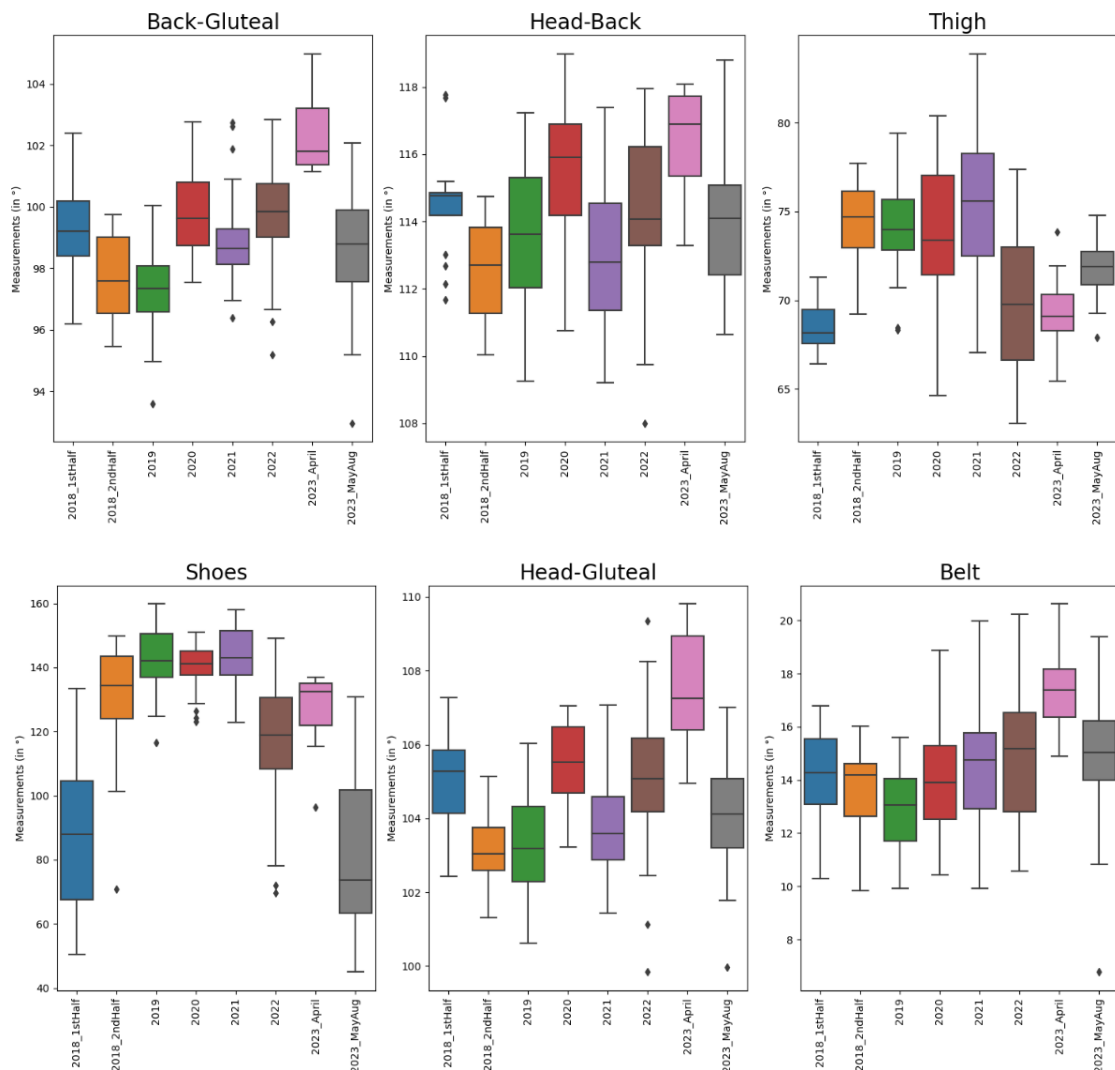

Figure 9: Box plot of the six measurements by year.

2018- 2019 – Peak years

Looking at the 2018 data provides a clearer insight into the true significance of the measured numbers and angles. In 2018 1st half, Yelich had a wRC+ of 123, while in the 2nd half his wRC+ increased to 221. He was well above an average player, and his offensive contributions were outstanding.

The most notable change observed in 2018 is the positioning of his feet. In the first half of 2018, his feet were relatively aligned in one line, averaging around 87°. However, in the second half, the average alignment of his shoes increased to 130°, indicating a more open stance with his front foot farther open then his back foot. Additionally, during the second half, he tended to have less bent legs and a

generally more upright posture, as evidenced by lower Back-Gluteal (-1.6° on average), Head-Back (-2° on average), and Head-Gluteal (-1.9° on average) angles.

2018 1st half   2018 2nd half

Figure 10: Christian Yelich's hitting stance on 2018-05-26 and 2018-08-22.

