

## PEER REVIEW HISTORY

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### ARTICLE DETAILS

<b>TITLE (PROVISIONAL)</b>	A cross-sectional analysis of sleep- and wake-promoting drug use on health, fatigue-related error and near crashes in police officers
<b>AUTHORS</b>	Ogeil, Rowan; Barger, Laura; Lockley, Steven; O'Brien, Conor; Sullivan, Jason; Qadri, Salim; Lubman, D; Czeisler, Charles; Rajaratnam, Shantha M. W.

### VERSION 1 – REVIEW

<b>REVIEWER</b>	Igor Radun University of Helsinki, Helsinki, Finland
<b>REVIEW RETURNED</b>	28-Feb-2018

<b>GENERAL COMMENTS</b>	<p>Thank you for the opportunity to review this manuscript. It addresses an important and timely question. It fits to the journal's scope and I believe it will contribute to the field. I have a few comments/questions. I hope the authors will consider them when revising their manuscript.</p> <p>1. As a traffic psychologist, I am very much interested in these findings:</p> <p>“Police using a sleep-promoting medication or a drug that listed sleepiness as a side-effect in the past month were more likely to report a near-crash while driving (sleep promoting: OR= 1.61, CI: 1.21-2.13, side effect: OR= 1.38, CI: 1.04-1.82), more likely to report a fatigue-related error at work...”</p> <p>while</p> <p>“Wake-promoting medication use was associated with increased odds of a fatigue-related error (OR= 1.68, CI: 1.01-2.79)...”</p> <p>First, I assume when you write “fatigue-related error” you always mean “fatigue-related error at work.” I hope you can be consistent throughout the text, as I got confused several times.</p> <p>Secondly, you touched upon this in the discussion, but I believe you could discuss more about why sleep-promoting medication or a drug that listed sleepiness as a side-effect would lead/associated to both more near-crashes and fatigue-related error at work, while wake-promoting medication use was associated with increased odds of a fatigue-related error (at work), but not with near-crashes. Is this finding of a broader importance or...?</p> <p>2. Continuing on the issue of wake-promoting medication use was</p>
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	<p>associated with increased odds of a fatigue-related error (at work), but not with near-crashes, I am surprised you have not presented/examined the number of police officers who use both “sleep-promoting medication or a drug that listed sleepiness as a side-effect” and “Wake-promoting medication.”</p> <p>Do police officers exclusively use one type of these medications? I know that in logistic regression, when you enter both variables, it means “all else equal,” but I just wonder whether those police officers who use both types of medications, if there are such people, would represent a group at the highest risk for both negative outcomes “near crashes” and “fatigue-related error (at work).”</p> <p>I know we authors hate when reviewers tell us to check the data again, but please consider briefly checking whether you indeed have 4 different groups of police officers: (i) never use sleep or wake promoting medication, (ii) uses only sleep-promoting medication, (iii) uses only wake-promoting medication, (iv) uses both of them.</p> <p>3. You collected data from 4957 police officers, but in your tables you have up to 3340. Please explain why did you exclude more than 1500 participants? Or did I miss something here?</p> <p>4. I got confused with participants coming from “North America” and making references to “U.S. population.” Did you include also participants from Canada?</p> <p>5. Page 4, end of third paragraph. Very long sentence, which is difficult to read.</p> <p>6. Page 5, you write: “The protocol was approved by the Partners and Monash Human Research Ethics Committees. Participants provided written or electronic informed consent and were not informed about study hypotheses.”</p> <p>As I understand, the study was conducted in the U.S. Has the Australian research ethics committee approved the original study or only this new analysis of the retrieved data?</p> <p>7. Page 9, end of second paragraph. Is this hypothetical question as it seems difficult to understand why anybody would ban drinking coffee at a work place. I am not sure what you wanted to say with this.</p>
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<b>REVIEWER</b>	Xianglong Xu Chongqing Medical University, China
<b>REVIEW RETURNED</b>	20-Apr-2018

