Feasibility of Virtual Exercise Intervention on Occupational Fatigue, Perceived Burnout, and Daily Sleep Time Among Family Medicine Residents

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Abstract

Introduction: A career in medicine is a job of demanding hours by sacrificing one's own needs, causing an increase in mental fatigue and burnout syndrome. The purpose of this study was to examine the impact of a short-term tailored virtual exercise intervention on occupation-related fatigue, perceived burnout levels, and daily sleep time among family medicine residents. **Methods:** Thirteen participants were recruited and asked to complete two questionnaires related to occupational fatigue and perceived burnout level. They were then asked to wear three monitoring devices (thigh, hip, and wrist) for fourteen consecutive days (one-week overnight shifts and another week of non-overnight shifts). Based on the feedback gained during a virtual interview with each participant on current exercise habits and perceived exercise barriers, a three-week tailored exercise program was developed, and videoclips demonstrating the exercises were prerecorded. During the second and third weeks of the intervention period, participants were asked to wear the three devices. Post-intervention questionnaires on fatigue and burnout were completed. Paired sample t-tests were employed to examine the changes in outcome variables from baseline to during intervention. **Results:** One participant withdrew from the study due to injury; therefore, 12 participants were included in the analyses. Total sleep time was higher during day shifts compared to night shifts for both baseline and intervention periods. In relation, there was a significant decrease in chronic fatigue from baseline to during-intervention. Acute fatigue and inter-shift recovery improved from baseline to intervention, but not statistically significant. A result of the three-week intervention showed chronic fatigue significantly decreased from baseline to during-intervention (p <.05). Acute fatigue and inter-shift recovery slightly improved from baseline to intervention but did not show a statistically significant difference. No significant changes were seen in three subscales of the burnout inventory. Daily sleep time was also higher during day shifts than night shifts for baseline and intervention periods (p <.05). **Conclusion:** Longer intervention period with a larger sample size is warranted to explore the effectiveness of the virtual exercise program on family medicine residents' perceived burnout, sleep patterns, sedentary behavior, and physical activity levels.

Introduction

The sufficient care given by healthcare workers is greatly impacted by the physical and psychological well-being of the employees themselves. The term burnout is defined as a psychological syndrome in response to chronic interpersonal stressors from workplace

demands associated with emotional exhaustion, depersonalization, and diminished personal accomplishment (Maslach & Leiter, 2016). Those who work as medicine residents are at a higher risk for burnout relative to the longer work hours, increased stress levels, sleep deprivation, and lack of leisure time during residency training (Baer et al., 2017). Once in existence, burnout can persistently continue throughout the residency (Campbell et al., 2010; Pantaleoni et. al., 2014). A national study showed physicians were more likely to develop symptoms of burnout and be discontent with their work-life balance (Shanafelt et al., 2012). Prior literature has mainly focused on internal medicine and surgery with no specific studies showing a relationship between burnout and self-reported attitudes and behaviors (Baer et al., 2017).

Current research shows little information on specific exercise intervention strategies for reducing burnout and occupational fatigue in medical residents. Organizations are able to utilize strategies for the workplace to address burnout by altering work hours, changing workload, modifying work tasks and providing educational knowledge pertaining to burnout, wellness, and management of stress (Ishak et al., 2009). A study completed by Kancherla found that by acknowledging hours, responsibility, and central role of sleep contributing to burnout was an essential part of helping a physician's work life. It also stated sleep deprivation was a main risk factor for burnout occurring from night shifts, clinical clerkship, on-call, prolonged work hours, moonlighting (staying awake in the night), and inadequate recovery (Kancherla, et al., 2020).

