A prospective pedometer study of doctors working in an Emergency Department

Craig Brian Beringer

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Author: Dr Craig Beringer

Address: 38 Ditton Avenue

Auckland Park

Johannesburg

South Africa

2092

+2784 325 3608

craigorollo@gmail.com

Co-authors:

Dr Lara Goldstein

The School of Clinical Medicine, Faculty of Health Sciences,

University of the Witwatersrand, Johannesburg, South Africa

+2782 459 9181

drg666@gmail.com

Professor Mike Wells

Division of Emergency Medicine, Faculty of Health Sciences,

University of the Witwatersrand, Johannesburg, South Africa.

+2782 491 0369

profmikewells@gmail.com

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DECLARATION

I, Craig Brian Beringer, declare that this research report is my own work. It is being submitted for the degree of Master of Medicine (Emergency Medicine) in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other university.

Signed:_____

Date:_____

ABSTRACT

Objective

The positive impact of physical activity and exercise on health is well known; conversely a lack of physical activity has been clearly demonstrated to increase the risk of several non-communicable diseases. Individuals who walk 10 000 steps per day or more are likely to meet recommended physical activity guidelines. Very little is known about the physical activity levels of doctors at work, in particular those working in busy Emergency Departments (ED). Our primary objective was to determine how many steps per shift doctors working in a South African ED took. The secondary objectives were to assess what factors influenced the number of steps taken.

Methods

This was a prospective observational cohort study undertaken at Helen Joseph Hospital ED, Johannesburg, South Africa over a one-month period. The 32 participating doctors wore pedometers during their day shifts in the ED and the number of steps taken during their shifts were measured; as well as the number and triage category of patients seen; and whether chest compressions were performed.

Results

The median number of steps taken per shift was 6328 (Interquartile Range [IQR] 4646-8409). This was significantly less than the 10 000 recommended steps per day ($p<0.0001$). In only 11.7% (37/317) of shifts did the number of steps taken exceed

the target of 10 000 steps. Factors which significantly increased the number of steps taken included shift duration and the performance of chest compressions. Each additional hour of shift led to a mean increase of 600 steps (95% CI: 548-772 steps). The mean number of steps for shift with chest compressions was 8308 (95% CI:7479-9137) while the mean number of steps for shifts without chest compressions was 6503 (95% CI: 6121-6885). A low patient per hour rate was shown with an average rate, for all participants over the one month period of 0.9.

Conclusions

The results show that doctors working in the ED are not achieving the recommended number of daily steps while at work. Failing to meet the current physical activity guidelines can be explained by the overall low rate of patients seen per hour as well as the general layout of the ED. With little time outside of working hours for exercise and further physical activity, achieving the desired steps per day seems unlikely, which could potentially increase the risk of ill health and burnout.

INTRODUCTION

Physical inactivity has been labeled a pandemic and noted to be the fourth leading contributing cause of death worldwide.[1] The positive impact of physical activity and exercise on health is well known, conversely a lack of physical activity has been clearly demonstrated to increase the risk of several non-communicable diseases such as hypertension, coronary artery disease and type 2 diabetes.[1,2] A clear directly proportional relationship between levels of physical activity and health and well-being has been demonstrated. [2] This also has local significance as South Africans have been found to be amongst the least active on the African continent.[3] Overall, very little is known about the physical activity of doctors.[4] No studies have been undertaken in a South African environment, and only one has assessed the physical activity of doctors in an emergency department (ED) in New York, USA. [5]

To encourage a healthy lifestyle, The American College of Sports Medicine, the American Heart Association and the US surgeon general recommend moderate intensity physical activity for a minimum of 30 minutes on 5 days of the week.[6] Current evidence suggests that individuals who walk 10 000 steps per day or more are likely to meet these physical activity guidelines, which is seen as an appropriate activity target for healthy adults.[4,7]

To date, none of the studies assessing doctors' physical activity levels have shown them achieving these suggested guidelines while at work, with steps well below the recommended figure of 10 000. [4,5,8-12] As doctors seldom achieve the daily requirements during their working hours, they would have to achieve the deficit, after hours. This has not been studied previously.

