Three-Unit Rule Scoring Research Report

OCTOBER 2024

Contents

OVERVIEW

In 2018, USBC announced the suspension of the 3-unit rule starting 8/1/2019. The three-unit rule was a lane conditioning rule that dictated:

"If dressing is used, it shall meet specifications and must comply with the following:

a. Dressing must be distributed from edge board to edge board for the entire distance that dressing is applied. (in the application of this rule, buffing the lane is considered dressing.)
b. Following any application of dressing, the dressed portion of the lane shall have a minimum of three units of dressing at all points on the lane surface.
c. Any stripping (cleaning) of dressing from the lanes must be uniform from edge board to edge board and at least from the headpin to the distance to which dressing has been applied."

As average integrity is of the utmost importance to USBC, we committed to monitoring the averages over the next several seasons to determine the impact of suspending this requirement.

By evaluating the averages submitted each season USBC has determined:

- There has been no meaningful change in the scoring pace due to the suspension of the 3-unit rule
- Paired average differences between seasons show little to no change from season to season.
- Reporting of honor scores, 300 games and 800 series has not increased.

RESEARCH

BACKGROUND: WHAT IS A UNIT OF OIL?

The layman answer is a specified thickness of oil out on the lane. Units of oil were derived from utilizing a UV additive in the lane conditioners. Once a pattern was in place on the lane, operators could "take tapes" a process of collecting an approximately 1" wide strip of the oil on the lane to then pass that tape through an optical reader to determine how much UV additive was picked up, and consequently how many units of oil were on each board across the lane at that distance.

A unit of oil is defined as 0.0167 mL of lane dressing per square foot of lane surface.

$$1 \; unit \; of \; oil = \frac{0.0167 \; mL}{ft^2}$$

Applying the known unit conversions that one milliliter is a cubic centimeter, and there are 2.54 centimeters in an inch and 12 inches in a foot we can convert this definition into a thickness.

$$1 \; unit \; of \; oil = \frac{0.0167 \; mL}{ft^2}\left(\frac{1 \; cm^3}{1 \; mL}\right)\left(\frac{1 \; in}{2.54 \; cm}\right)^3\left(\frac{1 \; ft}{12 \; in}\right)^2 = \frac{0.0167}{(2.54^3)*(12^2)} in \cong \mathbf{7.08 \; x \; 10^{-6} in} \cong \mathbf{180 \; \mu m}$$

One unit of oil is just over 7 millionths of an inch thick. For some perspective, a small flea is about 1.5 millimeters long, that's about 0.059 inches long. That means a small flea is about 8333 units of oil long.

The three-unit rule was a center certification requirement that when the lanes are dressed with oil, there must be at least 3 units of oil on each board across the lane, allowing for some variances in the measurement accuracy. The goal of the regulation was to prevent steering the bowling balls with lane conditions and was the evolution of many such attempts such as flat oil (no crosswise variation in the amount of oil applied), crowned oil (slight crosswise tapper allowed) and short oil (no oiling past 26 ft down lane).

Overall, the reasoning of the rule was to control scoring. If lane patterns steer the balls to the pocket too well, scores will go up. Enforcing the minimum requirement of 3 units of oil on every board aimed to control the scoring pace and not allow excessive steering of the bowling balls to the pocket. The concept is that less steering equals less scoring.

Prior to the suspension of the rule, USBC consulted industry groups, gathered data on lane tape reports sent in from around the country and conducted league simulation studies bowling with and without three units of oil on the lane. The results all indicated that the rule was no longer necessary and thus it was suspended.

To ensure that the scoring pace does not change because of this suspension, USBC has been monitoring scoring data each season to evaluate the impact of suspending this regulation.

AVERAGE SCORE DATA

Each season all the bowling averages are uploaded from the local association records to USBC headquarters. That data is used to analyze scoring pace across the country. We can make comparisons over time looking at multiple different factors, including how well specific members are bowling over time.

When we look at the data submitted for a season at a time, it follows a distribution like this:

HISTOGRRAM OF AVERAGES
ALL 2022-23 AVERAGES
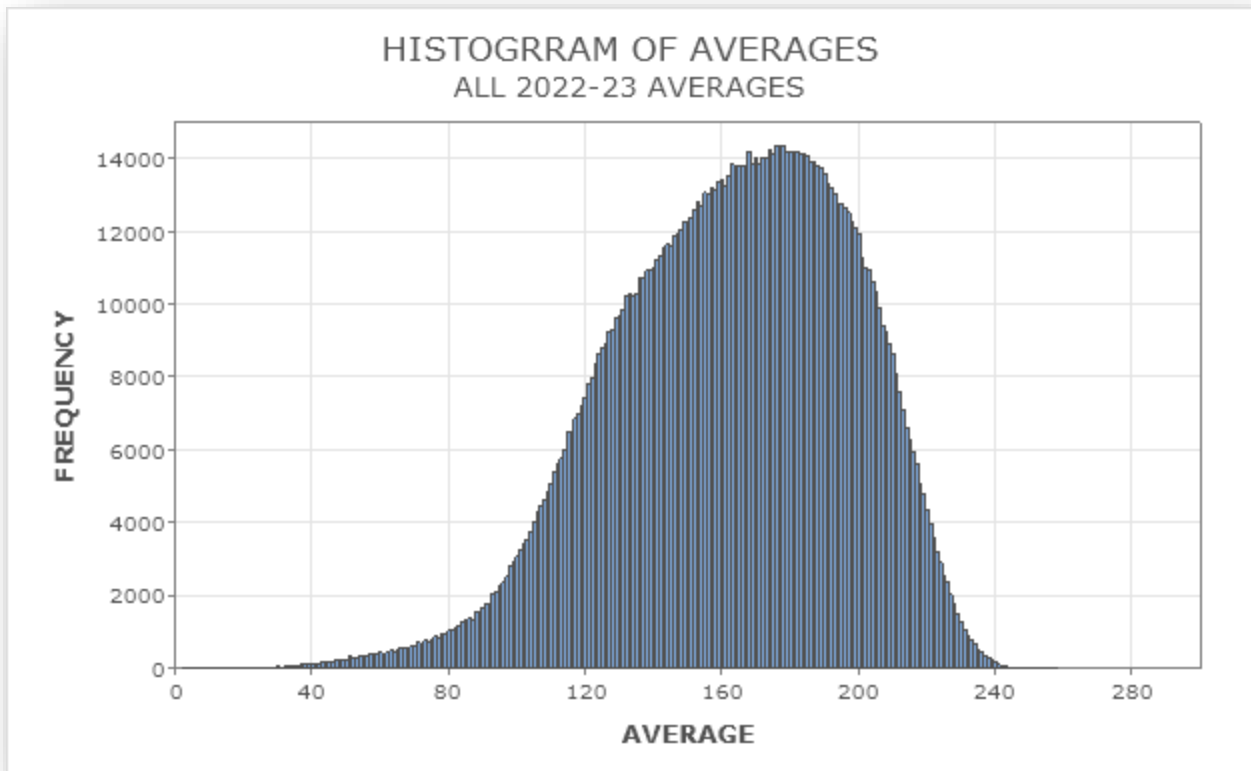
The simplest way we can examine the scoring pace within the data, is to collectively take the total games and pins of each season and plot the ratio. What are the season's averages?

