Analysis of NCAA Division III 200/400 Indoor Track Conversions

Jordan Wheeler[a] and Ted Bulling, Ph.D.[b]

[a]Mathematics Department, University of Nebraska-Omaha, Omaha, NE 68182, USA;
[b]Psychology Department and Head Track and Field Coach, Nebraska Wesleyan University, Lincoln, NE 68504, USA

ARTICLE HISTORY
Compiled September 19, 2018

ABSTRACT
Analysis on NCAA's Men and Women 200/400 meter current Indoor Track and Field conversions. Data on qualifying and national times from the 2014-2018 Division III Indoor seasons were compared via a Paired Sample t-Test to see if there is evidence that suggests the conversions are inaccurate. The researchers found that both the Female 200 and Male 200 conversions were off. There was statistically significant evidence that the Female 200 runners, who qualified on a flat track (post conversion), times were faster than their national times on a banked track ($p < .05$), while there was no statistically significant evidence that the Female 200 runners, who qualified on a flat track, times were different (neither faster nor slower) than their national times on a flat track ($p > .05$). Similarly, there was statistically significant evidence that the Male 200 runners, who qualified on a flat track (post conversion), times were faster than their national times on a banked track ($p < .05$), while there was no statistically significant evidence that the Male 200 runners, who qualified on a flat track, times were different (neither faster nor slower) than their national times on a flat track ($p > .05$)

KEYWORDS
Indoor Track Conversions; 200 meters; 400 meters; NCAA Indoor Track and Field; Paired Sample t-Test; Shapiro-Wilk Normality Check

1. Introduction

During the indoor season, NCAA track & field athletes compete on tracks of different sizes ranging from 133 to 352 meters (Pederson, K., Larson, G., Jones, S., & Podkaminer, B. , 2012). These tracks can be flat or banked for non-sprint races. In general, these indoor track facilities can fit into one of the four categories: flat ($200m$), banked ($200m$), oversized ($> 200m$) or undersized ($< 200m$). The most common configuration is a flat 200 meter track.

It is well established that athletes run faster on tracks that are oversized or banked. Selecting participants for championship events requires equitable conversion of times from different types of tracks to a common standard. Prior to 2012 the NCAA indoor track conversions were based on limited data gathering and were adjusted annually by each NCAA division track & field committee independent of each other. The

CONTACT Jordan Wheeler. Email: jordanwheeler@outlook.com

conversions involved adding or subtracting an amount of time to a runner's actual race time depending on the track type the athlete ran on.

The advent of mandatory reporting of results to the Track & Field Results Reporting System (TFRRS) in 2010 provided a robust database that could be used to systematically analyze performances on different types of tracks. Using this newly available information Pederson et al., (2012) performed an analysis of running performances from 2008-2012. Only meets from approximately mid January through the end of February were used in order to negate the sometimes tactical racing employed in conference and national championships. Based on this research, in 2012 the NCAA implemented new indoor track conversions in an attempt to standardize times from different size of tracks and banked versus flat tracks. The new set of conversions use a multiplier instead of adding/subtracting a specific amount of time. The new standards have significantly increased the size of the conversion between flat tracks and banked/oversized tracks.

Since the advent of the new conversions in 2012, a common discussion topic among coaches and athletes concerns the validity of the conversion factors. This discussion is important because qualification for the NCAA Indoor Championship is often dependent on the conversions. Previous research into the accuracy of the conversions is mixed. In a study focusing on the 200, Corts, (2017) suggests that the current conversion factor for the 200 is too severe. Barnes & Macata (2017) suggest that the current conversion factors for the 200 and 400 is a bit too small. Richard (2013) found evidence that the current conversion factors were too much using one statistical model and not large enough using another model.

None of the studies noted previously used data from the two NCAA division III Indoor championships that were conducted on a banked track (2014 & 2018). The focus of this paper is to use data from those two championship meets and the qualifying marks of the participants to investigate the validity of current NCAA conversion factors for the 200 and 400 meter races for both men and women NCAA division III athletes.

