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What is special about spatial aspects in subjective well-being analysis?

Subjective well-being (SWB) is a complex phenomenon originating from the interplay of various subjective and less subjective factors ranging from health conditions to standard of living. Although some of the SWB parameters have important spatial dimensions and aspects – particularly those characterizing the living environment where people potentially spend a significant amount of time – they are often neglected or underrepresented as a context in SWB studies. In our analysis, we investigated the role of spatial and environmental factors using self-reported SWB values of more than 2000 patients living in Innsbruck, Austria, combined with various spatial data sets characterizing the environment. The patients evaluated their current level of SWB anonymously on a scale from one to six, where six means the highest level of satisfaction with their life overall. These values, along with the patients' addresses were used for geostatistical analysis to understand the connection between one's home location, their health condition, and the self-reported SWB. We identified a set of environmental factors such as the characteristics of urban green spaces (e.g. proportion of surface, type), average building height, exposure to noise and air pollution, or the walkability of the area and used them as inputs for our analysis. Based on our results we can emphasize the role of the environment in terms of the spatial composition of SWB factors, and its relevance for urban planning purposes by identifying interrelation between factors such as the greenness of an area and SWB.

Keywords: urban environment, urban form, urban green, GIS, subjective well-being, health

1. Introduction

Happiness, well-being, and satisfaction with life are topics that have been investigated by philosophers for thousands of years yet remained in the center of attention even nowadays. Back in the Ancient Greek times, Aristotle already identified that health has a special role in being happy and satisfied with life (Kraut, 2018). However, modern scientific approaches to quantify happiness or to understand the complex direct interrelationship of well-being, health, and the environment have been only established after the Second World War. From the 1950s on, mostly psychologists have studied subjective well-being (SWB) to interpret how and why people experience their lives in positive ways (Diener, 1984; Lyubomksky and Dickerhoof, 2005; Lyubomksky, Sheldon and Schkade, 2005). Lyubomirsky et. al (2005) found that happiness is defined mostly by our genes (50%) or life choices and other behavioral aspects (40%), whereas our life circumstances – the urban environment and housing conditions among others – are only responsible for 10% of it. Nevertheless, there is a difference between SWB and happiness, mostly on a temporal scale. While SWB considers the (self-evaluated) conditions of a person in the moment of the question is asked regarding how satisfied they are with their life, happiness in general would rather refer to long-term satisfaction. Therefore, SWB assessments usually include questions about the current or recent life conditions and how satisfied the subjects are with them in that moment. Typical questions accordingly are: "How satisfied are you with your life nowadays?", "How happy did you feel yesterday?", or "How anxious did you feel yesterday?" (e.g. Annual Population Survey, UK 2012).

According to Diener (1984) who first developed the concept of SWB, there are three "distinct but often related components of wellbeing": *frequent positive affect*, *infrequent negative affect*, and *cognitive life evaluations* (i.e. life satisfaction). Thereby the concept of SWB encompasses moods, emotions and evaluations of one's satisfaction with general and specific areas of one's life (Diener *et al.*, 1999). In our paper we are focusing on the latter part using self-reported SWB values of residents from the city of Innsbruck, Austria and we intend to identify to what degree given environmental variables can affect these "cognitive life evaluations" and satisfaction.

Urban environmental quality assessment is a continuously growing scientific field, mostly due to the steady increase of the urban population globally, and because these people are facing divers challenges, also induced by the poor quality of the environment (e.g. pollution, lack of green space, serving the needs of motorized traffic, etc.). Various scientific fields intend therefore, to trace and understand the determinants of quality of life in urban environment (Brown, 2003; Kamp, Leidelmeijer and Marsman, 2003; Marans, 2003; Pacione, 2003). According to Van Kamp et al. (2003), there is a conceptual overlap between quality of life (QoL), livability and well-being. However, in QoL and especially livability assessment, the (direct) role of the environment is more significant in the analysis than in the case of SWB, where the cognition of the people is emphasized over other subjects. Thereby, in our paper we intend to illustrate the relevance of environmental factors in SWB analysis as well, even if these environmental factors are less likely to influence SWB as directly as genetic conditions or behavioral aspects, according to Lyubomirsky et. al (2005).

2. Background

In this section we provide a brief summary on the most relevant aspects of urban life and the satisfaction with it based on state-of-the art literature regarding livability, SWB and health research. We specifically address the following three aspects of urban life, and how they are mutually affecting each other: *lifestyle, health* (both physical and mental), and the *urban* *environment* (Figure 1). In the analyses for our case study, we considered these three aspects as starting points.

