

Predictors of Intershift Fatigue Recovery Among Doctors: A Protocol

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ABSTRACT

Background: Doctors are exposed to various psychosocial hazards such as high task demands and demanding work schedule, which may influence fatigue, recovery, stress, job satisfaction, wellbeing, and work-family interface. This research generally aims to examine the interrelationship between work-home domain variables with outcomes of fatigue, its recovery, and others related outcomes such as work-to-family conflict, general wellbeing, and perceived stress level among doctors working at public hospital at general and day-level on-call duty.

Methods: This is a multicenter analytical mix cross sectional (general) and longitudinal (day-level) research among proposed 390 randomly-sampled post-call doctors working at seven core clinical disciplines from seven public tertiary hospitals in Malaysia. Data will be collected three times: (a) any days after obtaining informed consent (cross sectional), (b) at the end of on-call duty (first wave longitudinal), and (c) at the beginning of subsequent work period (second wave longitudinal). Data will be modelled by covariance-based structural equation modelling (SEM).

Discussion: This research is well justifiable in view of limited available research on complex interrelationship of work domain, home domain and work-home boundary control with fatigue, recovery and other psychological health consequences (e.g., stress, wellbeing, work-home conflict) among doctors, particularly in Asia and developed countries, including Malaysia. This research is expected to provide strong evidence to policy makers in developing prevention and management policy related to fatigue, recovery and other psychological health consequences among doctors.

Keywords: doctor, fatigue, recovery, on-call, intershift, wellbeing, stress

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1. Background

1.1 Overview

Fatigue among doctors, particularly post-call doctors, has long been voiced out by health professional. Long working hours, particularly during on-call which can be up to 33 hours, and lack of recovery opportunity, have been blamed for this (Islamic Medical Association of Malaysia, 2017; Medical Mythbusters Malaysia, 2017; Yaacob, 2017). In 2017, there was growing concern regarding multiple fatal fatigue-related commuting accidents among post-call doctors who just finished their continuous long-hours on-call work (Islamic Medical Association of Malaysia, 2017; Medical Mythbusters Malaysia, 2017; Ministry of Health Malaysia, 2017; Yaacob, 2017). Following this, a joint statement was issued by non-governmental organizations (NGOs) and government agencies urging the government to address the issues of fatigue and recovery among post-call doctors (Islamic Medical Association of Malaysia, 2017; Medical Mythbusters Malaysia, 2017).

In Malaysia, it is a common practice that on-call doctors have to work continuously for 24 to 33 hours, followed by intershift period for 15 to 24 hours before starting the subsequent work period (Ministry of Health Malaysia, 2019). This is exceeding the 'safe hours' limit, which is generally defined as less than 50 hours worked per week with no more than 10 consecutive hours in any one work period and more than 10 continuous hours break between work period (Australian Medical Association, 2016). 'On-call' is defined as continuous work period, commonly started at 0800H, for duration of 24 to 33 hours, in which the on-call doctor is expected to be available physically at the workplace for the whole on-call period (Ministry of Health Malaysia, 2017, 2019). The period after 24 hours on-call work from 0800H to 0800H subsequent day is commonly known as 'post-call', in which most of the on-call doctors have to continue working up to 1700H (on-call duration: up to 33 hours), while some can enjoy post-call off as early as 0800H (on-call duration: as long as 24 hours) (Ministry of Health Malaysia, 2019). 'Intershift' is defined as continuous non-work period between the ending of prior on-call period and the beginning of subsequent work period.

With long hours of on-call duration, it is not surprising that the doctors' weekly and monthly working hours exceeding the safe hours limit. Long working hours and high demanding job as doctors (British Medical Association, 2018) are psychosocial hazards that will consumes body's internal resources (e.g., time, value, energy) and predispose them to adverse psychosocial health (e.g., fatigue, stress), wellbeing, and home-family consequences (e.g., work-to-family conflict) (Bakker, Demerouti, & Schaufeli, 2003; Hobfoll, 1989). Based on conservation of resources (COR) and effort-recovery (E-R) models, these depleted internal resources have to be replaced by stopping all the demanding effort or taking rest to allow recovery (Hobfoll, 1989; Meijman, 1989). If the recovery is not adequate, the adverse consequences may worsen; for example, the acute fatigue which is reversible may become irreversible chronic fatigue.

