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mHealth Application as Physical Activity Intervention: A Case Study on Physical Activity, Emotional Exhaustion, and Work Performance

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Abstract

Empirical studies on exercise for health concluded that physical activity interventions could mitigate job stress and improve work performance. However, the recommended threshold of physical activity is not considered in most cases when evaluating the effect of physical activity. Research emphasizing the threshold of physical activity in mHealth applications is also rare. Therefore, this study adopted case study approach to investigate the moderating effect of the threshold point of physical activity on the relationship between emotional exhaustion and work performance, based on the conservation of resources theory. The research site was an Asian university wherein the university developed a mHealth application and organized a walking contest as a physical activity intervention to promote Exercise-is-Medicine® On Campus initiative. 580 university members registered for the mHealth application and participated in the walking contest. A longitudinal survey was conducted to collect quantitative data to test the hypotheses. Additional qualitative data was collected through interviews to draw further insights. The results supported the hypotheses that the threshold of physical activity was an effective moderator in the exhaustion-performance relationship. This study enriches the burnout literature and substantiates literature on technology-enabled solutions for improving work performance by engaging users to do sufficient physical activity regularly.

Introduction

According to the American College Health Association, over half of American college students reported suffering from “more than average stress” (45%) and “tremendous stress” (12.7%). These students also claimed that stress and anxiety were the significant causes of their deteriorating academic performance for the past 12 months ("50 Current Student Stress Statistics: 2019/2020 Data, Analysis & Predictions," 2020). In addition, the American Institute of Stress reported that 80% of employees feel stressed from their current job. More than a quarter of employees viewed their jobs as the No. 1 stressor in their lives (*Stress At Work*, 2013). Around one million workers were absent from work because of stress, which led to an unanticipated cost of approximately $600 per employee per year (*Workplace Stress: Are you experiencing workplace stress?*, 2015). An optimal level of stress may fuel students’ and employees’ motivation, but excessive stress that cannot be appropriately managed will definitely lead to adverse outcomes.

Emotional exhaustion, depersonalization, and reduced perceptions of personal accomplishment are typical job burnout symptoms – physiological responses due to chronic work-related stress (Maslach & Jackson, 1981; Maslach et al., 2001). These symptoms and responses are always negatively associated with predicted work performance (Cropanzano et al., 2003; De Bloom et al., 2014; Moon & Hur, 2011; Ornek & Esin, 2020; Sun et al., 2020). Although the relationship between emotional exhaustion and work performance is well studied, limited research has investigated potential moderators to alleviate the relationship between emotional exhaustion and work performance. In particular, moderators that are not related to the business environment or personality, such as the physical activity of employees, have been under-researched.

Physical activity has received much attention in academic research because it is one of the most effective and economical contributors to stress reduction, health enhancement,

and longevity (Korpela & Kinnunen, 2010; Thompson et al., 2020; Zuzanek et al., 1998). Many studies have suggested that physical activity can offset burnout by alleviating depression, reducing anxiety, relieving stress, and thereby allowing recovery (Blasche et al., 2014; Korpela & Kinnunen, 2010; Mücke et al., 2018; Petruzzello et al., 1991; Salmon, 2001). Other research shows a significant relationship between physical activity and work performance (Brown et al., 2011; de Bloom et al., 2018; Pedersen et al., 2009; Zuzanek et al., 1998). However, the association of physical activity with emotional exhaustion and work performance has been studied separately in previous literature, and the relationship between the three constructs remains unclear. In particular, studies on the moderating role of physical activity between emotional exhaustion and work performance are limited.

In addition, the prior literature often focuses on physical activity interventions but places less emphasis on the threshold requirement of physical activity in the intervention. In fact, the intensity of and the time spent on physical activity can affect the reactivity and recovery of stressed employees (Gunnell et al., 2012; Hackney, 2006; Korpela & Kinnunen, 2010; Van Hoecke et al., 2014). Generally, the recommended physical activity threshold, i.e., an adult to perform a total of 150 minutes of moderate physical activity every week, should be attained for health benefits to occur (Thompson et al., 2020; WHO, 2010). Hence, whether or not participants can achieve the recommended threshold of physical activity is crucial to the efficacy of a physical activity intervention and outcome prediction. These circumstances led to the research question, “Can sufficient physical activity buffer the negative effect of emotional exhaustion on work performance, using a tailor-made mHealth application?” By answering this question, this study may inspire employers to enhance employees’ work performance without compromising their well-being in an economical way.

Thanks to the ubiquity of mobile devices, various technology-enabled solutions have been developed to nudge human behaviors (Chandra & Palvia, 2021). This study adopts case

study approach to analyze an Asian university wherein the university used a tailor-made mHealth application to motivate its members to perform sufficient physical activity regularly through the promotion of Exercise-is-Medicine® On Campus (EIM-OC). In the context of EIM-OC, this study examines whether sufficient physical activity is a possible moderator in the relationship between emotional exhaustion and work performance. Specifically, the conservation of resources theory (Hobfoll, 1989) is leveraged to explore the effect of a technology-enabled physical activity intervention regarding the importance of meeting the recommended threshold for alleviating the negative relationship between emotional exhaustion and work performance. A set of longitudinal data from 580 participants in a campus-wide event was used to test the proposed model. Participants were also randomly selected to join an interview subsequent to the event. The qualitative data obtained from the interviews were used to draw additional insights into participants' experience of the physical activity intervention.

This study contributes to the growing body of research on exercise for health. It sheds light on the notion that the physical activity variable can be a moderator of the relationship between emotional exhaustion and work performance, leading to improved in-role work performance and organizational citizenship behaviors that benefit individuals. These findings supported the conservation of resources model to illuminate the exhaustion-performance relationship regarding the underlying psychological process and outcomes. This study also adds to the limited research on technology-enabled solutions for implementing EIM-OC initiatives across tertiary education campuses.

The study findings highlighted practical contributions for fitness practitioners, mobile application designers, and organizational health intervention program leaders. They showed the importance of meeting the recommended physical activity threshold to buffer the negative exhaustion-performance relationship. We suggest that organizations that provide or intend to

implement EIM-OC programs should take advantage of the mHealth application and pay attention to the required level of physical activity. The selected interventions should regard meeting the physical activity threshold as one of the goals or requirements for better development of physical activity benefits.

