Using Self-Management and Social Media to Increase Steps in Sedentary College Students

Hafsa Junaid¹ · Andrew J. Bulla¹ · Monique Benjamin¹ · Talia Wind¹ · Dziyana Nazaruk¹

Published online: 17 August 2020

© Association for Behavior Analysis International 2020

Abstract

Physical inactivity increases the risk of many chronic diseases. Approximately 40% to 50% of college students are physically inactive. Research suggests that when students establish physical activity routines during their college careers, they have a greater chance of maintaining those specific behaviors over time. The current study sought to increase steps in sedentary college students by using a self-management intervention consisting of self-monitoring, goal setting, social media (Instagram), weekly meetings, and social feedback. Researchers used a multiple-baseline across-participants design with an embedded reversal to assess the effects of the packaged intervention. The intervention increased the physical activity levels of 3 of the 4 participants. The results of the current study suggest that multiple strategies such as the use of technological innovations, goal setting, and social media feedback should be considered and leveraged in programs aimed at increasing the level of physical activity among college students.

Keywords Fitbit · goal setting · Increasing steps · Physical activity · Precision teaching · Sedentary college students · Self-management · Social media · Standard celeration chart

Scientific studies have long proven the benefits of physical activity. Previous research estimated that 10.8% of U.S. deaths, 6.2% of coronary disease cases, 8.3% of type 2 diabetes cases, 12.4% of breast cancer cases, and 12.0% of colon cancer cases could be avoided if individuals engaged in regular physical activity at the recommended level (Lee et al., 2012). Physical activity can also improve mental health and psychological well-being, muscle and bone strength, daily functioning, and the likelihood of living longer (Centers for Disease Control and Prevention [CDC], 2019b). The American College of Sports Medicine (ACSM) recommends

that adults should get at least 150 min of moderate-intensity exercise per week (ACSM, 2018). One example of a moderate-intensity activity would be walking at 3.0 miles per hour (Office of Disease Prevention and Health Promotion, 2019). Despite these recommendations, only 54.2% of adults met that requirement in 2018 (CDC, 2019a).

To receive the optimal health benefits of physical activity, health-related behavior must be established early and persist throughout all stages of life (Hirvensalo & Lintunen, 2011). However, maintaining the recommended physical activity levels through various life transitions (e.g., going to college/university, marriage, becoming a parent, retirement) serves as one of the biggest challenges for adults in the United States (Hirvensalo & Lintunen, 2011). Although early engagement in physical activities is essential, physical activity levels deteriorate over the course of one's life (Raudsepp, Neissar, & Kull, 2008). Prior research demonstrates that when students establish physical activity routines early in their college careers, they have a greater chance of maintaining those behaviors over time (Sparling & Snow, 2002); however, 40% to 50% of college students are still physically inactive (Keating, Guan, Piñero, & Bridges, 2005). Thus, interventions targeting the establishment of physical activity routines in this age group are warranted.

This project was funded by Georgia Southern University's Graduate Student Organization. We thank Dr. Jennifer Wertalik and Dr. Erin Frick for providing us with their valuable feedback and assistance during data collection. Special thanks go to Dr. Joshua L. Williams and Ms. Sheryl Powell for allowing us to conduct the weekly meetings in the Psychology Department. Lastly, we extend deep thanks to Dr. Nancy McCarley for her thoughtful edits on previous versions of this article.

✉ Hafsa Junaid
hj01653@georgiasouthern.edu

¹ Health Policy and Community Health, Georgia Southern University, Armstrong, Savannah, GA 31419, USA

Many behavior-change techniques exist that have the potential to increase physical activity levels. In particular, self-management interventions have led to increases in physical activity (Van Camp & Hayes, 2012). Self-management entails the personal use of behavioral strategies to obtain a desirable change in the targeted behavior (Cooper, Heron, & Heward, 2007). Self-management strategies help facilitate generalization and maintenance of behavior change (Cooper et al., 2007), making these strategies an attractive option for physical activity interventions. For example, LaLonde, MacNeill, Eversole, Ragotzy, and Poling (2014) used a packaged intervention consisting of goal setting and reinforcement. All five participants had an individual daily goal and received a reinforcer upon meeting their goals. The goal increased by 10% when individuals met the preceding goal twice in a row. Overall, the intervention increased participants' physical activity to 10,000 or more steps daily (LaLonde et al., 2014). Even though the use of tangible reinforcement is an effective way to promote physical activity, tangible items may not be feasible or sustainable in the long term (e.g., if a researcher wanted to use a \$5 gift card each week, the total price would equal to \$260 a year per person). Consequently, there exists a need to develop more sustainable interventions that can maintain physical activity levels over time.

In combination with other intervention components, brief e-counseling has shown promising results in increasing physical activity levels and may be one alternative to tangible reinforcers. VanWormer (2004) used pedometer-aided self-monitoring plus brief e-counseling as an intervention to increase physical activity in three overweight adults. During the baseline condition, participants received a Yamax Digi-WalkerModel SW-200 masked pedometer (i.e., sealed with a sticker) to prevent activity feedback. During the pedometer-aided self-monitoring phase, participants wore their pedometers unsealed and recorded daily step totals each night on a personal weekly progress spreadsheet. Participants e-mailed their weekly progress charts to the investigators. Researchers discussed the participants' weekly goals, reviewed their steps, and gave advice and support for increasing their steps during the treatment phase. Results indicated that all three participants increased their steps during treatment phases. Two participants doubled their step count from their baseline condition by the end of the study, and the most active participant at baseline averaged 11,444 steps per day during the intervention (VanWormer, 2004).

