Contribution to the discussion on healthy cities: analysis of the correlation between the MHDI and the presence of public open spaces in the city of Recife/PE

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SUMMARY

In Brazil there is an intuitive comprehension of the idea that open and green spaces affect the quality of life, but there are few effective correlation studies about the aspects that most contribute and support efficacious interventions in cities and their degree of relevance. In Europe and other countries, such as Canada, efforts have been made since the late 1980s to understand the contribution of these open spaces to quality urban living. Aiming to identify the intensity of this correlation in Brazil, and more precisely in Recife/PE, this paper explores the variables of the MHDI in different ways, as they relate to the concept of quality of life through the availability of public open spaces in the city. To support the study, a review of the literature about healthy cities, quality of life and open and green spaces was carried out, as well as an analysis of the available indexes that reflect the correlation of these concepts. As a result, the study identified a weak correlation between the MHDI variables and the presence of open spaces, including paved and green spaces; but also a better correlation when only the spaces with the largest vegetation coverage were considered. Finally, the study emphasizes the need to carry out new research based on other aspects of quality of life, in particular those related to health already contemplated in the international literature, to foster healthier cities in Brazil through a more efficient implementation of open space systems.

KEYWORDS: Healthy Cities. Longevity. Open space systems.

1. INTRODUCTION

In the urbanism literature there is a tradition of associating urban green areas with the promotion of quality of life in cities. The establishment of green areas in cities surges for this purpose in the 19th century, in the early stages of urbanism, always associated with the need for spaces of social intersection and health.

For many years, this treatment of urban spaces has been carried out through the construction of ideal models of the city, and an assertive correlation between the presence of green spaces and the quality of life of the population has not been thoroughly developed with regards to specific aspects, such as: best areas with respect to environmental attributes; location in the urban structure in relation to accessibility, or consideration of the predominant age groups in the neighborhood. It is true that some manuals and/or technical books have been produced, as with the contribution by Ferrari (1986), with action radii or densities, but without a clear relation of the benefits for the population.

In the late 1980s, discussions about sustainable and healthy cities gained momentum. Their starting point was both the movement that emerged with the launch of the Ottawa Charter (WHO *et al*, 2017; SILVEIRA *et al*, 2014) at the I International Conference on Health Promotion in 1986, in Canada; and Agenda 21, the result of the United Nations Conference on Development and Environment, in Rio de Janeiro in 1992.

Moving forward in time and in the discussions on sustainable and healthy cities, the 9th Global Conference on Health Promotion, in 2016, focused on the 2030 Agenda (launched by the United Nations in 2015), highlighting that "health is created at the local level, in the settings of everyday life, in the neighborhoods and communities where people of all ages live, love, work, study and play" (WHO, 2017). Ten priority guidelines for the achievement of Healthy Cities were proposed, one of them referring to territorial planning with an emphasis on green areas, which refers to the scope of this article – namely the importance of the presence of green and open spaces in the different neighborhoods of a city, in order to enable the practice of physical, leisure and recreation activities.

Today, especially in the European literature, there are extensive studies that support public policies that associate the presence of diseases with the level of access to green and open areas by the population, such as HUDU (2007), Bell *et al*, (2008), NYC (2010) and Higueras (2015). They even discriminate by age groups and by types of green and open spaces, elaborating on the effect they can generate to improve health.

In Brazil, these studies are incipient since researchers, faced with the absence of basic sanitation solutions in cities, such as access to potable water and sanitary sewage, focus on studying more primary issues of health in the city. It should also be noted that research on the subject is hampered by the challenge of obtaining health data in a spatialized manner, so that the correlation between access by different groups of people and the quality of public spaces can be investigated, and more specifically the correlation between green and open areas with health.

As a result of this discussion, the present exploratory study aims to analyze the relationships between open spaces in the City of Recife / PE, in order to understand whether it is possible to establish any correlation with the aspect of longevity.

1.1 Quality of life and open spaces

Discussions on urban sustainability have evolved from the consolidation of its conceptual understanding to actual efforts to establish actions to reach it aim. With regard to forms of urbanization that minimize the negative impacts on people and the environment, some specific approaches have been established, ranging from landscape architecture to green infrastructure, or what has been called Nature-based Solutions (NbS), a term coined by the International Union for Conservation of Nature (IUCN), between 2009 and 2010.

In this context, urban solutions have been broadened to include systems of green and open areas, especially through the protection of the environmental services that these spaces can promote, as well as the elaboration of studies aimed at understanding their health benefits more assertively. The present study seeks to establish a relationship between health and open and green spaces through the concept of quality of life, health being understood as a component of this quality (WHO *et al*, 1998; WHO *et al*, 2017) – even if this definition is also considered quite broad (WHO *et al*, 1998; SILVEIRA *et al*, 2014; PEREIRA *et al*, 2012).

To address quality of life – despite the continuing theoretical discussion in course to define the determinant indicators for its scope (SILVEIRA *et al*, 2014; PEREIRA *et al*, 2012; BEZERRA and SILVA, 2020) – the MHDI[1] will be used, which is an extension of the globally used indicator HDI[2]. Both the HDI and the MHDI present an understanding of quality of life based on an arrangement of a reduced number of variables, namely: income, longevity and education. However, the MHDI is a more adequate methodology for the characteristics of Brazilian cities, making it more suitable for assessing local development (UNDP, IPEA and FJP, 2013).