2. Methods

2.1. Data Collection

This research focused on comparing an individual qualifying time and how that individual ran at nationals. This relies upon an assumption that qualifying times and national times are equivalent, even though an individual may be "peaked." Since the NCAA last updated indoor track conversion during the 2014 Indoor season, our data is limited to the 2014 Indoor season through the 2018 Indoor season. Division III times are used because the national meet has been held on a banked track twice and on a flat track three times since the new conversions (this allows for a comparison of flat to banked in the years 2014, and 2018, and a comparison of flat to flat in the years 2015, 2016, and 2017). Lastly, this research was restricted to just two events: 200 meters and 400 meters. Other events were not evaluated because strategy tends the play a role in championship races beyond the 400 meters. The data was collected from the Track and Field Results Reporting System (TFRRS) website by cycling through the past five years of Division III results (Indoor 2014 to Indoor 2018), and entering this data into multiple tables using the R programming language.

A Qualifying table was created for the top 50 fastest times in the 200 and 400 between the years 2014 and 2018. A Nationals table collected both the preliminary and final times from these events at the national meets (DQs and DNFs were not included). The preliminary and final times were compared for each individual and the faster of the two represented the individual's national time (e.g. if runner A ran the 200 meter prelims in 21.56 and finals in 21.87, the prelim time was runner A's national meet time). In the case where a runner did not qualify for the finals, the preliminary time was used by default. From there, a new table was created from merging the Qualifying and Nationals tables based on individual, event, and year. The resulting table had the following columns: Athlete Name, Year, Team, Event, Qualifying Time (the time which was posted on TFRRS for a distinct year, these times were post conversion, meaning they were converted to the track type which the national meet was held on that year), Qualifying Bank (whether or not the qualifying time was ran on a bank track or not), National Time (time which was ran at nationals, the faster time between preliminary and final rounds), and National Bank (whether or not the National meet was on a banked track, 2014 and 2018 were banked, rest were flat tracks). An example data entry of the resulting table is shown in Table 1.

Table 1. Resulting Table from Merging the Qualifying and Nationals Tables (Based on Individual, Event, and Year)

Athlete Name	Year	Team	Event	Qualifying Time	Qualifying Bank	National Time	National Bank
John Doe	2014	Team A	200	21.45	FALSE	21.72	TRUE

2.2. Data Analysis Preparation

For the evaluation of the conversions, four sub datasets were created for the individuals who qualified on a flat track with Nationals on a banked track (the four sub datasets were: Female 200 meters, Female 400 meters, Male 200 meters, and Male 400 meters). To help normalize the data, outliers were detected and removed from the dataset (each event either had one or no outliers, and the outliers that were detected were due to slower than normal performances at nationals). Since the data is limited to a few years, sample sizes were relatively small (ranging from 20 to 41), meaning assumption that the data follows a normal distribution due to large sample size cannot be used. Instead, the Shapiro-Wilk Test, which is a statistical test that determines if the data follows a normal distribution, provides sufficient evidence that the data is normally distributed. Next a Paired Sample t-Test is performed between the qualifying time and national meet time to determine whether or not there is a significant difference between the two (the qualifying time is post conversion).