<b>GENERAL COMMENTS</b>	<p>It's my pleasure to review your manuscript. I have some comments or suggestions for the authors.</p> <p>In the title the authors use big words (health and safety), could the authors provide more specific word?</p> <p>Abstract</p> <p>When did the survey conduct?</p> <p>The authors wrote “3693 online and 1264 on-site”. The authors used online survey and on-site survey, why did the authors use these two</p>
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	<p>methods. In fact, I know that some research team conducted on-site surveys, but the quality of the data was not good.  How did the authors ensure the quality of the online data?  How did the authors ensure that all participants through online survey were police officers in North America?  Do you think that is there any difference between online survey and on-site survey? How this will affect the result?</p> <p>Introduction  Why did the authors select police officers as participants? The authors should explain this in the introduction.  Is sleep- and wake-promoting drug widely used among police officers?  Could the authors provide some information about the usage of sleep- and wake-promoting drug in police officers or other population?  Could the authors provide some information about health and safety outcomes in police officers or other population?  Authors may consider adding literature on the necessity of this study, for instance, limitation of previous studies about the association between sleep- and wake-promoting drug use and health and safety outcomes.</p> <p>Method  Although further details of the sample have been described previously, in order to make it easier for readers to understand the study, the authors also could describe the study design in brief.  “...a cooperation rate of 63.1% in the on-site cohort...” the cooperation rate was not high, did many police officers reject answer? What’s the reason, will this affect the results?  The authors should provide more information about the questionnaire, such as what demographic variables included in this study, how to collect the information of sleep-promoting drug use and wake-promoting drug use.  The authors also should provide more information about health, performance and safety outcomes, for example, what aspects of health included in this study, why include these aspects.</p> <p>In page 6, Role of the funding source  To my knowledge, “Role of the funding source” should not place between data analysis and results. What’s more, in page 11, the authors also provide Funding.</p> <p>Results  It’s better for the authors to provide a table of collected sociodemographic factors of participants in this study, such as gender, age, education level, income, marital status. This will help readers understand the characteristics of the participants.</p> <p>Discussion  Authors may consider adding more deep discussion about the</p>
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	<p>findings, for example, the significance of this study for future practice</p> <p>The authors found that “one-in-five police officers reported using a sleep-promoting drug, or drug that listed sleepiness as a side-effect, and almost one-in-three used a wake promoting drug”? Regarding this, the authors could make a comparison with previous studies.</p> <p>In the table, we can see the authors collected information wake-promoting drugs used in the past month, why the authors select the information in the past month, not in the past week or in the last half year? Sometimes, if we want to observe the effect of drugs on some diseases or conditions, it usually takes a relatively long time to observe.</p> <p>In this study the authors adjusted for gender and age, residual confounding (such as education level, income, marital status) may still affect the study outcomes. How did the authors consider this point?</p> <p>I am not familiar with wake-promoting drugs and sleep-promoting drugs in North America. It seems that the authors did not distinguish the different brands of drugs. Are there any differences in different brands of drugs? Will this affect the results?</p> <p>Conclusion The authors should write the conclusions based on your own findings. Based on this study, the authors cannot conclude “Shift work is pervasive in society, enabling essential services to be provided around the clock, but also due to the rapid growth in flexible working arrangements”.</p> <p>The survey was conducted among police officers in North America, therefore, the conclusion about the status of sleep-promoting drug should also be limited among this population.</p>
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**VERSION 1 – AUTHOR RESPONSE**

**Reviewer(s)' Comments to Author:**

**Reviewer: 1**

**Please leave your comments for the authors below**

**Thank you for the opportunity to review this manuscript. It addresses an important and timely question. It fits to the journal’s scope and I believe it will contribute to the field. I have a few comments/questions. I hope the authors will consider them when revising their manuscript.**

**1. As a traffic psychologist, I am very much interested in these findings:**

**“Police using a sleep-promoting medication or a drug that listed sleepiness as a side-effect in the past month were more likely to report a near-crash while driving (sleep promoting: OR= 1.61, CI: 1.21-2.13, side effect: OR= 1.38, CI: 1.04-1.82), more likely to report a fatigue-related**

**error at work...” while**

**“Wake-promoting medication use was associated with increased odds of a fatigue-related error (OR= 1.68, CI: 1.01-2.79)...”**

**First, I assume when you write “fatigue-related error” you always mean “fatigue-related error at work.” I hope you can be consistent throughout the text, as I got confused several times.**

We apologise for any confusion, and have included the exact wording of this item in the Methods (Materials and Survey Instruments Section). The item does not specifically include the term “work-related”, so we have retained the use of “fatigue-related error(s)” throughout the text. We have also modified our future directions section within the Discussion to note that “future research should investigate both the time of day and intention for use of wake-promoting drugs to determine whether they are being used to aid fatigue-related tasks specifically at work” (page 9, para 1).

