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An Analysis of Physical Activity, Sleep, and Work Shift in Nurses**

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Reproducibility as a Stepping Stone to Intelligent Assistants for Data Analysis: An Analysis of Physical Activity, Sleep, and Work Shift in Nurses

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Abstract

This report presents our work in reproducing a published study with a framework and implemented system that are intended to support automation of future analyses. This automation will allow us to develop intelligent systems to assist non-experts in getting useful information out of their own data. Our framework takes high-level questions, automatically elaborates them, and run the necessary analyses on the data. Our TGN10+ system implements that framework and was used to reproduce an analysis of behavioral, psychological, and physiological data of healthcare workers to uncover differences in subjects that can help improve their work conditions. TGN10+ can also be used to update the results when new data becomes available, and could be used to analyze new data using the same method. Our ultimate goal is to develop intelligent systems that will empower healthcare workers to analyze their own data, and ultimately anyone who wants to understand their own health and wellbeing.

1 INTRODUCTION

Reproducibility allows researchers to leverage the same data and same methods to achieve consistent outcomes with previous work [1, 2, 3]. One important reason for reproducing an original study is to confirm the results with different data or settings. Some challenges in reproducing other work are data unavailability, effort required, incomplete documentation, and human bias [4, 5, 6, 7, 8]. Our motivation for reproducing prior studies is to automate major analytic steps so that others can reuse the same analysis method for their own data.

This work focuses on reproducing a multimodal analysis of wearable sensor data from nurses to study their psychological and physical state particularly under pressure [11]. We reproduced this published work using an approach that automates the generation of questions and the execution of code to generate results. This approach can help us design an intelligent system for assisting users to analyze their own data where the system automates the data analysis steps while allowing users to specify the questions they are interested in. This would democratize the analysis of personal data for people who are not analytics experts. In our application, the analysis in the original article was done by computer scientists but we would like to enable nurses to use the same type of analysis for their own personal data, or nurse managers to design shifts and schedules that take into account patterns that emerge from data in their organizations. Therefore, we consider this reproducibility study as a stepping stone to an intelligent assistant for the analysis of personal data.

The report begins with a brief overview of the original study. Section 3 describes our framework and approach to reproducing the original study. We show our results to date in section 4, followed by a conclusion.

2 ORIGINAL STUDY

TILES-2018 is a longitudinal physiologic and behavioral dataset of hospital personnel working under pressure [10]. Behavioral, psychological, and physiological data was collected via smart watches and other sensors as well as brief surveys throughout their work day. Data was collected on 212 healthcare workers for many months.

We focus on reproducing an analysis of this dataset reported in [11]. The analysis focused on a subset comprising all nurses, 113 in total. T-test, analysis of variance, linear regression, and other types of analysis were performed to analyze the data with respect to variables of interest for different work shifts.

The dataset is described in [10] and is publicly available at <https://tiles-data.isi.edu/>. The software is available at <https://github.com/usc-sail/tiles-day-night>.

3 APPROACH

Our approach to reproducibility is to develop a framework that automates as much as possible the generation of the questions posed in the original study and the methods used. Our framework follows five phases, illustrated in Figure 1 and described in detail in the rest of this section. The first two phases help us understand the domain variables contained in the data, as well as the general types of questions addressed by a study and the methods used to answer them. The former are described in a Domain Ontology, and the latter in a Question Template Library. The next three phases focus on automated questions generation and analyses to reconstruct what is reported in the original paper. Phase III focuses on taking all the generic categories of questions and generating specific questions from them given the data at hand. Phase IV maps specific questions to function in the code. Lastly, Phase V runs all the code and organizes the results.

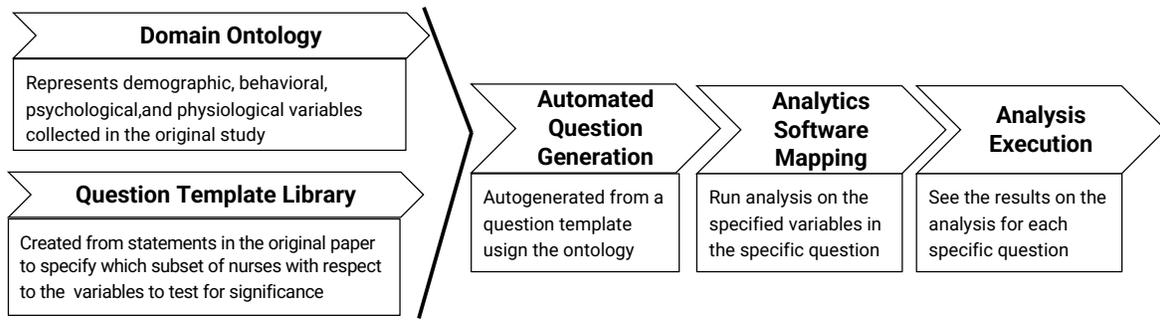


Figure 1: Overview of our framework

The system we implemented, called TGN10+ (named after nurse Tereatha Grant Nwankwo), automatically carries out Phases III-V to reproduce the analysis of the original paper using the Domain Ontology and the Question Template Library that resulted from Phases I-II. The software for TGN10+ is available at <https://github.com/Brinkley97/tiles-day-night>.

3.1 Phase I: Identify Statements in the Paper that Describe the Analysis

In Phase I we looked at the text passages that describe the analysis reported in the paper. These are statements that specify the question that was asked, the data that was used, the variables of interest, the type of analysis, and the software functions executed. This is one example:

<i>Statement in paper</i>	“Independent two-sample t-tests were performed to assess differences in the demographic variables and behavioral variables between nurses who primarily worked a day shift and those primarily worked a night shift (see Table 1).”
<i>Data used</i>	Nurses with primarily day shift and nurses with primarily night shift
<i>Variables</i>	Demographic and behavioral
<i>Type of analysis</i>	Independent two-sample t-test, two-way ANOVA, three-way ANOVA
<i>Software function</i>	<code>pg.ttest()</code> , <code>sm.stats.anova_lm()</code> , <code>stats.fisher_exact()</code>

The software function was found in the code that was released with the original publication. There are over 40 such statements in the original paper. These are included in Table 1 in the Appendix, listed in column 1.

3.2 Phase II: Identify Question Templates and Variables

In Phase II, we took the statements identified in Phase I and looked for general patterns in the questions.

We designed a Domain Ontology that grouped variables into categories that allowed us to make the patterns more compact. For example, the demographic variable category can be decomposed into age, gender, and other variables. The question templates are based on these variable categories.

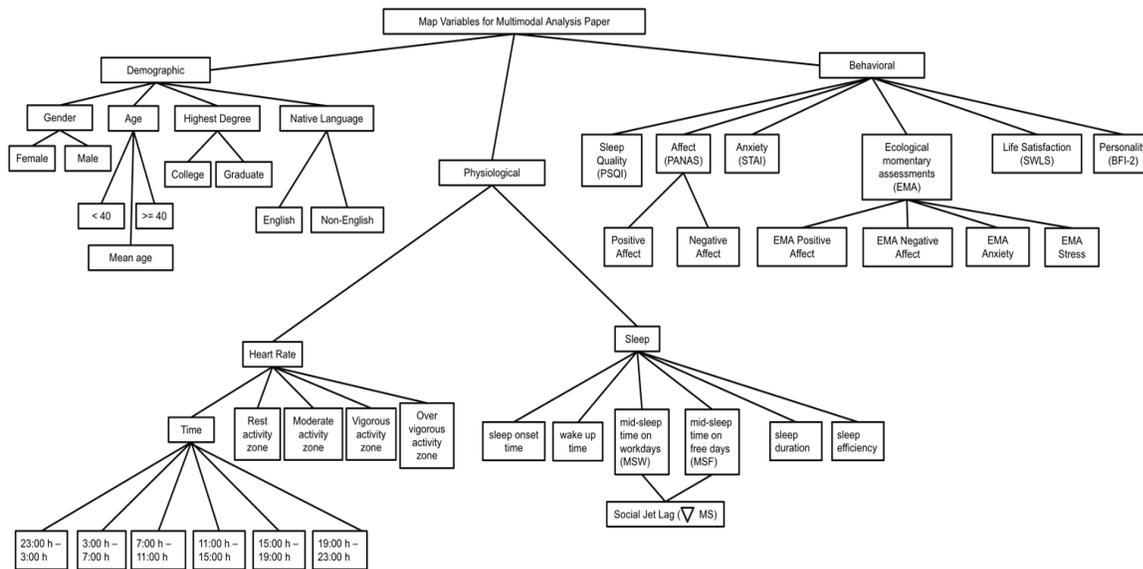


Figure 2: Domain Ontology.

Figure 2 gives an overview of the Domain Ontology that we used. For example, the ontology includes variables such as “age” and “gender” classified under the “demographic variable” category. The “behavioral variable” category included variables for measuring anxiety, affect, and sleep quality among others. The “physiological variable” category included variables for measuring heart rate, walk activity ratio, and sleep. The variables were collected in 6 time periods throughout the day. In the original study, there were special features created for some of the variables. For example, the variable “age” was used in the original study as “< 40 Years” and “>=40 Years”, so these new features are included in the Domain Ontology and appear as leaves in the tree.