Similar research has also shown enhanced effects for goal setting when the goals are made public (Brobst & Ward, 2002). Public posting makes the performances public and provides feedback to participants. The advantage of combining public posting and goal setting as a package intervention is that it provides an explicit criterion, as opposed to "do your best." Van Houten (1980) suggests that public posting both prompts and reinforces performance. Kurti and Dallery (2013) introduced public posting with technological advances

contemporary with the date of their study (i.e., biomarker detectors and real-time access to therapeutic interventions via information technology). This included devices for electronically delivering a comment through a social networking application (e.g., Instagram, Facebook, Twitter). Kurti and Dallery (2013) conducted two simultaneous experimental studies integrating Internet-based contingency management to increase walking in sedentary adults. During the first experiment, the participants received monetary consequences for meeting their step goals for at least 3 days during consecutive 5-day blocks. Experiment 1 resulted in a 182% increase in steps across participants and 87% of goals being met. Aiming to reduce cost, Kurti and Dallery (2013) replicated the intervention without the use of monetary consequences. Results showed an increase in steps by 108% across participants, and 52% of goals were met at the group level, indicating that Internet-based goal setting without incentives could be an effective way to promote physical activity. The findings also provide evidence that basic social media platforms, such as Instagram and Facebook, are as effective in maintaining the desired behavior over time as other social media applications tailored to health promotion (e.g., mHealth, websites, health applications; Santarossa & Woodruff, 2018).

Although research shows promising results for the Internet-based interventions, there are some limitations, such as inconsistency and subjective measures of physical activity, a lack of multiple approaches (Keating et al., 2005) and, most importantly, a need for more objective measures (Kurti & Dallery, 2013). Further, Keating et al. (2005) noted that to understand physical activity across the student population, there exists a need to standardize the measurement system to be more specific and objective. The standard celeration chart (SCC) offers a standardized measurement system for behavior analysts, researchers, and practitioners.

The SCC presents a standardized chart used to measure behaviors across time. The *x*-axis of the chart displays a continuous measure of time. The most common SCC used is the daily chart, which displays successive calendar days on the *x*-axis. The *y*-axis of the SCC displays a logarithmic scale, which represents multiplicative growth. This allows individuals to look at the proportional growth of behavior across time, taking into account an individual's current performance. Coupled with the call for standardized measurement (Keating et al., 2005), this feature of the chart may lend itself particularly well to physical activity.

By looking at the current performance of an individual, one could use the chart to set proportional goals (i.e., multiply/divide) for increasing physical activity rather than absolute goals (i.e., add/subtract). For example, if Participant A currently walks an average of 500 steps per day, and Participant B currently walks an average of 9,000 steps per day, an absolute goal of increasing steps by 500 steps would be a very different expectation for each participant. If Participant A

added 500 steps for a total of 1,000 steps, daily physical activity would double (i.e., $\times 2$). If Participant B added 500 steps per day, the total of 9,500 steps would not be as meaningful, as the change would be only $\times 1.056$. Proportional goals would be displayed differently on a chart. One could identify baseline performance for both participants and select a proportional goal to increase steps by $\times 1.5$ steps per week. That would result in Participant A increasing steps to 750 steps by the end of the week, and Participant B increasing steps to 13,500—both marked improvements from where they started.

Given the unique benefits the SCC presents for physical activity research and the present literature on Internet-based self-management interventions, the current study sought to extend the research on increasing physical activity in college students. More specifically, the researchers evaluated the effects of self-monitoring, goal setting, social media (Instagram), weekly meetings, and social feedback on the physical activity of sedentary college students. In so doing, the researchers aspired for the participants to meet the recommended physical activity guidelines set by the ACSM (2018) by implementing feasible and cost-efficient techniques to increase physical activity.

Method

Participants and Setting

A total of four individuals participated in the current study. All participants were required to be full-time college students and at least 18 years of age. Participants were recruited by the use of flyers posted throughout a southeastern university. Based on an initial meeting, only those individuals who reported walking less than the recommended 10,000 steps per day were recruited to participate in the study. All four participants filled out a demographic survey where they self-reported their age, gender, and race. See Table 1 for the self-reported responses for each participant.

Materials

The researchers used a Fitbit Ace to track the number of steps taken by the participants. The Fitbit Ace is a fitness tracker that uses a three-axis accelerometer to detect any motion or

movement and then converts it into measurable data (i.e., frequency of steps). The screen of the Fitbit Ace displays the total number of steps. A wristband displayed the screen, a feature similar to a regular watch. The participants were able to view their daily steps by tapping on the screen. The Fitbit™ Ace saves data for up to 7 days and can be synced via Bluetooth. This device has a “Parent View” feature that allowed the researchers to monitor the progress of the participants at all times. The researchers used a Fitbit Zip as a secondary measure to check the accuracy of the measurement. A Fitbit Zip resembles a pedometer that tracks your steps and the distance you walk. The Fitbit Zip can be worn on or very close to the body. Ideal places to wear the Fitbit Zip are the pants pocket, belt, or waistband; however, the person can place it in a location he or she deems most comfortable. Each participant also received an activity log data sheet and a daily SCC to chart their data during the intervention condition. Activity log data sheets consisted of eight columns labeled “Phase/Condition,” “Day,” “Date,” “Goal Distance,” “Steps Taken (Fitbit Ace and Fitbit Zip),” “Requirements Met (Y/N),” “Checked Instagram Post (Y/N),” and “Gave Feedback to Peers (Y/N).” This ensured that participants recorded their data every day during the intervention condition.

