Preventive Medicine Reports 37 (2024) 102543

Contents lists available at ScienceDirect

Preventive Medicine Reports

journal homepage: www.elsevier.com/locate/pmedr

Nurses' occupational physical activity and workload in a perioperative intensive care unit in Slovenia

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ARTICLE INFO

Keywords:
Healthcare professionals
Nursing
Occupational health
Shift work
Workload
Physical activity
Accelerometer

ABSTRACT

The field of nursing includes heavy occupational physical demands, including walking and standing for longer periods of time, in addition to moving and lifting. As such, in the context of a typical work shift, many nurses generally achieve the World Health Organization's recommended 10,000 steps per day. This study aimed at estimating the daily physical activity and workload of nurses in a perioperative intensive care unit. The data sources for this study included data from the hospital information system on various procedures and interventions, and the Silva Ex3 Plus pedometers for measuring steps, kilometers, calories, and activity time across various shifts in a perioperative intensive care unit. Twenty nurses from Slovenia volunteered to participate in this observational study. Over 13 weeks, a nurse working an 8-hour shift walked an average of 5,938 steps (4.4 km). However, nurses who worked a 12-hour weekend day shift came very close to the World Health Organization's recommendation with an average of 9,003 steps (6.5 km). A total of 227 patients were admitted and an average of 80 nursing interventions were performed per day and there was a positive relationship between physical activity, workload, and patient admissions in the perioperative intensive care unit ($p = 0.001$). Results of this study could help managers better understand nurses' physical activity and workload during various shifts in the perioperative intensive care unit.

1. Introduction

The World Health Organization [WHO] defines physical activity as any bodily movement produced by skeletal muscles that require energy expenditure (World Health Organization. Physical activity [internet]., 2022). The WHO's global recommendation is at least 150 min of moderate-intensity activity per week, (World Health Organization. Global action plan on physical activity, 2018) or 10,000 steps per day for adults (Rosenkranz et al., 2015; Caperchione et al., 2016; World Health Organization. Pacific Physical Activity Guidelines for Adults [internet]., 2008). Steps are often measured using devices such as pedometers, accelerometers (Freak-Poli et al., 2020), smartphones, and increasingly, smartwatches.

Physical activity reduces the risk of multiple chronic diseases, including diabetes, osteoarthritis, and hypertension, and it improves the general health, cognitive function, and quality of life (Committee, 2018). Physical activity not only improves physical health, but also mental well-being by promoting self-esteem, alleviating symptoms of depression, anxiety, stress, and other mental and mood disorders (Sosso and Raouafi, 2017).

Inadequate activity is responsible for more than 3.2 million deaths per year and represents the fourth leading mortality risk factor globally (World Health Organization. Physical inactivity [internet]., 2022). Sedentary behavior contributes to insulin resistance, obesity, reduced maximal oxygen uptake, muscle atrophy, and increased blood pressure (Kerr and Booth, 2022). It is also associated with a decline in the ability to perform activities of daily living, increased mobility disability, and mortality (Stenholm et al., 2016). The economic burden of physical inactivity is enormous and the cost of treatment for preventable chronic diseases globally is estimated to be about 27 billion US dollars annually

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https://doi.org/10.1016/j.pmedr.2023.102543
Received 4 April 2023; Received in revised form 4 December 2023; Accepted 6 December 2023
Available online 9 December 2023

(World Health Organization. WHO highlits high cost of physical inactivity in first-ever global report [internet]., 2022). Physical inactivity is not only an individual risk factor for poor health, but also poses risks to global public health systems.

The most common physical activities in nursing are walking and standing; however, this varies by the specific work shift and unit of employment. Benzo, et al. (Benzo et al., 2021) reported that nurses who worked day shifts spent more time standing and walking compared to those who worked night shifts, which makes sense given that most medical procedures take place during the day (Chang and Cho, 2022). Shift nurses were found to engage in less moderate to vigorous physical activity on a weekly basis, demonstrating the influence of work-related factors, such as time constraints and fatigue (Brunet et al., 2021). In contrast, in the emergency room, nurses took more steps (9720 ± 4072 steps) during the evening shift due to the high amount of unpredictable work (Chang and Cho, 2022).