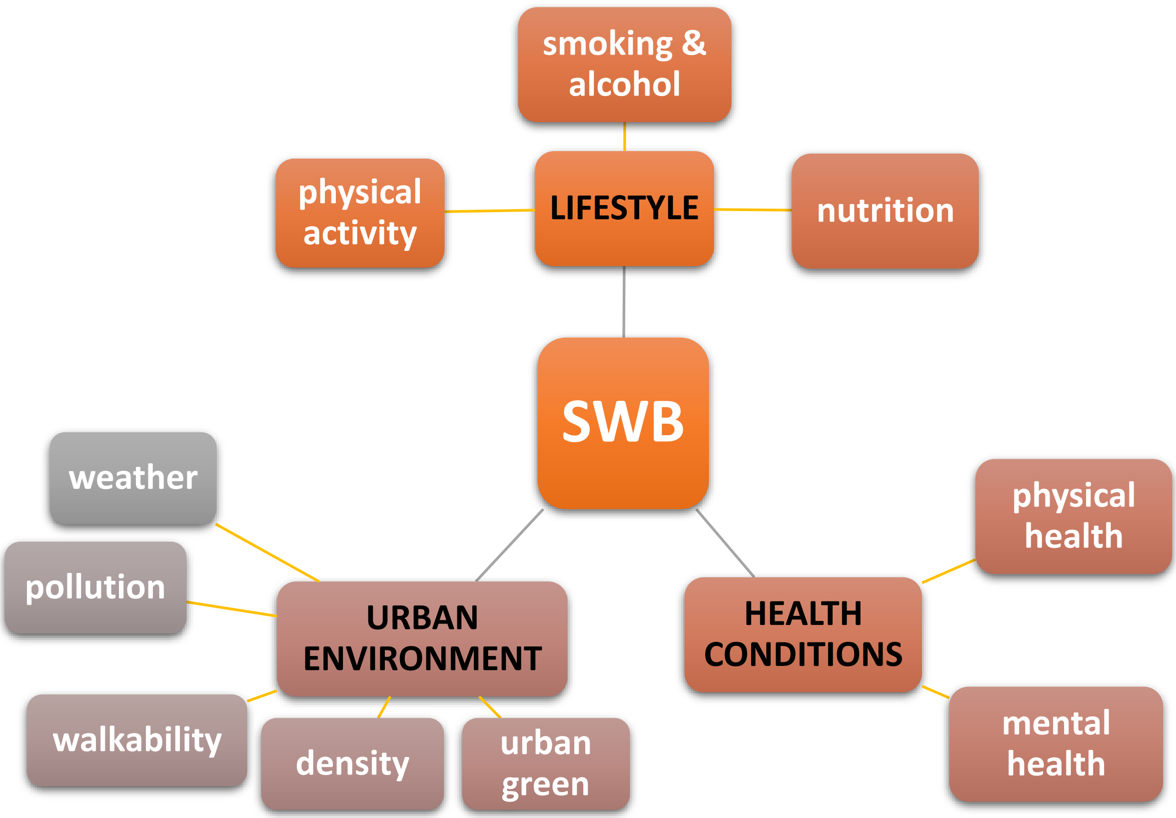

Figure 1. The key elements in our SWB analysis case study

2.1 Lifestyle – How the built environment can affect health through behavioral choices?

Lifestyle clearly includes more than just physical activity (Figure 1), but this is the aspect where the connection between lifestyle and urban environment is the most obvious and where the (direct and indirect) health-related effect has been thoroughly investigated by scientists (Bauman and Bull, 2007).

Sedentary lifestyle and physical inactivity have a strong negative impact on human health, and still it is quite frequent that people do not have the minimum suggested amount of physical activity (WHO) in a day (Wen *et al.*, 2011). Although it could be partially achieved through one of the simplest examples of how the design of the built environment can affect health through behavioral choices: by using stairs in public spaces. Unfortunately, these stairs are usually neglected by most of the people if there are other alternatives (e.g. ramp, escalator, elevator) (Gehl, 2010; Schneider, 2011).