Independent Variable

A packaged self-management intervention consisting of self-monitoring, goal setting, social media (Instagram), weekly meetings, and social feedback served as the independent variable. For the self-monitoring component, the participants recorded their data on an activity log and charted on their SCC each day. The SCC provided participants with immediate feedback on their performance, as well as how their current performance related to their past performance. They could also visually confirm whether they met their daily goals, how many days they were at or above their goals, and the distance between their current step count and the ultimate goal of 10,000 steps. Additionally, participants had access to the Fitbit Ace monitor. For goal setting, the first daily goal was derived from the mean level (i.e., geometric mean) of performance in the baseline condition. The daily goal increased by 15% every 2 consecutive days the participants met their current goal until they reached 10,000 steps per day. If the participant did not meet the goal for 2 days in a row, then the goal stayed the same until the participant reached the same goal for 2 consecutive days. Researchers used the social media application Instagram as the public-posting component. All participants joined the private Instagram account. Researchers set the group to private, so the comments and posts were not visible to friends and family members of the participants. The participants were not tagged in posts and could not be traced to the Instagram page. The researchers posted screenshots of the participants’ SCCs with their names in the

Table 1. Participant Demographic Information

Participant Name	Age	Gender	Race
Erica	19	Female	Black or African American
Ky’Aria	21	Female	Black or African American
Frick	25	Female	White/Caucasian
Geetika	22	Female	Black or African American

top corner and either a smiley face emoji or a frowning face emoji. The emojis allowed the participants to know whether they had met their goals or not before clicking on the post to read the comments. See Fig. 1 for an example of posts made when participants met and did not meet their daily goals. The researchers also included positive feedback when participants met their goals (e.g., “Geetika reached her goal with 11,463 steps yesterday!”) and encouraging words and suggestions when they did not meet their goals (e.g., “Geetika did not reach her step goal today. Keep going Geetika! We know you can do it!”). The participants were also encouraged to comment on each other’s posts to congratulate one another or simply give some helpful tips for how to stay on track and meet their goals for the next day. Lastly, the researchers held weekly meetings with the participants. Weekly meetings allowed the researchers to review charts with each participant and troubleshoot any problems with the devices; the meetings also allowed participants to share tips about how they met their goals.

Dependent Variables

Researchers defined and measured physical activity by the number of daily steps taken by the participants, using three dependent variables over the course of the study to measure different aspects of physical activity: (a) frequency, (b) bounce, and (c) level.

Frequency Frequency represents a count of behavior across time. Researchers collected frequency data on the number of steps taken per day. The fitness tracker recorded these data

automatically and included any steps taken by the participant throughout her daily routine for a 24-hour cycle (12:00 a.m. to 11:59 p.m.).

Bounce Bounce represents a measure of the variability among the data points. The higher the bounce, the greater the variability. Bounce is expressed and reported as a proportional value. For example, a x2 bounce would indicate that the space between the highest data point (e.g., 20) and the lowest data point (e.g., 10) was a distance of x2. All bounce values were calculated using the data analysis software Chartlytics (Chartlytics, n.d.).

Level Level represents a measure of the overall location of where the data converge on the y-axis. For the purposes of this study, researchers calculated level by using the geometric mean, which accounts for outliers, unlike the arithmetic mean. All level values were calculated using the data analysis software Chartlytics (Chartlytics, n.d.).

Research Design and Analysis

Researchers used a multiple-baseline across-participants design with an additional component of a multitreatment reversal (A-B-C-B-A) to measure the effects of the intervention (Cooper et al., 2007). Data are displayed on a count-per-day SCC. Between-condition comparison analyses were conducted for measures of level and bounce. Between-condition comparisons allow researchers to examine the proportional difference between each measure of the dependent variable. Between-condition comparison analyses are calculated by

Fig. 1 Sample Instagram example of when a met their goal (left) and an example of when did not meet their goal

taking the larger value of the two conditions (e.g., a level of 10,000 in intervention) and dividing it by the smaller value (e.g., a level 5,000 in the baseline) to produce a quotient (e.g., 2). One then applies the appropriate symbol (i.e., either the sign for multiplication or division) based on the direction of the change. For example, if steps increased from 5,000 in baseline to 10,000 in intervention, the between-condition change would be expressed as $\times 2$. Between-condition changes in bounce were also conducted in this analysis in an identical fashion.

