Bellabeat analysis

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Bellabeat Analysis of the usage data

Bellabeat is a health and wellness technology company that creates smart jewelry and accessories designed to track and improve women's overall well-being. Their products, such as activity trackers and smart jewelry, combine fashion with functionality, allowing users to monitor their activity, sleep, stress levels, and menstrual cycles. Bellabeat's devices are tailored to the unique health needs of women, providing insights and guidance to support a balanced lifestyle. In this analysis I have focused the most on Bellabeat membership implementation and advertisement, which is a subscription-based membership program that grants users round-the-clock access to personalized advice on nutrition, physical activity, sleep, health and beauty, and mindfulness, tailored to their individual lifestyles and objectives.

- **Stakeholders:**
  - Urška Sršen: Bellabeat's cofounder and Chief Creative Officer
  - Sando Mur: Mathematician and Bellabeat's cofounder; key member of the Bellabeat executive team
  - Bellabeat marketing analytics team

Main analysis objective:

1. User-oriented approach Identifying weekly and hourly trends in user data which will be used to improve Bellabeat health and wellness guidance, and encourage data record entry by users.
2. Marketing-oriented approach Identifying weekly and hourly trends in user data which will be used to improve the advertising strategy of the company towards new users.

Quality of the datasets

Data sets are sourced from the Kaggle "FitBit Fitness Tracker Data" collection containing the records of sleep, heart rate and activity levels of 33 users between March 12th 2016 and May 12th 2016. It contains a disclaimer that the variables in output arrive due to the usage of different types of Fitbit trackers, which can be seen in the dataset (for example Sedentary Distance which is more than 0 in the case of 82 records coming from 10 users).
Data sets are updated annually and are under the CC0:Public Domain License.
Data sets have a small sample of users with 33 max number for some data sets, while others have only 14 or only 8 users. This poses a big problem since a minimal significant sample should contain at least 100 users. That is why it should be advised to gather data from more users to create a significant analysis that will produce more confident results. (However, I do not have that possibility in that project thus we will treat that 33-user sample as a "bearable" size.) If we would like to have the best sample size in the case of Fitbit

users population it should count around 385 users minimum.
The data come from the source but were just reposed to Kaggle, where acknowledgment is given to the original direct source.
Regarding comprehensiveness, we do not know what units are being used to measure intensity, distance, or at what time the person went to sleep, or when did they wake up. Furthermore, data is missing millisecond measurement in heart rate which makes calculation of stress through the day impossible. There is a different number of users for different data sets for example we observe 33 users in the "daily Activity" table while in the "weight" table there are only 8 users. Additionally, in the weight table, there are many NA values in the "Fat" column. Besides that we do not know what job our users perform, and most importantly what gender are they. Next, there are no data such as water intake or menstrual cycle entries. This leads to decreasing our analysis to assess the: activity and sleep variables. Since we do not possess the data for the rest.
Data are pretty well cited since they are being sued in the capstone project of a very popular Data Analyst Course. Regarding the date of collection of the data was 2016 the data sets are not current.
Data sets are divided into three main categories by time:

- daily data: steps, calories, activity, intensity
- hour data: steps, calories, intensity
- minute: calories, steps, METs, sleep, intensity
- second: heart rate
- weight which has different hours, minutes, and seconds.
  Minute data sets are provided in the narrow and wide tables.

Data sets used

Daily data sets regarding activity, calories, and steps will be used to assess the number of entries during the week and try to identify the weekly trends in activity patterns, caloric intake as well and steps taken. Additionally number of days logging will be measured against the mentioned variables to see whether the number of log entries does impact them.
Hourly steps, caloric and intensity data will be used to assess the hourly pattern of mentioned variables for each weekday to asses the hourly patterns of our users. METs and heart rate will be used to assess the hourly changes in given variables throughout the week to improve Bellabeat membership guidance.
Sleep records will be analyzed throughout the week to see what part of the sleeping pattern of our users might use an improvement.
Based on the mentioned analysis I will try to suggest the best time to advertise particular features of the Bellabeat membership guidance to new potential users.

The first part of the R data analysis

To perform data analysis in R I needed to install packages such as Tidyverse, skimr, and janitor. Additionally, I installed ggplot2 so as not to forget it.

Uploading and dividing the data

More general analyses were carried out in Google Sheets, after data cleaning and filtering in SQL (Bigquery - SQL codes can be found here). However, due to the limited amount of data that can be imported to the spreadsheets while simultaneously keeping up good program performance, for data with more records, I have decided to use R.

While some data might be filtered here, I have noticed that as.POSIXct/POSIXlt function does not combine well with AM/PM time formatting and returns a lot of NA values, thus I have decided to import csv file which contained data already filtered in the BigQuery database.

METs, heart rate, sleep, and hourly data were grouped by the weekdays and hours of the day.
Data such as METs, heart rate(HR), sleep, and hourly data (hour_steps,hour_calories,hour_intensity) might benefit from more specialized insight with the R visualization and manipulation. In the case of METs and HR main argument for R analysis was the size of the data, while in the case of hourly data (hour_steps,hour_calories,hour_intensity) it was possibility of making a facets charts which will allow to visualize hour distribution through the day through all week contributing to more thorough analysis.

General analysis of the recorded data

First I inspected data sets that were provided to me and counted the number of distinct records found in each of them by SQL query in BigQuery. Datasets with the highest count of users which equals 33 are:

- All daily data sets: dailyActivity_merged, dailyCalories_merged, dailyIntensity_merged, dailyStep_merged

- All hourly data sets: hourlyCalories_merged, hourlySteps_merged, hourlyIntensity_merged
- METs data set: minuteMETsNarrow_merged.
  The sleep data set contains only 24 users, heart rate 14 users and the weight dataset contains records coming only from 8 users.
  Considering intensity, METs, and steps as "Activity" tracking variables, I have assigned them to the "Activity" group. Then I grouped all calories and weight records into the "Wellness" category and grouped the Sleep data set into the "Sleep" tacking category and "Heart rate" as a possible "Stress" tracking feature.
  The table below shows that in sleep and stress categories do have the smallest amount of users recording the heart rate and sleep variables, but also these categories do have only one data set of records.
  Weight while being the one out of three "Wellness" category data sets contains the least users recording its measurements regarding weight fluctuations.

Daily activity analysis

Daily activity in minutes

Most amount of entries are submitted on Tuesday(139), Wednesday(136), and Thursday(134), so basically in the middle of the work week. While other days suffer from a visible decrease in a number of entries, with Monday counting only 108 entries, equaling to more than 20% decrease.

20 out of 33 users have submitted their entries through 30 days which is 60.6% of all user's adherence.

By analyzing the median percentage time spent through each day of the week, we can see that the most "active" day is Saturday. Interestingly Sunday on the other hand is the least active day out of all.
The type of activity intensity in which users tend to spend the most time besides sedentary activity (min. 79.97% on Saturday and max. 82.87% on Sunday) is light activity, which is undertaken the most during Saturday(16.84%) and Friday(15.96%). The least amount of light activity was registered yet again on Sunday(14.40%), and Monday(14.85%).
Fairly active median time is the most stable throughout the week ranging from 1.04% on Thursday to 1.35% on Saturday.
The median percentage of time being spent very active is the highest on Tuesday reaching 2.01% while the

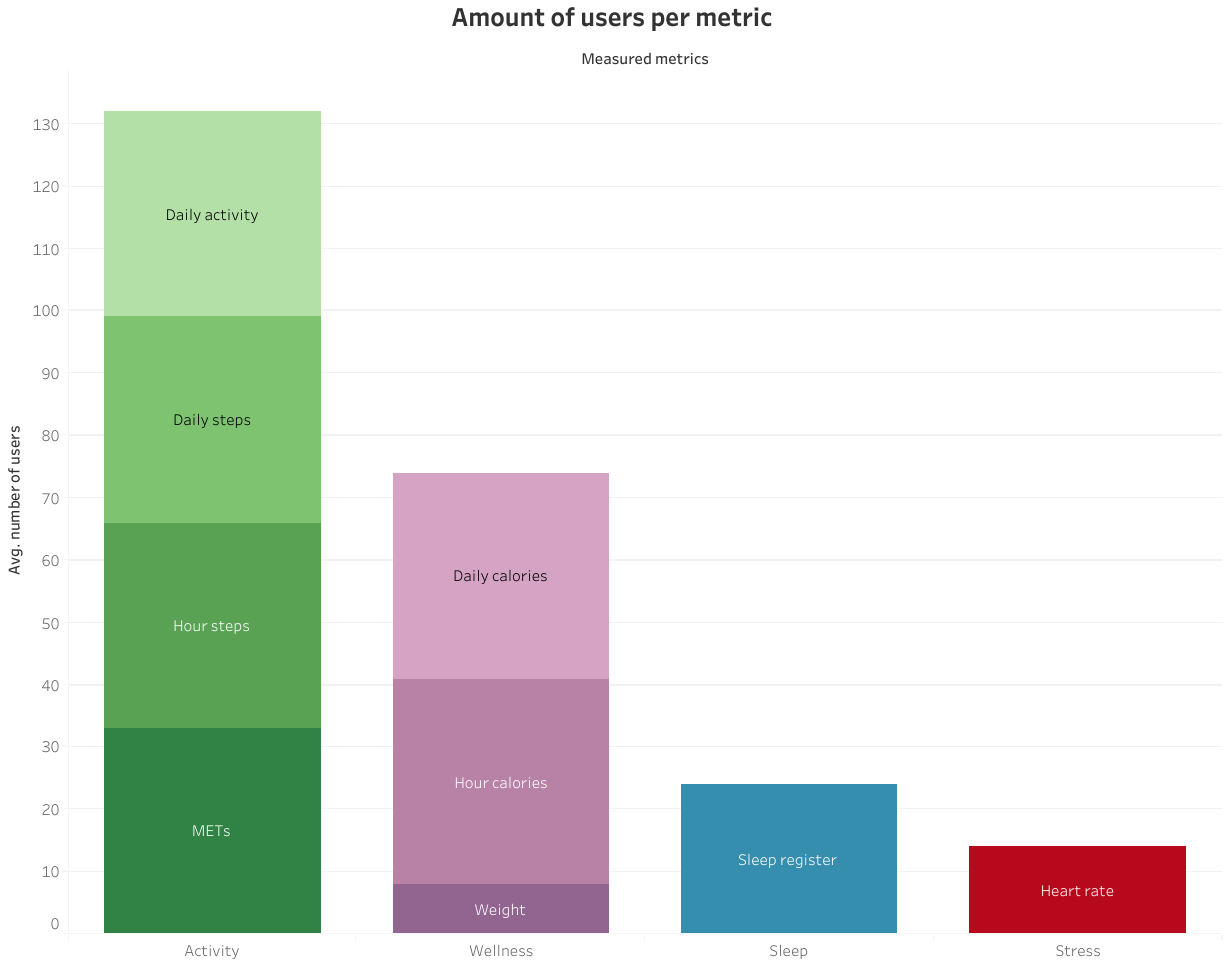


Figure 1: Fig.1 General analysis of the user count for each picked data set accordding to their category.

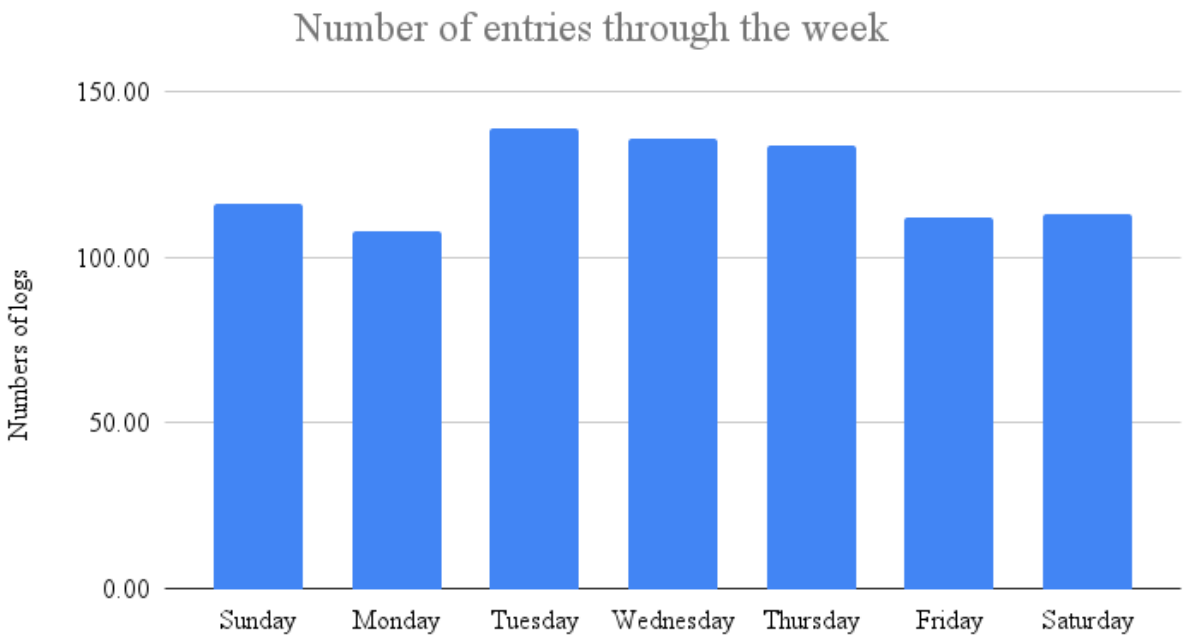


Figure 2: Fig.2 Number of entries on daily activity minutes submitted through the week.