A more complex and usually indirect connection can be identified by analyzing the accessibility of specific urban functions such as urban parks, or shops providing fresh and healthy food or ingredients (Walker, Keane and Burke, 2010; Schneider, 2011; Wolch, Byrne and Newell, 2014; Ekkel and de Vries, 2017). If people have destinations from their home within 1 km (or even 0.5 mile), it is more likely that they will be more active physically in total (Frank *et al.*, 2005;

Kligerman *et al.*, 2007). It has been scientifically proven that people living close to parks, trails, and recreation facilities use these facilities more often, also in the form of various recreational physical activities (Davison and Lawson, 2006; Bauman and Bull, 2007; Kaczynski and Henderson, 2007). However, building and improving these facilities is not enough on its own to have a more active population – marketing and different campaigns are also required (Schneider, 2011).

The most complex and slightly less unequivocal relationship between the built environment and health is the role of walkable, mixed-use neighborhoods. According to Saelens et al. (2003) adults tend to walk more if their neighborhood's road network has high connectivity, mixed land use and high population or residential density. A well-connected street network can result in shorter routes to facilities, while higher density supports retail functions or even perceived safety (Jacobs, 1961; Frank *et al.*, 2005). The concept of walkability also includes the condition of sidewalks, safe crossings, traffic-calming elements, or even streetscape and other qualitative aspects, when it comes to walk or not in an area, especially for youths (Frank *et al.*, 2005; Carver, Timperio and Crawford, 2008)(Carver, Timperio and Crawford, 2008) . According to King et. al (2006) the perception of walkability has clearly a strong influence on actually performing regular physical activity. Yet, the question can be raised immediately: do these people really walk more because the environment promotes it, or due to residential self-selection they wanted to live in a neighborhood like this because they prefer walking over driving?

Overall, it is important to emphasize that design is just one aspect of influencing people's lifestyle and therefore its efficiency depends on many other aspects as well, such as personal motivation, or the social environment leading to individual decisions. The environment might promote healthy lifestyle choices for a few people in the neighborhood, and have almost no impact on other residents.

2.2 Environment – What is the role of natural environments in facilitating good quality of urban life?

In our work we use the term "environment" referring to everything outside the residents' home, it can be built with houses and roads or natural with urban green and water bodies. However, in this section we focus on the relevance of natural environments in urbanized areas.

Nature and the contact with it can have various forms in cities, ranging from parks and green facades to community gardens or even street trees only seen from inside. Humans need for contact with nature must root in our evolutionary development – it is also called *biophilia* (Kellert, 1993). Among others, contact with nature can improve cognitive abilities through attention restoration (Berman, Jonides and Kaplan, 2008), reduce stress (Hartig and Kahn, 2016) and even provides an important role in the development of children by facilitating perceptual and expressive skills or imagination (Louv, 2008). Furthermore, nature contact can also provide social support and community development (Chiesura, 2004; Kim and Kaplan, 2004). Therefore, natural environment has a positive impact both on physical and mental health.

Nature, especially trees and green areas have also less direct but more practical effects on residents' health by improving air quality or the microclimate through evaporation and cooling the temperature of the surface (Hartig *et al.*, 2014; Maimaitiyiming *et al.*, 2014; Wolch, Byrne and Newell, 2014).

3. Study area

Our case study was performed in the city of Innsbruck, Austria. Innsbruck is the capital of the province Tyrol and has a population of around 132,000 residents (Innsbruck, 2018). The city is located in a broad valley crossed by the river Inn, surrounded by high mountains that are parts of the North Chain in the Karwendel-Alps (Figure 2). This geographic setting has a strong influence on the local weather and climate, mostly by the occurance of the so-called foehn wind (Bammel and Kilian, 2009; MeteoGroup, 2019). This type of wind is dry and warm and develops on the downwind side of the mountains. It can cause a significant rise in the temperature locally in a very short time, compared to the opposite side (windward) of the mountain, at the same elevation. Due to the rapid changes in the weather (temperature, air pressure, humidity, etc.) the foehn is associated with various health symptoms for those who are more sensitive, such as headache or even circulatory problems (Tuller, 1980).

Concerning the traffic infrastructure of the city, Innsbruck has an airport providing national and international flight connections, as well as a major motorway (A12) runs near the city granting also fast connection between Germany and Italy. Both of these infrastructures can have an impact on residents' health mostly due to the air and noise pollution in their vicinity (Figure 2). In our analysis, we intended to investigate the impact (both direct and indirect) of noise and air pollution on the residents, however the connection between these factors and the SWB is complex.

Urban green has many advantages not just on the health of the residents, but even on their social contacts or sense of belonging in the case of publicly available green areas such as parks. In Innsbruck 79,2% of the area of the city is green (European Environmental Agency, 2017), which is one of the highest value in Europe. According to the European Environment Agency clustering, Innsbruck is a "Natural city", due to its very high proportion of green urban and Natura 2000 (nature conservation) areas.