SEASON	GAMES	PINS	AVERAGE, AVERAGE	PINS / GAMES
2016-17	116,707,357	19,184,713,907	161.9	164.4
2017-18	110,854,890	18,267,300,841	162.2	164.8
2018-19	103,836,584	17,080,094,483	161.9	164.5
2019-20	78,307,087	12,876,764,026	162.2	164.4
2020-21	60,075,094	10,032,066,200	164.2	167.0
2021-22	84,499,070	13,992,619,154	162.7	165.6
2022-23	89,039,714	14,735,186,543	162.6	165.5

Those are some big numbers of bowling games and pins. Over the past seven seasons, we have collectively bowled 643,319,796 certified league games scoring a total of 106,168,745,154 pins. If someone moved one inch for every one of those pins, they would have traveled to the moon and back over seven times.
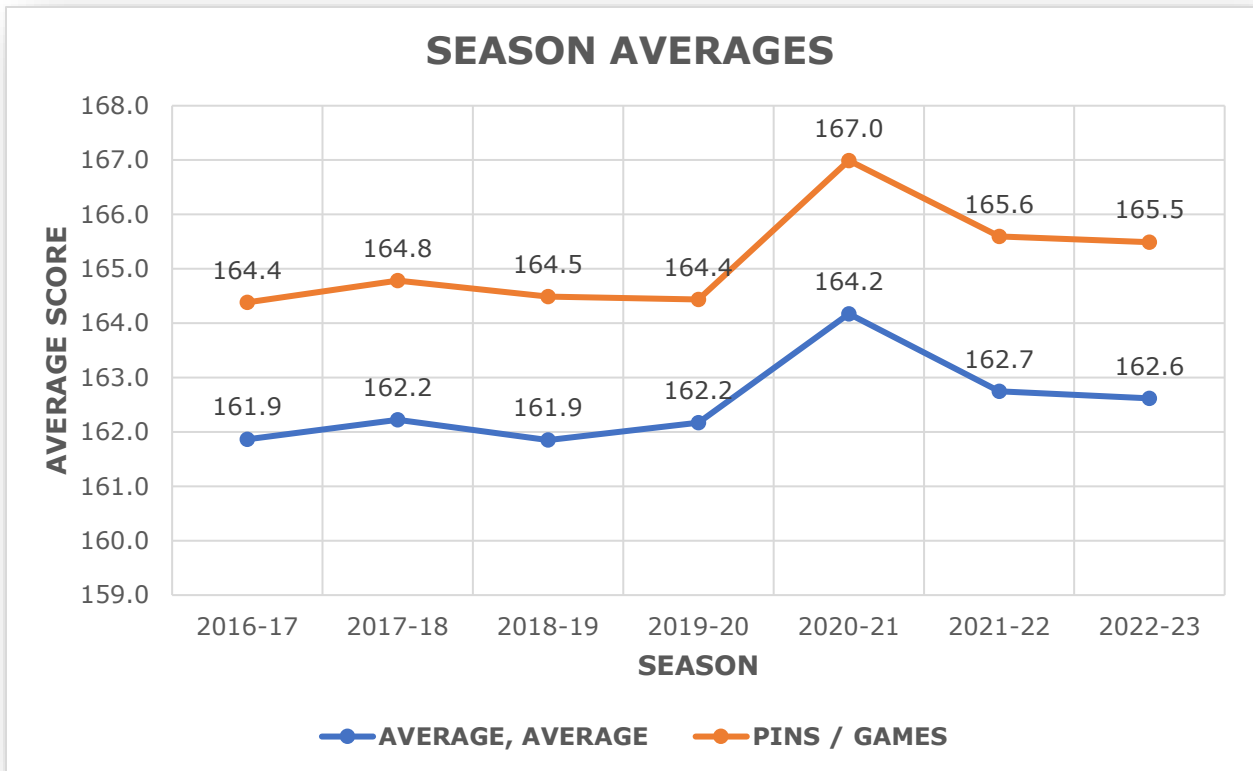
SEASON AVERAGES

Looking at the result, we can see that using total pins divided by total games for the season results in consistently higher values than using the average, average. This can likely be correlated to higher average bowlers being more likely to bowl multiple leagues resulting in more of the overall games and pins coming from higher average bowlers. Both trends appear quite flat from 2016-17 until 2020-21, including the seasonal change between 2018-19 and 2019-20 when the 3-unit rule suspension went into effect. In 2020-21 we see a +2-pin spike that returns down by about a pin and a half in 2021-22. The net change between 2016-17 and 2022-23 is +0.7 and +1.1 respectfully.

