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# Increasing Sleep Duration in Collegiate Athletes: A Behavioral Intervention Involving Sleep Education, Self-Tracking, Goal Setting, and Self-Reinforcement

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Increasing Sleep Duration in Collegiate Athletes: A Behavioral Intervention Involving Sleep

Education, Self-Tracking, Goal Setting, and Self-Reinforcement

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**Table of Contents**

Abstract

The purpose of this study was to examine the impact of a behavioral intervention on sleep duration in a group of Division I student athletes from a women's rowing team. This participant pool was specifically selected because they have early morning practice due to several scheduling constraints, which can make adequate sleep duration more difficult to obtain. Further, the participants in this pool were selected because they had the lowest previous nights sleep and perceived average sleep duration, and therefore in most need of this type of intervention. A multiple baseline design was used to determine if a functional relationship between the intervention and sleep duration behavior exists. Five participants were given an actigraph to wear that tracked their sleep duration during baseline, and during intervention were given access to the phone application that syncs with the actigraph to display sleep duration. Sleep duration data collected by the actigraph was then evaluated using visual analysis to determine if a functional relationship between the behavior change and intervention existed. Although all participants' mean levels of sleep increased during intervention, high levels of variability and overlapping data for two participants prevent conclusions about the effectiveness of teaching self-management skills on sleep duration behavior. The present data indicate the potential promise of this type of intervention, however the data do not support a functional relation between the intervention and behavior. However, since this type of intervention is low cost and simple to execute, additional research should be conducted to determine whether self-management could be applied to improve sleep duration in student athletes.

*Keywords:* sleep duration, behavioral intervention, student athletes, self-management

**Introduction**

Increasing student athlete performance is a well-funded priority of collegiate athletic departments. Considerable sports performance centers have been built, equipped with top of the line strength training tools and educated staff. Athletic training rooms are well stocked with the newest technology to decrease recovery time from injuries. Academic counselors who are experts at navigating degree completion support athletes with tutoring, class scheduling, and time management. On top of that, a team of athletic directors works to improve the student athlete experience in all regards. Despite the volume of support, there are some athletes who fail to perform to their academic or athletic potential, for a variety of reasons. One potential reason for this could be lack of sleep.

Sleep has already been suspected to influence to athletic performance, and more sleep can increase sport specific skills like free throw shooting and wellness factors like mood (Mah, Mah, Keziriant, & Dement, 2011). Lack of sleep, on the other hand, has a whole host of detrimental effects, such as slower reaction time, difficulty remembering things, decreased vision, and increased illness (Orzech, Acebom Seifer, Barker, & Carskadon, 2014; Sleep.org, n.d.). One of the biggest limitations in sleep research on athletic performance is that the majority of studies have examined acute sleep deprivation and found small effects on physiological performance (Duffield, Hammes, Coutts, & Meyer, 2015). However, chronic sleep deprivation, as often seen in the college student population, may have even more significant effects on both athletic and academic performance (Fullagar, Skorski, Duffield, Hammes, Coutts, & Meyers, 2015).

Despite an emphasis on welfare and student-athlete development in universities, collegiate athletes are also still reporting lower wellness than the non-athlete student population (Lightfoot, 2014). There are several factors that may influence this phenomenon, but mental

health stigma seems to be the most prominent. This is likely due to the celebrity status student athletes can have within campuses, along with the idea that athletes are supposed to be strong in mind and body, and any exposed weakness can be used against them (Watson & Kissinger, 2007). Student-athletes also already have a time demanding schedule, academic requirements that affect their eligibility, daily pressures of performing at practice and competitions, and social strain of having to manage team dynamics, while also developing relationships outside of athletics.

The multifaceted demands on collegiate athletes may also have detrimental physical effects. Risk of injury in student-athletes greatly increases during high academic stress periods, and lack of sleep is a strong predictor of injury risk (Laux, Krumm, Diers, & Flor, 2015; Mann, Bryant, Johnstone, Ivey, & Sayers, 2015). It may be even more important that student athletes are getting enough sleep specifically during high academic stress periods to try to counter that effect. As noted in the Mah et al., (2011) study with the Stanford Men's Basketball team, it was often difficult for the players to get ample sleep because of their travel schedule. With the rise of cross country athletic conferences, student athletes may travel from coast to coast multiple times in a month, undergoing a three hour time change each way.

There has been an unfortunate amount of conflicting and inconclusive research on how sleep impacts physical performance. Most studies have suggested that acute sleep deprivation has little to no effect on peak power output, but may affect response time, short term memory, learning ability, motivation, mood, and cognitive stamina (Duffield et al., 2015). Orzech et al. (2014) found that illness was much more common in young adults who averaged 6.5 hours of sleep than the group who averaged 7.5 hours. Psychological detriments like reduced motivation and mood, as well as illness can significantly impact performance ability, even if peak power is

not affected. Regardless, sleep detriments that cause decreased memory and learning ability, as well as illness that increases missed class time are likely to negatively impact academic performance of student athletes.

There has also been very little research on sleep duration and performance impacts specifically on collegiate athletes, and most of the research has examined different extents of sleep deprivation, rather than increasing sleep duration. Coutts and Meyer (2015) did find that early morning practice following a sleep disturbance was detrimental to muscle strength and power. Over time, this could become a chronic and harmful problem, inhibiting strength and conditioning progression and increasing the risk of overtraining syndrome (Foster, 1998). Mah et al., (2011) however, studied the effects of sleep extension, or getting as much sleep as possible, in collegiate basketball players with convincing result, which lends evidence that increasing sleep duration in collegiate athletes could havebeneficial performance and psychological effects.

