

# **“Examining the Relationship between Selected Urban Determinants and Respiratory Diseases in Alexandria, Egypt”**

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## **1. Introduction**

The world is witnessing rapid expansion in its urban environment, with increasing population moving to cities. This condition is directly affecting the standard of living of individuals as well as imposing serious health risks to the local communities. Urban areas usually show increasing signs of environmental stress: loss of open space, traffic congestion, noise and air quality degradation (Fenger et al. 1998). Other health risks in urban settings might include road traffic accidents, injuries, contaminated food or water, exposure to infectious diseases and non-communicable diseases. These, in turn, are associated to a wide range of inter-related spatial and socio-economic urban characteristics that directly influence health conditions and prevalence of diseases.

In this respect, Corburn (2004 ), Thompson (2007), PHAC (2010) and others emphasize the importance of understanding how different urban forms, urban settings and urban contexts affect the well-being and health of the population. The reconnection of the study of health to urban planning could provide an understanding of health as a continual and cumulative interplay between exposure, susceptibility, and resistance, all of which occur at multiple levels (e.g., individual, neighborhood, national), in multiple domains (e.g., home, work, school, community) and in different urban configurations (e.g. densities, building heights, accessibility to adequate ventilation and sunlight).

### *Health and the Urban Environment*

Several authors have proposed frameworks for considering the relation between city living and health, and they have identified features of the urban context that may be particularly important for specific diseases. Smith (2010) suggests that some elements of the built environment (e.g. densities, land use mix, street connectivity) could influence both physical and mental health conditions, including asthma and other respiratory conditions, injuries, psychological distress, and child development. Similarly, Gebel et al. (2005) identify associations between healthy physical activity and high population density, mixed land use, and street and urban form connectivity. The correlation between some psychosocial factors, such as social support and depression and heart health was studied by Diez Roux (2003), suggesting evidences that these might be affected by the physical design of neighbourhoods.

Finally, in terms of land use pattern, air pollution and noise exposure are two identified stressors with greater impacts on health. In high density/ high rise urban areas, both stressors show higher values above the healthy established limits, leading to various types of health risks and reduction of life expectancy (URBAN-NEXUS WP3 2012). In the same context, there are evidence that several respiratory diseases, like allergies and asthma, are directly related to urban related factors such as proximity to busy roads, high traffic density and increased exposure to pollution (Corti et al. 2012).

### *Situation Analysis*

According to WHO(2010), Egypt is the second most populous country in the WHO Eastern Mediterranean Region. Today, Egypt suffers from two critical urban problems; over-urbanization and over-concentration. First, the over urbanization problem exists, due to high rates of population growth, in addition to the effect of rural-urban migration that pushes the urban growth rate to be about 4% annually during the past four decades. In addition, nearly 40% of the population lives in urban areas, with much of the population living in crowded conditions. In some areas of Cairo and Alexandria, the number of persons per square kilometer exceeds 100 000. Second, the over concentration of the urban migrants occurs in two cities “Cairo and Alexandria”, rather than being distributed through different urban areas. This over concentration in primate cities creates such an imbalanced urban structure both of its hierarchy and its spatial distribution.

Egypt, like many other developing countries faces a dual disease burden: a persistent though much diminished communicable disease burden and a large and rapidly growing non-communicable disease burden including mental health related diseases. According to WHO (2010), Non-communicable diseases (NCDs) are currently the leading national cause of death in Egypt. NCDs are estimated to account for 82% of all deaths in Egypt and 67% of premature deaths. Neuropsychiatric, digestive diseases, chronic respiratory diseases, cardiovascular diseases and diabetes are the major NCDs diseases whose incidence continues to increase. Diabetes mellitus affects nearly 3.9 million people in Egypt, and its prevalence is expected to increase to 9 million by 2025 (Ismail 2011). In a WHO (2014) survey, a significantly high prevalence of risk factors for NCDs among the Egyptian adult population in urban areas was revealed. It demonstrated that Egypt has one of the most overweight populations in the world, with 66% of women overweight and 42% obese and almost three quarters of the population

not involved in vigorous activity, a 17% prevalence of diabetes and a 40% prevalence of hypertension.

The aim of this research is twofold: (a) to examine some urban quality/wellbeing determinants in different urban typologies in Alexandria city, Egypt, and (b) to investigate the relationship between specific urban determinants and the prevalence of respiratory diseases in the city.

## **2. Methods and Implementation:**

### *Adopted Methodology*

The research adopts a four-steps method: Data collection of both urban determinants and health records, preparation and processing of collected data, spatial analysis, and statistical data analysis.

