

Using Fitbit Fitness Trackers to Measure Teacher Stress and Coping

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Abstract

In this mixed-methods study, we used Fitbit fitness trackers to monitor the heart rate, sleep, and step counts of four teachers from diverse backgrounds for twelve consecutive weeks. Weekly interviews took place where researchers inquired about the teachers' most and least stressful days as evidenced by the data provided from the Fitbit. The most common stressor indicated was poor student behavior and the most common coping mechanisms used were self-care techniques such as taking baths, naps, and massages. Prior to the beginning of the interview period, each teacher completed the Classroom Appraisal of Resources and Demands (CARD) to measure their stress risk, the Preventative Resources Inventory (PRI) to measure their preventative coping skills, and the Maslach Burnout Inventory (MBI) to measure their burnout. Data was triangulated through the initial surveys, coding from weekly interviews, and the Fitbit data to create a profile and results for each teacher.

Keywords: Teacher Stress, Teacher Burnout, Fitness Trackers, Coping Skills

1. Introduction

Teachers are the largest occupational group studied in burnout research (Schaufeli & Enzmann, 1998). Burnout occurs from prolonged periods of stress and for decades, researchers in social sciences have deemed teaching as an occupation with a high risk of stress (Travers & Cooper, 1996). These risk factors are one of the reasons that 30-50% of teachers leave the profession within the first 5 years and 20-30% leave within the first 3 years (Prilleltensky, Neff, & Bessell, 2016). Teacher stress is many times defined as an imbalance of demands and resources, which corresponds with Lazarus and Folkman's (1984) theory that stress occurs when those risk factors exceed the resources available. Stress is "the relationship between the person and the environment that is appraised by the person as taxing or exceeding his or her resources and endangering his or her well-being" (Lazarus and Folkman, 1984, p. 21). McCarthy (2019) groups teachers into three categories: (a) *resourced* teachers who appraise resources higher than demands, (b) *balanced* teachers who appraise resources and demands as equal, and (c) *demand* teachers who appraise the demands higher than resources. Those demanded teachers are at the highest risk of stress and their job satisfaction is lowered and burnout is elevated (McCarthy, Lambert, Lineback, Fitchett, & Baddouh, 2016). Thus, to improve stress, risk factors must be

lowered (i.e. student behavior, meetings requiring time away from classrooms, unnecessary trainings), and protective factors must increase (i.e. administrative support, reduction in expectations for non-teaching duties, parental support).

Since stress is directly related to a person's environment (Lazarus and Folkman, 1984) and that personal environment includes health and fitness activities (ranging from minimal to extremely active), the use of fitness trackers should be a valid way to make connections to stress-related activities. More specifically, Fitbit fitness bands can also be used to track health and fitness data in teachers, as they are the most valid for tracking heart rate, sleep cycles, and step counts compared to many medical-grade devices (Ferguson, Rowlands, Olds, & Maher, 2015). According to Ertzberger and Martin (2016), there was even a slightly higher improvement in teacher fitness and fitness awareness when using the Fitbit. It was also concluded that teachers felt more confident in the classroom while using the Fitbit. While these results do support fitness awareness in teachers, there is a gap in the literature on whether the fitness trackers can be used to measure stress levels of teachers in efforts to eventually be able to reduce stress levels for teachers using affordable consumer grade devices, such as Fitbits. This current study serves as a jumping off point to discuss if it is even possible to monitor stress levels in teachers using these devices that many teachers already own. Therefore, in this paper, we aim to answer the following research question: *To what extent can Fitbit fitness trackers be used to measure teacher stress through heart rate tracking, amount of sleep, and step count?*

1.1 Stress, Burnout, and Coping in the Teaching Profession

Stress has been defined in a myriad of ways in previous research studies. In most cases, researchers studying stress in the teaching profession use Lazarus and Folkman's (1984) model that indicates higher stress when an appraisal of the demands of the profession outweigh the resources available to cope with those demands (Fisher, 2011; Lambert, McCarthy, O'Donnell, & Melendres, 2007; O'Donnell, Lambert, & McCarthy, 2008; Prillelensky, et al., 2016; McCarthy, Lambert, Beard, & Dematatis, 2002; McCarthy, 2019; Saeki, Segool, Pendergast, & Embse, 2018). McCarthy, Lambert, Beard, & Dematatis (2002) developed a model for prevention of stress and coping (see Figure 1) that outlines the appraisals of coping resources and awareness of demands. It shows when demands outweigh resources ($R < D$) stress occurs with a stress response and when resources are greater than demands ($R > D$), it results in optimal functioning.

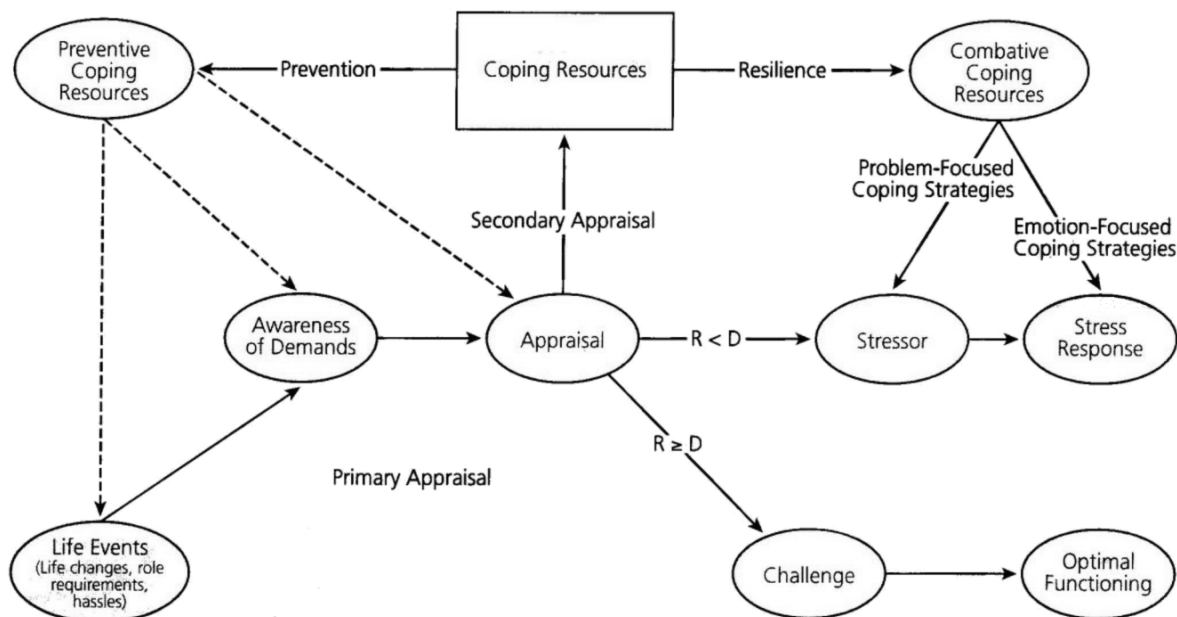


Figure 1. Model of prevention of stress and coping (McCarthy, Lambert, Beard, & Dematatis, 2002).