The doctor's office where the SWB data were collected is located in the city center. In the Austrian healthcare system the patients can choose their doctors freely, they are not bound to one based on their address. Thereby the location of the office did not influence directly the distribution of the patient's within the city, resulting in a relatively even distribution all around the administrative area of Innsbruck (Figure 3).

4. Data

For our analyses we used three major types of datasets:

a) *Data collected at the doctor's office*: this includes the questionnaire about subjective well-being and lifestyle, along with the diagnosis of the people.
b) *Official datasets*: For calculating the environmental (spatial) variables, we collected official datasets from either the city administration or the respective authorities for the Tyrolian administration. We also used the Urban Atlas as source, which is maintained by the European Environment Agency (European Environmental Agency, 2012).
c) *OpenStreetMap (OSM)*: The basis of the spatial analyses was OSM that is a crowdsource map, maintained by volunteers. We used OSM for extracting the street network and geolocating the addresses of the patients. OSM also contains information about the location of street trees, which we also used in our analysis.

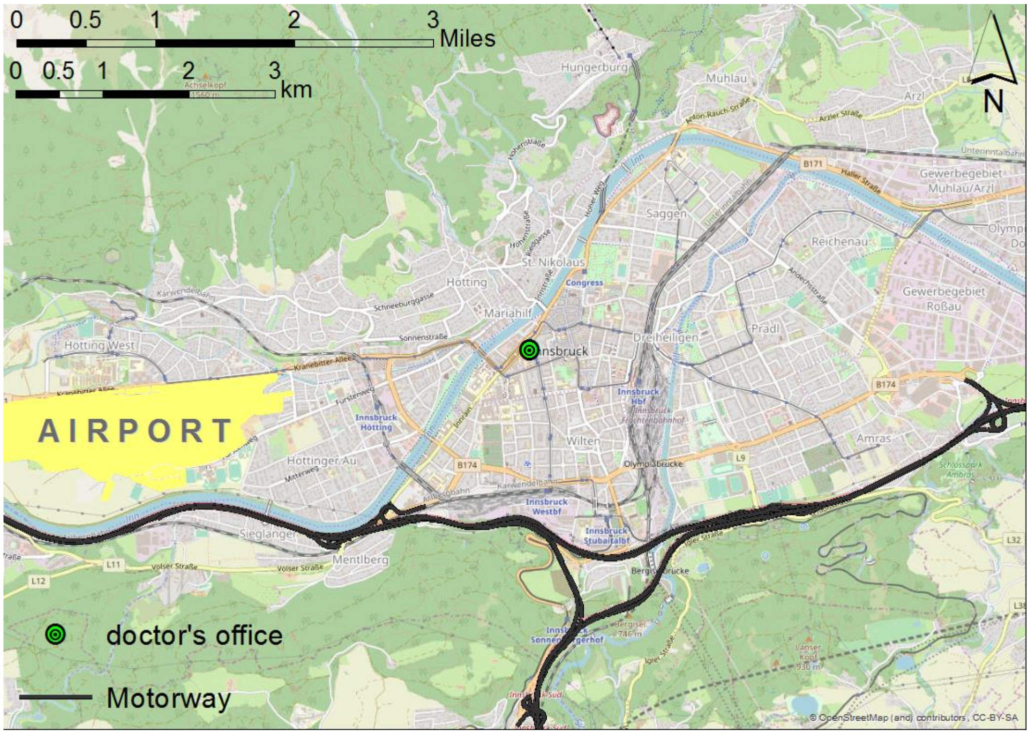

Figure 2. Study area (airport, motorway, doctors' office highlighted)

In the first category (doctor's office data) each record contains the address and ID of a patient along with the date when they visited the doctor and the self-reported SWB value. This value is the answer to the question: "On a scale from 1 to 6 how well do you feel today?". 1 is the lowest score, representing lowest satisfaction, and 6 means "very good". For many patients, there are further information available related to their lifestyle regarding physical activity, smoking, alcohol consumption, etc. and their diagnosis along with medication if applicable. Our analysis mainly focused on the SWB values but in some cases we also used the data on lifestyle and health conditions.