Procedure

Baseline During the baseline condition, participants were given a Fitbit Ace with detailed instructions on how to wear them according to the device's manual. The researchers synced the Fitbits to the participants' personal mobile devices and covered the fitness tracker with a piece of tape to prevent self-monitoring. Researchers removed all displays of any measure of the dependent variable from the participants' Fitbit mobile app and locked them using Parent Mode. These conditions ensured participants could not access their data via the mobile app. The participants were instructed to wear the fitness tracker on their wrist day and night, only removing it to charge the device, and to continue their routine as normal to ensure accuracy of steps. Researchers required participants to come to the weekly meetings during this condition to address any technological issues or concerns. The researchers had access to each participant's data at all times through the "Parent View" feature specific to the Fitbit Ace. Participants remained in the baseline condition until the number of steps they took achieved steady-state responding (e.g., a $\times 1$ acceleration) or were decelerating (e.g., a $/1.2$ acceleration).

Intervention The intervention included components of self-monitoring, goal setting, social media (Instagram), weekly meetings, and social feedback. All participants received basic training on how to calculate their daily goals and instructions on how to chart their data on an SCC before they started the intervention.

During the intervention condition, researchers removed the tape that had previously restricted the participants' access to their screen to account for self-monitoring. Participants were instructed to wear the Fitbit Ace for 24 hours to allow the researchers to track their activity level; however, the participants could now self-monitor their steps. Each participant received a goal-setting sheet that included their individual goals for the study, which were derived from their geometric mean from the baseline condition. Once they met their goals 2 days in a row, the participants calculated a new daily goal until they reached the terminal goal of 10,000 steps per day. The statistics reset every night at midnight (12:00 a.m.), leaving the participants until 11:59 p.m. to meet their goals for the day. The next day, the participants recorded on their activity log data sheet and charted the number of steps on

their personal SCC. The researchers posted the participants' daily updates on the Instagram page by 11:00 a.m. the following morning. The post consisted of a screenshot of each participant's SCC, the picture captioned with feedback that stated whether or not the participant had met her daily goal. The researchers also gave appropriate feedback contingent on the participant's performance of meeting the daily goal. The feedback delivered from other participants occurred by either liking the picture or commenting in the comment section below each post on Instagram. All of the participants had access to posts on the Instagram page. Both the researchers and the participants received netiquette training to ensure participants gave positive and respectful feedback when individuals did not meet their goals. The netiquette training consisted of teaching acceptable communication via the Internet with examples and nonexamples of encouraging phrases that could be used when posting the pictures and/or commenting on the posts. This also allowed researchers to control for the risk of posting unacceptable feedback when participants met their step goals (e.g., all capped words and abbreviations that symbolize inappropriate words: "YOU FINALLY DID IT!"), as well to avoid any negative comments when participants did not reach their goals (e.g., "Why didn't you complete your goal?" "Get over your failure!" or "Suck it up!").

Weekly group meetings were held each Wednesday during the study. During the weekly meetings, the participants met with the researchers together to discuss how the previous week had gone. The researchers addressed any questions or concerns the participants may have had regarding the Fitbit, data collection, Instagram posts, and so on. In the meetings, the researchers initiated a conversation to discuss each participant's experience, if participants met their goals during the week, and if they encountered any discomfort while completing their goals, as well as reviewed their charted data. Researchers also checked the accuracy of the data displayed on individual SCCs and reviewed netiquette principles, if needed. The weekly meetings also served as a chance for the researchers to go over any new or upcoming changes being made (e.g., changing the participants' condition from intervention to baseline or vice versa).

No Weekly Meeting Participants were involved in the study for the duration of a 4-month school semester. The spring semester held a student holiday from academic responsibility for a full 7-day week. During spring break, participants had access to all components of the independent variable with the exception of the weekly meeting component. They were instructed to wear the Fitbit Ace, access their daily goals, and check their Instagram accounts to view social feedback provided by researchers.

Return to Intervention In this condition, the participants went back to the intervention condition. They had access to all of the components of the independent variable.

Return to Baseline During this condition, researchers exposed the participants to baseline conditions as described previously.

Device Record Correspondence and Treatment Integrity

Researchers used a total-agreement procedure to calculate the correspondence between the two individual Fitbit devices. Correspondence was calculated by dividing the smaller number of steps by the larger number of steps from both the Fitbit Ace and the Fitbit Zip and then multiplying by 100. Correspondence data were collected for 33% of the total days for each participant during the baseline and intervention conditions. The average calculated correspondence measurements were 52.11% for Ky'Aria, 90.59% for Frick, 42.22% for Erica, and 63.32% for Geetika.

Researchers also calculated treatment integrity by randomly selecting 18 days (i.e., 33% of the total days) between the baseline and intervention conditions from the participants. Researchers divided the number of steps of the intervention implemented correctly by the total number of steps. A total of nine steps needed to be completed by the researcher daily, including updating the activity log to include the condition, the day of the week, the specific date, the appropriate goal for the day, the number of steps taken, if the participants met their goals, if the data were charted on the SCC, if researchers posted the SCC on Instagram before 11:00 a.m., and whether the appropriate feedback was given on the Instagram post. The average treatment integrity calculated for all four participants was 100% of steps implemented correctly. Researchers checked participants' activity logs during each weekly meeting to ensure participants listed the appropriate goals and, if they self-monitored, whether they completed each of the daily requirements of the study.

Social Acceptability Survey

At the end of this study, participants completed a social acceptability survey. The survey included a total of six questions. Results are displayed in Table 2. The first three

questions were answered using yes or no, and the last three questions were answered using a 7-point Likert-type scale. The scale included *strongly disagree*, *disagree*, *somewhat disagree*, *neutral*, *somewhat agree*, *agree*, and *strongly agree*.