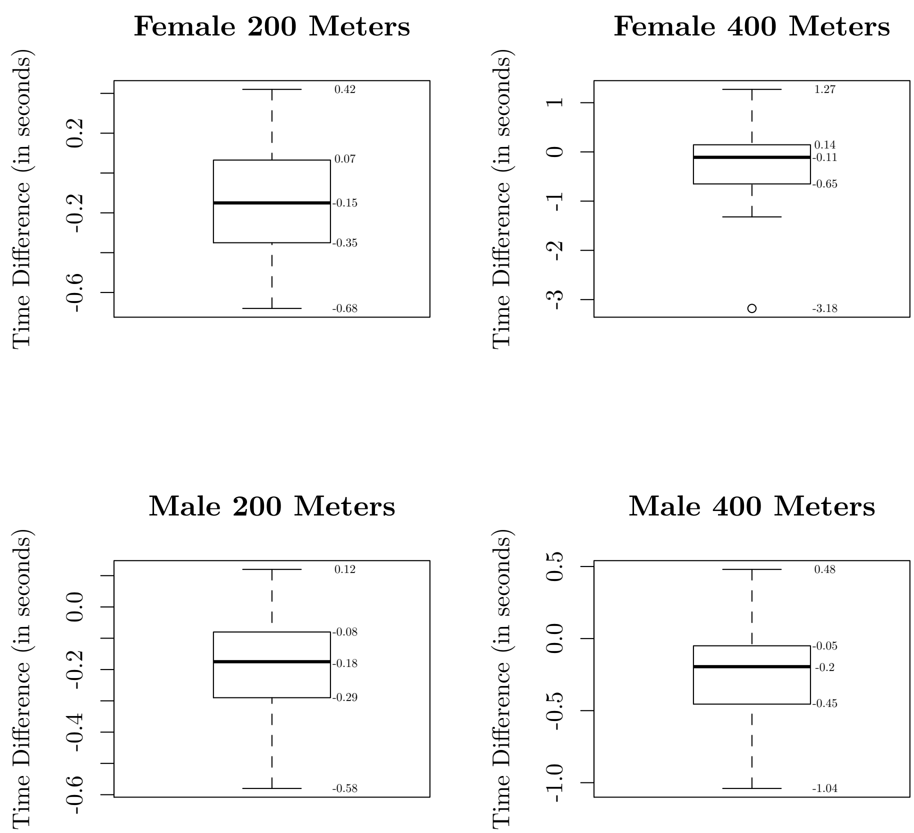
A similar approach was used to justify the assumptions that qualifying times and national meet times are equivalent. Four sub datasets were created and an evaluation was done on the individuals who qualified on a flat track and Nationals was on a flat track. The same process was done for normalizing the data, as well as the verification that the dataset is normally distributed. Next a Paired Sample t-Test was performed between the qualifying time and national meet time to determine whether or not there is a significant difference between the two (to justify the assumption that qualifying times and national meet times are equivalent, there should be no significant difference between the two).

3. Results

3.1. Qualifying on a Flat Track and Nationals on a Banked Track

Evaluating the data from individuals who qualified on a flat track and the national meet was on a banked track, boxplots revealed that an outlier existed in the Female 400, as seen in Figure 1. These outliers were removed from the dataset for analysis.

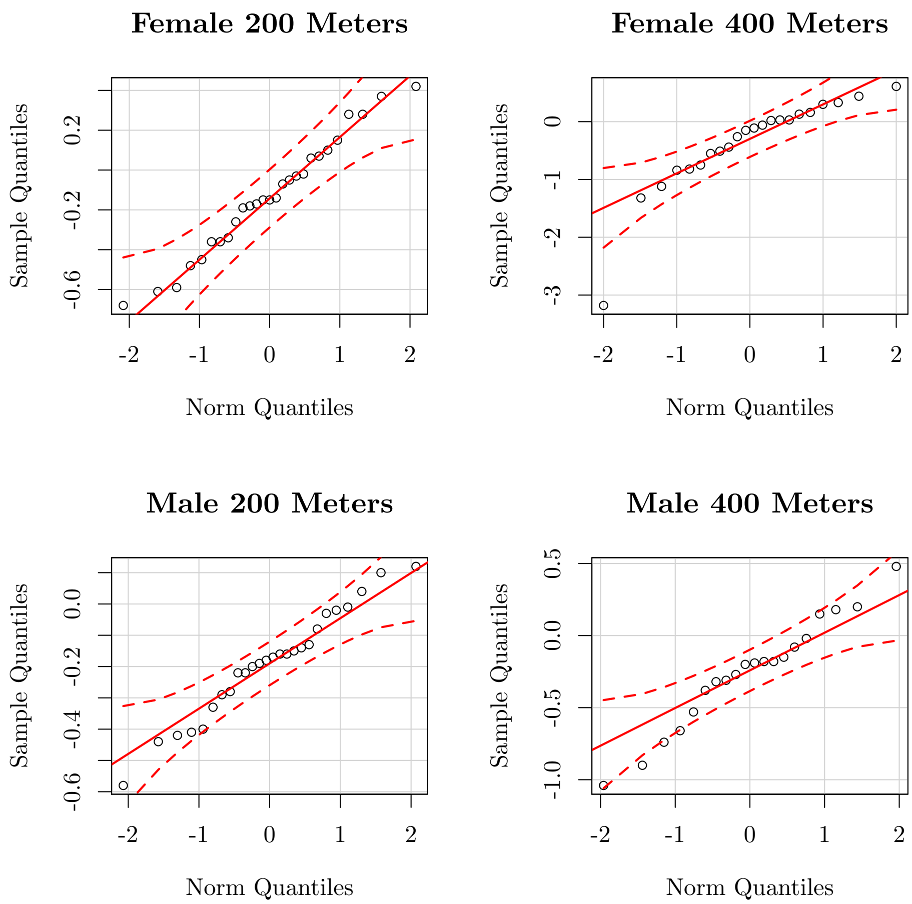
Figure 1. Boxplots of the difference between Qualifying and National times; Qualifying on a Flat Track and Nationals on a Banked Track



