# Study Protocol

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# Project title

Are health and medical researchers submitting and reviewing more papers on weekends? An observational study

# Researchers

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# Introduction

* Researchers are working longer hours to stay competitive in the “publish or perish” game, which creates higher expectations for job and grant applications. This creates a vicious circle of hyper-competition.
* The number of published papers has been increasing exponentially (Bastian et al, 2010) creating ever higher benchmarks for researchers looking to survive in the publish-or-perish game.
* Working weekends is a symptom of the pressure on researchers.
* If there has been an increase in weekend submissions and/or reviews over time, then this points towards a growing pressure on researchers to work ever longer hours.
* Investigating this issue is part of the ongoing research into work-life balance for researchers and creating a healthier work place.
* Some researchers advocate not working on the weekends to achieve a better work-life balance and be more productive (Reed, 2017).

# Preliminary analysis

We made a preliminary analysis of researchers working weekends by examining data from the journal *PLOS ONE* who publish submission dates for accepted papers.

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|  | Figure 1: Annual percentages of published papers submitted to the journal *PLOS ONE* by day of the week for the years 2007 to 2018 (n = 202,471 papers) |

Figure 1 shows a clear increase over time in papers submitted on the weekend and commensurate decrease in papers submitted during the working week.

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|  | Figure 2: Weekly percentage of papers submitted to the journal *PLOS ONE* on the weekend from late 2006 to late 2018 (n = 202,471 papers). The blue line is a non-linear smooth. |

The plot above shows the week-to-week changes in the percent of papers submitted on the weekend. A binomial regression model estimates a relative 6.0% increase per year in the proportion of papers submitted on the weekend (95% confidence interval: 5.4% to 6.5%). Hence there is evidence of an increase in weekend submissions based on the *PLOS ONE* data.

The *PLOS ONE* data have some limitations:

1. They only include papers that were eventually published and not those rejected.
2. The data does not include the time of submission, and so it is not possible to adjust for time zones or examine out of office hours submissions.
3. We did not include data on the submitting author’s country, hence the increase observed on the weekends could be due to a rise in submissions from a particular time zone (e.g., China).

# Hypotheses

* There will be an increase over time in the proportion of research manuscript submissions to *The BMJ* and *BMJ Open* during weekends, public holidays, and evenings and late nights.
* There will be an increase over time in the proportion of submission of peer reviewers’ reports of research papers to *The BMJ* and *BMJ Open* during weekends, public holidays, and evenings and late nights.

# Data sources and preparation

## Journal data

The data for submissions of both research manuscripts and peer reviewers’ reports are from *The BMJ* and *BMJ Open*, both international general medical journals based in London. The reviewer data are from 1-Jan-2012 to 31-December-2018 (2,556 days) and the submission data from 1-Jan-2012 to 5-April-2019 (2,651 days).

The submissions are limited to first version manuscript submissions, and so do not include resubmissions. The articles types are: research and research methods and reporting articles for *The BMJ* and all article types for *BMJ Open* which only publishes research. The data are: the date and time of transmission (in Eastern Standard Time), the author/reviewer’s address (city, state and country), and the article type.

For the reviewers’ data, statistical reviews were excluded as they are paid. The data are completed reviews for article types of Research, Research methods and Reporting. Patient and public reviews were included for *The BMJ*.

## Time zone differences

*The BMJ* and *BMJ Open* receive submissions and reviews from all over the world. We want the time and date of submission (of a paper or report) relative to each country. We will therefore change the time and date of submission depending on the submitting author’s country and city by:

1. Geo-locating each submission using the submitting author’s country and city to get a longitude and latitude. We will use the Google Geocoding API (<https://developers.google.com/maps/documentation/geocoding/start>); investigator AB registered with this service. We will use the R library “ggmap” (Kahle & Wickham, 2013).
2. Adding the time zone to each submission using the longitude and latitude using the R package “geonames” (Rowlingson, 2019). We will then create a local time and date using this local time zone.

We will record the number of times that the geolocation did not work because of an incomplete address.

## Public holidays

Public holidays are similar to weekends as researchers would ideally be taking a break during this time. However, researchers may be under increasing pressure to work on public holidays as well as weekends. In a second analysis we will therefore examine submissions and reviews on public holidays for countries with holiday data available. We will use holiday data from the Nager.Date which has data on 100 countries (Hager 2019). We will only use national holidays and will not examine holidays that are only celebrated in a state (e.g., the Picnic Day holiday in the Northern Territory of Australia). We will use holidays from 2012 to 2019.

# Inclusion and exclusion criteria

The inclusion criteria are submitting a first version research paper to *The BMJ* or *BMJ Open* between 1-Jan-2012 to 5-April-2019 or submitting a review (of any version of a manuscript) to either journal between 1-Jan-2012 to 31-December-2018. We will exclude countries with less than 100 submissions/ reviews so that we have sufficient data to estimate each country’s probability of weekend submissions/reviews. We will exclude submissions/reviews that could not be geocoded because we cannot estimate the time zone.

We will use a flow diagram to show the numbers at each stage of data collection.

# Statistical methods

All analyses will be performed in R (R Core Team, 2018).

The results will be written up using the STROBE guidelines for cross-sectional studies (von Elm et al, 2007).

## An initial analysis will be created using a scrambled submission/review date and time by randomly re-ordering the submission variable. This will destroy any potential signal in the key outcomes, whilst keeping the rest of the data features intact. A complete statistical report will be created using this scrambled data and sent to all investigators for discussion. This allows investigators to query the methods and approaches used prior to the final report. It can also uncover errors in the code or data. Changes can be made prior to seeing the main results, which helps avoid the bias of only making changes where results are perceived as unfavourable.