Maslach, Jackson, and Leiter (1996) originally stated that burnout is from extended exposure to stress and Maslach and Leiter (2016) more recently define burnout as “a psychological syndrome emerging as a prolonged response to chronic interpersonal stressors on the job” (p. 103) with there being three key factors within burnout: exhaustion, feelings of cynicism, and detachment from the job. In Freudenberger (1974), staff burnout is explored in terms of physical signs and behavioral indicators. He reports that those who are most prone to stress and burnout are the ones who are dedicated and committed, and those who work too much, too long, and too extensively and that leads to exhaustion (Freudenberger, 1974). In a study conducted by Fisher

(2011), the stress and burnout of 385 secondary teachers were investigated. The goal of the study was to find relationships in the stress, burnout, and retention rates in novice teachers (less than 3 years of experience), and experienced teachers (more than 3 years of experience). Fisher used McCarthy, Lambert, Beard, & Dematatis's (2002) model for stress in which stress is the outcome when demands outweigh the resources available to combat those demands and Maslach, Jackson, and Leiter's (1996, 2016) theory that burnout occurs from prolonged exposure to stress. This current study will follow in using the same definitions for stress and burnout.

There are many factors that have proven to impact teacher stress and burnout levels and many of them contradict each other. In the Fisher (2011) study, between novice and experienced teachers, burnout was higher in novice teachers, but there was no significant difference in stress levels between novice and experienced teachers. Beyond experience level, teachers in different socioeconomic areas also have their stress affected differently. In O'Donnell et al. (2008), significantly higher levels of stress and lower levels of psychological well-being are present in elementary school teachers' in low SES schools. Teachers in low SES schools also experience higher levels of emotional exhaustion (O'Donnell et al., 2008). Fisher (2011) found that low job satisfaction, poor preventative coping skills for stress, and high stress were statistically significant predictors for burnout. Similarly, low years of experience, low job satisfaction, and high burnout were statistically significant predictors for stress (Fisher, 2011). Lambert et al. (2007) found that the variables they tested (class size, behavior problems, and external demands) did not prove to be significant contributors to the teachers' stress. Conversely, Bottiani, Druan, Pas, & Bradshaw (2019) found that student behavior problems did significantly impact stress and burnout of teachers and that as resources were added to the model, student behavior was no longer statistically significant.

Not only does stress in the teaching profession impact teacher retention, but it also can impact a teachers' physical and mental health. McEwen (2008) reports that being "stressed out" can impact an adult's lifestyle, including sleeping habits, physical activity, and social interactions. Even more serious implications can come from increased stress. Adults that are stressed and know that stress can impact their health are at a greater risk of premature death (Keller, Litzelman, Wisk, Maddox, Cheng, Creswell, & Witt, 2012). While every adult body is impacted in different ways by stress, stress has been shown to impact their bodies by increasing blood pressure, increasing appetite that can lead to overeating, and elevating insulin and blood glucose levels (McEwen, 2006).

1.2 Fitness Trackers in Education

Ertzberger and Martin (2016) reviewed the impact fitness tracking technology has on teaching practices. In their study, they had teachers (n=28) wear Fitbits for 35 days and administered pre and post assessments asking questions about their health, teaching practices, and motivation. They found that the teachers were more motivated for physical activity while wearing the fitness band, but their teaching performance was not impacted by the fitness band. Overall, there were no statistically significant changes measured; however, their researcher-created assessment also measured low reliability as there are not previously tested surveys that were suitable for use for this study. Teachers in the study also felt that it would be hard to remember to use these every day on their own (Ertzberger & Martin, 2016). In terms of academic behavior in children, Lowe (2016) studied how wearable technology devices affected education by studying children's physical activity, sleep patterns, and location. It was concluded that the wearable device did not find any strong correlation between social and academic behavior among the children in the study.

It should also be noted that the Fitbit Flex used in the Ertzberger and Martin (2016) study did not contain a heart rate monitor. The data for that study was collected in 2014 and affordable fitness trackers containing heart rate monitors were not introduced until 2015. In a more in-depth study, Ferguson et al. (2015) conducted a study to determine the convergent validity of different consumer-level activity monitors with medical grade devices. The Fitbit products tested had the highest validity compared to medical grade devices. Technology can be beneficial for many different reasons in the field of education; however, there has been no previous research measuring how these devices can be used to measure stress in teachers. Ertzberger and Martin (2016) are the only study to use these trackers with teacher participants and they only studied the teachers' physical activity. There is research that uses Fitbit technology to measure exercise and its effect on stress (Xu, et al., 2018) and the use of wearable devices to measure mental health outcomes (Knight & Bidargaddi, 2018), but there is a gap in literature to support teachers using Fitbits to pinpoint stressful occurrences in their daily work. This study serves as an introductory path to attempt to use fitness trackers for measuring stress and since Ferguson et al. (2015) found that Fitbit products were just as favorable and more affordable, then they were selected for use in this study.

2. Methodology

Four teachers were studied for 12 consecutive weeks (November through February). Through a convenience sampling process, the four teachers selected were from elementary, middle, and high schools with years of experience ranging from less than one year of experience to over 20 years of experience. Mixed methods research was collected through surveys, Fitbit statistics, and weekly interviews and analyzed through a *concurrent triangulation* method in which the qualitative and quantitative data were concurrently collected at the same time without preference given to either data type (Creswell, Plano Clark, Gutmann, & Hanson, 2003). During the 12-week research period, each teacher wore a Fitbit fitness tracker. We recorded their sleep, heart rate, and step count daily, and we interviewed each teacher weekly to discuss possible reasons for any fluctuations in the Fitbit data. During the month prior to the data collection period using the Fitbits, each teacher completed surveys to measure their stress, burnout, and preventative coping skills in order to use that information to help make sense of any outcomes from the Fitbit data. Once the data tracking using the Fitbits began, weekly interviews took place on the same day and time each week during the 12-week data collection period. Based on the initial interviews, each teacher was given a “profile” to describe their personal life, teaching career, perceived stress, and coping mechanisms.