For the example statement in Section 3.1, we create the following question templates that use the demographic and behavioral variable categories in the ontology:

Question template 1 (QT-1)	What are differences in primarily *group_1* nurses and primarily *group_2* nurses for *demographic*?
Question template 2 (QT-2)	What are differences in primarily *group_1* nurses and primarily *group_2* nurses for *behavioral*?

Appendix 1 Table 1 column 3 shows the question templates for all the text passages that we identified in the paper. Note that several separate statements can correspond to the same question template. Note that we chose to state the question templates to refer to nurse subgroups, but could be stated in a more general way as “What are differences in *group_1* and *group_2* for *demographic*?”, but the overall approach would be the same.

Once this is done, we proceed to create a Question Template Library by identifying for each question template the methods used to answer them. Recall that most statements in the original paper mentioned the function to be executed. We also identify the software functions in the code that were used to run the methods. Finally, we specify a Mapping Pattern, as we describe in the next section.

Table 2 in Appendix 1 gives an overview of the Question Template Library for this study.

3.3 Phase III: Identify Question Templates and Analysis Types

In this phase, we automatically run the analyses in the paper using TGN10+. TGN10+ uses the results from the prior two phases:

- A **Domain Ontology**, also resulting from the prior phase, that represents variables and their categories which can be used to express question templates more compactly.
- A **Question Template Library**, resulting from the prior phase, includes all question templates and specifies the method and software functions needed to get each answer.

TGN10+ has three major modules:

- An **Automated Question Generation** module that takes the question templates from the Question Template Library and automatically generates specific questions by taking the variable categories in each question template and replacing them with variables based on the Domain Ontology.
- An **Analytics Software Mapping** module takes the specific questions from the Automated Question Generator and the software functions indicated in the Statements in the Paper and uses them to specify the function invocation that will do the kind of analysis required when executed.
- An **Analysis Execution** module runs all the functions needed and organizes the results for all the questions.

These modules are used in Phases III, IV, and V respectively.

The Automated Question Generation module starts with all the Question Templates (QTs) from the Question Template Library. For each QT, it replaces the variable categories with specific variables to create Specific Questions (SQs). For example, these are some of the SQs generated for QT-1 and QT-2 by TGN10+:

SQ-1-1	what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *Gender* ?
SQ-1-2	what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *Age* ?
SQ-2-1	what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *stai* ?
SQ-2-2	what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *pan_PosAffect* ?

All the SQs of the different QTs can be found in the Appendix in Table 3 (A.3).

3.4 Phase IV: Automated Mapping to Analytics Software

In this phase, the Analytics Software Mapping module of TGN10+ takes each of the specific questions generated in Phase III and specifies the function invocation command to run that analysis.

This mapping generates the invocation command to run the code for each SQ, and is done as follows. The data is stored in a Pandas DataFrame. Recall that we mentioned that the Question Template Library includes a Mapping Pattern that specifies how the command invocation needs to be formulated based on the SQ. For example, for QT-2 the Mapping Pattern is:

```

pg.ttest(
    np.array(group1_df[behavioral].dropna()),
    np.array(group2_df[behavioral].dropna())
)

```

This pattern expresses that the DataFrame (df) would retrieve group 1 and group2, and for each of them we would retrieve a particular variable, in this case of the “behavioral” category. Here is an example of how to use the Mapping Pattern above for SQ-2-1 to generate the specific function invocation command:

<i>Statement in paper</i>	“Independent two-sample t-tests were performed to assess differences in the demographic variables and behavioral variables between nurses who primarily worked a day shift and those primarily worked a night shift (see Table 1).”
Type of Analysis	Independent two-sample t-test, two-way ANOVA, three-way ANOVA
QT-2	What are differences in primarily *group_1* nurses and primarily *group_2* nurses for *behavioral*?
SQ-2-1	What are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *stai*?
Mapping	group_1 ==> day-shift group_2 ==> night-shift behavioral ==> stai group1_df ==> day_df group2_df ==> night_df
Function invocation command	pg.ttest(np.array(day_df[stai].dropna()), np.array(night_df[stai].dropna()))

3.5 Phase V: Running Analyses to Generate Results

In this phase, the Analysis Execution module will run the invocation commands for all the SQs generated. Table 1 shows the reproduced results generated for each specific question of question templates QT-1 and QT-2.

Note that TGN10+ generated additional specific questions for QT-1, but we do not include the results here because they were not included in the original paper (possibly because the results were not interesting enough to report for that particular dataset).

For SQ-1-2, the original paper states: “There is a significant difference in age between the day shift group and night shift group ($t(112)=2.63, p=0.010$),” and we were not able to replicate the result. After consulting with the authors, they revealed that for the purpose of anonymization they had not released the raw age data. They used a data perturbation technique where the real age was rounded up, for instance 37 years could be rounded up to 40 years. When using Fisher’s Exact Test odds ratio, our results for SQ-1-2 is 0.160 which is the same as the original researchers. The raw age value is not used in any other analysis, so we get the exact same results for all the other questions.

Table 1: Results Obtained with TGN10+ for QT1 and QT2.

<i>Specific Question #</i>	<i>Specific Question</i>	<i>Original Results</i>	<i>Reproduced Results</i>
SQ-1-1	what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *Gender* ?	0.829	0.829
SQ-1-2	what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *Age* ?	0.010*	0.16
SQ-1-3	what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *Educ* ?	0.215	0.215
SQ-1-4	what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *native_lang* ?	1	1
SQ-2-1	what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *stai* ?	0.13	0.13
SQ-2-2	what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *pan_PosAffect* ?	0.764	0.764
SQ-2-3	what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *pan_NegAffect* ?	0.065	0.065
SQ-2-4	what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *swls* ?	0.030*	0.030*
SQ-2-5	what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *bfi_Neuroticism* ?	0.166	0.166
SQ-2-6	what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *bfi_Conscientiousness* ?	0.601	0.601
SQ-2-7	what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *bfi_Extraversion* ?	0.6	0.6
SQ-2-8	what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *bfi_Agreeableness* ?	0.994	0.994
SQ-2-9	what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *bfi_Openness* ?	0.058	0.058
SQ-2-10	what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *psqi* ?	0.04	0.04**

Statistical significance denoted by: p** < 0.01 , p* < 0.05.

4 RESULTS OVERVIEW

Using the approach described in this paper, we used TGN10+ to reproduce several figures and tables in the original paper, specifically Tables 1 (compared results in Section 3.5), 2, and 4 as well as Figures 2 and 3 of that original article. Each Table and Figure require a different type of analysis. Appendix 1.3 shows the specific questions generated for each of them.

We include here only the reproduced results correspond to Figure 2 in the original paper, since the results for other figures and tables are also the same as the original article. Figure 2 of the original paper corresponds to this statement and question template:

<i>Statement in paper</i>	“To examine the effect of primary shift type and time within a day on physical activity characteristics, a 2 × 6 repeated ANOVA (primary shift [day shift, night shift], time within a day [23:00–3:00 h, 3:00–7:00 h, 7:00–11:00 h, 11:00–15:00 h, 15:00–19:00 h, 19:00–23:00 h]) was used for rest-activity ratio and walk time ratio on both workdays and off-days (see Fig. 2).”
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<i>Question Template QT-4</i>	on both <i>*work_1*</i> day and <i>*work_2*</i> day, what is the effect of primarily <i>*group_1*</i> nurses and primarily <i>*group_2*</i> nurses on <i>*physiological*</i> between the hours of <i>*time_within_a_day*</i> ?
-------------------------------	--

Table 2 shows the specific results obtained for question template QT-4: “on both **work_1** day and **work_2** day, what is the effect of primarily **group_1** nurses and primarily **group_2** nurses on **physiological** between the hours of **time_within_a_day** ?” These show how primarily day-shift nurses and primarily night-shift nurses differ in their physiological variables for different times within a day [23:00–3:00 h, 3:00–7:00 h, 7:00–11:00 h, 11:00–15:00 h, 15:00–19:00 h, 19:00–23:00 h]). For example, during the hours of 23:00 – 3:00 the primarily night-shift nurses walk more compared to day-shift nurses, while during the hours of 11:00 – 15:00 the primarily night-shift nurses walk less compared to day-shift nurses.

In future work, we plan to reproduce Tables 3 and 5 and Figure 1 in the original paper [11]. Those two tables (Tables 3 and 5) and figure (Figure 1) have more complex methods and software, but our framework would be applicable in terms of automating Phases III-V. In fact, we already have created the question templates for Tables 3 and 5, shown in the Appendix. We have not yet worked on automating the analysis due to the complexities of ensuring we use the right data by communicating with the original authors, identify the right code to run, and verifying our results with the original authors or with running their original code.