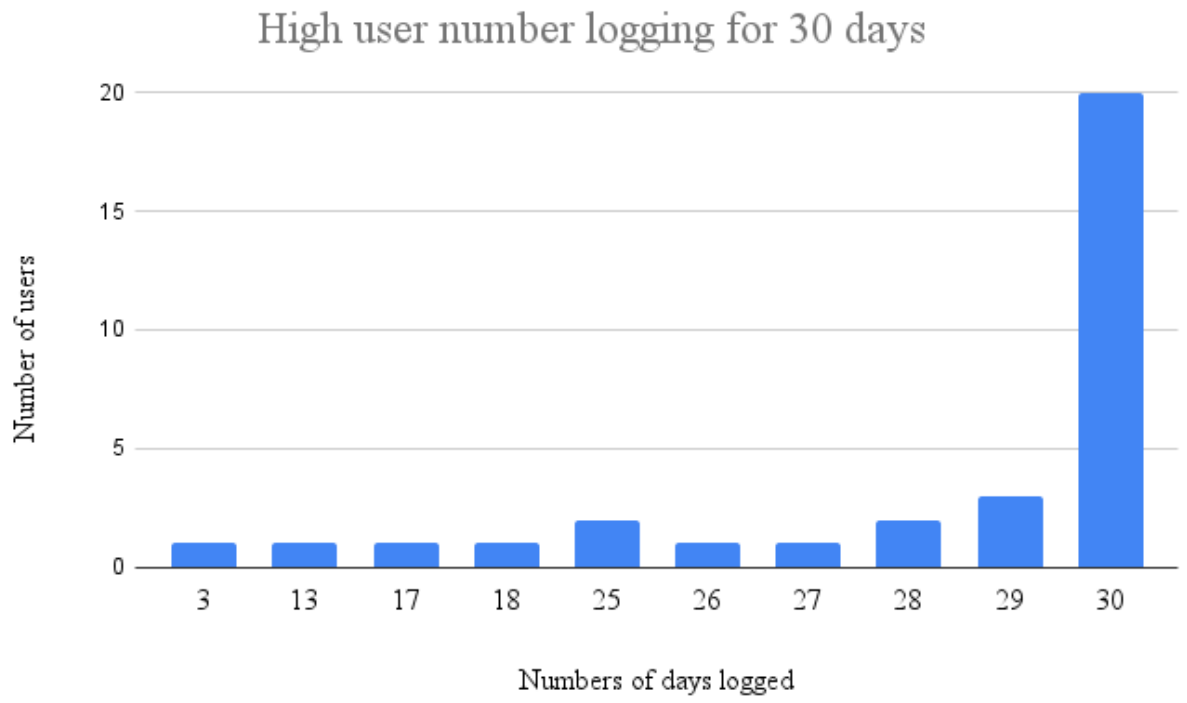


Figure 3: Fig.3 Users number logginf for particular amount of days.

lowest value was reported on Sunday.
Interestingly while comparing the fairly active minutes percentage with the very active time percentage we noticed that users tend to spend more time being very active (1.58% - 2.01%) than fairly active (1.04% - 1.35%).

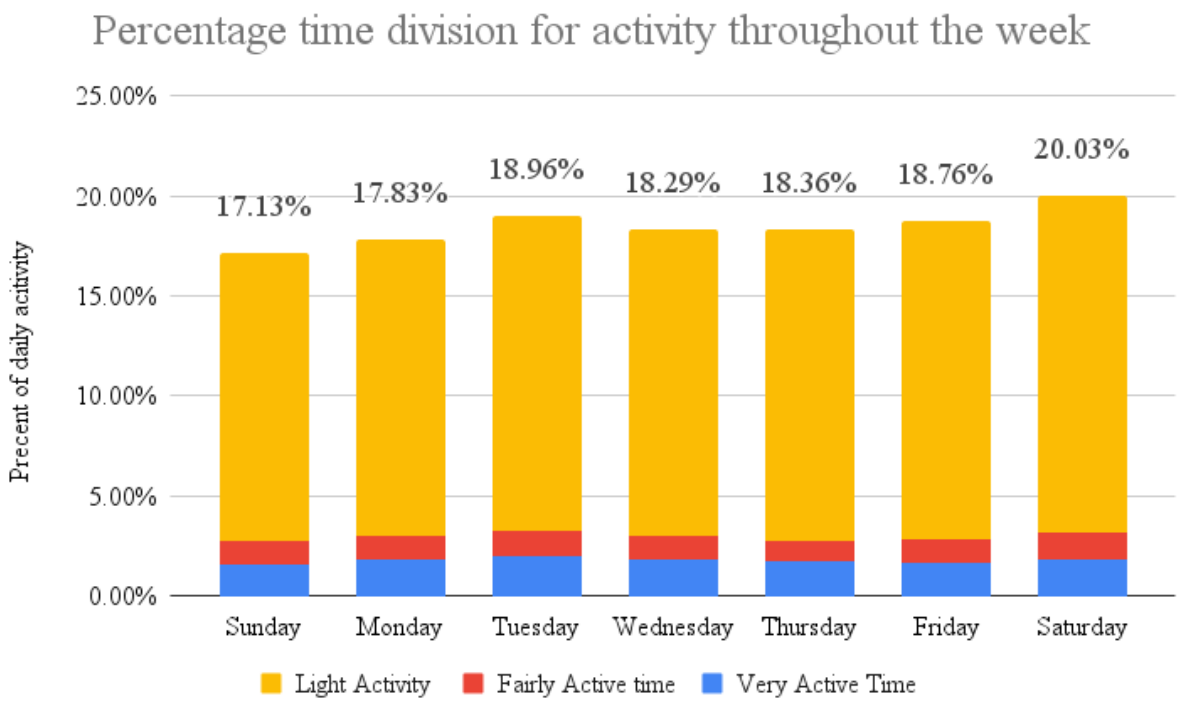


Figure 4: Fig.4 Precentage of time in minutes dedicated by user for activity with given intensity.

Summary of the daily activity time

- Most entries are being submitted in the middle of the work week, Tuesday-Thursday, while on Monday we can observe a more than 20% decrease in the number of entries.
- 60.6% adherence rate of users logging their activity for 30 days.
- The most active day is Saturday, and Tuesday during the work days.
- The least active day of the week is Sunday and Monday during the work days.
- Most of the percentage time users spend sedentary (79.97%-82.87%), light activity (14.40%-16.84%), thirdly the very active time (1.58% - 2.01%) and lastly fairly active (1.04% - 1.35%).

1. Suggestion regarding users: Regarding that Sunday and Monday are the least active, while simultaneously having the least entries, I would advise starting walking or sports events on these days, to improve entry numbers as well as activity levels through these days. Bellabeat membership guidance should promote walking with family, or bike rides on Sunday as a weekend day that should be spent with family. On Monday should propagate walking or riding by bike to work, choosing stairs, or standing up every 45 min from the user desk to briefly stretch or have a few steps. Additionally, we should encourage users to log in more frequently by adding perks and awards through continuous log entries to keep users motivated.

2. Marketing suggestion: Since Monday and Sunday are the least active days the advertisement should focus on promoting a fun way of staying active and how Bellabeat membership can help with that,while allowing for enjoying great health.

Daily activity distance

Disclaimer Records where Sedentary Distance was different than zero were treated as measurement mistake and were excluded from the further analysis.
Regarding bumper of entries is analogical to the activity minutes through the week with Monday being the day with the least entries (108), and Tuesday with the highest count (139). Equaling to 22% difference between the highest and smallest value.

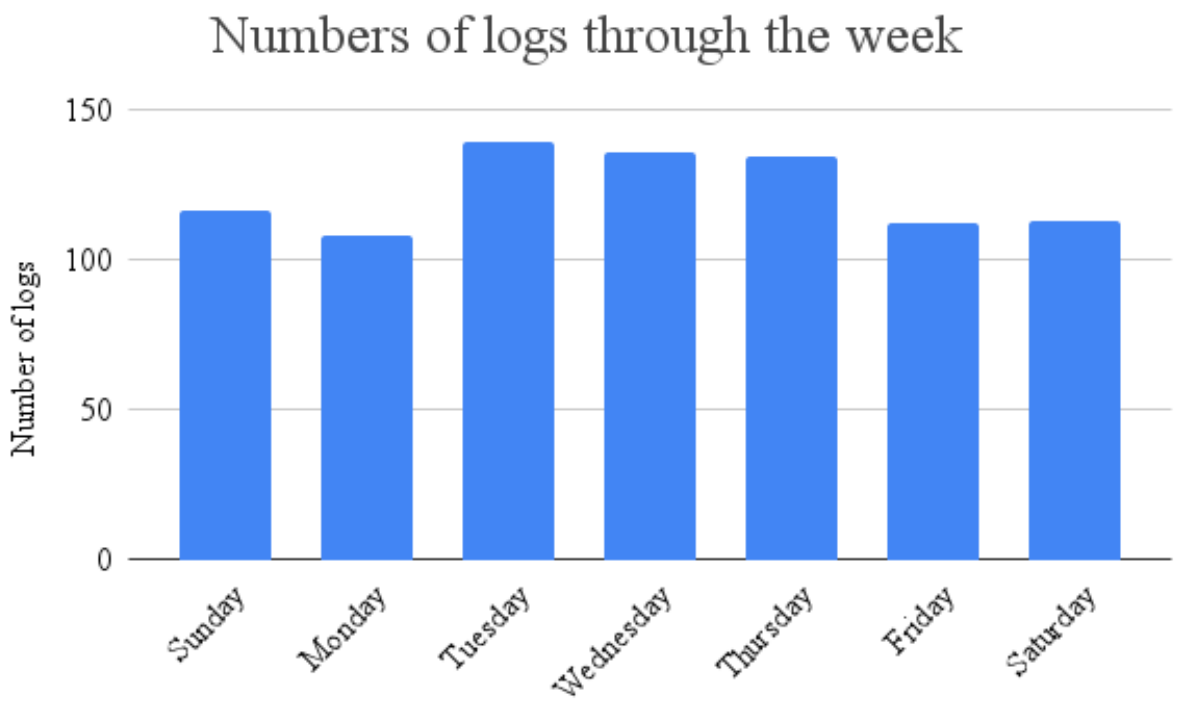


Figure 5: Fig.5 Number of entries on daily activity distance submitted through the week.

Users go through the longest distance on Tuesday on average 5.94, another day with the highest distance is Wednesday with 5.60. On the contrary on Sunday, users travel the least distance on average 4.81, and the second lowest distance value belongs to Friday with 5.26.
Additionally, it is worth noticing that there is a consistent inaccuracy between total distance, tracker distance, and summed distance for all activity intensity types, which in theory should be equal.

The plot below visualizes the tracker difference value throughout the week, which shows that Tuesday, Wednesday, and Thursday have the highest difference between registered total distance and tracker distance. This mistake might have occurred due to different Fitbit devices, but shows an unsettling pattern where with an increased amount of entries the mistake is only getting bigger.

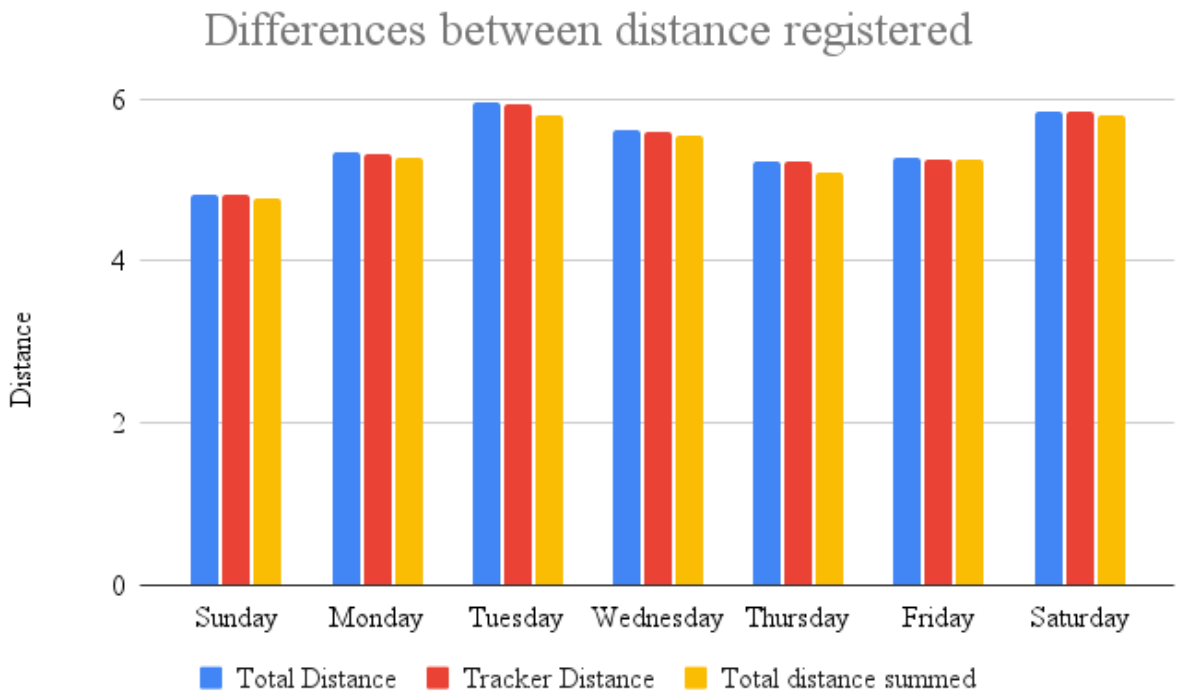


Figure 6: Fig.6 Difference bewteen distance registered by different values.