1.2 Rationale

There is limited research on complex interrelationship of work domain, home domain and work-home boundary control with fatigue, recovery and other psychological health consequences (e.g., stress, wellbeing, work-home conflict) among doctors, particularly those involved in on-call duty. Most available research were conducted in the western or developed countries, which may not be generalized to Asia and developing countries including Malaysia. Furthermore, the issues of demanding work schedule, high intensity job, and adverse psychological health among doctors are still major occupational problems in such countries.

Thus, there is a strong indication to explore on doctors' work schedule at both general and day-level on-call duty, and activities/experiences related to the job in order to identify predictors to fatigue and other psychosocial consequences. It is similarly important to explore the intershift period in order to identify predictors of fatigue recovery. The boundary between work and home domain is also necessary to be examined in order to determine its interrelationship with work variables and home variables. Apart from limited study on abovementioned variables among doctors, the use of structural equation modelling (SEM) in examining the interrelationship on similar psychosocial issue is also scarce. The advantage of SEM is that it provides better methodological approach in addressing a critical gap understanding the complex interrelationship among constructs (Hair, Black, Babin, & Anderson, 2014). The findings are critical for health-related and human resource-related policy makers in developing evidence-based policy in management of work-related fatigue and other psychosocial consequences.

1.3 Objectives

The general objective is to examine the interrelationship between potential work-home variables and outcomes of fatigue, its recovery, and other outcomes (e.g., work-to-family conflict, general wellbeing, and perceived stress level) among doctors working at public hospital at general and day-level on-call duty.

The specific objectives are:

1. To explore the general work schedule and specific day-level on-call duty schedule.
2. To determine the interrelationship between work schedule discrepancy with job satisfaction, work-to-family conflict, general wellbeing, and perceived stress level.
3. To determine the interrelationship between work-related electronic communication use with job satisfaction, work-to-family conflict, general wellbeing, and perceived stress level.
4. To determine the interrelationship among on-call demands, on-call satisfaction, on-call duration, and post-call fatigue level at day-level on-call period setting.
5. To determine the interrelationship among on-call demands, on-call duration post-call fatigue level, work-related activities, recovery experiences, intershift duration, post-intershift fatigue level and work engagement at day-level intershift period setting.
6. To explore the roles of boundary control on the relationship between work-domain and home-domain variables, and interrelationship with work-related activities during non-work time and recovery experiences at day-level intershift period setting.

1.4 Hypothesis

The hypothesis are outlined based on respective specific objectives which are the second to sixth objectives:

1. Based on objective 2, the hypothesis are:
 - a) Job satisfaction and work-to-family conflict mediates the relationship between work schedule with general wellbeing and perceived stress level.
 - b) Work-to-family conflict mediates the relationship between job satisfaction with general wellbeing and perceived stress level.

2. Based on objective 3, the hypothesis are:
 - a) Job satisfaction and work-to-family conflict mediates the relationship between work-related electronic communication use with general wellbeing and perceived stress level.
 - b) Work-to-family conflict mediates the relationship between job satisfaction with general wellbeing and perceived stress level.

3. Based on objective 4, the hypothesis are:
 - a) On-call satisfaction mediates the relationship between on-call demands with post-call fatigue.
 - b) On-call duration moderates the direct and indirect relationship between on-call demands with post-call fatigue.