The Shapiro-Wilk Normality tests relieved that there is no significant difference between the datasets' distributions and normal distributions. The results (p-values) from the Shapiro-Wilk Normality Test is displayed in Table 2. If the p-values are greater than .05 (*Shapiro-Wilk Normality* $p > .05$) this indicates that there is no significant evidence to say that the dataset's distribution deviates from a normal distribution. Additionally, a higher p-value implies more confidence that the dataset distribution does not deviate from a normal distribution.

Furthermore, the quantiles for each dataset were graphed against the quantiles for a normal distribution. This provides a second layer of indication that the datasets do not deviate from a normal distribution. These plots can be seen in Figure 2.

Figure 2. Normal Density Quantiles vs. Time Difference Quantiles; Qualifying on a Flat Track and Nationals on a Banked Track



Note. Points falling between the dashed redlines means there is no reason to believe that the data does not follow a Normal distribution

With evidence that the distribution of all events (i.e. sub datasets) do not deviate from a normal distribution, Paired Sample t-Test can be performed for the evaluation of the conversion. The Paired Sample t-Test gives the average difference between the converted qualifying times and the national banked times along with a p-value. If there is significant difference between the converted qualifying times and national banked times, the p-value will be less than .05 ($p < .05$). Therefore, if the p-value is less than .05, the average difference between the converted qualifying times and national banked times needs to be interpreted. If the difference is negative (*Mean of Difference* < 0), the converted qualifying time is smaller than the national banked time, meaning the converted qualifying times are faster compared to the national banked times. If the difference is positive (*Mean of Difference* > 0), the converted qualifying time is greater than the national banked time, meaning the converted qualifying times are slower compared to the national banked times.

Table 2 shows the results from analyzing converted qualifying times and national banked times. The n column shows the number of data points that were used in the analysis, the p column shows the level of significance, the Mean of Difference column shows the average difference between the two, and the .95 Confidence Interval column shows the 95% confidence interval for the difference between the two, meaning if an infinite amount of samples were taken to analyze the converted qualifying times and national banked times, 95% of them would contain the true difference between the two. To show that there is significant difference between two, the 95% confidence interval must not contain the value 0.

Table 2. Paired Sample t-Test and Shapiro-Wilk Normality Check on the Difference Between Converted Qualifying on Flat Track and Nationals on Banked Track

Event	n	t statistic	P	Mean of Difference	.95 Confidence Interval	Shapiro Wilk Normality p
Female 200	27	-2.31	0.03	-0.13	(- 0.2484, - 0.0145)	0.84
Female 400	21	-2.04	0.06	-0.23	(- 0.4705, 0.0058)	0.62
Male 200	26	-5.64	0.00	-0.19	(- 0.2600, - 0.1208)	0.79
Male 400	20	-3.02	0.01	-0.26	(- 0.4349, - 0.0791)	0.80