As illustrated in Figure 10, by putting his front foot farther away from the plate, he rotated his hip positioning to become more open towards the pitcher. This adjustment resulted in a batting stance that was not only more stable and upright, but also helped him to stay balanced during the swing, enhancing his ability to track the ball effectively.

The hip rotation has a notable impact on Yelich's upper body as well. Observing his elbow alignment, in the first half his left or back elbow is positioned more behind his right elbow, and his upper body is slightly rotated towards the catcher. In the second half, his upper body faces towards the plate, and his elbows align in a vertical line. This rotational adjustment also affects the positioning of his head, as he needs to make a reduced head rotation to maintain the same viewpoint.

The same trend persisted in 2019, with all the numbers showing slight but consistent movement in the same direction. Independent t-test shows no statistically significant difference in any variables between 2018 second half and 2019 (see Table 5).

Based on the findings we can assume that with a healthy body, his natural balanced position is somewhere around the position of his peak performance in 2018 second half and 2019. In 2019, Yelich had an impressive wRC+ of 174, securing the second-highest ranking in the league, just behind Mike Trout with a wRC+ of 177.

Variables	2018_2ndHalf (N = 14) Mean±SD	2019 (N = 33) Mean±SD	pvalue
BackGluteal	97.64 ± 1.41	97.28 ± 1.44	0.442000
HeadBack	112.51 ± 1.52	113.62 ± 2.11	0.082000
Thigh	74.28 ± 2.56	74.33 ± 2.67	0.953000
Shoes	129.5 ± 21.56	142.49 ± 9.77	nan
HeadGluteal	103.15 ± 1.13	103.35 ± 1.47	0.658000
Belt	13.44 ± 1.98	13.03 ± 1.64	0.456000

Table 5: Mean and standard deviation for 2018 2nd half and 2019 and p-value of the independent sample t-test (cells highlighted in red shows a statistically significant difference between the two years while cells highlighted in green show no difference between the two years).

September 2019 – knee injury

In September 2019, Yelich sat in pain near home plate during his first at-bat against the Miami Marlins at Marlins Park. He sustained a broken right kneecap and missed the remainder of the season. After flying back to Milwaukee for further testing the team announced some good news: Yelich won't need surgery but placed a timeline of eight to ten weeks on his recovery. They also noted the injury is a small fracture and added that they don't expect a long-term impact.

The hip and knee joints are closely connected and work together to facilitate various movements during athletic activities. When there is an injury to the knee, it can create imbalances and compensatory movements that can affect the stability of the hip joint.

There are several ways how a knee injury can impact hip stability. Following a knee injury, there can be joint stiffness and reduced range of motion. Athletes may unconsciously alter their movement patterns to avoid putting too much pressure on the injured knee. It can result in muscle weakness or imbalances around the knee and hip. Athletes may rely more on certain muscles to compensate for the weakness or pain in the injured knee. These compensatory mechanisms can place additional stress on the hip joint, leading to abnormal movements and potentially instability over time.

It is important for athletes with knee injuries to receive appropriate medical evaluation and rehabilitation to address not only the knee itself but also any potential impact on the surrounding joints, including the hip. It is not available how Yelich's injury was treated. However, it is also important to mention that Yelich's injury happened in the end of 2019 season followed by the year of 2020 with the lockdown and shortened season where athletes had to train in a changed environment on their own for an extended period which might negatively impacted his recovery.

Yelich already experienced back pain in the 2019 season. It is possible that he experienced some kind of postural or muscle problems prior to his knee injury, which the knee injury only worsened.

In case the knee injury or other contributing factors led to hip instability, particularly if the side of the knee injury experienced a different kind of impact than the other side, it could potentially be a factor contributing to a one-sided anterior pelvic tilt, along with its implications for the body and batting performance.

2020 – Shortened pandemic season

Between 2019 and 2020, Thigh angles and Shoes alignment shows no statistically significant difference while there is a significant increase in the Back-Gluteal (+2.5° on average), Head-Back (+1.9° on

average) and Head-Gluteal (+2.1° on average) line angles as shown in Table 6, putting Yelich in a less upright position in 2020.

	2019 (N = 33)	2020 (N = 31)	
Variables	Mean±SD	Mean±SD	pvalue
BackGluteal	97.28 ± 1.44	99.75 ± 1.33	0.000000
HeadBack	113.62 ± 2.11	115.55 ± 1.92	0.000000
Thigh	74.33 ± 2.67	73.82 ± 3.84	0.542000
Shoes	142.49 ± 9.77	139.88 ± 7.47	0.236000
HeadGluteal	103.35 ± 1.47	105.46 ± 1.06	0.000000
Belt	13.03 ± 1.64	14.05 ± 2.02	0.029000

Table 6: Mean and standard deviation for 2019 and 2020 and p-value of the independent sample t-test (cells highlighted in red shows a statistically significant difference between the two years while cells highlighted in green show no difference between the two years).