2.1 Teacher Profiles

2.1.1 Ms. Klein.Ms. Klein is a Caucasian 34-year-old suburban elementary school teacher who has taught general education to fourth graders for 11 years. She is married with two children and has a very active lifestyle. She typically works out 5-7 mornings a week. The majority (95%) of the students at her school are Caucasian and 20% are receiving free or reduced meals. Test scores at this school are above the state average. She perceives her stress as low, but also wants to work on her coping mechanisms. In her initial interview, she expressed that one of the most stressful things she’s felt in her career is that there is not enough time in a day to do all of the extra tasks teachers are required to do. When she gets stressed out, she has to “decompress by herself” so she will go into her classroom, make a to-do list and prioritize what she needs to get done versus what she wants to get done. In her initial interview, she stated that she does not like dwelling on her stressors, so she likes to knock them out as quickly as possible.

2.1.2 Ms. Conway.Ms. Conway is a 22-year-old Hispanic urban middle school teacher who has taught science to sixth, seventh, and eighth graders for less than a year. She is not married and does not have any children. Ms. Conway does not have a vigorous fitness routine but tries to keep a healthy lifestyle. She perceives her stress as “fresh” (i.e. common) as she sees it as similar to other first year teachers. When asked about what she typically stresses about, Ms. Conway spoke about their testing accountability by saying “Science is only tested in seventh grade...but, we still have to stay along with the pacing guide because 7th grade is tested 5th, 6th, and 7th grade science, and then, 8th grade, they’re going on to high school, so you want to make sure that they understand the basics of everything they’re going to be learning.” Her school is quite diverse as 32.8% of the students are Hispanic, 31.4% of the students are Caucasian, 26.5% of the students are African American, and 67% are on free or reduced meals. Test scores at this school are below the state average. In an initial interview with Ms. Conway, she stated that she stresses most about teaching 7th grade correctly because they are the group being tested based on her teaching. When she gets stressed out, she said “I want to be able to remain calm, because sometimes I may not be showing that I’m calm to my kids. And I don’t want to seem frustrated about things they can’t control.”

2.1.3 Ms. Chase.Ms. Chase is a Caucasian 29-year-old urban elementary school teacher who has taught general education to 4th graders for 5 years. She is married and has no children. Ms. Chase works out and runs frequently. At the time of this study, she was training to run a marathon. She perceives her stress as high, but also perceives her coping as high. At her school, 65% of the students are African American, 16% are Caucasian, 14% are Hispanic, and 90% are on free or reduced meals. Test scores at her school are below the state average. In the initial interview with Ms. Chase, she expressed that student behavior is a big stressor because of the low socio-economic status of the school. The school is located near a high drug trafficking area. “They deal with a lot of trauma, so a lot of them will shut down or be very explosive so it’s really hard to deal with because you don’t want them to miss anything, but you also don’t want the other kids to miss out either.” Her main source of coping is going to the gym as Ms. Chase joined a gym to help combat stress.

2.1.4 Ms. Reeman.Ms. Reeman is a Caucasian 46-year-old suburban high school teacher with 21 years of experience. She has taught many categories of social studies including American History, World Civilizations, Political Science, and Popular Culture. She is married and has 3 adult children. Ms. Reeman does not see herself as overly active, but she does try to add in a stationary bike workout once or twice a week. Of the

students in her school, 79% are Caucasian, 9% are Hispanic, 7% are African American, and 52% are on free or reduced meals. Test scores at this school are above the state average. In an initial interview with Ms. Reeman, she expressed that her main source of stress is student behavior and extra teaching duties such as professional development and other things required by the school district. "Behavior issues with kids can be very stressful...kids that aren't coming to school regularly...[and] extra work like PD stuff that we have to do that's required through the district can be very stressful."

3. Quantitative Data

Prior to the initial interviews, the participants were asked to complete three surveys: Preventative Resources Inventory (PRI, McCarthy & Lambert, 2001), Maslach Burnout Inventory (MBI, Maslach, Jackson, & Leiter, 1996), and Classroom Appraisal of Resources and Demands (CARD, O'Donnell, Lambert, & McCarthy, 2008). These surveys were given to determine baseline stress, coping skills, and burnout of each teacher in order to develop a clearer profile of the teachers prior to the study.

The PRI measures preventative coping skills, which is to what extent participants can use strategies and resources to reduce the impact of perceived stress. There are five factors included in McCarthy and Lambert's (2001) original instrument: perceived control, maintaining perspective, social resourcefulness, self-acceptance, and scanning. In previous research using the PRI (Lambert, McCarthy, Gilbert, Seabee, & Steinley-Bumgarner, 2006), the self-acceptance factor was shown to be an indicator of the other factors, thus the instrument was shortened to the 15likert-style questions from the self-acceptance factor. Self-acceptance questions included items such as "I know how to think about situations in a positive way" and "I can accept the fact that things will not always turn out the way I want."Fisher (2011) also used the condensed version of the PRI and found high reliability with the self-acceptance factor ($\alpha = .846$) thus the same version was used for this study.

The MBI is the most widely used burnout instrument and there are multiple versions used for a variety of careers. The teachers in this study completed the MBI for Health and Human Services – Educators version (MBI – ES; Maslach, Jackson, & Leiter, 1996). In previous research with teachers, the MBI has posted reliability of $\alpha = .895$ (Fisher, 2011). This 22-item instrument measures frequencies from 0 ("never") to 6 ("everyday") in three factors: depersonalization (i.e. "I feel I treat some students as if they were impersonal objects"), personal accomplishment (i.e. "I feel exhilarated after working closely with my students"), and emotional exhaustion (i.e. "Working with people all day is a strain for me").Due to the positive nature of the wording of the personal accomplishment questions, they were reverse coded for analyses.

O'Donnell, Lambert, and McCarthy (2008) use the imbalance between resources and demands to indicate stress levels; thus, the CARD instrument measures just that. The CARD was designed based on Lazarus and Folkman's (1984) transactional theory of stress in which stress is a result of demands outweighing resources. Resources can be material resources or cognitive resources and the CARD covers the variety of resources available for teachers. A series of likert-scale questions are provided that indicate the perceived resources in the teaching profession (i.e. office staff, counselors, materials provided) and another set of likert-scale questions are provided that indicate the perceived demands of the profession (i.e. disruptive children, paperwork, parent conferences). Once the perceived demands (D) and resources (R) are averaged, then subtraction of D minus R provides the researcher with a score to represent the stress of the participant. A positive score indicates the demands outweigh the resources (high stress) and a negative score indicates the resources outweigh the demands (low stress). There is not a "cut off score" to indicate when a person is stressed; however, the score obtained using the CARD can be used in comparisons and as a variable for stress in statistical tests. In previous research with teachers, the combined score (D minus R) has proven to have high reliability ($\alpha = .895$) with the reliability on the individual appraisals of demands and resources even higher (Fisher, 2011).