If doctors are unable to achieve the required target after hours, they might be at an increased risk for disease, mental health problems and burnout. The concept of increasing physical activity and its positive impact on mental health with a reduction in burnout symptoms is not new. [13]

The limited data that is available relating to doctors working in EDs shows an overall failure to achieve the recommended daily physical activity guidelines while at work. As emergency medicine is seen as a relatively fast paced and busy specialty, it was surprising to find the single study assessing ED doctors fell short of the recommended target.[5] We therefore wanted to determine if this was also the case in our setting of long hours and busy shifts. We hypothesized that in our South African setting the opposite would be true, with ED doctors walking well above the 10 000 mark, due to our busy, overburdened and understaffed departments, which historically have poor layouts and lack any form of ergonomic design.[14,15]

METHODS

Study design

This was a prospective observational cohort study undertaken at Helen Joseph Hospital (HJH); a tertiary academic teaching hospital in Johannesburg, South Africa; in the ED, over a one-month period from 3 August 2015 to 2 September 2015. The ED sees approximately 65 000 patients per annum.

The HJH ED consists of 2500m^2 floor space, which includes a seven-bedded resuscitation area, a six-bedded acute observation area, a eight-bedded surgical area and an eight-bedded medical area, as well as triage, orthopaedics, psychiatric and

radiology sections. Ethics approval was obtained from the Human Research Ethics Committee of the University of the Witwatersrand (Reference Number: M150405).

Study Population

Medical Officers and Emergency Medicine Registrars (residents) working day shifts in the ED made up the study population

Written informed consent was obtained from each participant prior to participation in the study. Those doctors who consented to a one-month pedometer assessment were included in the study.

Measuring Instrument

All doctors included in the study used a standardised, pre-tested commercially available pedometer. (Sportline Pedometer 360, EB Brands, Yonkers, NY). The Sportline series has been validated in several previous studies.[16]

The pedometers were labeled from 1 to 20 and distributed randomly to individual doctors, each day. This was done using a random number generator table, using Microsoft Excel©. The random assignment of pedometers to study participants was done to guarantee equal distribution of the possible variability amongst the pedometers.

Each pedometer's screen, displaying the number of steps taken was concealed so as to ensure the study participants remained blinded to the number of steps taken. A

clear concise instruction guide on the correct usage of the pedometer was provided and explained to each study participant to ensure accuracy of data collection.

It was recognized that other activities other than walking contributed to step counting by the pedometer device, most notably chest compressions when performing CPR (cardio-pulmonary resuscitation). Although no literature could be found to confirm or refute this, pilot testing of the pedometers during the performance of chest compressions confirmed recording of steps on the devices, which was deemed equivalent to walking.

A daily log sheet was completed over the study period, which included the shift time and duration in hours, as well as the number of steps taken at the end of each shift. The number of patients seen by each doctor per shift was documented on the daily log sheet, including the triage category of each patient seen (Green, Yellow, Orange or Red) according to the South African Triage Scale.[17]

Statistical Analysis

Categorical variables were summarised by frequency as percentages, and illustrated by means of bar charts. Continuous variables were summarised by the mean, standard deviation or median and interquartile range, and their distribution illustrated by means of histograms.

The number of shifts for which the number of steps met the target was determined.

A mixed model was used to determine the relationship between the number of steps per shift; the number of patients in each triage category seen by the participant; the total number of patients seen by the participant; the total number of patients in the ED on the date of the shift, and whether or not chest compressions were performed

in that shift. Participant was included as a random repeated measures effect. A log transformation of the number of steps was used where necessary to meet the assumptions of the analysis.

For the participants with five or more shifts, the association between the median number of steps per shift and age group, sex, and doctor qualification level was determined by the independent samples t-test for age and sex, and by one-way Analysis of Variance (ANOVA) for doctor qualification level.

Data analysis was carried out using SAS. The 5% significance level was used throughout.

RESULTS

A total of 32 doctors participated in the study, with a male to female ratio of 1:1. Eighty-four percent of the participants were Medical officers, while 16% were Registrars.

The median age of the participants was 29 years (interquartile range(IQR) 27.5-32 years). The distribution of ages was heavily skewed towards younger doctors.

A total of 319 shifts were included in the study with each of the 32 participants contributing between one and 20 shifts.

The distribution of shift durations is shown in Figure 1, with the most common shift duration being 8 hours. An overall working day averaged 9.0 hours.

Figure 1 The distribution of shift duration

The mean number of patients seen in the ED on the date of the shift was 100 (95% CI: 63-137), and the mean number of patients visiting the ED per hour was 11.7 (95% CI: 5.2-18.2).