Table 2: Results Reproduced for Figure 2 in the Original Paper with TGN10+

Specific Question #	Specific Question	Original Results (work day, rest activity ratio)	Reproduced Results (work day, rest activity ratio)	Original Results (off day, rest activity ratio)	Reproduced Results (off day, rest activity ratio)
SQ-4-1-1	on both <i>*work*</i> day and <i>*off*</i> day, what is the effect of primarily <i>*day-shift*</i> nurses and primarily <i>*night-shift*</i> nurses on <i>*rest*</i> between the hours of <i>*23:00–3:00 h*</i> ?	< 0.01**	< 0.01**	0.850	0.850
SQ-4-1-2	on both <i>*work*</i> day and <i>*off*</i> day, what is the effect of primarily <i>*day-shift*</i> nurses and primarily <i>*night-shift*</i> nurses on <i>*rest*</i> between the hours of <i>*3:00–7:00 h*</i> ?	0.034*	0.034*	0.317	0.318
SQ-4-1-3	on both <i>*work*</i> day and <i>*off*</i> day, what is the effect of primarily <i>*day-shift*</i> nurses and primarily <i>*night-shift*</i> nurses on <i>*rest*</i> between the hours of <i>*7:00–11:00 h*</i> ?	< 0.01**	< 0.01**	< 0.01**	< 0.01**
SQ-4-1-4	on both <i>*work*</i> day and <i>*off*</i> day, what is the effect of primarily <i>*day-shift*</i> nurses and primarily <i>*night-shift*</i> nurses on <i>*rest*</i> between the hours of <i>*11:00–15:00 h*</i> ?	< 0.01**	< 0.01**	< 0.01**	< 0.01**
SQ-4-1-5	on both <i>*work*</i> day and <i>*off*</i> day, what is the effect of primarily <i>*day-shift*</i> nurses and primarily <i>*night-</i>	< 0.01**	< 0.01**	< 0.01**	< 0.01**

	shift* nurses on *rest* between the hours of *15:00–19:00 h* ?				
SQ-4-1-6	on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *rest* between the hours of *19:00–23:00 h* ?	0.800	0.800	0.146	0.146
Specific Question #	Specific Question	Original Results (work day, step activity ratio)	Reproduced Results (work day, step activity ratio)	Original Results (off day, step activity ratio)	Reproduced Results (off day, step activity ratio)
SQ-4-2-1	on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *step_ratio* between the hours of *23:00–3:00 h* ?	< 0.01**	< 0.01**	< 0.01**	< 0.01**
SQ-4-2-2	on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *step_ratio* between the hours of *3:00–7:00 h* ?	< 0.01**	< 0.01**	0.149	0.149
SQ-2-2-3	on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *step_ratio* between the hours of *7:00–11:00 h* ?	< 0.01**	< 0.01**	< 0.01**	< 0.01**
SQ-2-2-4	on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *step_ratio* between the hours of *11:00–15:00 h* ?	< 0.01**	< 0.01**	< 0.01**	< 0.01**
SQ-2-2-5	on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *step_ratio* between the hours of *15:00–19:00 h* ?	< 0.01**	< 0.01**	0.018*	0.018*
SQ-2-2-6	on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *step_ratio* between the hours of *19:00–23:00 h* ?	< 0.01**	< 0.01**	0.206	0.206

Asterisks indicate statistical differences at each time period with $p^{**} < 0.01$, $p^{*} < 0.05$.

5 CONCLUSIONS

In conclusion, we have demonstrated a framework and implemented system to reproduce previously published work that analyzed a variety of data for health care providers. Our TGN10+ system achieved similar results as the published paper we set out to reproduce when the data was available. By automating various steps of the data analytic process of a paper, we bring our work one step closer to developing intelligent assistants to support non-experts to analyze their personal data on their own.

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A APPENDIX

This appendix includes several tables that provide further detail on the TGN10+ system to reproduce the work described in [11].

A.1 Statements in the Original Paper About the Analysis

The results of Phase I are shown in Table A.1. We identified statements in the text of the original article that indicated the analyses that were carried out. Then, we created question templates that reflected the types of analysis.

Table A.1: Statements in the Original Paper and Question Templates Created

Statement in Original Paper	Page in Original Paper	Question Template
Consistent with the anxiety score, the work status is significant for stress ($t(5941) = -14.46, p < 0.01$) and negative affect ($t(5941) = 3.60, p < 0.01$) but the primary shift pattern is not.	3	what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *behavioral* ?
Although shift type is not significant for openness from the independent t-test, the three-way ANOVA analysis shows that the primary shift schedule ($F(1, 107) = 7.65, p = 0.007$) is significant for the openness with the covariates as age and gender.	3	what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *behavioral* ?
Similarly, the age and the gender are not significant for PSQI scores from the ANOVA analysis but the shift was ($F(1, 108) = 4.40, p = 0.038$).	3	what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *behavioral* ?
Additionally, night shift nurses report significantly higher PSQI scores than day shift nurses, indicating poor sleep quality (day shift: 7.0 ± 2.0 ; night shift nurses: 8.4 ± 2.5 ; $t(110) = -2.97, p = 0.004$).	3	what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *behavioral* ?
From the two-sample independent t-test results shown in Table 1, the day shift group and night shift group do not differ in the STAI scores, the PANAS scores, or the personality.	3	what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *behavioral* ?
However, the day shift group and night shift group differ significantly in reported life satisfaction scores (day shift: 14.9 ± 3.7 ; night shift nurses: 16.5 ± 4.9 ; $t(111) = 2.21, p = 0.030$).	3	what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *behavioral* ?
Independent two-sample t-tests were performed to assess differences in the demographic variables and behavioral variables between nurses who primarily worked a day shift and those primarily worked a night shift (see Table 1).	3	what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *behavioral* ?
The day shift and night shift groups do not differ significantly in gender (Fisher's Exact Test odds ratio: 1.19, $p = 0.829$), highest degree earned (Fisher's Exact Test odds	3	what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *demographic* ?

ratio: 1.97, $p = 0.215$), and native language (Fisher's Exact Test odds ratio: 0.99, $p = 1.000$).		
Independent two-sample t-tests were performed to assess differences in the demographic variables and behavioral variables between nurses who primarily worked a day shift and those primarily worked a night shift (see Table 1).	3	what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *demographic* ?
The linear regression model (see Table 3) was applied to assess the effect of the shift schedule, the physical activity, and the shift by physical activity interaction on the behavioral variables. The factor age and the factor gender were added in the model as covariates. Each physical activity feature (e.g., the rest activity ratio on off-days) combined with the primary shift variable on a behavioral measure was modeled independently. The behavioral variables were STAI, PANAS, SWLS, and PSQI.	5	what is the affect on *behavioral* with respect to *some_variable* ?
We applied a linear regression model to assess the effect of the shift schedule and the shift by sleep pattern interaction on behavioral variables with the factor age and the factor gender (see Table 5). Similarly, the behavioral variables were STAI, PANAS, SWLS, and PSQI.	6	what is the affect on *behavioral* with respect to *some_variable* ?
From the three-way ANOVA tests, the shift schedule ($F(1, 108) = 3.99, p = 0.048$) is significant for the SWLS but the gender, the age does not have an effect on SWLS.	7	what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *behavioral* ?
To examine the effect of primary shift type and time within a day on physical activity characteristics, a 2×6 repeated ANOVA (primary shift [day shift, night shift], time within a day [23:00–3:00 h, 3:00–7:00 h, 7:00–11:00 h, 11:00–15:00 h, 15:00–19:00 h, 19:00–23:00 h]) was used for rest-activity ratio and walk time ratio on both workdays and off-days (see Fig. 2).	8	on both *work_1* day and *work_2* day, what is the effect of primarily *group_1* nurses and primarily *group_2* nurses on *physiological* between the hours of *time_within_a_day* ?
From the two-way repeated ANOVA test, we observe a main effect of shift ($F(1, 102) = 7.18, p < 0.01$), time within a day ($F(5, 510) = 74.82, p < 0.01$), and shift by time interaction ($F(5, 510) = 6.79, p < 0.01$) for the rest-activity ratio on workdays.	8	on both *work_1* day and *work_2* day, what is the effect of primarily *group_1* nurses and primarily *group_2* nurses on *physiological* between the hours of *time_within_a_day* ?
Main effect analyses showed that the night shift group ($\mu = 83.5\%, \sigma = 2.4\%$) has a higher rest-activity ratio on off-days than day shift group ($\mu = 76.5\%, \sigma = 2.1\%$)	8	on both *work_1* day and *work_2* day, what is the effect of primarily *group_1* nurses and primarily *group_2* nurses on *physiological* between the hours of *time_within_a_day* ?
Pairwise comparisons with Fisher's Least Significant Difference test reveal that the night shift group has a higher rest-activity ratio during 7–19 h ($p < 0.05$) and a lower rest-activity ratio during 23–7 h on workdays than the day shift group ($p < 0.05$).	8	on both *work_1* day and *work_2* day, what is the effect of primarily *group_1* nurses and primarily *group_2* nurses on *physiological* between the hours of *time_within_a_day* ?
Lastly, day shift group also has a higher walk activity ratio on off-days during 7–19 h ($p < 0.05$), with the largest difference ($11.3\%, p < 0.01$) occurring within 7–11 h in a day.	8	on both *work_1* day and *work_2* day, what is the effect of primarily *group_1* nurses and primarily *group_2* nurses on