**Literature Review**

Applied Behavior Analysis (ABA) is a methodology that assumes that behavior is an individual phenomenon, dynamic and continuous, and variable and influenced by the environment. It is then possible to manipulate behaviors by manipulating the antecedent or consequence of the behavior. ABA research is more traditionally used to address undesired behaviors of children in schools or to teach people with disabilities specific skills. Behavior management techniques like goal setting and positive feedback have also increased healthy behaviors in the general adult population. Specific to athletic behaviors, Andrade, Barry, Litt, and Petry (2014)found that with a self-tracking fitness device, goal setting, and reinforcement, 91% of overweight adult participants increased their daily steps taken by 6,000 steps, with two thirds maintaining that behavior change six months after the intervention. It is likely that the

reinforcement provided by the researchers allowed the participants enough time to access the automatic rewards of increased exercise, which continued to reinforce the behavior after the intervention (Andrade et al., 2014). Similarly, Wack, Crosland, & Miltenberger (2014) found that a fitness tracking device and goal setting intervention increased running distance in healthy, collage-aged women. Both of these studies suggest that it may also be effective to use behavioral programming to promote healthy habits in adults.

There has been a recent interest in determining if behavior management programs could also be effective in the student athlete population for teaching sport specific skills. Brobst and Ward (2002) found with goal setting, positive verbal feedback, and public posting of goals, sport specific skills in three female soccer players improved. Similarly, Ward and Carnes (2002) found that goal setting and public posting increased tackling skill execution by up to 40% in DIII football players. Stokes, Luiselli, and Reed (2010) found that by simply removing negative feedback and incorporating positive feedback and a sticker reward system, successful tackling technique improved from 35% to 75% in high school football players.

Bicard, Lott, Mills, Bicard, and Baylot-Casey (2012)ran a text-message based intervention that significantly reduced missed class time in student athletes who were considered high risk for NCAA academic probation. While attending class isn't a sport specific skill, it is a behavior that can be improved in student athletes using a behavior management program. This specific intervention was especially powerful because it was simple to execute, low cost, and was effective at increasing desired behavior in a population that was struggling. The intervention dramatically reduced missed class time. While there was not a follow up to determine if this resulted in improved grades, it did demonstrate that it is possible to change non-sport specific behaviors with behavior interventions in collegiate athletes.

Mah et al. (2011) conducted a study using the Stanford Men's Basketball team where the athletes were asked to get as much sleep as possible, with a goal of 10 hours of sleep. The athletes wore sleep-tracking devices that helped them track their sleep. As a result, nightly sleep increased by 111 minutes, sprint time decreased by 0.7 seconds, shooting accuracy increased by 9%, and reaction time decreased. Additionally, daytime sleepiness decreased and reported mood increased significantly. This suggests that it is possible to manipulate non-sport specific behaviors in athletes to improve performance, and that it is possible to manipulate sleep duration in collegiate student athletes.

**Significance of the Study**

The current study intends to expand on the knowledge of effective behavior management programing in collegiate athletes by determining if sleep duration can be increased with an intervention that includes self-monitoring, goal setting, and self-reinforcement. Increasing sleep duration was selected as the target behavior because several studies have suggested that chronic lack of sleep significantly affects athletic performance and increases risk of injury (Laux et al., 2015; Duffield et al., 2015).

For emphasis, the population of interest selected for this study is a NCAA Division I women's rowing team at a large state school on the east coast. Rowing teams traditionally practice early in the morning due to the size of the team and university class scheduling restraints, and commercial and private boat traffic on shared waterways. The team selected for this study typically starts practice between 5:00am and 7:00am. While this team has structural constraints that may make it more difficult to get the recommended amount of sleep for collegiate athletes, it still may be possible to change the behavior of the athletes so they are going to bed earlier and increasing their sleep quantity. This is expected to have positive athletic and

physical benefits like reduced risk of injury and improved performance, as well as positive mental and emotional benefits due to decreased stress, as other studies have found (Mah et al., 2011).

This study focused on determining if sleep duration behavior can be changed with a behavioral intervention that includes sleep education, self-tracking, goal setting, and self-reinforcement. There are expected positive outcomes that have been suggested from other studies, but those will not be investigated in this study. Once proven to be effective at increasing sleep duration in the collegiate athlete population, this intervention could then be applied to other student athletes who are struggling to get adequate sleep. This procedure of using an individualized and specified behavioral intervention is expected to be much more effective than simply providing education and support because it teaches the student athletes a self-management skill that can be applied to sleep duration, as well as other behaviors. The researcher of this study sought to determine the following research questions:

1. When applied, does the sleep duration behavioral intervention increase sleep duration from the baseline average sleep duration for a group of Division I collegiate women's rowers?

2. After undergoing the intervention, do Division I collegiate women's rowers view the intervention as valuable for them and their peers?

**Methods**

**Participant Selection Process**

Participants included in this study were members of a women's rowing team at the University of Connecticut. The advantage of using a singular athletic team to draw participants from for this type of study design is that extraneous variables are better accounted for than if the

population was drawn from the general population. The athletes are all similar ages, are taking

similar course loads, have similar schedule demands, and very similar morning wake-up times.

The University of Connecticut was also the only DI rowing team in the surrounding area, and as

discussed, rowing teams typically have early morning practices that can restrict sleep duration

more than student athletes from other teams. IRB approval was obtained prior to beginning the

study, as well as permission from the team's coach and athletic directors.

A screening survey was distributed initially to determine eligibility for the study.