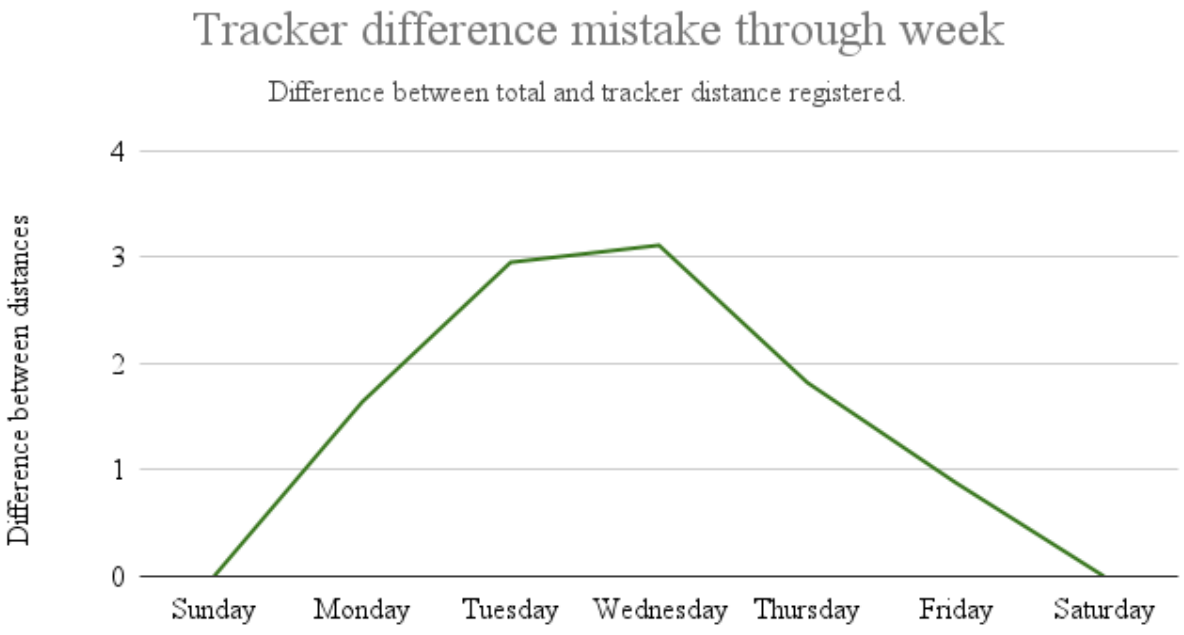


Figure 7: Fig.7 Mistake between tracker difference and total distance measured by the devices of the users.

Daily steps

The most steps (on average) are taken on Tuesday(8125) and Saturday(8152). While the least steps number can be observe on Thursday(7405) and Sunday (6933).

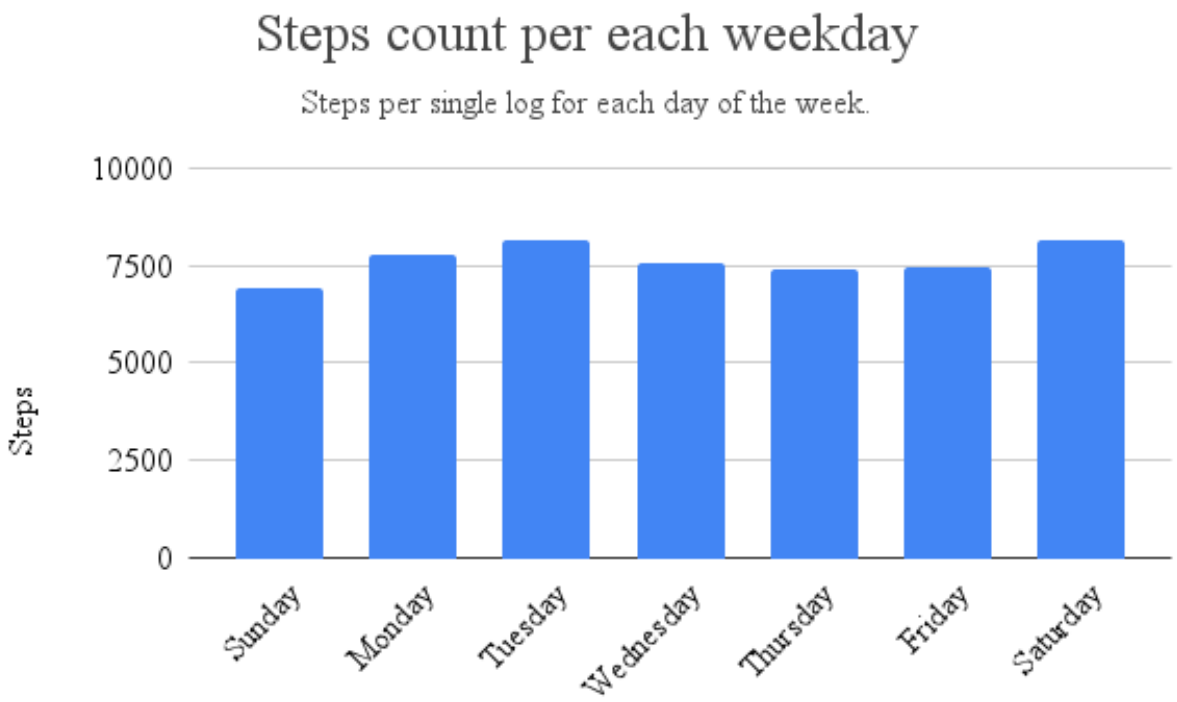
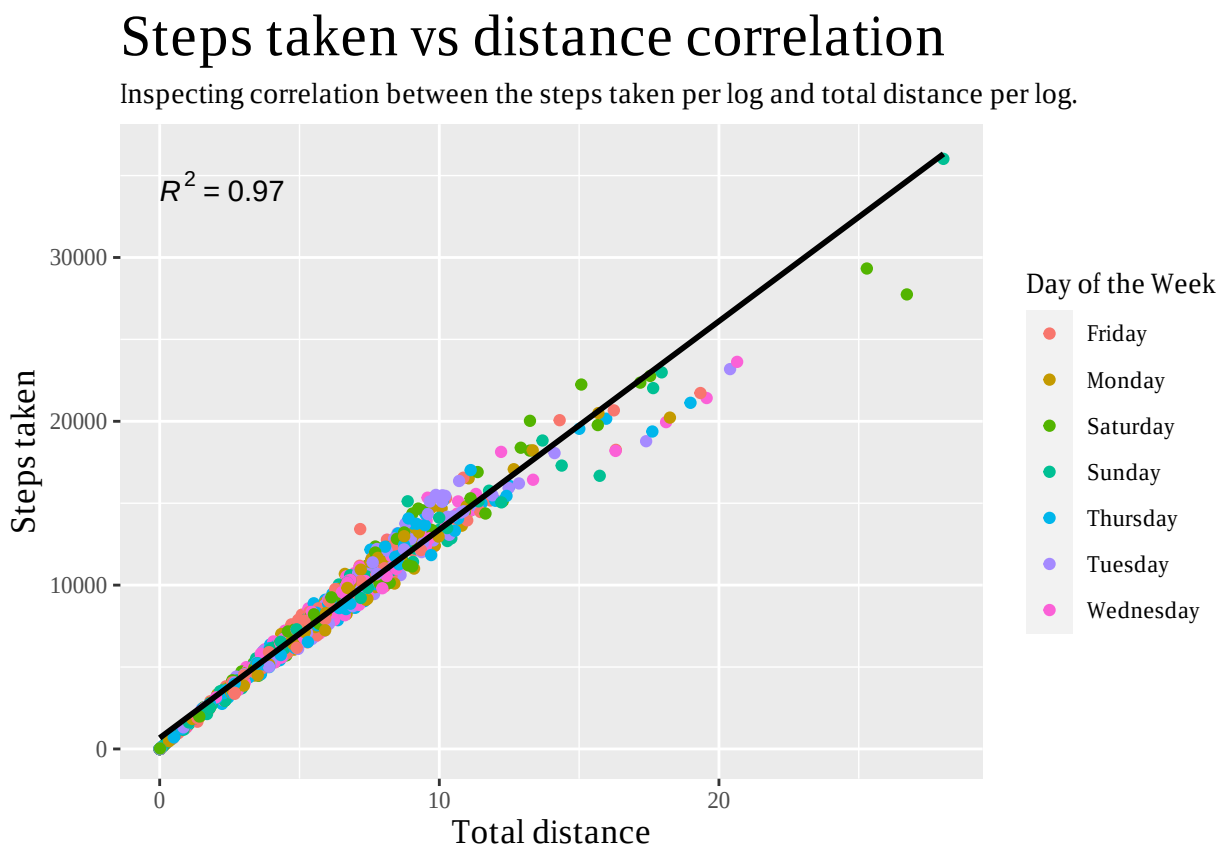


Figure 8: Fig.8 Average steps count for each day of the week.

The plot below shows 97% correlation between steps taken and distance traveled by the users, which is a high value. This means that these traits are correlated and depend on each other as they should.



Summary of daily activity distance and steps

- Most entries are submitted on Tuesday, Wednesday and Thursday. The last entries were submitted on Monday leading to a 22% decrease on that day.
- Users tend to travel the longest distance on Tuesday and Saturday. Shortest distance users tend to travel on Sunday and Friday, which is reflected in the number of steps.
- There is 97% correlation between distance traveled and steps taken.
- There is an inconsistency between the total distance tracked, tracker distance, and cumulative sum of distances of different intensities.
- The difference in value recorded by total distance and tracker distance grows with the increase of several entries.
- The most steps are taken on Saturday and Tuesday. Least steps are taken on Sunday.

1. User suggestion: Encouraging users for weekend family activity outdoors or indoors (based on the weather forecast), to increase their step count. On Monday and Friday, the Bellabeat membership guidance app should focus on promoting "steps" busting tactics at work or during the commute. For example: standing up every 45 min and going for water, walking to work, or parking your car further from the entrance. Additionally, consistent recording by the user should be awarded in the form of a discount on another month or by gadgets or content that will be unlocked by certain entries through a certain period.

2. Marketing suggestion: The Highest number of entries during the middle of the week shows that people are most dedicated to recording and measuring their activity these days. During these days advertisements

should focus on tracking the ability of our devices, while on days with fewer entries and activity Bellabeat advertisements should focus more on propagating movement in fun and creative ways. For example when the advertisement is on the radio encourages listeners to listen to the music even when they are waiting for the bus, when the advertisement is on social media encourages people to go for a 5-minute walk around the block, or even a living room. It would be suggested to back up the movement's cognitive benefits with a research paper.
Like this

Technical issues: The inconsistency in tracker distance, total distance, and summed distance of all activity intensity should be examined by the software team since it might lead to skewed measurement and inaccuracy, which might drive away potential customers.

Daily calories

The number of calorie intake through the week has a similar pattern to those seen in daily activity entries, meaning more entries during the middle of the week From Tuesday to Thursday, and a decrease during other days. While the highest number of entries is 152 on Tuesday the lowest number appears on Monday and equals 120, which can be calculated as a 21% decrease in entry number.

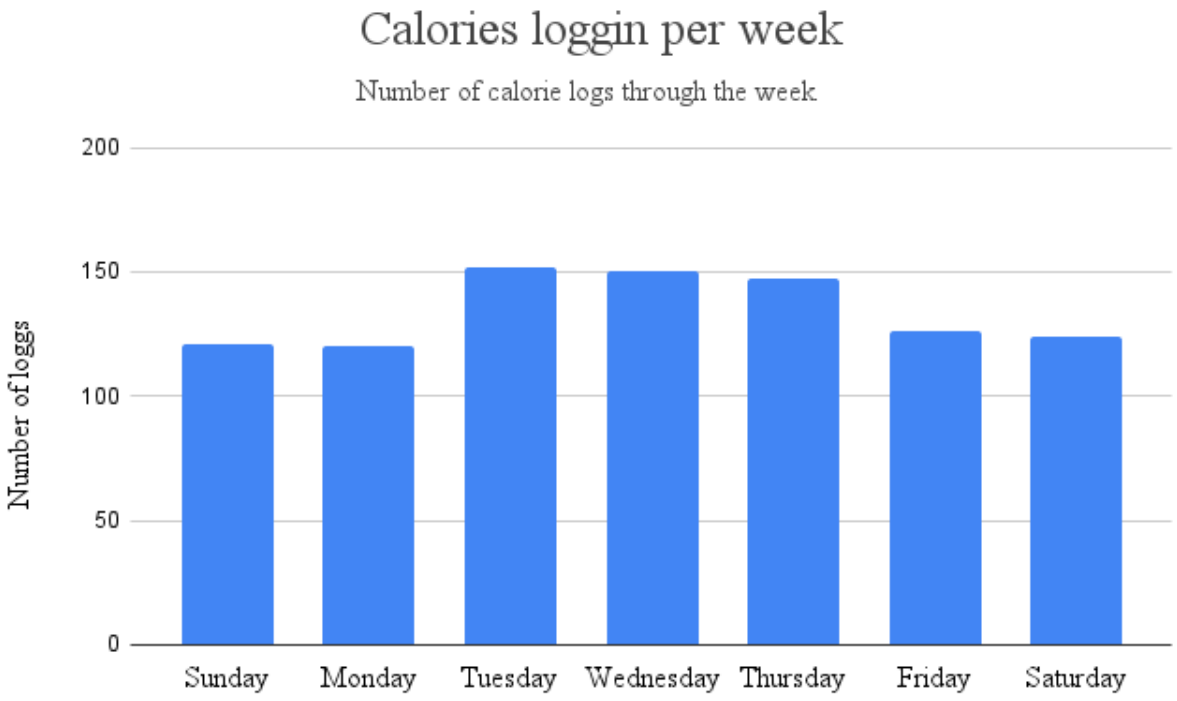


Figure 9: Fig.9 Number of calories entries through the week.