Prior research showed a significant decrease in reported acute fatigue and an increase in sleep quality among the nursing-assisted personnel following the implementation of fatigue management strategies. In a study focusing on burnout, medical staff evaluated on one of the four intervention units reported a significant increase in inter-shift recovery and an improvement in sleep quality following the implementation of fatigue management strategies (Seaman et al., 2015). According to van Vandeloo et al., Dutch medicine residents who had 12 shift hours less than the Belgian medicine residents reported a lower prevalence of burnout syndrome. This type of learning environment increases the risk of developing burnout syndrome among residents with high educational demands and a lack of autonomy. Results of this study showed medicine residents in all specialties presented a high prevalence of burnout syndrome, and their psychological condition continued to arise from a continued response to chronic interpersonal stressors while at work. It was also shown that the clinical clerkship included schedule changes every 4–8 weeks leading to a shift change in hours of the day of time was also a factor in burnout syndrome (van Vendeloo et al., 2018). A career in medicine is a job with high demand hours that require individuals to sacrifice their own needs. Therefore, it is important to decrease the possibility of mental fatigue and burnout syndrome. By understanding the relationship between sleep patterns and mental fatigue, residents can assimilate their personal needs to do their job as medical professionals safely and effectively. The strenuous lifestyle of a resident can impact their quality of life, patient care, and performance as medical health professionals. Current research does not pertain to a virtual exercise intervention on the burnout out and mental fatigue on family medicine residents, allowing this study to work towards filling that gap.

The purpose of this study is to analyze the relationship between a short-term, tailored virtual exercise intervention, as well as occupation-related fatigue, perceived burnout levels, and daily sleep time for family medicine residents. Sleep variables will also be measured to analyze an association with mental fatigue levels. This study aims to replicate statistics in a

clinical health system to help further understand and explore effective intervention strategies to manage burnout and mental fatigue. There were two main hypotheses in this study: 1) chronic fatigue, acute fatigue, and inter-shift recovery will improve after the three-week virtual exercise intervention among family medicine residents, 2) perceived burnout level will decrease after the three-week virtual exercise intervention among family medicine residents.

Methods

Participants

A total of 15 family medicine residents were recruited through email and virtual meetings. Five residents were employed and were from first-, second-, and third-year cohorts at the Mayo Clinic Health System. All participants were required to have a fundamental knowledge of technology to access the virtual workout program and Qualtrics surveys. Prior to their participation, 13 participants signed an informed consent form. This study was approved by the Mayo Clinic Institutional Review Board.

Instrumentation

Sleep and Posture

The device used to categorize sleep and posture is called activPAL (PAL Technologies Ltd., Glasgow, Scotland). The version PALConnect Version 8.12.6.118 was primarily utilized for initiating and downloading data while the PALanalysis version 8.11.8.75 was used for the CREA algorithm 1.3 to analyze the data collected. The activPAL device contained an inclinometer device used to sense mixed postural shifts such as sitting, lying down, or standing. This device was also used for collecting variables related to sleep duration and the number of horizontal shifts each night. Participants were instructed to wear the activPAL device on the anterior mid-thigh of the non-dominate leg with a medical-grade 3M Tegaderm adhesive. The activPAL device was worn concurrently with the ActiGraph device during pre- and post-intervention periods and was advised to be taken off only for bathing or water-related activities. The activPAL device reliability has been found to be in an ICC range of 0.78-0.99 during a classification intervention ($p<.05$) (Lyden et al., 2018).

Sleep, Postures, and Physical Activity

The ActiGraph (ActiGraph LLC, Pensacola, FL, USA) was a device used to measure physical activity, intensity-specific, postural behaviors, and sleep characteristics of participants. ActiLife 6 software Version 6.13.4 and ActiGraph wGT3X-bt were used to gather specific variables such as frequency of exercise, intensity-specific, exercise duration, and time spent sitting, lying down, or standing. Other variables measured during sleep duration were total sleep time, total time in bed, number of disruptions per night, and the average length of disruptions made during sleep time. Participants were instructed to wear the ActiGraph device on the right wrist concurrently with the activPAL device during the two monitored periods and were advised to be taken off only for bathing or activities involving water. The ActiGraph device reliability has been found to be an ICC value of 0.99 (McClain et at.,).

