



Physical activity among shift workers: accumulating data to guide health promotion strategies

Actividad física entre trabajadores por turnos: acumulación de datos para orientar estrategias de promoción de la salud

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Abstract

Objective: This study examines how shift workers' health indicators are affected by both conventional and virtual exercise regimens.

Methodology: 33 shift workers (17 women and 16 men, mean age 25.6 ± 3.5 years) participated in the study. They were split into two experimental groups: one that did traditional exercises with an on-site trainer, and the other that took live, virtual classes through Zoom. The control group carried on with their regular routines. A number of health outcomes were examined before and after the 12-week intervention, including body mass index (BMI), waist circumference, waist-hip ratio, resting heart rate, and blood pressure (both diastolic and systolic).

Results: Significantly higher drops in the diastolic blood pressure ($F(2,36) = 4.7, p < 0.05$), systolic blood pressure ($F(2,37) = 4.7, p < 0.05$), body mass index ($F(2,36) = 4.8, p < 0.05$), and waist circumference ($F(2,37) = 4.9, p < 0.05$) were obtained using one-way analysis of covariance.

Conclusion: The study comes to the conclusion that online fitness regimens are just as successful as conventional ones. Providing a virtual workout alternative allows for flexibility and may improve shift workers' compliance with their fitness regimens.

Keywords

Blood pressure; body composition; heart rate; remote exercise; web-based exercise; waist circumference.

Resumen

Objetivo: Este estudio examina cómo los regímenes de ejercicio, tanto convencionales como virtuales, afectan los indicadores de salud de los trabajadores por turnos.

Metodología: Participaron en el estudio 33 trabajadores por turnos (17 mujeres y 16 hombres, con una edad media de $25,6 \pm 3,5$ años). Se dividieron en dos grupos experimentales: uno que realizó ejercicios tradicionales con un entrenador presencial y el otro que asistió a clases virtuales en vivo a través de Zoom. El grupo de control continuó con sus rutinas habituales. Se examinaron diversos indicadores de salud antes y después de la intervención de 12 semanas, incluyendo el índice de masa corporal (IMC), la circunferencia de la cintura, el índice cintura-cadera, la frecuencia cardíaca en reposo y la presión arterial (diastólica y sistólica). **Resultados:** Se obtuvieron descensos significativamente mayores en la presión arterial diastólica ($F(2,36) = 4,7, p < 0,05$), la presión arterial sistólica ($F(2,37) = 4,7, p < 0,05$), el índice de masa corporal ($F(2,36) = 4,8, p < 0,05$) y la circunferencia de la cintura ($F(2,37) = 4,9, p < 0,05$) mediante un análisis de covarianza unidireccional.

Conclusión: El estudio concluye que los programas de ejercicio en línea son tan eficaces como los convencionales. Ofrecer una alternativa de entrenamiento virtual permite flexibilidad y puede mejorar el cumplimiento de los programas de ejercicio por parte de los trabajadores a turnos.

Palabras clave

Presión arterial; composición corporal; frecuencia cardíaca; ejercicio a distancia; ejercicio en línea; circunferencia de la cintura.

Introduction

Shift work has been linked to several negative health outcomes and is a contributing factor in the emergence of a number of non-communicable illnesses. Since chronic illnesses cause more than three-quarters of all chronic disease deaths worldwide, they are a major issue, especially in poor and middle-income nations (Lassen et al., 2018; Souza et al., 2019). A major global public health risk is inadequate physical exercise. An estimated 25% of adults and more than 80% of adolescents are thought to be insufficiently active. There hasn't been much of a shift in these figures during the last 20 years (Gupta et al., 2019; Hulsege et al., 2017; Nea et al., 2018). Numerous studies have focused on the health surveillance of shift workers, and there is enough data to demonstrate that shift work can alter human physiology and behavior, increasing the risk of non-communicable illnesses.