When we look at the overall shape of the average distribution, we see that the shape is irregular. The distribution is bimodal with a clear distinction between the distribution of averages produced by male and female bowlers.

**HISTOGRAM OF AVERAGES**
FEMALE 2022-23 AVERAGES
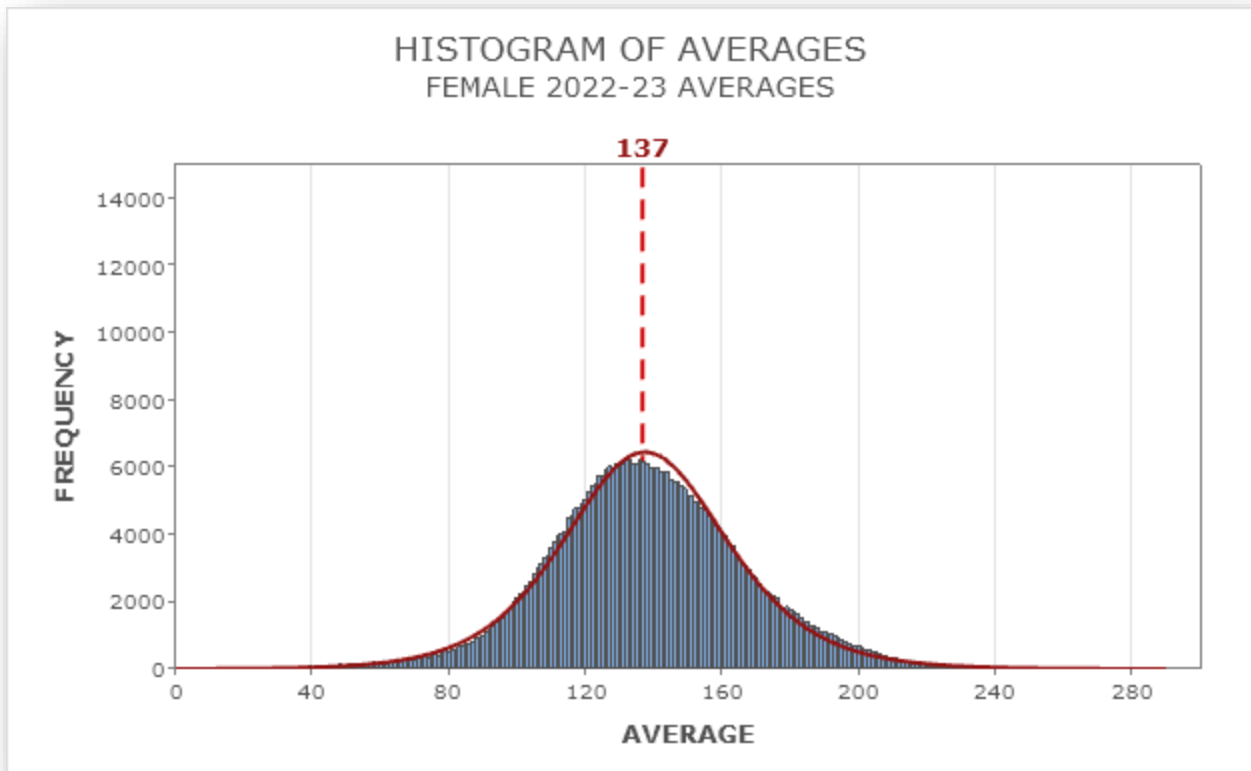
Female bowler averages make up about one third of the overall averages and tend to be lower with a median score of 137 in the 2022-23 season. Their distribution is right skewed, indicating there is a longer tail of the distribution reaching toward higher scores. The data tends to follow and loglogistic distribution.

HISTOGRAM OF AVERAGES
MALE 2022-23 AVERAGES
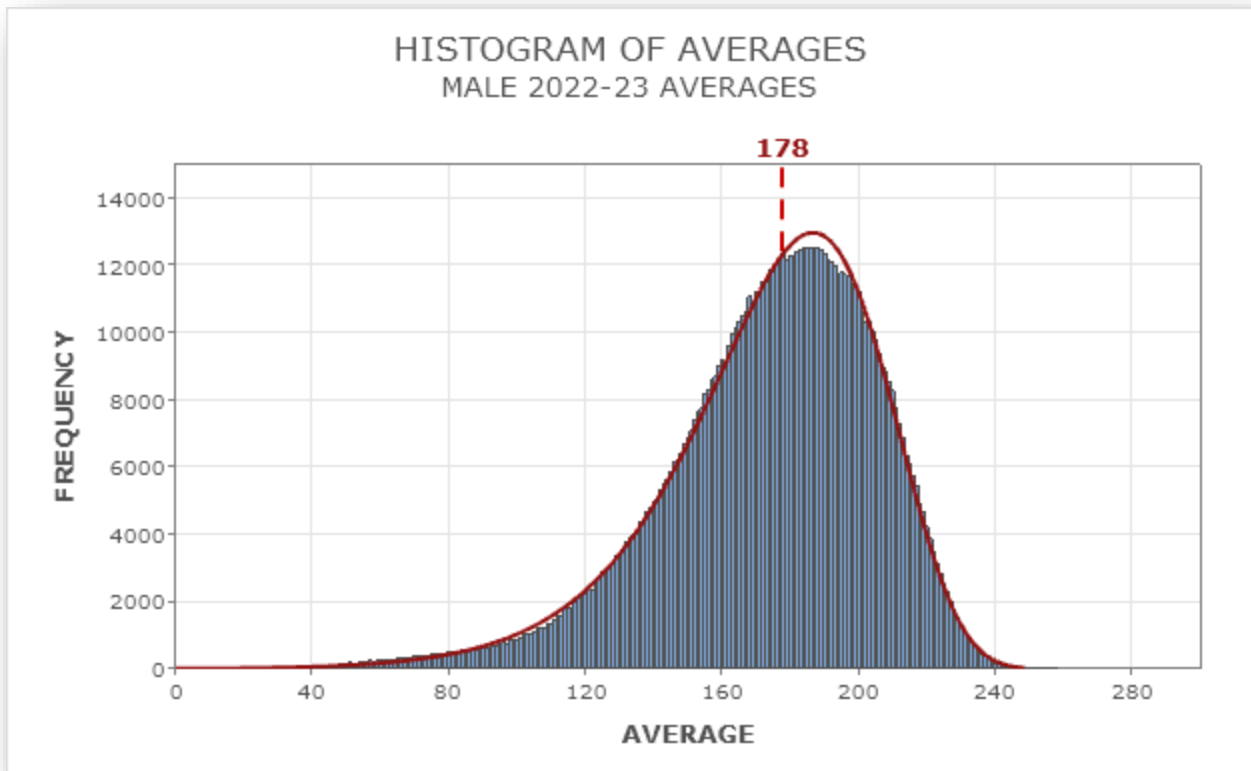
The male data on the other hand tends to be higher with a median score of 178 pins. Their scoring distribution is left-skewed with a much longer tail reaching to the left towards the lower scores. The male averages make up approximately two-thirds of the scoring data. Their results tend to follow the Weibull distribution.