Looking at Figure 11, the change may not be immediately visible, but there is an observable change in the shoulder and neck area. In 2020, his shoulders are higher, positioned closer to his ears, and shifted more forward, resulting in a reduced visibility of his neck. Consequently, his elbows are positioned higher and farther away from his body. In contrast, in 2019, his overall appearance seems more relaxed. This transformation in the upper body could potentially be linked to an ongoing change in the hip area, which may be influenced by his knee injury.
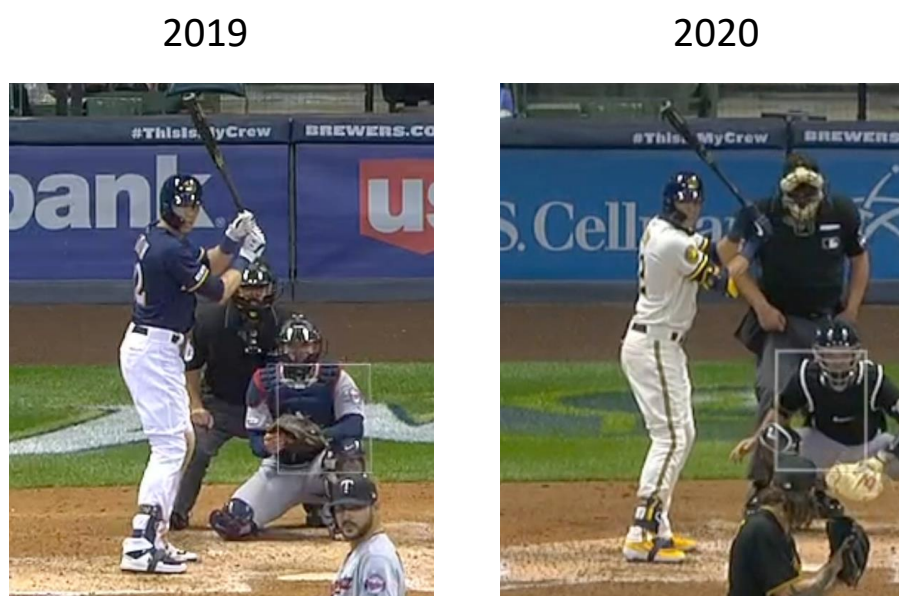
2019   2020

Figure 11: Christian Yelich's hitting stance on 2019-08-13 and 2020-08-31.

The decline in his hitting performance aligns with our previous findings that an increased Back-Gluteal angle results in decreased performance. In 2020, Yelich's wRC+ was 114, which still places him above the level of an average player.

2021 – The year of back pain

While Yelich seemed healthy in 2020 and missed only two games out of the 60 games in the shortened season, in 2021 he missed a substantial amount of time with the Milwaukee Brewers due to his back

pain. Back pain is something that has bothered him on and off for several years. An MRI showed no major issues in the lower-back problem that kept him off the field in the beginning of the season. By the end of the 2021 season, he missed 45 games mainly in the first half and only played 117 games out of the 162.

In 2021, Yelich's Thigh and Shoes alignment remain largely unchanged, while the Head-Gluteal and Head-Back angles are reverting close to their levels from the peak year of 2019 (103.4° vs 103.9° and 113.6° vs 112.8°). Overall, the data closely resembles that of 2019, as indicated in Table 7, except for the Back-Gluteal and Belt lines, which maintain slightly higher angles in 2021 by 1.5-1.6°. The question arises: Why hasn't this translated into Yelich achieving a wRC+ of 174 like in 2019 and instead maintaining an average performance of 102? To gain insight, let's see how his hip moves as he starts his leg kick during his swing.