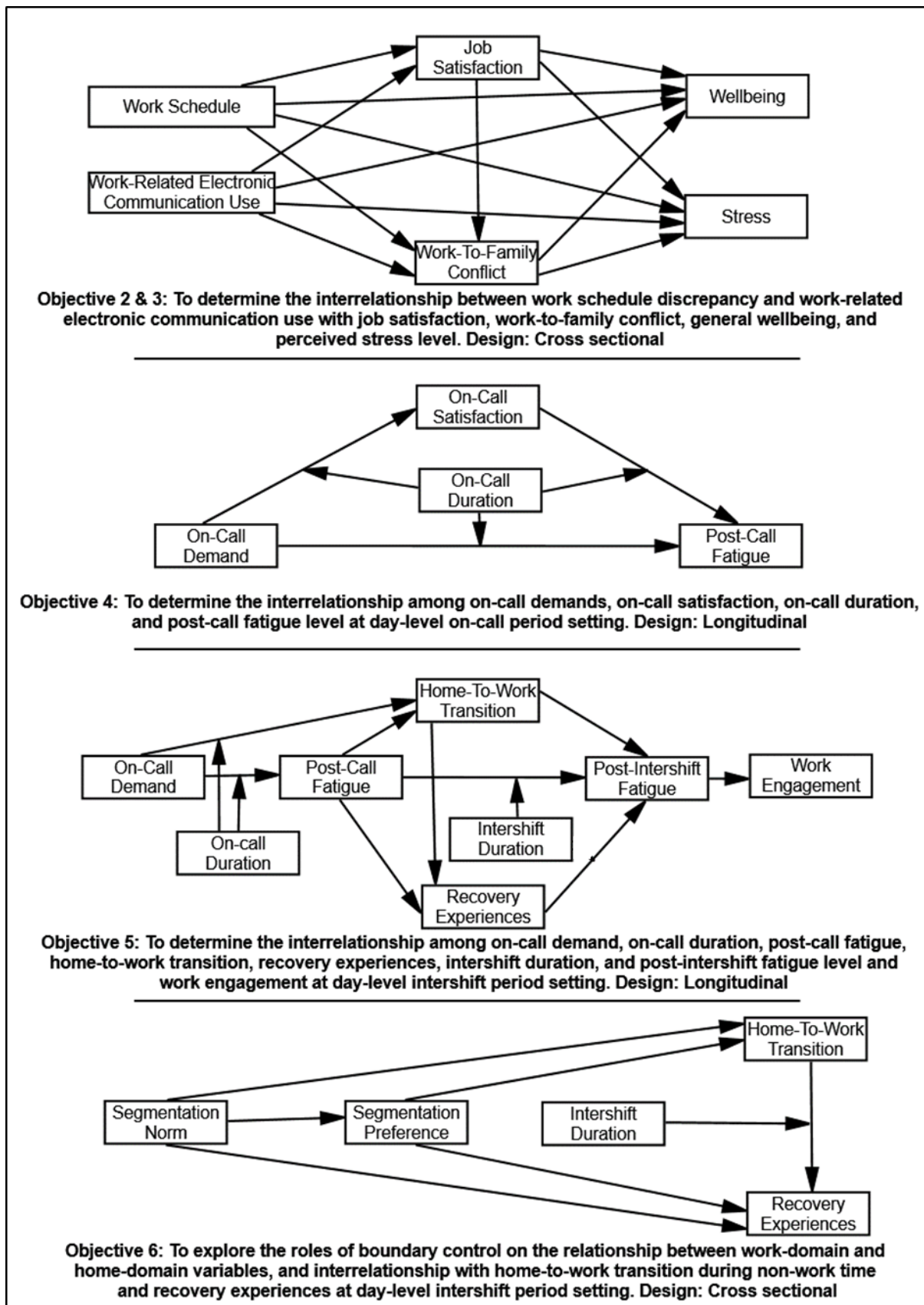
4. Based on objective 5, the hypothesis are:
 - a) On-call demand has positive direct relationship with home-to-work transition.
 - b) On-call demand has positive direct relationship with post-call fatigue.
 - c) On-call duration moderates the relationship between on-call demand with home-to-work transition.
 - d) On-call duration moderates the relationship between on-call demand with post-call fatigue.
 - e) Home-to-work transition mediates the relationship between post-call fatigue with post-intershift fatigue.
 - f) Recovery experiences mediates the relationship between post-call fatigue with post-intershift fatigue.
 - g) Recovery experiences mediates the relationship between home-to-work transition with post-intershift fatigue.
 - h) Intershift duration moderates the relationship between post-call fatigue with post-intershift fatigue.
 - i) Post-intershift fatigue has positive relationship with work engagement.

5. Based on objective 6, the hypothesis are:
 - a) Segmentation preference mediates the relationship between segmentation norms with home-to-work transition.
 - b) Segmentation preference mediates the relationship between segmentation norms with recovery experiences.
 - c) Home-to-work transition mediates the relationship between segmentation norms with recovery experiences.
 - d) Home-to-work transition mediates the relationship between segmentation preference with recovery experiences.
 - e) Intershift duration moderates the indirect relationship between segmentation norms with recovery experiences.
 - f) Intershift duration moderates the indirect relationship between segmentation preference with recovery experiences.

