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A Dynamic Online Dashboard for Tracking the Performance of Division 1 Basketball Athletic Performance

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***Abstract*—Using Data Analytics is a vital part of sport performance enhancement. We collect data from the Division 1 'Women's basketball athletes and coaches at our university, for use in analysis and prediction. Several data sources are used daily and weekly: WHOOP straps, weekly surveys, polar straps, jump analysis, and training session information. In this paper, we present an online dashboard to visually present the data to the athletes and coaches. R shiny was used to develop the platform, with the data stored on the cloud for instant updates of the dashboard as the data becomes available. The performance of athletes can be compared to the group averages, while coaches have access to all athletes and can compare them to each other and the team averages for all parameters. A simple color-coded design was utilized to convey the coaches which of the measured parameters is in an acceptable range and which is deficient. The dashboard was reviewed by the athletes, coaches, and exercise scientists and was useful for their needs.**

Keywords—Athletic tracking, Sleep monitoring, R Shiny, Dashboard, Athletic performance

I. Introduction

Data Analytics has gained significant attention in sports science, including collegiate leagues in different team sports. Data is collected and analyzed to gain insights that can improve players' performance or prevent injury [1]. It is particularly important in team sports to ensure that the entire team is doing their part towards the team's success by improving their overall fitness level.

A multi-disciplinary international team of exercise scientists, data scientists, and coaches collected data from a division 1 college women's basketball team and used it to analyze the effect of sleep and exercise on performance and injury [2], [3]. The athletes wore WHOOP © [4] and Polar © [5] straps, responded to weekly surveys, and their training sessions data was recorded. While it is essential to present the findings from a season's data to the research sports science community, it is also helpful to present the coaches and athletes with some straightforward analytics and visualization every week so they can fine-tune their performance.

In this paper, we present a dynamic dashboard that is designed for use by athletes and coaches. It visualizes the data as soon as it is collected and provides a simple way for the coach to evaluate performance at a glance [6]. It was coded in the R programming language [7] and uses the R Shiny interface [8] to make it easy to use on any device. The dashboard was developed by seeking the opinions and suggestions of coaches and athletes.

II. Data Preparation

The dashboard uses data collected by the basketball team players and their trainers from five different sources: The WHOOP strap© worn by the players all the time, the bi-weekly SRSS (Short Recovery Short Stress) survey, the weekly training data obtained from the strength coach, game and league statistics, and the jump analysis data from their weekly jump sessions. The data is collected weekly and appended to the dataset. The athlete IDs and dates are the primary keys for the data over the years. Data has been collected for 3 years, each year from early September to mid-March. In this section, we describe the different data parameters used by the dashboard.

The WHOOP strap is worn all the time by the players and provides data daily. It mainly measures the players' sleep patterns and respiratory and heart rates. The following 23 parameters were provided by the WHOOP strap (a description of each can be found at reference [4]):

- Hours in Bed
- Sleep Need
- Wake Periods
- Latency min
- REM Sleep hours
- Light Sleep hours
- Recovery
- Sleep Debt hours
- Respiratory Rate
- Deep Sleep Percent
- RHR (Resting Heart Rate)
- HRV (Heart Rate Variability)
- Total Cycle Sleep Time hours
- Hours of Sleep
- Sleep Efficiency
- Sleep Disturbances
- Cycles
- Deep Sleep hours
- Awake hours
- Sleep Score
- Sleep Consistency
- REM Percentage
- Restorative Sleep hours

The SRSS [9] data is collected bi-weekly with a numerical answer in the range 0 (strongly disagree) to 6 (strongly agree):

- PPC Physical Performance Capability
- MPC Mental Performance Capability

- EB Emotional Balance
- OR Overall Recovery
- MS Muscular Stress
- LA Lack of Activation
- NES Negative Emotional State
- OS Overall Stress

Three parameters were obtained from the bi-weekly training data:

- Weekly SD: Quantifying training load by summing session ratings of perceived exertion per week.
- Monotony: Quantifying training load by normalizing the mean daily load by the weekly SD of training load.
- Strain: Quantification of training load calculated by multiplying the total weekly load by the monotony score.