Literature Review

Work Performance

Work performance is considered the most crucial variable in research in different disciplines (Martz & Rawlins, 2000). Early studies focused on the factors that affect work performance. For example, Bakker and Demerouti examined various antecedents and mediators of work performance in terms of in-role and extra-role performances (Bakker et al., 2004). Based on the job demands-resources model, they found that the major predictors of in-role and extra-role performances were different. High job demand might lead to employee physical and cognitive exhaustion and result in decreased in-role performance. When employees discover available job resources to support them, they tend to engage in additional activities that enhance their extra-role performance (Bakker et al., 2004). Besides industrial and organizational studies, work performance is also popular in psychology research (Barrick & Mount, 1991). Employee mental problems were found to have significant negative impacts on their work performance, for example, lower work engagement (Demerouti et al., 2010; Ornek & Esin, 2020), lessened organizational commitment (Cropanzano et al., 2003), higher turnover intention, and absenteeism (Lewig & Dollard, 2003; Moore, 2000; Qiao & Schaufeli, 2011).

Work Performance and Emotional Exhaustion

Emotional exhaustion is a typical job burnout symptom – a physiological response due to chronic work-related stress (Maslach & Jackson, 1981; Maslach et al., 2001). This study focuses on the relationship between emotional exhaustion and work performance. This

approach is justified by the literature, as emotional exhaustion is treated as the strongest, most consistent, and core variable in understanding the job burnout process (Cropanzano et al., 2003; Maslach et al., 2001; Moon & Hur, 2011; Wright & Cropanzano, 1998). The negative relationship between emotional exhaustion and work performance has been the most frequently cited topic (Halbesleben & Bowler, 2007; Vahey et al., 2004; Wright & Bonett, 1997). It is widely supported that declining work performance is a common negative consequence of emotional exhaustion (Halbesleben & Bowler, 2007; Maslach et al., 2001). Although empirical research shows that many factors affect one's work performance, emotional exhaustion is still the most cited and recognized predictor (Bakker et al., 2004; Keijsers et al., 1995).

Work Performance, Emotional Exhaustion, and the Conservation of Resources Model

The relationship between emotional exhaustion and work performance has been widely examined based on the conservation of resources model of job burnout (Hobfoll, 1989). The conservation of resources model suggests that individuals feel exhausted when they experience loss or threat of existing resources or insufficient return of investments contributed to increased resources. At the same time, individuals will try to recover from exhaustion by carefully investing their remaining resources (Hobfoll, 1989).

The conservation of resources model has been extended to investigate the moderators and mediators of the relationship between emotional exhaustion and work performance. For example, Demerouti et al. (2014) have found effective and ineffective strategies in buffering the negative effect of exhaustion on work performance. Janssen et al. (2010) have used the conservation of resources model to examine how positive affect and distributive justice moderate the relationship between emotional exhaustion and emotional display, organizational citizenship behaviors, and overall work performance. Halbesleben and Wheeler (2011) have focused on how employee day-level exhaustion fluctuations are

associated differently with various performance behaviors and moderated by perceived reciprocity when positive inequity occurs. Understanding the factors that affect employee work performance can help identify moderators for alleviating the negative relationship between emotional exhaustion and work performance. However, there is limited research investigating these potential moderators, especially those unrelated to the business environment or employee personality, such as physical activity.

Physical Activity

Physical activity refers to "any bodily movement produced by skeletal muscles that result in energy expenditure" (Caspersen et al., 1985, p. 126). Physical activity and wellness programs, such as aerobic, strength, and flexibility exercises, have been commonly used in the workplace to stress management and reduce stress symptoms (Buckingham et al., 2019; Howarth et al., 2018; Quick et al., 1997).

Previous literature has found that increasing the level of and the time spent on leisure-time physical activity would lower stress and depressive symptoms of employees and help them to recover from stress (de Bloom et al., 2018; Kekäläinen et al., 2020; Korpela & Kinnunen, 2010; Yang et al., 2012; Zuzanek et al., 1998). Others have found that physical activity on various occasions, such as working, commuting, leisure-time, or lunch break, brings positive outcomes in different aspects, for example, lower burnout levels (Carson et al., 2010), improved subjective well-being (Lera-López et al., 2017), enhanced life satisfaction (Mutz et al., 2020), and increased creativity (De Bloom et al., 2014). Some studies have also compared the positive associations of physical health conditions and physical activity participation with different work performance measurements (de Bloom et al., 2018; Merrill et al., 2013; Moradi et al., 2014; Pronk et al., 2004). As prior studies have mainly examined the effect of physical activity on emotional exhaustion and work performance in isolation, the relationship between the three constructs remains unclear.

Additionally, studying the moderating role of physical activity between emotional exhaustion and work performance is limited in prior work.

In addition, previous related research has neglected the importance of the recommended threshold of physical activity. The World Health Organization recommended a physical activity threshold, i.e., adults should meet a minimum of 150 minutes of moderate-intensity exercise, for health benefits to occur (Thompson et al., 2020; WHO, 2010). However, most prior studies have focused only on physical activity interventions without considering the threshold point (Gunnell et al., 2012; Hackney, 2006; Hosseinpour & Terlutter, 2019; Van Hoecke et al., 2014). The physical activity intervention may increase participant physical activity engagement, but the physical activity level may still be insufficient to develop its positive impacts. To the best of our knowledge, the physical activity threshold for alleviating the exhaustion-performance relationship has not been discussed in prior literature.

Moderating Effect of Physical Activity on the Relationship between Emotional Exhaustion and Work Performance

This study draws on the leading stress theory – the conservation of resources theory (Hobfoll, 1989) – to explain the possible moderating effect of physical activity on the exhaustion-performance relationship (see Figure 1).

[Insert Figure 1 around here]

Regarding emotional exhaustion as the extended exhaustion of energetic resources at work, exhausted people will consider physical activity a recovery mechanism to refill their active resources and relieve exhaustion (Toker & Biron, 2012). This potential is also supported by research that suggests that physical activity can offset burnout by alleviating depression, reducing anxiety, relieving stress, and thereby allowing individuals to recover from stress (Blasche et al., 2014; Korpela & Kinnunen, 2010; Mücke et al., 2018; Petruzzello

et al., 1991; Salmon, 2001). Based on the conservation of resources model, this study hypothesizes that physical activity may help exhausted people attenuate the negative effect of emotional exhaustion on work performance.

In addition, the intensity of and the time spent on physical activity can affect the reactivity and recovery of stressed employees (Gunnell et al., 2012; Hackney, 2006; Korpela & Kinnunen, 2010; Van Hoecke et al., 2014). People have to attain the recommended threshold of physical activity, i.e., adults should meet a minimum of 150 minutes of moderate-intensity exercise, for health benefits to occur (Thompson et al., 2020; WHO, 2010). Hence, this study proposes that the relationship between emotional exhaustion and work performance will be moderated by physical activity as the threshold is attained. The moderating effect will reflect on in-role performance as well as organizational citizenship behaviors that benefit individuals. In other words, the negative impacts of emotional exhaustion on in-role performance and organizational citizenship behaviors that benefit individuals will be weaker when exhausted employees regularly reach the recommended threshold of physical activity. Thus, this leads to the hypotheses:

H1a: The threshold point of physical activity (at Time 1) moderates the relationship between emotional exhaustion (from Time 1 to Time 2) and in-role performance over time (from Time 1 to Time 2).