Participants were considered eligible if they owned a smart phone, were not already tracking

their sleep, and believed they do not sleep enough. Eligible participants were then ranked using

the sum of their last nights sleep duration and their perceived average sleep duration, and the

lowest five participants were asked to participate. Three to five participants are considered

appropriate for behavioral intervention studies due to the study design type (Kazdin, 2011). With

only one or two baselines, data patterns would need to be explicitly clear to draw conclusions

about the intervention. Additionally, it is always likely that an intervention does not cause

behavior change, or that participants choose to leave the study. Three baselines are considered

the minimum, but five is recommended to help the validity of the data (Kazdin, 2011).

Participants were excluded if they did not have a smartphone because the intervention

component utilizes a phone application and Bluetooth technology, and if they were already using

a fitness-tracking device, because the self-tracking is an important component of the

intervention. Participants were also excluded if they reported a major illness or life stressor that

they perceived to impact their sleep duration, or if they were non compliant with the study

demands.

**Study Design**

A multiple baseline across subject design was used for this study. This type of single case design is appropriate for interventions that involve a learning component because there is no need to withdrawal or reverse the intervention to establish validity. Instead, validity is established by implementing the intervention on different days across participants. This type of study design is preferred for when a single behavior is targeted in a small group setting, and has been used successfully with athletic teams in previous studies (Ward & Carnes, 2002; Bicard et al., 2012; Stokes et al., 2010; Brobst & Ward, 2002). Demonstrating points of change across participants after the intervention is implemented increases confidence that the intervention is responsible for the behavior change observed (Kazdin, 2011).

The target behavior for this study was sleep duration, which was measured in hours and minutes using a fitness-tracking device called Misfit Link. The Misfit Link is a small, nondescript disk that can be worn anywhere on the body. Information collected by the Misfit Link is synced to a phone application using Bluetooth technology. The application also has a goal-setting component, and will display daily if that goal is obtained, or how far behind the goal the user is. A previous study using a similar phone application found that it is sufficient to monitor sleep duration with a phone application, and that actigraph or accelerometer devices were not statistically more accurate (Shirazi et al., 2013).

During the baseline phase, participants were instructed to wear the Misfit Link overnight and to practice, and then as much as they were comfortable wearing the device for the rest of the day. Because the only data collected was on sleep duration, the study would not be affected if the participants did not want to wear the device during the day. A de-identified email and password was created for each participant, but they were not given the password to access their

information during baseline because that would constitute as self-tracking. The data was synced with the researcher's phone during team practices when the participants were wearing the device within Bluetooth range.

The intervention consisted of four components; sleep education, self-tracking, goal setting, and self-reinforcement. During the intermediate interview, the researcher presented sleep education and sleep hygiene (habits and practices to help improve sleep) recommendations from the National Sleep Foundation, and discussed the potential detriments to academic and athletic performance when sleep is consistently less than the recommended 7 to 9 hours. The researcher also helped the participants with sleep hygiene skills, including setting a bedtime routine and scheduling commitments during the day to allow for a consistent bedtime.

For the self-management component of the intervention, the participants were instructed to set up the Misfit app on their personal phone that linked to the Misfit Link. The app displays the sleep duration data collected by the Misfit Link and calculates deviation from the goal sleep time set. The participants were instructed to use this app daily to evaluate if they had met their goal sleep duration, which was the third component of the intervention, self-tracking. The researcher then helped the participant select a reasonable sleep duration goal that was greater than the average sleep duration during the baseline phase. The final component was self-reinforcement. The researcher helped the participant select a reinforcement to be delivered daily by the participant if the sleep duration goal was reached. Reinforcements used during this study were a bowl of cereal, fruit snacks, and an episode of a T.V. show.

A social validity survey titled Intervention Rating Profile-15 (Adapted from Martens, Witt, Elliott, & Darveaux, 1985) was administered at the end of the study. This is a 15-item

single factor scale, with a reported Cronbach's alpha of 0.98, and included an open-ended

response question that asked how participants felt about the intervention (Appendix A).

**Procedure**

1. Participants were recruited from the women's rowing team using a screening survey.

The purpose of this survey was to identify athletes who are not sleeping enough and would

like to sleep more. Athletes who were already tracking their sleep using a fitness device

were excluded from the study because it interferes with the self-tracking intervention

component. Additionally, athletes without smart phones, and those who did not think they

needed to increase their sleep were excluded. The screening survey was scored as a sum of

the number of hours slept the previous night, and the perceived number of hours usually

slept per night.

2. Five participants were selected from the screening survey, and were scheduled to meet

with the researcher over three days. During this initial meeting, the researcher collected

informed consent and distributed the fitness-tracking device (Misfit Link), and taught the

participant how to use the device. The baseline phase of this study began the following

two days.

3. After the data points stabilized over five days, the first participant met with the

researcher to begin the intervention phase (Kazdin, 2011). During this meeting, the

researcher reviewed the educational component, helped the participant set a reasonable

sleep duration goal, and assisted with their time management. Additionally, the researcher

helped the participant select a self-reinforcement to be delivered when the participant met

their sleep duration goal. Finally, the researcher helped the participant set up the app on

their phone that displayed their sleep duration data collected by the Misfit Link. The app

was used as a self-management mechanism to help participants determine if they met their

daily goal or not.

 4. After the first participant's sleep duration stabilized in intervention, the second

participant entered the intervention phase, and so on (Kazdin, 2011). Stabilized described

two data points within 90 minutes of each other, or three data points where two were

within 60 minutes of each other.  If a participant had not experience a change in sleep

duration following the intervention If there were no change following the second meeting

in seven days, the next participant would have entered the intervention stage for the sake

of time.