		physiological between the hours of *time_within_a_day*?
Post-hoc analysis shows that the day shift group has more walk activity during 7–19 h ($p < 0.05$) and less walk activity during 19–7 h ($p < 0.05$).	8	on both *work_1* day and *work_2* day, what is the effect of primarily *group_1* nurses and primarily *group_2* nurses on *physiological* between the hours of *time_within_a_day*?
Moreover, a two-way repeated ANOVA test reveals a main effect of shift ($F(1, 102) = 1.17, p < 0.01$), time within a day ($F(5, 510) = 178.45, p < 0.01$), and shift-by-time interaction ($F(5, 510) = 24.64, p < 0.01$) for the walk activity ratio on workdays.	8	on both *work_1* day and *work_2* day, what is the effect of primarily *group_1* nurses and primarily *group_2* nurses on *physiological* between the hours of *time_within_a_day*?
Particularly, night shift nurses consistently have higher rest-activity ratio during 7–19 h on off-days ($p < 0.05$)	8	on both *work_1* day and *work_2* day, what is the effect of primarily *group_1* nurses and primarily *group_2* nurses on *physiological* between the hours of *time_within_a_day*?
Diurnal patterns of the the rest-activity ratio and the walk-activity ratio on workdays and off-days between the day and night shift groups are shown in Fig. 2.	8	on both *work_1* day and *work_2* day, what is the effect of primarily *group_1* nurses and primarily *group_2* nurses on *physiological* between the hours of *time_within_a_day*?
The walk-activity ratio on workdays is higher in the day shift group ($\mu = 31.3\%$, $\sigma = 0.9\%$) than the night shift group ($\mu = 27.6\%$, $\sigma = 1.2\%$).	8	what are differences between *work_1* day and *work_2* day for primarily *group_1* nurses and primarily *group_2* nurses with *demographic* on *physiological*?
Three-way ANOVA model to test for the effect of primary shift [day shift; night shift] on daily physical activity characteristics with the covariate age [age ≥ 40 years; age < 40 years], and the covariate gender [male; female] (see Table 2). The covariate age was included in the analysis as the day shift group and the night shift group in our dataset differed significantly in age, and the physical activity can be impacted by the age. We also included gender as the covariate since it was correlated with different levels of physical activity in previous studies. The dependent variables were average rest-activity ratio, average walk activity ratio, and average vigorous activity duration (both on workdays and off-days).	8	what are differences between *work_1* day and *work_2* day for primarily *group_1* nurses and primarily *group_2* nurses with *demographic* on *physiological*?
Three-way ANOVA tests reveal that the shift factor is significant for the rest- activity ratio on workdays ($F(1, 101) = 9.77, p = 0.002$).	8	what are differences between *work_1* day and *work_2* day for primarily *group_1* nurses and primarily *group_2* nurses with *demographic* on *physiological*?
The three-way ANOVA test results also suggest that the effect of shift is significant for the walk-activity ratio on off-days ($F(1, 101) = 5.16, p = 0.025$), and that the day shift group ($\mu = 25.3\%$, $\sigma = 1.1\%$) has a higher walk-activity ratio on off-days than night shift group ($\mu = 21.3\%$, $\sigma = 1.2\%$).	8	what are differences between *work_1* day and *work_2* day for primarily *group_1* nurses and primarily *group_2* nurses with *demographic* on *physiological*?

Neither the age ($F(1, 101) = 3.73, p = 0.056$) nor the gender ($F(1, 101) = 0.05, p = 0.826$) are significant for the rest-activity ratio on workdays.	8	what are differences between *work_1* day and *work_2* day for primarily *group_1* nurses and primarily *group_2* nurses with *demographic* on *physiological* ?
A three-way ANOVA test on walk-activity ratio on workdays shows that shift factor ($F(1, 101) = 4.92, p = 0.029$) and gender factor ($F(1, 101) = 8.71, p = 0.004$) are significant, but age factor ($F(1, 101) = 3.34, p = 0.071$) is not.	8	what are differences between *work_1* day and *work_2* day for primarily *group_1* nurses and primarily *group_2* nurses with *demographic* on *physiological* ?
Lastly, the effect of shift ($F(1, 91) = 4.50, p = 0.037$) and age ($F(1, 91) = 9.76, p = 0.002$) are significant on vigorous activity duration on off-days but the gender ($F(1, 91) = 0.46, p = 0.498$) is not.	8	what are differences between *work_1* day and *work_2* day for primarily *group_1* nurses and primarily *group_2* nurses with *demographic* on *physiological* ?
Moreover, the shift factor ($F(1, 91) = 7.36, p = 0.008$) and age factor ($F(1, 91) = 5.06, p = 0.027$) are both significant for the rest-activity ratio on off-days while the gender is not ($F(1, 91) = 0.015, p = 0.903$).	8	what are differences between *work_1* day and *work_2* day for primarily *group_1* nurses and primarily *group_2* nurses with *demographic* on *physiological* ?
The estimated marginal means are 410.4 ± 7.1 min and 330.4 ± 8.4 min for night shift participants and day shift participants, respectively (see Table 4).	8	what are differences between *work_1* days and *work_2* days for primarily *group_1* nurses and primarily *group_2* nurses with *demographic* on sleep *physiological_sleep* ?
The effect of the shift ($F(1, 90) = 2.65, p = 0.107$) and the gender ($F(1, 90) = 1.392, p = 0.241$) are not significant for sleep duration on off-days, but the age is significant ($F(1, 90) = 2.65, p < 0.01$).	8	what are differences between *work_1* days and *work_2* days for primarily *group_1* nurses and primarily *group_2* nurses with *demographic* on sleep *physiological_sleep* ?
The factor gender ($F(1, 90) = 4.79, p = 0.031$) is also significant for the sleep duration on workdays.	8	what are differences between *work_1* days and *work_2* days for primarily *group_1* nurses and primarily *group_2* nurses with *demographic* on sleep *physiological_sleep* ?
The three-way ANOVA test shows a main effect of the shift ($F(1, 90) = 65.55, p < 0.01$) on sleep duration on workdays, but not the age ($F(1, 90) = 0.67, p = 0.415$).	8	what are differences between *work_1* days and *work_2* days for primarily *group_1* nurses and primarily *group_2* nurses with *demographic* on sleep *physiological_sleep* ?
Lastly, a significant difference on (delta)MS is found between day shift and night shift group ($F(1, 85) = 274.11, p < 0.01$), with night shift group of 425.0 ± 18.4 min and day shift group of 52.5 ± 16.5 . Neither the effect of age ($F(1, 85) = 2 \times 10^{-3}, p = 0.960$) nor the factor gender ($F(1, 85) = 0.545, p = 0.462$) are significant for (delta)MS.	8	what are differences between *work_1* days and *work_2* days for primarily *group_1* nurses and primarily *group_2* nurses with *demographic* on sleep *physiological_sleep* ?
Similar to the physical activity analyses, we applied a three-way ANOVA model to test for effect of the primary shift [day shift; night shift], the covariate age [age \geq 40 years; age < 40 years] and covariate gender [male; female] on sleep-related characteristics (see Table 4).	8	what are differences between *work_1* days and *work_2* days for primarily *group_1* nurses and primarily *group_2* nurses with *demographic* on sleep *physiological_sleep* ?
Figure 3 presents the comparisons of sleep patterns (median sleep start time; median sleep end time) between day and night shift groups.	8	what are differences between sleep *physiological_sleep_1* and sleep *physiological_sleep_2* on *work_1* days for primarily *group_1* nurses ?

Figure 3 presents the comparisons of sleep patterns (median sleep start time; median sleep end time) between day and night shift groups.	8	what are differences between sleep *physiological_sleep_1* and sleep *physiological_sleep_2* on *work_1* days for primarily *group_2* nurses ?
Figure 3 presents the comparisons of sleep patterns (median sleep start time; median sleep end time) between day and night shift groups.	8	what are differences between sleep *physiological_sleep_1* and sleep *physiological_sleep_2* on *work_2* days for primarily *group_1* nurses ?
Figure 3 presents the comparisons of sleep patterns (median sleep start time; median sleep end time) between day and night shift groups.	8	what are differences between sleep *physiological_sleep_1* and sleep *physiological_sleep_2* on *work_2* days for primarily *group_2* nurses ?
The shift [Day shift] × Rest-activity ratio (off-day) is significant for predicting PA ($\beta = 0.57$, $t(89) = 2.16$, $p = 0.033$).	8	what is the affect on *behavioral* with respect to *some_variable* ?
Moreover, the model including the walk activity ratio (off-day) can predict SWLS ($F(5, 88) = 4.07$, $p < 0.01$, Adj. $R^2 = 0.142$) with a reasonable R^2 score.	8	what is the affect on *behavioral* with respect to *some_variable* ?
The day shift group by walk-activity ratio on off-days has negative effect on SWLS ($\beta = -0.62$, $t(88) = -3.06$, $p < 0.01$).	8	what is the affect on *behavioral* with respect to *some_variable* ?
Linear regression analyses in Table 3 shows that the walk activity ratio on off-days with the age, the gender, and the shift schedule can fit a reasonable R^2 score with SWLS ($F(5, 88) = 3.79$, $p < 0.01$, adj. $R^2 = 0.131$), PSQI ($F(5, 88) = 4.54$, $p < 0.01$, adj. $R^2 = 0.160$), and PA ($F(5, 89) = 3.36$, $p < 0.01$, adj. $R^2 = 0.112$).	8	what is the affect on *behavioral* with respect to *some_variable* ?
However, the sleep efficiency (off-day) is not significant for SWLS, STAI, PA, and NA.	9	what is the affect on *behavioral* with respect to *some_variable* ?
Moreover, we observe that the linear regression model including the sleep efficiency (off-day) can fit PSQI with a moderate R^2 score ($F(5, 87) = 5.65$, $p < 0.01$, adj. $R^2 = 0.202$).	9	what is the affect on *behavioral* with respect to *some_variable* ?
The standard β coefficients show that the higher sleep efficiency (off-day) is associated with higher PSQI in day shift nurses ($\beta = 1.41$, $t(87) = 2.78$, $p < 0.01$).	9	what is the affect on *behavioral* with respect to *some_variable* ?
Linear regression analyses reveal that although models including sleep duration on off-days are indicative of SWLS, PSQI, and PA, neither the sleep duration on off-days nor its interaction with shift schedule are significant in the models.	9	what is the affect on *behavioral* with respect to *some_variable* ?

