

Note to future readers: This is a research paper written for my writing seminar in freshman year, in its original state after submission. To date, this is my most comprehensive data science project, although I have been working on others in my free time. Thank you for your time, and I hope you find this topic interesting.

December 14, 2019

Dear Reader,

In this paper, we discuss the merits of resting players in the NBA. In the end, we reach several factors that negatively impact teams who rest players, and explore why certain teams that have implemented load management in the past have nevertheless had success.

I feel like I did a really great job in the research for this paper. Because resting has expanded throughout the league so recently, there is limited existing scholarly research on the topic for me to piggyback off of. To combat this, I utilized significant amounts of statistical analysis on data sets compiled from accredited websites like NBA.com and Basketball Reference in order to reach my own conclusions that I could not find otherwise. In my analysis, I applied methods from simple averages of scoring outputs to two-sample hypothesis testing, which I learned recently in my ORFE class and used to deduce that players perform significantly less efficiently in games returning from rest. Analyzing the data was seriously a lot of fun and I was pleasantly surprised that I had as much fun as I did composing this paper.

However, I do have reservations. Although I believe the motivational tension provided by the current discourse and commissioner Silver's statement is meaningful enough to inspire this research and paper, my anxiety boils down to the lack of established scholarly research and tension. The lone scholarly paper I found that even remotely explores the motive of my paper is extremely narrow in scope and thus suffered from a seriously limited sample size. However, this topic is something I really find intriguing and may continue to delve into for fun, and I'm proud of the work I was able to do with the limited existing conversation.

Thank you for reading, and I hope you enjoy!

Sincerely,

Kenny Huang

This paper represents my own work in accordance with University regulations. /s/ Kenny Huang

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Load Management and its Effect on the Rest of the Season

In November 2019, the NBA announced that it is considering implementing several reforms to the structure of the season. Currently, each of the 30 NBA franchises plays 82 regular season games over six months, which many view as placing too much stress on players' bodies. In 2006, as a precautionary measure, coach Gregg Popovich of the San Antonio Spurs began the practice of "resting" his star player Tim Duncan during selected regular season games by having him not even suit up in uniform for the game (Jones). According to researcher Tony Jones, this practice allowed Duncan to remain impactful well past his prime and extended the Spurs' championship window by several years. Since then, most teams in the league have imitated this concept of "load management", much to the dismay of fans, former NBA players, and the league office. For example, teams usually neglect to publicize who would be resting until right before the game, leaving fans and television networks in difficult situations. In order to combat this, the NBA began fining teams up to \$100,000 for resting players in nationally televised games, but the policy was mostly ineffective as teams saw enough incentive to continue doing so. As the issue gained national prominence, commissioner Adam Silver appeared to take the middle ground, stating that "if legitimate resting of players resulted in them being healthier for the playoffs, healthier longer, able to continue their careers longer, I think we'd be in favor of it" (Goldberg). However, the implied question behind his words is clear: does resting actually result in the benefits that its supporters tout? Although the physical grind of the season is undeniable, data suggests that "load management" is indeed not as one-sidedly beneficial to teams as most believe.

I. The Case for Resting

On the surface level, resting certainly has its merits. Proponents for load management denounce the long grind of an 82-game season for causing fatigue, deteriorated performance, and serious injuries. In the 2018-19 season, the thirty most active players (about one per team) traveled more than 2.47 miles per game, equivalent to sprinting a 5k race every other night; an additional 109 averaged 2.0 miles or more (NBA). Players, particularly those in their rookie or early seasons, often are worn down mentally during the season due to a variety of factors including fatigue, travel, homesickness, and even mental illness. For instance, former player Larry Sanders suffered from a mental disorder that required him to spend hours alone when recovering from anxiety attacks. However, due to the constant grind of practices and traveling to new cities, Sanders struggled to cope with his anxiety and eventually retired at just 27 years old (ESPN). Although a busy schedule is inevitable, the impact that it has on the mental state of NBA players is undeniable. Even on Christmas Day, more than a hundred players will suit up instead of spending time with their families, igniting discussion about reforming the schedule.

Another undocumented aspect of playing in the NBA is travel. With thirty teams spread all over the country playing 41 of their 82 games in a different city, planning logistics is obviously a monumental task. In the 2018-19 season, all but seven teams, more than three-quarters of the league, traveled upwards of 40,000 miles, with the Portland Trailblazers and Los Angeles Clippers accruing more than 54,000 miles (Villas). In addition, time zones are a major factor in player performance. Considering that most games start between 8 and 10 PM, players from cities in Eastern time playing a road game on the west coast thus run many of their 5K's after what their Circadian rhythms perceive as midnight— all after cramming their

abnormally long bodies into an airplane seat for hours earlier that day. The results of these two factors are as expected: NBA teams traveling eastward won 45.4% of games compared with 36.2% for teams traveling westward, with both conspicuously sitting below fifty (Huyghe).