Results

Results are displayed on segments of the daily per-day SCCs. Charts are presented in pairs rather than traditionally stacked as one multiple-baseline figure to enhance the quality of visual inspection for readers. Staggered intervention dates can be seen on the x-axis, as all charts are calibrated with the same start date. Each figure displays two charts: (a) raw data to allow for visual inspection at the molecular level and (b) aggregate level lines and bounce envelopes to look at the effects of the intervention at the molar level. Statistical data for all figures are presented in Table 3.

Figure 2 displays the daily frequency of steps per day and the overall level lines and bounce envelopes for Ky'Aria and Geetika. In the baseline condition, Ky'Aria took an average of 5,874 steps with a bounce of x2.1. During the intervention condition, steps increased to an average of 9,418, a x1.6 improvement in her performance compared to baseline. Overall bounce decreased from x2.1 in baseline to x1.4, indicating a /1.5 between-condition change. This illustrates that her steps were more consistent during the intervention condition. The weekly meetings were removed due to spring break occurring during the semester. Steps maintained at an average of 9,427 steps, a x1 change from the intervention condition, indicating no change despite the initial decay in performance on the first day. This suggests the weekly meeting component may not have played a crucial role in maintaining her performance. When weekly meetings were reintroduced, her steps increased to an average of 11,522, a x1.2 improvement. Bounce also decreased from x1.7 to x1.4, demonstrating a /1.2 between-condition change. When baseline conditions were reintroduced, the level of steps slightly decreased to 9,257, indicating a /1.25 in performance. There was also an increase

Table 2. Results of Social Acceptability Survey

	Will you purchase an activity tracker after this study?	Would you want to wear the and set goals for the fall semester?	Did you find Instagram beneficial in improving your steps?	The treatment was acceptable.	I was willing to carry out the study.	The treatment was effective.
Ky'Aria	Yes	No	No	Agree	Disagree	Neutral
Geetika	Yes	No	No	Agree	Agree	Strongly Agree
Frick	Yes	Yes	Yes	Strongly Agree	Strongly Agree	Somewhat Agree
Erica	No	No	No	Strongly Agree	Strongly Agree	Strongly Disagree

Table 3. Statistical Measures Between Conditions

	Measure	Baseline	Between Condition Change	Intervention	Between Condition Change	No Weekly Meeting	Between Condition Change	Intervention	Between Condition Change	Baseline
Ky'Aria	Level	5,874	$\times 1.6$	9,418	$\times 1$	9,427	$\times 1.2$	11,522	$/1.25$	9,257
	Bounce	$\times 2.1$	$/1.5$	$\times 1.4$	$\times 1.21$	$\times 1.7$	$/1.2$	$\times 1.4$	$\times 2.57$	$\times 3.6$
Geetika	Level	8,003	$\times 1.4$	11,228	$/1.68$	6,666	$\times 1.7$	11,352	$/1.07$	10,606
	Bounce	$\times 3$	$/1.43$	$\times 2.1$	$\times 1.29$	$\times 2.7$	$/1.93$	$\times 1.4$	$\times 1.79$	$\times 2.5$
Frick	Level	5,470	$\times 1.5$	8,294	$/1.93$	4,292	$\times 2$	8,588	$/1.5$	5,689
	Bounce	$\times 4$	$/1.82$	$\times 2.2$	$\times 1.27$	$\times 2.8$	$\times 1$	$\times 2.8$	$/1.08$	$\times 2.6$
Erica	Level	6,481	N/A	N/A	N/A	7,541	$/1.29$	5,841	$/1.06$	5,521
	Bounce	$\times 3.9$	N/A	N/A	N/A	$\times 3.4$	$/1.79$	$\times 1.9$	$\times 1.95$	$\times 3.7$

in bounce from $\times 1.4$ during the intervention condition to $\times 3.6$ in the second baseline condition, demonstrating a $\times 2.57$

increase in bounce. This suggests that although the average number of steps taken was still above the 10,000-step goal, the

Fig. 2 Result for Ky'Aria and Geetika. The top panels are Ky'Aria's data and the bottom panels are data. The left chart segments demonstrate the raw data in each condition. The right chart segments demonstrate the level lines and bounce envelopes in each condition. The shaded bar represents the goal

consistency of meeting that goal daily fluctuated in the absence of the intervention.

Geetika took an average of 8,003 steps with a bounce of $\times 3$ in the initial baseline condition. During the intervention condition, steps increased to an average of 11,228, a $\times 1.25$ improvement in her performance compared to baseline. Bounce decreased from $\times 3$ in baseline to $\times 2.1$, a $/1.43$ between-condition change. This illustrates that her steps were more consistent during the intervention condition. During the no weekly meeting condition, Geetika's performance dropped to an average of 6,666 steps, a $/1.49$ decay in her performance from the intervention condition. The decay suggests that the weekly meeting component may have played a crucial role in maintaining her performance. When weekly meetings were reintroduced, we observed that her steps increased to an average of 11,352, a $\times 1.52$ improvement, and the bounce also decreased from $\times 2.7$ to $\times 1.4$, demonstrating a $/1.93$ between-condition change. When baseline conditions were reintroduced, the level of steps decreased to 10,606, indicating a $/1.07$ in performance. There was also an increase in bounce from $\times 1.4$ during the intervention condition to $\times 2.5$ in the second baseline condition, demonstrating a $\times 1.79$ increase in bounce.