3.1 Fitbit Data

Each teacher in this study was given a stipend to purchase a Fitbit fitness tracker that records step count, heart rate, and sleep cycles. Throughout the 12 weeks of this study, each teacher's average data from their Fitbit was charted in order to find fluctuations in the three variables being measured using the Fitbits. The average resting heartrate (HR) was measured in beats per minute (bpm) and ranges from 40 to 100 bpm in healthy adults. The average resting heart rate is calculated when at rest throughout the 24-hour period of one day. As the heart rate increases during activity on particular days, it takes longer for the average resting heart rate to decline, thus resulting in a higher average. Research has shown that the variability in heart rates can predict stress levels since heart rates increase during stressful situations (Taelman, Vandeput, Spaepen, & Van Huffel,

2009). Stress can greatly impact the lifestyles of adults, which includes their sleeping habits (McEwen, 2008), thus sleep was measured in hours and minutes with the recommended amount of sleep for adults ranging from seven to nine hours per night. In terms of steps, average adults range from 5,000 to 7,000 steps per day with more active adults many times acquiring over 7,000. Since many teachers participate in physical activity beyond the requirements of the school day, emphasis was placed on the heart rates and sleeping habits before focusing on the step counts. More specifically, we chose to analyze each teacher individually and look for fluctuations in their Fitbit data around these three variables.

4. Qualitative Data

Qualitative data was collected when one member of the research team met with each teacher for an initial interview, and then a video interview once a week for the 12 weeks of data collections. In the initial interview, teachers talked about their fitness routines, life at work, possible stressors in their life, personal life, and coping mechanisms. During the weekly interviews, our goal was to find out what events occurred on the days that were most stressful and how they coped with those stressful situations. Using the data from their Fitbit, we chose high heart rate, high step count, and low sleep as indicators for more stressful days (McEwen, 2008). Prior to beginning the interview each week, the interviewer logged into the teachers' Fitbit account and recorded their data for the week into a chart. Then, the interviewer asked the teachers to discuss the days that week in which their step count and heart rates were the highest and their sleep was the lowest, or where we saw abnormal fluctuations occurring with all three variables. The teachers were also given the chance to share any other experiences of the week that were not already asked. The interviews were conducted individually with their corresponding investigator once a week, usually on the same day and time of the week. The same investigator was paired with each teacher throughout the study in order to create relationships of trust between the teacher and the researcher. By the end of the twelve-week period, the teachers were monitoring their Fitbit data and could predict the days that would be questioned during their interviews. A final interview was conducted to wrap up data collections and finalize their thoughts on the research process.

4.1 Qualitative Validity

In order to gain validity with qualitative data studied from the lens of the participants, Creswell (2000) recommends the process of member checking in order to "confirm the credibility of the information and narrative account" (p. 127). After all interviews were completed and transcribed, each teacher participant was given a copy of the transcripts and given time to review, edit, redact, or comment on their narrative being shared. None of the teachers found any errors or stories they would like to redact from the study. It should be noted, however, that prior to sharing the transcripts, all names (students, parents, colleagues, etc.) were removed from the transcripts. To further validate our findings, the use of data triangulation was also used in that all findings consisted of the convergence of three data sources: initial surveys measuring stress, burnout, and coping; Fitbit data; and interview data (Creswell, 2000).

4.2 Data Analysis

"Category Construction" was used to analyze the interview data for emergent themes (Merriam, 2009). Merriam (2009) suggests identifying "segments in your data set that are responsive to your research question" (p. 203). Thus, a table was created to separate the transcriptions into the common themes based on the literature reviewed for the study (particularly stress and coping). Once the data spreadsheet was created and populated, the stress and coping mechanisms from each week were read by all members of the research team and a set of codes were established based on recurring themes in those two themed columns of the spreadsheet. Then, after those initial codes were established, one co-investigator and the principal investigator assigned codes per teacher per week, separately, then came together to discuss and come to consensus on assigned codes (Harry, Sturges, and Klingner, 2005). This resulted in 100% agreement after the consensus coding process. During this process, codes were added when coping mechanisms or stressors were revealed in the data that were not prevalent in the initial code development and others were refined by collapsing some similar codes or renaming codes with more appropriate names. This process resulted in two additional stress codes and one additional coping code created (see Table 1).

Table 1. Stress and Coping Codes

Stress Codes (S)	CopingCodes (C)
S1- Professional Development	C1- GoingOut
S2- StudentBehavior	C2- HealthyLiving
S3- Extra Tasks	C3- Beverages
S4- Accountability	C4- SelfCare
S5- Extra Classes/Students	C5- Staff/AdministrationSupport
S6- Professional Relationships	C6- Family/Friends/Spouse
S7- StudentNeeds	C7- T.V., Reading, Video Games
S8- Personal	C8- Other
S9- Other	C9- UpcomingHolidayBreaks
S10- No School	
S11- ParentCommunication	

5. Results and Discussion

Table 2 shows the stress, burnout, and coping scores as measured from the CARD, MBI, and PRI, respectively, for each of the four teachers as well as the average of those scores from the same surveys used in the Fisher (2011) study. Since the Fisher study used the same measures with a larger sample size, the averages from that study are being used as a comparison for the four participants in the current study. The table also includes the average daily heart rate, average daily sleep, and average daily step count of each participant throughout the 12-week duration of the study. In the current study as well as the original Fisher(2011) study, the average stress score shows that resources were higher than demands since the averages were below 0. The burnout score indicates that the average amount of burnout amongst teachers from the previous study conducted by Fisherin 2011 was 1.92.

Table 2. Stress, burnout, coping scores, and average daily Fitbit data by teacher

	Klein	Conway	Chase	Reeman	Average (Fisher, 2011)
Stress	-1.95	-1.32	-.61	-.47	-.209
Burnout	1.32	2.09	2.36	1.14	1.92
Coping	4.93	3.60	3.93	4.73	4.06
Average HR	61.54	70.17	53.48	53.31	
Average Sleep	7:18	6:48	8:27	6:59	
Average Steps	9,065	9,623	7,933	6,056	

When comparing the four teachers in the current study, Ms. Reeman and Klein were both below average in burnout scores while Ms. Conway and Chase were both above the average. In regard to coping, the average score from the previous study was 4.06 (Fisher, 2011). In the current study, similar results prevailed with Ms. Reeman and Klein having above average coping while Ms. Conway and Chase had below average coping. It should be noted that Ms. Conway and Chase were also the two teachers that were teaching in urban schools, and they were also the least experienced teachers. While their lack of experience could be an indicator for their below average coping skills, many factors could be attributed to their burnout. Fisher (2011) found that novice teachers experienced higher burnout than experienced teachers and Ms. Conway and Chase follow that same pattern. Additionally, O'Donnell et al. (2008) found that teachers in low SES schools experience higher emotional exhaustion (a component of burnout) and since Ms. Conway and Chase are both in urban schools with a lower SES, then their results support those findings.

