**A Tribute to My Wrongness: The Relationship Between Airbnb Rental Prices and the Distance to the Nearest Health Tourism Institutions**

*Are the prices of Airbnb rentals in Istanbul correlated with the distance to the nearest institutions related to health tourism? I really hoped that the answer was yes. However, it was not. Here is a tribute to my wrongness.*

*A picture containing map

Description automatically generatedA sneak peek into the results of the analysis conducted in this project.*

Influenced by my previous analysis(), I wanted to know more about the health institutions in Istanbul. I had two particular types of health institutions in my mind: **aesthetic clinics and hair transplant centers.**

Why? Well, before the Coronavirus pandemic, if you were to come to Istanbul, there was one thing that you would surely notice: the amount of people walking around with bandages around their scalps.

Graphical user interface, text, application, email

Description automatically generated

*Health tourism (especially for hair transplants) was big business in Istanbul.*

A quick google search using the keywords “Istanbul” and “hair transplant” will reveal to you the reasons of this odd sighting. Istanbul is a hotspot for health tourism. There are many aesthetics clinics and hair transplant centers throughout the city. Their customers are mostly tourists that are looking to sneak in some kind of a cosmetics-related medical procedure into their vacation time. Among these operations, hair transplant is the most popular one.

Motivated by the existence of this very niche type of tourism, I started wondering if I can somehow analyze the interaction of health tourism related institutions with the overall tourism economy of the city.

As in other tourism hotspots, Airbnb rentals are a very popular choice of accommodation for tourists in Istanbul. **Perhaps I could find some kind of a linear or monotonic relationship in between the price of an Airbnb rental and its closeness to a health tourism institution?** Since health tourism is a big reason why people come to Istanbul, it might be possible to see that closeness to health tourism related institutions is correlated with higher rents.

**The distribution of health tourism related institutions across Istanbul**

The question that I set out to answer had a spatial dimension to it. I figured that looking at the distribution of health tourism institutions and Airbnb rentals across Istanbul could be a great first step in understanding the relationship in between these two. Drawing data from IMM’s (Istanbul Metropolitan Municipality) dataset on health institutions and from web scraping scripts that I have wrote, I plotted out all health tourism related institutions (aesthetic clinics and hair transplant centers) both on the individual level and on the district level.

Diagram, schematic

Description automatically generated

*An overview of the distribution of health tourism related institutions across Istanbul, featuring two maps and a bar chart. Aesthetic clinics and hair transplant centers seem to be focused around centralized and well-connected districts.*

As it can be seen on the choropleth map above, health tourism related institutions in Istanbul seem to be congregated around central and southern districts such as Şişli, Beşiktaş and Kadıköy. These three, with 33, 19 and 17 health tourism related institutions respectively, are very well connected to other districts. Along with Ataşehir and Üsküdar, the 4th and 5th districts on the list, they serve as major economic centers that draw people in from other districts. The districts that lie on the southern shoreline of the European side of the city are also major population centers.

Looking at the distribution of health tourism related institutions on an individual level confirms our previous statement related to their distribution. Even within the southern districts, most health tourism related institutions congregate around the southern shoreline. There are very few institutions that are outside the central southern cluster.

These results are hardly shocking when we consider that the gravity center of Istanbul, at least tourism wise, lies on the southern edge of the city. These are the districts that are most frequented by tourists and operating a health tourism related clinic around tourist hotspots makes sense.

Perhaps delving deeper into the specifics of this spatial distribution can help us gain a deeper insight about the topic before moving on. Considering this, we can look at how the number of institutions related to health tourism within a district relates to some other statistics such as population and yearly average household income. We can use a scatterplot to investigate the relationship in between these variables.

Chart, scatter chart

Description automatically generated

*Two scatterplots that show the relationship in between the number of institutions related to health tourism (dependent variable) in a district and two other independent variables. The dependent variable has no linear relationship whatsoever with population and somewhat of a mild positive linear relationship with yearly average household income.*

What we discover is that there is practically no linear relationship in between the population of a district and the number of health tourism related institutions that the same district has. Considering this, the fact that the southern districts are also population hotspots does not seem to be relevant. However, there appears to be a mild linear relationship in between the yearly average household income of a district and the number of health tourism related institutions that the same district houses.

Moving on, we can now look at the second element of the question that we are seeking to answer: Airbnb rentals.

**The distribution of Airbnb rentals across Istanbul.**

The dataset that I used to learn about the spatial distribution of Airbnb rentals belongs to a project called *Inside Airbnb*. Considering that worldwide tourism took a great hit because of the Coronavirus pandemic that we are still battling by the time I am writing about this analysis; I choose to base my analysis on data from May 2019.