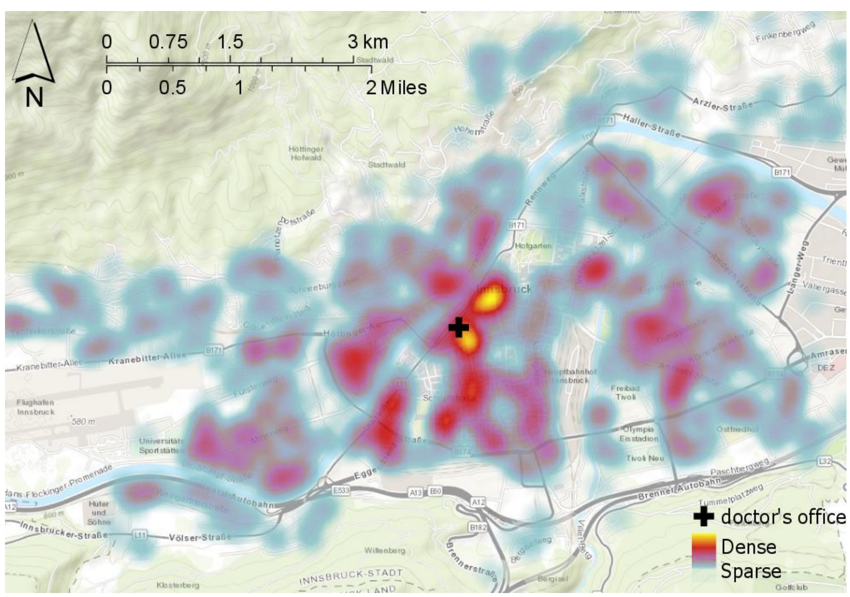

Figure 3. Distribution of the patients' home locations

Data provided by the authorities included air and noise pollution measurements. Air pollution data were provided in an aggregated format for administrative units called "Sprengel" in German (Amt der Tiroler Landesregierung - Abteilung Geoinformation, 2017). The data represents emission values, namely the amount of pollutant emitted by different sources in a given unit of time (hour, year, etc.). The provided dataset contains the yearly amount of 22 different pollutants (e.g. SO_2, CO_2, or cadmium) for each spatial unit according to different sources (e.g. households, industry, traffic). Noise pollution values were visualized as polygons representing the affected area along with the level of noise in decibels (e.g. 65 decibel - every 5 decibel is a new level). Similar to the emission data, in the case of noise pollution the source was distinguished as well: street traffic, rail traffic, air traffic or industry all had their polygons respectively (Umweltbundesamt, 2017). There are two different types of temporal aggregations: values represent either the 24 h average or only the nighttime average.

Urban Atlas is a remote sensing imagery-based dataset providing high-resolution land use maps for each city in the European Union that has a population of at least 100,000. For Innsbruck, there were two types of data available, (i) general land use categories, and (ii) street trees canopy extent. There are 17 different urban classes based on land use and density, ranging from residential areas (urban fabric) to even airports or construction sites. The minimum mapping unit is 500 m^2.

OpenStreetMap was used to extract the road network and its characteristics, along with the location of street trees. There are various road classes used, which helped to identify more walkable areas with a good approximation by selecting road types such as pedestrian areas, or footways – however it was not possible to extract information on more qualitative aspects of walkability, which is beyond the scope of the current case study.

5. Methodology

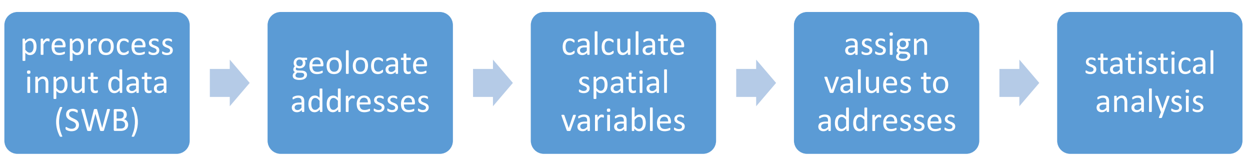

Figure 4. The overview of the workflow for our case study

Figure 4 represents the key steps performed in our workflow. The first step is the preprocessing of the input data containing patients' data and their self-reported SWB values. The preprocessing includes the selection of the patients with an address falling into the administrative boundaries of the city of Innsbruck, followed by the extraction of unique addresses and their IDs and fixing any errors with street names, or excluding invalid and duplicate records. After we have a final list of unique addresses, we assign geographic coordinates to each address that makes the further spatial analysis possible.