The data collection is conducted for both urban determinants and health records. According to table (1), 12 urban parameters are selected for analysis. The parameters are collected from different sources (GOPP 2011; CAPMAS 2006; INP 2014) at the neighborhood (*Shiakha*) level. In future studies this list of parameters could be expanded to include additional urban and socio-economic parameters. The health records are also selected at the level of medical units across Alexandria city. The records are collected from year 2011 data from several sources (CHDIC 2011; EEAA 2011). Records of respiratory diseases are collected and examined in terms of data availability, accuracy and consistency. Data are selected from only 24 medical units in four (*Sharq, Wasat, Gharb and El Gomrok*) out of the seven city districts.

The processing and analysis of data include the normalization and weighing of the urban parameters using the "Probability Density Function" (PDF) algorithm (Figure 1). The normalization process magnifies the dominant values (most frequent values and within + or - two standard deviations) and reduces the influence of the low frequency data that are out-layered, to produce more precise results. The PDF algorithm is also used to filter and smoothen the value of the parameters to enhance and clarify the dominant factors. Next, the

output attributes and ‘urban quality’ are spatially classified into three classes using the “Natural Breaks (Jenks)<sup>2</sup>” classification method in ArcGIS ©, version 9.3.

In addition, each of the 24 medical units are georeferenced using the ArcGIS ©, version 9.3. Each point represents its spatial location on the map and contains the number of patients suffering from respiratory diseases that visited that medical unit during the year 2011. Points are then interpolated to present the distribution and intensity of the disease in the study area.

*Table (1) List of selected urban determinants*

<b>Attribute</b>	<b>Parameter</b>
Cluster 1: Urban aspects	Population density
	Built up density
	Floor area ratio
	Building rise
Cluster 2: Socio-economic aspects	Occupancy rate
	Unemployment rate
	Illiteracy
	Income
Cluster 3: Environmental aspects and air quality in the study area	Proximity to main roads
	Proximity to industrial areas
	Distance from the sea
	Distance form open spaces

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<sup>2</sup> The "Natural breaks" or "Jenks" classification method is a data clustering method designed to determine the best arrangement of values into different classes. ArcMap identifies break points by picking the class breaks that best group similar values and maximize the differences between classes. The features are divided into classes whose boundaries are set where there are relatively big jumps in the data values.