Three parameters were chosen from the weekly jump analysis sessions:

- Peak Power: Peak power is the greatest output or production of work over time. Power can account for a combination of strength, velocity, force and neuromuscular adaptations.
- RSI: The reactive strength index measures reactive jump capacity and displays how an athlete copes with and performs plyometric activities.
- Jump Height: A measure of the difference between an athlete's standing height and a jump's height.

Finally, three parameters were obtained about their game performance (publicly available):

- Win: A 1 if the player played in a game and their team won. A 0 if the player played in a game and their team lost.
- Game Score: The game score roughly measures each 'player's productivity in a game. The higher the game score, the better. A game score of 10 is average, and 40 is considered exceptional [10].
- PER: A measure of a player's per-minute performance. The measurement takes into account both positive and negative metrics. Then it is adjusted based on the team's and the NEC's average [11].

The goal is to help the athletes, and the coaches visualize this large dataset, about 3000 rows of 17 athletes per season, with about 60 columns.

III. Dashboard Development

A dashboard was developed using the R coding language and the R shiny web interface to visualize the data to the athletes, coaches, and researchers in a simple graphical way. The app is designed to be used on a tablet or a smart phone. There are two types of users of the dashboard: the athletes themselves and their coaches/researchers. Separate accounts were created for each type of user: The athlete account has access only to their data and the average stats about the team. The 'coaches' account has access to all data for all athletes.

The data is collected weekly and appended to the large data file. To enable the data to be automatically updated in the dashboard without intervention, the data file is saved on the cloud (google drive) and accessed at each app refresh by the user. Fig. 1 shows the R code used to access the file from the google drive. After logging on using their password, users are given the screen shown in Fig. 2. The left-hand side menu has three components to choose from: "Detailed view," "Overview," and "Variable Definition."

```
# Get Login Information pulled from google drive
options(
  gargle_oauth_cache = ".secrets",
  gargle_oauth_email = "shuwbbresearch@gmail.com"
)
# run sheets auth
drive_auth(cache = ".secrets", email = TRUE, use_oob = TRUE)
mydrive <- drive_find(n_max = 2) # list 1 file in drive
Data <- drive_get("AllforE&C.csv") # Read datafile from drive
ID <- Data$id   # Athlete IDs
# read in csv file from google
df <- read.csv(
  sprintf("https://docs.google.com/uc?id=%s&export=download", ID))
```

Figure 1 Code to access data on Google Drive.

The detailed view displays scatterplots and trend lines from the dataset. The user has four choices: the date range using a scrollbar, where the user can choose to range from a few days to the entire season. Then, the parameters for the x and y lines of the plot. The user can choose any of the 40 parameters in the data set for either of them. And also, the choice of players to compare. Fig. 2 shows a choice of the "Date" for the x bar and "Sleep Score" for the y bar for the period from September 6th, 2021, to March 7th, 2022 (the whole 2021-2022 season). The trend line (red) shows a gradual increase over the season on average for all players.

The user can also see the chart for an individual player and compare it to the group average. An athlete can only compare their data with the average for any parameter. In contrast, the coach can compare one or more players against the average, as shown in Fig. 2. The coach chooses two players (names hidden), and their data are shown as dots in yellow and orange as well as their trend lines (yellow and orange) and compare it to the group trend in red. We observe that the player in yellow had their sleep score gets worse during the season, while the orange player maintained a good above-average score throughout the season.

The second component of the dashboard is the "overview," and was developed as a request by the coaches to get a quick analysis of several aspects of the team. This component is visible to all dashboard users and does not provide individual data, just group averages.