5.1 Stress

The totals of stress codes in Table 3 represent the total number occurrences across all four teachers in all 12 weeks. The most common stress code was student behavior (S2). S2 appeared 26 times among all four teachers' transcriptions, occurring 10 more times than the next most used codes, Accountability (S4) and Personal (S8). The student behavior stressors occurred when students misbehaved during class, on field trips, or in other times when they were under the supervision of the teacher. There were some weeks in which multiple student behavior codes were applied with each teacher. Multiples of the same code were only counted when the instances were unique. For example, in week 10, Ms. Chase discussed two distinct cases of student behavior concerns when she described one student who slept all morning and she and her colleagues could not motivate him, and another instance of a student whose grandfather passed away. She described that

second instance by saying “now he lives with his mom but he was telling me [he] kept picturing his grandpa dying and I immediately sent him to the counselor...It started off just that he was sad but then he was saying he was having suicidal thoughts.” On the other hand, Ms. Conway discussed a disastrous field trip that occurred in week 12 and that same field trip was mentioned in multiple responses, thus it was only coded once as S3 (extra tasks).

Table 3. Stress codes by teacher

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
Klein	1	8	5	4	0	0	3	2	2	3	3
Conway	0	3	2	2	1	2	0	0	2	0	0
Chase	3	8	4	8	7	4	2	3	3	2	1
Reeman	2	7	2	2	0	0	0	11	3	2	0
Total	6	26	13	16	8	6	5	16	10	7	4

Ms. Chase and Ms. Klein had the highest frequency of S2. Ms. Chase notes that she has had several instances of student behavior problems among different students in the same day; usually with a particular student with an emotional/behavioral disorder and her new students in the classroom. Mrs. Klein often worried about one student because she knew when he would put on a specific hoodie, he was under distress and would most likely struggle in his educational performance that day. She also struggled with classroom behavior on days that the school had assemblies, fields trips, or anything that may have thrown the students' routine off track. After student behavior, accountability (S4) and personal (S8) were the codes that occurred the most often at 16 instances. Accountability refers to ensuring students are meeting standards, classroom visits from the principal, and school walkthroughs from the district. The personal (S8) code was used when the teacher noted events in their personal lives that caused stress for the week. Due to the holiday breaks that occurred during the data collection period (November through February), many of the personal stressors involved decorating, buying gifts, cooking for family, and other typical events that occur around US holidays.

5.2 Coping

There were nine codes used to model the coping mechanisms the teachers employed throughout the study. The frequencies of each of the coping codes are found in Table 4. The most common coping code was self-care (C4). Self-care was coded when teachers referred to self-care techniques such as taking baths, napping, getting a massage, or general relaxation techniques. C4 appeared 25 times among all 4 participants' transcriptions and was the most common among Ms. Klein. Her most frequently used self-care technique was taking baths. The next most common coping code was Healthy Living (C2) and those were coded when the teacher referred to exercise, gym time, yoga, and living a healthy lifestyle. C2 appeared 16 times among all 4 participants and was most common in Ms. Chase. Every week, Ms. Chase mentioned either yoga, the gym, or getting a massage.

Table 4. Coping codes by teacher

	C1	C2	C3	C4	C5	C6	C7	C8	C9
Klein	2	3	0	10	6	0	1	4	1
Conway	0	1	0	2	0	0	1	0	2
Chase	7	11	0	7	1	2	4	2	1
Reeman	2	1	6	6	0	1	5	1	0
Total	11	16	6	25	7	3	11	7	4

5.3 Fitbit Results

Line graphs were constructed to manage all data for each individual teacher. The numbers on the x-axis represent the weeks that Fitbit data was collected. The left y-axis represents the average amount of sleep for the week in hours, and the average amount of steps for the week (divided by 1000 to fit onto the table). The right y-axis represents the average resting heart rate for the week in beats per minute. The dotted lines represent the teacher's overall average of sleep (dark grey), steps (black), or heart rate (light grey) throughout the study. We chose to define high levels of stress by weeks indicating above average heart rate, above average step count, and below average sleep.

5.3.1 Ms. Klein. Over 12 weeks, Ms. Klein's average resting heart rate was 61.51 beats per minute. Her average amount of sleep a night was 7 hours and 18 minutes and her average daily step count was 9,065 steps. Her Fitbit data is provided in Figure 2.

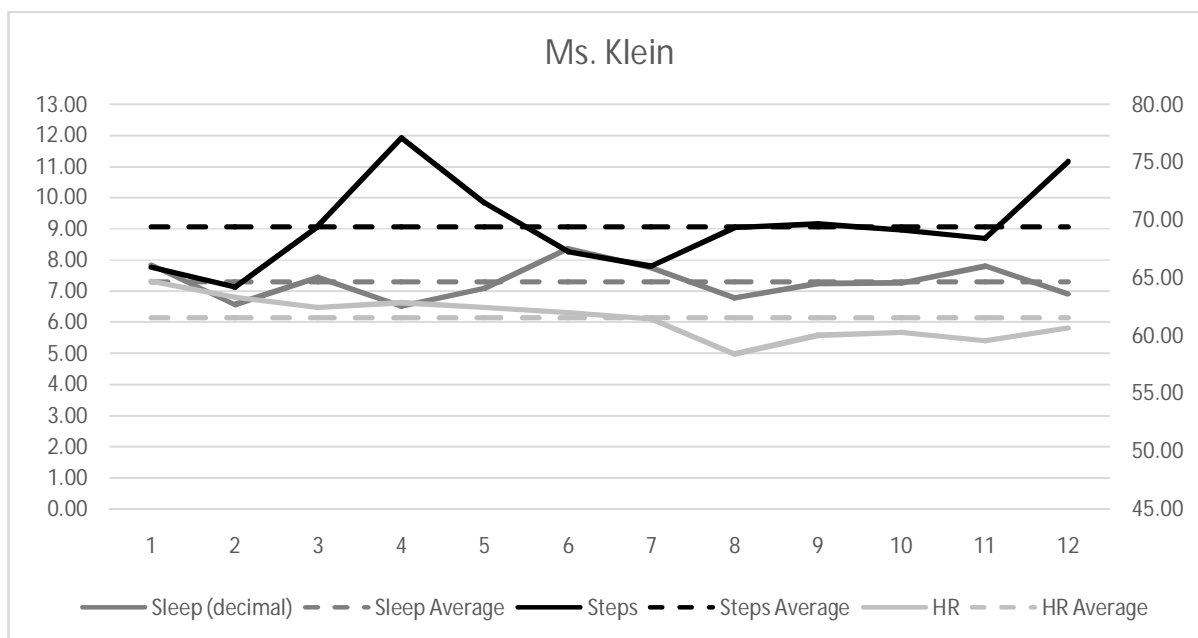


Figure 2. Ms. Klein's weekly Fitbit data.