H1b: The threshold point of physical activity (at Time 1) moderates the relationship between emotional exhaustion (from Time 1 to Time 2) and organizational citizenship behaviors that benefit individuals over time (from Time 1 to Time 2).

Case Study

This research adopts case study approach to analyze a publicly funded university in Asia wherein the university developed a mHealth application as physical activity intervention to motivate its members to perform sufficient physical activity regularly through the promotion

of Exercise-is-Medicine® On Campus (EIM-OC). This study was based on the empirical data obtained from this specific university because the selected university was one of the few Asian universities dedicated to tackling the sedentariness of their members. Besides, the case-based approach, which ensures samples are from similar backgrounds and data reflect samples' experiences and behaviors within a certain period, can help avoid the potential complications created by a large pool of samples possessing diverse perceptions of the constructs of this study (Gordon et al., 2014). Although case study approach is often criticized for its limited generalization possibility, scholars have pointed out that, whenever the research design and methodology are theory-driven and carefully constructed, the analytical results of a case study can be generalized to studies with the same settings and robustness (Rowley, 2002; Wikfeldt, 2016; Yin, 2013). Therefore, the generalizability of this study is not compromised as the research model of this study was grounded in the leading stress theory (i.e., the conservation of resources theory) and its data validity and reliability were confirmed. Its analytical results can be generalized to the case studies with the same settings and robustness and, practically, inspire other tertiary institutions to motivate their members to have sufficient physical activity habits.

EIM-OC is the initiative to promote that exercise can be considered medicine to prevent and cure health problems, specifically regarding the campus facet targeting members of educational institutions (Bopp et al., 2015; "Exercise Professionals' Action Guide," 2020). According to the action guides of the EIM-OC, ensuring pleasant and safe physical activity is particularly important for engaging inactive participants and sustaining their exercise habits ("Exercise Professionals' Action Guide," 2020). Walking is considered a simple, safe, and inexpensive solution for an inactive lifestyle to boost the immune system and improve health and well-being (Pillay et al., 2015; Thompson et al., 2020). Walking slowly and brisk walking are classified as light-intensity and moderate-intensity physical activities ("Physical

Activity Guidelines for Americans," 2016). It also suggests that technology-enabled solutions provide automatic and reliable computing, recording, and feedback functions for participants to manage their daily workout plan and monitor their physical activity performance ("Exercise Professionals' Action Guide," 2020).

As part of the EIM-OC program, the university developed a tailor-made mHealth application and organized annual one-month institutional walking contests as a part of the technology-enabled physical activity intervention of the EIM-OC program. The university expected participants could be motivated to start and maintain their regular walking habits, monitor and manage their daily walking plan, and enhance their physical activity engagement as a result (Shen, 2021).

Technology-enabled Intervention of the EIM-OC Program – a Tailor-made mHealth Application

Through the mHealth application, participant walking step-count records were uploaded to the university server for counting team, departmental, and institutional performance records and survey purposes. As previous literature has mentioned, information and communication technology design, guided by a theoretical framework, can be more reliable and convincing (Zhang, 2008). Certain gamified features grounded in the theoretical foundation were incorporated into the tailor-made mHealth application to motivate participants (Anderson et al., 2019; Degroote et al., 2020).

For example, as participants registered their departmental information, they were automatically grouped with their affiliations and departments. Participants could also team up or compete with their selected partners in the walking contest. All these features could foster social connections among participants and allow them to motivate each other through social interactions (Stevens et al., 2017). Moreover, achievement pages and push notifications that provided immediate positive feedback were available for participants to track their team,

affiliations, and institutional achievements. Gold, silver, and bronze medals were awarded to individual users who attained daily targets of 10,000, 8,000, and 6,000 steps, respectively. Their team or department ranking in the university step grand total could be checked through different achievement pages in the mHealth application. Reward-based gamification can trigger human attempts to be competent and enhance participant self-efficacy, which motivates them to continue exercising together more often (Anderson et al., 2019; Buckingham et al., 2019; Hales et al., 2017; Zhang, 2008).

Methods

In the context where a university used a tailor-made mHealth application to promote EIM-OC, the proposed model was designed to investigate the effect of physical activity intervention regarding the importance of meeting the recommended threshold for alleviating the negative relationship between emotional exhaustion and work performance. It was tested using longitudinal survey research and structural equation model analysis. Additional qualitative data was collected from the subsequent interviews to draw additional insights into participants' experience of the physical activity intervention.

All the measurement items were adopted from previous studies. The list of measurement items is shown in Appendix 1. The emotional exhaustion subscale of the Maslach Burnout Inventory (MBI) – General Survey was used to measure the emotional exhaustion component of burnout (Maslach et al., 1986). This scale included four questions with a 7-point scale ranging from 1 (*never*) to 7 (*every day*). The measure of physical activity behavior was adapted from a cross-national monitoring instrument, The International Physical Activity Questionnaire – short versions (Craig et al., 2003; Macfarlane et al., 2007). Respondents were required to provide their physical activity frequency, time, and intensity for the previous seven days. To account for below- and above-threshold factors, any responses attaining the recommended threshold of physical activity (WHO, 2010) were

categorized as 1, while others were 0. Both in-role performance behaviors and organizational citizenship behaviors that benefit individuals were assessed by the performance measure developed by Williams and Anderson (Williams & Anderson, 1991). Each respondent answered eight questions on a 7-point Likert-scaled measure, from 1=*strongly disagree* to 7=*strongly agree*.

To account for individual users' differences and minimize factor endogeneity issues, control variables that potentially affected physical activity behavior were considered, i.e., age**,** gender**,** role**,** body mass index, and mobile operating system (Wu et al., 2015). To facilitate data analysis, age variables were categorized as 1=low risk, i.e., men under 45 years old and women under 55 years old, and 2=high risk; gender variables as 1=male, 2=female; role variables as 1=student, 2=staff, 3=alumni, 4=others; and body mass index variable as 1=normal, 2=underweight, 3=overweight, 4=obese (Cropanzano et al., 2003; Toker & Biron, 2012).

A pilot test was conducted among 30 individuals (students, staff, and alumni of the university) to confirm the scales and validate the new instrument for the current study. Minor changes in expression and flow were made according to the comments received in the pilot test before rolling the longitudinal survey out.