Twenty-four parameters were chosen by the coaches as of particular interest for them to track, and those 24 parameters were divided into 4 groups: "Load and Polar Unit," "Jump Data," "Whoop data," and "Recovery/Stress." The parameters are shown in a simple color-coded format, green for within the acceptable range and red for not in the normal range; the average value is also displayed for reference. Fig. 3 shows a sample page for the WHOOP data analysis from week March 1st to March 7th, 2022. The red and green indicate if the team is trending better or not than one week back from the start date

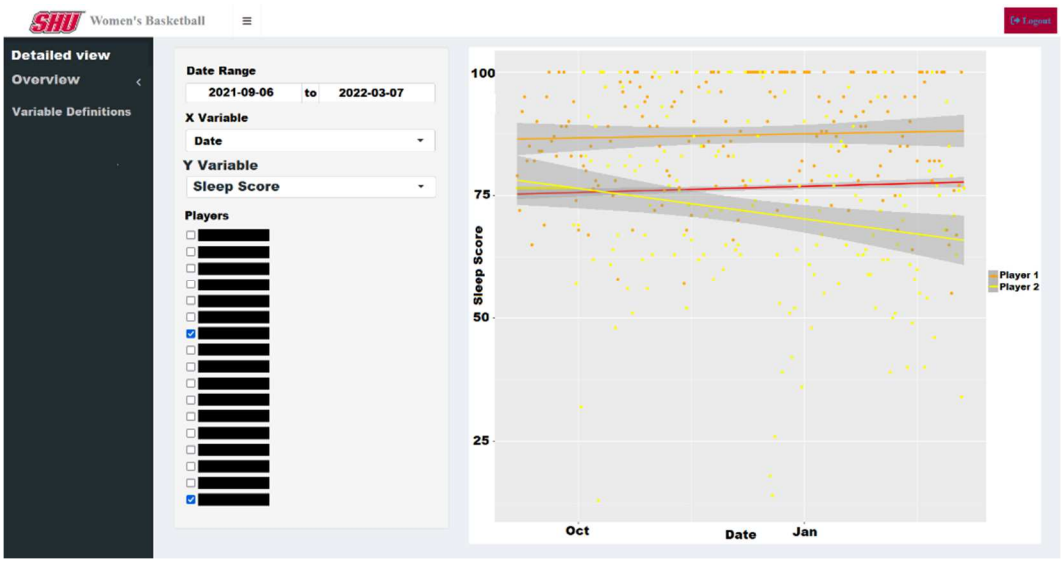

Figure 3 "Detailed View" of the coach dashboard comparing two players to the team average

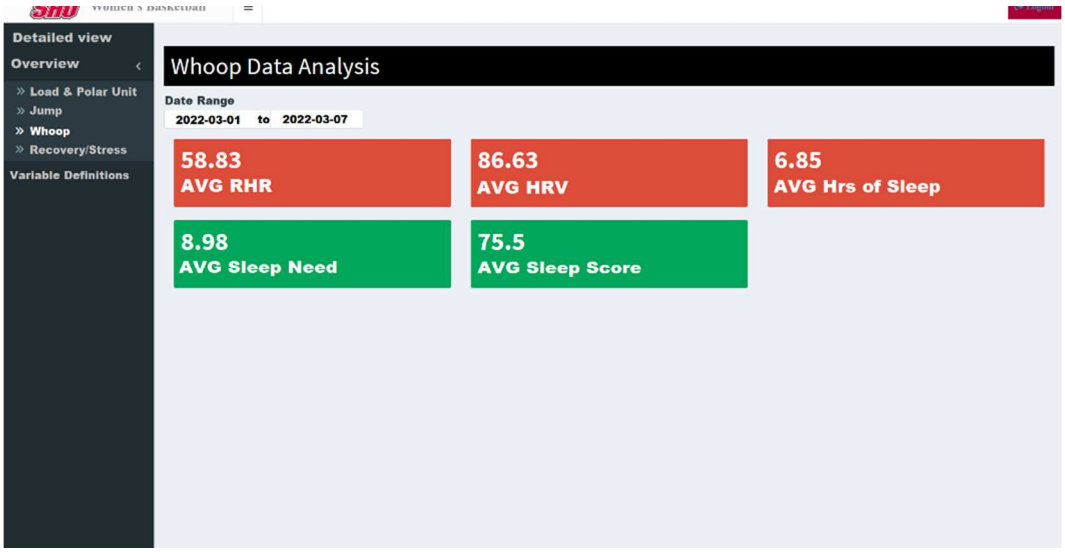

Figure 2 "Overview" Screen: The color-coded overview of important parameters (WHOOP data).

and end date. In other words, it compares the current average to the average minus 1 week from the selected dates.