Occupational Fatigue and Inter-shift Recovery

Online surveys were given to participants to ensure contactless interaction concerning

their burnout and mental fatigue. An online format Qualtrics was used to acquire responses regarding basic demographic information including age, cisgender, date of birth, year of residency, height in centimeters, waist circumference in centimeters, weight in pounds, and their declared dominant hand. Pre-intervention participants were asked to complete an online questionnaire related to occupational fatigue called Occupational Fatigue Exhaustion Recovery Scale (OFER 15). The OFER 15 measured variables on three subscales of mental fatigue such as acute fatigue, chronic fatigue, and inter-shift recovery (Winwood et al., 2005).

Perceived Burnout Level

The Maslach Burnout Inventory (MBI) measured emotional exhaustion, depersonalization, and personal accomplishment; all of which were three subscales of burnout. The MBI has been utilized in over 90% of studies focusing on burnout and has generally been regarded as a classification tool that appoints individuals to categories of burnout instead of a calculated point system for the burnout continuum (Shi et al., 2019). Participants were given a visual analogue scale that measured their mental fatigue level every day during the two monitoring periods.

Study Procedure

All participants were assigned an ID number for classification purposes that allowed them to be nonidentifiable throughout the study. Over a 6-month period, participants were individually going through their two monitoring periods based on their own schedule and availability, therefore, all participants were not going through the data collection process simultaneously. Each participant went through the same procedures beginning with two Qualtrics surveys: the Maslach Burnout Inventory and the Occupational Fatigue Exhaustion Recovery 15. Prepped and given to them at the start of their process was a bag with materials such as 14 days of log sheets, 30 Tegaderms, device application instructions, ActiGraph device, and an activPAL device in protected lining. The Wednesday prior to their scheduled monitoring period, the bag of materials was dropped off and picked up at the family medicine reception desk within the Mayo Clinic Luther campus. Data collection was scheduled to begin at midnight on Sunday when participants were instructed to place both devices on the designated part of their body before bed. Starting at midnight, the device was programmed to begin monitoring for 14 days. One week of monitoring occurred during overnight inpatient work shifts and another week during non-overnight shifts for a baseline. After 14 days of collecting data, participants were interviewed by the principal investigator to better understand the resident's time availability, lifestyle habits, exercise preferences, and perceived exercise barriers. In response to their worn devices and interviews, a three-week tailored exercise program was developed and tailored to each individual. Participants were given a prerecorded tutorial for each exercise in their program. After the three-week exercise intervention, participants were once again given the MBI and OFER 15 questionnaires. To show our gratitude, participants received a YETI Water Bottle and were provided with a summary of the results.

Data Analysis

This study design was a complex, experimental study because of the cause-and-effect relationship between exercise intervention and burnout, mental fatigue, and sleep disruptions. A one-group pretest-posttest design was employed when comparing results from baseline activity

and sleep monitoring and the third week of intervention monitoring. Given the pre- and post-intervention comparison, a paired sample t-test was utilized within the study. All monitoring information from the Actigraph and activPAL device was uploaded and stored onto Microsoft Excel where each participant's data had their own spreadsheet. Calculating the MBI responses was based on a 7-point likert scale reflecting 22 given statements. All questions were divided into three subscales of categories regarding burnout: emotional exhaustion, depersonalization, and personal accomplishment. To calculate the OFER 15 responses, scores were received from a 7-point Likert scale from the level of agreement participants chose based on 15 statements. All questions were divided into three subscales of mental fatigue: acute fatigue, chronic fatigue, and inter-shift recovery. To compare baseline and intervention results, a paired sample t-test was utilized to calculate the totals from both the MBI and OFER 15 questionnaires. The statistical significance was set at ($p<0.05$) where data and tests were run through the IBM Statistical Package of Social Sciences (SPSS) version 28.