Modern technology-enabled therapies use techniques including social media-infused podcasts, text messaging, smartphone applications, and web-based platforms (Kozak et al., 2017; Piette et al., 2015). These strategies show how digital technologies may encourage active lives by utilizing the pervasiveness of technology to encourage healthy behaviors (Stephenson et al., 2017). The use of mobile devices to assist medical and public health activities is known as mobile health (mHealth), according to the World Health Organization (Bonn et al., 2019). Because it is more flexible, affordable, scalable, and accessible than traditional approaches, MHealth coaching is becoming more and more popular (Ismail & Al Thani, 2022). The environment of mHealth interventions has changed dramatically as a result of technological breakthroughs including ubiquitous smartphones, apps, and sophisticated data analytics (Gao et al., 2023). This discovery has enhanced the effectiveness of health promotion initiatives, increasing their efficacy while also facilitating them. The growing availability and ownership of electronic gadgets, especially smartphones, is one of the main reasons for the growing acceptance of these interventions (McDonough et al., 2021). Wearables and applications are examples of mHealth tools that have been demonstrated to be effective in promoting physical activity and yielding favorable results, including weight loss, a lower body mass index, improved dietary compliance, and a decrease in sedentary behavior. This is especially true when combined with other intervention elements (McDonough et al., 2021; Rodríguez-González et al., 2023). Digital platform-based interventions for physical activity have shown effective in meeting physical activity guidelines for specific populations (King et al., 2019). However, there is limited proof that virtual workplace interventions are beneficial for health-related outcomes, according to a comprehensive study.

Shift workers are often reported to engage in sedentary behaviors and light-intensity physical exercise, which can lead to higher body mass index and blood pressure (Alkhatib, 2015; Bellettiere et al., 2017; Wattanapisit et al., 2020). Previous studies have shown that shift workers' sedentary lifestyles put them at higher risk of chronic illnesses (Arslan et al., 2019; Moreira et al., 2022). Nonetheless, workplace physical activity programs have shown a number of benefits, such as increased flexibility, decreased musculoskeletal problems, and an overall improvement in quality of life (Holzgreve et al., 2018). Additionally, Moreira et al. (Moreira et al., 2022) discovered that online office fitness programs had advantages such as better physical function, increased productivity, and an improved quality of life. This is in line with earlier studies. Furthermore, it has been shown that online lifestyle treatments are successful in lowering psychological stress, which is connected to improvements in a number of employee health outcomes (McKeon et al., 2023). Digital platform-based physical exercise programs have been shown to be successful in reaching physical activity (PA) requirements in some groups (Howarth et al., 2018; King et al., 2019). A comprehensive research, however, revealed that there is no evidence of the benefits of virtual workplace interventions for health-related outcomes. The prevalence of cellphones has increased in recent years, and it is evident that comprehensive scientific research on the effectiveness of mHealth interventions for promoting physical activity and fitness among adults and corporate workers is lacking. In order to address the lack of information on mHealth interventions intended to encourage physical activity and exercise in adults, this study attempts to close the knowledge gap. There is a great desire to improve the overall health, productivity, and standard of living of corporate workers, according to research.

Thus, this study aims to explore the impact of both conventional and virtual physical training regimens on the health outcomes of shift workers in a field with less research. Offering useful knowledge on how



to apply technology-driven tactics to improve physical activity quality and overall health is the goal of this study.

Method

Study design

The Center for Ethics in Human Research at Universitas Negeri Yogyakarta approved the randomized controlled trial design of this investigation. The study complied with national rules and legislation as well as the Declaration of Helsinki. All participants were stratified according to gender, age, and BMI classifications (underweight, normal weight, overweight, and obesity (Malik et al., 2020) after baseline assessments. Assistants then randomly assigned each participant to either the TC group or the control group from the envelopes, keeping the allocation a secret from the researchers. Figure 1 shows the data acquired at baseline and after 12 weeks of TC training. Throughout the trial, all participants were instructed to maintain their regular lifestyle habits.

