

Pediatric Resident's Perception of Night Float System Compared to 24 Hours System, a Prospective Study

Fahad Alsohime (✉ falsohime@ksu.edu.sa)

King Saud Medical City

Hamad Alkhalaf

King Saud bin Abdulaziz University for Health Sciences

Hissah Almuzini

King Saud Medical City

Malak Alyahya

King Saud Medical City

Reema Allhidan

King Saud Medical City

Ghadeer Assiry

King Saud Medical City

Munirah AlSalman

King Saud Medical City

Walaa Alshuaibi

King Saud Medical City

Mohamad-Hani Temsah

King Saud Medical City

Abdullah Alakeel

King Saud Medical City

Ayman Aleyadhy

King Saud Medical City

Research article

Keywords: duty hour, post-graduate, residency, well-being, work schedule tolerance, night float

Posted Date: June 9th, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-31495/v1>

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Version of Record: A version of this preprint was published on January 6th, 2021. See the published version at <https://doi.org/10.1186/s12909-020-02474-x>.

Abstract

Background: This study aims to evaluate the pediatric residents' perceptions of the Night Float (NF) on-call system and its impact on their well-being, education and patient safety and compare it with the previous traditional 24-hour on-call system.

Methods: This is a prospective study conducted in two pediatric residents training centers who applied the NF on call system as a pilot project. The senior residents enrolled in the two training centers were invited to participate in this study before changing the on-call system and 6 months after starting the new NF on-call system. A self-administered online questionnaire was distributed to them. A five-point Likert-type scale was used to rank the residents' responses, covering three main domains; residents' well-being, ability to deliver health care, and their medical education experience. Pre- and post-intervention scores were presented as means and compared using the t-test for paired samples.

Results: A total of 42 residents participated in the survey. Of these, 24 (57.1%) were females. All participants were senior residents; 25 (59.6%) were third year residents while 17 (40.4%) were fourth year residents. Participants felt that most aspects of the three domains were improved by the introduction of the NF system. The NF system had less adverse health effect on the residents (Mean 2.37 ± 1.01), compared to the 24 hours on-call system (Mean 4.19 ± 0.60), $P < 0.001$. The NF system had less exposure to personal harm, less negative impact on the quality of care, better work efficiency, reduced potential for medical error, more successful teaching and fewer disruptions to other rotations compared to the 24 hours on-call system, ($P < 0.001$).

Conclusion: In this study, we found that the NF on-call system positively impacts residents' well-being, education and patient care. This pilot study demonstrates that the restricted duty hours are useful from pedagogic aspect and sets the ground for Pediatric residency training programs in Saudi Arabia to consider resident duty hour reform.

Trial registration: Not applicable

Background

For several decades, adjusting working hours for residents have been a concern. The Saudi Commission for Health Specialties introduced some guidelines regarding duty hour's regulations including the 24-hour on-call traditional shift system. The number of on-calls for pediatric residents in the first two years of the training program should not exceed 7 on-calls every month while for residents in the third and fourth year of the program should not exceed 6 every month according to Pediatric Residency Training Program Manual [1].

In several studies, the traditional 24-hour on-call system was associated with sleep deprivation and fatigue, which subsequently, resulted in increased medical errors and motor vehicle occlusions.

Furthermore, an increase in burnout and suicide attempt among physicians. As a result, several countries have established the Night Float (NF) shifts system [2–6].

The NF system is where residents take care of patients for 12–16 hours either during daytime or nighttime [7]. Or in some contexts in order to conduct the NF system, the residents are divided into two alternating groups where one group work at nighttime, and the other work in the daytime [8]. On the other hand, traditional on-call system is where doctors are responsible for receiving calls from the emergency department, or medical teaching unit for 24 hours [9].