Despite an active work environment, nurses are often not physically active enough outside of work (Kunene and Taukobong, 2015; Saridi et al., 2019; Jun et al., 2019), and about half of nurses are overweight or obese (Nahm et al., 2012; Flannery et al., 2014; Flannery et al., 2014; Almajwal, 2015; Blake and Batt, 2015; Chin et al., 2016). The most common work-related factors associated with obesity in nurses are shift work, especially working night shifts only (Zhang et al., 2020), high job demands (Chin et al., 2016), and unhealthy food options (Nicholls et al., 2016).

The objective of this study was to estimate the daily physical activity and workload of nurses in a perioperative intensive care unit and to provide an answer to the research question: "Does patient admission to the perioperative intensive care unit have an impact on the nurses' physical activity and workload?".

2. Materials and methods

This observational study took place in the perioperative intensive care unit at Maribor University Medical Centre, Slovenia. Patients admitted to the perioperative intensive care unit area were classified as Category IV based on the San Joaquin Patient Classification and their vital signs were monitored more than 24 times per 24-hour period (Sermeus et al., 2008). The maximum number of patients in the perioperative intensive care unit was 15, with a maximum of four hospital beds per room.

The work in the perioperative intensive care unit was carried out in five different shifts: the 8-hour morning shift (from 7:00 a.m. to 15:00p.m.), 7-hour afternoon shift (from 15:00p.m. to 22:00p.m.), 9-hour weekday night shift (from 22:00p.m. to 7:00 a.m.), 12-hour weekend day shift (from 8:00 a.m. to 19:00p.m.), and 12-hour weekend night shift (from 19:00p.m. to 7:00 a.m.). For better visualization of the results, the week was divided into *weekdays* (Monday to Friday) and *weekend days* (Saturday and Sunday).

The number of nurses varied according to the shift, with a maximum of 25 (weekdays) and a minimum of 12 (weekend days). Permission to conduct this study was obtained from the Chief of Medicine and Nursing of the perioperative intensive care unit. The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of the Faculty of Health Sciences, University of Maribor (protocol code 038/2023/780–2/902 and 23 February 2023).

After the presentation of the research protocol at the meeting, the nurses were invited to voluntarily participate in the study by signing the consent form. Each nurse was informed that the research was anonymous and that the results would only be used for scientific purposes. Inclusion criteria for the study participants were direct patient care nurses and shift workers. Based on the comparisons with similar studies (Al-Mohannadi et al., 2019; Croteau, 2017; Chaisurin et al., 2023), we estimated that the duration of data collection would last more than 90 days. Since we had 20 Silva Ex3 Plus pedometers, the goal was to perform the study with 20 nurses. Sociodemographic data (e.g., age, gender, etc.) were collected individually from each nurse. The data were entered into Excel spreadsheets.

The Silva Ex3 Plus pedometer was used in this study to measure the number of steps, number of kilometers, number of burnt calories, and time of activity. Several reasons prompted the choice of the Silva Ex3 Plus pedometer for our research. The main requirements were a reliable mechanism (Wiklund et al., 2012), an affordable price, low weight, the ability to store a large number of readings, and the ability to wear it around the neck. Wearing a pedometer around the neck poses no risk to the nurse or patient because it is hidden under the filter scrub (Fig. 1).

To calibrate the pedometer, we measured the body weight and average step length for each nurse. Per manufacturer guidelines, the average step length was calculated by taking ten steps and then dividing the cumulative length by the number of steps (Silva. User guide Pedometer Ex3 Plus art. No. 56026 [internet]., 2023). The measurement of the average step length was done using two 10-meter-long gauges that were laid on the floor. The nurse started walking with the right foot forward first and took ten steps, repeating the procedure ten times. The measurement was conducted twice, the second time with the left foot forward first. The same process was repeated ten times with the acquired lengths summed up and divided by the number of all steps to obtain the average step length.