The highest caloric intake of our users can be observed on Tuesday(2229 kcal/day) and Friday (2203 kcal/day), while the least caloric intake can be observed on Thursday (2065 kcal/day) and Sunday (2063 kcal/day).

Additionally, I have analyzed the standard deviation for each day, which shows that the biggest variety of consumed calories can be observed on Saturday and Thursday. The more red the bar is the bigger the standard deviation.

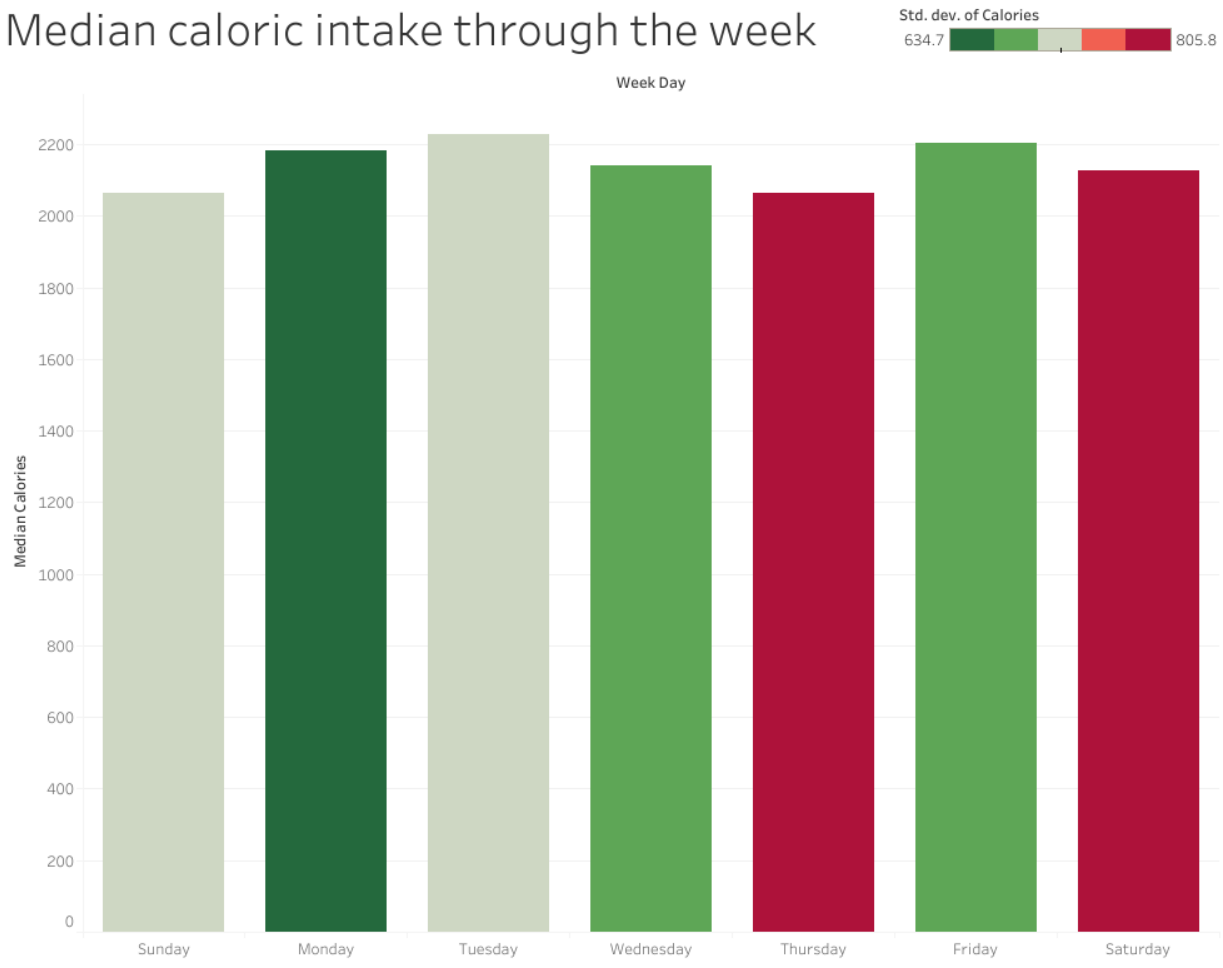


Figure 10: Fig.10 Median caloric intake of the users with standard deviation through the week.

Inspecting correlation between caloric intake and distance traveled by the users. There is a weak correlation about 41%.

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## `geom_smooth()` using formula = 'y ~ x'
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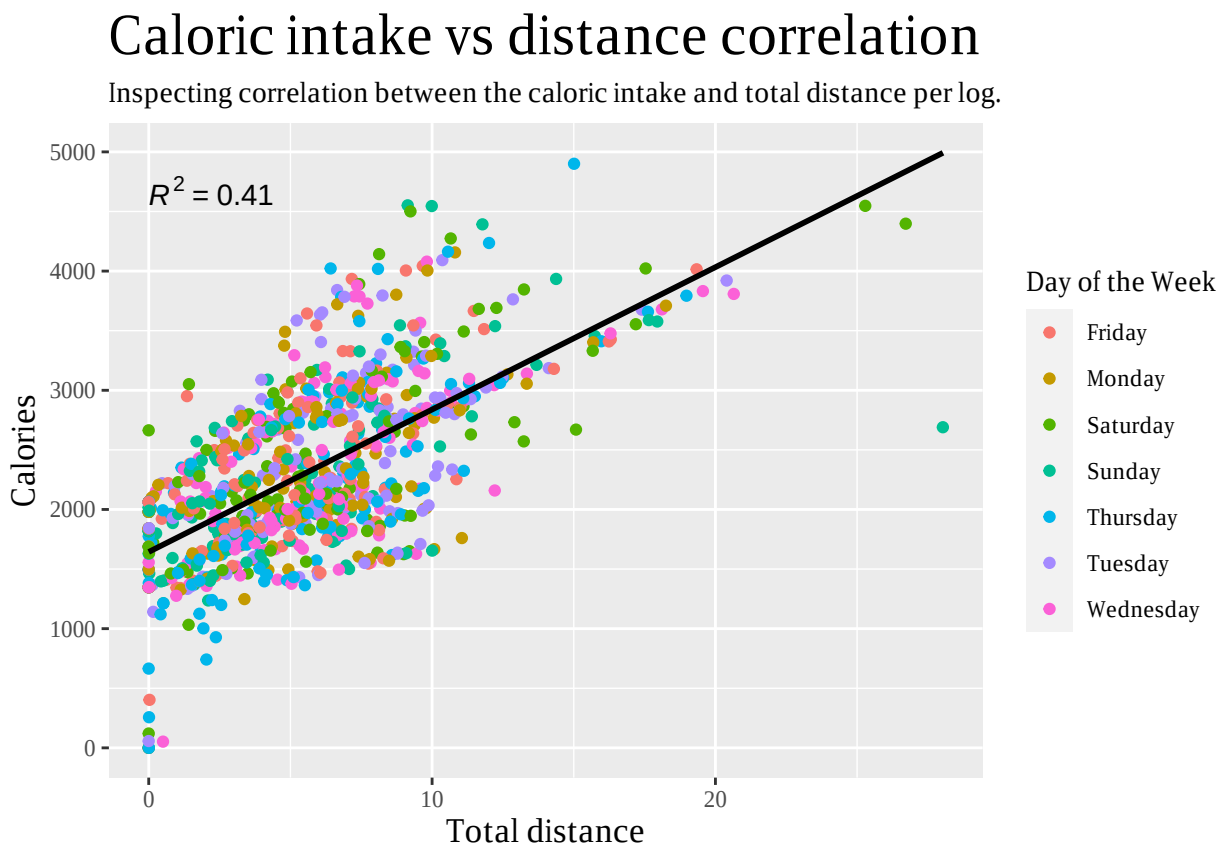


There is also very weak correlation between steps taken and caloric intake, around 35%.

```
## `geom_smooth()` using formula = 'y ~ x'
```

Summary of daily calories

- Caloric intake is more or less stable through the week, with the highest value being 2229 kcal/day on Tuesday, while the lowest is 2063 kcal/day on Sunday.
- The biggest standard deviation value was registered for Saturday and Thursday, while the lowest was on Monday.
- The lowest number of entries was also submitted yet again on Monday, with a 21% decrease in number in comparison to the day with the most entries which is Tuesday.
- There is no significant correlation between steps or distance and caloric intake.

1. User suggestion: Yet again the idea of encouraging users to continuously record their measurements should be implemented in a way that will be attractive to the user.

METs

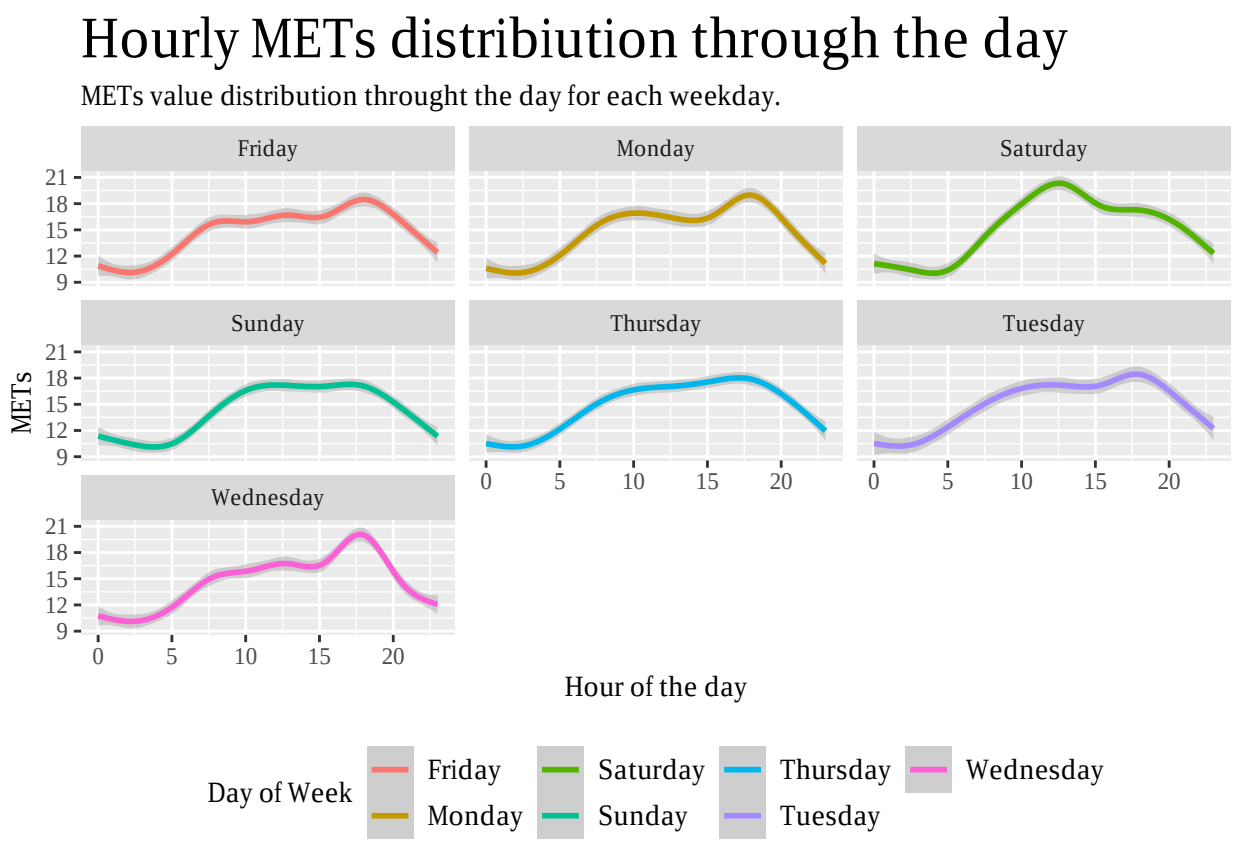
Let's start with explaining what METs are, METs are short for metabolic equivalent of task, which is a measurement of energy use for a particular task- so basically intensity of a given task. For example, sitting is 1 MET. However, since our plot consists of average MET value per single log per person our scale starts at around 10 and tops at 22.

The lowest average METs are registered between 22:00 and 5:00 which is caused by most users sleeping being a low-intensity activity. MET value starts to rise around 5:00 and rises steadily until 7:00 during workdays while in the case of the weekend days the rise continues until around 10:00 (Sunday) and 13:00(Saturday). This points to less busy mornings on weekends.

Between hours 7:00-15:00 during workdays MET values are more or less the same, however, they stay at a pretty high value around 17 which would point to users having pretty active work (maybe walking or standing).
Around 16 we can spot a slight yet sudden increase in METs value, which peaks around 17:30 with value 20. Considering rush hours this hour corresponds with the end of work and heading home by users. Especially since this value only decreases steadily until the end of the day.

Regarding work days Tuesday and Thursday seem to have more subtle differences in MET values in comparison to the rest. While Monday, Wednesday, and Friday are more variable.

Sunday is the day when the METs value is the most stable after peaking at value 18 at 10:00. This value proceeds until 17:00 while a decrease in METs value can be observed. Saturday seems to be a more active weekend day since the highest value is 21 at noon.