Figure 12 shows four stages of his motion in 2019 and 2021. The two batting stances (1) look similar, with a nearly identical hip position. However, in 2021, a notable change occurs during his leg kick (2) – by raising his front leg his hips become more rotated towards the catcher, and the right or front side becomes elevated. In the load position (3) when he puts down his front foot, this over rotation of his hips toward the catcher persists, causing a corresponding over rotation of his upper body to the same direction and it makes his back or left elbow more visible.
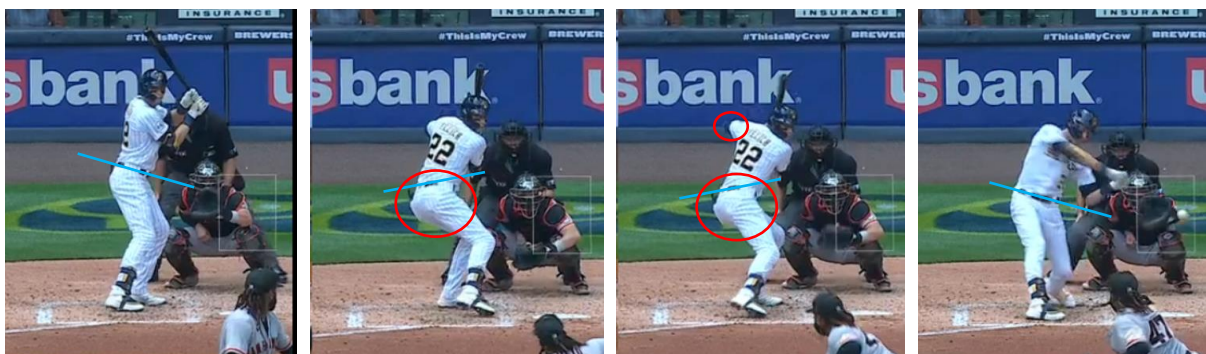
2019
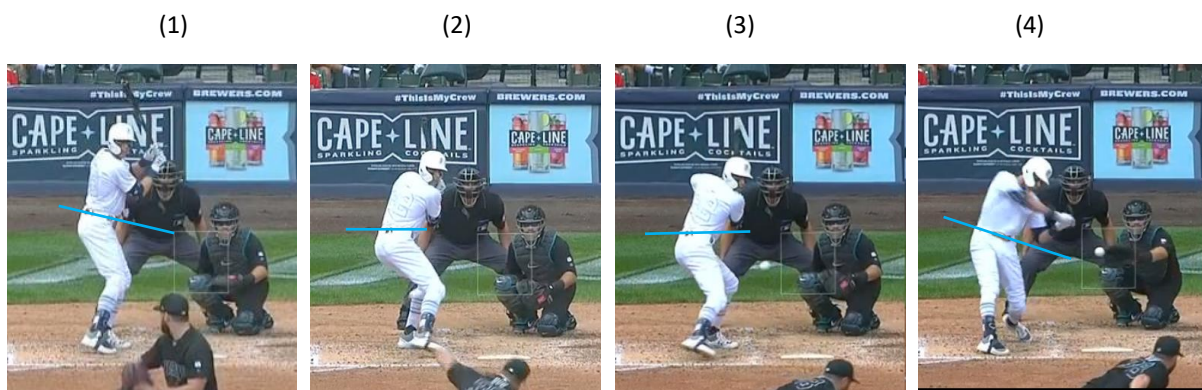
2021

Figure 12: Christian Yelich's (1) batting stance, (2) during leg kick, (3) load position and (4) contact on 2019-08-25 and 2021-08-08.

At contact (4) his hips are again in a nearly identical position, but the changes in the hip position during the movement and starting his swing from this excessively rotated position possibly affects his timing and his capacity to track the ball effectively, ultimately resulting in a lower performance.

	2020 (N = 31)	2021 (N = 31)			2019 (N = 33)	2021 (N = 31)	
Variables	**Mean±SD**	**Mean±SD**	**pvalue**	**Variables**	**Mean±SD**	**Mean±SD**	**pvalue**
BackGluteal	99.75 ± 1.33	98.87 ± 1.46	0.016000	BackGluteal	97.28 ± 1.44	98.87 ± 1.46	0.000000
HeadBack	115.55 ± 1.92	112.84 ± 2.01	0.000000	HeadBack	113.62 ± 2.11	112.84 ± 2.01	0.136000
Thigh	73.82 ± 3.84	75.17 ± 4.4	0.202000	Thigh	74.33 ± 2.67	75.17 ± 4.4	0.351000
Shoes	139.88 ± 7.47	143.4 ± 9.76	0.116000	Shoes	142.49 ± 9.77	143.4 ± 9.76	0.712000
HeadGluteal	105.46 ± 1.06	103.86 ± 1.39	0.000000	HeadGluteal	103.35 ± 1.47	103.86 ± 1.39	0.158000
Belt	14.05 ± 2.02	14.56 ± 2.2	0.349000	Belt	13.03 ± 1.64	14.56 ± 2.2	0.002000

Table 7: Mean and standard deviation for 2019 and 2020 and p-value of the independent sample t-test (cells highlighted in red shows a statistically significant difference between the two years while cells highlighted in green show no difference between the two years).

Sign of muscle weakness

When raising one leg and experiencing an elevation of the hip on the same side, it can be indicative of muscle weakness or imbalances. The muscles responsible for stabilizing the pelvis, particularly the hip abductor muscles, are not functioning properly. The specific muscles that may be weak or underactive in this situation typically include the gluteus medius and minimus muscles.

Weak hip abductor muscles are often a part of the muscle imbalances seen in individuals with anterior pelvic tilt. In APT, the hip flexors are typically tight and overactive, while the hip abductors are weak and underactive. As a result, the weak hip abductors can contribute to the issue of hip elevation on one side, which, in turn, can further exacerbate the anterior pelvic tilt by disrupting the balance of the pelvis.

In Yelich's case the elevated hip on the front side is in line with our assumption, that he has a right-sided anterior pelvic tilt. When his front leg is lifted, it leads to an uneven pelvis and an altered posture. It decreases the distance between his right hip and right shoulder and can push that shoulder more forward. Since the shoulders and head are connected in multiple ways, this can impact his head positioning and can result in less visibility of the ball.

The tight hip flexors could explain Yelich's back pain during the 2021 season. As the body adjusts with time and compensates to accommodate the new position of the pelvis, back pain may gradually lessen. However, these adjustments can often result in increased tightness in other areas of the body consequently.