In 2003, the Accreditation Council for Graduate Medical Education (ACGME) In the United States the limited the working hours to 80 hours per week which restricted overnight shift length and assigned minimum out of duty hours between shifts. In 2011, Quebec province in Canada restricted duty hours to not exceed more than 16 hours for a shift [10]. Also, Europe has implemented residents' duty hour restrictions. In 2017, Korea has established the NF system for 6 months [8]. In Singapore, the NF system was applied for interns in the internal medicine department for a research study [6]. However, multiple studies have shown controversial results regarding the implementation of the NF shifts system [2]. In this study, we evaluated the experience of pediatric senior residents with the duty hours after implementing the NF system as a pilot project in two pediatric residency training centers in Saudi Arabia and compared it to the traditional 24-hour on-call system in term of effect of their health, education, patients care and safety.

Methods

This is a prospective study conducted in two pediatric residents training centers who applied the NF on call system as a pilot project. Three months after the implementation of the Night Float (NF) system as academic quality improvement project in two training centers in Saudi Arabia, where the on-call hours were reduced from 24 hours to 18 hours maximally for senior residents only (R3 & R4).

The project involved changing the Residents' on-call shift from the previous 24- hour coverage to a day-float and night-float schedule for both, the weekdays and the weekends with a 9-hour day shift and 17-hour night shift. There was a scheduled, dedicated 1-hour overlap structured at shift change for effective handover.

Before the beginning of this modality of on-call system, we administered a previously validated, evidence-based questionnaire to assess residents' perceptions of the implications of duty hour reform with permission from the author Fabreau G et al, 2013. [11].

This same questionnaire was resent to the trainee six months after the implementation of this new form of duty hours (Appendix A). The questionnaire was composed of Likert items which measured the extent to which respondents agreed or disagreed with statements relating to the three major domains of the senior residents' wellness (16 items), ability to deliver quality health care (17 items), and medical

education experience (16 items) (Appendix 2). The responses to each item were coded as strongly disagree (1), disagree (2), neither agree nor disagree (3) agree (4) and strongly agree (5).

The primary outcome was the change in all senior pediatric residents' perceptions of senior residents' well-being, ability to deliver quality health care and medical education experience, pre- and post-intervention, as measured by a questionnaire.

This study received ethical approval from the Institutional Review Board (IRB) of King Saud University. Residents were informed that participation was not mandatory and assured of the anonymity and confidentiality of their responses. A written consent was obtained from the participants before their enrollment in this survey.

Statistical Data Analysis:

The means and standard deviations were used to describe the continuous variables, and the categorically measured variables were described using frequencies and percentages. The compute command in the analysis program was used to estimate the mean score for each domain using its sub-items after reverse coding the negatively worded statements to align their direction with their main sub-construct magnitude, i.e. agreement level. The paired samples t-test was used to assess the statistical significance on the mean indicators of physician satisfaction with the two used on-call systems.

Results

Participants

Forty-two residents accepted to enroll themselves into the study, 24 residents (57.1%) were female residents; 25 residents (59.6%) were in the third year of training (R-3) and 17 (40.4%) residents were in the fourth year of training (R-4) as shown in Table 1.

Perceptions of the impact of the Night Float system

Well-being

Regarding the general well-being, the analysis showed that the residents perceived significantly more negative impact of the 24-oncall system on their general well-being compared to the NF system (general effects on health, restriction to physical activity, impairment to their circadian rhythm, overall fatigue and physical illness episodes, as well as more need to consume stimulants like coca cola and coffee), $p < 0.001$. However, the NF system was associated significantly with enhanced energy levels than their working with the 24-hour on-call system, $p = 0.041$.

Nonetheless, the potential for harm for the two on-call systems was measured with two indicators. The analysis showed that the 24-hour on-call system was significantly higher potential for car accidents and needle stick accidents.

Anyhow, the two on-call systems had showed equivalent results in term of conflicting and resilience aspects that allowed to trade off on-call shifts with other residents, $p = 0.830$. However, the residents found the 24-hour on-call system had significantly less permissive (access) to free time to accomplish errands, less family friendly and more restrictive to residents to do research than the NF on-call system (see Table 2A).

With regards to the indicators of resident's relationships with others, the analysis showed that residents significantly felt more isolated in the 24-hours on-call system, but they had significantly better social relationships in NF system, $p \leq 0.001$.