**Secondly, you touched upon this in the discussion, but I believe you could discuss more about why sleep-promoting medication or a drug that listed sleepiness as a side-effect would lead/associated to both more near-crashes and fatigue-related error at work, while wake-promoting medication use was associated with increased odds of a fatigue-related error (at work), but not with near-crashes. Is this finding of a broader importance or...?**

We agree with the reviewer that this finding is of interest, and also an important avenue for future research, particularly with respect to the timing of when these drugs are being used. We have modified our discussion (page 8, para 3) to include the following:

“Previous studies have suggested that modafinil may have cognitive enhancing effects following sleep deprivation, including in those engaged in simulated night-shift work.<sup>25</sup> Other reports have suggested increases in some measures of simulated driving performance specifically lane deviation, but not speed deviation or off-road incidents following modafinil suggesting caution with its use as a countermeasure for sleepiness.<sup>26</sup> Our logistic regression analysis did not find wake-promoting drug use a significant predictor of near-crashes. This may reflect that these drugs are being used to alleviate tiredness prior to driving a vehicle, or alternatively, if there is a negative impact on driving performance as found in the studies above<sup>26</sup> that a much smaller proportion of police officers were using wake-promoting (~5.4%) compared with sleep-promoting drugs (~20%). Our study did find that use of wake-promoting drugs was associated with reported decrements in work performance, and also increased levels of stress/burnout that may be related to changes in shift schedule, particularly given the interaction between use of wake-promoting medication and night-shift work that significantly increases the odds of excessive levels of daytime sleepiness. Given this pattern of findings, future research should investigate both the time of day and intention for use of wake-promoting drugs to determine whether they are being used to aid work-related tasks and/or driving, and whether there are pharmacokinetic consequences to this timing which may impact subsequent behaviours.”

**2. Continuing on the issue of wake-promoting medication use was associated with increased odds of a fatigue-related error (at work), but not with near-crashes, I am surprised you have not presented/examined the number of police officers who use both “sleep-promoting medication or a drug that listed sleepiness as a side-effect” and “Wake-promoting medication.” Do police officers exclusively use one type of these medications? I know that in logistic regression, when you enter both variables, it means “all else equal,” but I just wonder whether those police officers who use both types of medications, if there are such people, would represent a group at the highest risk for both negative outcomes “near crashes” and “fatigue-related error (at work).”**

Only a small number of officers (n=98, 2.9%) reported use of both a sleep and a wake-promoting drug under these categories in the past month, and we now report this figure as an additional footnote in Table 1. We decided against further examination of this group because they likely represent a different sub-population of officers, and comment on this in our revision (Discussion page 10, limitations and future directions).

**I know we authors hate when reviewers tell us to check the data again, but please consider briefly checking whether you indeed have 4 different groups of police officers: (i) never use sleep or wake promoting medication, (ii) uses only sleep-promoting medication, (iii) uses only wake-promoting medication, (iv) uses both of them.**

We thank the reviewer for this query, however, as noted above the group that used a sleep-promoting drug was relatively distinct from those using a wake-promoting drug with only a small proportion of overlap. In the present study we have therefore chosen to present the data in our logistic regression models separately. This analysis best addresses the aims of the study (to assess use of the drug classes, and associations with the study outcomes). As noted by the reviewer above, this analysis allows for comparison figures and odds ratios for these predictor variables when all else is equal.

**3. You collected data from 4957 police officers, but in your tables you have up to 3340. Please explain why did you exclude more than 1500 participants? Or did I miss something here?**

Participants were not required, nor compelled to answer all questions from the survey, which is potentially a limitation of the design and generalisability of findings. To make this more explicit, we now modify the column heading in Table 1 to read "Categorisation for analysis (n, % valid responses)", and have also modified the limitations paragraph of the discussion on page 10 to note: "The present study used self-assessment of the primary health and performance outcomes, and may be subject to a bias not to report, given the consequences of work-related errors associated with police work and the non-complete cooperation and response rates. Previous studies using both cross-sectional and prospective designs have reported similar levels of outcomes as reported here, however, including in occupational groups such as police where errors can have large negative impacts."