Longitudinal Survey

A longitudinal survey is recommended to reveal meaningful behavioral change resulting from the use of a mHealth application over time (Silic & Lowry, 2020). Therefore, this study conducted a longitudinal survey in two time periods to collect data requiring individual perception and self-reported measures. The two data collection periods were designated to match the walking contest. The first data collection period (Time 1), representing the first week of the walking contest, was one month apart from the second data collection period (Time 2), representing the first week after the walking contest. Each data collection process

lasted for one week. This arrangement allowed for a time lag measurement of the independent and dependent variables to reduce common method bias in testing the hypotheses (Halbesleben & Bowler, 2007). Particularly, the independent variable (i.e., emotional exhaustion) and the dependent variables (i.e., in-role performance and organizational citizenship behaviors that benefit individuals) were captured at Time 1 and Time 2. The moderator variable (i.e., physical activity) was collected only at Time 1. The control variables were collected by capturing the tailor-made mHealth application data at Time 1.

To extend the prior research on either cross-sectional or longitudinal studies in measuring the relationship between emotional exhaustion and work performance (Halbesleben & Bowler, 2007; Moon & Hur, 2011), the current study applied a latent difference score approach to examine the direct and moderating effects on the temporal-cum-psychological relationship between emotional exhaustion, work performance, and physical activity (Toker & Biron, 2012). This study assumed that physical activity behavior would not be changed without intervention between Time 1 and Time 2. Hence, measuring participants' physical activity level at Time 1 would be appropriate for moderating the exhaustion-performance relationship.

The surveys were sent out by email and posted on the online platform Qualtrics. Participation in the surveys was voluntary. Participants were asked to give their informed consent at the beginning of the surveys and provide their email addresses for both the lucky draw and follow-up reminders. The follow-up reminders were sent to all Time 1 participants to complete another survey during the data collection period in Time 2. Participants who completed the two surveys were eligible to join the lucky draw for $500 superstore coupons.

A total of 580 participants successfully installed and registered on the first day of the EIM-OC walking contest, in which 375 participants stayed active during the whole contest. A

total of 217 and 292 responses were received at Time 1 and Time 2, respectively. Among these responses, 179 (Time 1) and 191 (Time 2) were classified as valid. Invalid responses included those from duplicate email addresses, responses with incomplete survey items in a whole session or more, and responses with the same answer for all survey items; they were all eliminated. Finally, 158 respondents who completed both surveys were captured for data analysis. Table 1 presents the demographic information of the 158 valid respondents. The sample comprised 56% females and 44% males. The respondents were mostly students (45%) and staff (42%), with an average age of 33. Most respondents (86%) were classified as in the normal age category, meaning they were under 45 years old for men or under 55 years old for women (*ACSM's guidelines for exercise testing and prescription*, 2013). Based on the demographic profile, this group of respondents was rather healthy, as 69% reported normal weight. 64% of respondents attained the physical activity recommended threshold, i.e., at least 150 minutes per week in moderate-intensity physical activity.

[Insert Table 1 around here]

Data Analysis Results

Reliability and Validity

All statistical analyses to test the research model and hypotheses were carried out using SPSS (Software Package for Social Science) version 24.0. We first focused on model confirmation to examine the consistency with prior findings and check the reliability and validity of the survey instruments. We then tested the primary hypothesis.

We examined the internal consistencies and convergent and divergent validity of all the measures, as summarized in Table 2. The results showed that the Cronbach's alphas for all construct survey instruments were greater than 0.7 (ranging from 0.83 to 0.92), which means that all the observed variables were statistically reliable (Nunnally, 1978).

In addition, the convergent and discriminant validities were satisfied as the square root of the average variance extracted (AVE) of each construct was greater than 0.5 and the AVE of each construct was larger than its correlations with all other constructs. The AVE scores range from 0.67 to 0.80, indicating that all the model constructs showed satisfactory convergent and discriminant validities, as shown in Table 2.

[Insert Table 2 around here]

We further assessed the convergent and discriminant validities by loading and cross-loading matrices. As shown in Table 2, all the items, except IR4, loaded high on their corresponding constructs. Good convergent and discriminant validities were guaranteed as there was a significant difference between the loading corresponding constructs and other constructs. We dropped IR4, as the items collected in both Time 1 and Time 2 did not meet the expected norms of the factor loading, i.e., same-factor loadings higher than 0.60 and cross-factor loadings less than 0.30.

Common Method Bias Analysis

Although data were collected through different periods to reduce the risk of common method bias in testing the hypotheses (Halbesleben & Bowler, 2007), potential bias might still exist as we collected data on the constructs from the self-reported subjective measures. There might be a risk that we measured "variance that is attributable to the measurement method rather than to the constructs the measures represent" (Podsakoff et al., 2003). We tried to avoid common method bias when setting up our survey. The order of questions in the questionnaire was randomized. Specifically, we separated questions related to both independent and dependent variables in random order. Hence, it should be harder for respondents to recall their previous answers and limit their ability to become familiar with the patterns between items.

Structural Model – Moderating Effect of Physical Activity on the Relationship between Emotional Exhaustion and Work Performance

We first checked the direct effect of the relationship on the differences in emotional exhaustion (Time 1 – Time 2) and work performance (Time 1 – Time 2). We then analyzed the moderating effect of physical activity (Time 1) on the exhaustion-performance relationship changes (Time 1 – Time 2).

Means, standard deviations, and correlations among all variables, including demographic profiles, are presented in Table 3. We first checked the direct effect of the research model. The changes in emotional exhaustion (Time 1 – Time 2) were found to be positively related to the changes in in-role (β=0.162, t=2.048, R^2=0.026, p<0.05) and organizational citizenship behaviors that benefit individuals (β=0.274, t=3.554, R^2=0.075, p<0.001) work performance (Time 1 – Time 2).

[Insert Table 3 around here]

We further analyzed the moderating effect of physical activity on the relationship between emotional exhaustion and work performance. The results supported our hypothesis, in which physical activity positively moderated the relationship between the exhaustion-performance relationships of in-role performance (β=0.158, t=2.00, R^2=0.025, p<0.05) and organizational citizenship behaviors that benefit individuals (β=0.224, t=2.864, R^2=0.05, p<0.01), as shown in Figure 2. Overall, we conclude that the increase in physical activity participation can moderate the exhaustion-performance relationship. H1a and H1b are supported for both in-role performance and organizational citizenship behaviors that benefit individuals (see Table 4).