1.5 Conceptual Framework

Figure 1 shows specific conceptual framework based on the respective objectives (p. 5).

Figure 1. Conceptual framework.

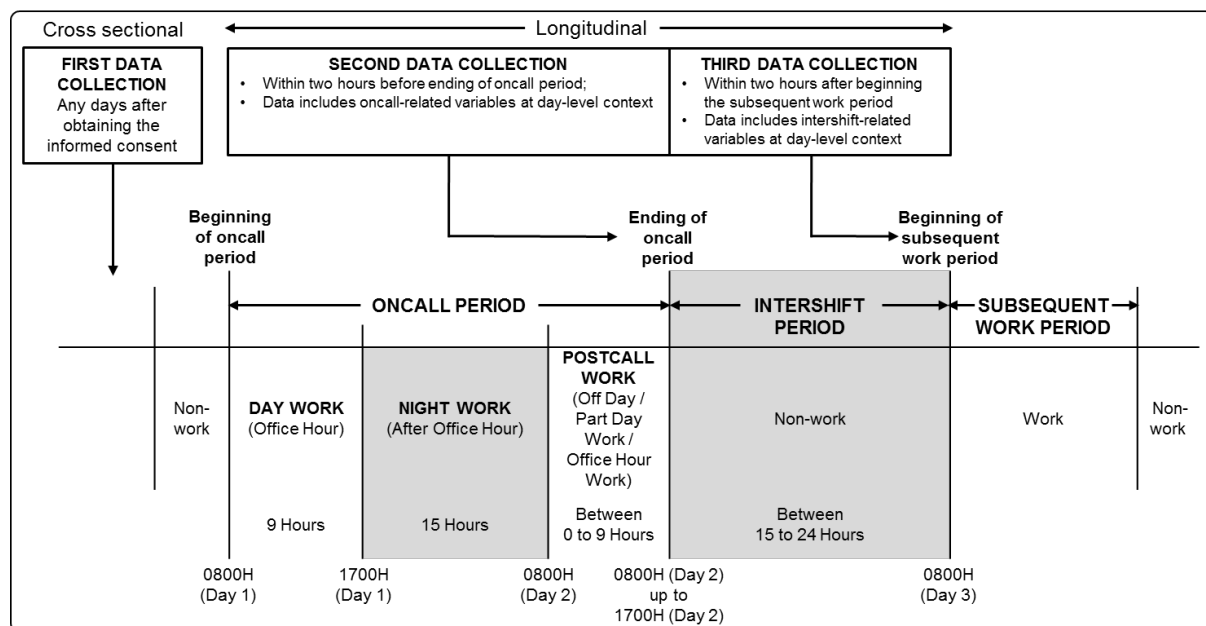


2. Methods/Design

2.1 Research design

This research will be conducted as quantitative analytical cross sectional and longitudinal design as illustrated in Figure 2. Cross sectional research refers to the first data collection in which multiple general data will be collected at once without temporality, while longitudinal data refers to the second and third data collection in which data will be collected at day-level situational (on-call and intershift) context with temporality.

Figure 2. Research design, participant timeline and data collection method.



2.2 Research setting

This research will be conducted at seven core clinical departments from seven public tertiary hospitals located in Selangor, which is the most populated states with 20% of total Malaysia population. Tertiary public hospital is a large hospital with specialist that provides tertiary care, and provides housemanship training to resident doctors. Core clinical departments include internal medicine, surgery, orthopaedic, paediatric, obstetrics and gynaecology, anaesthesiology and psychiatry. These departments are chosen as they implement on-call system among doctors, and the core departments for housemanship training. This research has started from 1st January 2019 and expected to finish on 31st December 2020.

2.3 Sampling procedure

Our reference population is non-resident non-specialist medical doctors (also known as medical officers) working at tertiary public hospitals in Malaysia. All tertiary public hospitals in Selangor state is purposively chosen to represent tertiary public hospitals in Malaysia for the following reasons: (a) all seven tertiary public hospitals in Selangor represent almost 20% of all tertiary public hospitals in Malaysia, or 8% of total public hospitals in Malaysia, and (b) number of government doctors working at government health facilities in Selangor represent 15% of total government doctors in Malaysia.