2022- 2023 – Showing good signs

Interestingly, in 2022 the Back-Gluteal, Head-Back and Head-Gluteal angles all increased by 1-1.5°, while Yelich hitting performance remained stable compared to the previous year. Based on the correlation between OBP and the Back-Gluteal angles, a better performance would have been expected, but the difference between expected and real performance got smaller than in 2021. This might be a sign of some solution for Yelich's struggles. For the first time since 2018 second half, his Thigh angles decreased by a large amount by 5.4° on average meaning that his legs are more bent. He also put his front foot closer to the plate seeing a decrease of 27.5° on average (from 143.4° to 115.9°) in the Shoe alignment measurement.

| | 2019 (N = 33) | 2023_MayAug (N = 24) | |
Variables	Mean±SD	Mean±SD	pvalue
BackGluteal	97.28 ± 1.44	98.58 ± 2.01	0.006000
HeadBack	113.62 ± 2.11	114.16 ± 2.01	0.330000
Thigh	74.33 ± 2.67	71.84 ± 1.8	0.000000
Shoes	142.49 ± 9.77	82.18 ± 24.14	nan
HeadGluteal	103.35 ± 1.47	104.08 ± 1.65	0.083000
Belt	13.03 ± 1.64	14.92 ± 2.53	0.001000

Table 8: Mean and standard deviation and p-value of the independent sample t-test (cells highlighted in red shows a statistically significant difference between the two years while cells highlighted in green show no difference between the two years).

In 2023 April, we observed elevated Head-Gluteal (+2.4° on average) and Back-Gluteal (+2.7° on average) angles that was in line with his performance drop, yielding a wRC+ of 86. However, the more interesting part is what happened since May. Notably, the Head-Back and Head-Gluteal lines have no statistically significant differences between 2019 and the period from May to August 2023, suggesting a return of his upper body to an optimal position, just like in 2021 (see Table 8 and Table 7). In contrast to 2021, Chirstian Yelich's performance is again close to what we would expect based on the correlation of the Head-Gluteal/Back-Gluteal lines and OBP.

In 2023, there is a further decrease in the Shoes alignment angles from 115.9° to 82.2° on average, which is even lower than in 2018 first half. His front foot is now closer to the plate than his back foot. By putting his front foot closer to the plate, he rotates his hips towards the catcher already in the starting position (see Figure 13) while in 2021 this rotation happened during the swing causing imbalance.

2021   2023

Figure 13: Christian Yelich's batting stance on 2021-07-21 and on 2023-07-26.

Starting from May 4th Yelich switched from a leg kick to a toe tap to find the right timing at the plate. The combination of the toe tap and the adjustment in his shoe alignment seems to have a significant impact on his performance. Looking at Figure 14, his overall batting stance (1) appears to be more relaxed again, similarly to the second half of 2018 and 2019. Although his shoulders remain higher, resulting in some upper-body tightness, the effect is not as significant. As seen on Figure 13, with the

new shoe alignment, he starts from an already rotated position, mitigating the effects of over rotation during the swing.

The leg raise, as part of his leg kick earlier led to an elevated right hip, whereas the shift from the leg kick to the toe tap helps in stabilizing the hips and consequently, the shoulder area. His hip is not as elevated anymore (2). As he gets to a loaded position (3) and puts down his front foot at the end of the toe tap (or previously leg kick), his hip is still better balanced and not tilted or raised. This enhances the stability of his shoulders, preventing the front shoulder from pushing forward, resulting in a more controlled upper body.