More importantly, this problem is being exacerbated by the natural evolution of the game. With the increased prominence of three-point shots and the rising popularity of “small-ball” lineups, where all five players on the court are generally shorter and faster, the game itself has sped up: pace, or the number of possessions per 48 minutes, has dramatically increased from 91.3 in 2001 to 101.4 in 2018, a significant 11% increase that places an even larger strain on the players (Basketball Reference).

In analyzing injury data from the past two decades, another concerning trend emerges. (Note: for this analysis, the 2000-01, 2010-11, and 2018-19 seasons were used. These seasons were chosen due to the lockouts in 1998 and 2011 distorting the data in the seasons that immediately followed.) After sorting all players from the 2000-01 season by usage rate, the percentage of plays “used” by the particular player and a good reflection of his importance to the team, the top thirty players appeared in an average of 76.0 games, missing only six games to injury during the regular season. In comparison, data from 2010-11 and 2018-19 reveal figures of 74.2 and 73.0 games, corresponding to eight and nine games missed, respectively. In other words, the number of games missed by the top player from each team increased by 50% over the past twenty years. When one instead considers the thirty players playing the most minutes per game, a more reliable estimate of the workload they actually shoulder, the games missed increased from 5.1 in 2001 to 9.8 in 2019, almost doubling. Clearly, the game and its increased pace is taking a toll on the players, including the biggest stars. High-profile injuries like those to

Stephen Curry and Kawhi Leonard harm the league's popularity and only motivate more teams to adopt load management to protect their marquee assets.

II. The Case Against Resting

Intuitively, then, it makes sense for coaches to rest their star players. After all, the primary objective of coaches lies not in generating revenue for the league or inflating player salaries or placating fans, but rather in maximizing the chances of a championship victory parade. If the rest of the roster is talented enough to guarantee making the playoffs, what's the harm in a star player taking a few meaningless games off in the middle of the season? Unfortunately, those few games have minimal effect on performance in the postseason and conversely can negatively impact teams in the long run.

2.1 Supercompensation

In sports science, supercompensation is a widely accepted method of improving athlete performance. In short, extended recovery after an elevated training period can stimulate the body to reach a level of fitness higher than that before the training period, a temporary improvement that typically lasts from five to ten days (Doering). Marathon runners widely adopt this technique in the week before their competitions, but what is known about supercompensation within the context of the NBA is unclear and incomplete. To gain a better understanding, I analyzed data from the 2018-19 season; after resting, NBA players theoretically would enjoy a similar boost in physical performance, so I expected to see a spike in production after returning from rest.

From Basketball Reference, I compiled game logs for the eight players who rested for at least five games in the 2018-19 season and analyzed their production in terms of points scored and Game Score (GS), a weighted average metric of a variety of statistics that is used to estimate

player efficiency (Basketball Reference). The players analyzed were Kawhi Leonard, Giannis Antetokounmpo, LeBron James, Anthony Davis, Jimmy Butler, Devin Booker, Kyrie Irving, and Joel Embiid, who are all superstars on their respective teams and have thus been rested relatively often. (Note: Due to the lack of data making it difficult to differentiate between injury and load management, “rest” is defined as games missed from which the player logged at least 30 minutes in his first game back, indicating no minutes restriction or physical limitation. Such games will now be referred to as “post-rest” games.) In total, the eight players missed a total of 144 of the 656 games analyzed, resulting in 52 post-rest games in which they collectively averaged a respectable 25.33 points and a GS of 19.85. However, in the remaining 460 games, those averages surprisingly stood higher, at 26.02 points per game and a GS of 21.70. After applying two-sample hypothesis testing, I acquired p-values of 0.236 and 0.036 for the discrepancies; in other words, players scored a negligibly lower amount while performing significantly less efficiently when they returned from rest.