The investigators initialized the pedometers prior to each shift by setting them to a 24-hour format, checking battery life, etc. (Wiklund et al., 2012). During their shifts, nurses wore pedometers around the neck to achieve the most accurate results. At the end of the shift, the nurses returned the pedometer to the investigators for data transcription into Excel spreadsheets.

To measure the workload, investigators collected the data from the hospital information system on the number of nursing interventions (e.g., central line blood draws, enteral nutrition, etc.) per nurse per day during the study.

All statistical analyses, from descriptive statistics (including figures, etc.) to inferential statistics, were performed in the R programming language (Version 4.1.0, R Foundation for Statistical Computing, Vienna, Austria) (Stiglic et al., 2019).

3. Results

Of the 61 nurses, 20 volunteered (33 %) to take part in the study whereby 16 were female (80 %). Twelve of 20 participants were registered nurses and eight were nurse technicians. The mean age of the

Fig. 1. A pedometer worn around the neck and under the scrub.

nurses was 33.8 years (95 % confidence interval [CI]: 95 % CI: 30.3 – 37.0). On average, they had worked for 9.8 years (95 % CI: 4.9–13.9) prior to this study.

Over the course of 13 weeks (i.e., 92 days), 1,016 daily measurements were recorded. Divided into shifts, this amounted to 419 morning shifts, 223 afternoon shifts, 182 weekday night shifts, 95 weekend day shifts, and 97 weekend night shifts during the study. In total there were 737-day shifts (morning, afternoon, and weekend day shifts) and 279-night shifts (weekday and weekend night shifts). This information provided the basis for a check of the average number of kilometers walked. The results showed that the day shift nurses walked an average of 4.5 km (95 % CI: 4.3–4.6) while the night shift nurses walked an average of 3.3 km (95 % CI: 3.1–3.4).

Fig. 2 shows the average number of steps taken (km = kilometers in the figure) in different shifts. The highest average was measured during the weekend day shift (6.5 km; 95 % CI: 6.1–6.9), followed by the morning (4.4 km; 95 % CI: 4.2–4.5) and afternoon (3.8 km; 95 % CI: 3.6–3.9) shift. Both night shifts (3.5 km; 95 % CI: 3.3–3.8 for weekend night 3.1 km; 95 % CI: 3.0–3.3 for weekday night) featured a similar number of kilometers walked.

To compare the five shifts, we calculated the number of kilometers walked per hour (Fig. 3). It was evident that three shifts had a similar average distance per hour, namely the weekend day shift (0.5 km; 95 % CI: 0.5–0.6), the morning shift (0.5 km; 95 % CI: 0.5–0.6), and the afternoon shift (0.5 km; 95 % CI: 0.5–0.6). These were followed by the weekday night shift (0.4 km; 95 % CI: 0.3–0.4) and the weekend night shift (0.3 km; 95 % CI: 0.3–0.3).

Fig. 4 shows a weekly breakdown of distances recorded for specific days in the week. During the entire length of the study, 1016 measurements were taken – 166 on Monday, 177 on Tuesday, 168 on Wednesday, 167 on Thursday, 166 on Friday, 94 on Saturday, and 78 on Sunday. The week was divided into weekdays (from Monday to Friday) and days of the weekend (Saturday and Sunday) to make the presentation more straightforward. The total number of measurements taken on weekdays was 824 and 192 during the weekend. On average, 3.9 km (95 % CI: 3.9–4.0) were walked on weekdays and 5.0 km (95 % CI: 4.7–5.3) during the weekend. Most kilometers were walked on Saturday (5.3 km; 95 % CI: 4:8–5.7) and Sunday (5.1 km, 95 % CI: 4.6–5.5).