2021
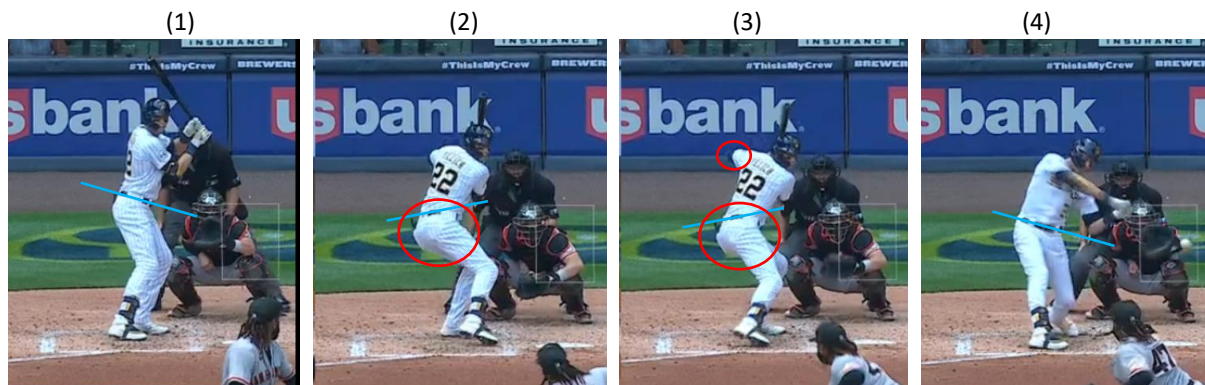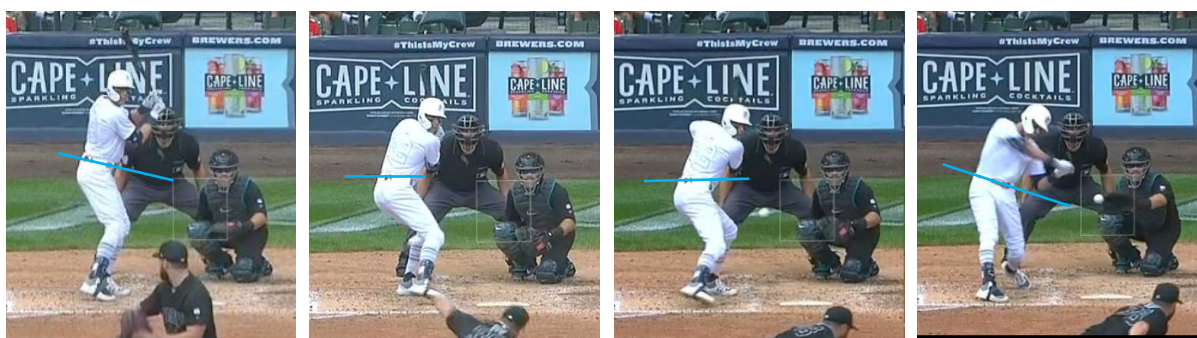

2023 May-August
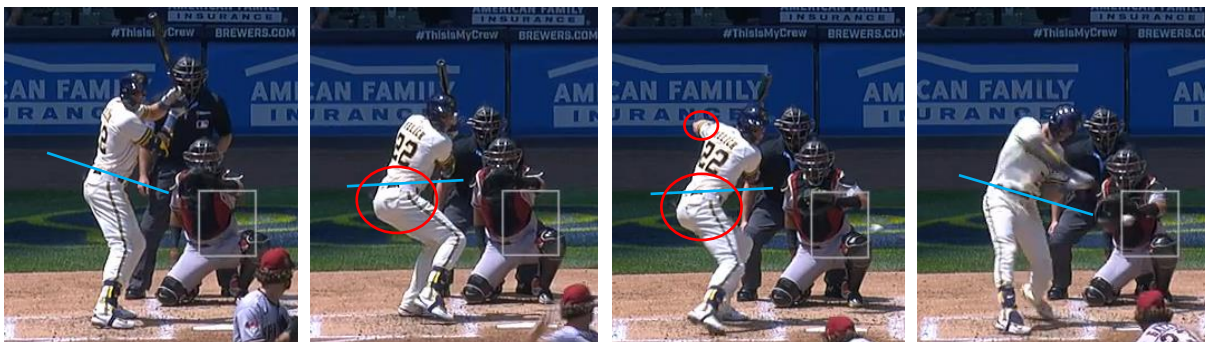
2019

Figure 14: Christian Yelich's (1) batting stance, (2) during leg kick, (3) load position and (4) contact on 2021-08-08, 2023-06-21 and 2019-08-25.

While there may not be a significant difference in the posture at contact (4), his body in the May to August 2023 period, much like in 2019, is in a better power position. In contrast, his 2021 posture appears somewhat weaker.

For the first time in years, Yelich is again the guiding force of Milwaukee's offence. By the end of my analysis period, August 5th, he is with an OPS over .800. While he hasn't quite reclaimed his status as one of the top sluggers in the game, Yelich has made a notable leap after three surprisingly mediocre seasons at the plate.

By putting his front leg closer to the plate, he naturally rotates his hips horizontally facing more towards the catcher. This is very similar to what he has done in 2018 but the opposite direction. With this change in 2018 he found a neutral balanced position, where his back reaches the most upright position. This balanced position seems to be different in 2023, most probably due to the postural changes in his body. To maintain the same upper body position as in 2019, now he needs to rotate his lower body towards the catcher. Although he seems to find his new balanced position, in this position in 2023 he is not able to keep his back as straight or upright anymore as in 2019.

Testing Hypothesis 3: Christian Yelich has right-sided anterior pelvic tilt. Although the study suggests that there is a change in his body alignment, it cannot be proved with statistical methods that it is a right-sided anterior pelvic tilt. The hypothesis has not been confirmed.

Change in the balanced position

When someone has a long-standing right-sided anterior pelvic tilt that leads to a rounded shoulder on the right side, the body often attempts to compensate for those asymmetries to maintain balance and function. This compensation can occur gradually over time.