**4. I got confused with participants coming from "North America" and making references to "U.S. population." Did you include also participants from Canada?**

Yes, a small proportion of participants were from Canada. We have modified the *Participants* subsection of our methods to include these data.

**5. Page 4, end of third paragraph. Very long sentence, which is difficult to read.**

We have modified this section of the manuscript, and now break this sentence into two.

**6. Page 5, you write: "The protocol was approved by the Partners and Monash Human Research Ethics Committees. Participants provided written or electronic informed consent and were not informed about study hypotheses." As I understand, the study was conducted in the U.S. Has the Australian research ethics committee approved the original study or only this new analysis of the retrieved data?**

Yes, the Australian research ethics committee approved the new secondary analysis of data, and the sharing of data between organisations across international borders was facilitated by having ethics approvals in both jurisdictions. In our revision we clarify this further under the *Participants* section of the Methods.

**7. Page 9, end of second paragraph. Is this hypothetical question as it seems difficult to understand why anybody would ban drinking coffee at a work place. I am not sure what you wanted to say with this.**

Yes, this is a hypothetical, and we have now state this in the revised manuscript. While we are not advocating for banning coffee in workplaces, we wanted to point out here that while excessive use of pharmacological countermeasures for fatigue may provide insight into vulnerable groups of shift workers, that licit and available stimulants including caffeine play an enabling role in shift-work and extended duration shift scenarios.

**Reviewer: 2**

**Reviewer Name: Xianglong Xu**

**Institution and Country: Chongqing Medical University, China**

**Please state any competing interests or state 'None declared': 'None declared'**

**Please leave your comments for the authors below**

**It's my pleasure to review your manuscript. I have some comments or suggestions for the authors.**

**In the title the authors use big words (health and safety), could the authors provide more specific word?**

We have modified the title to include the specific safety outcomes examined in our study. Our revised title is: "A cross-sectional analysis of sleep- and wake-promoting drug use on health, fatigue-related error and near crashes in police officers".

**Abstract**

**When did the survey conduct?**

Survey data from the original study were collected between July 2005 and December 2007. The secondary analysis of data for the present analysis was approved in April 2015.

**The authors wrote "3693 online and 1264 on-site". The authors used online survey and on-site survey, why did the authors use these two methods. In fact, I know that some research team conducted on-site surveys, but the quality of the data was not good.**

The justification for the multimodal methodology was provided in the first paper investigating this cohort (Rajaratnam et al. (2011), JAMA, 306, 2567-78). In brief, the on-site portion of the study included intense investigations of a municipal police department serving 1 of the 10 largest US cities and a state police department serving 1 of the 10 most densely populated states. The participating police departments were not from the same state. The on-site cohort was included to achieve a high cooperation rate within those departments and to compare characteristics of responders and non-responders (in the municipal police department). The online cohort was included to provide a comparison group of police officers from across North America. Both cohorts included monthly follow-up surveys.

In our revision, we now include cooperation and participation rates for the on-site and online studies respectively.

**How did the authors ensure the quality of the online data?**

Use of online methods to collect survey data is common in health-related research studies which ask about drug use. Indeed, soliciting information via this method carries a number of advantages including: (i) greater anonymity for participants which may offset inhibition of responses to drug use questions perceived to be socially desirable (Gosling et al., 2004, *Am Psychol* 59: 93–104.); and (ii) it allows participants to complete questionnaires in their own time around their relevant work and social schedules. This is important in a shift-work population such as the police cohort examined in this manuscript.

Secondly, related to the above and below queries raised by the reviewer, when recruiting for the online cohort, we directly corresponded with large law enforcement agencies across North America to solicit participation, and placed advertisements in police magazines and newsletters and on police-focused Web sites. We have previously reported that on key demographics including age, gender and ethnicity that our sample of police is comparable to a general US municipal police department (Rajaratnam et al. (2011), *JAMA*, 306, 2567-78).

**How did the authors ensure that all participants through online survey were police officers in North America?**

To verify that those who participated in the nationwide survey were bona fide police officers, we randomly selected 7% of the participants who completed the baseline scheduling questionnaire and called police departments that they listed as their place of employment. We were able to verify 92.5% of officers (232/251) were current or previously employed by the departments listed as their employer on the survey. Of the 19 we were unable to verify, we were unable to reach 15 police departments despite multiple attempts and 4 police departments would not provide us with the information requested. None of the police departments we called reported having no record of the participant.