For Keinert (2004), the HDI proposal, especially as it includes longevity as a development criterion alongside income and education, is a plausible alternative for assessing

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[1] Municipal Human Development Index
[2] Human Development Index

quality of life, since this conception highlights the choices social groups make in relation to their lifestyle. In other words, a person can have a very high income, but choose a standard of living that is unhealthy, despite having access to a good healthcare system. At the same time, access to higher income and education can give the individual the opportunity to choose a lifestyle which enables a better and longer life (KEINERT, 2004).

But how does the literature establish the connection between open spaces and people's quality of life? References to the benefits of these green and open areas can be found in a vast body of literature [Sá Carneiro (2000), Lombardo (1990); Loboda and Angelis (2005); Lima and Amorim (2006); Cavalheiro and Nucci (1998), Nucci and Cavalheiro (1999)]. These studies, as already mentioned, establish a positive association between the existence of these spaces and the promotion of quality of life, although mostly subjectively, with the exception of those more focused on urban environmental comfort.

Lombardo (1990) states that it is through the amount of vegetation that the quality of urban life can be evaluated, since this is an indicator of environmental performance which directly influences people. Cavalheiro and Nucci (1998) point out that the greatest relevance of green and open spaces is their relationship with the places of residence, to provide leisure and social interaction, emphasizing the importance of mapping their radii of influence. When analyzing some of the authors [Cavalheiro and Nucci (1998); Cavalheiro and Del Picchia (1992); Benini and Martin (2010); Campinas (2015)] the following aspects stand out as more relevant: the index of green and open spaces per inhabitant, their distribution by categories, by age group, minimum area, distance from the residence, as well as whether they are public, private or semi-private.

Studies carried out by HUDU (2007) and NYC (2010) underline the importance of green spaces, highlighting that green spaces attract the attention of the population not only for their beauty, but also as inviting to take walks and for recreational activities, which bring benefits to people's health.

There seems to be a consensus regarding the benefits that green areas and open spaces provide for the physical and mental health of the population. In many cases, this association is made intuitively or even morphologically, with a certain sense of spatial proportionality, without an effective relational study on the effects on people's quality of life.

In addition, there are studies, such as those developed by Ferreira *et al*. (2019), which seek to relate how the distribution of these green areas occurs in the urban fabric and its relation with the socioeconomic conditions of each location in the city. Ferreira *et al*. (2019) studied the relationship between the public green areas index - PGAI and the social development index - SDI[3]. As a result, the authors showed that the socioeconomic disparities are aligned with the unequal distribution of public green areas in the urban space of the city of Juiz de Fora, that is, a greater concentration of green and open areas was constituted in the central regions with better socioeconomic conditions.

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[3] The SDI was developed in Rio de Janeiro, by the Pereira Passos Institute, and measures the social development of a geographic area comparing it with others of similar nature.

Given the relevance of the relationship between quality of life and the system of green and open areas, it is necessary to identify the most common typologies of these spaces in the city, as well as revise the studies that have already been carried out on this subject matter. Thus, the definition of the categories of green and open areas analyzed in this study is based on the research by Sá Carneiro (2000 and 2004).

Sá Carneiro and Mesquita (2000) established a specific definition of public open spaces, private open spaces, open spaces that can be public or private and potential open spaces, in view of the reality of the city of Recife/PE. The first refers to spaces open to the population which may have pre-established schedules determined by the government, such as parks and squares. The second is limited to family use or a specific community, such as backyards, social areas of residential condominiums, social clubs, schools and hospital yards. The third includes conservation units, university campuses and cemeteries. The fourth refers to the spaces created by the population itself, given the real needs for recreation spaces, and are composed of: sports fields and improvised leisure areas on the banks of rivers, canals and vacant lots (SÁ CARNEIRO and MESQUITA, 2000).

The present study investigated the public and potential open spaces of the city of Recife, and given the very specific terminology adopted by Sá Carneiro and Mesquita, they will be jointly called *public open spaces* to facilitate general understanding. The relationship between the presence and access to these spaces was also established in neighborhoods with varying MHDI conditions, in the period between 2000 and 2010, and the percentage of vegetation cover of these areas was calculated to differentiate paved areas from green areas, as they have different relevance highlighted by different studies.

2. OBJECTIVE

The present study aims to analyze the relationship between the Municipal Human Development Index (MHDI) and the distribution of open spaces in the City of Recife / PE, in order to understand whether it is possible to establish any correlation with the aspect of longevity of the population, present in the MHDI, and thus use it to support decisions to establish a System of Open and Green Urban Areas.

3. METODOLOGY / METHOD OF ANALYSIS

The study is structured into five topics: the first, the Introduction, discusses the concepts and relationships between open spaces and quality of life; the second contemplates the Objective of this research study; the third contains the Method of Analysis adopted for the correlation between the MHDI and the presence and quality of green areas in the neighborhoods; the fourth presents and discusses the main Results obtained; and, finally, the fifth points out the Conclusions of this research study.

The qualitative and quantitative analyses of the open spaces and their relationship with the MHDI of the city of Recife, were carried out at the neighborhood scale. It is at this scale that it is possible to find the solution to various urban, environmental and social challenges, such as the adequate use of open spaces to reduce urban stress and, therefore, promote health for
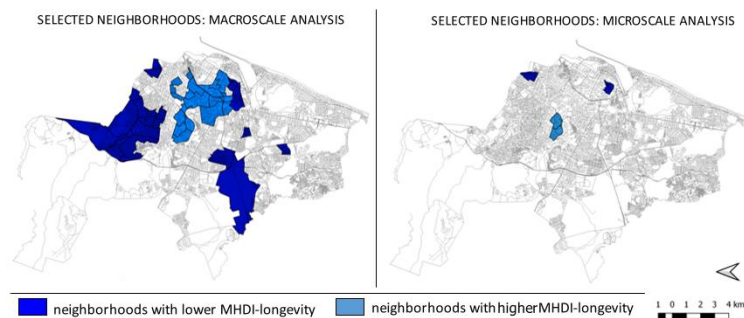
the resident population (HIGUERAS, 2015). Two stages of analysis were adopted as described below.