Graphical user interface, map

Description automatically generated

*An overview of the distribution of Airbnb rentals across Istanbul featuring two maps and a bar chart. While it is not completely the same, the ranking on the right corner seems to mimic the previous ranking.*

Once again, the first of the maps reveal that the southern districts overlooking the Bosphorus have the highest number of Airbnb rentals. Some of the districts with the highest amount of health tourism related institutions, namely Şişli, Beşiktaş and Kadıköy, also make it to the top five in the Airbnb rankings. However, the 1st place and the 3rd place in the rankings are held by Beyoğlu and Fatih respectively. These two districts were not among the top five in the health tourism related institution ranking.

On an individual level, the distribution of Airbnb rentals seems far less clustered when compared to the distribution of health tourism related institutions. The number of Airbnb rentals and the granularity level of the map presented here makes it hard to arrive at a more nuanced conclusion. However, it is clear that Airbnb rentals are present in some tourism hotspots where health tourism institutions are absent. The northeastern district of Şile, the southwestern district of Silivri and the Princes’ Islands can be considered as independent clusters. Even without making any analysis about the relationship in between distance and price, we can say that the existence of such sub-clusters will significantly lower the chances of observing any meaningful linear or monotonic relationship.

Before moving on, we can once again look at how the number of Airbnb rentals in a district relates to the population and the yearly average household income of that same district.

Chart, scatter chart

Description automatically generated

*Two scatterplots that show the relationship in between the number of Airbnb rentals (dependent variable) in a district and two other independent variables. The dependent variable has no linear relationship whatsoever with population and yearly average household income.*

Just like our previous correlation analysis, we see that the number of Airbnb rentals in a district has no meaningful linear relationship with population. The same applies to yearly average household income.

**From entity to attribute: Airbnb rental prices**

We have gained valuable information about the geographical distribution of our two elements of interest. However, what we are ultimately interested in is two specific attributes (nightly rent and the distance to the nearest health tourism related institution) that belong to one of these entities. The dependent variable of our final analysis is Airbnb rental prices. Therefore, looking at how Airbnb rental prices are distributed is a great idea before we move on to the final correlation analysis. We can achieve this by utilizing a histogram:

Chart, histogram

Description automatically generated *Two histograms that show the distribution of Airbnb rental prices. The first histogram does not tell us anything except the fact that the distribution is extremely right skewed. The second histogram allows us to see the distribution at a different level of granularity.*

The first histogram is nothing but a very tall column and a few extremely short ones. This is a very bad sign for our prospects of finding a linear or monotic relationship in between the variables of interest because it signals that the distribution is heavily skewed to the right. The skewness of this distribution is 33.74. A skewness value greater than zero means that there is more weight to the right of the distribution because there are outliers in that direction. These outliers drag the mean of the distribution of rental prices away from a normal distribution shape and lower our chances of finding a linear relationship.

The extreme right skew of the rental price distribution also makes it impractical to use a histogram. The first histogram looks the way it does because it has to account for the presence of some values that are infrequent but big in effect. We cannot see what happens at the more “normal” parts of the distribution because of this distortion. The second histogram shows the log10 transformation of the same data. This transformation allows us to take a peek at the smaller kinks in the distribution. Sadly, seeing the distribution in more detail does not give us any more hope about discovering a linear relationship.

A picture containing chart

Description automatically generated

*Multiple histograms that show the distribution of Airbnb rental prices at the district level. Even with a very generous threshold, most district-level distributions are heavily skewed to the right.*

The extreme right skew of Airbnb rental prices persists when the distributions are considered at the district level. Even with a very generous and arbitrary threshold of skewness at 5, there are districts (yellow colored) that can be considered heavily skewed. Most districts have the skewness of at least 1.

By now we have noticed some very serious red flags which tell us that we will most likely not find a linear or even monotonic relationship in between the price of an Airbnb rental and its distance to the nearest health tourism related institution. However, we will still go ahead and see how wrong we were about our initial assumption. But first, we have to talk about how I came up with the “distance to the nearest health tourism related institution” metric.

**Interlude: how did I conduct the nearest neighbor analysis?**

**Map

Description automatically generated**

*An abstract map of Istanbul confirming that the nearest neighbor analysis script used in this project managed to match each Airbnb rental (blue circle) with the nearest health tourism related institution (orange triangle.)*

In the scripts I wrote (more info at References), I have used two popular Python GIS packages (GeoPandas and Shapely) to process my geospatial data and to calculate the nearest health tourism related institution (“nearest neighbor”) for each Airbnb rental. After this, I used another Python GIS package called Geopy to calculate the geodesic distance between each Airbnb rental and its nearest neighbor. The geodesic distance (in meters) formula calculates the distance in between two points by taking the shortest path in between them. It does not take into account things like street grids and elevation. It works with the least error when the WGS-84 coordinate reference system (CRS) is used. The datasets that I have used were adjusted to this CRS.

The abstract map of Istanbul above visually confirms that the analysis worked. Each blue circle (Airbnb rentals) is linked with white lines only to the nearest orange triangle (health tourism related institutions.) While the resolution of the map is not enough to see the link for each rental, some sub-clusters, such as the southwestern sub-cluster, clearly show that the matching was successful.