Participants

Forty-twoshift workers who met the study's eligibility requirements were divided into three groups: the Traditional group ($n = 14$), the Virtual group ($n = 14$), and the Control group ($n = 14$). Every participant gave their written, informed consent to take part in the research. Based on the findings of a prior study, the sample size was estimated, and G*Power software was used for computations. Using a total of 11 individuals, the study obtained an effect size of 0.85 and a significant effect of 0.8 at a significance level of $\alpha = 0.05$. With possible dropout rates in each group taken into consideration, 42 individuals was the total expected sample size.

The following inclusion criteria were used to screen the participants: (1) being between the ages of 18 and 55, (2) being able to walk around independently, (3) being able to engage in low-to-moderate intensity physical activity, (4) not taking antioxidant supplements or taking medication on a regular basis, and (5) not having musculoskeletal discomfort or other disorders that prevent them from exercising. The following were the exclusion criteria: (1) disclosing a history or risk of cardiovascular symptoms, and (2) had prior familiarity with virtual tasks. Prior to the experiment, each participant was asked about their demographics, medical history, and health-related practices.

Thirty-three shift workers (17 women and 16 men, mean age 35.6 ± 13.5 years) willingly were included in the convenience sample. Through word-of-mouth marketing and conversations with small groups on the research project in an educational setting, informal recruiting was carried out. Having a smartphone running the Android or iOS operating system and a dependable internet connection, being a shift worker for a limited liability firm, and being prepared to give informed permission and accept randomization were among the eligibility requirements. The study excluded participants who had been physically active for 30 minutes on most days of the week, were pregnant, or were at risk of sickness or injury as a result of their increased physical activity. The investigation's data collecting phase ran from August 2024 until January 2025. Three groups, each with eleven individuals, were randomly selected from the on-site physical exercise group, the virtual exercise group, and the control group. The Physical Activity Readiness Questionnaire and the informed consent process were completed by all participants before they began their participation (Warburton et al., 2021). The study was conducted in accordance with the Declaration of Helsinki and its later revisions, and the methods followed adhered to the ethical norms of the institution and/or national research council ('World Medical Association Declaration of Helsinki: Ethical Principles for Medical Research Involving Human Subjects', 2013).

Procedure

Intervention

Whereas the virtual group also engaged with a trained exercise leader via Zoom who had expertise in trained group exercise training and was in charge of guaranteeing the efficacy of the exercise sessions, the traditional group engaged in a physical exercise intervention program overseen by a trained exercise leader. The workouts took place over a period of twelve weeks. The control group, on the other hand, had no intervention program and was told to continue living their normal lives.



The physical exercise regimen was put into place with minor adjustments in compliance with the American College of Sports Medicine's (American College of Sports Medicine, 2018) recommendations for the prescription of aerobic exercise. For twelve weeks, both intervention groups had three sessions per week, each lasting seventy minutes. A 5- to 15-minute warm-up preceded 30 to 45 minutes of aerobic conditioning activities as part of the physical activity program. Stretching exercises and a cool-down that lasted seven to ten minutes followed each session.

Group conditioning programs incorporate a variety of aerobic exercises, such as conventional or modified leaping jacks, aerobic dancing, aerobic steps, and jogging (jogging while positioned for the virtual group). The exercise sessions were initially low-intensity, with the exercise leader engaging with participants at frequent intervals (e.g., every 3–5 minutes) to ensure they weren't weary and to gauge the activity's intensity using the Talk Test (Montoye et al., 2022; Persinger et al., 2004). In the early stages of aerobic exercise development, time was increased by no more than 10% each week, and then intensity was appropriately increased (American College of Sports Medicine, 2018; Garber et al., 2011; Persinger et al., 2004). Prioritizing the development of appropriate form, the exercise leader demonstrated activities to participants and then gave comments. Participants were able to develop the confidence that they were carrying out activities accurately and effectively as a result. Notably, the exercise regimens of the two intervention groups were similar.