Reviewing the proportion of averages collected for male and female bowers each season results in the following trend:

MALE PERCENTAGE OF AVERAGES BY SEASON
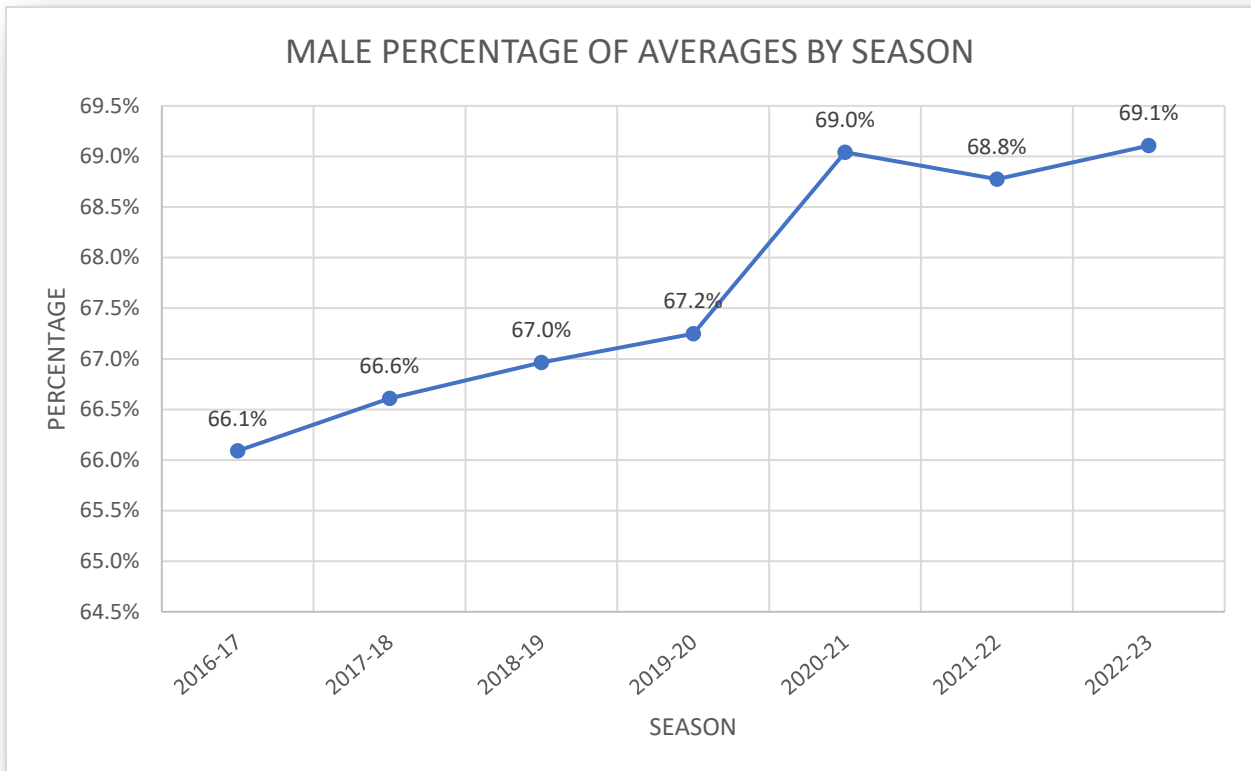
In general, we see an increasing trend in the percentage of averages collected for men. On average, the percentage of averages being collected for men increases by about 0.5% each year. In the 2020-21 season, the percentage increased by 1.9%.

In the following tables, we summarize statistics from the male and female average distributions for each season, looking at the results from the 2020-21 season, we can achieve the combined average by using the following formula:

$$Combined\ AVG. \cong (Male\ Percentage)(Male\ Average) + (Female\ Percentage)(Female\ Average)$$

For the 2020-21 season below:

$$(0.690)(175.7) + (0.310)(139.1) \cong 164.4$$

This means that the overall average for the season will inevitably be tied to the ratio of male to female averages each season. If the ratio tips one way or the other, the overall average will approach the average of the majority.