A.2 Question Templates Library to Code Invocations

Table A.2 shows the Question Template Library that results of Phase II of our approach.

Table A.2: Question Template Library

Question Template	Type of Analysis	Function Call
what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *behavioral* ?	independent two-sample t-test, two-way ANOVA, three-way ANOVA	pg.ttest(), sm.stats.anova_lm()
what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *demographic* ?	independent two-sample t-test, Fisher's Exact Test odds ratio	pg.ttest(), stats.fisher_exact()
what is the affect on *behavioral* with respect to *some_variable* ?	linear regression	sm.stats.anova_lm()
on both *work_1* day and *work_2* day, what is the effect of primarily *group_1* nurses and primarily *group_2* nurses on *physiological* between the hours of *time_within_a_day* ?	repeated ANOVA, two-way ANOVA, three-way ANOVA, Fisher's Least Significant Difference, Post-hoc	stats.ttest_ind(), LSD.test(), PostHocTest(), ezANOVA(),
what are differences between *work_1* day and *work_2* day for primarily *group_1* nurses and primarily *group_2* nurses with *demographic* on *physiological* ?	three-way ANOVA	aov()
what are differences between *work_1* days and *work_2* days for primarily *group_1* nurses and primarily *group_2* nurses with *demographic* on sleep *physiological_sleep* ?	Estimated marginal means, three-way ANOVA	emmeans(), aov()
what are differences between sleep *physiological_sleep_1* and sleep *physiological_sleep_2* on *work_1* days for primarily *group_1* nurses ?	Median	np.nanmean(), np.nanmin(), np.nanmax()
what are differences between sleep *physiological_sleep_1* and sleep *physiological_sleep_2* on *work_1* days for primarily *group_2* nurses ?	Median	np.nanmean(), np.nanmin(), np.nanmax()
what are differences between sleep *physiological_sleep_1* and sleep *physiological_sleep_2* on *work_2* days for primarily *group_1* nurses ?	Median	np.nanmean(), np.nanmin(), np.nanmax()
what are differences between sleep *physiological_sleep_1* and sleep *physiological_sleep_2* on *work_2* days for primarily *group_2* nurses ?	Median	np.nanmean(), np.nanmin(), np.nanmax()

A.3 Questions Generated

Table A.3 shows the questions reproduced automatically with TGN10+. They correspond to figures and tables that appear in the original paper, specifically Tables 1, 2, 3, 4 and 5 as well as Figures 2 and 3.

Table A.3: Questions Generated by TGN10+

Question Template	Relevant Ontology Terms for the Mappings	Generated Specific Questions
For Table 1 in Original Paper		
what are differences in primarily *group_1* nurses and primarily *group_2* nurses for *demographic* ?	group_1: day-shift	what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *Gender* ?
	group_2: night-shift	what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *Age* ?
	demographic: Gender: Female, Male, Age: < 40 Years >= 40 Years, Educ: Some college or College Graduate, native_lang: English non-english	what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *Educ* ?
		what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *native_lang* ?
		what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *Female* ?
		what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *Male* ?
		what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *< 40 Years* ?
		what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *>= 40 Years* ?
		what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *Some college or College* ?
		what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *Graduate* ?
		what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *English* ?
		what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *non-english* ?

what are differences in primarily *group_1* nurses and primarily *group_2* nurses for *behavioral* ?	group_1: day-shift group_2: night-shift behavioral: stai, pan_PosAffect, pan_NegAffect, swls, bfi_Neuroticism, bfi_Conscientiousness, bfi_Extraversion, bfi_Agreeableness, bfi_Openness, psqi	what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *stai* ?
		what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *pan_PosAffect* ?
		what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *pan_NegAffect* ?
		what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *swls* ?
		what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *bfi_Neuroticism* ?
		what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *bfi_Conscientiousness* ?
		what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *bfi_Extraversion* ?
		what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *bfi_Agreeableness* ?
		what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *bfi_Openness* ?
		what are differences in primarily *day-shift* nurses and primarily *night-shift* nurses for *psqi* ?
For Table 2 in Original Paper		
what are differences between *work_1* day and *work_2* day for primarily *group_1* nurses and primarily *group_2* nurses for *demographic* on *physiological* ?	work_1: work work_2: off group_1: day-shift	what are differences between *work* day and *off* day for primarily *day-shift* nurses and primarily *night-shift* nurses for *Gender* on *rest* ?

	group_2: night-shift physiological: rest, step_ratio, run_ratio, vigorous_min, duration, efficiency, mid	
		what are differences between *work* day and *off* day for primarily *day-shift* nurses and primarily *night-shift* nurses for *Gender* on *step_ratio* ?
		what are differences between *work* day and *off* day for primarily *day-shift* nurses and primarily *night-shift* nurses for *Gender* on *run_ratio* ?
		what are differences between *work* day and *off* day for primarily *day-shift* nurses and primarily *night-shift* nurses for *Gender* on *vigorous_min* ?
		what are differences between *work* day and *off* day for primarily *day-shift* nurses and primarily *night-shift* nurses for *Gender* on *duration* ?
		what are differences between *work* day and *off* day for primarily *day-shift* nurses and primarily *night-shift* nurses for *Gender* on *efficiency* ?
		what are differences between *work* day and *off* day for primarily *day-shift* nurses and primarily *night-shift* nurses for *Gender* on *mid* ?
		what are differences between *work* day and *off* day for primarily *day-shift* nurses and primarily *night-shift* nurses for *Age* on *rest* ?
		what are differences between *work* day and *off* day for primarily *day-shift* nurses and primarily *night-shift* nurses for *Age* on *step_ratio* ?
		what are differences between *work* day and *off* day for primarily *day-shift* nurses and primarily *night-shift* nurses for *Age* on *run_ratio* ?
		what are differences between *work* day and *off* day for primarily *day-shift* nurses and primarily *night-shift* nurses for *Age* on *vigorous_min* ?
		what are differences between *work* day and *off* day for primarily *day-shift* nurses and primarily *night-shift* nurses for *Age* on *duration* ?
		what are differences between *work* day and *off* day for primarily *day-shift* nurses and primarily *night-shift* nurses for *Age* on *efficiency* ?
		what are differences between *work* day and *off* day for primarily *day-shift* nurses and primarily *night-shift* nurses for *Age* on *mid* ?

		shift* nurses for *Age* on *vigorous_min* ?
		what are differences between *work* day and *off* day for primarily *day-shift* nurses and primarily *night-shift* nurses for *Age* on *duration* ?
		what are differences between *work* day and *off* day for primarily *day-shift* nurses and primarily *night-shift* nurses for *Age* on *efficiency* ?
		what are differences between *work* day and *off* day for primarily *day-shift* nurses and primarily *night-shift* nurses for *Age* on *mid* ?
		what are differences between *work* day and *off* day for primarily *day-shift* nurses and primarily *night-shift* nurses for *Gender* on *rest* ?
		what are differences between *work* day and *off* day for primarily *day-shift* nurses and primarily *night-shift* nurses for *Gender* on *step_ratio* ?
		what are differences between *work* day and *off* day for primarily *day-shift* nurses and primarily *night-shift* nurses for *Gender* on *run_ratio* ?
		what are differences between *work* day and *off* day for primarily *day-shift* nurses and primarily *night-shift* nurses for *Gender* on *vigorous_min* ?
		what are differences between *work* day and *off* day for primarily *day-shift* nurses and primarily *night-shift* nurses for *Gender* on *duration* ?
		what are differences between *work* day and *off* day for primarily *day-shift* nurses and primarily *night-shift* nurses for *Gender* on *efficiency* ?
		what are differences between *work* day and *off* day for primarily *day-shift* nurses and primarily *night-shift* nurses for *Gender* on *mid* ?
		what are differences between *work* day and *off* day for primarily

		day-shift nurses and primarily *night-shift* nurses for *Age* on *rest* ?
		what are differences between *work* day and *off* day for primarily *day-shift* nurses and primarily *night-shift* nurses for *Age* on *step_ratio* ?
For Table 3 in Original Paper		
what is the affect on *behavioral* with respect to *some_variable* ?	behavioral: psqi, stai, pan_PosAffect, pan_NegAffect, swls, bfi_Neuroticism, bfi_Conscientiousness, bfi_Extraversion, bfi_Agreeableness, bfi_Openness intercept, Age [<40 years], Gender [female], Shift [day shift], Number of observations, Adjust R2, Rest-activity ratio (off-day), Shift [day shift] x rest-activity ratio (off-day), Walk-activity ratio (off-day), Shift [day shift] x walk-activity ratio (off-day)	what is the affect on *psqi* with respect to *intercept* ?
		what is the affect on *psqi* with respect to *Age [<40 years]* ?
		what is the affect on *psqi* with respect to *Gender [female]* ?
		what is the affect on *psqi* with respect to *Shift [day shift]* ?
		what is the affect on *psqi* with respect to *Number of observations* ?
		what is the affect on *psqi* with respect to *Adjust R2* ?
		what is the affect on *psqi* with respect to *Rest-activity ratio (off-day)* ?
		what is the affect on *psqi* with respect to *Shift [day shift] x rest-activity ratio (off-day)* ?
		what is the affect on *psqi* with respect to *Walk-activity ratio (off-day)* ?
		what is the affect on *psqi* with respect to *Shift [day shift] x walk-activity ratio (off-day)* ?
		what is the affect on *stai* with respect to *intercept* ?
		what is the affect on *stai* with respect to *Age [<40 years]* ?