Figure 3 displays the daily frequency of steps per day and the overall level lines and bounce envelopes for Frick and Erica. In the baseline condition, Frick took an average of 5,470 steps with a bounce of $\times 4$. During the intervention condition, steps increased to an average of 8,294, a $\times 1.5$ improvement in her performance compared to baseline. Bounce decreased from $\times 4$ in baseline to $\times 2.2$, a $/1.82$ between-condition change. This illustrates that the frequency of her steps was more consistent during the intervention condition. During the no weekly meeting condition, Frick's performance dropped to an average of 4,292 steps, a $/1.93$ decay in her performance from the intervention condition. The decay indicates that the weekly meeting component may have played a crucial role in maintaining her performance. When weekly meetings were reintroduced, we observed that her steps increased to an average of 8,588, a $\times 2$ improvement. There was no change in the bounce between conditions. When baseline conditions were reintroduced, the level of steps decreased to 5,698, indicating a $/1.5$ in performance. There was also a slight decrease in bounce from $\times 2.8$ during the intervention condition to $\times 2.6$ in the second baseline condition, demonstrating a $/1.08$ decrease in bounce.

Erica took an average of 6,481 steps with a bounce of $\times 3.9$ in the initial baseline condition. During the fourth week of the baseline condition, Erica's Fitbit experienced technical issues; thus data were not collected for 3 days. Erica was only in the intervention condition for 2 days before commencing the no weekly meeting condition. The geometric mean and bounce were not derived for the initial intervention, as there were not enough data points. The two data points demonstrated a high

degree of variability; thus conclusions cannot be made based on the data. During the no weekly meeting condition, Erica's performance increased from the initial baseline to an average of 7,541 steps. When weekly meetings were reintroduced, her steps decreased to an average of 5,841, a $/1.29$ decay in performance. Bounce decreased from $\times 3.4$ in the no weekly meeting condition to $\times 1.9$ in the second intervention, a $/1.79$ change in bounce. When baseline conditions were reintroduced, the level of steps slightly decreased to 5,521, indicating a $/1.06$ in performance. There was also an increase in bounce from $\times 1.9$ during the intervention condition to $\times 3.7$ in the second baseline condition, demonstrating a $\times 1.95$ decrease in bounce. Due to the inconsistency in data between conditions, a functional relationship was not observed based on Erica's data.

Discussion

The current study sought to increase physical activity in college students by using self-monitoring, goal setting, social media (Instagram), weekly meetings, and social feedback. The intervention increased daily steps to the recommended 10,000-step goal for two participants, moderately increased steps to an average of 8,441 steps for one participant, and had no effect for one participant. Findings from the current study further extend previous research suggesting pedometer-aided packaged interventions consisting of goal setting and reinforcement are effective in increasing physical activity levels (LaLonde et al., 2014). Current results suggest a starting point for increasing physical activity in sedentary college students without the use of monetary reinforcers. The implications of these findings could aid in the design of programs to decrease the likelihood of disease caused by physical inactivity worldwide and increase life expectancy (Lee et al., 2012).

Daily steps are one of the most readily accessible means to decrease a sedentary lifestyle (Kraus et al., 2019). Results of the current study present a viable option for college students to increase their physical activity levels. Three participants increased their number of steps substantially, with two out of the three consistently attaining the daily 10,000-step goal. Increases were achieved without any tangible reinforcers or incentives while participants carried out their daily routines and responsibilities as college students. This yields an important finding, as it may not be practical or financially possible to implement large-scale programs to increase steps that rely solely on tangible reinforcers. For example, the delivery of a \$5 gift card for meeting a weekly goal for 10 participants would equate to \$2,600 a year. This suggests that the current intervention presents a cost-effective way to increase steps, thus making it an attractive option for adoption.

It is also important to note the duration of the study encompassed an entire semester. Essentially, it captured

Fig. 3 Result for Frick and Erica. The top panels are data and the bottom panels are Erica's data. The left chart segments demonstrate the raw data in each condition. The right chart segments demonstrate the level lines and bounce envelopes in each condition. The shaded bar represents the 10,000 step goal

realistic and practical situations (e.g., midterms, spring break, finals) that students experience throughout the semester. Participants could walk at any time of the day, for whatever duration, and without any constraints, provided they completed their daily goals. This component of the intervention allowed the participants to be more involved in the creation of individualized behavior-change strategies to facilitate meeting their daily goals. For example, participants self-reported that they would park their car farther away from their destination in order to achieve their goals. Given the dynamic nature of the college lifestyle, the intervention was potent enough to compete with other reinforcers available for alternate behaviors incompatible with physical activity.