The average patient per hour rate for all participants over the one month period was 0.9 patients per hour. The mean number of patients seen by each participant per shift, according to triage category, is shown in Table 1 below.

Table 1 Patients seen by each participant

Green, Yellow, Orange and Red represents the Triage category of the patient based on the South African Triage Scale.

Participant	CPR	Green	Yellow	Orange	Red	Total Patients	Patients/hour	Steps/hour
1	0	27	50	12	3	92	0.93	611
2	1	12	49	36	19	116	0.99	797
3	1	10	35	32	13	90	0.88	750
4	3	16	53	20	3	92	0.91	975
5	1	17	53	27	1	98	0.98	787
6	0	6	50	18	4	78	0.77	501
7	1	6	34	26	7	72	0.70	744
8	1	6	57	22	4	89	0.90	630
9	0	0	58	12	1	71	0.88	618
10	1	8	70	25	3	106	1.09	698
11	2	6	85	41	7	139	0.71	763
12	5	8	63	60	15	146	0.77	725
13	0	3	37	24	10	74	0.64	638
14	1	0	5	2	1	8	1.14	1195
15	0	15	76	12	1	104	0.97	554
16	0	13	45	5	0	63	1.00	740
17	0	10	41	31	5	87	0.96	760
18	0	7	55	16	2	80	0.89	561
19	0	3	34	32	6	75	0.78	833
20	3	4	50	24	6	84	0.99	1006
21	0	10	70	33	1	114	0.96	672
22	0	16	62	17	4	99	1.01	775
23	0	8	49	12	1	70	1.02	610
24	0	0	25	16	5	46	0.62	914
25	4	7	46	51	23	128	0.71	872
26	0	2	4	9	15	30	0.76	807
27	1	15	14	6	0	35	0.97	629
28	0	3	13	3	0	19	1.19	950
29	0	11	20	8	2	41	0.8	869
30	0	5	1	0	0	6	0.75	539
31	1	3	16	22	4	45	0.77	764
32	0	6	8	2	0	16	1.33	755
MEAN	**0.8**	**0.8**	**4.2**	**2.1**	**0.5**	**100**	**0.90 (95% CI: 0.3-1.5)**	**744 (95% CI: 254-1234).**

The number of steps was available for 317 of the 319 shifts, with two data collections lost due to pedometer malfunction.

On average the participating doctors walked 744 steps per hour. (95% CI: 254-1234).

The median number of steps taken per shift was 6328 (Interquartile Range [IQR] 4646-8409; range 2056-15 856). The distribution is shown in figure 2, with the 10 000 step target marked by the red vertical line.