Based on Ms. Klein's data, weeks 4 and 12 were further investigated. When week 4 of her transcriptions were studied further, it was noted that she stayed after school for student clubs (S3) and parent-teacher conferences (S11). Her main coping mechanism for this week was taking baths (C4). When week 12 of her transcriptions were studied, it was noted that a student wrote a death note to herself, making it look like someone else wrote it, which caused concern for Ms. Klein (S2) and the student's parents. She stayed after school and held a conference with the student's parents. Ms. Klein's coping mechanism for that week was also taking baths (C4).

It should be noted that, prior to beginning the study, Ms. Klein had the lowest stress and highest coping score. Her ability to prevent stressful events, as measured by the PRI, could be linked to her lower stress score, as evidenced by the CARD. During the 12 weeks of interviews, Ms. Klein discussed 31 unique stressors, but she did not acquire codes S5 (extra classes/students) and S6 (professional relationships) which can both be connected to her school-level administrators. As a matter of fact, six times, she was assigned code C5 (staff/administration support) as a coping mechanism for stress instead of being the cause of the stress. In one situation that occurred in week 4, she spoke about a disastrous trip to a nearby nursing home. The students were misbehaved, and it got beyond her control (S2). She said "I was a complete mess. I went home and cried." But she then stated, "The next morning, it worked out...My boss had given me flowers, and I had a talk with my students about it" (C5). Previous research has shown that administrators can be a key component in creating more stress for teachers, or they can be supportive in helping teachers cope with stress (Prilleltensky, et al., 2016) and Ms. Klein appears to be in a situation where her administration is a supporter instead of a cause for stress.

5.3.2 Ms. Conway. Over 12 weeks, Ms. Conway's average heart resting rate was 70.17 beats per minute. Her average amount of sleep a night was 6 hours and 48 minutes. Her average step count was 9,623 steps. Her Fitbit data is provided in Figure 3, below.

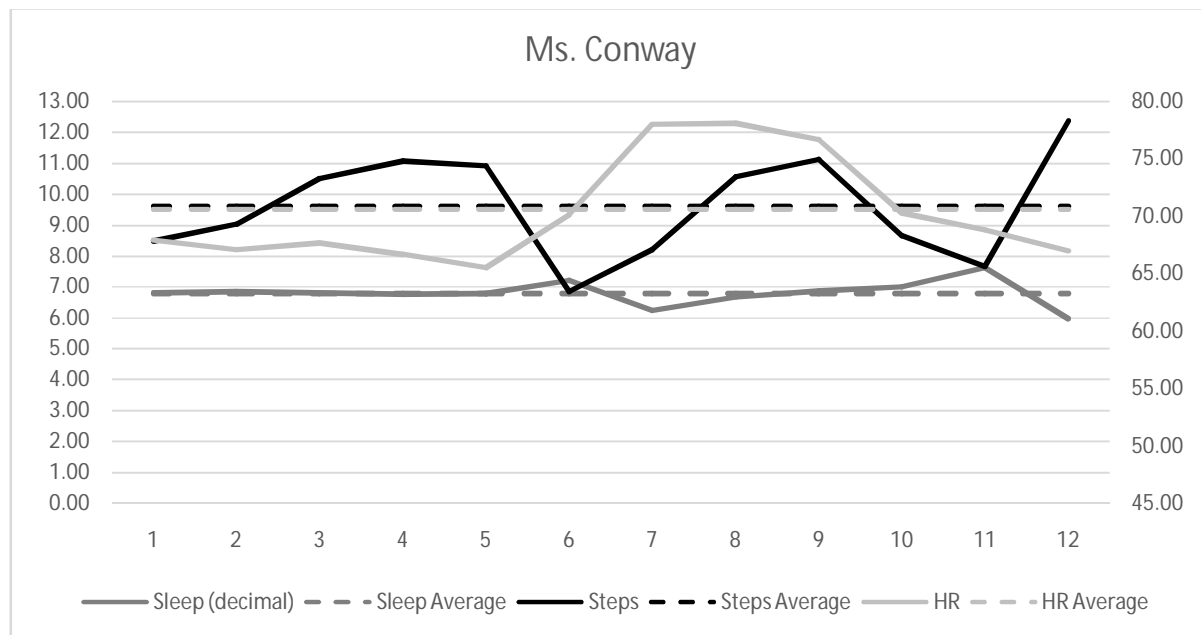


Figure 3. Ms. Conway's weekly Fitbit data.

Based on Ms. Conway's data, weeks 8 and 9 were further investigated. When week 8 of her transcriptions were further investigated, Ms. Conway's stress centered around her sympathy for a student that had committed suicide over the weekend (S7). When asked what caused her to get so many steps that week, she replied "I was walking around making sure everyone was doing okay and helped those who needed the extra help in the school." Her main coping mechanism for this week was extra sleep (C4). When week 9 of her transcriptions were studied, it was noted that a teacher had left unexpectedly, giving her an extra class and a planning period was taken away (S5). Ms. Conway's coping mechanism for that week was taking baths (C4).

Prior to the start of the study, Ms. Conway had the lowest coping score and above average burnout. Ms. Conway's overall Fitbit data revealed she had the highest average heart rate, lowest average sleep, and highest average steps of all four teachers during the 12 weeks of data collection. All of this together should point to the fact that Ms. Conway is dealing with the highest level of stress of the four teachers, however she still measured below average in stress based on her score from the CARD instrument. It should also be reiterated that she is the only first-year teacher in the study, and she is teaching at a very challenging urban middle school. While the demands for teaching in this type of school could be high, Ms. Conway very strongly scored the resources that are also available to her, which is how her resources outweighed the demands of her job. When coding her interviews, she only acquired four unique coping codes: C2 (healthy living), C4 (self care), C7 (T.V., reading, video games), and C9 (upcoming holiday breaks), while the other three teachers in the study acquired seven to eight different coping codes throughout the study. Research has shown that teachers in their first three years of teaching are the most vulnerable (Prilleltensky, et al., 2016) and Ms. Conway's results support the need for additional support mechanisms in place for teachers in the early years of their careers.