The third component of the dashboard is the "Variable definitions," which contains a simple table of the parameters used in the dashboard and a simple description of the meaning of each of them. This data is saved as a static separate data file and does not need updating during the season.

IV. Discussion

As the goal of the dashboard is to provide a simple visual way to access their sleep and exercise data, it was vital to include the athletes and coaches in the development of the dashboard. We started by developing a prototype, then showing it to the athletes and coaches for initial feedback. We included their suggestions in the final dashboard and surveyed them for their opinion of the final design.

Table 1 shows the initial survey results from the athletes (12 out of 17 responded). Two changes were implemented based on their feedback: (1) showing them their trend and the team averages and (2) adding a parameter description in simple words to the dashboard.

Table 1: Athlete Survey questions.

Questions and Answers
What would make you want to use the app? "Easy to read graphs & easy to see my information", "I would want to use this app to better understand my individual sleep trends/recovery etc.", "It's helpful tracking progress; helps prevent injury, make necessary changes to diet/lifestyle, and maintain consistency", "I would want to use this app to see my recovery and overall sleep score"

Please list any features that you would like included that currently are not. "I would like to be able to view my individual trends, rather than just the team trends.", "A key that explains abbreviations for Y Variables"

The results of the survey questions to the 8 coaches and exercise science faculty are shown in Table 2. They prefer to have the data updated weekly, not once per season as was originally implemented. Therefore, it was essential to have the data load dynamically by using a cloud-based dataset so data could be updated and analyzed weekly, starting in 2023. The technical issues they noted were also fixed in the dashboard. A prediction system for different parameters was suggested and is yet to be added to the dashboard due to technical complexity.

Table 2: Trainer/Faculty survey questions.

Questions and Sample answers
What was your favorite feature of the app? "Comparing the players to the team trend", "Ability to pick and choose what metrics I wanted to look at", "The graph plots allow an athlete-to-athlete comparison", "Freedom to choose amongst all parameters for analysis and also category wise analysis for the coaches", "app was easy to navigate and adjust."
How frequently, if at all, would you use this feature? "Weekly, I guess", "Daily if it was kept up to date!", "At least twice a week", "Almost all times", "The data range scroll bar is useful if I want to visualize the data for a particular season or set of seasons.", "once or twice a week", "Every week."
What would make you want to use the app? "Gain useful insight into how our girls are feeling / performing daily to help make sure we are providing the correct amount of strain during training and ensuring that we are staying healthy in-season.", "Being able to track individual athletes over time.", "Data Visualization, Analytics and Inference", and "Whenever I need to visualize the collected data over a certain period, I would want to use this app.", "team's physiology data", "Improve the training process."
Please list any features that you would like included that currently are not. "The dot plots can sometimes be a bit hard to work with. Maybe altering the presentation of the data would better help.", "machine learning based predictions", "The foreground-background may have a better contrast. 2. Some color dots merge with the background. 3. Average trend lines for all parameter views can be provided.", "User experience-wise, the application is definitely great; however, the experience can be made better if the plots are more explainable (such that the normal users can understand the gist of the data). pie and bar plots in addition to the scatter and line plots can also be useful.", "It is bit confusing to interpret dot chart, if you could add a trend line it will be helpful to monitor players' data", "Ability to print a report would be a nice feature in the future"

After updating the dashboard, another simple survey was conducted, with the results shown in Table 3. The survey was conducted in February 2023 with 12 participants, athletes, coaches, and faculty. Each question had five answer options 5=Strongly agree, 4=agree, 3= neutral, 2=disagree, 1=strongly disagree. The results show positive responses to all questions. The dashboard will be used in the 2023/2024 basketball season with weekly updates to the data. Updates will be made to the dashboard to help the athletes and the coach perform their best and remedy any weakness found as soon as possible.