 5. After all participants went through the intervention phase, the researcher held a follow

up meeting with participants individually. The participants were asked to fill out a post

study survey that asked about how participants felt about the intervention. They were also

asked if they experienced any illness or life stressors, or extenuating circumstances during

the study. They were asked how frequently they delivered their self-reinforcement when

they met their goal, and if they felt like the reinforcement was influencing their behavior.

The fitness-tracking devices were collected, and the app was deleted from the participants'

phone. All data collected by the app was also destroyed.

**Data Analysis**

 Data for multiple baseline single case studies are analyzed using visual analysis. Visual

analysis is preferred over statistical analysis in single case research because interventions are

only considered successful if they produce clear and obvious differences. It is possible for an

intervention to produce statistically significant behavior change, but not practical change (Baer,

1997; Kazdin, 2011). For example, it is possible the intervention for this study increased sleep a

statistically significant amount, but if it is only 15 minutes more than the baseline sleep duration, the intervention would not be considered practically or socially effective. Visual analysis does increase the risk for type II statistical error because marginal effects may be ignored (Kazdin, 2011). The intervention is deemed successful if there is an increase in sleep duration between the baseline and intervention phase, and if that increase is stable and consistent. This suggests that behavior change occurred when and only when the intervention was applied. When behavior changes follow the staggered interventions across participants, it is unlikely that extraneous factors were the cause (Kazdin, 2011). In figure 1, the dotted horizontal lines represent the means for the baseline or intervention phase. The solid black horizontal line represents the goal the participant set for herself during the intervention. The vertical dotted line represents the phase changes as participants moved from baseline to intervention. The circled data points represent self reported data when the device did not record, or recorded inaccurately.

## Results

Figure 1 presents the data for participants Meredith[1], Christina, and Callie. During baseline Meredith averaged 5.46 hours of sleep. After implementation of the intervention, she averaged 7.09 hours of sleep, for an increase of 1.63 hours. During baseline this participant was very stable, and became much less stable after the intervention, ranging from a minimum of 1.8 to a max of 9.5. Interestingly, Meredith emailed the researcher to apologize following the two nights of less than 3 hours of sleep, and reported that her poor sleep was due to a mismanaged group project. After the 2.9 hour night followed by the 4 hour night, the researcher emailed Meredith to remind her of the sleep debt recommendations from the National Sleep Foundation, and from then on out, if Meredith was under her goal, she made sure to get or exceed her goal sleep the next night. She only had 6 nights under her goal sleep out of 27 nights in intervention,

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[1] Pseudonyms were used to preserve participant privacy

and her average sleep duration was markedly higher than baseline. She reported that she thinks "many student athletes would find using sleep SM to increase their sleep because it makes you more aware of the amount of sleep you are really getting every night. However, some athletes might still struggle to meet the sleep requirements due to the amount of time required in the day for practice, class, homework, and other activities such as work and clubs." Meredith reported that she felt like the intervention was acceptable and effective.

Christina averaged 6.21 hours of sleep during baseline, and 6.63 after the intervention. This participant was more hesitant with the intervention components, and made several comments about her skepticism of it working. She also struggled with choosing her reinforcement, finally settling on fruit snacks. She expressed that her intervention selection might not be the best choice, but couldn't think of anything better. She also expressed struggling academically March 7th- 10th, and noted that affected her sleep. She recognized that she felt much better when she got plenty of sleep, and after March 10th, she vowed to make it a priority. While there was a delayed latency in the change, its possible that the self-monitoring component of the intervention allowed her to eventually attribute how she was feeling with her sleep graph, and then she decided to make a behavior change. The last 8 days of the intervention she exceeded her goal sleep duration consistently[2].

Christina reported feeling that the intervention was "acceptable in its approach, but not necessarily effective...there would need to be an identified desire[3] to increase sleep duration and self-efficacy to do so in a given athlete in order for the approach to be effective". She did not feel

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[2] It is important to note that the last eight days of the study, the team was on a training trip during the school break. The researcher decided to continue data collection through the training trip because the team still had early morning practice, and the student athletes still had academic demands even if they didn't have to be in class that week. However, the athletes were in a different environment and had different roommates, and this may have affected sleep duration independently from the intervention. That being said, one of the values of this study is that it was conducted in a natural environment, and training trips are a normal experience for student athletes.

[3] Participants were screened for desired to increase sleep duration in the screening survey. This participant reported that yes, she did want to increase their sleep duration, and did not think her current sleep duration was adequate.

like the intervention was beneficial for her, but still thought it was appropriate for a variety of athletes. In further discussion during the post interview, this athlete disclosed that there were several instances where she thought about going to bed earlier, but decided that hanging out with her friends sounded more fun. It was evident that Christina did not select an appropriate reinforcement. Had the study been able to progress longer, and had Christina agreed to it, a social based reinforcement likely would have been extremely powerful in increasing her sleep duration. It is also possible that Christina's behavior would have changed with a larger dose of the intervention and more involvement from the researcher daily. Regardless, Christina still increased her average sleep duration during the study and achieved her goal sleep duration.

Callie averaged 6.54 during baseline, and 7.58 following the intervention, for an increase of 1.04 hours. Callie chose to reinforce herself with an episode of an online show, and commented that it was very effective. She only spent 3 days under her goal out of 14, and always got over her goal the following night (Figure 1). This was an important change from her baseline sleep, where she spent multiple days in a row under her average sleep. She was hesitant setting her goal at 7 hours, and it was only slightly more than her baseline average, but she managed to exceed that goal most of the time. She reported feeling that the intervention "helped me get more sleep, by giving me something to look forward to if I got more sleep...helped me not procrastinate my work because I knew I had to go to bed earlier to get the number of hours I set as my goal. I felt more awake too the next day and didn't feel the need to nap as much." Callie rated the acceptability of the intervention very favorably during the validity survey.