The cost-effectiveness in combination with the ability to compete with other reinforcers indicates the potential application of the current intervention to larger scales. Adherence to physical

activity is a primary prevention strategy in limiting the onset of various diseases and disorders (e.g., stroke, cardiovascular diseases, diabetes; Adámková, Belohoubek, Adámek, Juhanáková, & Pirk, 2015). Future research should evaluate the effectiveness of the current intervention as a universal strategy to prevent inactivity in college students. For example, 75% of the individuals who participated in the study responded positively to the intervention. Because the majority of participants increased their physical activity with the universal intervention, fewer modified and/or individualized interventions would need to be used. This would allow for the use of other, potentially more costly, evidence-based interventions that previously produced increases in physical activity (e.g., LaLonde et al., 2014). This model could decrease the overall cost for programs to use tangible reinforcers, given the fact that tangible reinforcers would only be reserved for individuals who do not respond to the universal

intervention. However, researchers using systems operating under this design should carefully plan for the potential for individuals to sabotage preventative measures to gain access to tangible reinforcers.

Results of the social acceptability questionnaire illustrated that all of the participants found the intervention acceptable. These findings suggest the intervention may be accessible to a wide range of individuals. Additionally, the participants who demonstrated increases in physical activity (i.e., Ky'Aria, Geetika, and Frick) reported that they each would like to purchase a fitness tracker after the study, thus continuing to use a technology to track their physical activity levels. Geetika and Frick reported they felt the treatment was effective, whereas Ky'Aria reported neutral feelings about the effectiveness, and Erica strongly disagreed that the treatment was effective, consistent with their results. Furthermore, all participants, with the exception of Frick, did not find Instagram beneficial in improving their steps. This finding suggests that the public-posting component may not have been a critical variable in increasing the frequency of steps. Future researchers may conduct a component analysis to identify which components of the treatment package accounted for the behavior change.

Despite the effectiveness of the intervention for the majority of participants, several limitations in the study warrant consideration. First, the device correspondence measures yielded a low score. This is most likely a result of participants not reliably wearing the Fitbit Zip. During the weekly meetings, participants reported that they would forget to wear that device because it required them to attach it to their clothing, unlike the wristband feature associated with the Fitbit Ace. Participants reported that some of the measures used for correspondence were collected on incomplete days, as they would put the device on only when they remembered they had not done so in the morning. Additionally, the two measures of correspondence did not use the same devices (i.e., Fitbit Ace and Fitbit Zip), and the individual measurement technology used by both devices may have negatively affected the correspondence scores. These findings further support previous literature on the lack of reliability of step counts between Fitbit devices (Feehan et al., 2018). Future research should use the same devices instead of different ones to ensure reliability between them.

Second, participants were not taught to make decisions based on their own data. Instead, they followed an intervention prescribed by the researchers. Future research should focus on the concept of precision exercise. This would entail teaching participants to analyze data on their own charts, make decisions about their growth in steps, implement self-created interventions, and observe the effects on their performance. Methods exist for teaching individuals to make decisions based on their educational data (Lindsley, 1990), and those methods could directly be extended to the area of physical activity. This may also help with individuals who do not

respond to the prescribed intervention, by allowing them autonomy over their intervention. Individuals could then use the weekly meeting to share intervention ideas and outcomes, thus enhancing the role of social feedback.

Third, the researchers did not count the frequency of posts per participant on Instagram or the peer feedback between the participants via the comments section. These occurrences suggest a potential for an additional dependent variable. Future studies should consider feedback measures for additional insights as to which components of the study resulted in an increase in physical activity. It is important to note the degree of privacy the Instagram group presented, and that participants were not tagged in the posts. Future research could incorporate family members or friends of the participants as a part of the social media group to garner additional social support.

Fourth, the participants did not have 100% attendance for the weekly meetings. Researchers required the participants to meet weekly with the researchers and other participants to discuss their progress and facilitate social feedback. Conflicting schedules and personal responsibilities may have inhibited the participants' ability to attend the meeting. For example, one participant had personal and professional meetings and obligations that prevented her from having the flexibility to attend some meetings. Future studies could hold the meeting using web-based technology. This may help increase weekly meeting attendance. For instance, Kurti and Dallery (2013) had a 95% attendance rate, on average, for their participants' scheduled videoconferences. Additionally, making the meeting online may reduce the response effort, making attendance more feasible for participants. Participants would be able to meet in the location most convenient for them (e.g., home, school, the library).

This study highlights the need to increase physical activity and identify feasible interventions to increase steps in sedentary college students. Additionally, it identified a combination of strategies and components used to create an innovative method that did not require the use of monetary reinforcers or compensation. The low cost and effort of the intervention make it an attractive option for adoption in preventative health care programs. The findings from this study further add to the growing literature base on the use of self-management interventions to improve physical activity in sedentary college students, thus aiding in the establishment of a lifestyle of physical activity accompanied by positive and lifelong health effects that can be sustained over time.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Approval All of the procedures in this study, which involved human participants, were conducted according to ethical standards of

the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. University institutional review board approval was obtained.

Informed Consent Informed consent was obtained from all individual participants included in the study.