5.3.3 Ms. Chase. Ms. Chase's average resting heart rate over 12 weeks was 53.48 beats per minute. Her average sleep was 8 hours 27 minutes, and average steps were 7,933. Her Fitbit data is provided in Figure 4, below.

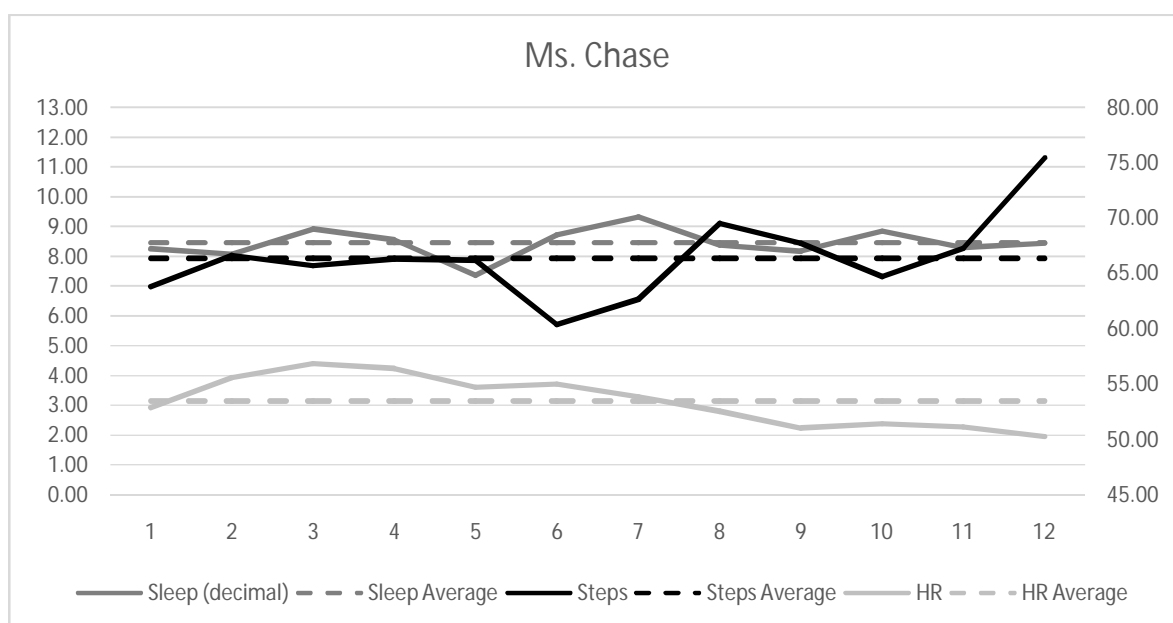


Figure 4. Ms. Chase's weekly Fitbit data.

Based on Ms. Chase's data, weeks 3, 5, and 12 were further investigated. During week 3, Ms. Chase expressed that a student in her class with an emotional behavioral disorder was being disruptive, leaving the room, and not completing any work. "She shuts down and she won't work for anybody" (S2). Ms. Chase's main coping mechanism was going to the gym (C2). During week 5, Ms. Chase stated that a teacher quit, and those students were split among the two remaining teachers, meaning that Ms. Chase gained 8 new students, increasing her class size from 18 to 26. "I was told they're taking out one of the fourth-grade teachers and they're splitting her class. So, I will have half of her kids starting in January" (S5). To cope with this, she mentioned shopping and going out with friends (C1).

Several things occurred during week 12 for Ms. Chase. One of which was a school-wide lockdown after there was a standoff between police and a shooting suspect in a nearby neighborhood. "There was a standoff at an abandoned home and that was right in the neighborhood, so the principal made the decision that we couldn't send the kids home. We had to contact every parent, and this was the last 30 minutes of the day. We were supposed to contact all the parents and let them know and then halfway through I had only gotten ahold of one parent, just one. A lot of their phone numbers didn't work and then they made an announcement that the issue was resolved so we could send the kids home. It was a lot of stress" (S3, S11). Another was that she was dealing with a student who had thoughts of self-harm and she received a new student with an IEP. (S2, S7).

Prior to the start of the study, Ms. Chase had the highest burnout score and below average coping, but still scored a below average stress score when compared to the Fisher(2011) study. It should be noted that her stress score of -0.61 is very close to 0, which indicates equilibrium with perceived resources and demands. When scoring the resources and demands of her position, she scored her resources the lowest of all four teachers, but considering she also scored her demands lower, it resulted in a stress score close to 0. When coding Ms. Chase's weekly interview data, she acquired the most codes of all four teachers in the study. She noted at least one instance of every stress code used (S1 through S11) and noted at least one instance of all but one of the coping codes (C3 was not coded). We would like to highlight that while Ms. Chase acquired the S2 code (student behavior) eight times over the twelve weeks of the study, she also acquired the S4 (accountability) code eight times, which was more than double any other teacher in the study. This frequency of accountability stressors could be linked to the fact that she is a teacher in one of the lowest performing elementary schools in the state; thus, the standardized testing and accountability measures are at the forefront of the administration and faculty at her school.

5.3.4 Ms. Reeman. Ms. Reeman's average resting heart rate over 12 weeks was 53.31 beats per minute. Her average sleep was 6 hours 59 minutes, and average steps were 6,056. Her Fitbit data is provided in Figure 5, below.