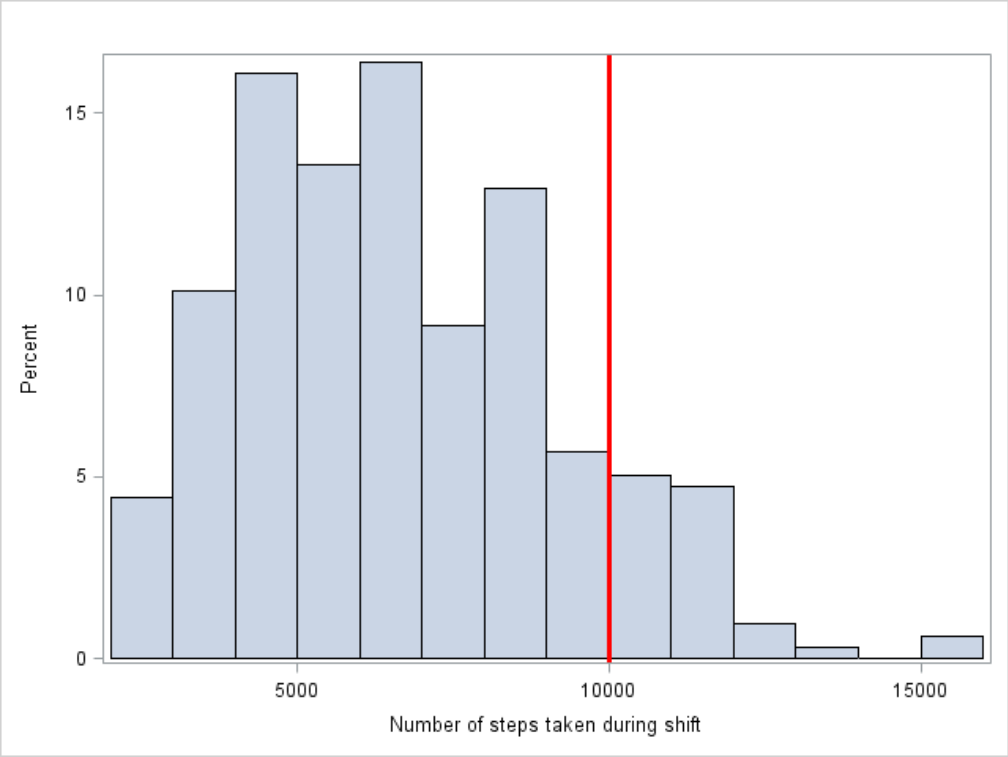

Figure 2 The distribution of the median number of steps taken per shift, with the 10 000 step target marked by the red vertical line

In only 11.7 percent (37/317) of shifts did the number of steps taken exceed the target of 10 000.

Figure 3 below represents the median number of steps taken per shift for each participant and the 10 000 step target marked by the red vertical line.

The six participants with fewer than five shifts were excluded from this analysis. The data are illustrated using a box-and whisker plot for each qualifying participant.

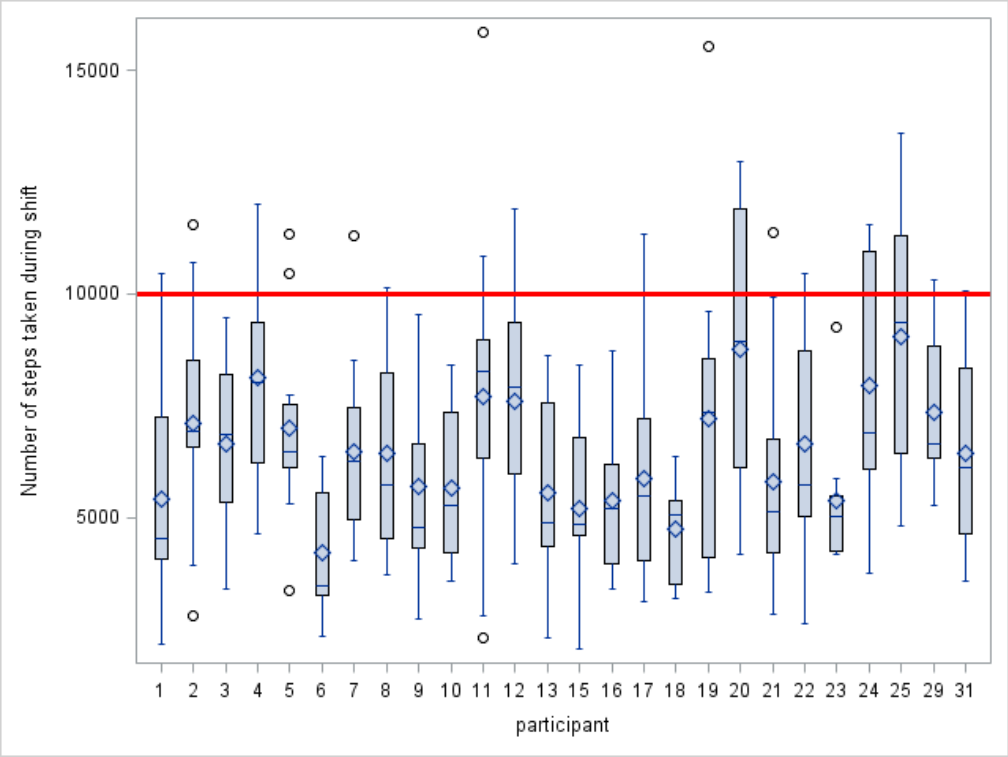

Figure 3 Box-and-whisker plot: The bottom and top edges of the box indicate the interquartile range (IQR), that is, the range of values between the first and third quartiles (the 25th and 75th percentiles). The marker inside the box indicates the mean value. The line inside the box indicates the median value. The whiskers that extend from each box indicate the range of values that are outside the interquartile range but within 1.5*IQR of the median. Values beyond this range (i.e. extreme values) are indicated by markers.

There was no significant association between the median number of steps and sex ($p=0.23$), age (≤30y vs. >30y) ($p=0.49$) or doctor level of experience ($p=0.11$).

A significant relationship was shown between the number of steps per shift and shift duration ($p<0.001$). Each additional hour of shift led to a mean increase of 600 steps (95% CI: 548-772 steps).