Heart Rate

Disclaimer The heart rate data can't be used for the assessment of stress since we do not possess the proper data. Stress is being measured by so-called heart rate variability (HRV) or in newer devices by electrodermal activity (EDA). Source In case of EDA we do not have a data on changes in the electrical activity of the skin of the user. Regarding HRV which is measured by the variation between single heartbeats, which is measured in milliseconds. HRV measurement Upon the inspection of the heart rate data, we can see that the smallest time unit being recorded is second, which means that these data cannot be used for the stress assessment and analysis of that factor. More on HRV measurement

Chart visualize the distribution of registered heart rate in beats per minute(BPM) for each hour of the day, for each day of the week.

Based on the plot we can see that the heart rate of users falls to its lowest point around 2:30 every day reaching 70 BPM. Then in the case of Monday, Wednesday and Friday heart rate rises until around 7:00 to 90 BPM, and from that point on it will slowly rise until 18:00. The most stepped rise can be observed during Monday when the heart rate peaks around 99 BPM.

Plots regarding Sunday and Saturday show analogical values regarding the lowest heart range value, and rise until 7:00. However from that point, it seems to fluctuate between peaks and valleys. Leading to three heart rate peaks throughout the day first one being the one already mentioned at 7:00 with 90 BPM, the second at 12:30 with 95 BPM, and the last one around 18:00 with the value of around 90 BPM.

Interestingly heart rate value curve is pretty smooth in the case of Thursday. Slow steady rise from 70 BPM to 95 BPM around 15:00. In comparison the 90 BPM value which is reached regularly by 7:00, on Tuesday isn't reached until 10:00, while on Thursday it is 9:30, which can be considered late at the comparison to rest of the week.