After we have the data cleaned, and all the addresses located on the map, we calculate all the spatial variables based on the input datasets listed in Section 4. As air pollution data is already aggregated on spatial units, we only have to summarize the values of each source for each pollutant in each spatial unit. Due to their impact on health, we selected NO_x, PM10 and PM2.5. Nitrogen is emitted during fuel combustion and then combines with oxygen in the air, resulting in nitric oxide (NO), which can take further oxygen and create nitrogen-dioxide. Nitrogen dioxide is an irritant gas, which at high concentrations causes inflammation of the airways. In large cities with high motorized traffic, the amount of nitrogen oxides as pollutants in the atmosphere can be especially high. Long-term exposure can lead to decrease in lung function, and increase the risk of respiratory conditions or the response to allergens (Icopal, 2011). PM10 and PM2.5 represents atmospheric aerosol particles, distinguishing based on their diameter (<10 and <2,5 micrometers). Their chemical composition is not considered, only their size. Particles smaller than 10 μm can already enter the human respiratory system, and the smallest particles (<2,5 μm) often accumulate in the lungs, thereby causing health problems in the long run. Similar to $NO_{x,}$ the main source of these particles in cities is motorized traffic (Brown *et al.*, 2013). To represent the overall exposure to these air pollutants, we construct an overall index for air quality based on three variables: nitrogen oxide (NOx), fine dust particulate matter 10 and fine dust particulate matter 2.5. For each of these variables, we build an indicator variable with entry 1 if the corresponding variable is above its median value, and zero otherwise. Then, we take the sum of these indicator variables and construct a new variable "air pollution" assigning a value of one if this sum is larger than 2, and zero otherwise. Consequently, a value of 1 (0) indicates bad (good) air quality.

To measure noise exposure, we generate an indicator variable taking entry 1 if noise at night at a specific address lies above the median value of all addresses in our sample. In a similar vein, we construct a variable for urban green based on the number of trees in the closer surrounding of the patients.

Finally, we build a binary variable for street network density based on two variables: We rely on road types that promote human scaled mobility (e.g., walking or cycling opportunities) and construct an indicator variable with entry '1' if the corresponding value of a certain address is above the median of the whole city (indicating good human scaled mobility conditions). Similarly, we use motor traffic roads to construct a binary variable, where '1' indicates good conditions. Taken together, we are able to employ a dummy variable for street network density. To calculate the input for the dummy variables in the case of street network density we use the Line Density tool in ArcGIS after grouping streets into two road type categories using the tags from OSM:

- promoting human-scaled mobility (class: *cycleway, footway, living street, path, pedestrian, steps*)
- or motorized traffic (class: *motorway, primary, secondary, service, tertiary, trunk*)

Following the categorization and the density calculation we define five density groups and assign each address to one of these categories (1 – very high density, 5 – very low density). Human-scaled road types can represent more walkable neighborhoods, whereas the other group with roads promoting motorized traffic can reflect rather negative aspects on health and quality of life due to cars, such as lower traffic safety or air and noise pollution.

The next step of the analysis is to assign spatial variable values to each address. Thereby we can statistically analyze how the SWB values of a person living at a given address is related to the environmental variables or in other words to investigate whether the environmental characteristics really have a clear influence on SWB. Do people from more walkable and green areas tend to report higher satisfaction? In the case of air pollution data, we perform a spatial join, as we assign the values of a "Sprengel" to an address falling into this given spatial unit. We represent the addresses by points, which is reliable in the case of larger spatial units, however the noise data is fine scaled so we intended to avoid any issues with the spatial resolution and considered a 25 m/82 ft buffer around the point representing the address before we performed the spatial join. Once we had this extra search radius, we calculate the average of each source for the same address (if there are multiple values falling into the 25 m /82 ft radius), and then take the sum of the the different sources to define the overall noise level. The original noise values in the data are averages, but when we summarize the different sources, sometimes we get a quite high value.

However it does not mean that the values are so high all the time, as most of the sources will not occur together constantly. Still, the different sources definitely add up in noise pollution so using these summaries we were able to represent areas where many different sources of noise are present. This means that although we have numeric values, they can be considered rather as a categorical values representing that one area has higher noise levels than another part of the city. Similar to the noise data, for the Urban Atlas density types we used a buffer, but this time bigger (100 m/328ft), as the data is less fine scale. Each address was assigned to the category, which they fall into on the map (or what is the closest to them within 100 m/328 ft). There were a few addresses outside the main residential areas, where a different category had to be assigned (non-residential), such as "isolated structures" or "Industrial, commercial, public, military and private units" (according to Urban Atlas land use categories). In the case of urban green and trees we considered walking distances from the address, such as how many parks/public urban green facilities or trees are present within a 100 m (328 ft) walking distance. As Urban Atlas has the information on trees as polygons instead of points (representing the actual tree crown) we summarized the area of the tree crowns within this 100 m/328 ft walking distance. This distance represents the kind of sight distance vicinity around one's home, what they can still see from their window or would encounter most of the time when leaving or arriving home.