To calculate the average distance walked on the weekends, two shifts were considered, namely the weekend day shift and weekend night shift. There were three shifts included in the calculation of the average weekday distance – the morning shift, afternoon shift, and night shift. Calculated distances showed that on average most kilometers were walked on Friday (4.1 km; 95 % CI: 3.9–4.3), followed by Monday (4.0 km; 95 % CI: 3.8–4.2), Thursday (3.9 km; 95 % CI: 3.7–4.1), Tuesday (3.8 km; 95 % CI: 3.6–4.0), and Wednesday (3.8 km; 95 % CI: 3.6–4.0).

Fig. 5 shows how the average distance walked has changed during the entire time of the study. A positive trend could be observed in the first half of the observed period for the weekend day shift, weekend night shift, and weekday night shift. The morning shift and afternoon shift showed a slight negative trend in the same period. A negative trend for all but one shift could be observed from the midpoint of the observed period (around day 50). The curve representing the afternoon shift started to decline as late as day 60 of the research. At the end, some curves started to rise again (weekend day shift, morning shift, weekend night shift), while others continued to decline (weekday night shift and afternoon shift).

During the observed period, a total of 227 patients were admitted with 147 (64.8 %) of them being female. On average, there were 11 patients in the perioperative intensive care unit per day with an average length of stay of 6.1 days. The total number of nursing interventions during the study was 937.2. The average number of nursing interventions per day was 80 (Fig. 6).

Fig. 6 shows the correlation between the current number of patients in the perioperative intensive care unit and the workload of nurses. At the beginning of the research, both curves rose similarly, which means that the number of patients started to grow, thus leading to an increased workload of nurses. Between days 20 and 40, both curves began to decline (the number of patients, as well as their workload, declined accordingly). Between days 60 and 70, both curves began to rise due to an increase in the patient numbers and nurses' workload. This meant that a greater number of patients led to an increased workload of nurses, as expected ($p = 0.001$).

Table 1 presents an overview of average distances, number of steps, calories burned, and estimated active time for all shifts in the perioperative intensive care unit. It could be observed that the weekend day had the highest numbers of kilometers, steps, calories, and time.

The mean weight of the nurses was 70.2 kg (95 % CI: 63.8–76.6) with an average height of 1.7 m (95 % CI: 1.6–1.7). The mean body mass index (BMI) was 25.0 kg/m^2 (95 % CI: 22.8–27.2). Ten nurses had a normal BMI (18.6–24.5 kg/m2) and 10 other nurses were overweight or obese BMI (25.7–33.7 kg/m2).

In Table 2 it was observed that nurses who were overweight or obese had similar average distances, number of steps, calories burned, and estimated activity time for all shifts as nurses who had normal BMI.

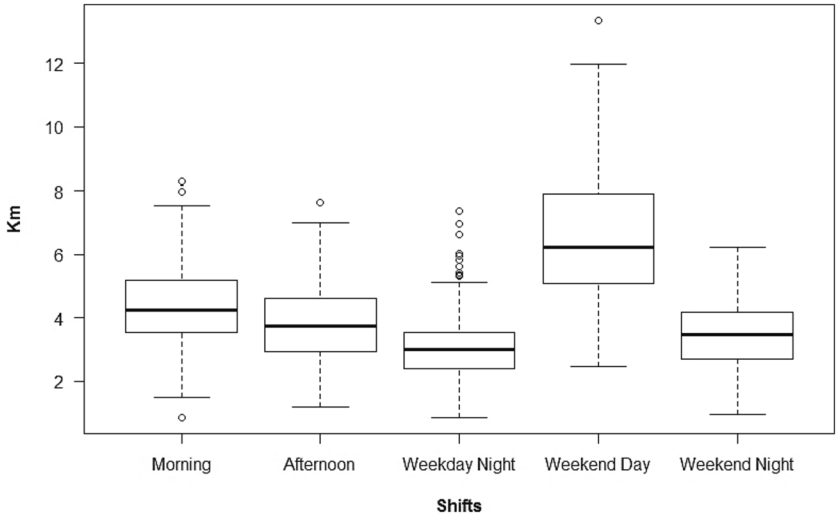

Fig. 2. Comparison of average distance measured for a single nurse using pedometer data for different shifts.