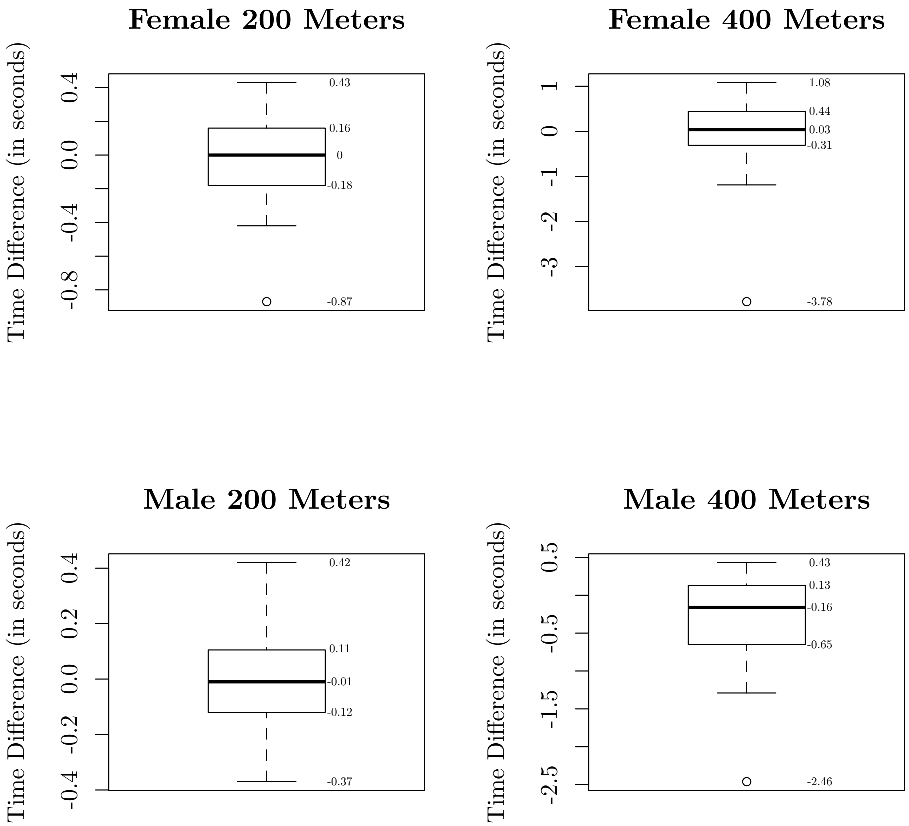
Note. Data from qualifying times on a flat track (converted to a banked track) were compared to national times on a banked track (Years data was from: 2014 and 2018)

From Table 2, the events that had significant difference between the converted qualifying times and the national banked times were the Female 200 ($p < .05$), Male 200 ($p < .0001$), and Male 400 ($p < .01$). Furthermore, for the Female 200, the mean difference between converted qualifying times and national banked times is -0.1315 ($\textit{Mean of Difference} = -0.1315$), suggesting that converted qualifying times are over converted, giving the athletes a faster time than they can actually run by over a 0.1 of a second. For the Male 200, the mean difference between converted qualifying times and national banked times is -0.1904 ($\textit{Mean of Difference} = -0.1904$), suggesting that converted qualifying times are over converted, giving the athletes a faster time than they can actually run by almost 0.2 of a second. Lastly, for the Male 400, the mean difference between converted qualifying times and national banked times is -0.2570 ($\textit{Mean of Difference} = -0.2570$), suggesting that converted qualifying times are over converted, giving the athletes a faster time than they can actually run by .25 of a second.

3.2. Qualifying on a Flat Track and Nationals on a Flat Track

Evaluating data from individuals who qualified on a flat track and the national meet was on a flat track, boxplots revealed that outliers existed in the Female 200, Female 400, and Male 400, as seen in Figure 3. These outliers were removed from the dataset for analysis.