[Insert Figure 2 around here]

[Insert Table 4 around here]

Results of Qualitative Analysis

Qualitative data were collected through interviews in regard to participants' experience of the physical activity intervention. Active users were randomly selected to answer the following questions: (1) Can the mHealth application encourage you to walk more steps and walk regularly? And why? (2) Which is the most effective way to motivate you to walk more: achievement badges, interactions with community members, or push notifications? (3) Can regular walking improve your mood as well as work performance? And how?

First of all, participants generally agreed that the gamified features of the mHealth application successfully motivated them to walk more steps and walk regularly. Some participants even claimed that the features changed their habits.

"She (My colleague and walking partner) always reminds me to keep walking via the app function or instant messages. Being supported by her, I scheduled a time to walk every day."

"I kept checking the leading board during the walking program, and those top-rank users motivated me to walk more."

"I tried to spend more time walking during the walking program. I took off the bus one stop earlier before and after work and walked after lunch and dinner."

"I like running, and I used to run every day. In the beginning, I consistently ranked the first; however, I found that some users were walking a lot, and their steps were very close to mine. Therefore, I spent more time walking except running."

Further, the participants shared that regular and sufficient walking exercise refreshed their minds and gave them satisfaction, resulting in improved moods.

"I set my target 10,000 steps per day, I felt accomplished when I completed my goal."

"I started to like this pattern as I could refresh myself during the walk."

"I felt good when I received the notification from the mobile app mentioning that I have achieved 10,000 steps every day. I am happy that I have lost 5 pounds already."

In addition, participants commended that regular and sufficient walking exercise was particularly helpful for enhancing work performance, i.e., in-role job performance and organization citizenship behaviors that benefit individuals.

"Joining this walking program improves my physical health and the relationship between colleagues. We have more chemistry as we know each other more."

"It seems like I know the other users very well as I realize their daily walking patterns. We can establish mutual understanding easily, even though our work doesn't require us to meet frequently. I wish to meet them in person."

"It was fun as we checked the leaderboard and discussed our positions during our free time. We feel like our department has become more energetic and productive than before."

"Our walking steps contributed to the total walking steps of the department, and I felt I was part of the team."

Discussion

This study adopts a case study approach to analyze an Asian university wherein the university developed a mHealth application to motivate its members to perform sufficient physical activity regularly. This study specifically explores the effect of physical activity regarding the importance of meeting the recommended threshold for alleviating the negative relationship between emotional exhaustion and work performance. It hypothesized that the negative impacts of emotional exhaustion on in-role performance and organizational citizenship behaviors that benefit individuals would be weaker when exhausted people regularly reach the recommended threshold of physical activity. A longitudinal survey was conducted in two periods to collect data requiring individual perception and self-reported measures. The qualitative data collected through interviews also offered insights into participants' experience of the physical activity intervention.

Before discussing the moderating effect, the results – interestingly and unexpectedly – show a positive relationship between emotional exhaustion and both in-role performances and organizational citizenship behaviors that benefit individuals. This finding is partially contrary to our assumptions and prior research. Previous research has shown a negative relationship between emotional exhaustion and in-role performance but a positive relationship between emotional exhaustion and organizational citizenship behaviors that benefit individuals (Halbesleben & Bowler, 2007). In the current study, the counterintuitive finding can be explained by participants' various stress responses, particularly on the effect of in-role performance.

The transactional theory of stress assumes stress is neutral in nature, and the outcome of stress depends on how the stress is evaluated (Lazarus, 1966; Lazarus et al., 1985; Lei & Ngai, 2014). Responses to stress will be appraised and sorted into "good" and "bad" stresses; a low level of burnout may be classified as "good" stress, which is also termed "eustress" (Selye, 1976). Eustress is associated with positive outcomes, including work performance (Quick et al., 1997; Simmons & Nelson, 2007). When a person encounters a stressor, he or she evaluates it as a positive affect and finds it meaningful and manageable. The positive response will lead the way to accomplishing valued goals at work under positive psychological states (Simmons & Nelson, 2007). Even though a person may feel frustrated and work too hard at work, he/she can still positively complete assigned duties, fulfill responsibilities specified in his/her job description, and perform tasks that are expected of him or her (LePine et al., 2005) as he/she thinks of the work as a challenge stressor.

Our results suggested that the recommended threshold of physical activity moderated the relationship between emotional exhaustion and work performance. The latent difference score approach was used to care for the difference in emotional exhaustion across time and examine the moderating effect of physical activity on the exhaustion-performance

relationship. The results showed that an increase in emotional exhaustion from Time 1 to Time 2 resulted in an increase in work performance from Time 1 to Time 2, which was a positive association of the direct effect enhanced by considering participants' physical activity level at Time 1. To ensure the benefits of physical activity are developed, the threshold requirement should be observed. The threshold requirement is a new possible factor that can buffer the exhaustion-performance relationship. In other words, participants who meet the recommended threshold of physical activity, i.e., 150 minutes per week of moderate-intensity physical activity, are more likely to be productive at work even though their emotional exhaustion level has increased.

It has been generally accepted that improving physical activity may also improve mental health (Blasche et al., 2014; De Bloom et al., 2014; Kekäläinen et al., 2020; Korpela & Kinnunen, 2010; Ströhle, 2009; Zuzanek et al., 1998). From the cognitive coping style perspective, attention and avoidance are two distinct cognitive responses to a stressful situation (Bijttebier et al., 2001). It is possible that people who reach the threshold are more alert and sensitized to stress-related information. They will react to the stressor by further searching for related information; thus, they will perform even better because they know more about the stress-related cues (Krohne, 1996). Another possible reason to explain our finding is that people who meet the threshold may experience self-efficacy feelings. From the conservation of resources perspective, exhausted people can refill their energy resources from other tasks outside of work, for instance, physical activity.

Theoretical Contributions and Practical implications

This case study is about the moderating effect of physical activity (with the threshold requirement) on the relationship between emotional exhaustion and work performance. A mHealth application, as part of the EIM-OC program, was developed to provide automatic and reliable computing, recording, and feedback functions for the university members to

manage their daily workout plan and monitor their physical activity performance. Moreover, certain gamified features grounded in the theoretical foundation were incorporated into the mHealth application to motivate participants to perform sufficient physical activity regularly, thereby enabling them to cope with stress and enjoy lifelong health benefits.

Our case study results suggested that, in the context of EIM-OC, the relationship between emotional exhaustion and work performance is moderated by the recommended threshold of physical activity, i.e., 150 minutes per week of moderate-intensity physical activity (WHO, 2010). In other words, university members who meet the recommended threshold are more likely to be productive at work in terms of enhanced in-role performance and organizational citizenship behaviors that benefit individuals, even though their emotional exhaustion level has increased. Our findings make theoretical and practical contributions in several ways.