Ability to deliver quality health care

Importantly, the perception of the impact of these on call systems on the quality of delivered healthcare services by the residents to their patients were measured with four indicators. The data showed that the residents were significantly less alert during the 24-hour on-call shifts in comparison with the NF system. Meanwhile, the residents perceived the 24-hour on-call system had significantly more association with preventable medical error density, more near missed errors, and more fatigue that impacted their patients care quality.

In regard to the impact of the two on-call systems on aspects of residents' expertise, the residents pointed that the 24-hour on-call system had significantly more missed important diagnoses of their patients, less ability to manage complex medical issues, less accurate medical handovers and less accountability to patients care, $p \leq 0.001$ in comparison to the NF system. As shown in the Table 2A.

Medical education experience

Table 2B displays the residents' responses on the aspects of emotional burden, efficiency of work, education, skills, learning ability, supervision, experiencing interruptions during rotations and post on-call. The analysis of the emotional burden on the residents showed that the residents had experienced significantly greater interaction and communication with their patients during the NF on-calls compared with their 24-hour on-call system. However, the data showed that the two on-call systems had nearly equivalent sensitivity to social issues related to their patients care and care planning like cultural and gender sensitivities, $P = 0.486$. Moreover, the analysis of the indicators of work efficiency showed that the residents had perceived significantly less multitasking ability, less hand over efficiency and less ability to attend pager buzzes during the 24-hour on-calls system compared to the NF on-calls, $p \leq 0.001$ each respectively.

In addition, the teaching of junior residents and clerks were significantly less timely permissive and more energy consuming with the 24-hour on-call system than when they worked during the NF shift. However, their 24-hour on-call shifts were highlighted with less confidence to teach, less efficacy on teaching management of unstable patients, and teaching skills on running codes and managing patients in emergencies. The indicators of skillfulness, had suggested that residents were less confidence with doing medical procedures. Also, had less confidence and ability in managing critically ill patients and performing cardiopulmonary resuscitations (i.e. patient code situations) during the 24-hour on-call shifts than during the NF shifts, $p \leq 0.050$ each respectively.

The analysis of data regarding residents learning showed that residents perceived less acquisition of knowledge, less usage of new knowledge, less satisfaction with education and learning thru simulation during their 24-hour on-call system compared to the NF systems, $p \leq 0.050$ respectively. Furthermore, the residents had perceived their 24-hour on-call system as significantly less helpful for reviewing cases with peers, less permitting to in depth discussion of clinical skills with other peers and allowed less feedback from attending seniors when compared to their experiences during the NF episodes, $p \leq 0.050$ each respectively.

The residents had perceived that the 24-hour on-call system is significantly more interruptive to ambulatory care rotations, more associated with post on-call call-backs and fatigue during weekends which affected their successive weekdays work rotations compared to their NF system, $p \leq 0.001$ each respectively.

The overall rating of the different domains:

The analysis findings of the overall concepts with experiences of the two on-call systems showed that, the NF system had significantly more positive impact on general wellness, more role resilient, healthier for residents' social and family relationships. On top of that, less exposure to harm and risk, less impact on the quality of care they had delivered to their patients while working, less disruptions during the post NF system. Also, it showed more resilient with regards to emotional integrity of their patients care in comparison to the traditional 24-hour on-call system.

Furthermore, they perceived more work efficiency, higher teaching ability, higher skillfulness, better learning, and more efficient supervision during the NF on-calls. Means and standard deviations are shown in Table 3 and Figure 1.

Discussion & Literature Review

Several studies tested the impact of the application of the Night Float (NF) system. In Korea in 2017, the NF system was implemented in a research study on surgery and emergency residents [8]. In Singapore, it was implemented on interns of internal medicine department [6]. The study showed that even though physicians have longer total work hours than non-health care providers they even exceed those official

schedule hours [12]. We conducted our study in Riyadh, Saudi Arabia among pediatrics residents to evaluate the impact of the NF system and the traditional 24-hour on-call system on several aspects.

The NF system showed improvement regarding rapid response to calls, better patient management in our study as well as other study conducted in Korea.

Furthermore, their study had showed decrease confusion and post-operative bleeding that we did not evaluate in our study [8]. Our study showed improvement regarding patient care, communication and physician sleep hours which is similar to another study that implemented the NF system on residents. Also, they found that NF system allowed more time for reading and family which is the same with our data that showed more free time to accomplish non-work related errands. In addition, it decreased fatigue, medical errors, and needle stick injuries [13]. The NF system was implemented in a group of interns in the internal medicine department in Singapore.