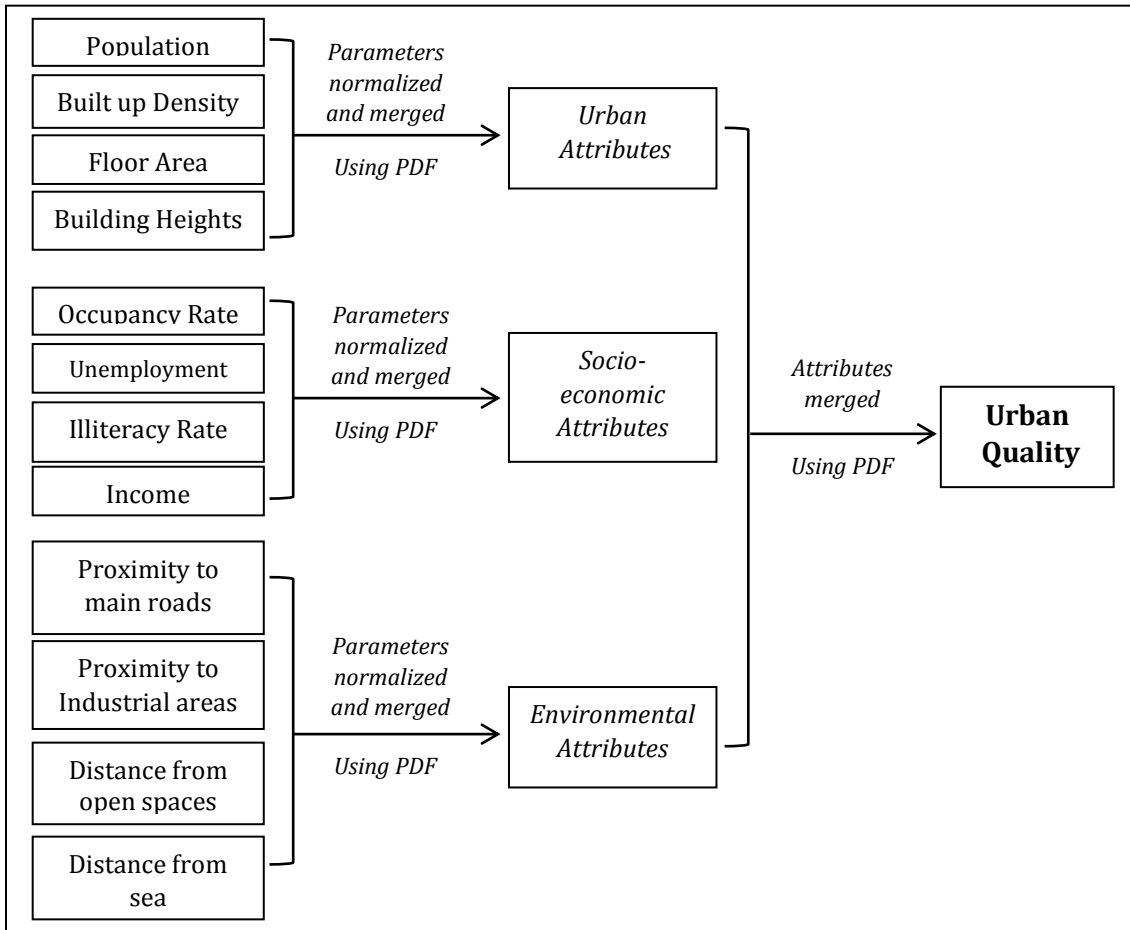


Figure (1): process of grouping parameters and attributes

The data is statistically inspected, cleaned, transformed and modeled with the goal of discovering useful information, suggesting conclusions and supporting decision making. A filtering process is adopted in order to smooth the data and to create an approximating function that attempts to capture important patterns in the data, while leaving and removing out noise. Short-term variations are removed to reveal the important underlying unadulterated form of the data. The different smoothing algorithms involve the input data with different coefficients. In smoothing, the data points of a signal are modified so individual points (presumably because of noise) are reduced, and points that are lower than the adjacent points are increased leading to a smoother signal. Smoothing may be used in two important ways that can aid in data analysis (1) by being able to extract more information from the data as long as the assumption of smoothing is reasonable and (2) by being able to provide analyses that are both flexible and robust.

Finally, the relationship between the different selected urban determinants and spatial distribution of respiratory diseases is examined. To enhance accuracy, only urban data that are within a distance of 300m of the medical units are used in this step. This data is refined using the elliptical method of the nearest neighbor algorithm to provide inferences on trends of variability. Lastly, the Pearson coefficient correlation is adopted to quantify and display the relation between the urban determinants and the health records.

## **2.1 Results and Discussion**

### *Spatial data analysis*

The processing and analysis of the three attributes (urban, socio-economic and environmental) are presented in figures (2,3 and 4). Three colour classes are depicted in each spatial analysis; green, representing the best condition for each attribute; yellow, representing the moderate condition; and red, which represents the worst attribute condition.

The examination of the urban attribute reveals the prevalence of the moderate urban condition in the four selected city districts (60.5%). In this class, the four parameters (population density, built up density, FAR and building rise) are contributing almost equally to its value . Furthermore, the worst urban condition accounts only for 10% of the total study area. This class is mainly distributed on the urban fringes as well as in parts of the old city core. It is also noticed that the contribution of the population density in this classification is always the highest in the three classes.

In contrast, the spatial distribution of the values of the socio-economic attribute uncovers a completely different pattern. Whilst the moderate socio-economic condition still dominates the urban context in the study area (40.5% of the total area), it is closely followed by the high (32.5%) and low (27%) socio-economic conditions. Also the spatial distribution of the three classes are well-defined, with the lowest socio-economic conditions located towards the western city expansions as well as on the southern urban fringes. It is also noticed that the four parameters constituting the attribute (unemployment, illiteracy, occupancy rates and average income) are contributing with nearly equal weights to the final value of each class.

Finally, the classes of the environmental attribute exhibits high spatial fragmentation rates. The low environmental quality is the largest in terms of area coverage (36.5%). Amongst the four parametrs constituting the attribute (proximity to industrial settings, roads, open spaces and water bodies), the proximity to industrial settings has the major effecton the final value of the three classes.

In figure (5), the three attributes are merged to produce the urban quality spatial distribution. In this map a clear separation between the three classes/values is depicted: the good urban quality covers the northern part of the city and accounts for 25% of the total study area, the moderate urban quality is located in the middle (40%) and lowest urban quality in the south (urban fringes and new expansions) and accounts for 35% of the total area. It is also noticed that the three attributes (urban, socio-economic and environmental) are contributing nearly in equal weights to the final value of each of the three urban quality classes.