**Do you think that is there any difference between online survey and on-site survey? How this will affect the result?**

As noted in our responses to the two queries above, we believe that use of both online and on-site methodologies for cross-sectional surveys are common, accepted, and specifically for the present study comparable. We have previously used this methodology and analytical technique (Rajaratnam et al. (2011), *JAMA*, 306, 2567-78).

**Introduction**

**Why did the authors select police officers as participants? The authors should explain this in the introduction.**

We clarify our justification for examining police officers in the study (page 4, para 2). Police officers were chosen given that as an occupational group, they provide services 24-hours a day, 7 days a week with officers required to work overnight shifts. In addition, shift-work in both police and other professionals is associated with adverse consequences which have been reported in previous literature and include an increased propensity for work related errors, decrements in work performance, and increase incidence of motor vehicle crashes or near-crashes (Barger et al., 2012. *Sleep*, 35, 1693-1703; Rajaratnam et al., 2011, *JAMA*, 306, 2567-78). These negative outcomes collectively negatively impact both individual officers and the community.

**Is sleep- and wake-promoting drug widely used among police officers?**



We note in our introduction that “research examining shift schedules and effects on health and performance outcomes has generally not considered the use of sleep- and wake-promoting drugs” (page 4, para 4). While some data is available from general community samples and other groups where shift work is common (e.g., nurses), we believe that assessing both use and consequences of use of these drugs provides a novel and unique contribution.

**Could the authors provide some information about the usage of sleep- and wake-promoting drug in police officers or other population?**

Yes, in our manuscript (Page 4, para 4) we note that: “Hitherto, research examining shift schedules and effects on health and performance outcomes has generally not considered the use of sleep- and wake-promoting drugs. While 1 in 10 adults in the general population have used alcohol as a sleep aid, recent data suggest higher rates of consumption in shift workers with one in six consuming alcohol to help initiate sleep between shifts. Indeed, following prescription sleep medications (e.g., benzodiazepines), alcohol is also commonly used as sleeping aid by shift workers. High alcohol or continued use of prescription sleeping aids is of concern given that their long-term use is associated with poor health and public health outcomes. For example, Roche et al. reported that high-risk drinkers are 22 times more likely than low-risk drinkers to be absent from work due to alcohol use, placing a large burden on the economy due to lost productivity. “

**Could the authors provide some information about health and safety outcomes in police officers or other population?**

The reviewer raises an important point. While we had included background information with respect to drug use, less justification for use of the outcome measures was provided in our original introduction. In our revision, we provide greater detail on the importance of studying these outcome measures in police officers, and cite a relevant reference to support this:

Vila B. Impact of long work hours on police officers and the communities they serve. *Am J Ind Med.* 2006; 49(11):972-980

**Authors may consider adding literature on the necessity of this study, for instance, limitation of previous studies about the association between sleep- and wake-promoting drug use and health and safety outcomes.**

We agree with the reviewer that the examination of all of these factors together is important, but believe our manuscript is quite novel in addressing these questions. If the reviewer has other recommendations for relevant literature to cite, we would most happily include these in our introduction.

**Method**

**Although further details of the sample have been described previously, in order to make it easier for readers to understand the study, the authors also could describe the study design in brief.**

We agree with the reviewer, and provide more details in the revised method including: the location of recruited police officers, the years when data collection occurred, and the relevant approval dates for the ethics committee that had reviewed the protocol and/or study.

**“...a cooperation rate of 63.1% in the on-site cohort...” the cooperation rate was not high, did many police officers reject answer? What’s the reason, will this affect the results?**

Response rates across different survey studies differ for numerous reasons including: the protocol or methodology chosen, the sample of potential participants available within a population, and the time-frame available for participants to complete the survey. Large population-based surveys that collect information on drug-use behaviours (e.g., National Health Survey, National Heart Foundation Risk Factor Prevalence Survey, National Drug Strategy Household Survey) routinely report between 35 and 60% coverage (see Rehm et al., 2003, *Drug Alcohol Rev.* 2006;25(6):503-13 or Ogeil et al. *ANZJPH*, 2015, 39(2), 121-123). Given this, the rates of cooperation and participation reported are comparable to those routinely generated in the public health field. We do agree with the reviewer that as with any survey, it is important to note for readers the limitations of the study, and have modified the first sentence of our Limitations and Future Research section of our Discussion (page 9, para 4), which now reads: “The present study used self-assessment of the primary health and performance outcomes, and may be subject to a bias not to report, given the consequences of work-related errors associated with police work and the non-complete cooperation and response rates”.