Results

Of the 15 volunteers contacted, 13 volunteers signed the consent form prior to the start of the study. One of the 13 participants withdrew from the study due to injury, therefore, 12 participants went through the full study (n=12). One participant had inaccurate activPAL data for both baseline and intervention monitoring periods and was excluded from the data analysis. There were three additional participants that contained inaccurate activPAL data for the intervention monitoring period, therefore, excluded from the paired samples t-tests involving intervention data. Participants' data were considered in the study if they had four days of valid and consistent data within a monitoring period. The devices needed to record at least twenty hours of data each day to be considered valid (Dowd et al., 2012). All 12 participants were female with four participants apart from each residency program year. The ages of participants ranged from 27-41 with an average age of 31 years old ± 3.95 years.

Paired Sample T-Tests

A series of eight different paired sample t-tests were run using an alpha level of .05. The first paired sample t-test indicated daily sleep time obtained from the activPAL device during baseline night shifts was significantly less than daily sleep time during baseline day shifts, $t(9) = -2.88$, $p = .018$. The second paired sample t-test indicated daily sleep time obtained from activPAL during intervention night shifts was not significantly different from daily sleep time during intervention day shifts, $t(6) = -0.36$, $p = .729$. The third paired sample t-test compared baseline night shift daily sleep time to intervention night shift daily sleep time, and showed there was no significant difference, $t(7) = -0.60$, $p = 566$. The fourth paired sample t-test compared baseline day shift daily sleep time to intervention day shift daily sleep time and showed there was no significant difference, $t(6) = 1.01$, $p = 351$. Refer to Table I for descriptive statistics; daily sleep time by shift type and time (Baseline vs. During-Intervention). The fifth paired sample t-test indicated the number of awakenings obtained from ActiGraph wrist device during baseline night shifts was significantly less than the number of awakenings recorded during baseline day shifts, $t(8) = -2.68$, $p = .028$. The sixth paired sample t-test indicated the number of awakenings obtained from ActiGraph wrist device during intervention night shifts was significantly less than

the number of awakenings recorded during intervention day shifts, $t(8) = -2.59$, $p = .032$. The seventh paired sample t-test indicated the number of awakenings obtained from ActiGraph wrist device during baseline night shifts was not significantly different than the number of awakenings recorded during intervention night shifts, $t(8) = 1.19$, $p = .269$. The eighth paired sample t-test indicated the number of awakenings obtained from ActiGraph wrist device during baseline day shifts was not significantly different than the number of awakenings recording intervention day shifts, $t(8) = -0.07$, $p = .947$. Refer to Table 1 for descriptive statistics of the number of awakenings by shift type and time (Baseline vs. During-Intervention). Refer to Figure 1 for a bar graph with error bars displaying measured variables on three categories of mental fatigue such as acute fatigue, chronic fatigue, and inter-shift recovery. Figure 2 is a bar graph with error bars displaying measured variables on three subscales of burnout measuring sleep patterns emotional exhaustion, depersonalization, personal accomplishments.

Burnout and Fatigue Questionnaires

The Maslach Burnout Inventory (MBI) and Occupational Fatigue Exhaustion Recovery (OFER 15) were questionnaires given to participants pre- and post-intervention. The emotional exhaustion, depersonalization, and personal accomplishment category for the MBI was found to have no significant change from pre- to post-intervention period. Of the OFER 15 questionnaire, acute fatigue and inter-shift recovery were categories that did not show a significant difference from pre- to post-intervention as well. The main significant change seen was chronic fatigue, showing a significant difference from pre- to post-intervention.

Table 1

Descriptive Statistics for Total Sleep Time and Numbers of Awakenings by Time and Shift

	Baseline		Intervention	
	Night Shift	Day Shift	Night Shift	Day Shift
Daily Sleep Time (hours)	8.51 ± 0.94*	9.45 ± 1.62	8.86 ± 1.56	9.08 ± 1.62
Number of Awakenings	14.28 ± 4.83*	16.85 ± 5.26	12.97 ± 5.02*	16.92 ± 7.10

Note: Values are presented in mean ± standard deviation. Total sleep time was obtained from activPAL devices, and number of awakenings were obtained from ActiGraph devices worn at the wrist.