Eligible population will be determined based on the inclusion and exclusion criteria. The inclusion criteria are permanent-scheme Malaysian non-resident non-specialist doctor (i.e., medical officer) who registered with Malaysia Medical Council and has been working at least for six months. The included doctors must undergo active call duty prior to day-level data collection. Active call duty was operationally defined as continuous work for two consecutive days at least for 24 hours that requires doctor to present physically at workplace and available to be contacted at all times. The exclusion criteria are resident doctor (i.e., house officer), physician or surgeon (i.e., medical specialist) and postgraduate candidate attached to the departments. Those that will be transferred or resign or taking long leave during data collection period will be excluded. Those who will be doing continuous on-call duty and intershift period beyond two consecutive days each will be excluded as well. Other exclusion criteria are those medically diagnosed as, or on treatment for, sleep disorder or mental illness. Those departments and hospitals that unable to provide administrative consent or cooperation, such as providing sufficient information to approach the participants or assisting in sampling procedure, will be excluded.

Sampling frame will be obtained by approaching the hospitals administrative for initial consent, followed by departments administrative for subsequent consent, and subsequently requesting sufficient information from them such as name list of eligible population to enable simple random sampling procedure. As stated in the exclusion criteria above, those hospitals and departments that unable to provide consent or necessary assistance for sufficient information will be excluded.

Once obtaining the name list of eligible doctors from each eligible departments and hospitals, we will conduct probabilistic simple random sampling procedure by combining all the names into one master list, followed by random selection using Microsoft Excel to select number of participants based on calculated sample size.

Sample size will be determined based on recommendation specifically for SEM (Hair, Black, Babin, & Anderson, 2014). It has been suggested that sample size decisions must be made by considering multiple factors, such as number of latent constructs and number of items per construct (Hair, Black, Babin, & Anderson, 2014). Since each objective involved seven or less latent constructs in a model being analysed by using SEM, a minimum sample size required is 300 participants (Hair, Black, Babin, & Anderson, 2014). Thus, after considering 30% non-response or drop-out during data collection phase, we will recruit 390 participants through simple random sampling after the name list from each consented departments being combined into one master list, followed by random selection using Microsoft Excel.

2.4 Interventions

There is no intervention that will be conducted in this research. Participants will be assessed under natural setting without any restriction to their routine life. This is a one-group sample research; thus there is no intervention or control group.

2.5 Data collection methods

All the randomly selected eligible participants will be approached and given detail information on the research with participant information sheet. They will be given adequate time to decide, which includes studying the participant information sheet at home for several days. If they agree to participate, they will be asked to sign informed consent form. Once informed consent has been obtained, they will be given the first set of questionnaires that is general questionnaires. Subsequently, we will set an appointment for second and third data collection at the end of their nearest scheduled on-call duty and the beginning of their

subsequent work period which should fulfil these criteria: (1) active call with more than 24 hours but not more than two consecutive days, and (2) followed by intershift period not more than two consecutive days.

Since response rate for survey without incentive among doctors is typically low (Thorpe et al., 2009), and to minimize the drop-out rate for longitudinal research, we will employ several methods to optimize the response rate. First, we will highlight the objective and importance of this research towards doctors' career in which the findings will be forwarded to relevant authorities to be translated into action for improving quality of working life among doctors (Sudman, 1985). Second, they will be approached individually for data collection, in which the individual reminders will be sent to them regularly. Third, due to unpredictable demand of doctors' work, the data collection will be determined by their convenient time, as long as it conform to the protocol, which are within two hours before ending their on-call duty (for second data collection) and within two hours after beginning their subsequent work period (for third data collection) (Flanigan, McFarlane, & Cook, 2008; Sudman, 1985). Fourth, we ensure their confidentiality and gain their trust on confidentiality issue by giving personalized pre-sealed envelope pre-filled with questionnaires, and once completed, they may return it in sealed form (Sudman, 1985).

Data will be collected three times, that is during first appointment, followed by at the end of on-call duty, and lastly at the beginning of subsequent work period.

2.5.1 First data collection

During first appointment, after obtaining the informed consent, general questionnaires will be given to the participants, which inquire on sociodemographic profile, occupational profile, work schedule profile, general job satisfaction, work-related electronic communication usage, work-family interface, perceived stress level and general wellbeing.