Every day heart rate decreases around 22:00 which is the average time when most people start to wind down after a whole day and start preparing to sleep. According to the SleepCycle report "average" American goes to sleep at 23:39 and wakes up at 7:09 which leads to a peak in heart rate. Source

```
## `geom_smooth()` using formula = 'y ~ s(x, bs = "cs")'
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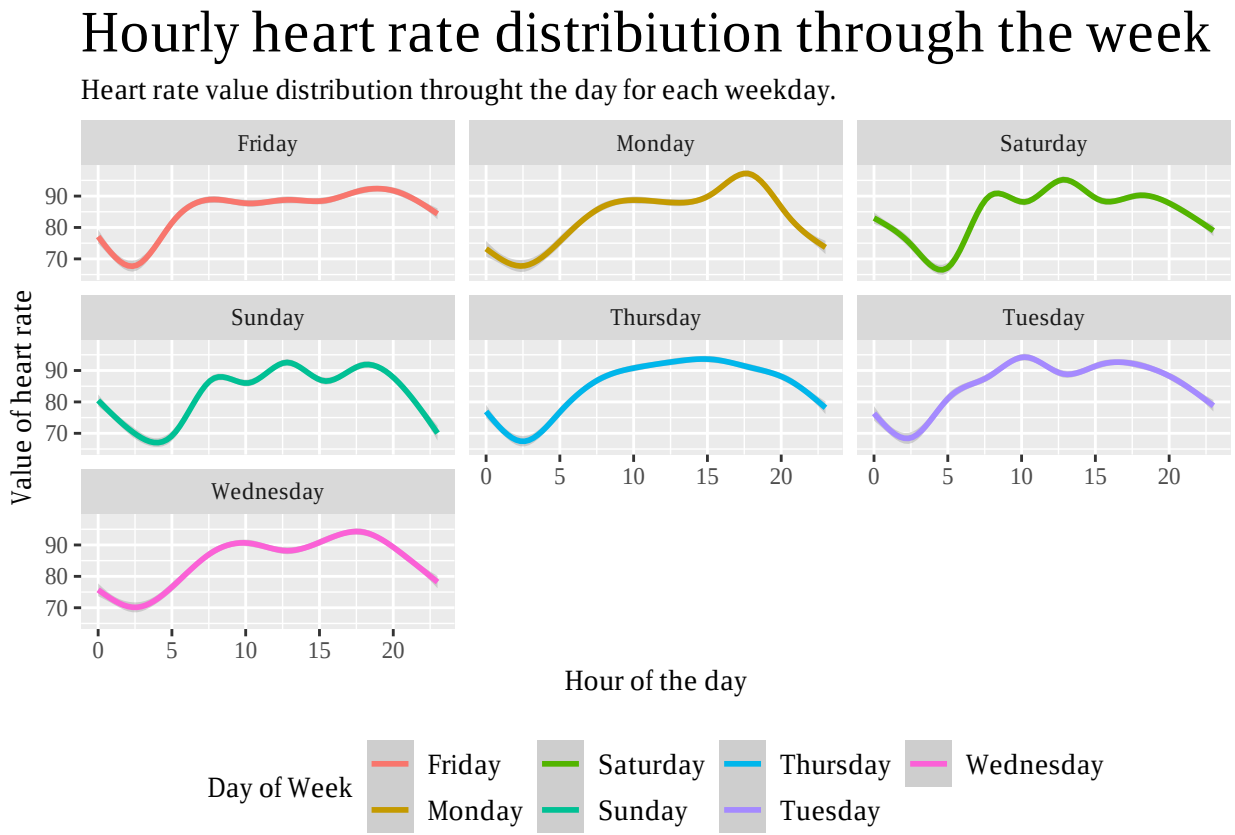

HR vs METs

Plot visualize the average heart rate value for a single log against a single record METs value each logged by the average person. The R square value does not exceed even 0.1 which points to a very weak (almost

non-existent) correlation between these two variables. Even though on previous plots it seems like some correlation might appear especially for days such as Monday or Thursday. Indeed these days show a bit stronger correlation than the rest of the days, nonetheless, the value is still not high enough to decide that the correlation between HR and METs exists.

Here one of the deciding factors might be the case that METs hold records of 33 users, while in the heart rate table, only 14 of them can be found leading to shrinkage of the measured sample to 14 records which does not reach the minimum value for the reliable correlation analysis. Source

The best way to obtain meaningful analysis would be to obtain at least 16 users to record their heart rate values over 30 days.

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## `geom_smooth()` using formula = 'y ~ x'
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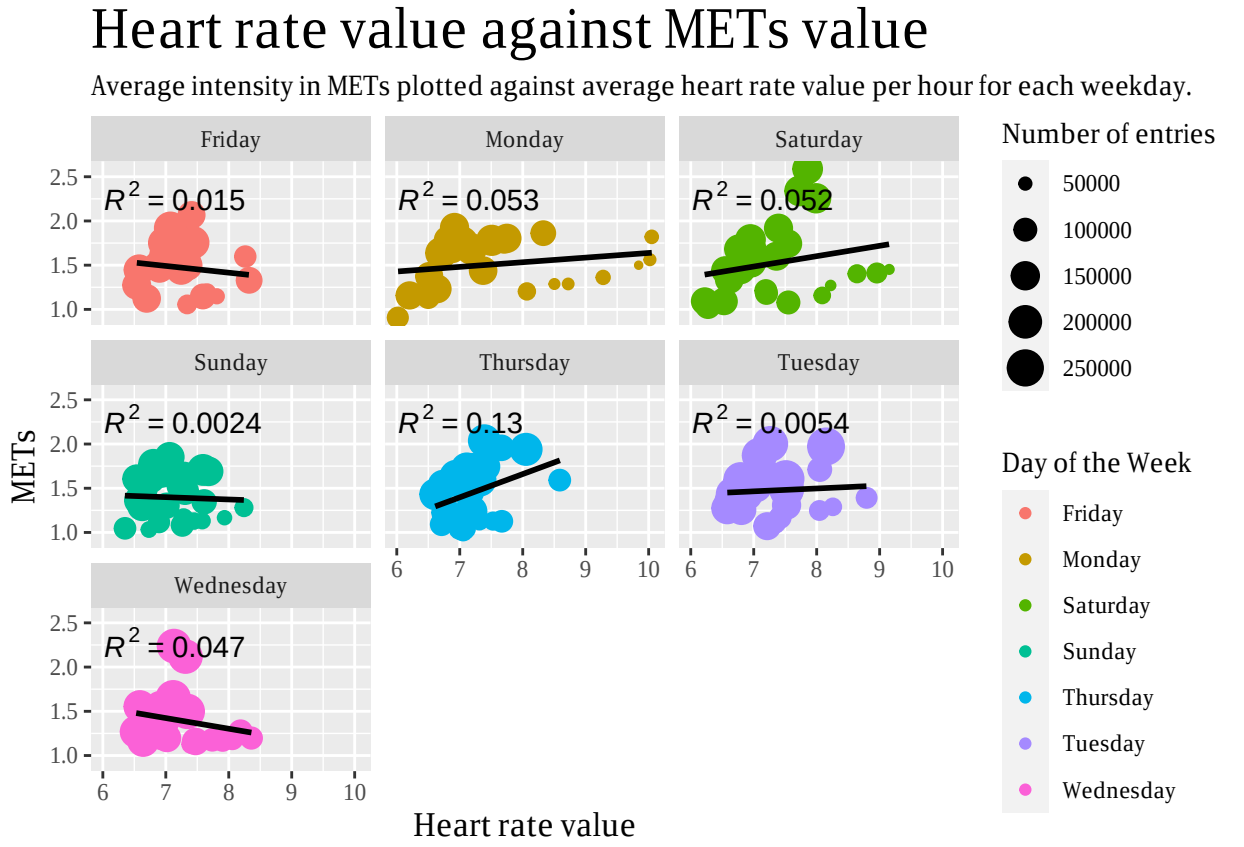

Hourly value of intensity, calories burned per hour and steps taken

Close inspection of each pattern for the hour distribution of steps, intensity, and calories revealed that their curves are similar, leading to the conclusion that they might correlate with each other.
Furthermore, the plots from heart rate values seem to correspond with those with intensity.
The steps peak during weekdays can be observed first at 7:00 to 8:00 and then at around 18:00 which overlap with regular rush hours leading to an increase in steps taken by the users.

Intensity hourly distribution through the week

Plot visualize the average intensity for every hour through the day, for each of the weekdays.

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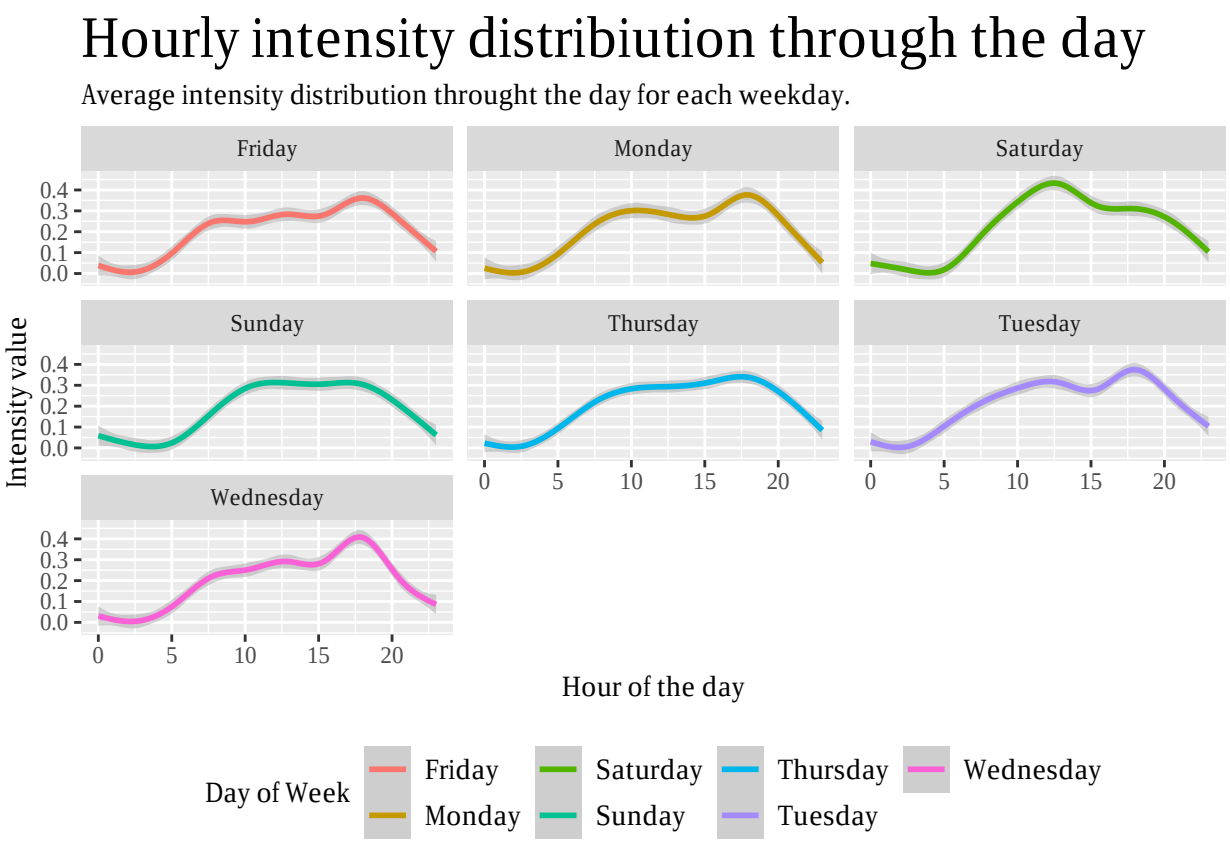

Steps taken hourly distribution through the week

Plots visualize total steps count for each hour of the particular day from the week.

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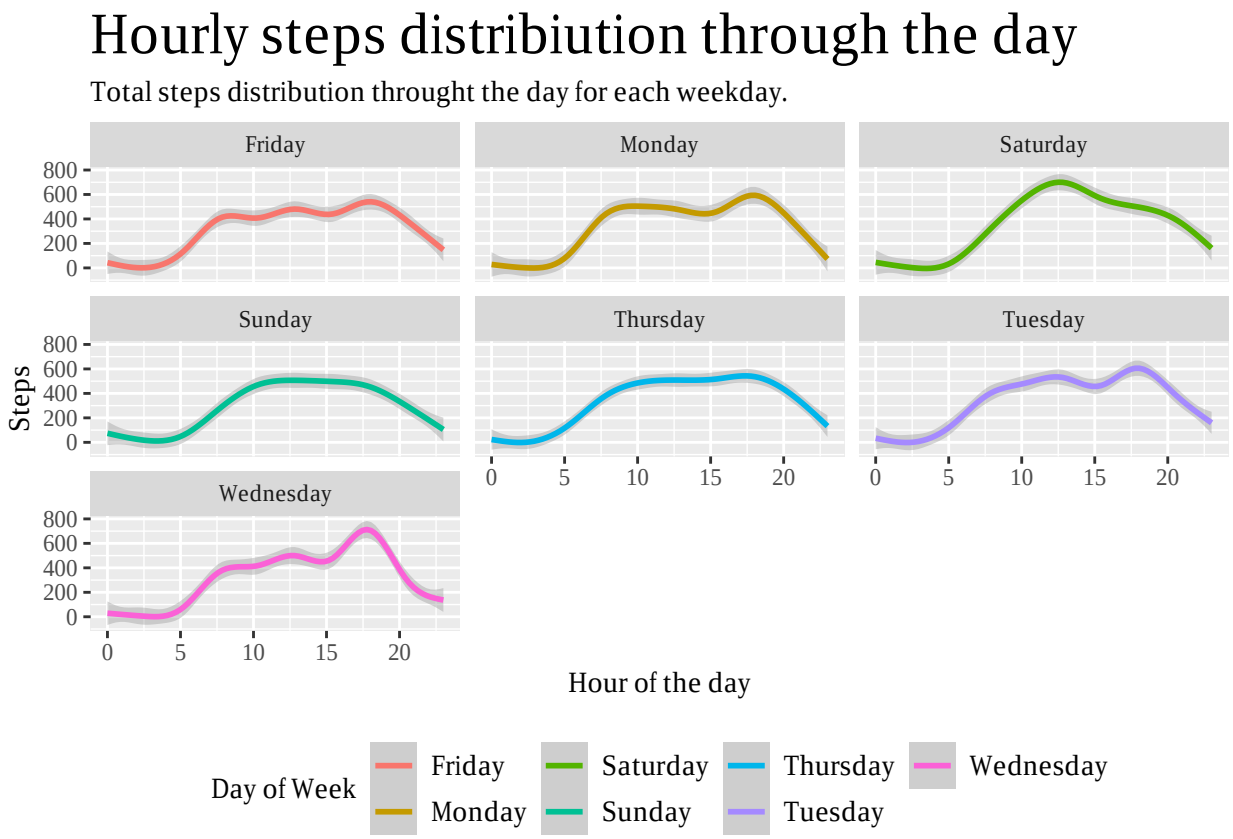

Calories through the day for each day of the week

Plot visualize average calorie burn per each hour of the day, for each day of the weekday.

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## `geom_smooth()` using formula = 'y ~ s(x, bs = "cs")'
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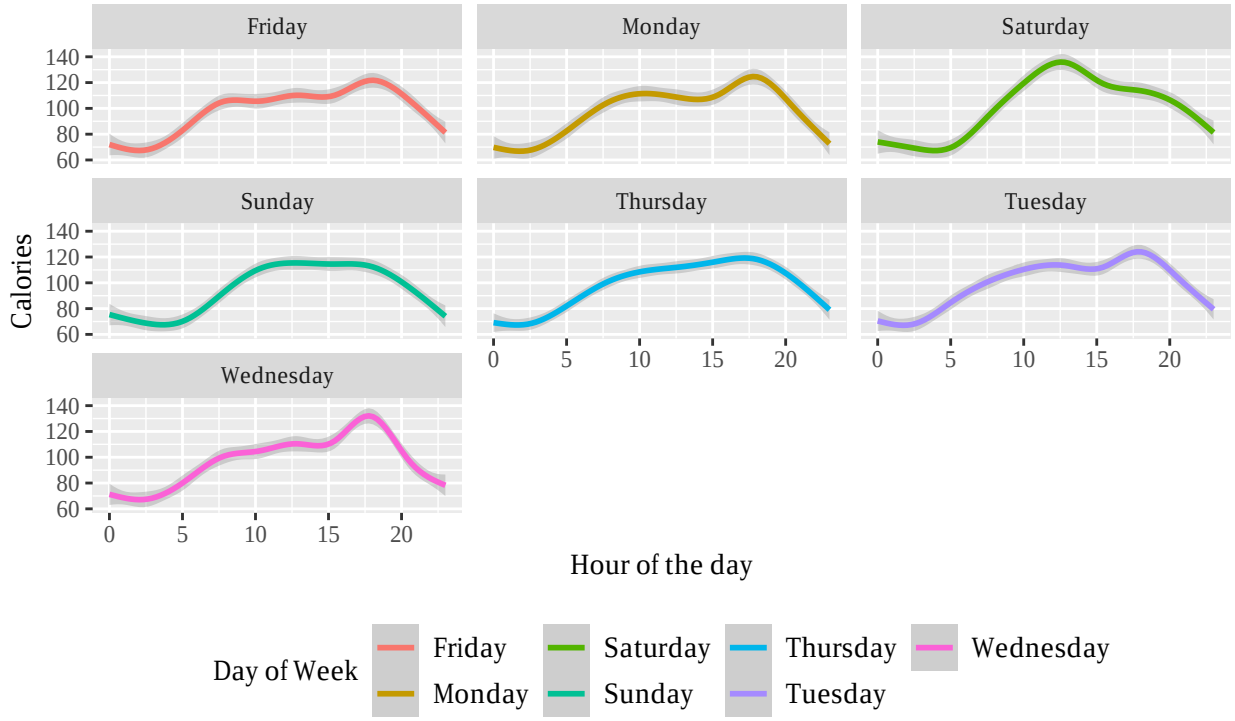

Correlation between hourly values

Since all three hourly distribution plots seem to correlate with one another I decided to check it by merging these tables, and further using that data to create scatter plots to visualize the hypothetical dependency.
First I have merged the data (in BigQuery, SQL queries can be found in my repository on GitHub) and found the average measure (total intensity, calories burned, or steps taken) for a single entry by a single person, for each hour of the day during the whole week.
Additionally, I have installed the package ggpubr which contains the 'stat_regline_equation' function which calculated the formula and R2 (coefficient of determination) which will help me to identify the linear relationship between two variables. The R2 = 1 means a 100% correlation between variables A and B.

Intensity vs Calories

By investigating our plots we can see that the lowest R square value is 0.99 which means that we observe a 99% correlation between Intensity and Calories, which is a pretty high value. It is also worth mentioning that Thursday, Tuesday, and Wednesday are days where number of entries is higher in comparison to the other days. On the other hand, Monday and Sunday seem to have the least amount of entries, which might influence on slightly higher R2 value in the case of Sunday.
Nonetheless, R2 is still high, which points to both of these variables being strongly correlated.

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## `geom_smooth()` using formula = 'y ~ x'
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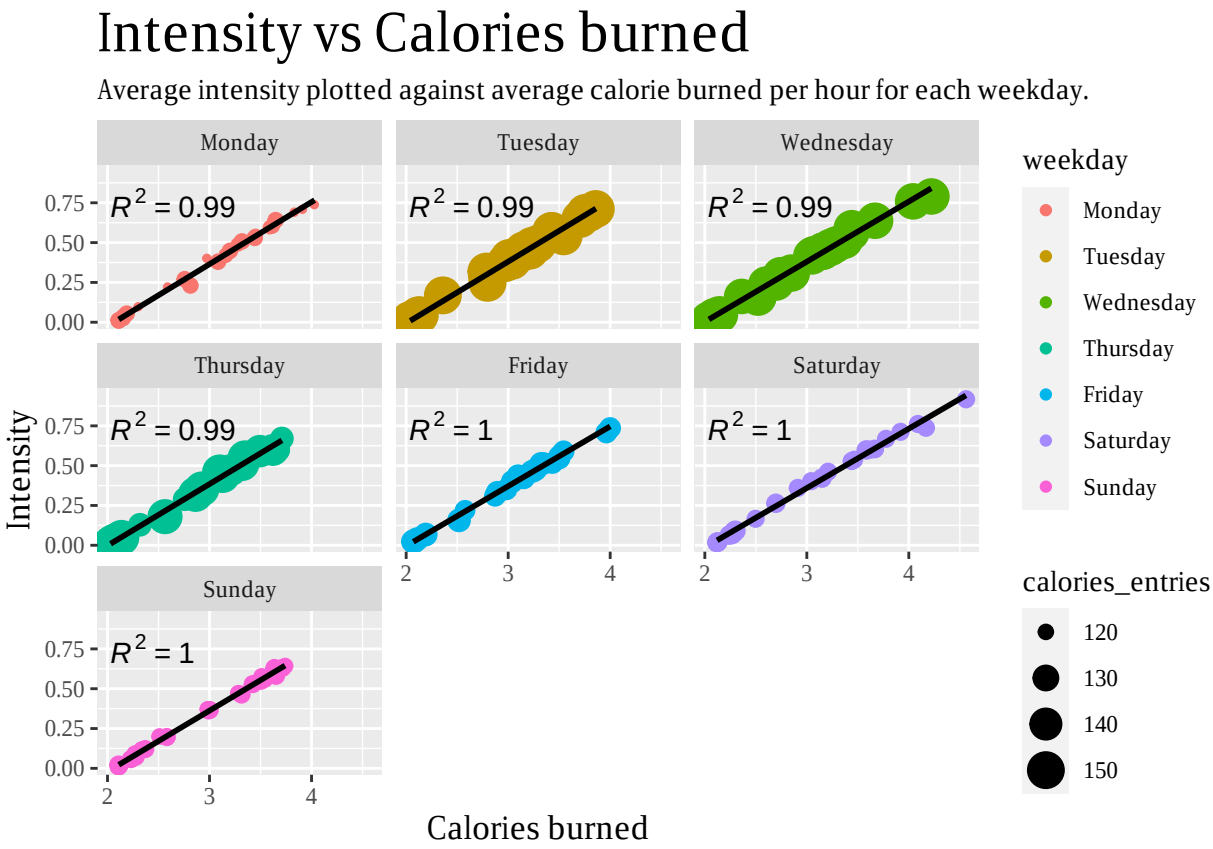
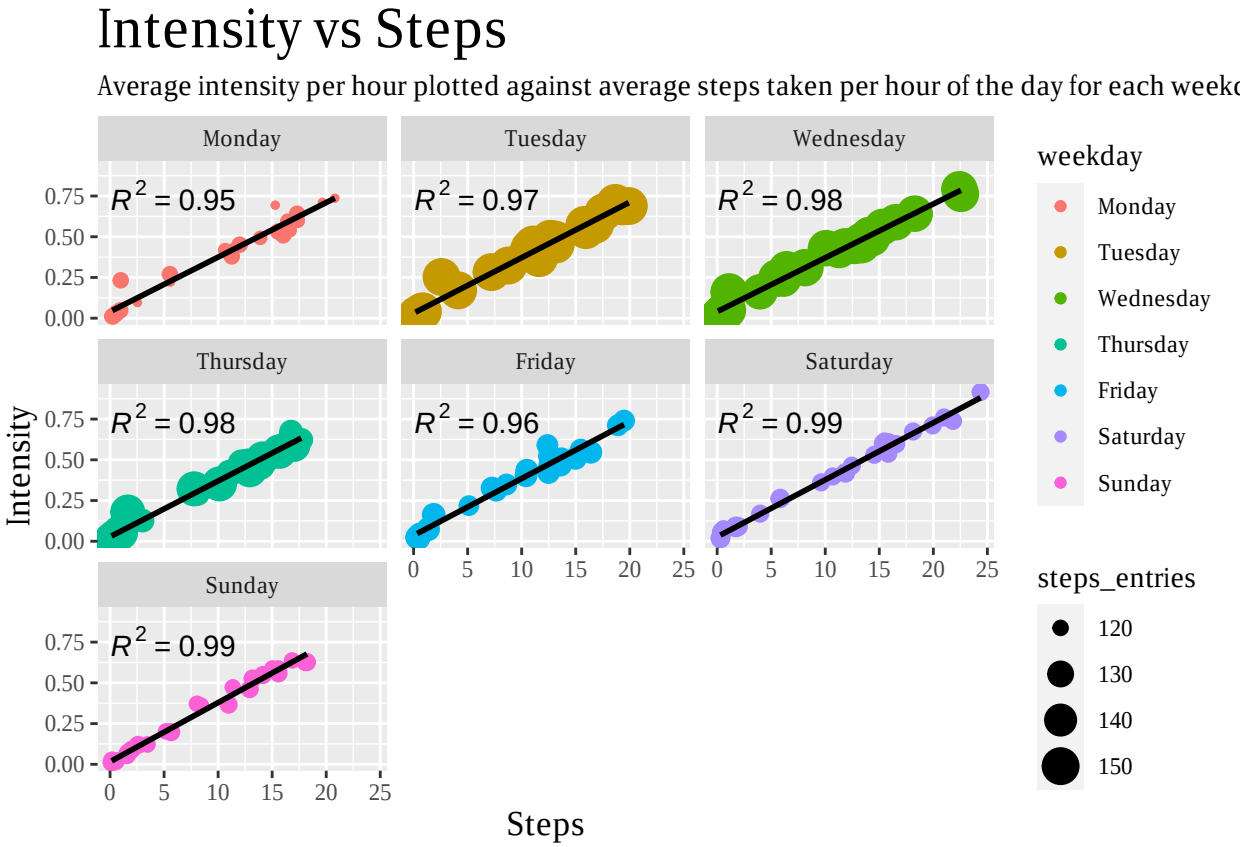


Steps vs Intensity

Here we can observe more variability among the traits, especially for days such as Monday and Friday where R values are 0.96 and 0.95 which puts them on the border of our analysis. On the other hand, weekend days are still showing a pretty strong correlation.
Several entries however follow the same pattern as it was in the previous plot.

Altogether correlation between steps taken and intensity through the day is still strong, however is not as much as the correlation between intensity and calories.