Table 3: Survey results (February 2023) from 12 athletes, trainers, and faculty.

Question	Median	Mean	Std Dev
How likely are you to use this app?	4	4.38	0.65
How likely are you to show this app to others?	5	4.61	0.87
The app was easy to comprehend.	4	3.79	1.17
It was easy to navigate the app to find what I was looking for.	4	4	1
I will use this app again.	5	4.38	0.77
How important is this app to you?	5	4.54	0.77
Overall, how satisfied are you with the app?	4	4.08	0.76

V. Conclusion

In this paper, we present an R Shiny dashboard to monitor the performance of athletes based on several data sources to track their sleep, training sessions, game results, performance metrics and league metrics. The goal was to simplify showing the data in an easy visual way, with the target audience being the athletes and the coaches.

The dashboard was designed with two tracks, one for athletes and one for coaches. Athletes can monitor their data, and the team averages only, while coaches have access to all data and can compare the performance of athletes to each other. The dashboard enables the user to plot a scatterplot with trendlines for the user's choice of the x- parameter and the Y-parameters for all parameters in the dataset. It also provides a simple color-based summary of specific data using a simple two-color system: green for the parameter being in the acceptable region and red otherwise. This enables coaches to track the parameters at a glance.

The intended audience tested the dashboard, and suggestions were implemented. It was found satisfactory by athletes, coaches, and faculty. The dashboard can be used by other team sports and be tailored to the needs of the sport and what parameters the coaches need to monitor. Predictions are planned to be added weekly and its effectiveness tested week by week.

The dashboard succeeded in its goal of closing the research loop by feeding the data back to the athletes and coaches in an easy, simple, and helpful way, thereby giving more meaning to the research done using the athlete's data, which tended to be geared to the sports research community not to the coaches and athletes themselves.

REFERENCES

[1] S. Vangelis, and C. Tjortjis, "Sports analytics—Evaluation of basketball players and team performance," in Information Systems vol. 93, 2020.

[2] S. Senbel et al., "Impact of Sleep and Training on Game Performance and Injury in Division-1 Women's Basketball Amidst the Pandemic," in IEEE Access, vol. 10, pp. 15516-15527, 2022, doi: 10.1109/ACCESS.2022.3145368.

[3] C. Taber et al., "Sleep and Physical Performance: A Case Study of Collegiate Women's Division 1 Basketball Players," 2021 43rd Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC), Mexico, 2021, pp. 6787-6790, doi: 10.1109/EMBC46164.2021.9630820.

[4] WHOOP. Experience WHOOP Recovery. Available online: https://www.whoop.com/experience/ (accessed on August 11, 2023).

[5] POLAR Straps, Available online: https://www.polar.com/en/science (accessed on August 11, 2023).

[6] Women's Basketball Performance Tracking app, Avaialble online: https://ericajuliano.shinyapps.io/SacredHeartWomensBasketball/ , (accessed on August 11, 2023).

[7] R Core Team, "The R Project for Statistical Computing." https://www.r-project.org/ (accessed on August 11, 2023).

[8] R Studio Interface https://www.rstudio.com/products/shiny/, (accessed on August 11, 2023).

[9] M. Kellmann and K. W. Kallus, Recovery-stress questionnaire for athletes: User manual. Champaign, IL, USA: Human Kinetics, 2001.

[10] J. Hollinger, Pro Basketball Forecast. Lincoln, NE, USA: Potomac Books, Univ. of Nebraska Press, 2005.

[11] L. Martin, "Sports performance measurement and analytics: The science of assessing performance, predicting future outcomes, interpreting statistical models, and evaluating the market value of athletes." FT Press, 2016.