3.1 Stage 1 - Macroscale study

In the first stage, an evaluation was carried out on the amount of public and potential open spaces (SÁ CARNEIRO and MESQUITA, 2000) in the neighborhoods of Recife with the highest and lowest value of MHDI for Longevity, and with up to 70% of its territory presenting the same value, since the same neighborhood can have more than one MHDI depending on its socioeconomic diversity. The MHDI data for the year 2010 was obtained from the Social Vulnerability Index – SVI, prepared by the Institute for Applied Economic Research.

The final sample of this stage of analysis resulted in 39 neighborhoods out of the 94 that make up Recife (see figure 3.1) – 18 neighborhoods with the highest MHDI (0.944 - 0.914) and 21 with the lowest MHDI (0.775 -0.737). The control criterion of adopting at least 70% of the territory of each neighborhood with the same MHDI value was used in order to select only the most homogeneous territories in terms of human development.

Figure 3.1: Neighborhoods selected for macro and microscale analysis

SELECTED NEIGHBORHOODS: MACROSCALE ANALYSIS　　SELECTED NEIGHBORHOODS: MICROSCALE ANALYSIS

neighborhoods with lower MHDI-longevity　　neighborhoods with higher MHDI-longevity

Source: the authors.

To define the open spaces for analysis, the classification of Sá Carneiro and Mesquita (2000) was used. Thus, parks, squares and sports fields were analyzed, as they represent the largest percentage of these open spaces in the city. The city's outdoor fitness-sites were also included, a typology that had not been included by Sá Carneiro and Mesquita (2000), since they were only implemented in 2003, that is, after their study. These fitness-sites are relevant because they represent health promotion equipment and because they are spread across both low-income and high-income neighborhoods in Recife (RECIFE, 2003, 2020).

Information about Recife's public open spaces was obtained from the City Hall website through the *Recife Data* and *Geographic Information of Recife* (ESIG) platforms. Then the data was launched on the free software QGis 3.10 with the Google Earth satellite images from the years 2009 and 2010. This allowed us to verify the existence of some empty open spaces, but which had a pre-established delimitation, such as the square Compositor Antônio Maria, in the neighborhood of Santana, opened only in 2012; as well as spaces that had been destined to be squares but were occupied by informal settlements (as the case of the Torrões settlement) or by buildings of public use (an UPA - Emergency Care Unit, in the neighborhood of Ponto de

Parada). Through the Google satellite images it was also possible to identify new squares, such as the only square present in the Coelhos neighborhood.

The city's outdoor fitness-sites were not geo-spatialized, but it was possible to map them through the addresses available on the City Hall website, based on Google Earth satellite images and through the work carried out by LIMA *et al*, (2012). The mapping of the sports fields was carried out with data from the study on the *Open Spaces of Recife* preceded by Sá Carneiro and Mesquita (2000), which was also adjusted with the support of Google Earth images.

After the mapping, the information was quantified by neighborhood and analyzed regarding: units and size (area) of parks, squares, city outdoor fitness-sites and sports fields. In parallel, indexes were established that explain the correlations sought in the research (see chart 2.1).

Chart 2.1: Open space indexes

Indexes	Meaning	Formula
Index of public open spaces by neighborhood - IPuOSN	Area availability of parks and squares (m²) in the neighborhood per inhabitant.	*IPuOSN = [∑ of the areas of parks and squares (m²) by neighborhood] / Total number of inhabitants*
Index of specific open spaces by neighborhood - ISOSN	Offered areas of parks, squares, sports fields and outside fitness-sites (m²) in the neighborhood per inhabitant.	*ISOSN = [∑ of the areas of parks and squares (m²), sports fields (m²) and outside fitness-sites (m²) by neighborhood] / Total number of inhabitants*
Index of public open spaces by neighborhood area - IPuOSNA	Destination of areas to parks and squares (m²) in relation to the area of the neighborhood.	*IPuOSNA = [∑ of the areas of parks and squares (m²) per neighborhood] / Area of the neighborhood (m²)*
Index of specific open spaces by neighborhood area - ISOSNA	Availability of areas of parks, squares, sports fields and outside fitness-sites (m²) in relation to the area of the neighborhood.	*ISOSNA = [∑ of the areas of parks and squares (m²), sports fields (m²) and outside fitness-sites (m²) by neighborhood] / Area of the neighborhood (m²)*

Source: the authors.

The use of indexes aims to identify the degree of appropriation of open spaces by the population, thus determining their relevance in each analyzed neighborhood, and then to verify if there is any relationship with high or low values of MHDI. In order to carry out this statistical analysis, dispersion graphs were created using the Google Drive spreadsheet to verify if there is a cause and effect relationship between the two variables and the intensity of this relationship.

3.2 Stage 2 - Microscale study

The second stage sought a more reliable assessment of the reality of each location. The concept used encompassed the idea of neighborhood, extrapolating a radius of 500 meters from the administrative political limit of each neighborhood, since the surrounding neighborhoods also influence the life of adjacent residents. The choice of 500 meters was due to the fact that it is a walking distance always used in urban mobility studies (BURTON and MITCHELL, 2006; GEHL, 2015).