```
## `geom_smooth()` using formula = 'y ~ x'
```

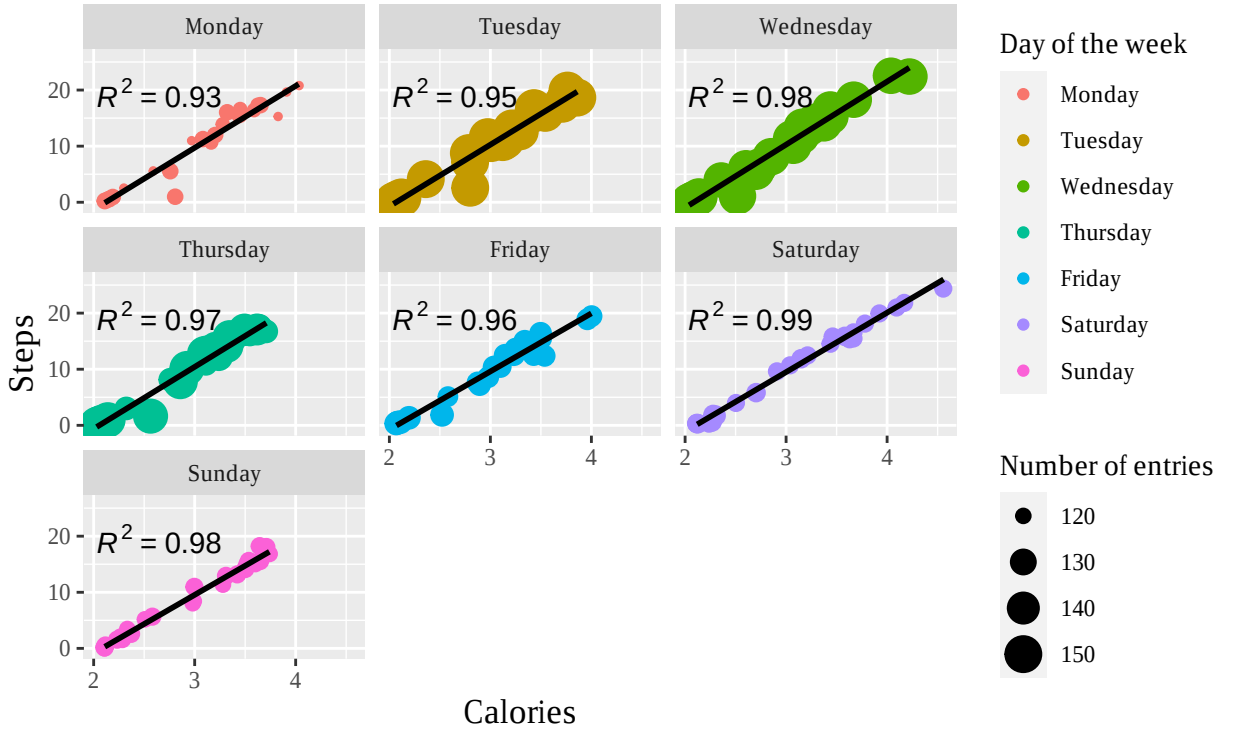


Calories vs Steps

R square during Monday equaling reaches the lowest value of all hourly plots with 0.93, next is Tuesday(0.95), Friday(0.96), Thursday(0.97), Sunday and Wednesday at 0.98 and finally Saturday with 0.99. This points to the lowest correlation value of all three plots. Correlation above 0.95 (depending on the discipline) is considered pretty high thus we will conclude here that all of these three variables are correlated with each other.
Although intensity is more strongly correlated with calories and steps, then steps and calories are to each other.

Regarding the number of entries Monday, Friday, Sunday and Saturday are the least logged day.