With a right-sided anterior pelvic tilt the right pelvis is tilted forward while the left side stays unchanged, thus the right side gets behind the left side. The right shoulder is rounded and more forward while the left shoulder stays unchanged. In response, the spine may develop a subtle rotation both ends to counteract the pelvis and shoulder asymmetry and turns the left shoulder and the right hips towards the middle of the body as shown in Figure 15. This way the hips and shoulder area can get in a more symmetric position.
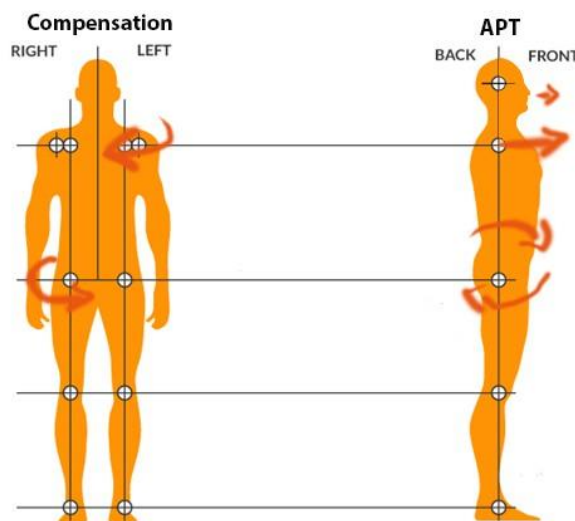

Figure 15: Anterior Pelvic Tilt and longtime compensations.

Overall, the body's adaptations are aimed at preserving a functional and balanced posture despite the underlying pelvic tilt and shoulder rounding. However, these compensations can lead to

musculoskeletal imbalances and potentially contribute to issues such as back pain, muscle tightness, and reduced mobility.

Using video analysis, it is hard to see the real changes in Christian Yelich's body but the compensation mechanism for APT can be a possible explanation for his new balanced position in 2023. By these compensatory rotations to maintain the same upper body position during the batting stance, Yelich needs to move his hips more towards the catcher to get into the new optimal position.

Running

We have seen that the position of Back-Gluteal and Head-Gluteal lines show a negative strong relationship with Yelich's performance, and the study suggests that there is a change of his optimal body alignments. Although, our Hypothesis 3: Christian Yelich has right-sided anterior pelvic tilt, has not been confirmed, the findings can be explained by the pelvic tilt in his body.

While the baseball swing is a very complex movement and is impacted by several factors, there are visible changes in Yelich's posture while running as well, which suggests that there is a real change in his body alignment, possibly a right-sided anterior pelvic tilt and its effects.

In 2023, his back and glute area tend to be more rounded (see Figure 16), while in 2019 it is more in one line. It can be seen on the middle picture, where the red line fits closer to his body in 2019 while there are larger gaps in 2023. His head is also more forward and closer to his shoulders in all positions in 2023. These changes become particularly noticeable when he is running at full speed. Additionally, his strides show some asymmetry on videos.
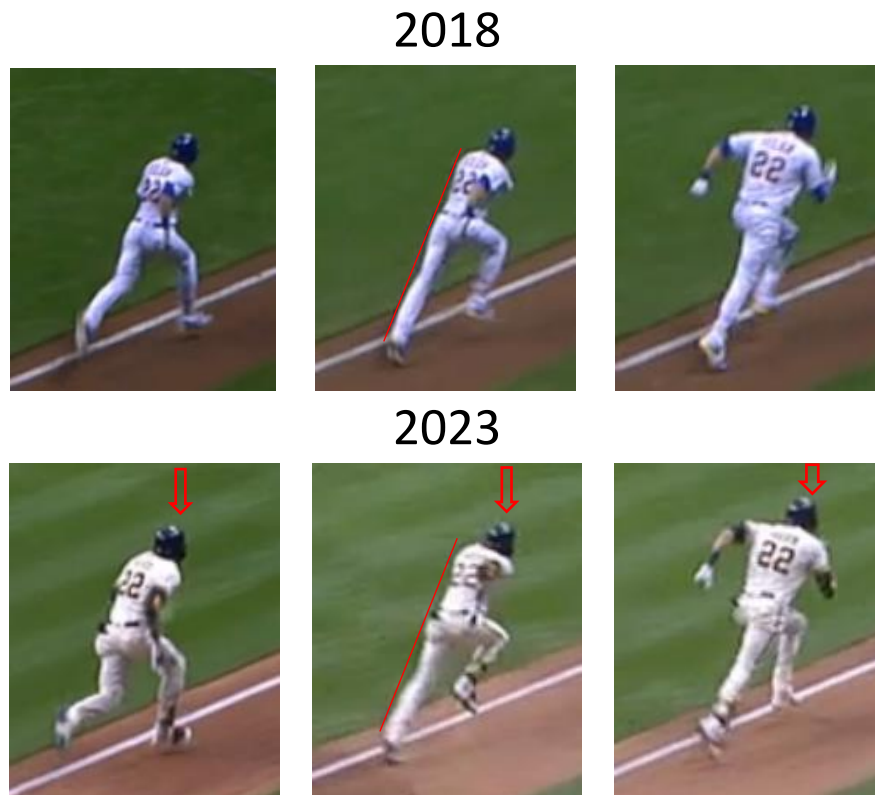
2018

2023

Figure 16: Christian Yelich running to first base in 2018 and 2023.