To carry out this stage, four neighborhoods were selected from the 39 analyzed in the first stage, two of them with the highest MHDI for longevity (Parnamirim - 0.941, and Casa Forte - 0.941) and two with the lowest (Coelhos - 0.738, and Campina do Barreto - 0.737). In addition to the difference in MHDI for longevity, another selection criterion was the presence of parks and squares in these locations, thus discarding the neighborhoods that did not contain any of these public open spaces within their administrative political limit. Also, the size of the neighborhood and the number of inhabitants were added to the selection criteria, so that the selected neighborhoods were similar in relation to these variables, giving better acuracy to the results.

The counting of open spaces considered those with a minimum area of up to 150m² [according to Jantzen (1973), available in Cavalheiro and Del Picchia (1992)], within the buffer area of 500 meters. For this end, the following QGis software tools were used: satellite images present on Google Earth; studies by Sá Carneiro and Mesquita (2000); Lima *et al*, (2012); and information about parks and squares provided by the platforms *Data Recife* and *Geographical Information of Recife* (ESIG).

Once the open spaces were identified, an evaluation of the vegetation cover was carried out, as well as the measuring of accessibility and distribution of parks and squares within the microscale sample. The analysis of the vegetation cover[4] of parks and squares was carried out using the photointerpretation technique. For this evaluation, a satellite image provided by ESIG in 2007 was used. Then, the percentage of green coverage of these spaces was calculated, using the QGis 3.10 software, and a comparison of these areas amongst the evaluated neighborhoods was performed.

The "network analysis" tool of the QGis 3.10 was used to analyze access conditions to parks and squares. A radius of influence was established for each of these spaces based on their respective areas, as cited by Cavalheiro and Nucci (1998). Thus, three layers of points were elaborated, referring to a 100m radius for spaces with areas greater than 150m² and less than 450m²; a 500m radius for spaces with areas of at least 450m² and less than 5,000m²; and a 1,000m radius for spaces 5,000m² or above. A system of lines capable of representing the street networks of the areas studied was also designed based on the satellite images provided by Google Earth up to 2010.

Thus, it was possible to analyze through the generated images how close these spaces are to the residents and their distribution in the system. The influence of the immediate surroundings within 500 meters, considered the buffer zone within the administrative political limit of the analyzed neighborhoods, was also verified. Finally, after carrying out the two stages of analysis and discussing the results found, final considerations on this article were then formulated in light of the intended objectives.

4. RESULTS: CORRELATION STUDY BETWEEN MHDI AND OPEN SPACES IN THE NEIGHBORHOODS OF RECIFE/PE

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[4] Vegetation cover is understood as the projection of green on planimetric maps and can be identified through aerial photographs, without the aid of stereoscopy (NUCCI and CAVALHEIRO, 1999).

The analysis included 26% of the population of Recife, distributed in different parts of the city. In this sample, 73% of residents were from neighborhoods with the lowest MHDI for Longevity, despite the fact that the amount of analyzed neighborhoods having the highest and lowest MHDI were practically the same.

Chart 4 1: Data from the analyzed neighborhoods

Neighborhood	Pop. IBGE (2010)	MHDI	MHDI Long.	MHDI Educa.	MHDI Income	IPuOSN	ISOSN	IPuOSNA	ISOSNA
Campina do Barreto	9484	0.615	0.737	0.544	0.579	0.283341	2.24277	0.00502643	0.039787
Peixinhos	4998	0.615	0.737	0.544	0.579	0	0	0	0
Ilha Joana Bezerra	12629	0.622	0.738	0.56	0.581	0.154385	1.57936	0.00167515	0.017137
Coelhos	7633	0.622	0.738	0.56	0.581	0.029141	0.25837	0.00052823	0.004683
Nova Descoberta	34212	0.643	0.742	0.606	0.591	0.013762	0.01376	0.00025815	0.000258
Córrego do Jenipapo	9246	0.654	0.754	0.618	0.599	0	0	0	0
Passarinho	20305	0.632	0.756	0.556	0.6	0	0.36315	0	0.001881
Brejo da Guabiraba	11362	0.632	0.756	0.556	0.6	0.094258	0.09426	0.00146982	0.00147
Brejo de Beberibe	8292	0.632	0.756	0.556	0.6	0	0.7692	0	0.009915
Dois Unidos	32805	0.648	0.763	0.59	0.604	0.020148	0.66788	0.00021185	0.007023
Curado	16418	0.653	0.766	0.597	0.61	0.128037	0.98307	0.00025488	0.001957
Linha do Tiro	14867	0.664	0.768	0.623	0.612	0	0.71996	0	0.013059
Caçote	10470	0.64	0.768	0.559	0.612	0	0.59174	0	0.013404
Beberibe	8856	0.664	0.768	0.623	0.612	0.278743	0.27874	0.00504395	0.005044
Alto Santa Terezinha	7703	0.664	0.768	0.623	0.612	0.004239	0.00424	0.00010668	0.000107
Vasco da Gama	31025	0.656	0.769	0.6	0.613	0.088724	0.38736	0.00171303	0.007479
Torrões	32015	0.665	0.771	0.618	0.617	1.097782	1.24208	0.02129471	0.024094
Mangueira	8480	0.656	0.773	0.59	0.619	0.056828	0.05683	0.00155855	0.001559
Alto Jose Bonifácio	12462	0.659	0.775	0.596	0.619	0	0	0	0
Alto Jose do Pinho	12334	0.659	0.775	0.596	0.619	0.076506	0.07651	0.00223802	0.002238
Morro da Conceição	10182	0.659	0.775	0.596	0.619	0.212589	0.34107	0.00568736	0.009125
Hipódromo	2658	0.893	0.914	0.889	0.877	5.556081	10.2733	0.04853729	0.089746
Ponto de Parada	1554	0.893	0.914	0.889	0.877	5.385542	5.38554	0.04443401	0.044434
Boa Vista	14778	0.893	0.918	0.862	0.901	1.694445	1.69445	0.01470305	0.014703
Soledade	2495	0.893	0.918	0.862	0.901	1.614907	1.61491	0.01250031	0.0125
Torreão	1083	0.893	0.918	0.862	0.901	11.37233	16.4964	0.06285828	0.09118
Paissandu	507	0.893	0.918	0.862	0.901	4.678973	4.67897	0.00637865	0.006379
Derby	2071	0.919	0.92	0.915	0.922	18.16285	18.1628	0.07795626	0.077956
Madalena	23082	0.93	0.929	0.905	0.958	1.823198	2.0737	0.02332332	0.026528
Ilha do Retiro	3740	0.93	0.929	0.905	0.958	0.129515	0.12951	0.00092383	0.000924
Espinheiro	10438	0.955	0.938	0.939	0.989	1.270084	1.27008	0.01744124	0.017441
Parnamirim	7636	0.941	0.941	0.886	1	1.258839	1.39418	0.01566483	0.017349
Casa forte	6750	0.941	0.941	0.886	1	2.052694	2.05269	0.02477962	0.02478
Poço da Panela	4615	0.941	0.941	0.886	1	1.187537	1.49103	0.0070897	0.008902
Rosarinho	4077	0.941	0.941	0.886	1	0.964395	0.9644	0.01532993	0.01533
Santana	3054	0.941	0.941	0.886	1	14.85043	15.2845	0.09652071	0.099342
Jaqueira	1591	0.941	0.941	0.886	1	52.17138	97.2959	0.33960302	0.633335
Graças	20538	0.952	0.944	0.915	1	0.403359	0.40336	0.00574592	0.005746
Aflitos	5773	0.952	0.944	0.915	1	0.208384	0.20838	0.00391381	0.003914