Season	Variable	GENDER	Average Counts	Mean	Q1	Median	Q3	5th Percentile	95th Percentile
2016-17	AVERAGE	Female	578946	138.6	122.0	138.0	155.0	95.8	182.1
2017-18	AVERAGE	Female	543360	138.7	122.0	138.0	155.0	95.7	182.7
2018-19	AVERAGE	Female	500804	138.4	122.0	138.0	155.0	95.0	182.4
2019-20	AVERAGE	Female	421126	138.2	122.0	138.0	155.0	94.5	182.2
2020-21	AVERAGE	Female	297342	139.1	121.0	138.0	157.0	92.5	185.7
2021-22	AVERAGE	Female	393623	138.0	120.0	137.0	156.0	91.9	185.0
2022-23	AVERAGE	Female	409997	137.9	120.0	137.0	156.0	91.4	185.0

Season	Variable	GENDER	Average Counts	Mean	Q1	Median	Q3	5th Percentile	95th Percentile
2016-17	AVERAGE	Male	1128406	173.9	157.0	178.0	196.0	116.9	216.3
2017-18	AVERAGE	Male	1083902	174.1	157.0	178.0	196.0	117.0	216.5
2018-19	AVERAGE	Male	1015124	173.6	156.0	177.0	196.0	116.2	216.1
2019-20	AVERAGE	Male	864739	174.0	157.0	178.0	196.0	117.0	216.3
2020-21	AVERAGE	Male	663135	175.7	158.0	180.0	198.0	117.8	218.1
2021-22	AVERAGE	Male	866959	174.3	157.0	178.0	197.0	116.0	217.3
2022-23	AVERAGE	Male	917172	173.9	156.0	178.0	197.0	115.5	217.1

*First expected three-unit rule change
*Global covid-19 pandemic

Scoring is often talked about in terms of the fact that it is going up and continuing to increase. However, when we plot the mean score for men and women against the seasons, we see the trends are exceptionally flat.

AVERAGE SCORE BY GENDER AND BOWLING SEASON
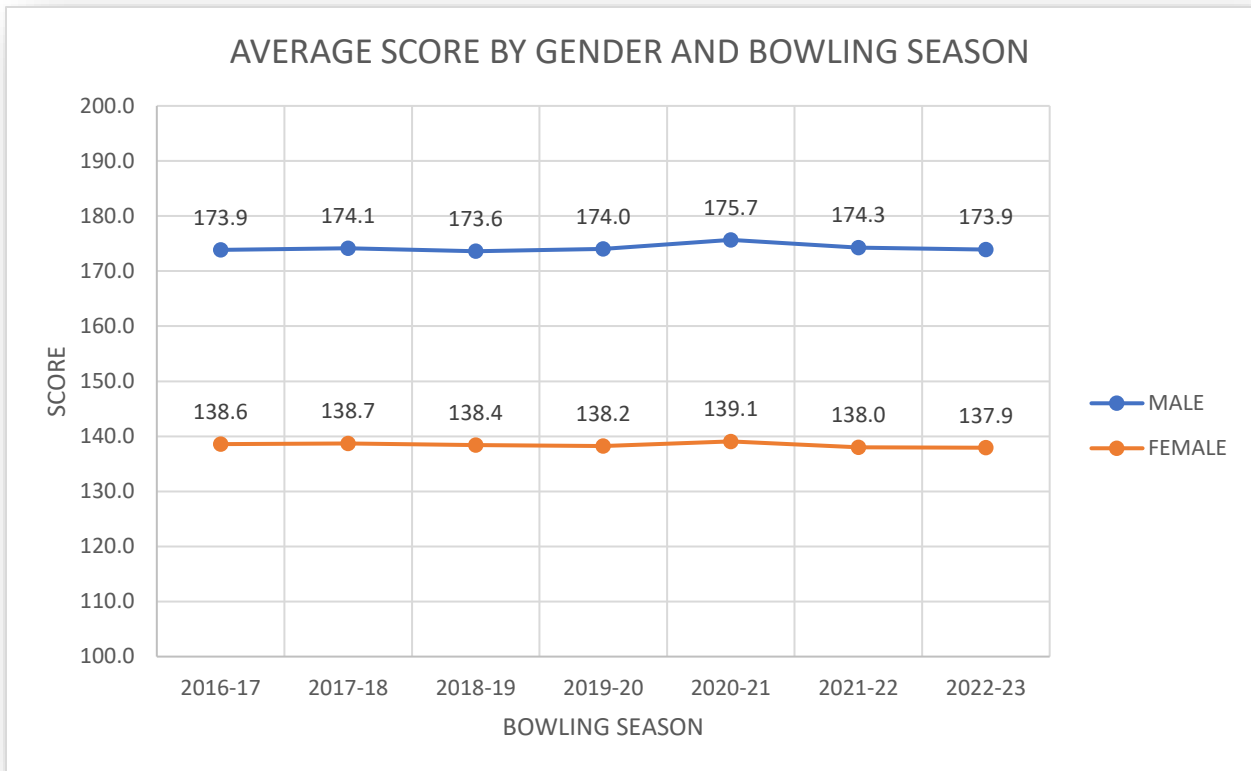
Each of the statistics tracked (mean, first quartile, median, third quartile, 5th percentile and 95th percentile) all show little to no change between the 2018-19 season and the 2019-20 season – the seasonal change directly related to the three-unit rule suspension.