Figure 17 shows his position when he is on his left foot (1), he raises his right foot (2), he steps on his right foot (3) and he raises his left foot (4) in 2019 and 2023. In the first two pictures his hips are almost identical and balanced. However, when he steps on his right foot on the second two pictures, his hips are still balanced in 2019, but in 2023 the right hip is highly elevated, and his upper body is bent towards his right hip showing signs of hip instability again.
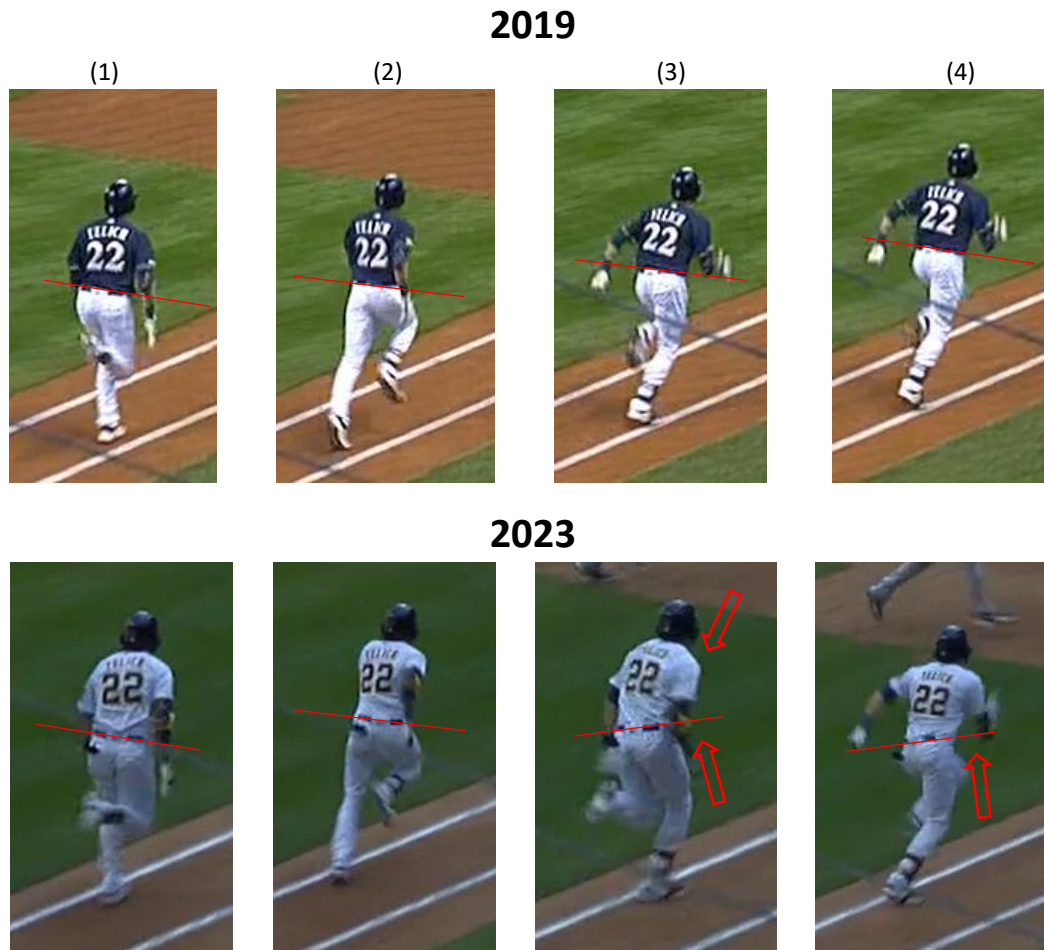
2019

2023

Figure 17: Christian Yelich running to first base in 2019 and 2023.

Similar changes can be seen in his standing posture: his head is in a more forward position compared to his shoulders, he is less upright, and his lower back has a larger curvature than in 2019 and earlier.

Final Thoughts

Rotating the hips horizontally more towards the catchers and fixing the hips with a toe tap can potentially have some positive effects for Yelich who, based on my assumptions, struggles with right-sided anterior pelvic tilt. However, it is important to note that this adjustment alone may not fully address the underlying issues, and a comprehensive approach to improving mechanics, posture, and muscle imbalances would be more beneficial. It's crucial to proceed with caution and ensure that the changes are introduced gradually, with proper guidance and attention to the player's individual needs. Monitoring for any signs of pain or discomfort and addressing underlying muscle imbalances are essential to minimize the risk of injuries and support long-term improvement.

In conclusion, bad posture isn't just a matter of looking slouched or unbalanced – it has real consequences for a baseball player's performance, especially in hitting. By maintaining proper alignment of the body's building blocks, a player can enhance their balance, coordination, and muscle engagement, ultimately improving their chances of hitting the ball with precision and power. Working on correcting bad posture through exercises, stretches, and awareness can play a crucial role in helping a struggling baseball player regain their hitting power.