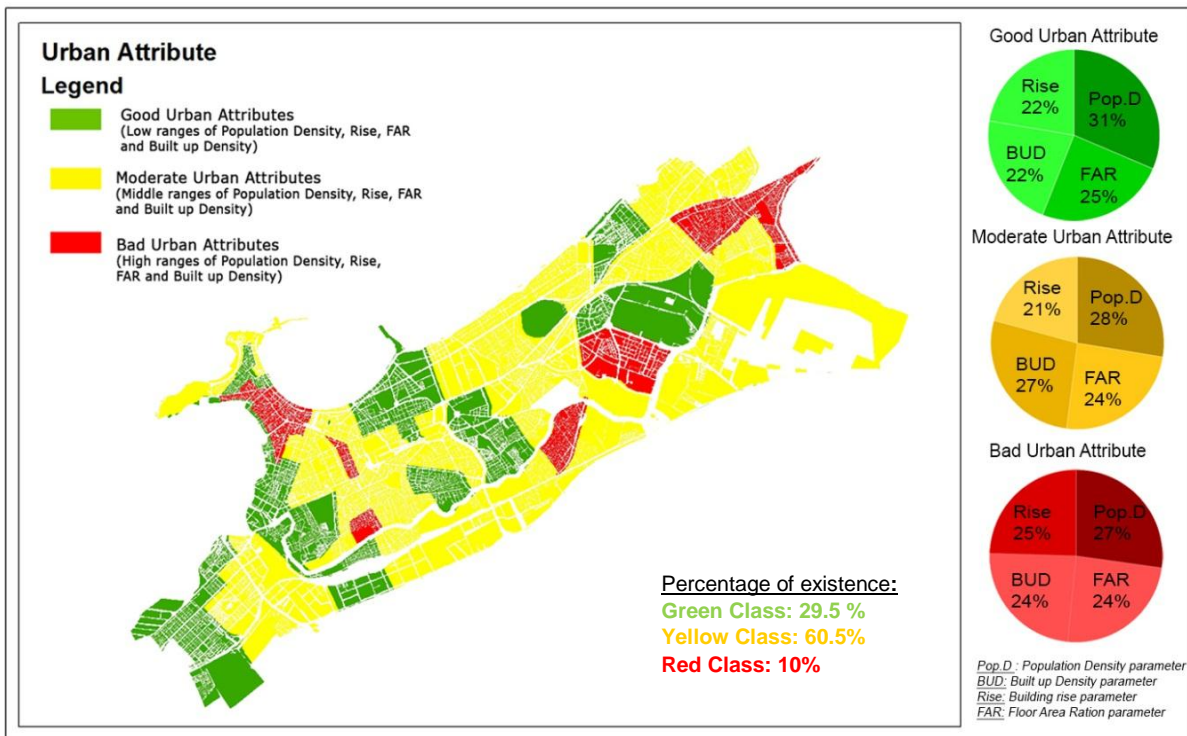


Figure (2) Spatial Analysis of Urban Attributes and contribution of parameters



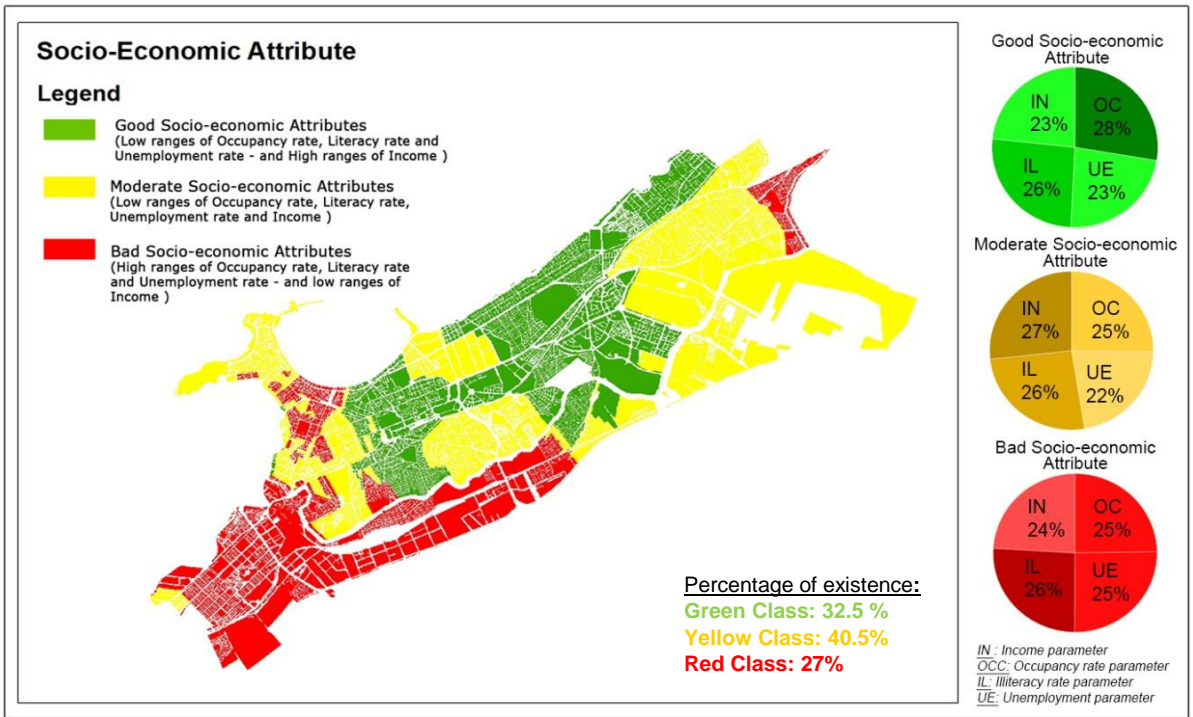


Figure (3) Spatial Analysis of