Source: Social Vulnerability Index – SVI (IPEA, 2020); Recife (2020). Adaptation of the authors.

The questions asked were: Is there a strong correlation between the supply of open spaces and the life expectancy of the population? Among the components that make up the MHDI, which one presents a better correlation with the distribution of public and potential open

spaces in the city of Recife? What is the effect of open spaces (parks and squares, sports fields and outdoor fitness sites) on people's quality of life, which can be verified using the MIDH for Longevity? To answer these questions, the following indexes were used to verify the potential correlations between the MHDI and open spaces.

1. *Index of public open spaces by neighborhood (IPuOSN)* in comparison with the values of MHDI (longevity, education and income): as demonstrated by calculating the r² and illustrated in chart 4.1, the correlation between the different MHDIs and IPuOSN is weak, the lowest value being 0.137 and the highest 0.151, referring respectively to education and income. This fact may be related to the presence of few squares and parks in neighborhoods with higher MHDI. At the same time, the greatest concentration of these spaces, albeit low, is located in the neighborhoods with the highest life expectancy.

2. *Index of specific open spaces by neighborhood (ISOSN)* - In this case, with the addition of these new spaces (Sports fields and outdoor fitness sites), the correlation of the ISOSN with the MHDIs came close to 0, and lower than that of IPuOSN. This fact is due to a slight approximation of the result of the sum of the areas of the neighborhoods' open spaces with the higher and lower MHDI for longevity, since the area of the sports fields and outdoor fitness sites, compared to some squares, is superior, which also becomes a factor of some balance between the open spaces of these neighborhoods. It should be noted that in this case, the MHDI for income was the variable that presented a better result, 0.105, despite being considered low.

3. *Index of public open spaces by neighborhood area (IPuOSNA)* - The IPuOSNA obtained a result that was a bit higher than the IPuOSN. However, it is still a weak correlation in which the highest r² was 0.16 corresponding to income. Longevity appeared soon after with 0.153.

4. *Index of specific open spaces by neighborhood area (ISOSNA)* - The sports fields and outdoor fitness sites together with the parks and squares resulted in an even weaker correlation than the previous one (IPuOSNA), and with similar reasons to that of ISOSN, since there is an increase in the sum of open spaces in neighborhoods with lower MHDI for Longevity. According to the previous results, income showed a better correlation with the ISOSNA, followed by longevity, as illustrated in the chart below.

Chart 4.2: Simple Linear Regression Analysis (r²)

| Index	Longevity (r²)	Education (r²)	Income (r²)	MHDI (r²)
IPuOSN	0.147	0.137	0.151	0.146
ISOSN	0.096	0.085	0.102	0.095
IPuOSNA	0.153	0.14	0.16	0.152
ISOSNA	0.088	0.077	0.095	0.087

Source: the authors.

Based on these results, it appears that the linear model used did not fit the sample of selected neighborhoods, since the correlation between the variables showed a weak correlation, with the r² being much lower than 0.3 and in some cases almost zero. Another

relevant factor is that income was the component of the MHDI that best correlated with the IPuOSN, ISOSN, IPuOSNA and ISOSNA, followed by longevity and education.

Another important point found was that the longevity variable, according to graph 4.1, assumes greater relevance in relation to education and income in neighborhoods with lower MHDI values. This fact leads to the conclusion that the low MHDI in these localities is more associated with education and income issues, and that despite the higher longevity, in this case, income and education do not give these individuals the opportunity to choose their lifestyle, which can in turn harm their life expectancy.