```
## `geom_smooth()` using formula = 'y ~ x'
```



Summary of the METs and heart rate data

Heart rate

- Most variable heart rates can be seen during weekend days.
- Highest values of heart rate are Monday 17:00, Tuesday 10:00, Wednesday 17:00, Thursday 15:00.

1. Marketing suggestion: Advertising stress guidance (Bellabeat membership), with fast free 2 min breathing exercises in mentioned hours: Monday 17:00, Tuesday 10:00, Wednesday 17:00, Thursday 15:00.

METs

- Based on METs values Saturday is the most active day of the weekend while Wednesday is the most busy workday.
- The least active weekend day is Sunday, and the work day is Thursday.

1. Suggestion for users: Activity reminder around noon on Sunday regarding going on a walk or having a bike trip. This could be dependent on the weather forecast, on which it will propose either outdoor(walking, bike) or indoor activities (yoga). Activity reminder: fast stretching at work, or a five-minute break to get "Fresh air" around 15:00, since this value has the highest heart rate during the day, "5 minutes relax" might help the users to unwind for a bit.

- Correlation can't be assessed due to insufficient sample size (min 30) of an analyzed group of users. To perform correlation analysis, 16 more users are needed at least.

Summary of the hourly data

- All three values correlate with each other, thus their plots are almost the same.
- The most intensive part of the work day is between 7:00 and 17:30, which are work hours, pointing to our users having pretty active work.
- During the weekend days users tend to start activity later on in the day around 10:00. During the weekend people tend to sleep longer. Source
- The days with the least amount of entries are Monday, Sunday, and Saturday. The highest entry number can be observed on Tuesday, Wednesday, and Thursday.

1. Suggestion users: Implementing reminders for logging in by gamifying the logging process (especially steps and intensity) boards through Monday, Sunday, and Saturday to increase the number of entries during these days. Proposed hours: 7:00 (Monday) or 10:00(Sunday and Saturday), 12:00, 17:00, and finally around 20:00. Start implementation by max 2 reminders per day so that the user won't get estrange.

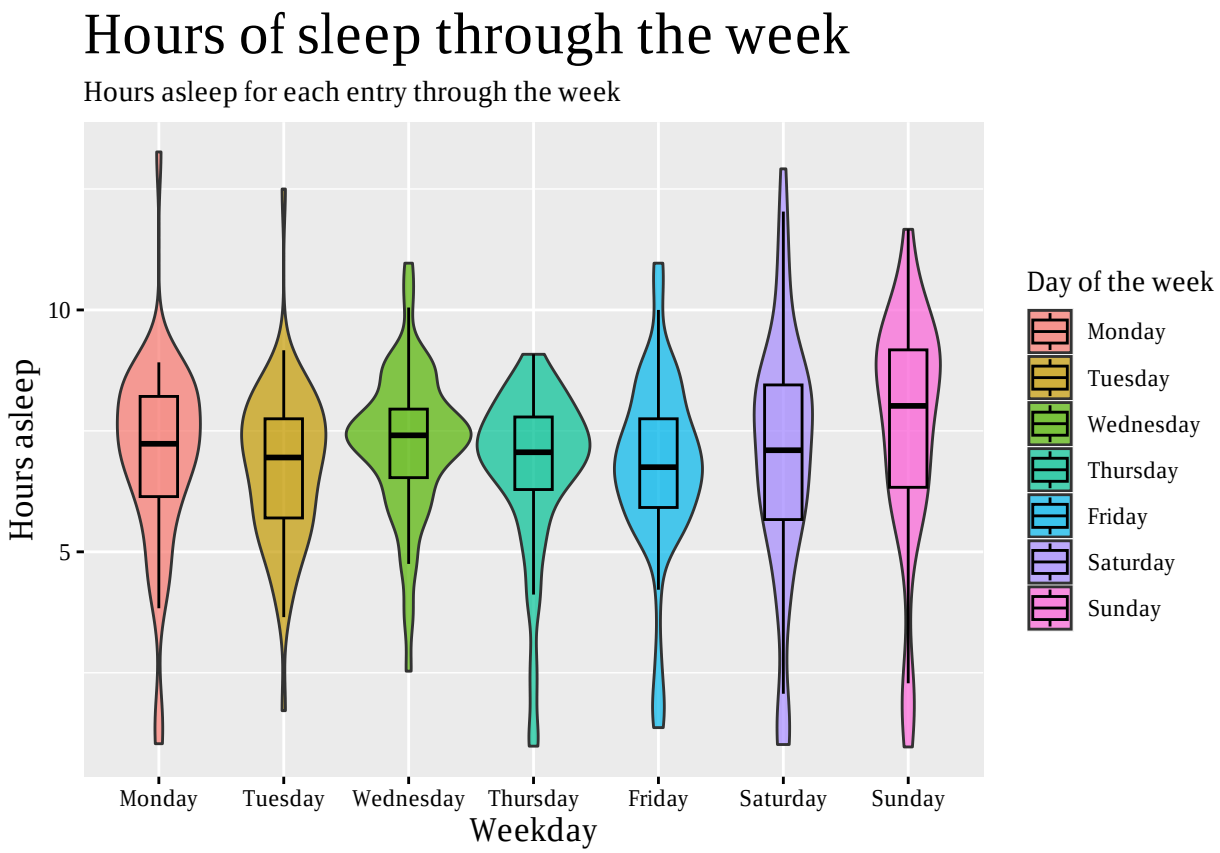
2. Suggestion advertisement: Since most users tend to go to work around 7:00 and come back around 17:30. This time would be great to upscale advertisement on social media, radio, and public transport.

- Correlation analysis: This shows that all three values are strongly correlated with one another. Although it would be advised to obtain the records from 100 users, logging for 30 days to strengthen the data.

Sleep data analysis

Minutes asleep through the week

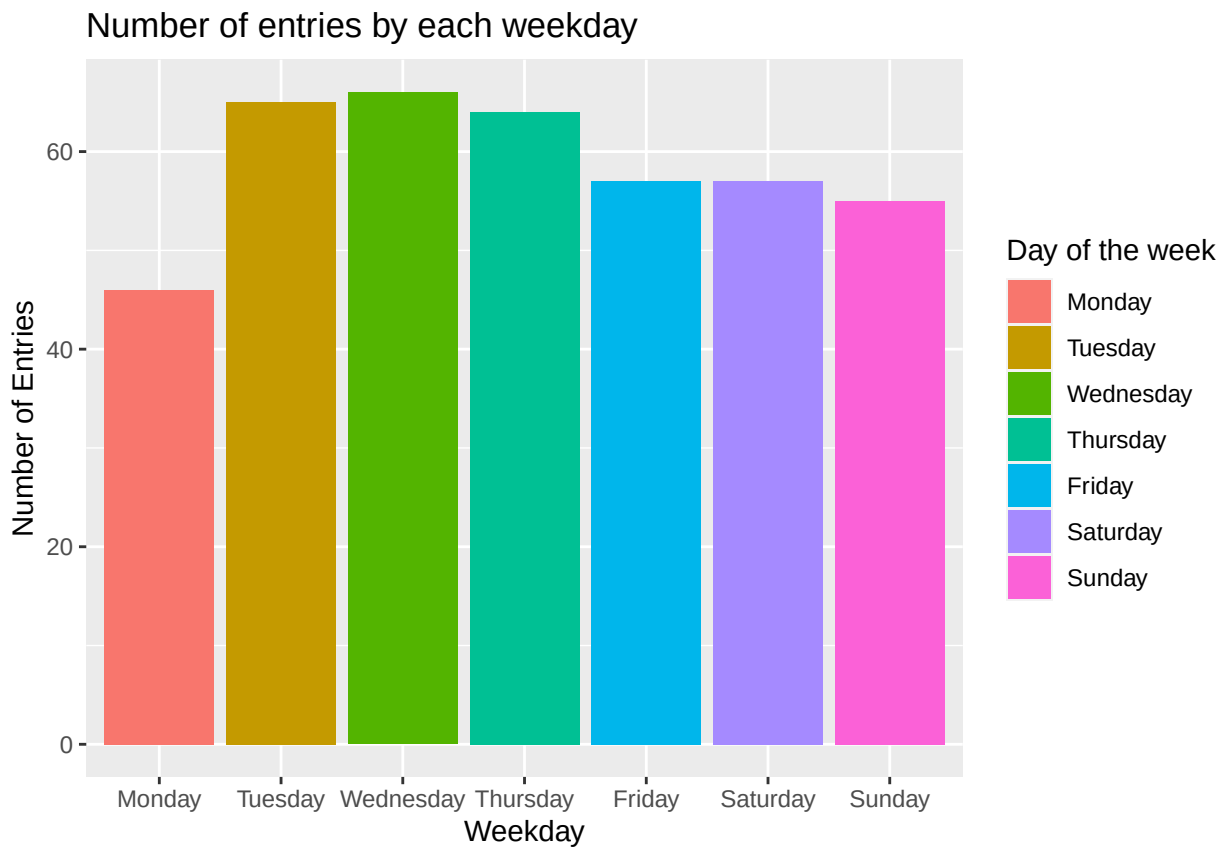
By analyzing the violin plot we can see that users tend to sleep the longest on Sunday(7.5 h on average), on the other hand, people sleep the least on Thursday (6.68 h on average). Saturday is the day with the most variability in its measurements.
Interestingly Wednesday (7.24 h) and then Monday(6.99 h) are the work days when more than a half (Wednesday) or at least half (Monday) of users tend to sleep the longest excluding Sunday.
The number of entries of users' length of sleep which was the closest to the average was logged on Wednesday, Thursday, and Friday. It might be caused by a different amount of entries submitted on each day, thus I have decided to analyze it in the next plot.



Number of entries through the week

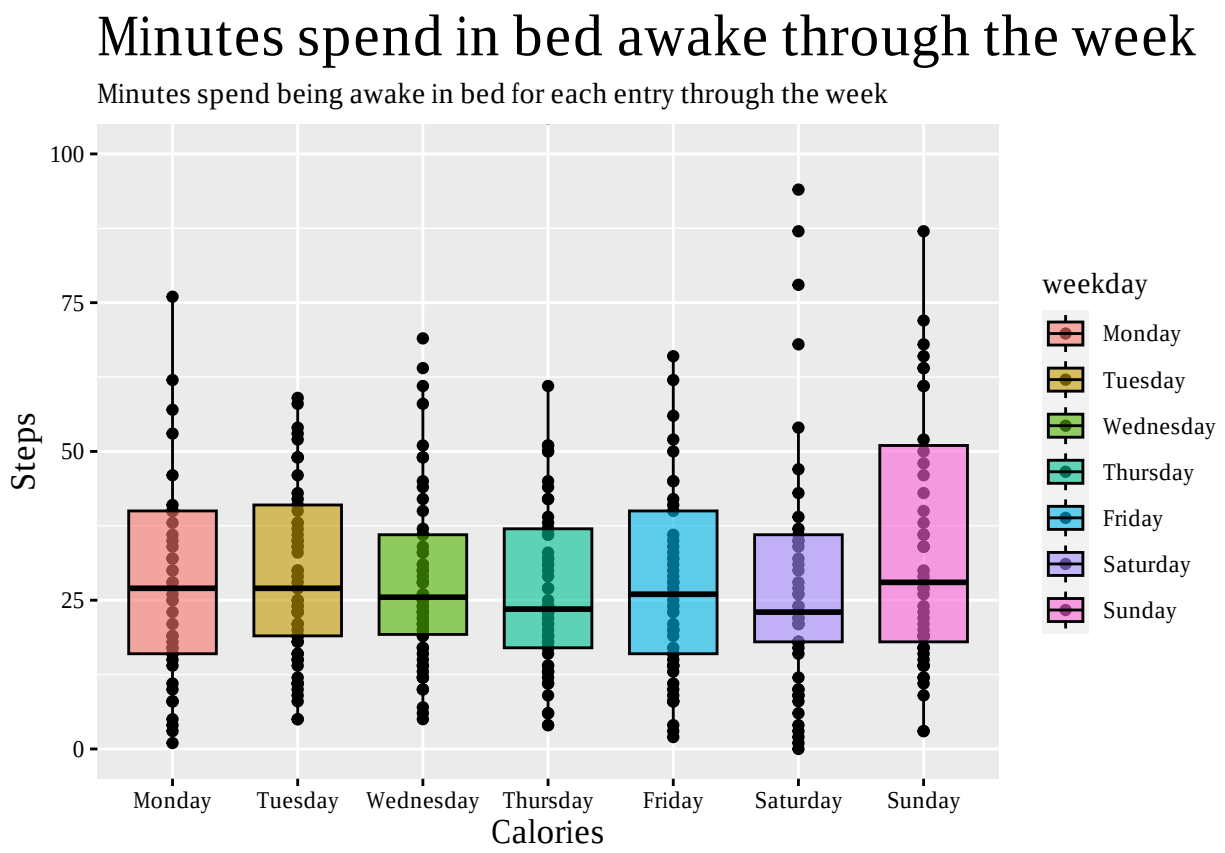
Based on we can see that the last entries were submitted on Monday with 47 entries. If we also consider Wednesday being the day with the most entries submitted with the value of 66 logs, we can calculate that on Monday we have almost 29% fewer entries.
Let's look at Sunday now where we can observe the least entries during the weekend days, with 55 entries which is a bit less difference than in the case of Monday, but still more than a 16% decrease.

This difference might contribute to a shift in the sample coverage of certain quartail in the previous plot as well as in the next one where I will analyze the amount of time spent in the bed awake for each weekday.



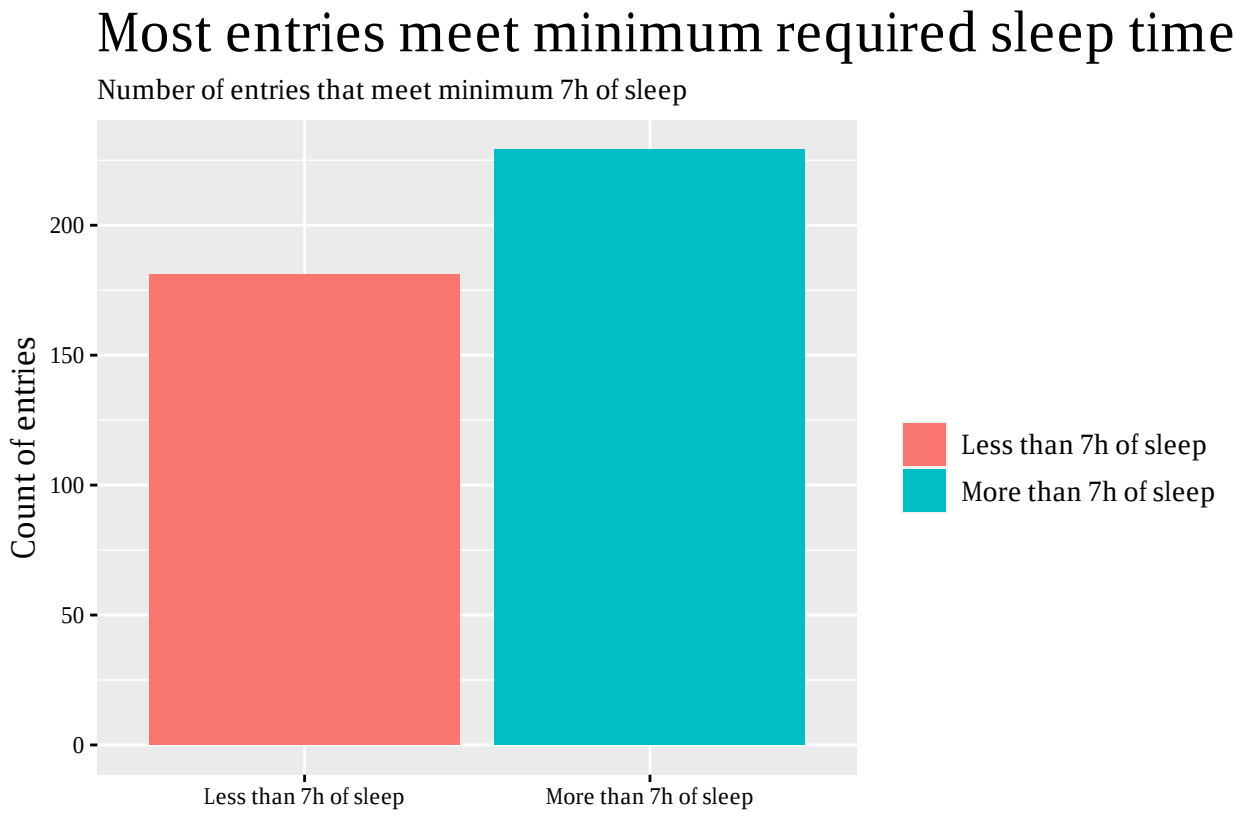
Minutes asleep vs minutes spend in bed

On Sunday people tend to spend the most time being awake in bed with the majority spending more than 50 min. Thursday and Wednesday are the days when users tend to spend the least time being awake in bed with an average of around 33-35 min.



Assesing the amount of sleep

228 user entries meet the minimum 7 hours of sleep according to Mayo Clinic, which is 60% of all entries. 181 user entries do not meet that requirement.



There is an interesting tendency visible in the data the number of entries meeting the minimal requirement for sleeping hours rises from Monday until Wednesday where it peaks with 45 entries. Since then number of these entries has fallen until Friday. During Saturday and Sunday number of entries with sleeping time of more than 7 hours rises again.

Tuesday and Friday are the days where the number of entries with sleeping hours below 7 rises the number of entries meeting the requirements of sleep time. Tuesday simultaneously being the top day with 35 entries where users slept less than 7 hours, while Friday reached 27 entries.

A top number of entries is noted on Wednesday with 45 entries, the next one is the Sunday with 37 entries.

Summary sleep

- Users tend to sleep the most on Sunday on the weekend and Wednesday on workdays. On the other hand, they get the least sleep on Thursday.
- Again sleep data shows us that Monday, Friday, Saturday, and Sunday are the days where a decrease in several entries submitted by the user is observed. With Monday counting the last entries.
- Users tend to spend the most time being awake in the bed on Sunday on the weekdays, and on Friday and Tuesday during work days.
- 60% of entries of the users tend to meet the minimum requirement of 7 hours of sleep minimum. The highest number of these entries is noted on Wednesday and Sunday.
- Tuesday poses an alarming statistic where 54% of entries do not meet the 7-hour mark of sleep time. Together with Friday, these are two days where several entries below 7 hours of sleep exceed the entries with a required minimum amount of sleep.

1. Suggestion users: Regarding the fact that the most time being awake in bed is being spent on Tuesday and Friday, while also the same days tend to have the most entries where the sleep time is below the 7 hours I propose to implementing prompts during this days around 21:00(since also the intensity decreases at that time and so does the step) promoting "clean sleep" techniques such as reducing exposition to blue light, airing the bedroom etc. To help them reduce the time of being awake in bed, simultaneously prolonging their sleep time.

2. Suggestion advertisement: Considering that Tuesday and Friday are the days when most of our users tend to get the least sleep, we can think that it might be reflected at least partially in the population. Thus the days after the least sleep people will be more prone to peak messages regarding a good night's sleep and well rest, furthermore morning hours such as 5:00 to 10:00 would be good hours on Tuesday and Friday for advertising the Bellabeat membership with sleep guidance, Bellabeat app, Leaf and Time.

General summary

1. Number of entries:

- Entry patterns: Fewest on Monday, Sunday, and Saturday; highest on Tuesday, Wednesday, and Thursday.
- Entry consistency: Fewest entries on Monday, 21% decrease compared to Tuesday with the most entries.

2. Sleeping patterns:

- Users' sleep patterns: Most sleep on Sunday and Wednesday, least on Thursday.
- Awake time in bed: Users spend more time awake in bed on Sunday, Friday, and Tuesday.
- 60% of entries meet 7-hour sleep requirement: Highest on Wednesday and Sunday, alarming 54% on Tuesday and Friday.

3. Activity patterns:

- Active work hours: Most active between 7:00 and 17:30, indicating active work.
- Weekend activity starts later: Activity starts around 10:00 on weekends, indicating longer sleep.

4. Heart rate patterns:

- Heart rate variability: Highest during weekends, specific high values on Monday 17:00, Tuesday 10:00, Wednesday 17:00, Thursday 15:00.

5. Intensity patterns:

- METs values: Saturday most active weekend day, Wednesday busiest workday; Sunday and Thursday least active.

6. Caloric intake patterns:

- Caloric intake stability: Stable throughout the week, highest on Tuesday (2229 kcal/day), lowest on Sunday (2063 kcal/day).

7. Travel and steps pattern:

- Travel patterns: Longest distance on Tuesday and Saturday, shortest on Sunday and Friday; 97% correlation between distance and steps.
- Step count: Most steps on Saturday and Tuesday, fewest on Sunday.
- Inconsistencies in distance tracking: Discrepancy between total distance, tracker distance, and cumulative distances of different intensities.
- Correlation between sleep, activity, and heart rate values.

Suggestion for the stakeholders

Users suggestions:

1.Promote family activities and active work habits.
2.Reward consistent user recording with discounts or gadgets.
3.Implement timely reminders and gamify logging process.
4.Address sleep issues with prompts and "clean sleep" techniques.

- More specific plan:

  Sunday: Promote family walks or bike rides.
  Monday: Encourage walking or biking to work, taking stairs, and regular stretching breaks.
  Friday: Emphasize steps-boosting tactics at work, like taking short breaks and walking to places.
  Sunday: Send reminders for outdoor or indoor activities around noon and short breaks at 15:00.
  Monday, Sunday, Saturday: Implement login reminders at 7:00, 10:00, 12:00, 17:00, and around 20:00.
  Tuesday, Friday: Introduce prompts at 21:00 for better sleep, promoting "clean sleep" techniques.

Marketing suggestions:

1. Focus midweek ads on device tracking, and creative movement on low-activity days.
2. Support ads with research on cognitive benefits of movement.
3. Advertise stress guidance during specific hours.
4. Target ads during commuting times and after poor sleep periods

- More specific plan:

  Midweek: Focus ads on device tracking.
  Low-activity days: Advertise creative movements, backed by research, on social media and radio.
  Specific Hours: Offer stress guidance at 17:00 (Monday), 10:00 (Tuesday), 17:00 (Wednesday), and 15:00 (Thursday).
  Morning Hours (Tuesday, Friday): Advertise sleep guidance, Bellabeat app, Leaf, and Time from 5:00 to 10:00.

Technical Issues:
Address inconsistencies in tracker data promptly to maintain accuracy and customer trust.