**The authors should provide more information about the questionnaire, such as what demographic variables included in this study, how to collect the information of sleep-promoting drug use and wake-promoting drug use.**

For consistency between the methods and results sections, we now state the relevant demographic variables which are reported later in this study (page 5, materials and survey instruments), and have also included further details on the demographic variables collected, but reported elsewhere. We thank the reviewer for noting the inconsistency in our description of the drug use variables. We have amended this to clarify the length of time over which recall was asked (1 month), and also how these were coded for analysis (Page 5, materials and survey instruments).

**The authors also should provide more information about health, performance and safety outcomes, for example, what aspects of health included in this study, why include these aspects.**

Outcome measures examined in our analysis were health-related (excessive sleepiness, burnout, stress), fatigue-errors and near-crashes while driving. These measures were chosen given that shift work has been previously shown to detrimentally impact these measures in multiple occupational groups, however the contribution of use of sleep- and wake-promoting drug use to these detriments has previously not been reported in such studies.

In our revision we have more explicitly clarified use of these terms in the following ways:

a) Modified both the title and abstract to more clearly delineate these outcomes and how they have been grouped under ‘health’ ‘performance’ and ‘safety’ categories.

b) To aid justification for inclusion of these outcomes based on previous literature, in the first paragraph of the introduction we have stated that excessive daytime sleepiness and mental health disturbances including stress and burnout are consequences associated with shift work. Additionally, in the justification of our aims (page 5, para 2) we now write that: “This study investigated the use of the sleep- and wake-promoting drugs and their associations with night shift work and health indices (excessive sleepiness, stress, burnout), performance (fatigue-related errors) and safety (near-

crashes) outcomes. These outcomes were chosen given that they have previously been demonstrated to be negatively impacted by night shifts, and increases in these outcomes is likely to play a role in unintentional injuries and increased mortality in police officers”

#### **In page 6, Role of the funding source**

**To my knowledge, “Role of the funding source” should not place between data analysis and results. What’s more, in page 11, the authors also provide Funding.**

We apologise for duplicating this information. We have deleted the ‘role of the funding source’ section of the methods, and retained it in the footnotes section which includes standardised headings provided by the journal.

#### **Results**

**It’s better for the authors to provide a table of collected sociodemographic factors of participants in this study, such as gender, age, education level, income, marital status. This will help readers understand the characteristics of the participants.**

In our revision we now include further contextual information on other demographic details collected on the participant group, but note that this information has previously been reported in other sources. In our results section for both brevity and consistency, we have reported information on gender and age only given that these sociodemographic variables are controlled for in our regression models, and hence are important for interpretation of analysis.

#### **Discussion**

**Authors may consider adding more deep discussion about the findings, for example, the significance of this study for future practice**

We thank the reviewer for this suggestion, and have provided further insight with respect to some of the key findings, and implications for future research. Specifically:

a) Page 8, para 3: We present a description of key differences between sleep vs. wake-promoting drugs in the logistic regression models, and discuss the need for future studies to consider issues of ‘timing’ of drug administration. This sections begins: “Our logistic regression analysis did not find wake-promoting drug use a significant predictor of near-crashes, which may reflect that these drugs are being used to alleviate tiredness prior to driving a vehicle, or alternatively, if there is a negative impact on driving performance as found in the studies above 26 that a much smaller proportion of police officers were using wake-promoting (~5.4%) compared with sleep-promoting drugs (~20%).”

b) We further integrate the information derived from the present analysis with the greater detail provided above in point a) in the “Limitations and future directions section” (page 10, para 1). This section now reads: “Despite this, we still found significant associations between the use of sleep- and wake-promoting drugs and health and performance outcomes. Future studies should incorporate amount and frequency estimates of drug and medication use, as well as eliciting more information about the time at which these drugs are used, and specific drug classes used to better understand these associations.”