Graph 4.1: Comparison between the diferente MHDIs in neighborhoods with greater and lesser longevity
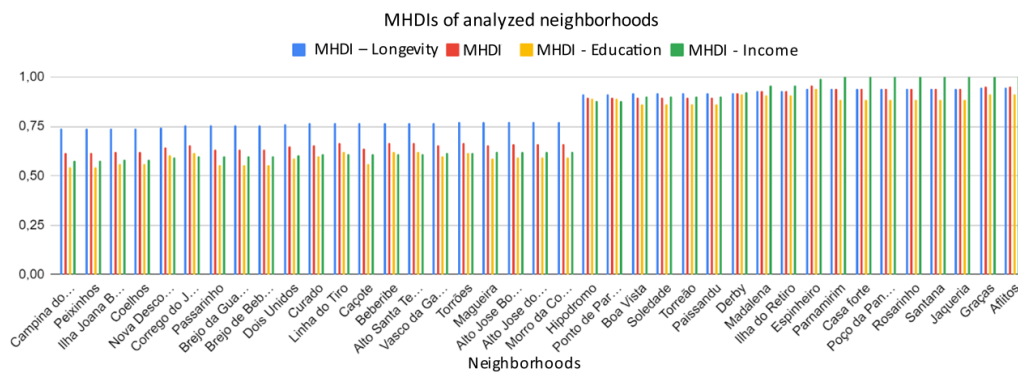
Source: IPEA (2020). Adaptation by authors

In neighborhoods with higher longevity, income is the predominant variable, followed respectively by longevity and education, and as mentioned by Keinert (2004), access to higher income and education can give individuals the opportunity to choose their lifestyle, allowing a person to live longer and better (KEINERT, 2004).

Another piece of data is that less than 30% of public open spaces (parks and squares) were located in neighborhoods with the lower life expectancy, that is, there is an unequal distribution of these spaces in the neighborhoods analyzed. This result reaffirms the thinking of several researchers, such as Hijioka *et al* (2007), that the fulfillment of demands for open spaces is concentrated in rich and middle-class areas.

At the same time, it was in the neighborhoods with less longevity where a higher percentage of sports fields was found, around 86% (25 of the total of 29 sports fields), which corroborates with the results of Sá Carneiro and Mesquita (2000). Here, the authors affirm the importance of these potential open spaces in the poorest areas of Recife and include them in one of the categories of open spaces in the city. Thus, they can be considered a "bottom up" alternative to meeting the sports and leisure demands of part of this population in Recife.

Regarding the distribution of the outdoor fitness sites, 4 of these facilities were found in neighborhoods with the highest MHDI for Longevity and 3 in neighborhoods with the lowest MHDI for Longevity, in the analyzed period from 2003 to mid-2010. However, less than 20% of the neighborhoods offered this type of space in their territories.

Finally, although the MHDI for Longevity has little correlation with the distribution of open spaces in the analyzed neighborhoods, it should be noted that it was in the neighborhoods with lower life expectancy that the amount of public open spaces was lower and in some cases

even null. On the other hand, it was possible to see some correlation with the indexes that considered only open spaces (parks and squares, that is, IPuOSN and IPuOSAN). This fact referred to a microscale study that detailed open spaces in four neighborhoods, two with higher MHDI for Longevity and two with lower MHDI for Longevity.

4.1 Assessment of the relevance of public open spaces for neighborhoods with the highest and lowest MHDI for Longevity

The evaluation on the urban microscale involved the neighborhoods of Casa Forte and Parnamirim, which are located in the north of the city of Recife/PE and had an MHDI for Longevity of 0.941; and the neighborhoods of Coelhos and Campina do Barreto, located respectively in the central and northern part of the city, and having an MHDI for Longevity of 0.738 and 0.737 (Figure 3.1). The neighborhoods of Casa Forte and Parnamirim presented within their administrative political limits a greater quantity and area of squares in relation to the neighborhoods of Coelhos and Campina do Barreto.

In addition, when the 500m buffer was considered, the quantity and area of squares increased significantly in neighborhoods with higher life expectancy, as they included important parks for the city of Recife (The 3 parks of Jaqueira, of Santana and of Sítio da Trindade). On the other hand, in neighborhoods with less longevity this was not the case, as illustrated in graphs 4.2 and 4.3 and in figures 4.1, 4.2, 4.3 and 4.4. Thus, the study demonstrates the relevance of considering the area around the neighborhoods (500m buffer), taking into account that the division of neighborhoods does not always correspond to the urban structure in its morphological aspects, and that the inhabitants experience the urban space without paying attention to administrative divisions.