A significant relationship was found between the number of steps per shift and the number of patients seen by the participant, controlling for shift duration ($p<0.001$). Each additional patient seen led to a mean increase of 155 steps (95% CI: 66-243 steps).

A further significant relationship was demonstrated between the number of steps per shift and the number of patients in the ED on the date of the shift, controlling for shift duration ($p=0.015$). Each additional patient in the ED led to a mean increase of 14 steps (95% CI: 3-26 steps).

Regarding the triage category of patients seen, no significant relationship was shown between the number of steps per shift and the number of GREEN or RED patients seen by the participant, controlling for shift duration and patients of other triage categories seen ($p=0.33$ and $p=0.26$ respectively).

There was, however, a significant relationship between the number of steps per shift and the number of YELLOW and ORANGE patients seen by the participant, ($p=0.004$ and $p=0.008$ respectively). Each additional YELLOW patient seen led to a mean increase of 118 steps (95% CI: 10-226 steps), while each additional ORANGE patient seen led to a mean increase of 209 steps (95% CI: 56-362 steps).

Chest compressions were performed in 8.5 percent of the shifts, with a significant relationship demonstrated between the number of steps per shift and chest compressions, controlling for shift duration ($p<0.001$). The mean number of steps for shift with chest compressions was significantly higher (8308 95% CI: 7474-9137) than the mean number of steps for shifts without chest compressions (6503 95% CI: 6121-6885).

DISCUSSION

Doctors working in the ED did not walk the recommended number of daily steps at work. They were well below the target of 10 000 steps and thus failed to achieve the current physical activity guidelines during working hours.[4] This is in line with similar studies done elsewhere, worldwide, where doctors were noted to be relatively inactive. [4, 5, 8-12]

The correct terminology and distinction of levels of activity need to be made. Tudor Locke and Bassett made this distinction in their study, describing five levels of activity based on steps taken per day, as shown in Table 2.[18]

Table 2 Pedometer-determined physical activity levels

Number of Steps taken per day	Physical Activity level
< 5000	Sedentary
5000 - 7499	Low Active
7500 - 9999	Somewhat Active
10 000 - 12499	Active
>12 500	Highly Active

All the studies assessing doctors' physical activity levels, demonstrated that they fell into the low active category, excluding steps taken outside of work. In a study by Abd et al assessing the physical activity of cardiovascular physicians, they found on average 6010 steps were taken per day while at work, with average daily work hours of 10.65. [4] A Dutch study by Goosen et al, although assessing internists and general surgeons, had similar results, with an average of 5325 steps taken on an averaged 9.8 hours working day. They also found no difference between levels of experience of doctors and number of steps taken. However, they did note a statistically

significant relationship, albeit a negligible number, between number of steps taken per hour and age of participant, which our data did not demonstrate. Each additional year of age meant a decrease in 5 steps per hour (p=0.001) in their study.[9]

Atkinson et al assessed the activity levels of doctors working in a Scottish hospital. They demonstrated a significant difference in steps taken between doctors of different levels of experience, with medical officers averaging 7907 steps whilst consultant physicians only managed an average of 4647 steps per day. This difference can be explained by the fact that the study included consultants, who by nature of their jobs fulfill a more supervisory role and can therefore be expected to walk less during their shifts. Although a wide variation between doctors' levels of experience existed in their study, the median number of steps taken was still well below that of the 10 000 target.[8]

The single study assessing emergency medicine registrars was in a busy ED in New York by Josephson et al, which demonstrated very similar findings to ours. The registrars' median steps taken per shift were 7333, with only 9.9 percent of the registrars reaching the target of 10 000 steps or more. [5] The similar findings suggest that EDs are not conducive to achieving the required level of physical activity while on shift; however further studies in different EDs are required before such conclusions can be drawn.

It is noted that there are limitations in all the above studies assessing doctors' activity levels based on the number of steps taken. They are all of a relatively small sample size; taken over a short period of time (all with less than 12 months of data

collection); and excepting one study, [9] all were undertaken at a single centre, and thus unable to account for differences in hospital layout and patient numbers.