They found that interns were satisfied regarding the implementation of the system, and thought the system decreased the incidence of medical errors, better physician health, and did not alter the quality of their education similar to our results [6].

It is important to draw attention that residents' well-being will affect their education, patient care, and patient safety [14]. A study was conducted in Saudi Arabia supported the same finding in which the 24-hour on-call system had a negative outcome on the residents' health, education, and safety of the patients. It suggested to investigate the impact of the duration of time residents spend in the hospital on their clinical performance, education, and quality of patient management [1]. Our study, showed that NF system had significant improvement in these three aspects. Several studies showed the traditional on-call system is associated with loss of sleep and fatigue which is like our study results [2–3]. Furthermore, the 24 hour on-call system shown to negatively affect physical function and memory in our pediatric residents and neurosurgery residents in another study [15].

Another study was done on neurosurgery residents showed that long and multiple shifts associated with burnout risk [4]. Another research emphasized the effect of stressful on-call duties, and long duty hours on the increase in the incidence of burnout [5]. In addition, a study suggested minimizing work hours and assigning health care workers to specific rules in order to prevent physician burnout [16]. Moreover, a survey advised a time off to improve residents' well-being as it showed that long duty hours could cause residents burnout which can cause depression, substance abuse, and suicide attempt [2–3, 5].

There were multiple surveys that have controversial results regarding the NF shifts in comparison to the traditional on-call system. Better ability to adapt to circadian rhythm changes and no restriction of physical activities were associated with NF shifts in our study while a study in Singapore showed no increase in sleep hours or reduce physical activity which contributes to the development of fatigue [2].

Also, there were some doubts that the NF system may reduce the quality of residents' education [8] as well as the education opportunities due to decrease interactions and conferences during the NF system

[17]. We found that education experiences and opportunities to learn procedures among pediatrics residents were in favor of the NF shifts. However, one of the proposed solutions for successful teaching during the NF system is the implementation of the nighthawk system and a must-call list [18].

The limitation of our study were lack of assessment regarding the risk of motor vehicle accidents and near-miss driving events that could be related with loss of sleep and fatigue during long-time shifts [2–3, 13]. Also, we did not evaluate the cognitive function which is another limitation [15].

Conclusion

The 24-hour on-call system negatively impacts residents' well-being and education and patient safety. On the other hand, the restricted duty hours were less harmful, more useful from pedagogic aspect and has positive impact on the quality of delivered health care services. Pediatric residency training programs in Saudi Arabia should consider resident duty hour reform and evaluate new on-call models to improve resident well-being, training and improve patient care.

List Of Abbreviations

(NF) Night Float

(ACGME) Accreditation Council for Graduate Medical Education

(R3) Level 3 resident

(R4) Level 4 resident

Declarations

Ethics approval and consent to participate: Approved by Institutional Review Board King Saud University, Research Project number E–16–1908.

Consent for publication: A written consent was obtained from each participant upon the enrollment in the study.

Availability of data and materials: The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests: Nothing to declare

Funding: Not applicable

Authors' contributions:

FA: Proposal writing, IRB application, Consenting process, Data collection, Data analysis, Methodology, manuscript writing, Manuscript revision.

HA: Consenting process, Data collection and Manuscript revision.

HRA: Data analysis, manuscript writing and manuscript revision.

MA: Data analysis, manuscript writing and manuscript revision.

RA: Data analysis, manuscript writing and manuscript revision.

GA: Data analysis, manuscript writing and manuscript revision.

MAA: Data analysis, manuscript writing and manuscript revision.

WA: Consenting process, Data collection and Manuscript revision.

MT: Proposal writing, IRB application, methodology and manuscript revision.

ASA: methodology and manuscript revision.

AA: Proposal writing, IRB application, methodology and manuscript revision

All authors have read and approved the manuscript.