Socio-economic Attributes and contribution of parameters

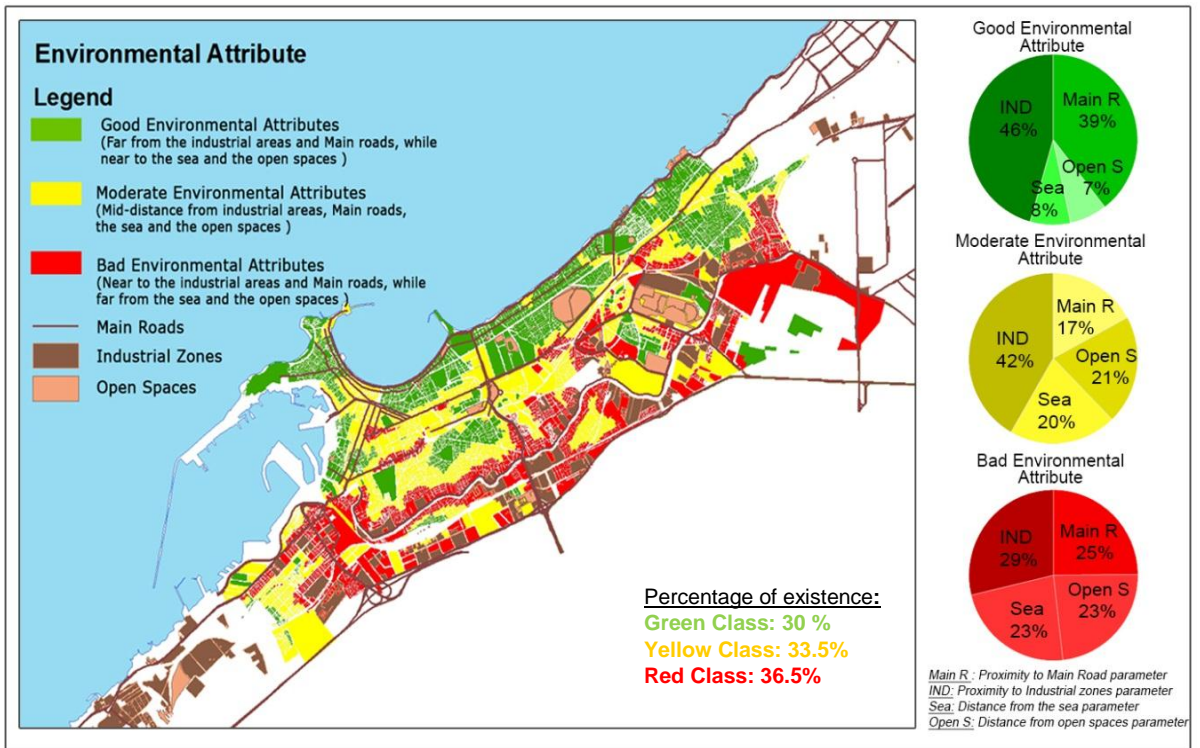


Figure (4) Spatial Analysis of Environmental Attributes and the contribution of the parameters