We originally hypothesized that the recommended number of daily steps would be easily achieved in our South African context, owing to the high patient load seen in our EDs, the relatively poor ED layout and shortage of assistant staff (nursing, porters etc.).[14,15] Despite the fact that HJH ED is a relatively large unit in terms of actual square meters, the radiology, laboratory and staff tearoom facilities are all within close proximity. This, together with the recent change to online laboratory result access and the introduction of a PACS (Picture Archive and Communication System) for radiological imaging reviewing, contributed to easier accessibility and fewer steps being taken. With the proposed change of record keeping to a computer based electronic system, the number of steps could be expected to decrease further as all chart related functions can be performed at a desk using a computer, as recognized in the study by Josephson et al.[5]

Factors which demonstrated an increase in steps taken included the shift duration the total number of patients seen in the ED that day, as well as the number of patients seen per participant. It was found that the longer the shift duration the more steps that were taken by the individual, however even in the longest shift (12 hours) the target of 10 000 steps was infrequently reached. This poses the question whether those individuals were able to find time to engage in additional out-of-hours exercise in order to consistently meet the current recommendations for physical activity, after a long, tiring 12 hour shift.

HJH ED is a busy unit, with a daily average of 170 patients and 65 000 patients visiting the department annually. These figures are far greater than the average visits seen internationally, in other EDs around the world.[19] Despite the large patient load, the doctors however did not achieve the desired step count. This can be explained by looking at the patients seen per hour by each doctor, with an average for all participants being 0.9 patients per hour. This, when compared with international standards, is significantly lower, with a purported average ranging from 1.8 – 2.8 patients per hour.[19]

The explanation for this low patient per hour average, despite a high overall patient load in the ED could be one of two reasons. Either there is more than sufficient doctor staffing, allowing doctors to see patients at a much slower rate than normal; or that doctors are having to perform several tasks, which could be done by other members of staff, such as phlebotomy; requiring more time spent per patient.

The triage category of patient seen had an effect on the number of steps taken per participant. Green and Red triage categories had no significant effect, while Yellow and Orange patient categories did. The Green patients, who are by nature quicker to assess and come to a management plan with little further investigations required, resulted in no additional steps being taken. The Red patients who are critically ill often require activities that can be performed in a small confined space, the resuscitation area. This, together with more time spent with this type of patient, meant no further steps were accumulated.

The Yellow and Orange patients required more investigations to be carried out at multiple locations (blood gas analysis; radiology etc.), which meant more time walking rather than at one location and therefore more steps were taken.

Performing chest compressions led to a significant increase in the number of "pseudo-steps" taken during that shift. Performance of CPR is a well-recognized form of physical activity and furthermore has been shown to be a good assessment of fitness level.[20] A total of 690 joules, on average are burnt during 15 minutes of CPR training, which equates to a 30 minute hike or light garden work. [21,22]

Limitations

The study enrolled a relatively small number of participants over a relatively short period of time, and only during day shifts in the ED.

Data was also only collected in a single ED, thus preventing any comparison between different departments and their layouts. The study participants also only included a certain group of doctors i.e. consultant emergency physicians and interns were not included, which may have demonstrated an obvious difference in steps taken.

Furthermore, although the pedometer screens were covered, blinding the participants from the amount of steps they had taken, it is a well-known fact that the mere awareness of wearing a pedometer increases the amount of steps taken.[8]

As noted in the study by Atkinson et al, even though no doctors declined participation in the study, it is a possibility that selection bias could have occurred as healthier more active individuals are more likely to agree to participate in such a study.[8]

Conclusion

This is one of the few studies to demonstrate the lack of physical activity during working hours by emergency medicine doctors, inferred by the deficiency of steps taken during shifts, and the only one undertaken in a South African setting.

Our results show that the doctors, rather than being sedentary fell within the low activity range during work hours. Failing to meet the current physical activity guidelines can be explained by the overall low rate of patients seen per hour as well as the overall layout of the ED.

With little time outside of working hours for exercise and further physical activity, achieving the desired steps per day seems unlikely, which would potentially influence the increased risk of ill health and burnout, in an already high-risk specialty.[23]

This illustrates the need for hospital management to provide interventions to promote healthier living and increase physical activity as well as to design burnout prevention strategies. Possible solutions could include an hourly roster for the on shift doctors; which includes laboratory or blood bank 'runs' to deliver and collect specimens; in this way ensuring all staff are involved in additional physical activity whilst at work. Lastly, hospital management needs to recognise that the provision of sufficient off time is vital to ensure happy, healthy doctors.

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COMPETING INTERESTS

None

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ETHICS APPROVAL

Human Research Ethics Committee (Medical) University of Witwatersrand M150405

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