Outcome measures

Blood pressure

Pulse rate and blood pressure were measured using the Omron Digital HEM 7156A, an Omron digital automated blood pressure monitor. Participants were required to sit silently in a chair with a back support for at least five minutes, keeping their feet on the ground and their arms at heart level. To ensure that the brachial artery was aligned, the appropriate cuff size was securely wound around the upper arm at heart level. A one-minute gap was seen between the first and second measurements, which were performed twice (American College of Sports Medicine, 2018). Heart rate, systolic, and diastolic pressure were recorded at rest using the datasheet.

Waist Circumferences

A flexible and inelastic 1 × 120 tape measure was used to measure them. The participant stands with their feet close together, their arms at their sides, and their abdomen relaxed in order to measure their waist circumference. The narrowest part of the thorax, which is precisely situated above the umbilicus and below the xiphoid process (American College of Sports Medicine, 2018), is then measured horizontally and measured in inches. The measurement is taken at the maximal circumference of the buttocks, just as the hip circumference, while the individual stands with their feet close together and their arms at their sides. By dividing the waist circumference by the hip circumference, the waist-hip ratio for each participant was calculated.

Anthropometry

The participants' weight was determined using the Omron HBF-214 weighing scale, and their height was measured using a fixed stadiometer. Their body mass index (BMI) was then determined by taking the square of their height and weight.

Physical Activity Readiness Questionnaire (PAR-Q+)

The seven-step PAR-Q+ questionnaire (Warburton et al., 2021), which additionally has extra follow-up sections, was used in the study. This survey aims to ascertain the prevalence of specific health issues and the presence of risk factors associated with moderate physical activity.

Data analysis

IBM-SPSS 29.0 (IMN Inc.; Armonk, NY, USA) was used to analyze all of the data. For age and gender, descriptive data were calculated. To evaluate the variations between the groups and the chosen outcomes, a subsequent analysis of covariance (ANCOVA) was performed, using baseline BMI as the covariate. The health results of the three groups were further examined using post-hoc Bonferroni analysis. The study's significance level was set at 0.05.



Results

The demographic details of the shift workers are shown in Table 1. Men and women were equally represented, with the majority of participants being middle-aged (19–55 years old) shift workers. The following results are assessed using the standardized process described in the technique section: BMI, waist circumference, waist–hip ratio, sedentary heart rate, and blood pressure. Using the analysis of covariance (ANCOVA), significant differences were found in several outcomes. Both diastolic blood pressure and systolic blood pressure were considerably impacted; $p < 0.05$ and $F(2.36 = 4.7$ and 4.7 , respectively). Significant changes were also seen in the body mass index, with a $F(2.36)$ value of 4.8 , $p < 0.05$, and the waist circumference, with a $F(2.37)$ value of 4.7 , $p < 0.05$ (Table 2).

Table 1. Demographics of shift workers.

Variables	N
Gender	
Male	16
Female	17
Age Category	
19-35 years	21
36-55 years	12
Marital status	
Single never married	11
Married and living with spouse	13
Married and separated from spouse	2
Divorced	5
Widowed	2
Calculated BMI	
Underweight	8
Normal weight	3
Overweight	13
Obese	9
Occupational sector	
Accommodation and food services	8
Health and social work	5
Retail	9
Manufacturing	10
Other*	1
Pattern of shift workers	
Predominantly days	6
Predominantly nights	11
Predominantly rotating	10
Other	6
Duration of exposure to shift workers	
< 8 years	18
≥ 8 years	15
Average length of shift	
< 8 hours	11
8-11 hours	13
≥ 12 hours	9