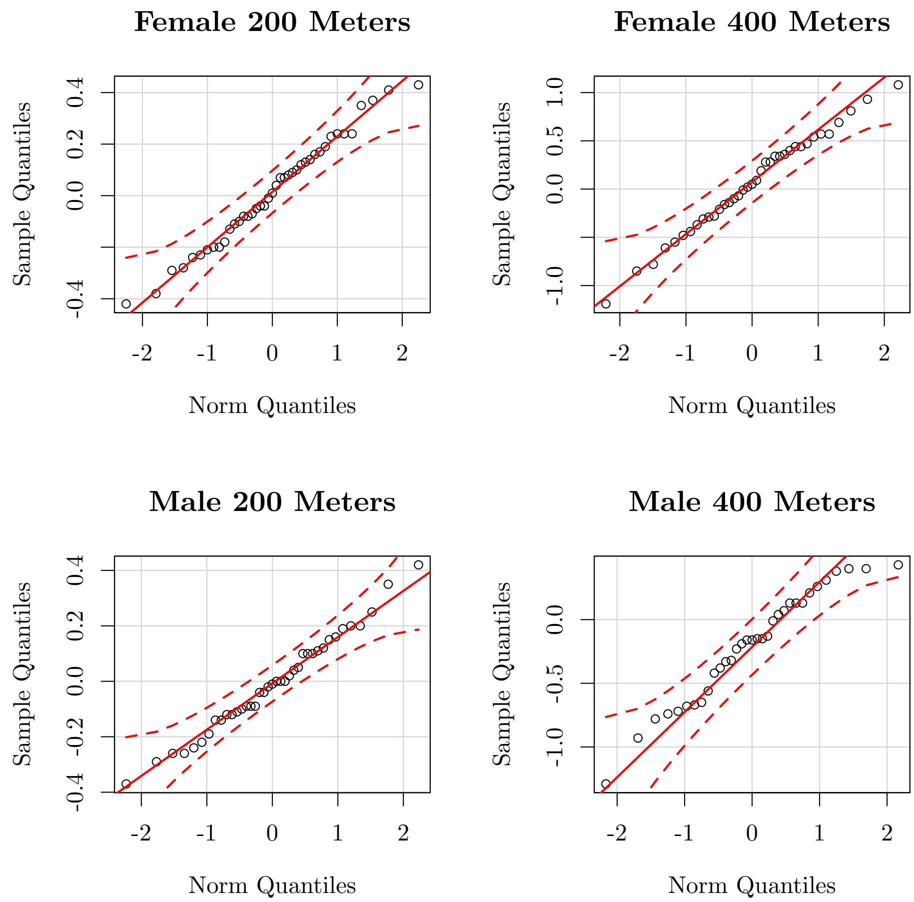
Figure 3. Boxplots of the difference between Qualifying and National times; Qualifying on a Flat Track and Nationals on a Flat Track



Similar to the converted qualifying times and national banked times, the Shapiro-Wilk Normality tests relieved that there is no significant difference between the datasets' distributions and normal distributions. The results (p-values) from the Shapiro-Wilk Normality Test is displayed in Table 3. If the p-values are greater than .05 (*Shapiro-Wilk Normality* $p > .05$) this indicates that there is no significant evidence to say that the dataset's distribution deviates from a normal distribution. Additionally, a higher p-value implies more confidence that the dataset distribution does not deviate from a normal distribution.

Furthermore, the quantiles for each dataset were graphed against the quantiles for a normal distribution. This provides a second layer of indication that the datasets do not deviate from a normal distribution. These plots can be seen in Figure 4.

Figure 4. Normal Density Quantiles vs. Time Difference Quantiles; Qualifying on a Flat Track and Nationals on a Flat Track



Note. Points falling between the dashed redlines means there is no reason to believe that the data does not follow a Normal distribution

A Paired Sample t-Test was performed for qualifying on a flat track and nationals on a flat track. This test gives the average difference between the qualifying times and the national flat track times along with a p-value. If there is not a significant difference between the qualifying times and national flat track times, the p-value will be greater than .05 ($p > .05$). Therefore, if the p-value is greater than .05, there is no significant difference between the qualifying flat track times and national flat track times.

Table 3 shows the results from analyzing qualifying flat track times and national flat track times. The n column shows the number of data points that were used in the analysis, the p column shows the level of significance, the Mean of Difference column shows the average difference between the two, and the .95 Confidence Interval column shows the 95% confidence interval for the difference between the two. To show that there is no significant difference between two, the 95% confidence interval must contain the value 0.