The first question the researcher sought to answer was if the population selected demonstrated a need for this type of intervention. The three participants averaged 5.46, 6.21, and 6.54 hours of sleep per night during the baseline, which is well below the recommendation of 7

to 9 by the National Sleep Foundation (Sleep, n.d.). All three participants also reported in the

screening survey that they thought they did not get enough sleep. This suggests that this

population does have a need to increase their sleep duration.

The second research question addressed if sleep duration increased from baseline during

the intervention. On average across participants, sleep duration increased by more than an hour

following implementation of the intervention, and two of the participants moved into the range

recommended by the National Sleep Foundation (Sleep n.d.). All participants increased their

sleep duration while using the intervention, suggesting that there was some functional

relationship between the intervention and increased sleep duration.

Finally, the researcher sought to determine if the participants felt like the intervention

was helpful and valuable, and if they felt like they would continue to use the intervention in the

future. A score of 6 on the survey correlates with strongly agreeing with the statement given,

while a score of 1 correlates with strongly disagreeing (Appendix A). Results from this survey

suggest that the participants felt like the intervention was acceptable, fair, and reasonable for

increasing sleep duration, would be appropriate for a variety of athletes, and participants would

recommend the use of the intervention to other athletes (Table 1). Christina did not rate the

intervention as being effective on the validity survey (scored as a 1), but Meredith and Callie

rated it as effective at increasing their sleep duration (scored as a 4 and 5 respectively). These

ratings are supported in the results, where Meredith and Callie increased their sleep duration by

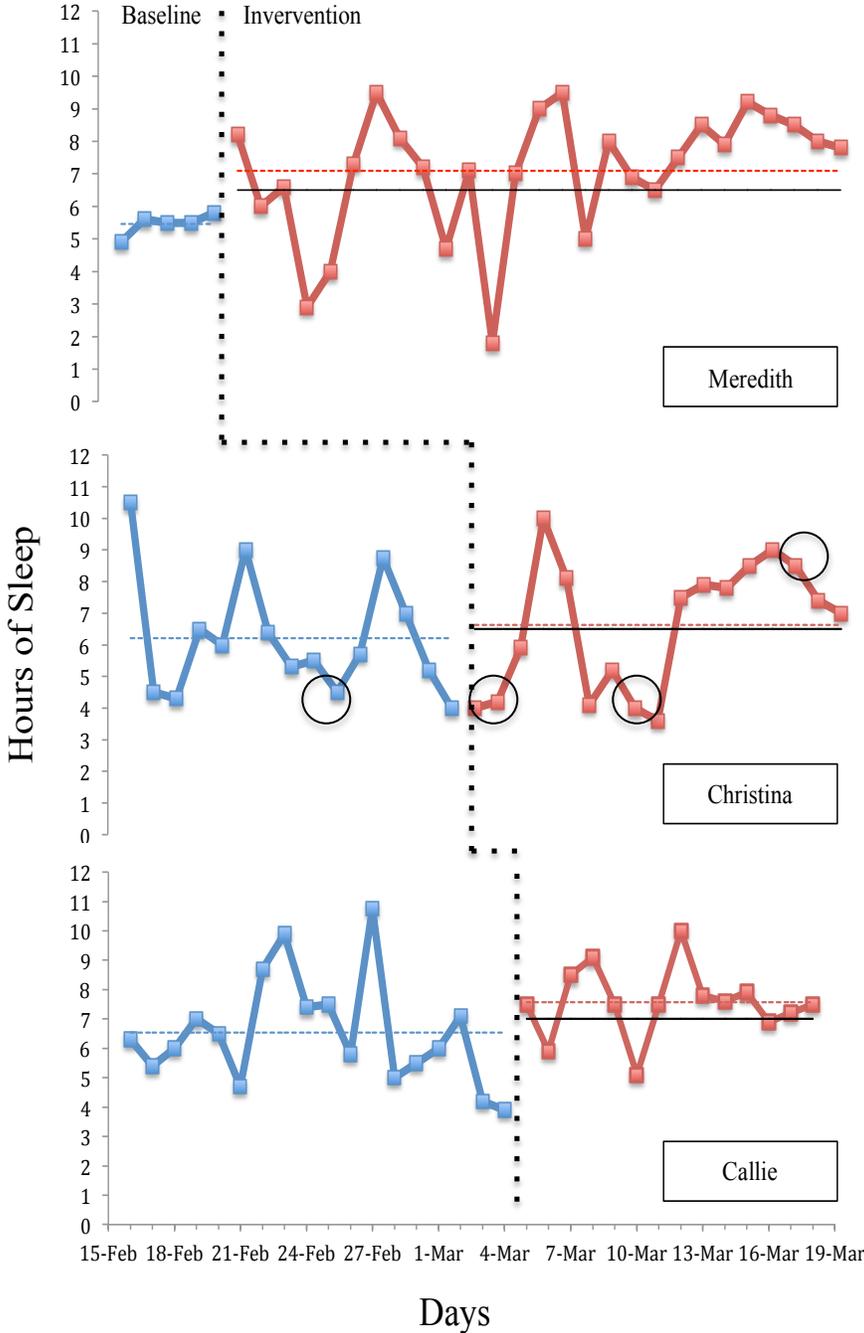over an hour and Christina saw a much smaller increase in her sleep duration.