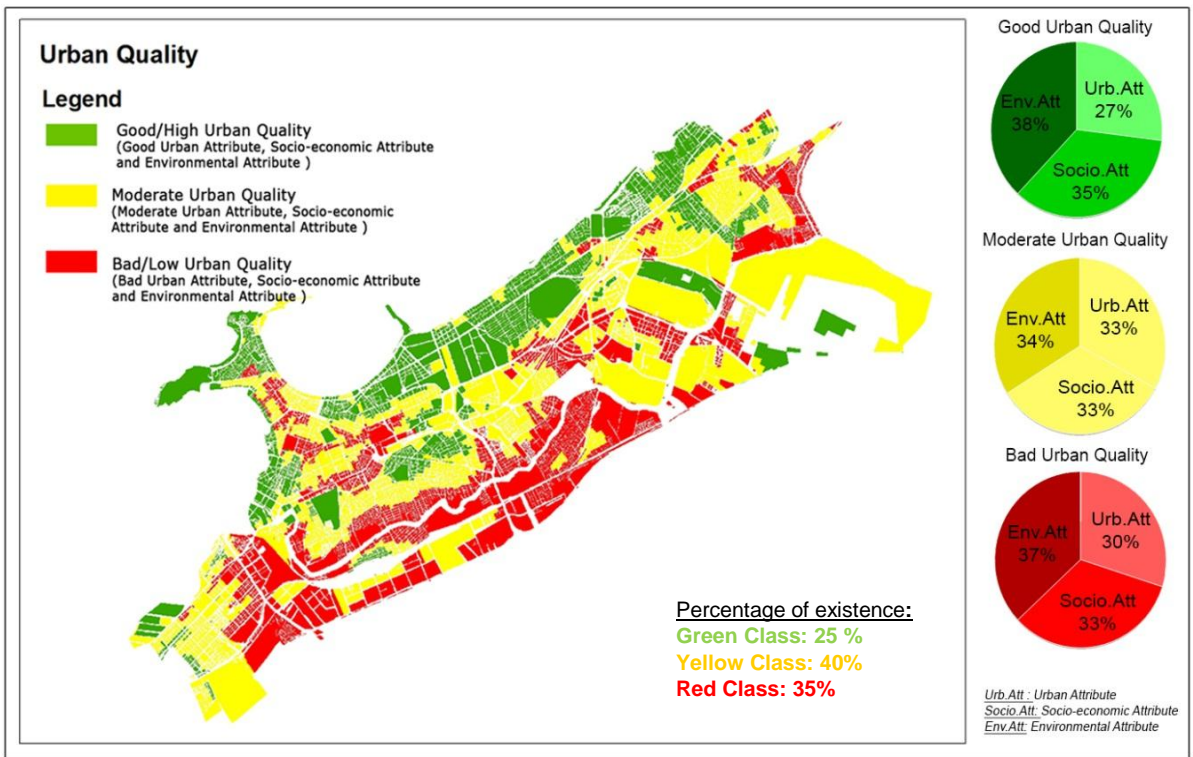


Figure (5) Spatial Analysis of Urban Quality and the contribution of the Attributes

The spatial distribution of respiratory diseases is presented in figure (6). The frequency of occurrence is depicted in four classes with the highest class located in the core and fringes of the study area. and shows the spatial distribution of patients with respiratory diseases across the study area. In general, it is observed that the respiratory diseases are spatially distributed as a nodal pattern. The green class exists in a large zone at Gleem zone in SharqDistrict, it also exists at El Gomrok District; at the arm of the harbor. The green class covers small nodal areas. The yellow and orange classes cover the largest zone of the study area. The red class, which represents the largest number of patients with respiratory diseases is found at the heart of the study area at Moharambeih, Ezbet El Game' and parts of EzbetSa'ad.

The last step of the spatial analysis is the overlapping of the urban quality attributes with the respiratory diseases distribution map (figure 7). The visual inspection of the overlap could reveal some relation between the nodes of high disease intensity and location of low and medium urban qualities.