Sociodemographic profile includes age, gender, ethnicity, marital status, monthly household income, dependant household members, comorbidity, and body mass index. Occupational profile includes current position, current workplace, and work tenure. Work schedule profile explore schedule discrepancy (by asking scheduled, actual and preferred weekly working hours and on-call duty) (Weber & Franziska, 2017), schedule decision, schedule adjustability, and schedule predictability. General job satisfaction is 11-item 5-points Likert scale modified from quality of work life instrument (Fernandes, Martins, Caixeta, da Costa Filho, Braga, & Antonialli, 2017) which taps on working hours, workload, use of technology at work, workplace healthiness, workplace safety, work-related tiredness, remuneration, work-rest schedules, work-to-family influence, and family-to-work influence. Usage of work-related electronic communication includes availability of policy, usage of smartphone for work, type of electronic communication medium, frequency of communication electronically based on groups of people, motivation to use electronic communication for work-related purposes (Ohly & Latour, 2014), workplace telepressure (Barber & Santuzzi, 2015; van Laethem, van Vianen, & Derks, 2018), and expectation to be contacted or responding to work-related communication and frequency being contacted about work matters during off-job hours. Work-family interface scale contained 5-item 7-point Likert scale of work-to-family conflict questionnaires (Netemeyer, Boles, & McMurrian, 1996), 4-item 7-points Likert scale of segmentation norms questionnaires, and 4-item 7-points Likert scale of segmentation preferences questionnaires (Kreiner, 2006). Perceived stress level is 4-item 5-points Likert scale asking about feelings and thoughts during past two weeks (Cohen, Kamarck, & Mermelstein, 1983). General wellbeing is 5-item 6-points Likert scale asking about feelings over the last two weeks (World Health Organization, 2016).

2.5.2 Second data collection

Nearest on-call duty after obtaining informed consent will be the data collection point for day-level on-call research. At the end of on-call duty, participants will be asked to undergo 3-minutes psychomotor vigilance test (PVT) as an objective fatigue measurement by using validated smartphone-based 3-minutes PVT (Brunet, Dagenais, Therrien, Gartenberg, & Forest, 2017). Specifically, we will use free validated smartphone-based apps named Sleep-2-Peak (s2P). This app is as sensitive as the gold-standard PVT for tracking fatigue-related changes (Brunet, Dagenais, Therrien, Gartenberg, & Forest, 2017). Participants will be instructed to tap the screen as soon as the target appeared. At the end of the task, average reaction time will be taken. Since this s2P apps can be used on any smartphone (Brunet, Dagenais, Therrien, Gartenberg, & Forest, 2017), in order to ensure data confidentiality, we will be using our smartphone to measure participants' mean reaction time via s2P apps in our smartphone and subsequently record the result into the participants' questionnaires. Thus, except for average reaction time, no personal information of the participants will be captured by the app.

Subsequently, they will be given on-call questionnaires which ask about real-time perceived fatigue level and work engagement, scheduled and actual on-call duration, on-call demand, and on-call satisfaction. Real-time perceived fatigue level will be measured by using single-item (van Hoof, Geurts, Kompier, & Taris, 2007) visual analog score consisting of 10cm horizontal line extending from no fatigue to extremely fatigue. Work engagement level will be measured by using 8-items 7-points scale adopted from Utrecht Work Engagement Scale (UWES) containing three subscales, namely vigor, dedication and absorption (de Bruin & Henn, 2013; Schaufeli, Bakker, & Salanova, 2006; Sonnentag & Kühnel, 2016). Scheduled and actual on-call duration will be measured by directly asking their scheduled and actual time they start and finish their on-call duty, followed by calculation of both duration. On-call demand will be measured by using task demand subscale of NASA Task Load Index (NASA-TLX) (Hart & Staveland, 1988) containing three items, namely mental demand, physical demand, and temporal demand.

2.5.3 Third data collection

The subsequent intershift period will be the data collection point for day-level intershift research. At the beginning of subsequent work period, participants will be asked to undergo 3-minutes psychomotor vigilance test (Brunet, Dagenais, Therrien, Gartenberg, & Forest, 2017) using s2P app with similar protocol as per during second data collection.