Theoretical Contributions

First, the study findings supported the conservation of resources model to understand the role of physical activity in exhaustion-performance associations. As we noted, prior studies focus less on the possible moderators between emotional exhaustion and work performance, especially those outside the workplace. This study tries to fill this research gap and identify a possible factor to moderate the exhaustion-performance relationship. Grounded in the conservation of resources theory, this study confirms physical activity as a potential recovery mechanism that allows one to gain energetic resources by meeting the recommended physical activity threshold.

Second, this study demonstrates the robust use of recommended physical activity threshold as a dichotomous variable. Previous literature has mainly focused on using physical activity interventions but overlooked the threshold requirement of physical activity in an intervention. The study results showed that participants who attained the recommended

threshold of physical activity in their daily workout achieved increased in-role performance and organizational citizenship behaviors that benefit individuals. This study further proves that whether or not participants can attain the recommended threshold of physical activity in their daily workout is crucial to the efficacy of a physical activity intervention and outcome prediction.

Third, this study provides further empirical evidence to support the past findings, suggesting that people who feel emotional exhaustion at work will carefully invest their remaining resources to support their coworkers (Halbesleben & Bowler, 2007). Similar to prior findings, our results showed a strong and positive relationship between emotional exhaustion and extra-role performance, i.e., organizational citizenship behaviors that benefit individuals. In other words, developing social support relationships among coworkers helped exhausted workers cope with stress and feel support from colleagues or friends.

Lastly, results also supported that literature on walking, one of the simplest physical activities (Hosseinpour & Terlutter, 2019; Pillay et al., 2015; Thompson et al., 2020), can be a good option for an organizational physical activity intervention program (Masitoh et al., 2015).

Practical Contributions

Our findings highlighted practical contributions for fitness practitioners, mobile application designers, and organizational health intervention program leaders, especially in the EIM-OC context.

The findings showed that meeting the recommended threshold of physical activity could moderate the exhaustion-performance relationship. In other words, the benefits of meeting the recommended threshold of physical activity were supported. We suggest that organizations that provide or intend to conduct health program interventions should

emphasize the recommended threshold to allow the health benefits of physical activity to develop.

The findings continued to confirm that one possible way to enhance physical activity participation is through intervention by mHealth applications. mHealth applications can be an effective intervention in either organizational health programs or leisure-time physical activity. They can be more beneficial if organizations consider including some appropriate gamification features, for instance, setting a target of walking 10,000 steps daily for each user or allowing them to create a team with coworkers, family members, or friends to achieve various goals. These interactive functions can motivate participants to continue exercising together more often to attain the recommended physical activity threshold.

This study also enriched the limited research on implementing the EIM-OC initiative across tertiary education campuses. Although EIM-OC has become a global trend, the literature that shares the experiences and outcomes of its implementation is limited (Bopp et al., 2015). Research into cases using mobile technology to facilitate the EIM-OC program and the potential impacts of physical activity on the exhaustion-performance relationship is also rare. This study consolidates the experiences of promoting the EIM-OC initiative in a tertiary education institution using the mHealth application to enrich the limited research on the relevant subject.

Limitations and Future Research Directions

There are several limitations that we should address and offer suggestions for future research. First, we used a self-report survey to test our hypotheses. Although the method suits the research purpose well, there are still potential risks of self-selection bias and common method bias. Future studies can combine other data collection methods for different variables. For instance, physical activity levels can be observed or collected by a mHealth application.

Second, our study was open to all in the university community, including staff, students, and alumni, which may not be an appropriate community to test work performance. To this end, remedial measures were applied. We advised students to interpret the work performance questions as study-related tasks such as assignments or projects or related to their part-time job. As a result, no differences were found between student samples and other samples in the results. We also adopted a latent difference score approach to care for the difference in emotional exhaustion across time and examine the role of physical activity in the exhaustion-performance relationship. Future research should put careful consideration in this regard to avoid any potential complications. Moreover, as this research took place in a university, the study results may not be generalized to employees from other sectors as their sources and types of stress are expected to differ. A wider spectrum of employees and cluster analysis can be considered in future research to yield meaningful findings.

Third, although we provide insights into the emotional-performance relationships, future studies could compare the different emotional exhaustion levels, i.e., low-, moderate-, and high-level exhaustion, on the effect of possible outcomes to broaden the topic.

Lastly, our current field study is limited to walking panel data. We recommend that future research can include other physical activities, such as running, swimming, and cycling.

Conclusion

This case study provided theoretical foundations for the research design to test the hypotheses using empirical data. Based on the conservation of resources model, this study suggested physical activity as a recovery source for emotionally exhausted workers to refill their energy resources. It also enriched the emotional-performance relationship by discovering physical activity as a moderator. Empirical evidence was provided to show the importance of meeting the recommended threshold of physical activity for work performance improvement. The study suggested that health program interventions should promote the goal of reaching the

recommended physical activity threshold. It also contributed to the literature that provides administrators and practitioners practical experiences to promote EIM-OC initiatives across campuses using a mHealth application.

We hope that our findings and the proposed research framework will significantly contribute to the research in exercise for health and exhaustion-performance relationships, especially in the context of EIM-OC – tackling the sedentariness of members in tertiary institutions. Moreover, as our research model was grounded in the conservation of resources theory and the data validity and reliability were guaranteed, our analytical results, hence, can be generalized to the case studies with the same settings and robustness (Rowley, 2002; Wikfeldt, 2016; Yin, 2013). Future research can make reference to our groundwork and expand to investigate a wider spectrum of employees and conduct cluster analysis to yield meaningful findings.

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Appendix 1 Measurement Items and the Time for Data Collection

Measurement Items:

Physical Activity (Macfarlane et al., 2007)

Think about all the physical activities that you did in the **past 7 days**:

- How many days & how much time did you do **vigorous** physical activities for at least 10 minutes at a time? Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal (i.e. heavy lifting, aerobics, or fast cycling, etc.)
  Days per week [Range 0-7] _____; Minutes per day [Range 0-960] _____.
- How many days & how much time did you do **moderate** physical activities for at least 10 minutes at a time? Do not include walking. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal (i.e. carrying light loads, cycling at a regular pace, and doubles tennis, etc.)
  Days per week [Range 0-7] _____; Minutes per day [Range 0-960] _____.
- How many days and how much time did you **walk for at least 10 minutes at a time**? Walking includes during work and at home, walking to travel from place to place, and any other forms of walking that you might do solely for recreation, sport, exercise, or leisure.
  Days per week [Range 0-7] _____; Minutes per day [Range 0-960] _____.

Data collection of this measure will be completed at Time 1.