Graph 4.2: Area of parks and squares and the effect of the 500m buffer in neighborhoods with greater and lesser longevity
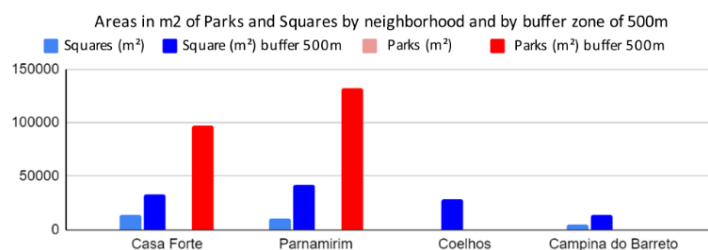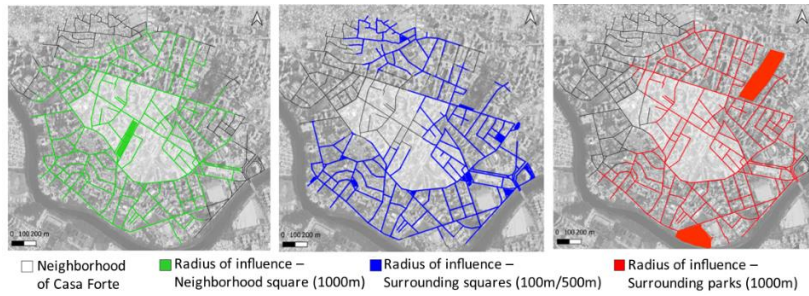

Source: Recife (2020). Adaptation by authors

Graph 4.3: Number of parks and squares and the effect of the 500m buffer in neighborhoods with greater and lesser longevity
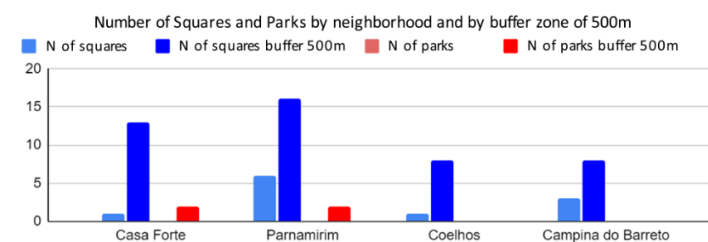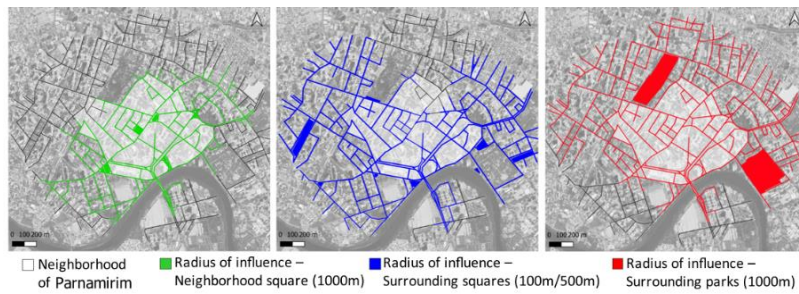

Source: Recife (2020). Adaptation by authors

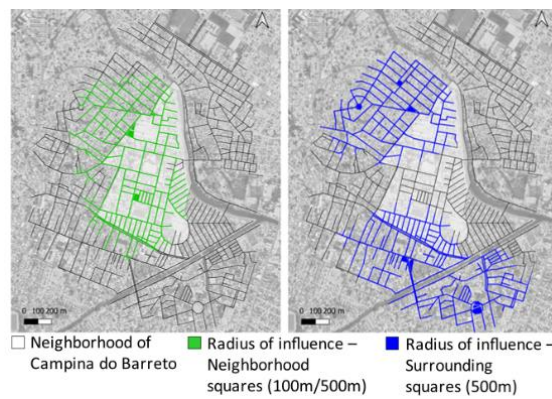**Figure 4.1: Neighborhood of Casa Forte- Radius of influence of Squares and Parks**

Source: the authors.

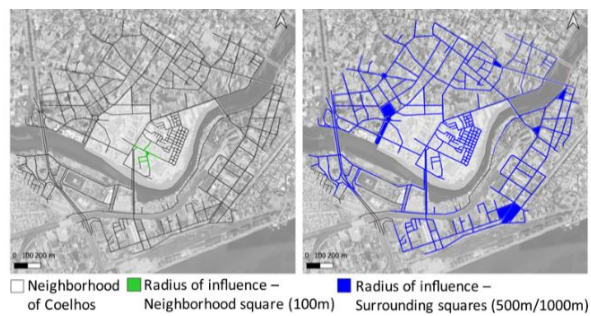**Figure 4.2: Neighborhood of Parnamirim- Radius of influence of Squares and Parks**

Source: the authors.

Figure 4.3: Neighborhood of Campina do Barreto- Radius of influence of Squares

Source: the authors.

Figure 4.4: Neighborhood of Coelhos- Radius of influence of Squares

Source: the authors.

Another aspect analyzed was the accessibility of these spaces considering their spatial arrangement (distribution and proximity) and the radius in meters to be covered by people. As a result, it was possible to notice that:

1. In the neighborhood of Casa Forte, the Square of Casa Forte, despite being the only square present in the neighborhood, is a space of relevance both locally and for its surrounding areas. Due to its territorial dimension of above 5000m², it has an influence of 1000m, which crosses the limits of the neighborhood (see figures 4.1 and 4.5). In addition, the squares and the two parks (Santana and Sítio da Trindade) contained within the administrative limits of the neighboring districts and inserted in the buffer zone, as illustrated in image 4.1, enhance people's access to public open spaces.
2. The neighborhoods of Parnamirim and Campo Grande [despite representing two different groups in relation to MHDI and to percentage of green areas (see chart 4.3)], present a more diffuse layout of their squares within their administrative limits, which facilitates access of residents of these neighborhoods to these spaces (see figures 4.2 and 4.3).
3. The locations of the Parks Jaqueira and Sítio da Trindade allow all residents of the neighborhood of Parnamirim to access these spaces within a maximum distance of 1000m. Another aspect is that the squares around Parnamirim increase people's access to other public open spaces, in addition to those existing in the neighborhood.
4. As seen in graphs 4.2 and 4.3 and in figures 4.3 and 4.4, the neighborhoods of Coelhos and Campina do Barreto do not have parks in their surroundings.
5. The squares present in the neighborhoods adjacent to Coelhos, inserted in the 500m buffer zone, allow residents access to these open spaces, since within the administrative limit of the neighborhood there is only one small square, of about 228m², with a radius of influence of 100m. This reinforces the study's idea of including the buffers in the analysis, to emphasize the importance of visualizing the neighborhood together with its surroundings (see Figure 4.4).