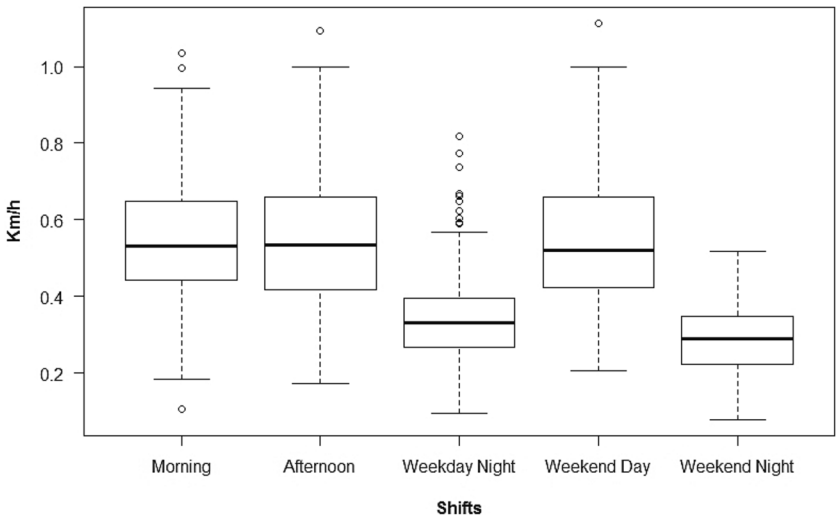

Fig. 3. Comparison of average distance measured for a single nurse using pedometer data for different shifts normalized by hour.

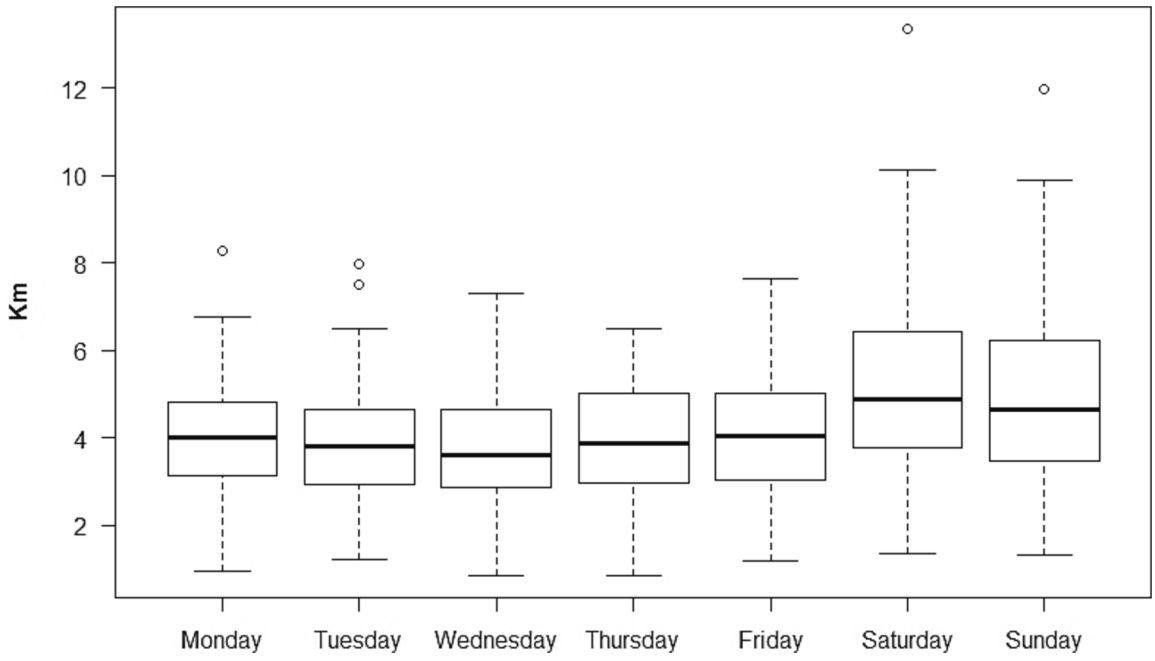

Fig. 4. *A*verage distance measured for a single nurse using pedometer data for different *days in a week*.