The first step in our statistical analysis is to prepare descriptive statistics as a starting point regarding the distribution of the SWB values, also according to sex, age, physical activity, sleeping time and body-mass index (BMI). The follow-up of the descriptive statistic is performing regression analysis using the preprocessed values described above. Thereby we are able to investigate the statistical relationship of environmental factors and SWB values.

6. Results

Table 1 summarizes some descriptive statistics for our sample. We can see that the SWB-index is skewed to the left (with a median of 5 on a scale from 1 to 6), a pattern which can be observed in many happiness studies, especially for western countries (e.g Ozcakir *et al.*, 2014). 40% of our sample are females and the average age is around 44 years. 75% of the patient cohort exercises physical activity on a regular basis, the average sleeping time is around 7 hours and the average BMI is around 24.5. The lower part of Table 1 reports descriptives for our spatial and environmental variables. 46% of our sample experiences bad air quality according to our categorization. Regarding noise pollution during the night, we observe that 45% of the patients in our sample have bad noise conditions. Whereas in terms of urban green infrastructure, 49% of the sample lives in a green environment. Last, but not least, 72 % of the patients in our sample are living in good street network conditions, supporting walking and cycling.

Based on the variables reported in Table 1 we are able to apply regression analysis. For this purpose, we use the SWB as the dependent variable and estimate a linear least squared model (OLS) where personal characteristics (sex and age), lifestyle (physical activity, sleeping time), health status (BMI) and the urban environment (air pollution, noise exposure, urban density, urban green density and street network density) are treated as explanatory variables.[1] The corresponding estimation results inform about the relative importance of these variables.

[1] As the SWB is discrete and is censored between 1 (bad) and 6 (very good), OLS might produce biased estimation results. Alternatively, we constructed a binary variable taking entry 1 for SWB-values above 4 (or 3) and used a logistic regression model (probit equation). We obtained very similar results as in the OLS-model, at least in

Table 1: Descriptive Statistics (N = 2,232)

	Variable	Mean	S.D.	Min.	Max.
Patients' characteristics	SWB	4.57	0.99	1.00	6.00
	Sex [D]	0.40	0.49	0.00	1.00
	Age	44.28	18.66	12.00	98.00
	Sport [D]	0.75	0.42	0.00	1.00
	Sleeping time p.D.	7.19	1.11	2.00	12.00
	BMI	24.44	4.52	14.84	53.15
Urban environment	Air pollution [D]	0.46	0.50	0.00	1.00
	NO_x (kg)	2,722.25	4,853.63	206.29	59,575.29
	PM10 (kg)	262.32	316.51	24.52	3,595.38
	PM25 (kg)	187.83	219.31	17.14	2,245.43
	Noise exposure [D]	0.45	0.50	0.00	1.00
	Noise at night (DB)	48.36	29.27	0.00	147.50
	Urban density [D]	0.71	0.45	0.00	1.00
	Urban green [D]	0.49	0.50	0.00	1.00
	Number of trees	13.39	20.58	0.00	141.00
	Street network density [D]	0.72	0.45	0.00	1.00
	Human scaled mobility	3.02	1.18	1.00	5.00
	Motor traffic	2.69	0.91	1.00	5.00

Notes: [D] indicates a dummy variable with entry 0 or entry 1.

Table 2 depicts our estimation results. First, it should be noticed that we are not faced with serious collinearity issues (see Table A1 in the Appendix). Sex, physical activity and sleeping enter significantly positively, while age and the BMI is negatively related to SWB. These finding are in line with previous evidence (e.g. Ozcakir *et al.*, 2014).

Table 2: Estimation results

Variable		Coef.	S.E.
Patients' characteristics	Sex	0.279	0.042 ***
	Age	-0.002	0.001 *
	Sport	0.253	0.051 ***
	Sleeping time	0.146	0.023 ***
	BMI	-0.031	0.005 ***
Urban environment	Air pollution	-0.076	0.042 *
	Noise exposure	-0.093	0.042 **
	Urban density	-0.010	0.047
	Urban green	0.014	0.044
	Street network density	0.125	0.047 ***

Notes: Dependent variable: SWB; N = 2,232, R^2=0.09; constant not reported; ***,**,* indicates significance at the 1-, 5-, and 10-percent level.

qualitative terms. For this reason, and as the estimates of the probit model are more difficult to interpret, we decided to report only the OLS-estimates here.