		what is the affect on *stai* with respect to *Gender [female]* ?
		what is the affect on *stai* with respect to *Shift [day shift]* ?
		what is the affect on *stai* with respect to *Number of observations* ?
		what is the affect on *stai* with respect to *Adjust R2* ?
		what is the affect on *stai* with respect to *Rest-activity ratio (off-day)* ?
		what is the affect on *stai* with respect to *Shift [day shift] x rest-activity ratio (off-day)* ?
		what is the affect on *stai* with respect to *Walk-activity ratio (off-day)* ?
		what is the affect on *stai* with respect to *Shift [day shift] x walk-activity ratio (off-day)* ?
		what is the affect on *pan_PosAffect* with respect to *intercept* ?
		what is the affect on *pan_PosAffect* with respect to *Age [<40 years]* ?
		what is the affect on *pan_PosAffect* with respect to *Gender [female]* ?
		what is the affect on *pan_PosAffect* with respect to *Shift [day shift]* ?
		what is the affect on *pan_PosAffect* with respect to *Number of observations* ?
		what is the affect on *pan_PosAffect* with respect to *Adjust R2* ?
		what is the affect on *pan_PosAffect* with respect to *Rest-activity ratio (off-day)* ?
		what is the affect on *pan_PosAffect* with respect to *Shift [day shift] x rest-activity ratio (off-day)* ?
		what is the affect on *pan_PosAffect* with respect to *Walk-activity ratio (off-day)* ?
		what is the affect on *pan_PosAffect* with respect to *Shift [day shift] x walk-activity ratio (off-day)* ?
		what is the affect on *pan_NegAffect* with respect to *intercept* ?

		what is the affect on *pan_NegAffect* with respect to *Age [<40 years]* ?
		what is the affect on *pan_NegAffect* with respect to *Gender [female]* ?
		what is the affect on *pan_NegAffect* with respect to *Shift [day shift]* ?
		what is the affect on *pan_NegAffect* with respect to *Number of observations* ?
		what is the affect on *pan_NegAffect* with respect to *Adjust R2* ?
		what is the affect on *pan_NegAffect* with respect to *Rest-activity ratio (off-day)* ?
		what is the affect on *pan_NegAffect* with respect to *Shift [day shift] x rest-activity ratio (off-day)* ?
		what is the affect on *pan_NegAffect* with respect to *Walk-activity ratio (off-day)* ?
		what is the affect on *pan_NegAffect* with respect to *Shift [day shift] x walk-activity ratio (off-day)* ?
		what is the affect on *swls* with respect to *intercept* ?
		what is the affect on *swls* with respect to *Age [<40 years]* ?
		what is the affect on *swls* with respect to *Gender [female]* ?
		what is the affect on *swls* with respect to *Shift [day shift]* ?
		what is the affect on *swls* with respect to *Number of observations* ?
		what is the affect on *swls* with respect to *Adjust R2* ?
		what is the affect on *swls* with respect to *Rest-activity ratio (off-day)* ?
		what is the affect on *swls* with respect to *Shift [day shift] x rest-activity ratio (off-day)* ?
		what is the affect on *swls* with respect to *Walk-activity ratio (off-day)* ?

		what is the affect on *swls* with respect to *Shift [day shift] x walk-activity ratio (off-day)* ?
		what is the affect on *bfi_Neuroticism* with respect to *intercept* ?
		what is the affect on *bfi_Neuroticism* with respect to *Age [<40 years]* ?
		what is the affect on *bfi_Neuroticism* with respect to *Gender [female]* ?
		what is the affect on *bfi_Neuroticism* with respect to *Shift [day shift]* ?
		what is the affect on *bfi_Neuroticism* with respect to *Number of observations* ?
		what is the affect on *bfi_Neuroticism* with respect to *Adjust R2* ?
		what is the affect on *bfi_Neuroticism* with respect to *Rest-activity ratio (off-day)* ?
		what is the affect on *bfi_Neuroticism* with respect to *Shift [day shift] x rest-activity ratio (off-day)* ?
		what is the affect on *bfi_Neuroticism* with respect to *Walk-activity ratio (off-day)* ?
		what is the affect on *bfi_Neuroticism* with respect to *Shift [day shift] x walk-activity ratio (off-day)* ?
		what is the affect on *bfi_Conscientiousness* with respect to *intercept* ?
		what is the affect on *bfi_Conscientiousness* with respect to *Age [<40 years]* ?
		what is the affect on *bfi_Conscientiousness* with respect to *Gender [female]* ?
		what is the affect on *bfi_Conscientiousness* with respect to *Shift [day shift]* ?
		what is the affect on *bfi_Conscientiousness* with respect to *Number of observations* ?

		what is the affect on *bfi_Conscientiousness* with respect to *Adjust R2* ?
		what is the affect on *bfi_Conscientiousness* with respect to *Rest-activity ratio (off-day)* ?
		what is the affect on *bfi_Conscientiousness* with respect to *Shift [day shift] x rest-activity ratio (off-day)* ?
		what is the affect on *bfi_Conscientiousness* with respect to *Walk-activity ratio (off-day)* ?
		what is the affect on *bfi_Conscientiousness* with respect to *Shift [day shift] x walk-activity ratio (off-day)* ?
		what is the affect on *bfi_Extraversion* with respect to *intercept* ?
		what is the affect on *bfi_Extraversion* with respect to *Age [<40 years]* ?
		what is the affect on *bfi_Extraversion* with respect to *Gender [female]* ?
		what is the affect on *bfi_Extraversion* with respect to *Shift [day shift]* ?
		what is the affect on *bfi_Extraversion* with respect to *Number of observations* ?
		what is the affect on *bfi_Extraversion* with respect to *Adjust R2* ?
		what is the affect on *bfi_Extraversion* with respect to *Rest-activity ratio (off-day)* ?
		what is the affect on *bfi_Extraversion* with respect to *Shift [day shift] x rest-activity ratio (off-day)* ?
		what is the affect on *bfi_Extraversion* with respect to *Walk-activity ratio (off-day)* ?
		what is the affect on *bfi_Extraversion* with respect to *Shift [day shift] x walk-activity ratio (off-day)* ?

		what is the affect on *bfi_Agreeableness* with respect to *intercept* ?
		what is the affect on *bfi_Agreeableness* with respect to *Age [<40 years]* ?
		what is the affect on *bfi_Agreeableness* with respect to *Gender [female]* ?
		what is the affect on *bfi_Agreeableness* with respect to *Shift [day shift]* ?
		what is the affect on *bfi_Agreeableness* with respect to *Number of observations* ?
		what is the affect on *bfi_Agreeableness* with respect to *Adjust R2* ?
		what is the affect on *bfi_Agreeableness* with respect to *Rest-activity ratio (off-day)* ?
		what is the affect on *bfi_Agreeableness* with respect to *Shift [day shift] x rest-activity ratio (off-day)* ?
		what is the affect on *bfi_Agreeableness* with respect to *Walk-activity ratio (off-day)* ?
		what is the affect on *bfi_Agreeableness* with respect to *Shift [day shift] x walk-activity ratio (off-day)* ?
		what is the affect on *bfi_Openness* with respect to *intercept* ?
		what is the affect on *bfi_Openness* with respect to *Age [<40 years]* ?
		what is the affect on *bfi_Openness* with respect to *Gender [female]* ?
		what is the affect on *bfi_Openness* with respect to *Shift [day shift]* ?
		what is the affect on *bfi_Openness* with respect to *Number of observations* ?
		what is the affect on *bfi_Openness* with respect to *Adjust R2* ?
		what is the affect on *bfi_Openness* with respect to *Rest-activity ratio (off-day)* ?