4. Discussion

The perioperative intensive care unit nurses in Slovenia who participated in our research achieved more than half of the WHO's recommended 10,000 steps per day (Rosenkranz et al., 2015; Caperchione et al., 2016; World Health Organization. Pacific Physical Activity Guidelines for Adults [internet]., 2008) during an 8-hour morning shift. The nurses who worked a 12-hour weekend day shift averaged 9,003 steps, 6.6 km and 226.3 calories in 101 min. Variations in the average distance walked by the day of the week (morning, afternoon and weekday night shift) were also observed in our study. The longest distances were covered on Saturday (weekend day shift) and the shortest distances were covered on Wednesday (afternoon shift). Based on these results, we observed a positive trend in the workload and consequently a higher physical activity from Wednesday to Saturday and a negative trend from Sunday to Tuesday. There was also seasonal variation in the number of kilometers walked by the nurses, with much less activity taking place around the holidays. Taken together, the heterogeneity of the physical activity and workload in the perioperative intensive care unit makes it difficult to predict staffing needs, as shown in the emergency departments (Svirsko et al., 2019).

These results are inconsistent with the findings reported by Al-Mohannadi, et al. (Al-Mohannadi et al., 2019) in Qatar and Kwiecien-Jagus, et al. (Kwiecień-Jaguś K, Medrzycka-Dabrowska W, Czyz-Szypenbeil K, Lewandowska K, Ozga D., 2019) in Poland, where nurses did not achieve an adequate number of steps during their work shifts, and the number of steps also differed between day and night shifts (Althoff et al., 2017).

We also presented a positive correlation between the physical activity, workload, and patient admissions in the perioperative intensive care unit. We demonstrated an association between the rise and decline of the average number of kilometers walked due to an increased/decreased physical activity and workload of nurses that resulted from a greater/lesser number of patients. The increase was most pronounced in