Acknowledgements: The authors thank the residents who participated in this survey and the staff of the academic department at the Saudi Commission for Health Specialties for facilitating the delivery of the survey to the pediatric residents. Lastly, the authors gratefully acknowledge the College of Medicine, the Medical Education Department, the Research Center and the Deanship of Scientific Research at King Saud University, Riyadh, Saudi Arabia.

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Tables

Table 1: Demographic and professional characteristics of the participants N=42.

	Frequency	Percentage
Male	18	42.9
Female	24	57.1
Residency Level		
R3	25	59.6
R4	17	40.4

R3: Level 3 resident, R4: Level 4 resident

Table 2A: Descriptive and bivariate analysis of the indicator of residents' satisfaction with various aspects of the two on-call systems N=42.

	Mean (SD)-likert agreement rating					
	hour 24	Night float			p-	
	oncall system	system	t/df=41		value	
TION ON GENERAL WELLNESS						
					0.0>	
ely affects my health	(0.92) 4.48	(1.27) 2.45	8.53		01	
ts my participation in physical					0.0>	
	(0.69) 4.67	(1.23) 2.38	11.45		01	
s my ability to adapt to Circadian						
l changes	(0.95) 4.33	(1.33) 2.55	7.85		0.003	
					0.0>	
utes to overall my fatigue levels	(0.59) 4.74	(1.26) 2.33	11.92		01	
utes to frequent episodes of physical					0.0>	
(eg. colds)	(1.08) 3.90	(1.22) 2.14	7.9		01	
es my overall energy levels***	(1.52) 2.86	(1.23) 3.60	2.11		0.041	
utes to my need to use stimulants					0.0>	
: caffeine	(0.89) 4.40	(1.24) 2.86	7.5		01	
POTENTIAL OF PERSONAL HARM						
s safety while driving home when I					0.0>	
t call	(0.86) 4.45	(1.19) 2.57	8.211		01	
potential for workplace harm (eg.					0.0>	
stick injuries)	(1.10) 4.10	(1.22) 2.21	9.3		01	
CONFLICT POTENTIAL/ROLE						
ANCE IMPACT						
sy for me to trade on-call shifts with		1.20) 3.02				
	(0.89) 3.07	(0.22		0.83	
me free time to accomplish my non-					0.0>	
elated errands	(1.33) 2.57	(1.20) 4.07	5.1		01	

as opportunities to spend time with family	(1.15) 2.0	(1.08) 4.26	8.5	0.0>01
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limits my time available to do what I want to do***	(0.98) 4.10	(1.27) 2.52	6.1	0.0>01
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STATEMENT ON PHYSICIANS HEALTH OF RELATIONSHIPS

maintain healthy interpersonal relationships	(1.06) 2.55	(0.88) 4.17	6.86	0.0>01
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feel alone or me to feel isolated at times	(0.85) 4.17	(1.33) 2.60	6.57	0.0>01
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STATEMENT ON PHYSICIANS QUALITY OF LIFE

During your work hours, do you feel alert during your work hours while on call***	(1.1) 2.90	(0.72) 4.14	5.83	0.0>01
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commit to preventable medical errors	(0.91) 3.64	(1.13) 2.55	5.23	0.0>01
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experience "near misses" related to patient care	(0.75) 3.86	(1.02) 2.52	6.95	0.0>01
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feel often too tired to provide safe patient care	(1.06) 3.83	(1) 2.14	7.8	0.0>01
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STATEMENT ON PHYSICIANS CLINICAL PRACTICE

consider it difficult to make important diagnoses	(0.88) 3.83	(0.88) 2.17	9.62	0.0>01
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manage complex medical patients	(1.08) 3.0	(0.87) 3.98	4.34	0.0>01
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confidence in the content of my patient care handover is	(1.06) 3.19	(0.74) 4.11	4.79	0.0>01
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feel responsible for the accountability for the patients I care for	(0.89) 3.57	(0.83) 4.12	3.41	0.001
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Table 2B: Descriptive and bivariate analysis of the *indicators* of physician's satisfaction with various aspects of the two resident on-call systems. N=42.