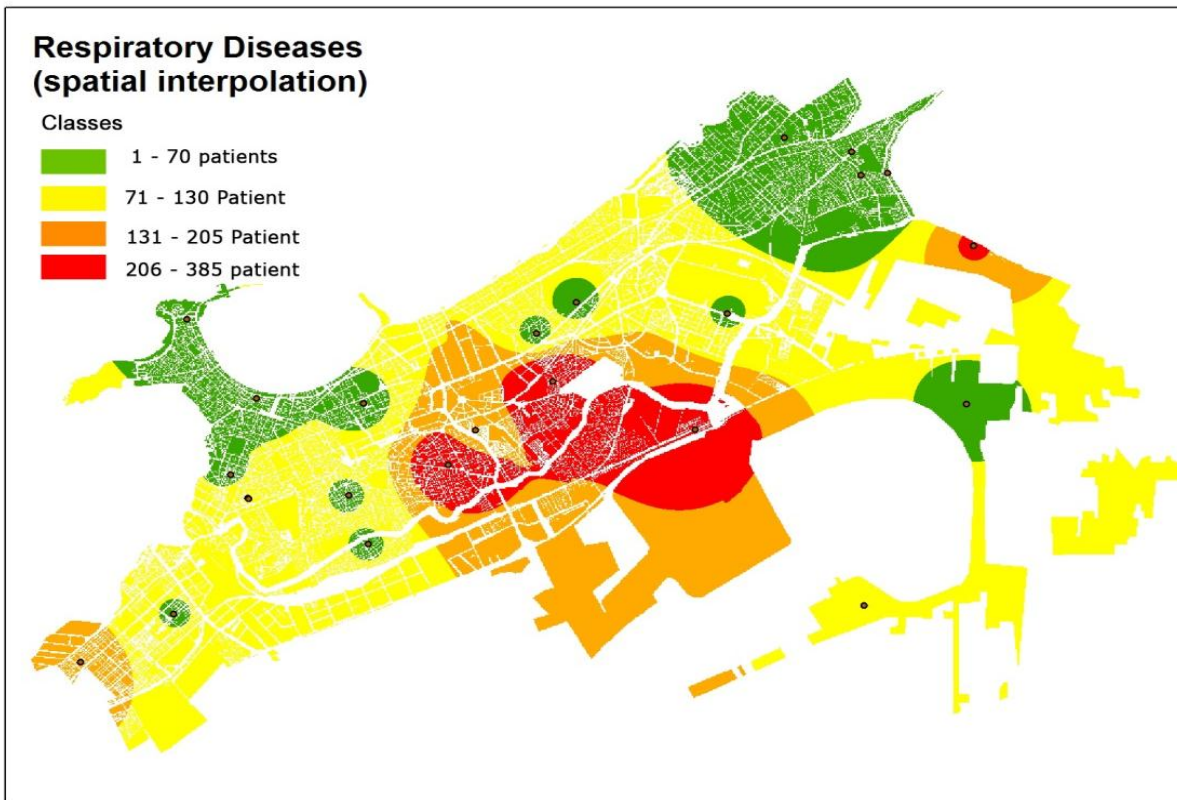


Figure (6) Interpolation to Respiratory Diseases

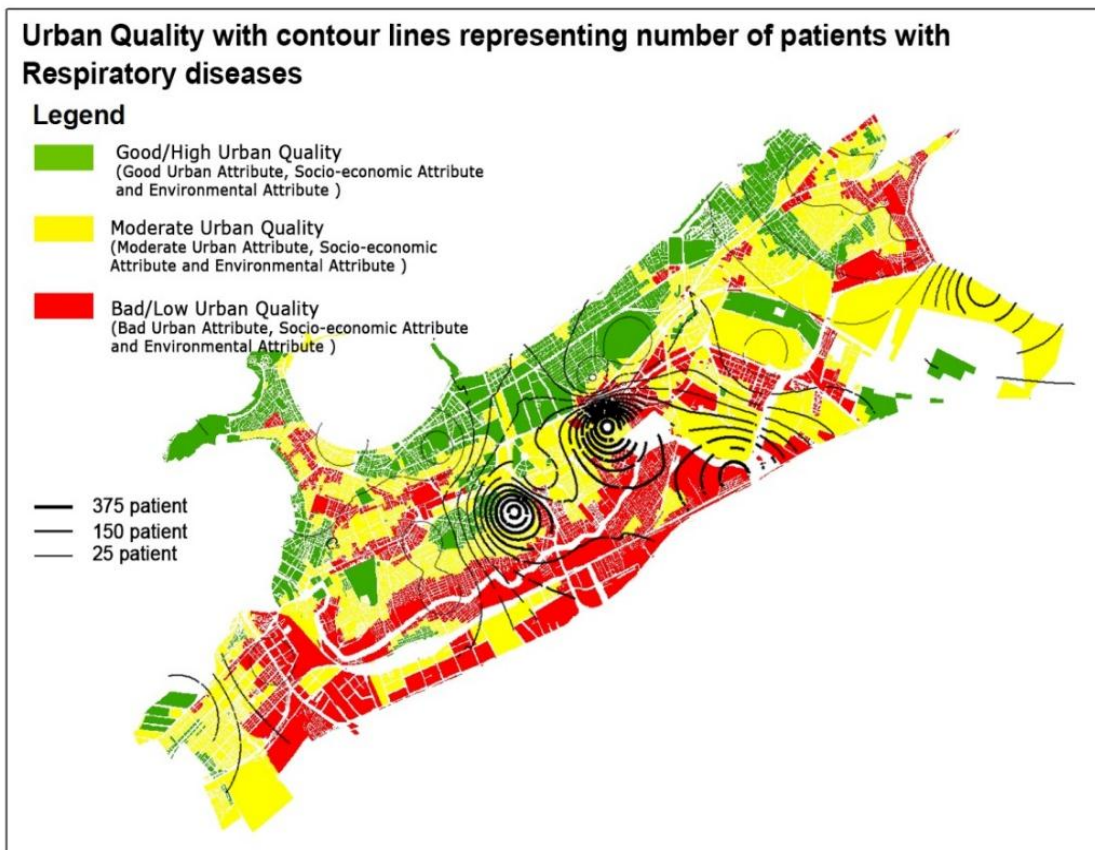


Figure (7) Urban Quality with contour lines depicting number of patients



*Statistical Data Analysis*

Through the process of iteration, it was found that there are two patterns on the scatter plot charts. These two patterns represent the distribution of the points (medical units) with respect to their spatial location. The first pattern contains the medical units that received the high number of patients suffering from respiratory diseases in year 2011. The second pattern contains the medical units that received low number of patients. Accordingly, the correlation analysis between the urban attributes and the spatial occurrence of respiratory diseases is presented in tables (2,3 and 4). In general a significant and positive correlations could be easily depicted.

*Table (2): Pearson correlation and significance of Urban Attribute*

Correlation Coefficient <i>Significance (α=0.05)</i>		Significance	Scatter Plot Chart
<b>URBAN ATTRIBUTE</b>			
Pattern 1:	<i>0.922 (0.729)</i>	<i>High significance</i>	<p>The scatter plot displays the relationship between 'Urban Attribute' (x-axis, 0 to 1) and 'Respiratory Diseases' (y-axis, 0 to 400). The data points are clustered into two distinct groups. 'Pattern 1' is the upper cluster, characterized by high values of respiratory diseases (approx. 150-350) and moderate urban attributes (approx. 0.3-0.7). 'Pattern 2' is the lower cluster, characterized by low values of respiratory diseases (approx. 0-100) and moderate urban attributes (approx. 0.3-0.7). A 'Total plot' label encompasses the entire set of data points.</p>
Pattern 2:	<i>0.450 (0.426)</i>	<i>Low significance</i>	
Total number of medical units:	<i>0.420 (0.360)</i>	<i>Moderate significance</i>	

Table (3): Pearson correlation and significance of Socio-economic Attribute

Correlation Coefficient <i>Significance (<math>\alpha=0.05</math>)</i>		Significance	Scatter Plot Chart
<b>SOCIO-ECONOMIC ATTRIBUTE</b>			
Pattern 1:	0.822 (0.729)	Moderate significance	
Pattern 2:	0.533 (0.426)	Moderate significance	
Total number of medical units:	0.683 (0.360)	High significance	

Table (4): Pearson correlation and significance of Environmental Attribute

Correlation Coefficient <i>Significance (<math>\alpha=0.05</math>)</i>		Significance	Scatter Plot Chart
<b>ENVIRONMENTAL ATTRIBUTE</b>			
Pattern 1:	0.860 (0.729)	Moderate significance	
Pattern 2:	0.627 (0.426)	High significance	