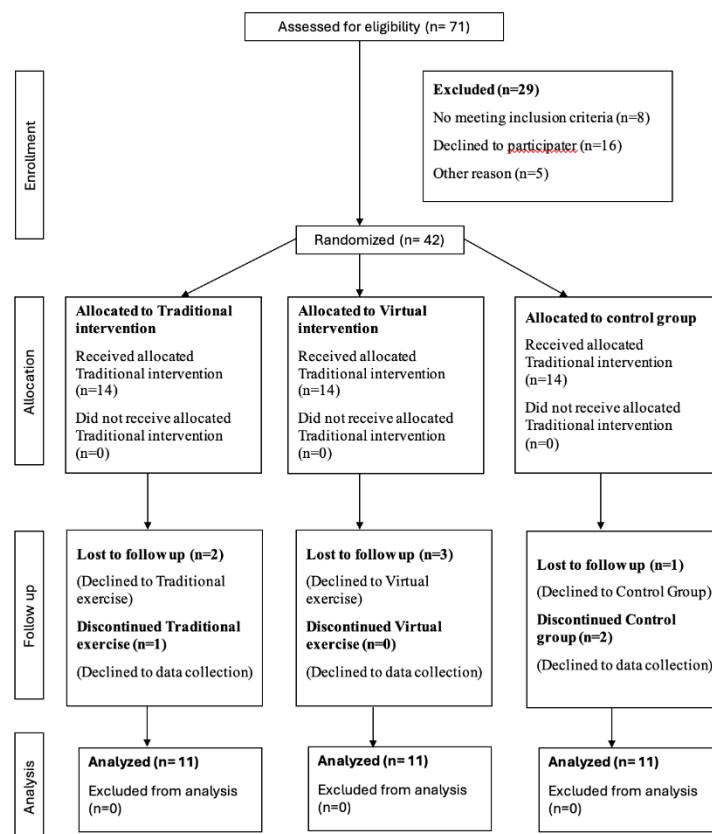
Table 2. Effects of traditional and virtual physical activity programs on health outcomes before and after the intervention

Outcome	Group	n	Test	Mean±SD	F	Adjust R2	p
Systolic Blood Pressure (mmhg)	Traditional	11	Pre-test	133.7 ± 11.2)	2,36 = 4.7	0.46	0.05
		11	Post-test	120.1 ± 11.1			
	Virtual	11	Pre-test	133.6 ± 12.4			
		11	Post-test	119.1 ± 12.2			
	Control	11	Pre-test	132.5 ± 12.3			
		11	Post-test	123.6 ± 12.2			
Diastolic Blood Pressure (mmhg)	Traditional	11	Pre-test	85.4 ± 5.8	2,37 = 4.7	0.46	0.05
		11	Post-test	79.7 ± 5.3			
	Virtual	11	Pre-test	85.5 ± 5.7			
		11	Post-test	79.5 ± 5.2			
	Control	11	Pre-test	86.2 ± 5.8			
		11	Post-test	81.3 ± 5.7			



Waist Circumference (inches)	Traditional	11	Pre-test	84.5 ± 4.6	2,37 = 4.9	0.81	0.05
		11	Post-test	80.6 ± 4.8			
	Virtual	11	Pre-test	86.3 ± 4.6			
		11	Post-test	80.3 ± 4.9			
	Control	11	Pre-test	85.5 ± 4.7			
		11	Post-test	85.1 ± 4.7			
BMI (kg/m ²)	Traditional	11	Pre-test	28.9 ± 2.7	2,36 = 4.8	0.47	0.05
		11	Post-test	27.5 ± 2.5			
	Virtual	11	Pre-test	28.6 ± 2.6			
		11	Post-test	27.6 ± 2.4			
	Control	11	Pre-test	28.7 ± 2.6			
		11	Post-test	28.6 ± 2.6			

Figure 1. Flowchart of the study protocol.



Discussion

The aim of this study was to assess the health effects of both virtual and traditional physical exercise programs on shift workers in order to fill the current information gap about mHealth treatments for the promotion of exercise and physical activity. According to the results, individuals in the traditional and virtual exercise groups significantly improved their waist circumference, BMI, and diastolic and systolic blood pressure when compared to the control group. These results demonstrate how beneficial virtual exercise programs may be for people who work. On the other hand, neither the sedentary heart rate nor the waist-to-hip ratio differed significantly between the intervention and control groups.