In the 2020-21 season, we see upticks in the scoring results, especially in the upper end of the data, the third quartile and the 95th percentile. Each of these stats for men and women increased by 2~3 points. This season was the first season for bowlers to decide whether to bowl during the COVID-19 pandemic. The result was a 29.4% reduction in the number of female averages submitted and a 23.3% reduction in the number of male averages submitted.
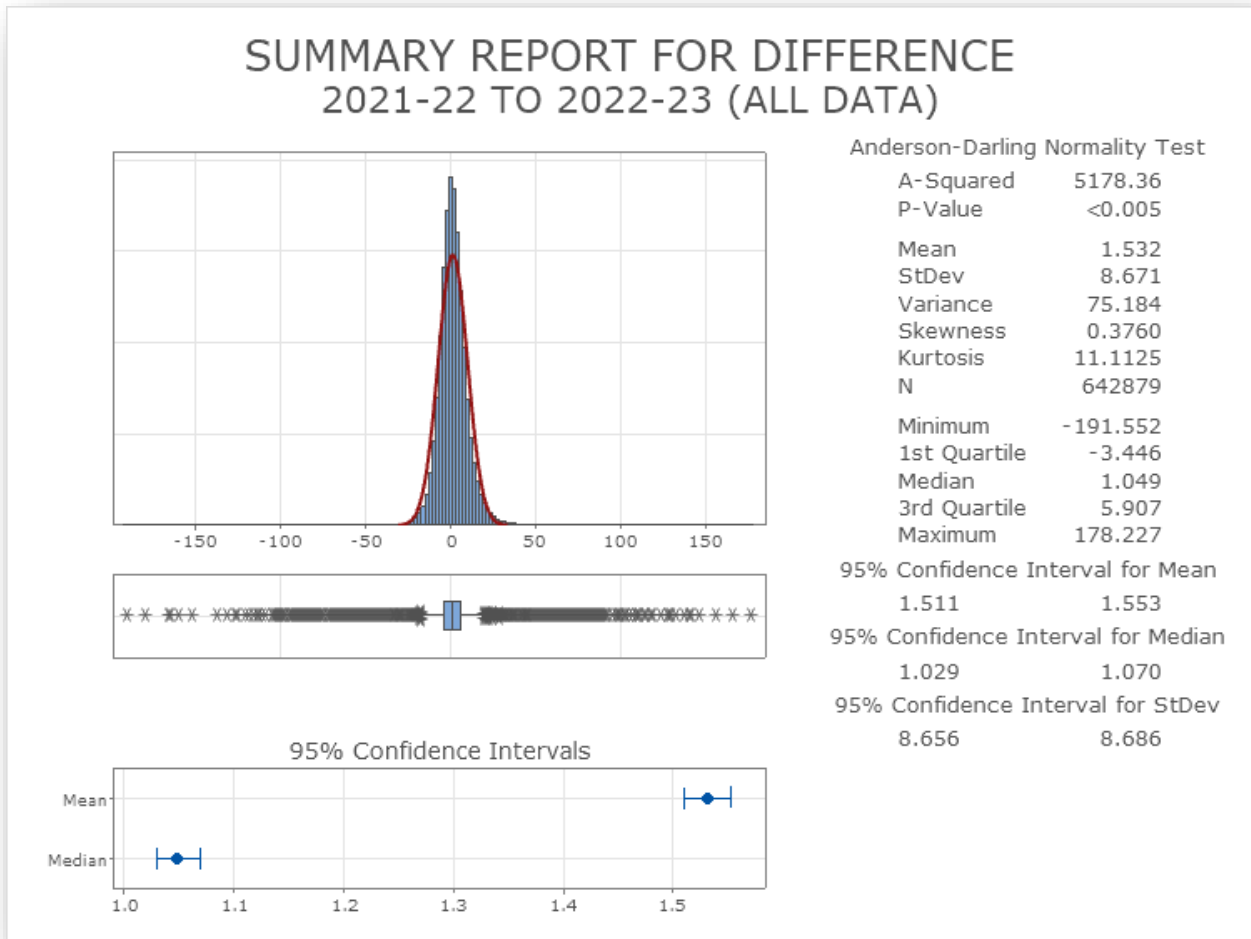
For the 2022-23 season we observed average submissions returning similar to what was seen in the 2019-20 season. 97.4% of the number of female averages submitted in 2019-20 season were submitted in 2022-23. We also saw 106% of the number of male averages submitted in 2019-20 submitted in 2022-23.

Looking at the overall results for the scoring mean and median between 2019-20 and 2022-23 we see almost no change for the men with a 0.1 pin average decrease and an equal median. The women see a 0.3 mean reduction and a 1 pin median reduction since 2019-20. However, their 95th percentile mark is still up 2.8 pins.

The data indicates little to no change has occurred in the overall scoring pace since the suspension of the three unit-rule and the global pandemic. There are some fluctuations in the upper percentile of scores, but even those appear to be less than 3 pins.

SCORING PAIRED DIFFERENCES

Another method for investigating differences in scoring from one season to the next is using a paired difference. A paired difference is when there is an underlying link between each data point in one dataset to a corresponding data point in a second dataset. In our case, we can look at all the bowlers that bowled in each season and the following season and look at a summarized difference between those two seasons. We can apply the process in perpetuity from each season to the next using the bowlers who bowled in both seasons. If we look at all the bowlers that bowled in 2021-22 and 2022-23, the following is a report of the difference in their standard composite averages.

SUMMARY REPORT FOR DIFFERENCE
2021-22 TO 2022-23 (ALL DATA)

Anderson-Darling Normality Test

A-Squared	5178.36
P-Value	<0.005
Mean	1.532
StDev	8.671
Variance	75.184
Skewness	0.3760
Kurtosis	11.1125
N	642879
Minimum	-191.552
1st Quartile	-3.446
Median	1.049
3rd Quartile	5.907
Maximum	178.227

95% Confidence Interval for Mean
1.511   1.553

95% Confidence Interval for Median
1.029   1.070

95% Confidence Interval for StDev
8.656   8.686

Here we see a distribution of 642,879 bowlers who bowled in both the 2021-22 and 2022-23 seasons. The data shows a 1.5 pin increase between these two seasons. In fact, when all the data is considered for paired differences between a set of two consecutive seasons, there is always an uptick of about 1.5 pins. The underlaying reason is that some of the bowlers are expected to get better. Particularly the youth.