		what is the affect on *bfi_Openness* with respect to *Shift [day shift] x rest-activity ratio (off-day)* ?
		what is the affect on *bfi_Openness* with respect to *Walk-activity ratio (off-day)* ?
		what is the affect on *bfi_Openness* with respect to *Shift [day shift] x walk-activity ratio (off-day)* ?
For Figure 2 in Original Paper		
on both *work_1* day and *work_2* day, what is the effect of primarily *group_1* nurses and primarily *group_2* nurses on *physiological* between the hours of *time_within_a_day* ?	<p>work_1: work</p> <p>work_2: off</p> <p>group_1: day-shift</p> <p>group_2: night-shift</p> <p>physiological: rest, step_ratio, run_ratio, vigorous_min, duration, efficiency, mid</p> <p>time_within_a_day: 23:00–3:00 h, 3:00–7:00 h, 7:00–11:00 h, 11:00–15:00 h, 15:00–19:00 h, 19:00–23:00 h</p>	on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *mid* between the hours of *23:00 - 3:00 h* ?
		on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *mid* between the hours of *3:00 - 7:00 h* ?
		on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *mid* between the hours of *7:00 - 11:00 h* ?
		on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *mid* between the hours of *11:00 - 15:00 h* ?
		on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *mid* between the hours of *11:00 - 15:00 h* ?

		nurses on *mid* between the hours of *15:00 - 19:00 h* ?
		on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *mid* between the hours of *19:00 - 23:00 h* ?
		on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *rest* between the hours of *23:00 - 3:00 h* ?
		on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *rest* between the hours of *3:00 - 7:00 h* ?
		on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *rest* between the hours of *7:00 - 11:00 h* ?
		on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *rest* between the hours of *11:00 - 15:00 h* ?
		on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *rest* between the hours of *15:00 - 19:00 h* ?
		on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *rest* between the hours of *19:00 - 23:00 h* ?
		on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *step_ratio* between the hours of *23:00 - 3:00 h* ?
		on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *step_ratio* between the hours of *3:00 - 7:00 h* ?
		on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *step_ratio* between the hours of *3:00 - 7:00 h* ?

		nurses on *step_ratio* between the hours of *7:00 - 11:00 h* ?
		on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *step_ratio* between the hours of *11:00 - 15:00 h* ?
		on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *step_ratio* between the hours of *15:00 - 19:00 h* ?
		on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *step_ratio* between the hours of *19:00 - 23:00 h* ?
		on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *run_ratio* between the hours of *23:00 - 3:00 h* ?
		on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *run_ratio* between the hours of *3:00 - 7:00 h* ?
		on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *run_ratio* between the hours of *7:00 - 11:00 h* ?
		on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *run_ratio* between the hours of *11:00 - 15:00 h* ?
		on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *run_ratio* between the hours of *15:00 - 19:00 h* ?
		on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *run_ratio* between the hours of *19:00 - 23:00 h* ?
		on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *run_ratio* between the hours of *19:00 - 23:00 h* ?

		nurses on <i>*vigorous_min*</i> between the hours of <i>*23:00 - 3:00 h*</i> ?
		on both <i>*work*</i> day and <i>*off*</i> day, what is the effect of primarily <i>*day-shift*</i> nurses and primarily <i>*night-shift*</i> nurses on <i>*vigorous_min*</i> between the hours of <i>*3:00 - 7:00 h*</i> ?
		on both <i>*work*</i> day and <i>*off*</i> day, what is the effect of primarily <i>*day-shift*</i> nurses and primarily <i>*night-shift*</i> nurses on <i>*vigorous_min*</i> between the hours of <i>*7:00 - 11:00 h*</i> ?
		on both <i>*work*</i> day and <i>*off*</i> day, what is the effect of primarily <i>*day-shift*</i> nurses and primarily <i>*night-shift*</i> nurses on <i>*vigorous_min*</i> between the hours of <i>*11:00 - 15:00 h*</i> ?
		on both <i>*work*</i> day and <i>*off*</i> day, what is the effect of primarily <i>*day-shift*</i> nurses and primarily <i>*night-shift*</i> nurses on <i>*vigorous_min*</i> between the hours of <i>*15:00 - 19:00 h*</i> ?
		on both <i>*work*</i> day and <i>*off*</i> day, what is the effect of primarily <i>*day-shift*</i> nurses and primarily <i>*night-shift*</i> nurses on <i>*vigorous_min*</i> between the hours of <i>*19:00 - 23:00 h*</i> ?
		on both <i>*work*</i> day and <i>*off*</i> day, what is the effect of primarily <i>*day-shift*</i> nurses and primarily <i>*night-shift*</i> nurses on <i>*duration*</i> between the hours of <i>*23:00 - 3:00 h*</i> ?
		on both <i>*work*</i> day and <i>*off*</i> day, what is the effect of primarily <i>*day-shift*</i> nurses and primarily <i>*night-shift*</i> nurses on <i>*duration*</i> between the hours of <i>*3:00 - 7:00 h*</i> ?
		on both <i>*work*</i> day and <i>*off*</i> day, what is the effect of primarily <i>*day-shift*</i> nurses and primarily <i>*night-shift*</i> nurses on <i>*duration*</i> between the hours of <i>*7:00 - 11:00 h*</i> ?
		on both <i>*work*</i> day and <i>*off*</i> day, what is the effect of primarily <i>*day-shift*</i> nurses and primarily <i>*night-shift*</i> nurses on <i>*duration*</i> between the hours of <i>*11:00 - 15:00 h*</i> ?
		on both <i>*work*</i> day and <i>*off*</i> day, what is the effect of primarily <i>*day-shift*</i> nurses and primarily <i>*night-shift*</i>

		nurses on *duration* between the hours of *15:00 - 19:00 h* ?
		on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *duration* between the hours of *19:00 - 23:00 h* ?
		on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *efficiency* between the hours of *23:00 - 3:00 h* ?
		on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *efficiency* between the hours of *3:00 - 7:00 h* ?
		on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *efficiency* between the hours of *7:00 - 11:00 h* ?
		on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *efficiency* between the hours of *11:00 - 15:00 h* ?
		on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *efficiency* between the hours of *15:00 - 19:00 h* ?
		on both *work* day and *off* day, what is the effect of primarily *day-shift* nurses and primarily *night-shift* nurses on *efficiency* between the hours of *19:00 - 23:00 h* ?
For Figure 3 in Original Paper		
what are differences between sleep *physiological_sleep_1* and sleep *physiological_sleep_2* on *work_1* days for primarily *group_1* nurses ?	<p>physiological_sleep_1: start</p> <p>physiological_sleep_2: end</p> <p>work_1: work</p> <p>group_1: day-shift</p>	what are differences between sleep *start* and sleep *end* on *work* days for primarily *day-shift* nurses ?

<p>what are differences between sleep *physiological_sleep_1* and sleep *physiological_sleep_2* on *work_2* days for primarily *group_1* nurses ?</p>	<p>physiological_sleep_1: start physiological_sleep_2: end work_2: off group_1: day-shift</p>	<p>what are differences between sleep *start* and sleep *end* on *off* days for primarily *day-shift* nurses ?</p>
<p>what are differences between sleep *physiological_sleep_1* and sleep *physiological_sleep_2* on *work_1* days for primarily *group_2* nurses ?</p>	<p>physiological_sleep_1: start physiological_sleep_2: end work_1: work group_2: night-shift</p>	<p>what are differences between sleep *start* and sleep *end* on *work* days for primarily *night-shift* nurses ?</p>
<p>what are differences between sleep *physiological_sleep_1* and sleep *physiological_sleep_2* on *work_2* days for primarily *group_2* nurses ?</p>	<p>physiological_sleep_1: start physiological_sleep_2: end work_2: off group_2: night-shift</p>	<p>what are differences between sleep *start* and sleep *end* on *off* days for primarily *night-shift* nurses ?</p>
<p>For Table 4 in Original Paper</p>		

<p>what are differences between *work_1* days and *work_2* days for primarily *group_1* nurses and primarily *group_2* nurses with *demographic* on sleep *physiological_sleep* ?</p>	<p>work_1: work work_2: off group_1: day-shift group_2: night-shift demographic: Gender, Age physiological: duration, efficiency, mid</p>	<p>what are differences between *work* days and *off* days for primarily *day-shift* nurses and primarily *night-shift* nurses with *Gender* on sleep *duration* ?</p>
		<p>what are differences between *work* days and *off* days for primarily *day-shift* nurses and primarily *night-shift* nurses with *Gender* on sleep *efficiency* ?</p>
		<p>what are differences between *work* days and *off* days for primarily *day-shift* nurses and primarily *night-shift* nurses with *Gender* on sleep *mid* ?</p>
		<p>what are differences between *work* days and *off* days for primarily *day-shift* nurses and primarily *night-shift* nurses with *Age* on sleep *duration* ?</p>
		<p>what are differences between *work* days and *off* days for primarily *day-shift* nurses and primarily *night-shift* nurses with *Age* on sleep *efficiency* ?</p>
		<p>what are differences between *work* days and *off* days for primarily *day-shift* nurses and primarily *night-shift* nurses with *Age* on sleep *mid* ?</p>
<p>For Table 5 in Original Paper</p>		