All plots and analyses will be run separately for the two journals. This is because *BMJ Open* is a relatively new journal that has grown substantially during the study period, where *The BMJ* is an established and high-profile journal. It is therefore possible that the cohorts of reviewers and authors may be somewhat different.

## Outcome measures

Our primary outcomes are the probability of a paper or review being submitted on a weekend versus all other times. Each day begins at midnight, hence a submission at 11pm on a Friday night is not on the weekend, nor is a submission at 1am on Monday.

In secondary analyses we will also examine the probability of papers/reviews being submitted on:

* Public holidays versus all other times (only for countries where we have data on public holidays)
* Weekday evenings and late nights, defined as between 6:00 pm and 7:00 am the following day, versus all other times

## Descriptive statistics

We will use a frequency table of the top ten most active countries for submissions and reviews. We will tabulate the weekend, public holiday and late night submissions rates of the top ten most active countries. The tables will be by individual countries and a combined table compared with all other countries. All these tables will use the data from both journals combined.

We will report the probability of weekend submissions/reviews together with 95% confidence or credible intervals.

## Plots

We will plot histograms and/or circular plots of the submissions and review times by hour of day for the top ten most active countries split by weekday and weekend.

We will plot the number of submissions and reviews over calendar time to examine how overall numbers have changed.

We will plot the annual number of submissions/reviews by day of the week over time (as per Figure 1). We will plot the proportion of weekend submissions/reviews over time with a loess smooth to summarise the non-linear trend (as per Figure 2). Both plots aim to show the trends in submissions/reviews by weekday over time. We will similarly plot the annual number of submissions/reviews on public holidays and late nights over time. We will combine all countries for these plots, but may also create separate versions for some countries.

We will compare the times of submissions for papers and reviews to examine how similar these distributions are. We will use a circular plot of the 24 hour clock with midnight at the top of the circle and midday at the bottom. These plots will be stratified by country.

## Models and tests

We will test for an increase in the probability of weekend submissions and reviews over time using a logistic regression model. The data will be arranged in weeks and the dependent variable will be the number of weekend submissions that week, with a denominator of the total number of papers that week. These numbers will be per country. Each weekend (Saturday/Sunday) will be compared with the previous Monday to Friday. Using this approach means we will examine a relative change in the probability of submission or review, and not a change in the absolute number of submissions or reviews on the weekend. An increase in the absolute numbers on the weekend could simply happen because of a rise over time in submissions or reviews.

The logistic regression model will include a random intercept for each country to model between country differences in the probability of submitting/reviewing on the weekend. We will plot these random intercepts to show which countries have relatively high and low weekend submission/review probabilities. In an alternative model we will allow a random slope per country as well as a random intercept. This will allow the key outcome (the change over time in the weekend effect) to vary by country.

The key result will be the estimated change in the probability of a weekend submission or review over time. We will present this as a probability ratio together with a 95% confidence interval, rather than an odds ratio as these are often misinterpreted (Marschner, 2015). We may use the more intuitive Bayesian 95% credible interval.

We will compare the fit of the models using the Akaike or Deviance Information Criterion (AIC or DIC) and present the results for the model with the best fit. We will include a table of the AICs or DICs for all models.

We will use the same modelling approach to test for submissions on: i) public holidays, ii) weekends and late nights.

For all models we will test for influential values and examine the residuals for outliers.

## Comparing the times of research paper submissions and reviews

There is anecdotal evidence that reviews are completed outside work hours because they are viewed as an additional voluntary task, whereas submitting research papers is more often seen as part of core business that would more typically be completed during work hours. To examine this we will calculate the difference in the times of submissions and reviews in the same country during weekdays, we will calculate the mean difference in times and 95% confidence interval for the mean difference. This will use circular means on the 24-hour clock.

## Statistical power

We will use all available research submissions on *The BMJ*’s and *BMJ Open*’s electronic submission systems. Based on this sample size of 48,520 submissions (after exclusions) we have an over 99% power to detect an absolute increase of 0.65% per year in the number of weekend submissions. We also have an over 99% power for the subsample of 11,566 papers submitted from the UK. This used the “pwr.f2.test” function in R (Champley, 2018). The 0.65% increase was from a linear regression model fitted to the *PLOS ONE* data. We used a significance level of 1% and a two-sided test. Hence we have excellent power to detect an increase in weekend submissions assuming a similar increase to the *PLOS ONE* data.

We will have less statistical power for the analysis that examines submissions on public holidays because public holidays are less common than weekends.

## Planned sensitivity and subgroup analyses

We plan to examine if the key outcomes vary by country using the random slope model as described above.

# Study limitations

Some authors may have been outside their country when they submitted their paper or review, meaning they would be out of their time zone. This will introduce measurement error to our key predictors. We have no way of knowing if this occurred. Researchers do move between countries for conferences and visits. Researchers may not update their personal details on journal systems after moving country. Some researchers may not have accurately completed their personal details.

Many researchers have multiple affiliations and their primary country affiliation may be different to the one they are working in. This would also introduce measurement error to our key predictors.

The data covers the years 2012 to 2018/2019, and it is possible that the large increase in weekend work may have occurred prior to this time (see Figure 2). We were limited to 2012 because this was year that BMJ introduced a new submission system.

Submitting the paper or review is the final step in a process, and even when submitting on the weekend the bulk of the work may have been done during the week.

We do not have the age or gender of the researchers or reviewers, and so cannot examine differences by these characteristics. We also do not have the researchers’ names, so we cannot examine a within-researcher change over time in working weekends.

*The BMJ* and *BMJ Open* are large general medical journals, but will not be representative of all researchers or all researchers in health and medicine.

# Ethics

No ethical clearance is required as this is administrative data with no private, sensitive or health data.

# References

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