The below chart shows the average paired difference of all the bowlers in each age group. Age groups of 9 years were chosen to show the clear youth distinction at 18 years old. Each

series shows the paired difference for the corresponding consecutive seasons that the data was calculated from, with a reference line drawn at a zero difference.
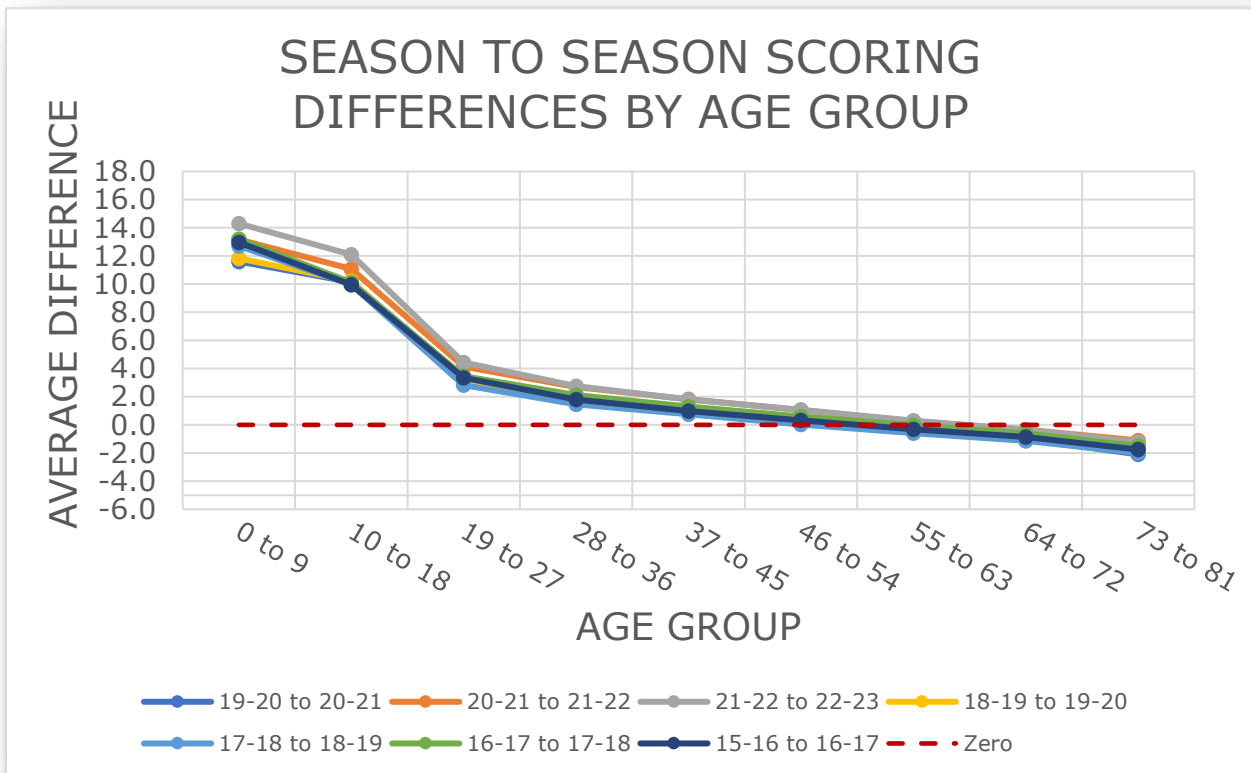
Here it is clear to see that the age ranges of 0 through 36 years old improve much more on average than the 64 and over groups decline. This disparity largely comes from young bowlers that are beginning with low averages with a lot of room for growth.

As outlined in the average score data, the largest fluctuations we saw were in the higher average bowlers. If we apply some logical filters on the data to investigate higher average bowlers (180+) in a more stable age group (28~63) we see the following paired difference between 2021-22 and 2022-23.

SUMMARY REPORT FOR DIFFERENCE
2021-22 TO 2022-23 SEASON (180+,28~63 YEARS OLD)
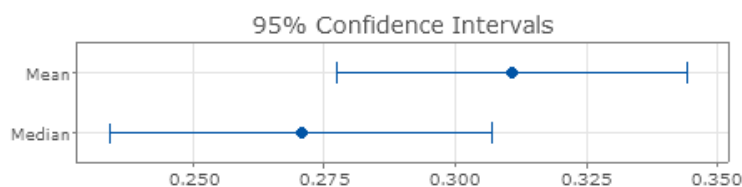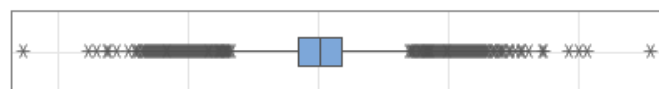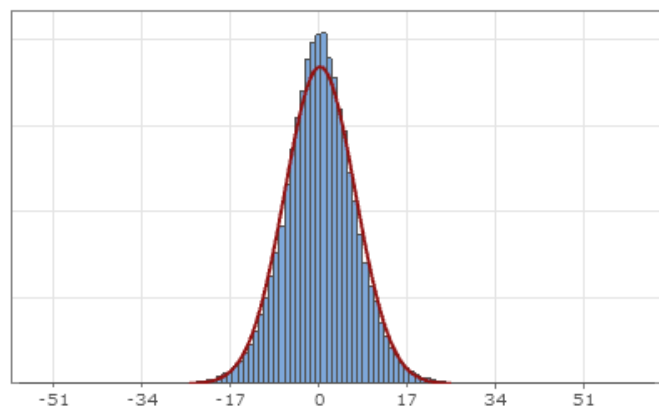
Anderson-Darling Normality Test
A-Squared   133.99
P-Value   <0.005

Mean   0.3110
StDev   6.7788
Variance   45.9518
Skewness   0.02881
Kurtosis   1.05485
N   156601

Minimum   -56.7063
1st Quartile   -3.9317
Median   0.2708
3rd Quartile   4.5384
Maximum   63.8371

95% Confidence Interval for Mean
0.2774   0.3446
95% Confidence Interval for Median
0.2342   0.3072
95% Confidence Interval for StDev
6.7551   6.8026