Most importantly, the lower block of Table 2 shows the impact of the urban environment on the SWB. We estimate a significantly negative impact of air pollution and noise exposure on the SWB. In contrast, a better network density increases the SWB significantly. However, it seems that urban density and urban green are not decisive in explaining SWB, at least for Innsbruck, where there are not so huge differences in the density within the city and effective green infrastructure has a very high percentage for the whole area (European Environmental Agency, 2017). The magnitude of the parameter estimates indicate an important contribution of the urban environment in the order of the ones of health conditions or lifestyle decisions (e.g., the parameter estimate for street network density is very similar to the one of the sleeping time).

7. Conclusions

Although it is not advisable to draw too general conclusions about the connection between spatial variables and SWB based on just one case study; we can clearly argue that urban environment can have a direct impact on SWB, which is recommended to consider in many instances from research to planning. Mostly because the degree of this influence can vary from place to place. In the case of Innsbruck, this impact is apparently similar in intensity to lifestyle, which shows a higher overall relevance compared to the general findings of Lyubomirsky et. al. (2005) representing 10%.

When outlining the current study, we intended to consider key characteristics of both the patients' lifestyle and the urban environment surrounding them, without oversimplifying the actual conditions. Thereby we got a clear structure, with not too many variables and parameters, however this also brought some limitations. Based on the current results we are planning a more thorough analysis to provide more details about the role of each factor, considering further elements such as the weather, or the physical and mental health of the patients. Yet, there will be always factors in SWB and life satisfaction analysis that would bring unnecessary complexity, even though they would also provide new information concerning someone's current mood or general satisfaction. Factors like this are for example, family and relationship status, or occupation and study-related aspects. Therefore, the analyzed health, lifestyle and environmental-related variables can explain someone's SWB only to a given degree, and the list of factors might be representative but never complete.

Our results show statistically significant connections, however it is not always easy to prove that these factors would also explain the real causal effect on SWB. For example, a walkable neighborhood that usually supports human-scaled mobility can have higher real estate prices; and thereby maybe higher SWB is more related to the socio-economic conditions of a person living there than the actual ability to walk in the neighborhood, which is often just a "spill-over" effect of an affluent area. Still, we illustrated in the Background section that given factors (parks, pedestrian infrastructure) can encourage people to perform more physical activity. This can lead to better health conditions (both mentally and physically) and thereby these environmental factors do have an important but often indirect influence on SWB.

Overall, Gehl (2010) and others have already pointed out that supporting human-scaled mobility in a neighborhood can positively influence livability and also SWB in various ways. Our results also support this statement. By providing more attractive conditions for pedestrians (or cyclists) should also mean at the same time that motorized traffic gets limited, thereby decreasing noise and air pollution, which amplifies the positive impact of the environment on SWB. We encourage researchers from disciplines with less spatial focus to consider environmental factors in SWB analysis. Finally yet importantly, investigating qualitative environmental aspects along with the interest and satisfaction of the people can also be of higher relevance for planners and decision-makers in the process of making cities healthier and more livable.

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Appendix

Table A1: Correlation matrix (N = 2,232)

Variable		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
SWB	(1)	1.000										
Sex	(2)	0.107	1.000									
Age	(3)	-0.079	0.054	1.000								
Sport	(4)	0.114	0.033	0.046	1.000							
Sleeping time	(5)	0.173	-0.030	-0.069	-0.010	1.000						
BMI	(6)	-0.149	0.174	0.290	-0.046	-0.091	1.000					
Air pollution	(7)	-0.039	0.001	0.034	-0.002	-0.024	0.020	1.000				
Noise exposure	(8)	-0.039	-0.005	-0.053	-0.003	-0.001	-0.012	-0.016	1.000			
Urban density	(9)	0.015	-0.001	-0.053	0.015	0.027	-0.025	-0.151	0.090	1.000		
Urban green	(10)	0.017	-0.009	-0.058	-0.009	0.007	-0.079	-0.196	0.153	0.249	1.000	
Street network density	(11)	0.060	-0.011	-0.051	0.016	0.018	-0.048	0.125	0.056	0.090	-0.030	1.000