Throughout the course of the twelve weeks, neither the virtual nor the conventional treatments considerably raised the resting heart rate, which was in contrast to our initial assumptions. This outcome is in accord with that of Gotink et al. (Gotink et al., 2017), who likewise found no discernible changes in heart rate following an online mindfulness exercise training program. However, a research by Daveri et al. (Daveri et al., 2022) found significant differences in baseline heart rate during remote online training

sessions, which runs counter to the findings. Since the length of the program is a crucial consideration, it is likely that the intervention period might provide different outcomes if the exercise program is prolonged over six weeks. Another important result was that individuals in both exercise regimens saw a substantial drop in both their systolic and diastolic blood pressure. A remote exercise training program is consistent with the findings of this investigation (Mannarino et al., 2023). Previous studies by Lisón et al. (Lisón et al., 2020) and Gotink et al. (Gotink et al., 2017) have also shown that web-based exercise treatments are successful in lowering blood pressure.

Furthermore, the intervention groups showed significant decreases in waist circumference and BMI. Compared to the control group, the virtual group's waist circumference was smaller. These findings are in line with specific treatments (Collins et al., 2012; Yamatsu & Narazaki, 2022) and meta-analyses (Seo & Niu, 2015) that have found comparable decreases with online exercise programs. This implies that the duration of the intervention is an important factor, with 12-week programs perhaps having greater success in changing body composition, particularly the waist-hip ratio (Montoye et al., 2022).

Additionally, the small or negligible changes in body composition that were observed may have been caused by the absence of dietary guidelines in our study. Workplace health promotion emerged as the second most popular fitness trend, suggesting a strong emphasis on enhancing the general health and well-being of corporate personnel as well as office productivity. The current study is very pertinent in this sense since it contributes to the scientific understanding of healthy practices. Numerous advantages result from these activities, including improved mental health, more productivity at work, and lower insurance premiums. Given the growing awareness of workplace health promotion, this study provides insightful information, highlighting its wider significance for the well-being of people and businesses. Despite its limitations, the findings of this study are worth taking into account. These difficulties had a significant impact on the recruiting of participants and the calculation of the ideal sample size, among other parts of the study process. As stressed by Faber and Fonseca (Faber & Fonseca, 2014), the choice of a small sample size may affect the study's internal and external validity.

Furthermore, the short twelve-week period of this research could have affected its results. According to training methods, this period of time corresponds to the fundamental conditioning phase. To obtain more thorough findings that are in line with the improvement stage and adherence to efficient training criteria, it is suggested that future study increase the length of physical exercise treatments to eight months. The real world can benefit from the research findings' practical implications. In order to get positive outcomes for blood pressure, waist circumference, and BMI, they first suggest that a virtual physical activity program could be equally effective as an in-person one. Second, especially for shift workers who frequently deal with time constraints, the flexibility provided by the virtual fitness program may improve adherence to exercise regimens. Increased job productivity and reduced insurance premiums are only two benefits that may result from this flexibility, which may also encourage the adoption of health-promoting behaviors. These findings demonstrate the potential of online exercise programs as a practical instrument for enhancing employees' health and happiness.

Conclusions

In the end, this study sheds light on how traditional and online physical exercise regimens affect health-related results. The fact that virtual physical training programs may achieve favorable results in terms of blood pressure, waist circumference, and BMI just as well as onsite programs is a noteworthy discovery. This gives those who work shifts and balance hectic schedules and significant obligations a flexible choice. Professionals and practitioners may find that remote physical exercise/physical activity programs are a reasonable and effective way to promote health. It's important to note that a mix of onsite and remote work hours distinguishes the present job environment. Employees can therefore benefit from active physical behaviors thanks to the flexibility and accessibility of virtual physical exercise.

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