Table 3. Paired Sample t-Test and Shapiro-Wilk Normality Check on the Difference Between Qualifying on Flat Track and Nationals on Flat Track

Event	n	t statistic	P	Mean of Difference	.95 Confidence Interval	Shapiro Wilk Normality p
Female 200	41	0.40	0.69	0.01	(- 0.0542, 0.0805)	0.84
Female 400	37	0.65	0.52	0.06	(- 0.1174, 0.2282)	0.97
Male 200	39	-0.34	0.73	-0.01	(- 0.0673, 0.0478)	0.95
Male 400	33	-2.69	0.01	-0.20	(- 0.3598, - 0.0498)	0.24

Note. Data from qualifying times on a flat track were compared to national times on a flat track (Years data was from: 2015, 2016, and 2017)

From Table 3, the events that did not have significant difference between the qualifying flat track times and the national flat track times were the Female 200 ($p = 0.6948 > .05$), Female 400 ($p = 0.5196 > .05$), and Male 200 ($p = 0.7339 > .05$). This suggests that there is no reason to believe that there is a difference between qualifying flat track times and national flat track times for these events. Furthermore, for the Female 200, the mean difference between qualifying flat track times and national flat track times is 0.0132 ($\textit{Mean of Difference} = 0.0132$), suggesting there is essentially no difference between qualifying flat track times and national flat track times. For the Female 400, the mean difference between qualifying flat track times and national flat track times is 0.0554 ($\textit{Mean of Difference} = 0.0554$), suggesting there is only a .05 of second difference between the two. Lastly, for the Male 200, the mean difference between qualifying flat track times and national flat track times is -0.0097 ($\textit{Mean of Difference} = -0.0097$), suggesting there is essentially no difference between qualifying flat track times and national flat track times.

4. Discussion

To suggest that the conversions are inaccurate for a specific event, there needs to be significant difference for that event when comparing the converted qualifying times to national banked times, and there needs to be no significant difference for that same event when comparing qualifying flat track times to national flat track times. From the results of this study, the Female 200 and Male 200 are the only events which satisfy these two conditions (both saw significance when comparing converted qualifying flat track times to national banked times and both saw no significance when comparing qualifying flat track times to national flat track times). This would suggest that the conversions are inaccurate. Furthermore, both had negative values for the mean difference, meaning that the conversions for the Female 200 and Male 200 are over converted. This means that athletes who run the 200, whether they are Female or Male, benefit from running on a flat 200-meter track when nationals is held on banked track.

This research did have its limitations, however.

One of these limitations is that the data only consisted of Division III athletes who qualified for nationals. Further research could be conducted across all the divisions, specifically Division II where nationals is held on both flat and banked tracks. Another limitation is the small sample sizes (between 20 and 41). As more years pass with these same conversions and more Division III National Indoor meets are held on banked tracks, further research can add insight to whether or not the conversions are inaccurate.

There are multiple conversions the NCAA uses (e.g. flat to banked, banked to flat, undersized to flat, altitude conversion, etc. - just to name a few). Since flat tracks are most common in Division III, this research strictly focused on flat to banked conversions. If the data suggests that the conversions are off for flat tracks to banked tracks, there might be reason to believe other conversions are off. Future research could be conducted on these other conversions or even on different events outside the 200 and 400.

This research was conducted to see if data suggests that the conversions are inaccurate, it was not conducted to suggest new conversion ratios. Further research could add value by producing new ratios that the NCAA could implement. New suggested ratios can be produced by simply taking the average national banked time divided by the average converted qualifying time for a specific event.

5. References

References

Barnes, K. R., & Malcata, R. (2017). Conversion index for running on different indoor track and field facility types. *International Journal of Performance Analysis in Sport*, 17(4), 375-384.

Corts, B., (2017), Quantitative Analysis of 200 Meter Track Times (B.S. Thesis) MIT, Cambridge, Massachusetts

Pederson, K., Larson, G., Jones, S., & Podkaminer, B. (2012). Indoor facility indexing for NCAA running event performances. A study commissioned by the NCAA Men?s and Women?s Track and Field Committee. National Collegiate Athletics Association.

Richard, N. M. (2013). *Statistical Models for NCAA Indoor Track and Field Data* (Doctoral dissertation, Worcester Polytechnic Institute).