**Failure: the correlation in between Airbnb rental prices and the distances to the nearest health tourism related institution**

Now that our definitions are clear and we have everything that we need, we can finally talk about our main analysis. Chart, scatter chart

Description automatically generated

*A scatterplot of Airbnb rental prices and the distances to the nearest health tourism related institution. There appears to be no linear or monotic relationship in between the two variables.*

The scatterplot above confirms the observations that we have made about the red flags on the road. There appears to be no linear relationship (r = 0.02) in between the two variables that we are interested in. We also cannot find any meaningful monotonic relationship (rho = -0.01, less strict than linear rel.) in between them. The price of an Airbnb rental is in no way linearly or monotonically related to its distance to the nearest health tourism related institution.

The reasons for this are clear: there are too many extreme values in the dataset, both in terms of price and distance, for there to be any meaningful relationship. The answer to the question that we have excitedly asked is no, for now.

**Take two: the correlation in between normalized Airbnb rental prices and the distances to the nearest health tourism related institution**

We know that the outliers found in the price distribution are one of the reasons why there wasn’t a linear or monotonic relationship in between the variables we are interested in. What would happen if we were to drop these outliers?

Normally, dropping the data that we find inconvenient is considered as a terrible statistical conduct. However, this analysis is a hobby project that I poured a significant amount of time into. Because of this, I can conduct a statistical crime for the sake of having another chance to confirm my obviously misguided intuition.

A common definition of an “outlier” is any value that is more than -/+ 1.5 Interquartile Range (IQR) away from Quarter 1 or Quarter 3. Let’s first normalize our dataset using this rule of thumb and then take a second look at the distribution.

Chart, histogram

Description automatically generated

A *histogram that shows the distribution of normalized Airbnb rental prices. The normalization appears to have made the distribution far more similar to a normal distribution.*

We can see that normalizing the dataset using the method described above has resulted in a distribution that resembles a normal distribution more. With a skewness of 1.06 and a standard deviation of 165.55, our dataset looks far less spread out.

**What about the distributions at the district level?**

Graphical user interface, chart

Description automatically generated

*Multiple histograms that show the distribution of normalized Airbnb rental prices at the district level. No distribution has a skewness of more than 2.20 and nearly all distributions are closer to normal.*

The small multiple view above confirms that our normalization has also had effects on nearly all district-level distributions. Now, no distribution exceeds the arbitrary skewness threshold of 5 that we have set.

**Can we find a relationship using the normalized price data that we have now? Let’s see.**

**Chart, scatter chart

Description automatically generated**

*A scatterplot of normalized Airbnb rental prices and the distances to the nearest health tourism related institution. There is no meaningful linear or monotonic relationship in between the two variables.*

Even with a normalized dataset, we cannot observe any linear or monotonic relationship in between the two variables of interest.

**Take three: correlation at the district level**

In a last attempt to get a positive answer, we can try narrowing down our scope. Perhaps there is some kind of a linear or monotonic relationship only at the district level for some districts.

Let’s shift our focus to the five districts with the highest number of health tourism related institutions: Şişli, Beşiktaş, Kadıköy, Ataşehir and Üsküdar. We will stick to the crime we have committed and look at only normalized values.

Chart

Description automatically generated

*Multiple histograms that show both the overall distribution of normalized Airbnb rental prices and the distributions at the district level. The skewness of this subset (1.31) is higher than the overall skewness (1.06).*

The big histogram above reveals that the skewness of this subset (1.31) is actually higher than the overall skewness (1.06) of the normalized price distribution. The individual districts are not that different from the overall normalized distribution either. Normalizing and narrowing our scope appears to have not increased our chances of finding the relationships we have been looking for. Still, let’s stick to what we have been doing and see the analysis through.

Here is the visual confirmation for the nearest neighbor analysis at the district level:

A picture containing map

Description automatically generated

*Five abstract maps of Istanbul districts confirming that the nearest neighbor analysis script used in this project managed to match each Airbnb rental (blue circle) with the nearest health tourism related institution (orange triangle.)*

And here are the scatterplots that conclude our analysis:

Chart, scatter chart

Description automatically generated

*Five scatterplots of normalized Airbnb rental prices and the distances to the nearest health tourism related institution. Once again, there is no meaningful linear or monotonic relationship in between the two variables in any of the five selected districts.*

Although the Pearson’s r and the Spearman’s rho, measures that signal the strength and the direction of linear and monotonic relationships, have changed a little bit, we still cannot talk about any meaningful relationship whatsoever.

**Conclusion**

**Diagram, schematic

Description automatically generated**

*I was wrong in numerous ways. This report is a detailed tribute to my wrongness. Credits to Nathan W. Pyle().*

No matter how we look at it, we cannot find any proof of a linear or monotonic relationship in between Airbnb rental prices and the distances to the nearest health tourism related institution. This analysis report serves as proof that I have at least tried.

**References**

This analysis was created with replicability principles in mind. All source code, datasets and references can be accessed through this GitHub repository. (https://github.com/ejgenc/Data-Analysis\_Istanbul-Health-Services-Map)