**The authors found that “one-in-five police officers reported using a sleep-promoting drug, or drug that listed sleepiness as a side-effect, and almost one-in-three used a wake promoting drug”? Regarding this, the authors could make a comparison with previous studies.**

We thank the reviewer for this suggestion. We now include a relevant comparison for sleep-promoting drugs with previous prevalence estimates (page 8, para 2). In addition, we now provide comparison

data on caffeine use (page 8, para 3), in addition to discussing smoking rates (pg. 9 para 3). While data on wake-promoting drug use differs by population and drug class, we now note this point explicitly in our discussion (page 8, para 3).

In addition to the above, we also now make comparisons between the use of sleep vs wake-promoting drugs by the sample and discuss the relevance of this for future studies as noted in our response to the reviewer above.

**In the table, we can see the authors collected information wake-promoting drugs used in the past month, why the authors select the information in the past month, not in the past week or in the last half year? Sometimes, if we want to observe the effect of drugs on some diseases or conditions, it usually takes a relatively long time to observe.**

All of the validated outcome-measure tools (e.g., Maslach Burnout Inventory, Epworth Sleepiness Scale), and the relevant questions about work errors and driving asked participants about these behaviours over the past month. For consistency with respect to the frame of reference, all of the drug use questions also followed this format, and in our revised manuscript we now note this in the Materials and Survey Instruments sub-section of the Methods.

We acknowledge the reviewers' comment that reference times may influence a participants responses, and have added a line into our limitations section: In addition, future studies may utilise other methods to gauge drug use and/or behavioural outcomes using timeline follow back methods (Pedersen, Grow, Duncan, Neighbors, & Larimer, 2012) over longer periods to further examine the relationship between drug use, health, productivity and safety variables.

**In this study the authors adjusted for gender and age, residual confounding (such as education level, income, marital status) may still affect the study outcomes. How did the authors consider this point?**

The reviewer correctly notes that our regression models control for age and gender given that these have been associated with some of the study outcomes in previous studies (e.g., stress and burnout differs by gender in police McCarthy et al., 2007 Policing, 30, 672-691) and prevalence of excessive daytime sleepiness varies as a function of age (Bixler et al., 2005 JCEM, 90, 4510-4515). In addition, we also have presented a series of analyses which control for a series of sleep-related variables (OSA, insomnia, shift work disorder) which may be confounders in Supplementary table 1. Together, we feel that these analyses provide a parsimonious and rigorous test of the study aims, and that examining other SES factors is outside the scope of the present manuscript.

**I am not familiar with wake-promoting drugs and sleep-promoting drugs in North America. It seems that the authors did not distinguish the different brands of drugs. Are there any differences in different brands of drugs? Will this affect the results?**

The reviewer raises an important point, and as we note in our discussion section we did not ask police officers about their use of specific drug types or classes of medication (see page 8 of revised manuscript). Indeed, the present study utilised a binary regression model which compares predictors on a "drug was used" with a "drug was not used" in the past month approach. Future studies could investigate whether there are qualitative differences depending on whether different drug classes or brands were used. In our revision we have added a further sentence to our limitations section (pg. 10) noting this: "we did not ask participants to nominate whether specific drug classes under the rubric of sleep-promoting or wake-promoting had been used".

**Conclusion**

**The authors should write the conclusions based on your own findings. Based on this study, the authors cannot conclude “Shift work is pervasive in society, enabling essential services to be provided around the clock, but also due to the rapid growth in flexible working arrangements”.**

**The survey was conducted among police officers in North America, therefore, the conclusion about the status of sleep-promoting drug should also be limited among this population.**

As per the reviewers recommendation we have deleted the first sentence of the conclusion, and now focus on the results of the present study. In addition, we have modified the conclusion to be consistent with the Abstract to highlight how the relevant outcome measures fit within the health, productivity and safety categories as recommended by the reviewer in a previous comment.

#### **VERSION 2 – REVIEW**

<b>REVIEWER</b>	Igor Radun University of Helsinki, Finland
<b>REVIEW RETURNED</b>	20-Jul-2018
<b>GENERAL COMMENTS</b>	Good work!
<b>REVIEWER</b>	Xianglong Xu Chongqing Medical University, China
<b>REVIEW RETURNED</b>	15-Jul-2018
<b>GENERAL COMMENTS</b>	The authors replied on each comment sincerely and the replies were appropriate. The quality of manuscript submitted for consideration is much better than before.