Figure 1: Sleep duration of three participants in baseline and intervention. The horizontal dotted lines represent the average for the phase, and the solid horizontal line represents the goal sleep duration. The circled data points represent the self-reported data.

## Discussion

While the data continued to overlap after the intervention for all participants and there was not a clear stabilizing change in trend, all participants increased their average sleep duration from baseline. Because this type of behavior management technique to improve sleep duration in collegiate athletes is a new and underdeveloped area of research, it is likely that a more effective intervention could be designed, and more conclusive results could occur. Regardless, the results from this study confirm that this is an area of research worth exploring in more depth. Not only can behavior management interventions improve desired behaviors in individuals, interventions can also teach those individuals life-long self-management skills. This type of intervention could be especially potent for the student athletes who continue to struggle with behaviors like sleep duration, even when presented information and encouraged to improve their sleep behaviors. While this specific intervention was time intensive to apply and may not be practical to implement team wide, increasing sleep duration by an hour on average can have a very significant impact on the overall health and wellness of student athletes who are struggling with their sleep duration, as well as on their physical performance (Orzech et al., 2014; Mah et al., 2014).  Ideally, the participants in this study could not only use the self-management techniques they learned to improve their sleep, but could also apply the same technique to other behaviors that they would like to change. Like seen in the Bicard et al. (2012) study with academically at risk student athletes, behavior management interventions can be helpful for teaching athletes skills to better manage their own behaviors. The goal-setting component on the intervention was rated very favorably, and results were consistent with the Wack et al. (2014) study with at similar population. Athletes use goal setting regularly in practice, so it is a natural carry over into life skills management. But as seen in several studies, goal setting does need to be fostered and

encouraged for it to be most impactful on behavior (Wack et al., 2014; Ward & Carnes, 2002; Brobst & Ward, 2002).

However, as demonstrated with one of the participants, it is necessary to want to change and to believe that it is possible to change your behavior for the intervention to work. It is also necessary to carefully select a reinforcement that will be more motivating than competing behaviors using a stimulus preference assessment. The same participant reported that while she did consider the loss of her reinforcement when choosing to stay awake, the social reinforcements gained by seeing her friends were much more powerful than the food reinforcement she chose for the study. Similar studies have seen better effects with using public and social based reinforcements. For example, Brobst and Ward's (2002) study with female student athletes featured an intervention that included public posting of goal achievement. While public posting would have contradicted the privacy considerations of this study, social reinforcements may be much more powerful for some student athletes than a food or entertainment reinforcement would be.

Typically, single case behavioral intervention programing is considered successful if there is a clear difference between phases, with no overlap and immediate response to the changing phase. While this data was highly variable and overlapped between phases, the average increase in sleep duration may still be significant enough for the participants to experience the positive effects of increased sleep duration. This was suggested in Orzech (2014) study that found significant differences in health in the group that slept for an hour longer each night, and is supported by the two participants who said they felt like the intervention was making them sleep more, and they were feeling better as a result.

Similar to the Bicard et al. (2012) study, the current study selected participants from a unique population who were struggling with a specific behavioral skill, and applied an intervention to determine if that skill could be improved. This was the only study reviewed in the literature that used women's collegiate rowers as its population base, and the only study that addressed a behavioral skill that is directly affected by team practice time constraints[4]. Increasing sleep duration by an average of an hour across the three participants could potentially have a significant positive impact on that participant as a student athlete, especially if that increase moves the student athlete into the sleep duration range recommended by the National Sleep Foundation (Sleep, n.d.). Not only was this intervention successful at changing behaviors to increase sleep duration, it was also viewed favorably by the participants, and would be simple and cost effective to apply to other student athletes who reported struggling with their sleep behaviors.

## Implications for Policy and Practice

### Implications for Student Athletes

Moving towards a more behavioral based approach to student athlete wellness could have a major impact on student athletes. As suggested in Beauchemin (2014), student athletes have several barriers of access that make traditional college student counseling and wellness services less accessible. On top of that, student athletes have higher rates of mental illness, and very unique life stressors that may be more difficult to address issues like performance anxiety, team dynamics, and developing non-athletic social support (Watson & Kissinger, 2007). In response, universities have started to address student athlete health with educational based outreach. Some schools have even created required wellness based courses for student athletes to enroll in. While

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[4] Mah's (2011) study addressed time constraints that are specific to the entire student athlete population, like NCAA maximum 20 hours of practice, video review sessions, athletic training treatments, competition and travel, and academic GPA and degree completion requirements.

education is certainly an important component, there has been little follow-up to see if these course and lectures are actually resulting in behavior change that is socially significant and longitudinal. If the required courses on wellness shifted towards learning behavior management skills and aiding the student athletes in applying those skills to their own behaviors, it is possible that those student athletes would be more empowered to make behavioral changes. Finally, if student athletes who were significantly struggling with a behavior like attending class on time or getting enough sleep, and those behaviors were putting the livelihood of that student athlete at risk, consulting with an applied behavioral management specialist who could assist with applying an appropriate intervention could help the student athlete to correct behaviors and graduate with a degree successfully (Bicard et al., 2012).

**Implications for Coaches**

A behavioral based approach to student athlete wellness could also be advantageous for coaches. Depending on the institution and team type, coaches are responsible for monitoring somewhere around 10 to 80 student athletes. Developing more effective and more efficient means to help improve student athlete welfare allows coaches to invest more time into other valuable areas like recruiting and coaching. Additionally, coaches should also be concerned about the welfare of their student athletes post graduation, and behavior management skills would likely carry over into post graduation life. The behavior skill component is especially important because in the student athletes future, there likely will not be a coach who monitors and directs them daily. Graduating student athletes should feel empowered with skills that can help them improve their own behaviors in the future. This would align with the NCAA mission statement of improving the well being and lifelong success of student athletes (Grander, 2016).