Subsequently, they will be given intershift questionnaires, which ask about real-time perceived fatigue level and work engagement, scheduled and actual intershift duration, work-related activities during intershift period, work-related activities during off-job time, and recovery experiences. Real-time perceived fatigue level will be measured by using same single-item (van Hoof, Geurts, Kompier, & Taris, 2007) visual analog score consisting of 10cm horizontal line extending from no fatigue to extremely fatigue. Work engagement level will be measured by using 9-items 7-points scale adopted from UWES containing three subscales, namely vigor, dedication and absorption (de Bruin & Henn, 2013; Schaufeli, Bakker, & Salanova, 2006). Scheduled and actual intershift duration will be measured by directly asking their scheduled and actual time they start and finish their intershift period, followed by calculation of both duration. Work-related activities during off-job time will be measured by 4-item 7-point Likert scale of work-home transition questionnaires (Delanoëije, Verbruggen, & Germeys, 2019). Recovery experiences will be measured by using Recovery Experiences Questionnaires (Sonnentag & Fritz, 2007) containing three subscales, namely

psychological detachment from work, relaxation and autonomy; each subscale consists of 4 items with 5-point Likert scale.

2.6 Data management

Questionnaires will be checked thoroughly to ensure completeness. Each response in the questionnaires will be appropriately coded. Data will be entered directly from raw filled-questionnaires into IBM-SPSS version 25 by single person to minimize error. Entered data will be randomly checked by another person to ensure correctness, and if there is any query, data verification will be done by checking the raw questionnaire. Once data entry settled, data validation will be done by checking the format, presence, range, and type of data being entered for each variables. Missing data, if any, will be handled by using multiple imputation technique.

2.7 Statistical methods

Initial data analysis will be conducted by using IBM-SPSS version 25. Univariable data will be presented descriptively. Continuous data will be summarized in term of minimum-maximum, central tendency (mean and standard deviation, or median and interquartiles range) and normality distribution. Categorical data will be presented as frequencies and percentages.

Modelling analysis will be conducted by using IBM-SPSS AMOS version 24 with maximum likelihood estimator. Measurement model will be analyzed using confirmatory factor analysis (CFA) to assess model fitness, normality distribution, unidimensionality, construct validity, discriminant validity, convergent validity, and reliability. Model fit will be determined by using fitness index as follow: RMSEA (≤ 0.08), CFI (≥ 0.90), and Relative Chi-Square (≤ 3.0) (Bentler, 1990; Bentler & Bonett, 1980; Browne & Cudeck, 1993; Hair, Black, Babin, & Anderson, 2014; Marsh & Hocevar, 1985). Subsequently, structural model will be analyzed for each hypothesis testing (Hair, Black, Babin, & Anderson, 2014). Bootstrapping analysis will be conducted if necessary. Testing for moderation will be conducted by using multi-group CFA analysis. Significant level is set at $p < 0.05$.

2.8 Ethics and dissemination

This research has been registered under National Medical Research Register (NMRR) (NMRR-18-2757-41115). Ethical approval has been obtained from Medical Research & Ethics Committee (KKM.NIHSEC.P18-2118) and Ethic Committee Universiti Kebangsaan Malaysia Medical Centre (FF-2018-456). Any important protocol modifications will be communicated to relevant parties.

Informed consent from the hospitals and departments will be obtained first by submitting formal letter explaining the research procedure, attached with the approval letter from ethical committee. A written informed consent from the participant will be asked before data collection being done. All the information obtained from the subjects will be kept confidential. The information will be used strictly for research. Those randomly selected participants will be approached individually on participants' convenient time at their workplace by researchers or our research assistant. They will be given Participant Information Sheet and detail explanation on this research. They will be given adequate time to decide, which includes bringing the Participant Information Sheet home to consider their participation in the research and contact investigators should they wish to participate. If they agree, they will be asked to sign Informed Consent Form. There is unlikely to be a direct benefit in participating in this research. However, participation could help in further planning

on fatigue management among doctors. There is unlikely to be any significant risk from participating in this research. Participation in this research is voluntary. Participants may decline to participate without any penalty. Should they decide to participate, they can still withdraw at any time without penalty and their data will be discarded. The researcher may also terminate the participant from the research due to various reasons including but not limited to the occurrence of unanticipated problem or if they opt not to response to any set of the questionnaire.

Each of the data gathered will be for research purposes only. No other parties can access the dataset except researchers. The personal information given is confidential. Participants will only be recognized by using coding number. If the information or data gathered validated and had significant impact and potentially relevant to the clinical management of the participant, the findings will be returned or informed to them personally. The information and data collected will be kept for five years. After that, the data will be destroyed.