References

- Adámková, V., Belohoubek, J., Adámek, V., Juhanáková, M., & Pirk, J. (2015). Physical activity and exercise as a basic preventive measure (primary prevention, prevention after renal transplantation). *Central European Journal of Public Health*, 23, S3. <https://doi.org/10.21101/cejph.a4014>.
- American College of Sports Medicine. (2018). *ACSM issues new guidelines on quantity and quality of exercise*. Retrieved from <https://www.prweb.com/releases/2011/6/prweb8606343.htm>
- Brobst, B., & Ward, P. (2002). Effects of public posting, goal setting, and oral feedback on the skills of female soccer players. *Journal of Applied Behavior Analysis*, 35(3), 247–257. <https://doi.org/10.1901/jaba.2002.35-247>.
- Center for Disease Control and Prevention. (2019a). *Data and statistics*. Retrieved from <https://www.cdc.gov/physicalactivity/downloads/trends-in-the-prevalence-of-physical-activity-508.pdf>
- Center for Disease Control and Prevention. (2019b). *Physical activity basics*. Retrieved from <http://www.cdc.gov/physicalactivity/everyone/measuring/index.html>
- Chartlytics. (n.d.). Retrieved July 30, 2020, from <https://app.chartlytics.com/login>
- Cooper, J. O., Heron, T. E., & Heward, W. L. (2007). *Applied behavior analysis* (2nd ed.). Saddle River, NJ: Pearson Prentice Hall.
- Feehan, L. M., Geldman, J., Sayre, E. C., Park, C., Ezzat, A. M., Yoo, J. Y., et al. (2018). Accuracy of Fitbit devices: Systematic review and narrative syntheses of quantitative data. *Journal of Medical Internet Research*, 20(8), 53. <https://doi.org/10.2196/10527>.
- Hirvensalo, M., & Lintunen, T. (2011). Life-course perspective for physical activity and sports participation. *European Review of Aging and Physical Activity*, 8(1), 13. <https://doi.org/10.1007/s11556-010-0076-3>.
- Keating, X. D., Guan, J., Piñero, J. C., & Bridges, D. M. (2005). A meta-analysis of college students' physical activity behaviors. *Journal of American College Health*, 54(2), 116–126. <https://doi.org/10.3200/jach.54.2.116-126>.
- Kraus, W., Janz, K., Powell, K., Campbell, W., Jakicic, J., Troiano, R., et al. (2019). Daily step counts for measuring physical activity exposure and its relation to health. *Medicine & Science in Sports & Exercise*, 51(6), 1206–1212. <https://doi.org/10.1249/MSS.0000000000001932>.
- Kurti, A. N., & Dallery, J. (2013). Internet-based contingency management increases walking in sedentary adults. *Journal of Applied Behavior Analysis*, 46(3), 568–581. <https://doi.org/10.1002/jaba.58>.
- LaLonde, K. B., MacNeill, B. R., Eversole, L. W., Ragotzy, S. P., & Poling, A. (2014). Increasing physical activity in young adults with autism spectrum disorders. *Research in Autism Spectrum Disorders*, 8(12), 1679–1684. <https://doi.org/10.1016/j.rasd.2014.09.001>.
- Lee, I. M., Shiroma, E. J., Lobelo, F., Puska, P., Blair, S. N., Katzmarzyk, P. T., & Lancet Physical Activity Series Working Group. (2012). Effect of physical inactivity on major non-communicable diseases worldwide: An analysis of burden of disease and life expectancy. *The Lancet*, 380(9838), 219–229. [https://doi.org/10.1016/S0140-6736\(12\)61031-9](https://doi.org/10.1016/S0140-6736(12)61031-9).
- Lindsley, O. R. (1990). Precision teaching: By teachers for children. *Teaching Exceptional Children*, 22(3), 10–15. <https://doi.org/10.1177/0040055999002200302>.
- Office of Disease Prevention and Health Promotion. (2019). *Appendix 1. Translating scientific evidence about total amount and intensity of physical activity into guidelines*. Retrieved from <https://health.gov/sites/default/files/2019-09/paguide.pdf>.
- Raudsepp, L., Neissar, I., & Kull, M. (2008). Longitudinal stability of sedentary behaviors and physical activity during early adolescence. *Pediatric Exercise Science*, 20(3), 251–262. <https://doi.org/10.1123/pes.20.3.251>.
- Santarossa, S., & Woodruff, S. J. (2018). #LancerHealth: Using Twitter and Instagram as a tool in a campus wide health promotion initiative. *Journal of Public Health Research*, 7(1), 1166. <https://doi.org/10.4081/jphr.2018.1166>.
- Sparling, P. B., & Snow, T. K. (2002). Physical activity patterns in recent college alumni. *Research Quarterly for Exercise and Sport*, 73(2), 200–205. <https://doi.org/10.1080/02701367.2002.10609009>.
- Van Camp, C. M., & Hayes, L. B. (2012). Assessing and increasing physical activity. *Journal of Applied Behavior Analysis*, 45(4), 871–875. <https://doi.org/10.1901/jaba.2012.45-871>.
- Van Houten, R. (1980). *Learning through feedback: A systematic approach for improving academic performance*. New York, NY: Human Sciences Press.
- Van Wormer, J. J. (2004). Pedometers and brief e-counseling: Increasing physical activity for overweight adults. *Journal of Applied Behavior Analysis*, 37(3), 421–425. <https://doi.org/10.1901/jaba.2004.37-421>.

Implications for Practice

- Intervention packages using self-management and social media are a viable option to increase physical activity without the use of tangible reinforcers.
- The cost-effectiveness of this intervention may be applicable at a larger scale to decrease physical inactivity in college students.
- Individualized interventions may be used for the few who do not respond to the universal intervention.

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.