Secondly, this study strongly suggested that sleep duration is an area that needs significant attention, and that it is possible to improve sleep duration without lifting demands on the athletes. This point is enforced by a recent article published by the NCAA on student athlete sleep behavior, which lists several of the major detriments poor sleep has on health and wellness, as well as athletic performance (Grandner, 2016). Monitoring sleep duration and other wellness behaviors, and intervening when appropriate is an evolving responsibility of coaches, and can potentially increase athletic performance significantly more than traditional coaching can, as seen in Mah et al. (2011).

**Implications for Athletic Administrators**

A report done in 2012 by Ramogi Huma, president of the National College Players Association (NCPA), reports that the fair market value of a FBS basketball player at a top 10 school is more than $900,000 (Huma & Staurowsky, 2012). While that figure represents the upper bounds of the value of student athletes to institutions, it is clear that fiscally, institutions should consider every way to improve the athletic performance of student athletes. The findings presented in this study suggest one way improve student athlete health and performance by increasing their sleep duration using a low cost behavioral intervention. If this type of behavioral management programing was expanded on and applied to several other areas of student athlete wellness like nutrition, academic performance, or stress management, student athlete wellness and performance could be maximized and the institution would likely see return on investment, whether through improved athletic performance or reduced health care and wellness based services costs.

**Implications for NCAA and Other Governing Bodies**

As called for in Grandner's article on sleep problems in student athletes, institutions should develop ways to monitor sleep of student athletes to be able to better address sleep issues (2015). Grandner also calls for the NCAA to add to the lack of research done on sleep issues in student athletes, citing the timing of practice, travel and competition, and academic demands as barriers for adequate sleep duration. A preliminary study conducted by the NCAA suggested that 1 out of 3 of student athletes get fewer than 7 hours of sleep, affecting females more than males. Additionally, am American College Health Association survey found that student athletes experience 4 nights of insufficient sleep per week on average (Grandner, 2015). The results from the current study support these findings, and also suggest that it may be possible to increase sleep duration in student athletes without limiting other aspects. However, the NCAA should reconsider conference realignment and develop protocol to protect student athlete's who travel frequently for competition and travel across time zones, potentially limiting the number of competitions that require a significant amount of travel or mandating a day of rest for each time zone crossed.

The current study also suggests that regulation around timing of practice be considered. In September 2015, the Pac-12 conference submitted an amendment to bylaw 17.1.7.6.3 of the NCAA manual calling for the prohibition on countable athletically related activities between 9:00pm and 6:00am. The rational was that mandating a time block free from practice will provide athletes better opportunity to participate in campus events, attend to academics, or sleep. The proposal was refereed to go under further review during the fall voting procedure, mostly due to complaints about facility availability and class scheduling conflicts (Mallonee & Zeller, 2015). The current amendment reflects the NCAA's heightened focus on student athlete

wellness, which has been supported by other amendments that have passed recently which include providing $70 million for concussion testing and diagnosis, and deregulating meal and snack legislation so schools can provide healthy meals to athletes (Wilfert, 2014). It would be in the best interest of the student athlete for the NCAA and other governing bodies to continue the wellness policy sweep and address sleep duration deficiencies to improve student athlete experience at member institutions.

**Limitations**

There are a few constraints with using a multiple baselines design to examine the effects of a behavior intervention on sleep duration. The inconsistent effects seen in the data from this study suggest that sleep duration is heavily influenced by outside factors like schoolwork, job hours, and even fire alarms in dorm buildings. All participants shared a dorm room with one to three other students , and it is possible that roommate sleep behavior is more influential than initially considered by the researcher. It is likely that behavior to allow for more sleep was altered some nights, but competing behaviors prevented desired sleep duration other nights, or the participants intended to get more sleep, but extraneous events occurred. For example, one participant reported struggling due to a group project, where her group members had waited until the last minute to complete their project, requiring her to stay up very late to fulfill her academic demands. A more controlled study may be able to find more consistent and stable results, but there is also value in conducting studies in natural environments, where results may be more generalizable.

Additionally, multiple baseline designs require prolonged baselines, or the intervention is withheld from participants for an extended period of time. Withholding interventions is an ethical concern that was carefully considered by the researcher. That concern was reconciled

because baseline data captured normal sleep duration for the student athletes, and they had

already been encouraged to improve their sleep duration as a group by their coaches. Without

this study, the student athletes would not have had the opportunity to undergo the intervention.

That being said, one participant was dropped from the study because her sleep duration declined

significantly to the point was it was affecting her acute health. The participant disclosed to the

researcher several major life stressors that would disqualify her from the study, and the

researcher determined that any additional stress that may have been caused by the study should

be removed. The participant was still given the National Sleep Foundation education and was

taught the self-management technique used during the intervention so she could apply it herself

if she wanted to. This was consistent with the IRB protocol that stated that participants would be

removed if they experienced any self-reported major life stressors.

Multiple baselines design also does not require removal and reapplication of the

intervention like traditional behavior management reversal designs do. Removing and reapplying

the intervention increases confidence that behavior change occurs as a result of the intervention

if behavior returns to baseline level when it is removed, and then improves when it is reapplied

(Kazdin, 2011). This intervention involved an educational component so it was not appropriate

to use a reversal design.