Describe the way you felt about and performed at work in the **past 7 days**:

Burnout – Emotional Exhaustion (Maslach et al., 1986)

[1=Never, 2=A few times per year, 3=Once a month, 4=A few times per month, 5=Once a week, 6=A few times per week, 7=Everyday]

I feel emotionally drained by my work.

I feel like my work is breaking me down.

I feel frustrated by my work.

I feel I work too hard at my work.

Data collection of this measure will be completed at Time 1 and Time 2.

Describe the way you felt about and performed at work in the **past 7 days**:

In-role Work Performance (Williams & Anderson, 1991)

[1= Strongly disagree, 2=Disagree, 3=Somewhat disagree, 4=Neither agree nor disagree, 5=Somewhat agree, 6=Agree, 7=Strongly agree]

- I was able to adequately complete assigned duties.
- I was able to fulfill responsibilities specified in work description.
- I was able to meet formal performance requirements of the work
- I engaged in activities that will directly affect my performance evaluation.

Organizational citizenship behaviors that benefit individuals (Williams & Anderson, 1991)

[1= Strongly disagree, 2=Disagree, 3=Somewhat disagree, 4=Neither agree nor disagree, 5=Somewhat agree, 6=Agree, 7=Strongly agree]

- I helped others who have been absent.
- I helped others who have heavy workloads.
- I took time to listen to co-workers' problems and worries.
- I took a personal interest in other co-workers.

Data collection of this measure will be completed at Time 1 and Time 2.

Reference

Macfarlane, D. J., Lee, C. C., Ho, E. Y., Chan, K. L., & Chan, D. T. (2007). Reliability and validity of the Chinese version of IPAQ (short, last 7 days). *Journal of science and medicine in sport*, *10*(1), 45-51.

Maslach, C., Jackson, S. E., Leiter, M. P., Schaufeli, W. B., & Schwab, R. L. (1986). *Maslach burnout inventory* (Vol. 21). Consulting psychologists press Palo Alto, CA.

Williams, L. J., & Anderson, S. E. (1991). Job satisfaction and organizational commitment as predictors of organizational citizenship and in-role behaviors. *Journal of management*, *17*(3), 601-617.

Table 1. Demographic information (n=158)

Variable	Category	Frequency	Percentage
Gender	Male	68	44.4
	Female	85	55.6
	Not provided	5	
Role	Student	69	45.1
	Staff	64	41.8
	Alumni	12	7.8
	Friends	8	5.2
	Not provided	5	
BMI Group	Underweight	16	10.5
	Normal weight	106	69.3
	Overweight	21	13.7
	Obese	10	6.5
	Not provided	5	
Age – Risky	Normal	131	85.6
	Risky for men	19	12.4
	Risky for women	3	2
	Not provided	5	
Age Category	< 21	23	14.6
	21-24	37	23.4
	25-40	54	34.2
	> 40	44	27.8
Physical Activity	Recommend	101	63.9
	Not recommend	48	30.4
	Not provided	9	

Table 2. Internal consistency, convergent, and divergent validity testing

Latent Factor	Items	1	2	3
Time 1				
Emotional Exhaustion	EE1	0.129	**0.899**	0.036
Cronbach's alpha = 0.92	EE2	0.086	**0.954**	-0.025
AVE = 0.80	EE3	0.062	**0.928**	-0.066
	EE4	0.143	**0.791**	0.126
Work Performance – In-role Behaviors	IR1	0.204	0.05	**0.885**
Cronbach's alpha = 0.83	IR2	0.423	-0.017	**0.846**
AVE = 0.56	IR3	0.436	-0.013	**0.822**
	IR4	**0.454**	0.193	0.246
Work Performance – Organizational Citizenship Behaviors that Benefit Individuals	OCBI1	**0.753**	0.134	0.314
Cronbach's alpha = 0.89	OCBI2	**0.857**	0.089	0.24
AVE = 0.67	OCBI3	**0.868**	0.127	0.133
	OCBI4	**0.782**	0.017	0.297
Time 2				
Emotional Exhaustion	EE1	0.071	**0.886**	-0.12
Cronbach's alpha = 0.88	EE2	0.055	**0.947**	-0.102
AVE = 0.74	EE3	0.021	**0.936**	-0.092
	EE4	0.15	**0.638**	0.291
Work Performance –In-role Behaviors	IR1	0.184	-0.005	**0.891**
Cronbach's alpha = 0.88	IR2	0.293	-0.022	**0.907**
AVE = 0.66	IR3	0.339	-0.033	**0.885**
	IR4	0.438	-0.094	**0.491**
Work Performance – Organizational Citizenship Behaviors that Benefit Individuals	OCBI1	**0.829**	0.107	0.166
Cronbach's alpha = 0.90	OCBI2	**0.818**	0.127	0.31
AVE = 0.69	OCBI3	**0.865**	0.077	0.259
	OCBI4	**0.812**	0.064	0.219

Table 3. Means, standard deviations, and correlations on the measured variable (n = 158)

Variable		M	SD	1	2	3	4	5	6	7	8	9	10	11	12
1	Age	33.35	13.75	-											
2	Gender (1=male, 2=female)	1.56	0.50	-0.013	-										
3	BMI (1=underweight, 2=normal weight, 3=overweight, 4=obese)	2.16	0.69	0.116	-.284**	-									
4	Age_risky (1=normal, 2=risky for men, 3=risky for women)	1.16	0.42	.662**	-.247**	0.111	-								
5	Role (0=student, 1=staff, 2=alumni, 3=friend)	0.73	0.82	.560**	0.061	0.101	.204*	-							
6	Emotional exhaustion, Time 1	3.97	1.43	0	0.071	0.068	-0.01	0.019	-						
7	Emotional exhaustion, Time 2	3.88	1.30	-0.105	0.144	-0.059	0.015	-0.113	.433**	-					
8	In-role performance, Time 1	5.03	0.99	.160*	-0.051	0.061	0.112	0.059	0.129	-0.035	-				
9	In-role performance, Time 2	5.09	1.03	0.132	-0.093	0.037	0.124	0.05	-0.056	-0.03	.356**	-			
10	Organizational citizenship behaviors that benefit individuals, Time 1	4.92	1.12	0.15	-0.03	-0.009	0.15	0.129	.224**	-0.024	.663**	.202*	-		
11	Organizational citizenship behaviors that benefit individuals, Time 2	4.94	1.07	0.122	-0.083	-0.009	0.126	0.061	0.108	.179*	.263**	.585**	.406**	-	
12	Physical activity, Time 1 (0=not recommend, 1=recommend)	1.20	0.68	-0.013	0.072	-0.13	-0.038	-0.003	0.077	0.073	-0.002	-0.069	0.047	-0.044	-

*p < .05. **p < .01.