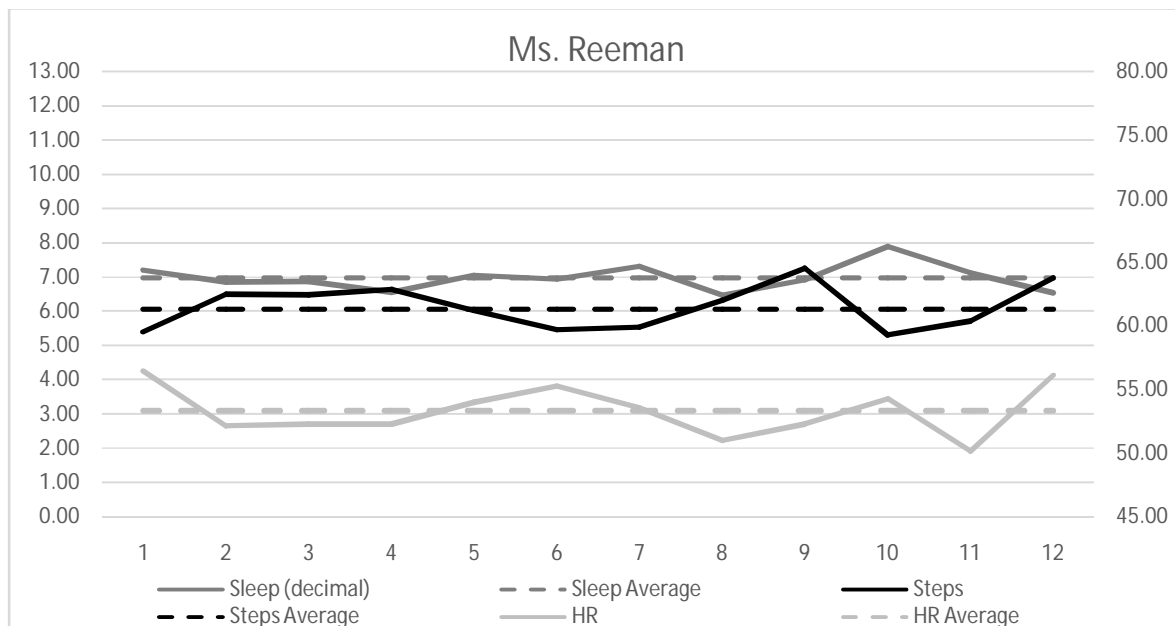


Figure 5. Ms. Reeman's weekly Fitbit data.

Based on Ms. Reeman's data, weeks 8 and 11-12 were investigated. During week 8, Ms. Reeman was dealing with a lot of cell phone issues in her classroom and arguing with students over this issue, which is a typical struggle of a high school teacher (S2). To cope with this, Ms. Reeman drank coffee and took a nap (C3, C4). Ms. Reeman often drinks coffee to relax when coming home at the end of the day. She is the only teacher that coded a C3 coping score (beverages) during the 12 weeks of the study.

Her stress went up during week 12 due to a verbal and then physical fight in her classroom between a male and a female. "I had to break up not a [physical] fight but, kids arguing back and forth about something that was posted on social media. So, I kind of had to step in and calm some kids down and then I had to turn their names in to the principal because I was afraid it was going to escalate into an actual fight. It was a guy mad at a girl because she had posted something about his girlfriend" (S2).

Prior to the start of the study, Ms. Reeman had the highest stress score, lowest burnout score, and above average coping skills. While her stress score was the highest, it was still below the average from the Fisher(2011) study; however, it should be noted that the version of the CARD used in this current study was initially created for elementary level teachers. A secondary level version of the CARD exists (Fisher, 2011), but for data comparison, we opted to use the same version for all four teachers in this study. The mismatch between Ms. Reeman's stress and her other scores could be linked to the fact that the CARD was not a perfect match for her job as a secondary level teacher.

One interesting outcome from coding Ms. Reeman's interviews was that while she also coded multiple stressors involving student behavior (such as the fight mentioned above), it wasn't her most common stressor. Unlike the other teachers, Ms. Reeman regularly noted personal stressors in her life (S8), and she mentioned those 11 times throughout the study. As the oldest teacher in the study and the only one with adult-aged children, her personal stressors came to the forefront, especially because this study took place over two major US holidays (Thanksgiving and Christmas) as she noted multiple occasions where she was preparing to entertain family for the holidays.

6. Conclusion

Due to the lack of research using Fitbits to measure stress in any situation, we were cautiously optimistic that we could find linkages between the data from the Fitbits and the stress in the teachers' everyday lives. This is an introductory study to attempt to find ways to measure teacher stress beyond using self-reported data. The small sample size of this study was a limitation in that it prevented us from conducting significance testing on the quantitative data from the surveys or the Fitbits. We found that by using the notion that high heart rate, high steps, and low sleep would indicate more stress, we could ultimately track the stressors that teachers were experiencing in their everyday lives.

Based on the teachers in this study, poor student behavior was the most recurring stressor. That code appeared 26 different times over all 4 transcriptions. These instances of student behavior included situations in the classroom and outside the classroom as long as the teacher was responsible for the students. Some particular instances of poor student behavior occurred during field trips away from school. There are mixed results in previous research regarding whether student behavior and academic skills are linked to teacher stress (Ouellette, et al., 2018; Bottiani, et al., 2019), however in our current study, it was the most prevalent stressor noted in weekly interviews. It should be noted, nonetheless, that frequency of particular stress codes does not imply they are the strongest *predictor* of overall stress, rather, they are simply the most common occurring stressors or demands of the profession. Stress is measured by weighing those demands with available resources, thus determining stress is not as simple as counting the number of times behaviors occur and this study is merely scratching the surface of this topic.

Similar arguments can be made regarding the effectiveness of the coping mechanisms from this study. Based on the teachers in this study, self-care was the most recurring coping mechanism. Self-care included factors like taking baths, getting extra sleep, meditating, or doing yoga. Self-care was reported 25 different times over all 4 transcriptions. The next most noted coping mechanism was healthy living techniques such as running and going to the gym. Overall, the coping mechanisms reported the most were those that correspond to a healthy body and lifestyle. We would like to reiterate that the Preventative Resources Inventory (PRI) does measure the ability to prevent stressful situations from occurring and our interviews focused on the coping mechanisms that occurred after the stress was induced. So, future research should be conducted to find a connection between those two types of coping resources in order to find ways to convert post-stress coping mechanisms to preventative coping mechanisms.

As with any human subjects research, there is always room for human error. In some cases, the teachers would remove their Fitbits to shower or charge them, and would forget to put them back on; thus, there were a few instances where data was missing for a day, which could confound the results. But, overall, the teachers were very open and honest about their daily lives and provided us with a plethora of data that highlight the highs and lows of the teaching profession. One unintended outcome was that all four teachers noted during the last interview that they became more hyper-aware of their Fitbit data throughout the study and could feel when they were getting stressed before they would check their data. They began checking their own data each day and knew which days we would ask about and most of the teachers would take notes on those days in preparation for the interview. It was found that in most cases, those days were the ones they felt the most need to discuss due to the occurrence of the stressful events. Ms. Chase even noted in her final interview that she would find herself checking her heart rate during the day and alerting her students that her heart rate was increased, so they were stressing her out. We are optimistic that this is an indicator that the variables measured with the Fitbit can be viable measures of stress. Future research is warranted with larger sample sizes and an increase in data collection points, possibly through daily journals or logs where the teachers can record events daily instead of having to recall a week of events for an interview.

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