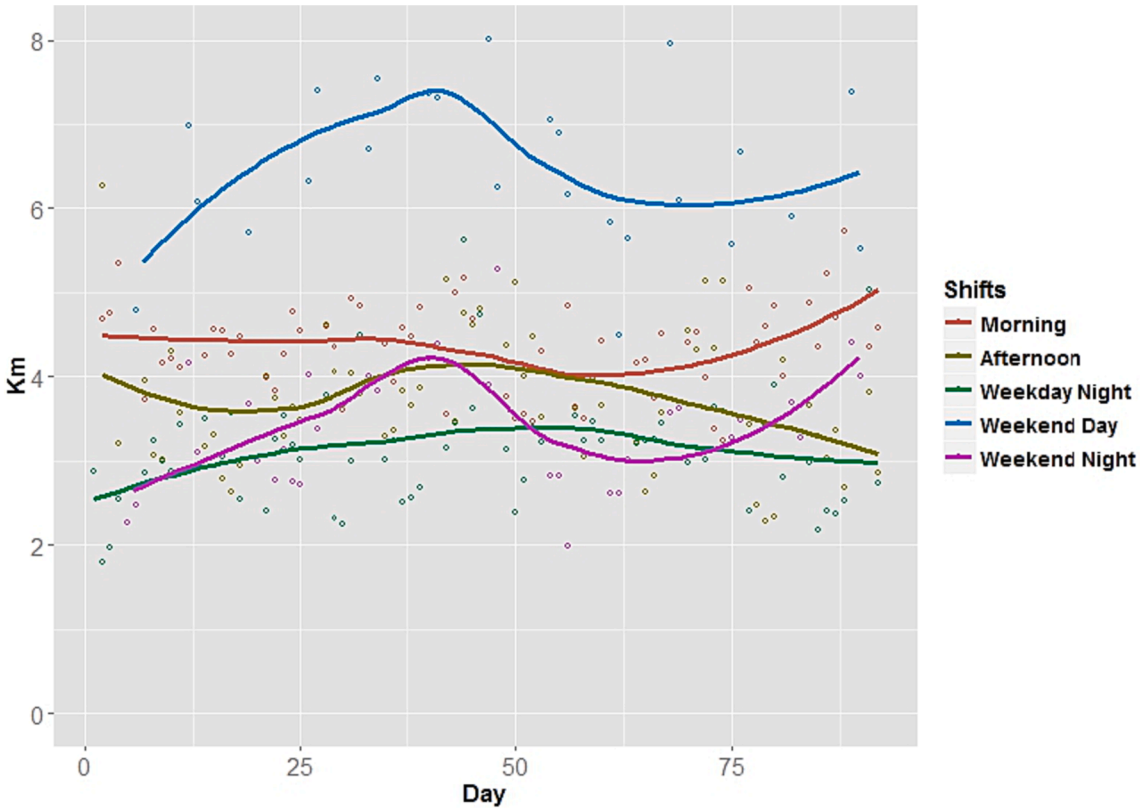

Fig. 5. Variability of the distance walked in different shifts during the period of the research on a daily level.

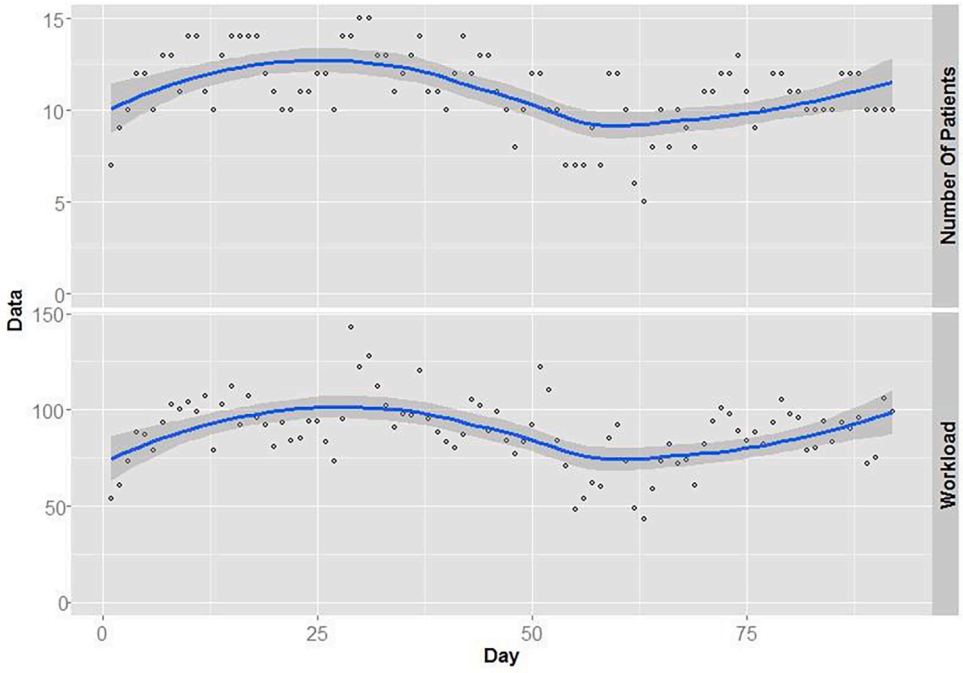

Fig. 6. Visualization of estimated workload and daily number of patients observed over 92 days.

the weekend day and night shifts, which were the busiest due to a shortage of nurses. Similar to Yu, et al. (Yu et al., 2020), we presented that physical activity during a 12-hour day shift was significantly higher than during a 12-hour night shift.