Table 4. Summary of the proposed hypotheses

	Coefficient (β)	t-value (df=158)	Hypotheses
Emotional Exhaustion (Time 1 – Time 2) → In-role Performance (Time 1 – Time 2)	0.162	2.048*	
Emotional Exhaustion (Time 1 – Time 2) → Organizational Citizenship Behaviors that Benefit Individuals (Time 1 – Time 2)	0.274	3.554***	
H1a: Emotional Exhaustion (Time 1 – Time 2) * Physical Activity (Time 1) → In-role Performance (Time 1 – Time 2)	0.158	2.000*	supported
H1b: Emotional Exhaustion (Time 1 – Time 2) * Physical Activity (Time 1) → Organizational Citizenship Behaviors that Benefit Individuals (Time 1 – Time 2)	0.224	2.864**	supported

**p<0.05, **p<0.01, ***p<0.001*

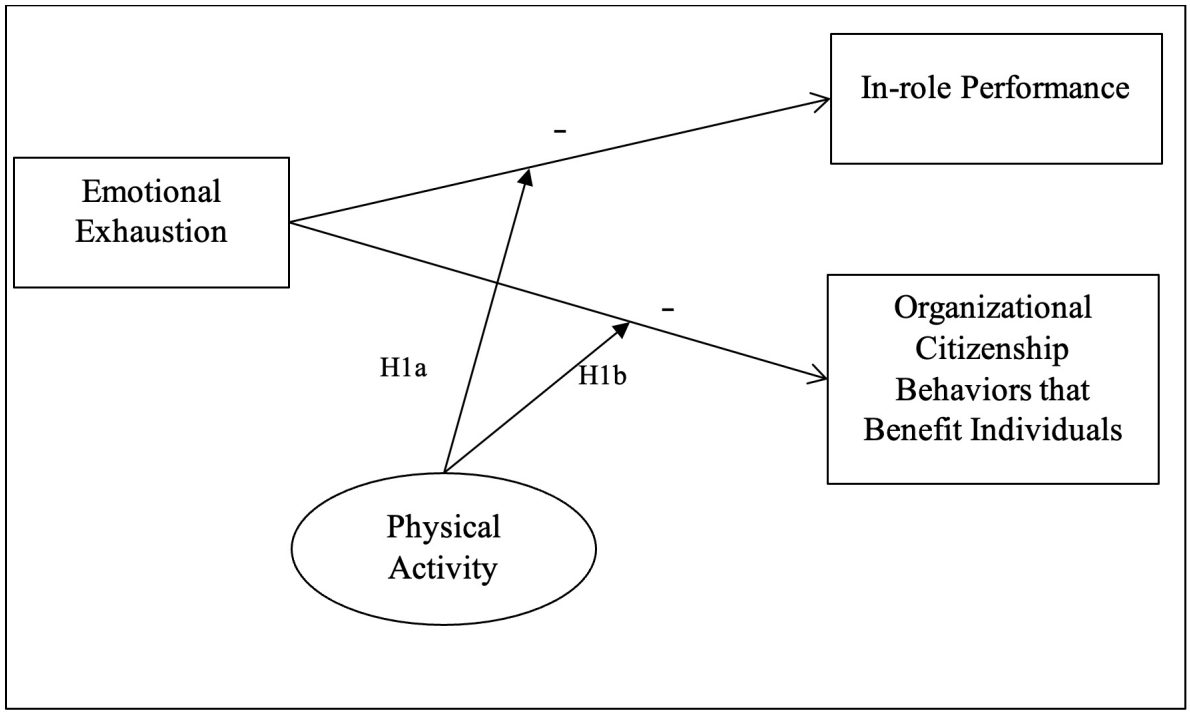

Fig. 1 Proposed research model.

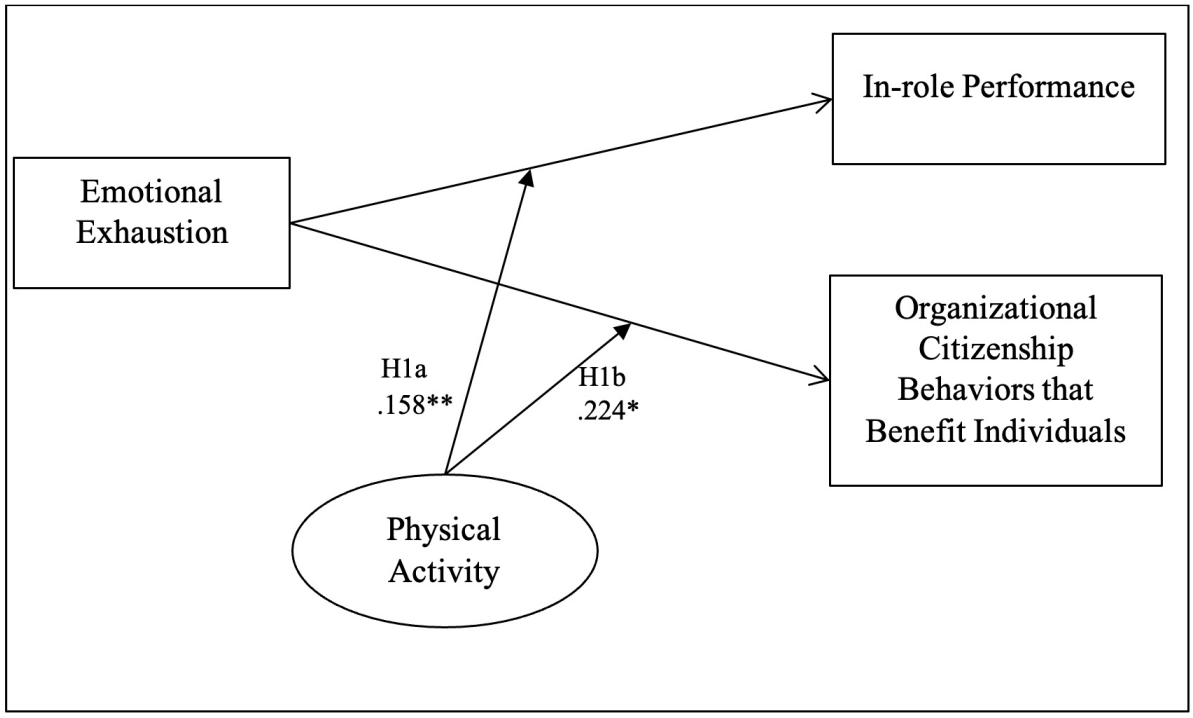

Fig. 2 Results of the research model.