	Mean (SD)-likert agreement rating		t/df=41	p-value
	hour-24 oncall system	Night float system		
WORKLOAD BURDEN				
Interactions with other MTU team members are positive	(0.99) 3.43	4.33 (0.57)	4.86	0.001
Communicate well with patients and their families	(1.04) 3.55	4.21 (0.81)	3.42	0.001
Sensitive to social issues pertaining to patients (e.g. Gender and Culture)	(0.86) 3.19	3.29 (0.99)	0.703	0.486
EFFICIENCY				
Unable to effectively multitask during busy times	(1.18) 2.67	(0.99) 4.0	5.99	0.001
Order patient care issues in a timely manner	(1.24) 2.93	4.19 (0.77)	5.4	0.001
Respond to pagers in a timely fashion	(1.21) 3.19	4.12 (0.86)	4.6	0.001
TEACHING ON MEDICAL EDUCATION AND LEARNING				
Do not have enough time to teach junior residents	(0.92) 2.19	3.83 (0.93)	7.84	0.001
Do not have enough energy to teach junior residents	(0.92) 2.12	3.83 (1.06)	7.4	0.001
Confident in my ability to teach technical skills	(1.14) 3.10	3.90 (0.93)	3.14	0.003
Confident in my ability to teach how to manage unstable critically ill patients	(1.10) 3.12	3.93 (0.95)	3.57	0.001
Confident in my ability to teach the skills to run a code	(1.11) 2.93	3.60 (0.96)	2.9	0.006
CONFIDENCE ON MEDICAL SKILL PROFICIENCY				
Confident in my ability to perform procedures	(0.92) 3.48	4.14 (0.65)	3.72	0.001
Confident in my ability to manage unstable critically ill patients	(0.80) 3.45	3.90 (0.88)	2.3	0.026
Confident in my ability to run a code	(1.02) 3.19	3.71 (0.97)	2.67	0.011
ON PHYSICIANS LEARNING				
Require new knowledge on call	(1.07) 3.33	4.12	3.76	0.001

			(0.80)		
gain new knowledge on call and apply			4.12		
ent care	(1.08)	3.38	(0.86)	3.26	0.002
all education experience on call is			3.95		0.0>
g	(0.99)	2.83	(0.91)	5.46	01
opportunities to learn procedures			3.86		
simulation training	(1.06)	3.36	(0.93)	2.51	0.016
NG STAFF PHYSICIAN SUPERVISION					
re opportunity to review cases with			3.79		0.0>
g physicians	(0.99)	2.95	(0.92)	4.14	01
ical skills (history and physical) are			3.10		0.0>
l by an attending physician	(1.0)	2.33	(1.16)	4.1	01
			3.24		
d feedback from attending physicians	(1.06)	2.74	(1.19)	2.86	0.007
TION FROM THE ONCALL SYSTEM					
ilatory care rotations are frequently			2.38		0.0>
ed due to MTU on call duties	(1.06)	3.95	(1.08)	5.55	01
			2.10		0.0>
ing post-call more often	(1.18)	3.79	(0.96)	6.38	01
d after a weekend of call and it			2.71		0.0>
ly week-day rotations	(0.70)	4.57	(1.42)	7.74	01

Table 3: Descriptive and bivariate analysis of the of physicians satisfaction with *main ASPECTS* of the two resident on-call systems. N=42.

	Mean (SD)-likert agreement rating			
	hour oncall-24 system	Night float system	t/df=41	p-value
effect on physicians health	(0.60) 4.19	(1.01) 2.37	11.32	0.001
ens safety/harm	(0.8) 4.27	(1.07) 2.39	10.17	0.001
liance	(0.59) 2.74	(0.77) 3.71	5.63	0.001
relationships health /integrity	(0.76) 2.19	(0.99) 3.79	7.4	0.001
impact on Quality of care and safety	(0.67) 3.61	(0.79) 2.27	7.8	0.001
ns expertise level	(0.75) 2.98	(0.61) 4.01	6.6	0.001
al burden on the physician	(0.74) 3.39	(0.61) 3.94	4.14	0.001
iciency	(1.01) 2.93	(0.75) 4.1	6.19	0.001
o teach and coach others	(0.82) 2.69	(0.85) 3.82	5.56	0.001
oficiency rating	(0.75) 3.37	(0.71) 3.92	3.16	0.003
o learn	(0.83) 3.23	(0.79) 4.01	4.34	0.01
ion	(0.80) 2.67	(0.92) 3.37	4.38	0.001
ons from the on-call system	(0.75) 4.10	(0.98) 2.40	7.36	0.001