Figure 4.5: Square of Casa Forte, Recife/PE. 08 of October, 2021

Source: the authors.

The percentage of vegetation cover in the parks and squares of each neighborhood studied and its surroundings was also calculated to verify its importance regarding quality of life,

according to information found by some of the authors studied, such as Nucci and Cavalheiro (1999). As a general result of the analysis, it was possible to verify that: the neighborhoods with greater longevity had a higher percentage of vegetation cover, that is, about 75% of the areas of parks and squares in the neighborhood of Parnamirim and 67% in the neighborhood of Casa Forte.

The neighborhoods with the lowest life expectancy presented much lower results: Coelhos with an average of 56% of green areas and Campina do Barreto with 37% of its territory covered by vegetation. However, this aggregate form in which the results are presented does not allow for a more in-depth understanding of the impact of these areas on people's lives, since in a single neighborhood there can be just one area totally covered by vegetation, but which is only accessible to a restricted group of people, as mentioned by Macedo (1995).

Thus, after making a more detailed analysis of the distribution of the vegetation cover of these spaces in the neighborhoods (chart 4.3), it was possible to verify that: the greater number of parks and squares with vegetated areas (more than 80%) was found in the neighborhood of Parnamirim (11 out of 18). This fact indicates a better environmental quality for the neighborhood, which in turn corroborates with the better quality of life demonstrated by the MHDI indicators (income, education and longevity).

Chart 4.3: Proportion of vegetation cover of Parks and Squares by neighborhood

Percentual of vegetation cover	Proportion of vegetation cover of Parks and Squares by neighborhood.							
	Casa Forte		Parnamirim		Coelhos		Campina do Barreto	
	Und.	(%)	Und.	(%)	Und.	(%)	Und.	(%)
100% - 80%	4	26.6%	11	61.1%	3	37.5%	2	25%
80% - 60%	2	13.3%	3	16.6%	1	12.5%	1	12.5%
60% - 40%	8	53.3%	3	16.6%	3	37.5%	2	25%
40% - 20%	1	6.6%	1	5.5%	1	12.5%	1	12.5%
20% - 0	0	0	0	0	0	0	2	25%
Total	15	100%	18	100%	8	100%	8	100%

Source: Data extracted from Ortofoto 2007 – available on the Portal ESIG Zoning, Recife 2020.

The neighborhood of Campina do Barreto had the lowest number of spaces (25%) with at least 80% vegetation cover (2 out of 8), followed by the neighborhood of Casa Forte with 26.6% (4 out of 15). However, Casa Forte concentrates 93.3% of green public spaces above 40% of open spaces and Campina do Barreto only 62.5%. In other words, one data refers to the number of open spaces and the other to the area of open spaces.

The neighborhood of Coelhos has a better result (87.5%) when compared to Campina do Barreto. However, as illustrated in Figure 4.4, this result is due to the influence of squares located in the surrounding neighborhoods, since in Coelhos only a very small square was identified with a radius of influence of 100m.

In short, most parks and squares – both in terms of quantity and area – are found in neighborhoods with greater longevity. In addition, a significant part of these spaces located in the neighborhood of Parnamirim, have a vegetation cover greater than 80%, which provides the

neighborhood with greater environmental quality together with a high quality of life for its residents, corroborated by the MHDI indicators (income, education and longevity). On the other hand, the neighborhoods with lower life expectancy also have the lowest percentage of green areas, which leads to the conclusion that these neighborhoods have a worse quality of life and environment. This result is similar to that obtained by Ferreira *et al*, (2019), who showed that socioeconomic disparities were aligned with a low Social Development Index.

5. CONCLUSION

This survey and the generation of new data through the use of different methodological procedures, provided macro evaluative results, which correlated the MHDI and its three derivations (longevity, education and income) with the distribution of public open spaces as well as potential spaces in the city of Recife. They also helped to understand some of the distribution of these spaces and their correlation with the variables of longevity, education and income.

It is also noteworthy that despite the MHDI being an indicator of quality of life – especially longevity – and public open spaces contributing to the promotion of this quality, the correlation found in the city of Recife was almost null. However, the present study points to the need for further studies to explore these correlations in more detail, due to the fact that when the spaces with vegetation were analyzed alone, an aspect of environmental quality, better results were obtained.

It is necessary to think of new strategies for correlating different aspects of environmental quality and quality of life, mainly with the aim of promoting the location, percentage and qualification of a network of urban green spaces. As examples of variables to be explored on quality of life there are different physical and mental health data, although it is still a challenge to obtain this information by specific neighborhood.

In addition, it is essential to carry out a field survey on the quality and quantity of public open spaces in neighborhoods with lower MHDI, since in many cases, due to high density, a study carried out through satellite maps may not characterize all the spaces used for socialization.

Finally, as this study was carried out based on data from between 2000 and 2010, and considering that many changes may have taken place since then in the neighborhoods of Recife, it would be necessary to replicate this study based on new MHDI data. A greater understanding of the dynamics between environmental quality and quality of life in the specific neighborhoods are key to more sustainable interventions and the promotion of healthier cities for all people.

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