Pedometers have the dual function of measuring and motivating people to increase their daily steps (Tudor-Locke, 2002). Al-Mohannadi, et al. (Al-Mohannadi et al., 2019) detected an increase of more than 1,300 steps per day after a 3-month pedometer-based walking program. Improvement was not only observed in the number of steps and sitting time reduction, but also in lowering the nurses' stress levels and levels of fatigue, weight loss, as well as decreasing insomnia and cholesterol (Lavoie-Tremblay et al., 2014).

Table 1
Comparison of distance, number of steps, calories burnt, and time spent from the pedometer measurements by different types of shifts.

Attributes	Weekdays			Weekend days	
	8-hour morning shift	7-hour afternoon shift	9-hour weekday night shift	12-hour weekend day shift	12-hour weekend night shift
Kilometers	4.4	3.8	3.1	6.6	3.5
Steps	5938	5222	4322	9003	4925
Calories	147.5	138.2	106.1	226.3	119.5
Time [min]	67	59	50	101	57

Table 2
Comparison of distance, number of steps, calories burnt, and time spent from the pedometer measurements by BMI categories.

BMI categories	Kilometers	Steps	Calories	Time [min]
Normal group	4.2	5718	133.8	64
Overweight or obese group	4.1	5671	151.6	65

Despite active work, nurses often do not get enough physical activity (Owusu-Sekyere, 2020). Similar studies (Nahm et al., 2012; Flannery et al., 2014; Flannery et al., 2014; Almajwal, 2015; Blake and Batt, 2015; Chin et al., 2016) showed that 50 % of nurses were obese or overweight, with the majority not engaging in at least 30 min of daily moderate level physical activity or walking 10,000 steps per day. It is important to investigate the factors influencing a reduced physical activity and to develop interventions to promote physical activity in healthcare workers. In this study, BMI was not associated with average distances, number of steps, calories burned, and estimated "active time" performed in the perioperative intensive care unit. In the perioperative critical care, the nurses performed a similar amount of work on a daily basis, regardless of the day of the week or type of shift.

There were some limitations to the study which could limit the generalizability of the findings. The first limitation was the small sample size, therefore more precise measurements would be possible in case of a larger sample. One function of the pedometer was the automatic filter, which started measuring steps only after five to ten steps had been walked. As a result, shorter distances (i.e., smaller steps) were not recorded, which may have affected the results when measuring nurse workload. This is because nurses often have these kinds of nursing activities in clinics, such as changing wound dressings, feeding, or positioning patients. Therefore, more advanced pedometers should be utilised in future research to generate accurate results for researchers.

5. Conclusion

The nurses in Slovenia's perioperative intensive care unit walked more than half of the recommended 10,000 steps a day. The study also found that an increase in patient admissions resulted in an increased nurses' workload and physical activity. Future research could show if the level of physical activity and workload is a frenemy to the occupational health of nurses.

CRediT authorship contribution statement

Nino Fijačko: . **Ruth Masterson Creber:** Writing – review & editing, Methodology, Conceptualization. **Špela Metličar:** Writing – review & editing, Writing – original draft, Conceptualization. **Lucija Gosak:** Writing – review & editing, Writing – original draft, Methodology. **Gregor Štiglic:** Writing – review & editing, Visualization, Methodology, Formal analysis.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Acknowledgements

Authors would like to thank all the nurses which participated in this study.

Funding.

Nino Fijačko, Lucija Gosak, and Gregor Štiglic are supported by Slovenian Research Agency grants ARRS P2-0057, ARRS N3-0307, ARRS BI-US/22-24-138, NextGenerationEU and MVZI (C3330-22-953012).

INSTITUTIONAL REVIEW BOARD STATEMENT.

The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of the Faculty of Health Sciences, University of Maribor (protocol code 038/2023/780-2/902 and 23 February 2023).

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