If subjected to publication, author will ensure the subject information will be kept confidential. Data will be reported in a collective manner with no reference to individual. The author will be fully responsible for content of the publication. The authorship eligibility will be strictly according to the guideline from International Committee of Medical Journal Editors (International Committee of Medical Journal Editors, 2019).

3. Discussion

Our protocol describe a comprehensive research exploring on doctors' nature of work from the perspective of work domain, home domain, and work-home boundary, at both general and day-level (on-call and intershift) context. At general context, the main outcome measures are work-to-family conflict, family-to-work conflict, perceived stress level, and general wellbeing. At day-level on-call and intershift context, the main outcome measures are recovery experiences, fatigue, fatigue recovery, and work engagement.

This research is critical in view of widely voiced out concern on doctors' health and wellbeing among health professionals and multiple agencies (Islamic Medical Association of Malaysia, 2017; Medical Mythbusters Malaysia, 2017; Ministry of Health Malaysia, 2017; Yaacob, 2017). At hospital setting, doctor is among high risk group involved in work-related accidents such as needlestick injury (Fadhli, Safian, Robat, Adibah, & Hanizah, 2018), and research found that long working hours (Motaarefi, Mahmoudi, Mohammad, & Hasanpour-Dehkordi, 2016) and fatigue (Nagandla et al., 2015) are related with needlestick injury cases. Apart from workload and time pressure, overworked and fatigue healthcare professionals may also influence medical errors (World Health Organization, 2016). Multiple fatigue interventions, such as filtered light glass, nap breaks, healthy meal and 17k blue-enriched white light, had been tested among night shift workers at work to minimize post-night work fatigue and its consequences; however, recent systematic review found that it was not sufficient to inform policy (Mohd Fauzi et al., 2019).

The strength of our proposed research are the strong indication in view of lack of regional and local research on widely concern issues among doctors. In addition, the conduct of the research involving multicentre data collection and simple random technique will increase the probability of achieving representativeness and minimizing selection bias. Furthermore, our capability in approaching the participants individually face-to-face and provision of sealable envelope allow us to build rapport, ensure high response rate, and minimizing risk of missing data. Last but not least, the use of covariance-based SEM method provide better methodological approach in addressing simple and complex interrelationship of observed and latent variables.

4. Conclusion

This proposed research will examine the interrelationship between potential work-home variables and outcomes of fatigue, its recovery, and others (e.g., work-to-family conflict, general wellbeing, and perceived stress level) among doctors working at public hospital at general and day-level on-call duty. This research is highly indicated and beneficial for the doctors, patients, and healthcare system.

List of Abbreviations

AMOS	Analysis of Moment Structures
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
COR	Conservation of Resources
E-R	Effort-Recovery
IBM	International Business Machines Corporation
MREC	Medical Research & Ethics Committee
NASA-TLX	NASA Task Load Index
NGOs	Non-Governmental Organizations
NMRR	National Medical Research Register
PVT	Psychomotor Vigilance Test
RMSEA	Root Mean Square Error of Approximation
s2P	Sleep-2-Peak
SEM	Structural Equation Modelling
SPSS	Statistical Package for the Social Sciences
UWES	Utretch Work Engagement Scale

Declarations

Competing interests: The authors declare that they have no competing interest.

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Ethics approval and consent to participate: This research has been registered under National Medical Research Register (NMRR) (NMRR-18-2757-41115). Ethical approval has been obtained from Medical Research & Ethics Committee (KKM.NIHSEC.P18-2118) and Ethic Committee Universiti Kebangsaan Malaysia Medical Centre (FF-2018-456). Informed consent will be obtained from relevant centers and participants before data collection.

Authors' Contribution: All authors have contributed substantially to the (a) conception and design, or analysis and interpretation of data, (b) drafting the article or revising it critically for important intellectual content; and (c) final approval of the version to be published. MFMY proposed the initial study idea. All authors involved in detail conceptualization and methodology. MFMY, NAMS, and RMR had the overall responsibility for drafting the paper. MFMY, NAMS, and RMR will be responsible for recruitment and data collection. HMY and

MRAM will be responsible for obtaining resources required to carry out the research, supervision, and critical revision of the draft. All authors have read and agreed to the published version of the manuscript.

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