This study also did not collect any longitudinal data due to time constraints, and did not

collect any data after the intervention component was removed, so it is unknown if behavior was

changed to the point where it would sustain without the intervention, or if the intervention would

be potent enough to affect behavior over a long period of time. Incorporating a maintenance

phase would help determine this. The study also did not collect data on performance measures

like the Mah et al. (2011) study did. While it is expected that athletic performance, as well as

academic performance and psychological health, is improved with increased sleep duration, it is also possible that there was no improvement in those areas.

Finally, the researcher used a measurement tool that had not been previously validated in previous research. While there were many benefits of using the Misfit Link because it was inexpensive and discrete, it was inconsistent with recording accurate sleep duration. One participant was dropped from the study because the device was not recording sleep for multiple days in a row, and the researcher was unable to determine why that was the case. This was consistent with the IRB approved procedure of participant selection, and was put in place to limit the time duration of the study. There were limited other instances of the device not recording randomly so the researcher had to rely on self-reported sleep duration. One participant curiously had a device that would incorrectly record her sleep duration occasionally (would record 10 hours of sleep when the participant only reported getting 7, or would record 4 when the participant reported sleeping for 8), so several of her data points were self-reported. The measurement inconsistencies may have impacted the data collected for this participant because the researcher was unable to confirm that the baseline data was collected correctly.

## Recommendations for Future Research

The impact of using behavior management interventions with student athletes for sport specific and life skills is still a new and under researched field. Researchers have demonstrated that behavioral programing can improve sport specific skills quickly, which can have a considerable impact on skills like football tackling, where improper form puts the athlete at serious risk for injury (Ward & Carnes, 2002). It has also been demonstrated that this type of programing can improve non-athletic behaviors, like class attendance and sleep duration (Bicard, et al., 2012). Future research should continue to expand the bounds of the impact of this type of

behavioral programing and continue to push for the appropriate application of behavior management outside of research settings.

Specific to the current study and sleep duration interventions, future research should investigate longitudinal effects of such interventions, and should include other subsets of the student athlete population. It would also be valuable to determine if specific performance measures increased with the sleep duration increase, as seen in the Mah et al. (2012) study.

Developing a mixed methods design may also be an interesting direction for future research, and could help confirm that the intervention did influence behavior. Specifically, it would be interesting to collect maintenance data where the self-monitoring and self-reinforcement component was removed but participants were still instructed to wear the Misfit Link to see if participants were successful with increasing their sleep duration without the aid of the intervention. Another mixed methods design that may be interesting would be applying the intervention during the entire freshman year, then continuing to monitor and implement refresher type interventions for the next three years of eligibility. Doing a multiple baselines design similar to this study across genders and across teams may also be interesting. The development and frequent use of phone applications makes widespread behavioral interventions across a large group of participants much more feasible.

Finally, it is recommended that future research use a device that has been experimentally validated so there is more confidence that the device records sleep duration accurately, especially during the baseline phase when participants are not supposed to be tracking their sleep duration. More research should also be done to determine if using a phone application to track sleep is as effective as other methods, as suggested in Shirazi et al. (2013).

Appendix

| Sleep Self-Management Acceptability Questionnaire | | | |
|---|---|---|---|
| Intervention Rating Profile-15 (Adapted from Martens, Witt, Elliott & Darveaux, 1985) | | | |
| | Meredith | Christina | Callie |
| 1. Sleep SM was an acceptable intervention for increasing sleep duration. | 4 | 5 | 5 |
| 2. Most athletes would find Sleep SM appropriate for increasing sleep duration. | 5 | 3 | 5 |
| 3. Sleep SM proved effective in increasing sleep duration. | 4 | 1 | 5 |
| 4. I would recommend the use of Sleep SM to other athletes. | 5 | 3 | 6 |
| 5. The sleep challenges for athletes are severe enough to warrant the use of the Sleep SM. | 4 | 3 | 4 |
| 6. Most athletes would find Sleep SM appropriate for increasing sleep duration. | 5 | 3 | 5 |
| 7. I would be willing to continue using the Sleep SM outside of this study. | 5 | 3 | 5 |
| 8. Sleep SM would not result in negative side effects for athletes. | 5 | 5 | 4 |
| 9. The Sleep SM would be appropriate for a variety of athletes | 5 | 5 | 5 |
| 10. The Sleep SM is consistent with trainings I have had before in the athletic setting. | 4 | 2 | 3 |
| 11. The Sleep SM is a fair way to increase use of specific health related skills. | 5 | 4 | 5 |
| 12. The Sleep SM is reasonable for increasing sleep duration. | 5 | 3 | 6 |
| 13. I liked the procedures used for the Sleep SM. | 5 | 2 | 6 |
| 14. Sleep SM is a good way to increase sleep duration. | 5 | 2 | 5 |
| 15. Overall, Sleep SM was beneficial for increasing sleep duration. | 4 | 2 | 6 |

Meredith "*I think many student athletes would find using sleep SM to increase their sleep because it makes you more aware of the amount of sleep you are really getting every night. However, some athletes might still struggle to meet the sleep requirements due to the amount of time required in the day for practice, class, homework, and other activities such as work and clubs.*"

Christina "*I would say that Sleep SM is "acceptable" in its approach, but not necessarily effective. I think there would need to be an identified desire to increase sleep duration and self efficacy to do so in a given athlete in order for the approach to be effective.*"

Callie "*I think it helped me get more sleep, by giving me something to look forward to if I got more sleep. Also helped me not procrastinate my work because I knew I had to go to bed earlier to get the number of hours I set as*

*my goal. I felt more awake too the next day and didn't feel the need to nap as much."*

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