<p>what is the affect on *behavioral* with respect to *some_variable* ?</p>	<p>behavioral: psqi, stai, pan_PosAffect, pan_NegAffect, swls, bfi_Neuroticism, bfi_Conscientiousness, bfi_Extraversion, bfi_Agreeableness, bfi_Openness</p> <p>intercept, Age [<40 years], Gender [female], Shift [day shift], Number of observations, Adjust R2, Sleep duration (off-day), Shift [day shift] x sleep duration (off-day), Sleep efficiency (off-day), Shift [day shift] x sleep efficiency (off-day)</p>	<p>what is the affect on *psqi* with respect to *intercept* ?</p>
		<p>what is the affect on *psqi* with respect to *Age [<40 years]* ?</p>
		<p>what is the affect on *psqi* with respect to *Gender [female]* ?</p>
		<p>what is the affect on *psqi* with respect to *Shift [day shift]* ?</p>
		<p>what is the affect on *psqi* with respect to *Number of observations* ?</p>
		<p>what is the affect on *psqi* with respect to *Adjust R2* ?</p>
		<p>what is the affect on *psqi* with respect to *Sleep duration (off-day)* ?</p>
		<p>what is the affect on *psqi* with respect to *Shift [day shift] x sleep duration (off-day)* ?</p>
		<p>what is the affect on *psqi* with respect to *Sleep efficiency (off-day)* ?</p>
		<p>what is the affect on *psqi* with respect to *Shift [day shift] x sleep efficiency (off-day)* ?</p>
		<p>what is the affect on *stai* with respect to *intercept* ?</p>
		<p>what is the affect on *stai* with respect to *Age [<40 years]* ?</p>
		<p>what is the affect on *stai* with respect to *Gender [female]* ?</p>
		<p>what is the affect on *stai* with respect to *Shift [day shift]* ?</p>
		<p>what is the affect on *stai* with respect to *Number of observations* ?</p>
		<p>what is the affect on *stai* with respect to *Adjust R2* ?</p>
		<p>what is the affect on *stai* with respect to *Sleep duration (off-day)* ?</p>

		what is the affect on *stai* with respect to *Shift [day shift] x sleep duration (off-day)* ?
		what is the affect on *stai* with respect to *Sleep efficiency (off-day)* ?
		what is the affect on *stai* with respect to *Shift [day shift] x sleep efficiency (off-day)* ?
		what is the affect on *pan_PosAffect* with respect to *intercept* ?
		what is the affect on *pan_PosAffect* with respect to *Age [<40 years]* ?
		what is the affect on *pan_PosAffect* with respect to *Gender [female]* ?
		what is the affect on *pan_PosAffect* with respect to *Shift [day shift]* ?
		what is the affect on *pan_PosAffect* with respect to *Number of observations* ?
		what is the affect on *pan_PosAffect* with respect to *Adjust R2* ?
		what is the affect on *pan_PosAffect* with respect to *Sleep duration (off-day)* ?
		what is the affect on *pan_PosAffect* with respect to *Shift [day shift] x sleep duration (off-day)* ?
		what is the affect on *pan_PosAffect* with respect to *Sleep efficiency (off-day)* ?
		what is the affect on *pan_PosAffect* with respect to *Shift [day shift] x sleep efficiency (off-day)* ?
		what is the affect on *pan_NegAffect* with respect to *intercept* ?
		what is the affect on *pan_NegAffect* with respect to *Age [<40 years]* ?
		what is the affect on *pan_NegAffect* with respect to *Gender [female]* ?
		what is the affect on *pan_NegAffect* with respect to *Shift [day shift]* ?
		what is the affect on *pan_NegAffect* with respect to *Number of observations* ?

		what is the affect on *pan_NegAffect* with respect to *Adjust R2* ?
		what is the affect on *pan_NegAffect* with respect to *Sleep duration (off-day)* ?
		what is the affect on *pan_NegAffect* with respect to *Shift [day shift] x sleep duration (off-day)* ?
		what is the affect on *pan_NegAffect* with respect to *Sleep efficiency (off-day)* ?
		what is the affect on *pan_NegAffect* with respect to *Shift [day shift] x sleep efficiency (off-day)* ?
		what is the affect on *swls* with respect to *intercept* ?
		what is the affect on *swls* with respect to *Age [<40 years]* ?
		what is the affect on *swls* with respect to *Gender [female]* ?
		what is the affect on *swls* with respect to *Shift [day shift]* ?
		what is the affect on *swls* with respect to *Number of observations* ?
		what is the affect on *swls* with respect to *Adjust R2* ?
		what is the affect on *swls* with respect to *Sleep duration (off-day)* ?
		what is the affect on *swls* with respect to *Shift [day shift] x sleep duration (off-day)* ?
		what is the affect on *swls* with respect to *Sleep efficiency (off-day)* ?
		what is the affect on *swls* with respect to *Shift [day shift] x sleep efficiency (off-day)* ?
		what is the affect on *bfi_Neuroticism* with respect to *intercept* ?
		what is the affect on *bfi_Neuroticism* with respect to *Age [<40 years]* ?
		what is the affect on *bfi_Neuroticism* with respect to *Gender [female]* ?
		what is the affect on *bfi_Neuroticism* with respect to *Shift [day shift]* ?

		what is the affect on *bfi_Neuroticism* with respect to *Number of observations* ?
		what is the affect on *bfi_Neuroticism* with respect to *Adjust R2* ?
		what is the affect on *bfi_Neuroticism* with respect to *Sleep duration (off-day)* ?
		what is the affect on *bfi_Neuroticism* with respect to *Shift [day shift] x sleep duration (off-day)* ?
		what is the affect on *bfi_Neuroticism* with respect to *Sleep efficiency (off-day)* ?
		what is the affect on *bfi_Neuroticism* with respect to *Shift [day shift] x sleep efficiency (off-day)* ?
		what is the affect on *bfi_Conscientiousness* with respect to *intercept* ?
		what is the affect on *bfi_Conscientiousness* with respect to *Age [<40 years]* ?
		what is the affect on *bfi_Conscientiousness* with respect to *Gender [female]* ?
		what is the affect on *bfi_Conscientiousness* with respect to *Shift [day shift]* ?
		what is the affect on *bfi_Conscientiousness* with respect to *Number of observations* ?
		what is the affect on *bfi_Conscientiousness* with respect to *Adjust R2* ?
		what is the affect on *bfi_Conscientiousness* with respect to *Sleep duration (off-day)* ?
		what is the affect on *bfi_Conscientiousness* with respect to *Shift [day shift] x sleep duration (off- day)* ?
		what is the affect on *bfi_Conscientiousness* with respect to *Sleep efficiency (off-day)* ?
		what is the affect on *bfi_Conscientiousness* with respect to *Shift [day shift] x sleep efficiency (off- day)* ?

		what is the affect on *bfi_Extraversion* with respect to *intercept* ?
		what is the affect on *bfi_Extraversion* with respect to *Age [<40 years]* ?
		what is the affect on *bfi_Extraversion* with respect to *Gender [female]* ?
		what is the affect on *bfi_Extraversion* with respect to *Shift [day shift]* ?
		what is the affect on *bfi_Extraversion* with respect to *Number of observations* ?
		what is the affect on *bfi_Extraversion* with respect to *Adjust R2* ?
		what is the affect on *bfi_Extraversion* with respect to *Sleep duration (off-day)* ?
		what is the affect on *bfi_Extraversion* with respect to *Shift [day shift] x sleep duration (off-day)* ?
		what is the affect on *bfi_Extraversion* with respect to *Sleep efficiency (off-day)* ?
		what is the affect on *bfi_Extraversion* with respect to *Shift [day shift] x sleep efficiency (off-day)* ?
		what is the affect on *bfi_Agreeableness* with respect to *intercept* ?
		what is the affect on *bfi_Agreeableness* with respect to *Age [<40 years]* ?
		what is the affect on *bfi_Agreeableness* with respect to *Gender [female]* ?
		what is the affect on *bfi_Agreeableness* with respect to *Shift [day shift]* ?
		what is the affect on *bfi_Agreeableness* with respect to *Number of observations* ?
		what is the affect on *bfi_Agreeableness* with respect to *Adjust R2* ?

		what is the affect on *bfi_Agreeableness* with respect to *Sleep duration (off-day)* ?
		what is the affect on *bfi_Agreeableness* with respect to *Shift [day shift] x sleep duration (off-day)* ?
		what is the affect on *bfi_Agreeableness* with respect to *Sleep efficiency (off-day)* ?
		what is the affect on *bfi_Agreeableness* with respect to *Shift [day shift] x sleep efficiency (off-day)* ?
		what is the affect on *bfi_Openness* with respect to *intercept* ?
		what is the affect on *bfi_Openness* with respect to *Age [<40 years]* ?
		what is the affect on *bfi_Openness* with respect to *Gender [female]* ?
		what is the affect on *bfi_Openness* with respect to *Shift [day shift]* ?
		what is the affect on *bfi_Openness* with respect to *Number of observations* ?
		what is the affect on *bfi_Openness* with respect to *Adjust R2* ?
		what is the affect on *bfi_Openness* with respect to *Sleep duration (off-day)* ?
		what is the affect on *bfi_Openness* with respect to *Shift [day shift] x sleep duration (off-day)* ?
		what is the affect on *bfi_Openness* with respect to *Sleep efficiency (off-day)* ?
		what is the affect on *bfi_Openness* with respect to *Shift [day shift] x sleep efficiency (off-day)* ?