Total number of medical units:	0.431 (0.360)	Moderate significance	

Table (5): Pearson correlation and significance of Urban Quality

Correlation Coefficient <i>Significance (<math>\alpha=0.05</math>)</i>		Significance	Scatter Plot Chart
<b>URBAN QUALITY</b>			
Pattern 1:	0.747 (0.729)	Low significance	
Pattern 2:	0.568 (0.426)	Moderate significance	
Total number of medical units	0.380 (0.360)	Low significance	

### 3. Conclusion

The aim of this study is to investigate the relation between the urban determinants and their impact on the health of the public. The methodology adopted in this study joined between the spatial and statistical analyses and dealt with the whole city as an integral system. That said, the findings of this study were generally consistent and supported the current view that urban design and planning determinants can affect the physical health of the population. The level of impact differs from one determinant to another.

The results of analyses generally depict that there is little clear evidence that increasing population or dwelling density is directly associated with increased health complications. Furthermore, it is apparent that the proximity to busy roads, high traffic density and pollution are strongly linked to various respiratory illnesses. However, it should be noted that investigating the relationship between respiratory diseases and health wasn't a smooth process, due to :

- Data availability: In order to conclude a more precise and a more decisive result more detailed data are needed (e.g. distribution of patients according to residence and place of work). The availability of these data could have enabled the study of a more accurate impact of the built environment on health issues.
- The study of the determinants of urban health is complex. Cities are constantly changing resulting in differences in living conditions. City-level analysis presumes a degree of homogeneity in individual behaviors. However, city-wide characteristics are not necessarily equally shared by all of its inhabitants. Further determinants are needed to quantify the strength of association between urban determinants and urban health.

To sum up, the result of this study could assist in the formulation of future urban intervention strategies in the cities, and calls for a multidisciplinary/system oriented approach to promoting health and well-being. Promoting health equity through urban planning, and thus building healthy cities, should become a major goal for urban decision makers.

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