*($p < 0.05$) indicates significant difference compared to day shift

Figure 1

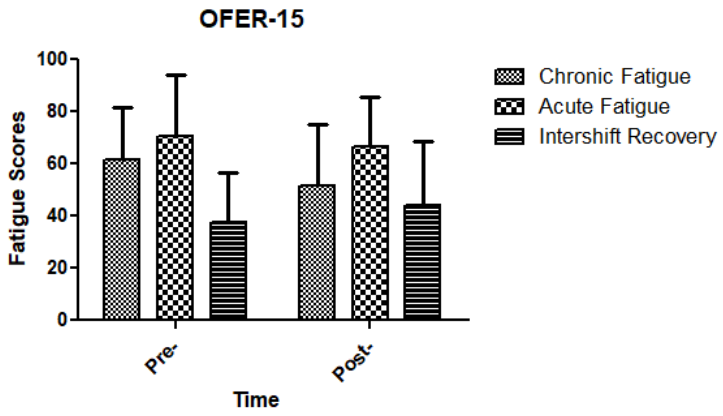
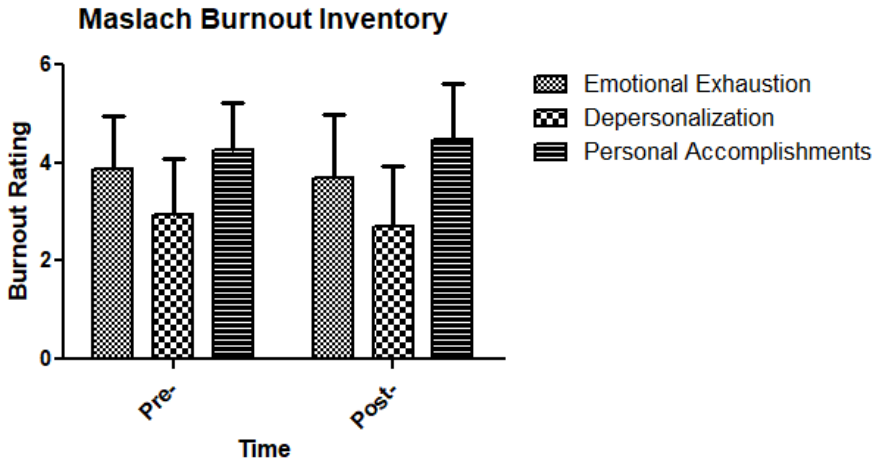


Figure 2



Discussion

As previously stated, sleep deprivation was a key risk factor for burnout in healthcare professionals. In a cross-sectional study focusing on the relationship of fatigue and work schedules, it was found that nurses who felt refreshed had experienced less chronic fatigue, acute fatigue, and had a higher recovery. It was also found that nurses who slept more than seven hours at a time had a higher recovery response (Sagherian et al., 2020).

Chronic Fatigue

The chronic fatigue category showed participants' levels decrease significantly from baseline to during-intervention after the tailored exercise program. While there were no

statistically significant changes for acute fatigue and inter-shift recovery, there were slight improvements in both post-interventions. Prior research looking at exercise therapy in persons with burnout concluded it could not support the theory that exercise lowered symptoms of burnout (Ochental et al., 2018). Confound variables that affected both acute fatigue and inter-shift recovery were personal health habits and weekly completion of exercises. Results from this study showed that a three-week exercise program helped decrease chronic fatigue for participants. According to a previous study focusing on burnout during residency training, an intervention for nursing staff was completed where they implemented duty-free breaks, and limited consecutive hours and shifts for a 12-week rotation period. Post-intervention results for this study showed no significant results in sleep quality (Seaman et al. 2015). The study included statistics regarding the number of awakenings and total hours of sleep per day but did not specifically look at sleep quality. The influence of quality in the OFER-15 subscales is important to refinement due to the limit of three categories and needs to be addressed further for future studies. Various levels of stress hormones, such as cortisone or nor-adrenalin, could be another factor associated with changes in chronic fatigue results (Winwood et al., 2005).