Rather than confirming the effects of supercompensation in the NBA, the data suggests the opposite, that players perform worse. But what could cause this reversal? When examining the data, one may also wonder why scoring declined so much less than GS. I hypothesize that these observations are due to the fact that basketball depends far more on skill and teamwork than sports like long-distance running. Although the players are empowered physically, their shooting, passing, and dribbling techniques suffer from a lack of in-game practice. This certainly explains the trends observed: comparatively, scoring depends more on individual physical effort than other aspects of the game, so players can match their typical scoring numbers by increasing their usage volume at the cost of being less efficient overall. Indeed, in analyzing the second

games after they return (note: to be referred to as “post-post-rest” games), I found that points scored and GS values in those 41 games each rebounded slightly above the pre-rest levels of 26.02 and 21.70 to sit at 27.21 and 22.62, respectively. However, these represented statistically insignificant gains, with hypothesis testing yielding p-values of 0.214 and 0.275. In other words, players re-acclimate to the flow of the game as the effects of supercompensation subside, so the two effects nullify each other. Unfortunately, although this suggests that supercompensation does indeed also apply in the NBA, the improvement that it provides is, after all, temporary. Any benefit gained from resting a game in the middle of the season would have dissipated long before the playoffs occurs. This begs the question, could resting star players at the end of the regular season be a valid approach to activate and utilize supercompensation in the playoffs?

To answer this, we need to first identify how teams would benefit from such a strategy. Currently, the NBA playoffs is structured as a four-round bracket tournament of the top eight teams in each conference, in which the winner of each best-of-seven series advances to the next round. Thus, each series lasts at least four games, or about six days, meaning that any improvement from resting the last week of the regular season would only benefit the team for the first and second rounds at most. For teams looking to make deep playoff runs, this strategy falls short. To counter this, one might argue to apply load management in the early playoff rounds; however, this practice is unheard of and actually runs counter to the original goal of resting to gain an advantage in the playoffs. All things considered, resting players near the end of the season or in the playoffs is not a valid strategy and can actually do more harm than good by disrupting the development of team chemistry.

2.2 Chemistry

Professor Andrew Fiala describes team chemistry as “the biological underpinning of the ways that groups of individuals coordinate their body–brains to accomplish complex activities” (Fiala); in other words, team chemistry allows a team to be more united in their pursuit of a common goal, such as, perhaps, winning a championship. Research indicates the substantial impact that chemistry has on the outcome of team activities, including basketball. One particular study examined the effect of “prior shared success” on current success in several different team sports (Mukherjee et al). Because of the positive emotions and camaraderie evoked in victory, the researchers defined prior shared success as the number of games that each pair of players has won while on the same team, summed over all pairs of players on a team. This value then serves as a rough quantification of team chemistry. The study found that within the sample of NBA games, the winning teams “had a significantly higher value for the number of times their players had previously played in games they won... than the losing teams (Wilcoxon signed-rank test, $z = 10.153, P < 0.001$)”.

In short, teams that win together generally play better, which on the court manifests through well-executed defensive schemes, extra passes, and an instinctive trust in teammates that is hard to artificially create. When star players rest, they reject opportunities to develop this chemistry in games, which puts them at a significant disadvantage during the playoffs. Of course, individual talents can overcome a well-oiled machine, but in many cases team chemistry serves as the deciding tie-break between two otherwise-evenly matched opponents, so its development has a serious impact on teams’ championship aspirations.

2.3 Playoffs

Furthermore, resting hurts teams more concretely by affecting playoff positioning. Seeding for the NBA playoffs within each conference is determined strictly on regular season win-loss record, with a tie-breaker system in place if needed. Under the current structure, a higher-seeded team gains two significant advantages. First, teams with higher seeds are matched up with weaker teams and thus have a better chance of winning and advancing. In the first round, for instance, the first seed team plays the eighth seed, the second seed team plays the seventh seed, and so on. A similar staggering effect occurs throughout the rest of the tournament, ensuring that the best teams meet head-to-head as late in the tournament as possible. Thus, having a higher seed not only improves the odds of advancing out of the first round, but also delays matchups against highly-ranked opponents in the conference.

Secondly, home-court advantage within each series is assigned to the team with the better regular season record—in other words, the benefitted team plays at least as many home games as road games. Thus, seeding in the top four provides home-court advantage in the first round, and securing the best record in the league ensures an advantage through the entirety of the playoffs. The effects of home-court advantage are well-documented and undisputed: according to Bleacher Report, home teams consistently win about 60% of regular season games every year (Bleacher Report). For reference, during the 2018-19 regular season, the home team won 58.8% of games, and 28 of the 30 teams had more wins at home than on the road. In the playoffs, many of the underlying causal factors, like fan attendance and rest, are even more impactful (Harris). Indeed, it's no wonder that in the 2018-19 playoffs, 11 of the 16 teams had home records of .500 or above, compared to only 6 teams on the road (NBA).