Applying these filters results in a data set of 156,601 bowlers that bowled in both seasons within our average and age criteria. The results show an average increase of 0.3110. Applying this paired difference method to each season since 2016-17 results in the following table.

| SEASONS	SAMPLE SIZE	MEAN DIFFERENCE	ST.DEV.
2016-17 TO 2017-18	197,453	0.1689	6.7238
2017-18 TO 2018-19	188,116	-0.5453	6.7216
2018-19 TO 2019-20	174,424	-0.0223	6.8346
2019-20 TO 2020-21	128,170	0.0780	7.0742
2020-21 TO 2021-22	130,061	0.3960	6.9407
2021-22 TO 2022-23	156,601	0.3110	6.7788

*Season change when the three-unit rule was suspended 8-1-2019

Over the past seven seasons, we have observed average paired differences from -0.5453 to 0.3960. These differences are small and are going back and forth. If you accumulate all the ups and downs since 2016-17, over the differences show scores are up by 0.3863 pins. It appears that the results for each season comparison will tend to be in the +/ -0.5 pin range,

and if 2023-24 shows us results similar results from 2017-18 to 2018-19 then the overall trend would be a decline of -0.1590 pins. The overall scoring pace has been very stable.

HONOR SCORE RATES

Another key metric we can examine versus the suspension of the three-unit rule is the honor score rates for each season. Each year honor scores get submitted from all over the country. The following illustrates the 300 game and 800 series award counts that are submitted for each season since the 2018-19 season.
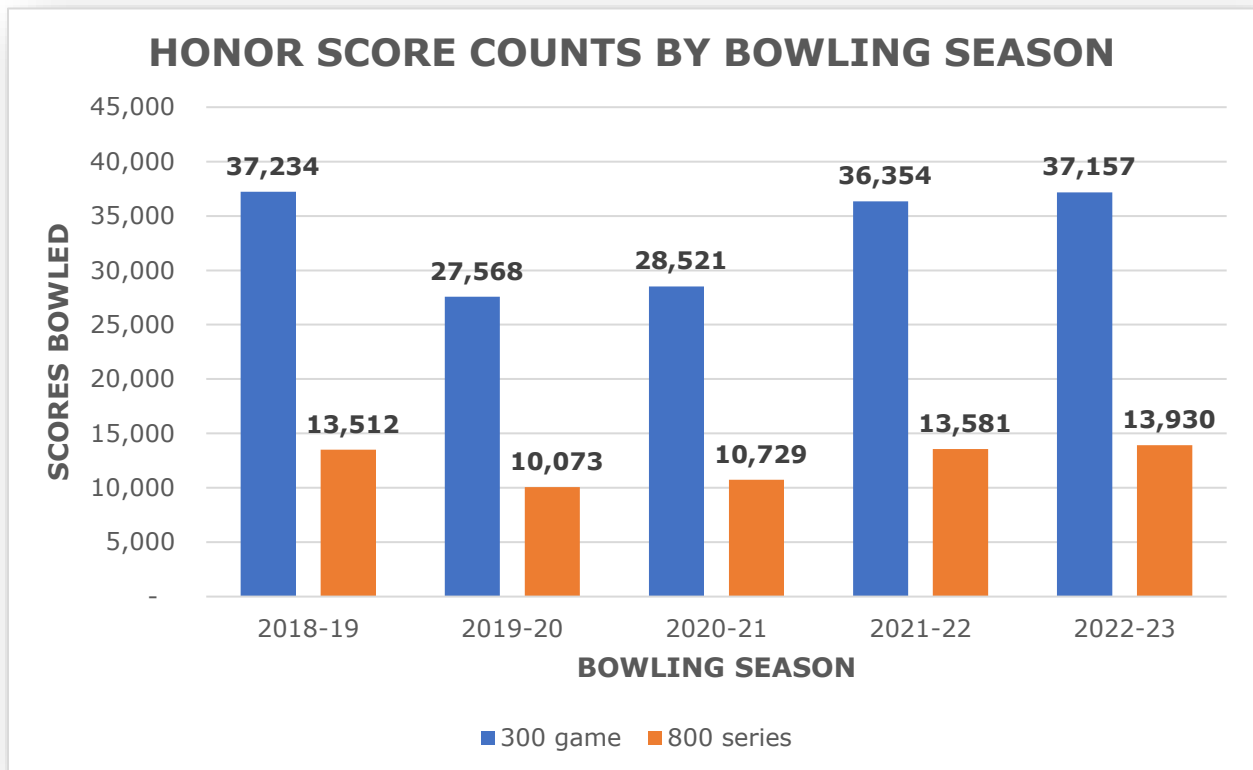
In this data, we see a similar dip in reported honor scores in 2019-20 due to the season being cut short during the Covid-19 pandemic. Likewise, with fewer bowlers returning in the 2020-21 season, reported honor scores remained down. Now after being back for two seasons with closer to normal participation, we see that reported honor scores are in line with what we saw for 2018-2019 season. There has been no meaningful change to the reported honor scores.

On a pure count basis, we see the highest number of reported 300 games (37,234) in the 2018-19 season prior to the suspension of the rule and the highest number of reported 800 series (13,930) in the 2022-23.

CONCLUSIONS

After a comprehensive review of the data, USBC has determined:

- There has been no meaningful change in the scoring pace due to the suspension of the 3-unit rule
- Paired average differences between seasons show little to no change from season to season.
- Reporting of honor scores, 300 games and 800 series has not increased.

Due to these findings, USBC sees no reason to address the suspension of the rule at this time.

The Equipment Specifications team along with the Equipment Specs Committee will continue to monitor the impact of this rule suspension through scoring analysis

All USBC national events, such as the Junior Gold Championships, USBC Open and Women's Championship tournaments, as well as all USBC short-duration tournaments, will continue to run Sport-compliant patterns. USBC must challenge the best bowlers in the world and highlight their abilities through tough competition and consumer education, ultimately crowning national champions.