Sleep Patterns

Using activPAL inclinometers, there was significantly less daily sleep time measured for night shifts compared to day shifts, although, there was no significant difference in sleep time for night shifts and day shifts during the intervention. These results convey the liability of change in healthcare night shifts and any stressors faced during work hours. Comparing night and day shift daily sleep time between baseline and intervention showed there was not a significant difference for either shift period. There was a significant difference seen in daily sleep time between night shifts and day shifts during baseline, but during the intervention, the difference in sleep time declined and no longer showed significance. This could lead to a discussion of whether an exercise intervention played a part in longer sleep times, but the results displayed in Table 1 showed an increase in daily sleep time for intervention night shifts, but not day shifts. Confounds in this study could relate to a participant's lifestyle habits or current stressors.

Sleep data from the ActiGraph wrist devices were also collected to focus on the number of awakenings per night. The results indicated that night shifts had a significantly lower number of awakenings than day shifts for both baseline and intervention periods. As shown in Table 1, night shifts had a lower average sleep time compared to day shifts, therefore, allowing us to conclude that fewer hours of sleep would have fewer opportunities for awakening. When comparing night shifts to day shifts, there was no significant difference of awakenings between monitoring periods.

Strengths and Limitations

Although there are few studies published on activPAL sleep data monitoring for medical residents, this study presents a different approach by implementing activPAL as a sleep monitoring device. Both activPAL and ActiGraph are reliable devices increasing the validity of the data that was collected and analyzed. The activPAL device itself is regarded as more dependable for accuracy when in postural activity, while the ActiGraph was more dependable in measuring intensity-specific activity. All participants worked at the same location allowing similar work conditions and stressors to be presented. Each participant was given an

individualized exercise program that fit their lifestyle habits, exercise preferences, and prior exercise barriers. ActivPAL and ActiGraph devices were worn on day and night shifts to fully capture the effects exercise intervention may present during other work shifts.

A limitation of this study included a short intervention period with a small sample size and all female participants. To address this, future studies should implement a longer intervention period with a larger sample size focusing on diversifying the gender as an all-female resident group does not reflect a representation of the medical residency program. The sample size quality was affected by one participant dropping out of the study. Another limitation of this study included a device failure affecting the accuracy of one participant's collected data for both monitoring periods, leading to their exclusion from the study. An additional three devices lacked validity in recording participants' data from the intervention monitoring period resulting in exclusion from the study. With these devices came some discrepancies in being able to differentiate sleep time from sedentary behavior due to the placement of the device. This resulted in a potential overestimation or underestimation of total sleep time captured from both the activPAL and ActiGrpah device. Future research should be completed to better understand the potential of accelerometers and inclinometers in capturing sleep attributes such as total sleep time. Some participants also reported skin irritation from the Tegaderm which could have affected the placement and wear time of the device. Participants were responsible for properly wearing both devices as well as documenting non-wear times. If done inaccurately, data collected may have been adjusted, leading to an invalid monitored period. Another limitation we faced was the accountability of participants completing the virtual exercise program recorded for them. Due to no-contact rules with participants, researchers were unable to capture an exercise adherence to the program which could have affected the outcomes of the post-intervention questionnaire results. To address this, future studies should implement a virtual accountability system such as weekly check-ins, meetings, or an online format made available to residents.

Conclusion

The hypothesis that sleep disruptions will decrease when residents are on day shift and increase when they are on night shift was not supported by our results, but instead found the opposite in our findings. The results showed a decrease in chronic fatigue, showing the feasibility of a virtual exercise intervention and the potential for reducing mental fatigue and occupational burnout. If future organizations are concerned about the chronic fatigue and burnout levels of their employees, a virtual exercise program could be provided to address this matter.

Future research is needed for a standardized definition of quality sleep so that sleep pattern data from activPAL and ActiGraph can be employed properly to monitor and improve sleep quality in family medicine residents.

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