Figures

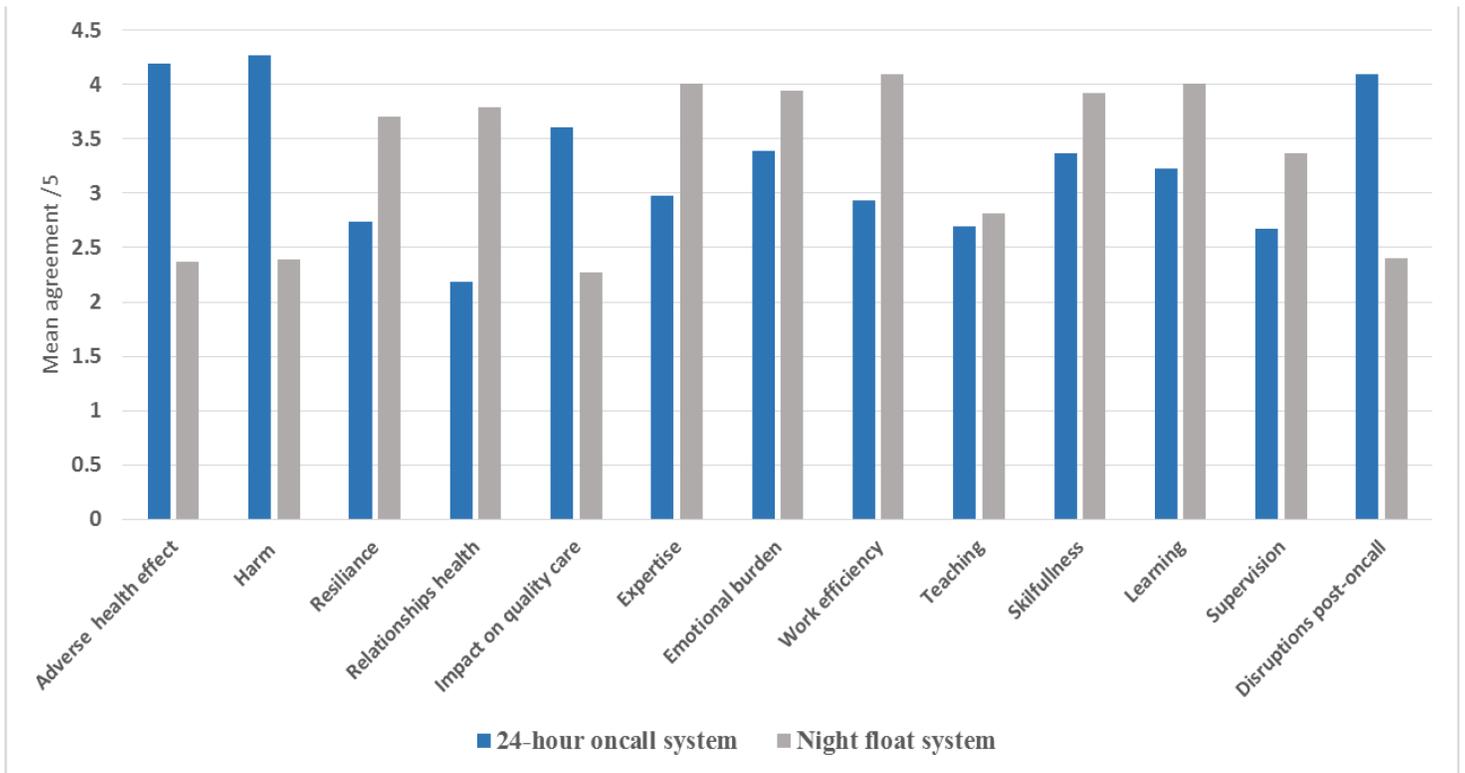


Figure 1

The medical residents mean perceptions of the two on-call systems