Clearly, playoff seeding impacts teams' performance in the postseason, and the few games in which star players rest can be pivotal in the race for a top seed. The analysis I performed on the eight players indicates a steep drop-off in games where they rested and the subsequent game when they return; their teams won only 47.22% of games when they sat and 53.85% in the first games back, figures that skyrocket to 56.28% in the second games and beyond once they have a chance to re-familiarize themselves with the flow of the game. In the 2018-19 season, the Toronto Raptors rested their star player Kawhi Leonard in a league-leading fourteen games, and they eventually settled for the second seed in the East, just two games behind the first-place Milwaukee Bucks. Mid-tier teams have an even smaller margin for error: the fifth-seed Indiana Pacers missed home-court advantage in the first round by just one game and were subsequently eliminated in the first round. Thus, no regular-season game is truly meaningless, and teams that rest their best players agree to a trade-off that sometimes negatively impacts their postseason situation.

2.4 Injury

One of the most often cited defenses of load management is the protection against serious injury. As of now, research on its effects on injury is limited. However, preliminary results seem to indicate that resting does not affect injury rates in the postseason. One study conducted by the University of Colorado at Boulder analyzed injured players in both the regular and postseason and concluded that "it should not be assumed that NBA players who rest more frequently during the regular season will perform at a higher level or be at a reduced risk of injury in the playoffs during that same season" (Belk). Although more research should be conducted to reach a more conclusive result, the preventative effects of resting just a few games per season are too small to

have a noticeable effect and in many cases may not be worth the negative impacts mentioned earlier in this paper.

III. Looking at History

With all this being said, is resting worth it? Certainly, the practice lowers league revenue and disappoints fans, but coaches should still evaluate the inconspicuous long-term effects of load management and determine whether the lower risk of injury is worth the aforementioned harmful effects. Looking at past situations, it's difficult to isolate to what degree resting actually affects the outcome of the season. For instance, the Kawhi Leonard-led Toronto Raptors surprised the world when they stormed to their first ever NBA title after extensively resting their best player during the regular season. But it is impossible to determine how much of their success should be attributed to that practice and how much to their underrated supporting cast. However, we can gain important insight by examining the one franchise who pioneered and had the most success with the art of resting: the San Antonio Spurs. As noted earlier, coach Gregg Popovich began resting Tim Duncan early in his 30's. Although many teams have imitated the Spurs in recent years, there are unique aspects of the Spurs situation that allowed them to see the consistent success that eludes most other teams.

First, coach Gregg Popovich, heralded as one of the greatest head coaches of all time, implemented in San Antonio a pass-heavy, unselfish style of play that greatly reduced the need for a dominant number-one option. Thus, although Duncan's value to the team was undeniable, the Spurs could afford to let him rest more than most other teams. In fact, in the last four years of his career, after the lockout-shortened season of 2011-12, the Spurs won 70.2% of the regular season games Duncan missed compared to 73.8% overall, a shockingly small shift in outcomes

for a player who averaged almost 20 points and 10 rebounds a game throughout his career and was viewed as the main pillar of the most steady dynasty in the league (NBA).

More importantly, the Spurs were an unbelievably stable franchise during Duncan's career. Popovich assumed the role of head coach just one year before Duncan was drafted in 1997, and the two developed a genuine relationship over their 18-season partnership evident in their off-court interactions. More importantly, Duncan was able to master the intricacies of the system implemented by Popovich and bring it to its maximum potential. Long-time teammates Manu Ginobili and Tony Parker were drafted in 1999 and 2001, respectively, thus creating a dominant "Big Three" that remained productive and intact until Duncan retired from the Spurs the summer of 2016. By the time Popovich started resting him halfway through his career, Duncan was extremely comfortable with his teammates and his role within the Spurs system and thus minimally affected by the team chemistry issues that plague other teams.

IV. Conclusion

From observing the Spurs, we reach some valuable conclusions. First and foremost, resting has its merits. Concerns surrounding fatigue are extremely valid, and teams are not wrong to prioritize their players' health during the postseason. Under the right conditions, load management can prove invaluable to a franchise over the long term, just as it was for the Spurs. However, resting is not the one-size-fits-all salve that many teams appear to use it as. Teams who are reliant on a single player, experience significant roster turnover, or lack an established supporting cast subject themselves to serious risks in the postseason and thus need to carefully evaluate their own situations.

In the grand scheme, the practice of load management is still too new, and research on the topic is limited. In this paper, I gathered as much quality data as I could, but the eliteness of the NBA resulted in a smaller sample size than expected. Nevertheless, I had enough data points to use standard statistical analysis and have confidence in the conclusions reached. Further research can explore the success of load management utilized in different scenarios as an extension of my analysis on the Spurs' success, or apply new data points to verify the findings in this paper. As the trend progresses and more data is observed, we'll naturally gain an even better understanding of this phenomenon and can finally put this issue to rest.

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