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Association between Urban Green Spaces and Symptoms of Depression in 17 years old adolescents in the City of Porto. The EPIteen (Epidemiological Health Investigation of teenagers in Porto) **Cohort**

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Dissertação de candidatura ao grau de Mestre em Epidemiologia apresentada à Faculdade de Medicina da Universidade do Porto

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Abbreviations List

BDI – Beck Depression Inventory

BMI- Body Mass Index

GIS- Geographic Information System

GPS- Global Position System

INE – National Statistics Institute

LCA- Location Coefficient Assigned

PCA – Principal Components Analysis

SCPR- Socioeconomic Condition of the Place of Residence

SES – Socioeconomic Status

UGS – Urban Green Spaces

WHO- World Health Organization

Resumo

Há um reconhecimento crescente de que a disponibilidade de espaços verdes em meios urbanos (EVU) pode estar associada a melhores níveis de saúde na população. A Saúde é, conforme preconizado pela Organização Mundial de Saúde, não é apenas a ausência de doenças, mas sim um completo bem-estar físico e mental, determinado por fatores físicos, biológicos e sociais do ambiente. Nas últimas décadas, diversos estudos apontam para a importância da sintomatologia depressiva na saúde das populações. A literatura mostra que a exposição aos EVU tem efeito sobre a saúde mental, mas a relação entre o acesso a EVU e depressão é menos conhecida. Neste trabalho, desenvolvido no âmbito da coorte EPITeen, objetivou-se examinar a associação entre as distâncias das residências de adolescentes de 17 anos da cidade do Porto aos EVU e a presença de sintomas de depressão medidos através do Beck Depression Inventory (BDI). Considerou-se existência de sintomatologia depressiva sempre que o score do BDI era ≥13 e os EVU referem-se a áreas abertas com a presença de vegetação, tais como parques e jardins.

Analisou-se uma amostra de 1431 (53% meninas) adolescentes que viviam na cidade do Porto. Os participantes foram georreferenciados a partir das moradas das suas residências, os limites dos EVU foram obtidos a partir de mapas digitais da Câmara Municipal do Porto de imagens de satélite do Google Earth e através do uso de Sistemas de Posicionamento Global (GPS) cada adolescente foi classificado de acordo com a distância da sua residência à área verde mais próxima em três classes: ≤ 100m, > 100m a 200m ≤ e > 200m. A análise de regressão logística foi usada para investigar a associação entre a distância aos EVU e os sintomas de depressão (ajustados para educação dos pais e depressão dos pais em ambos os sexos e coeficiente de localização só nos rapazes).

Analisando a sintomatologia depressiva de acordo com a escolaridade dos pais, para ambos os sexos, a proporção de adolescentes com sintomas de depressão é maior entre os adolescentes com pais com o nível do ensino secundário. A prevalência de sintomas de depressão é maior nas fumadores do que nas não fumadores (56,5% vs 43,5%), ($p<0.05$). Após ajuste e utilizando como referência os adolescentes que residem a 100m ou menos de uma área verde, nas raparigas o OR (IC 95%) de ter sintomas de depressão foi OR = 1.45 (0.62; 3.42) quando têm a área verde mais próxima a uma distância superior a 100m mas inferior a 200m e OR = 0.83 (0.37; 1.85) se a distância era superior a 200m. Nos rapazes os valores foram OR = 0.85 (0.35; 2.09) e OR = 0.91 (0.43; 1.93), respectivamente.

Neste estudo não foi encontrada associação significativa entre a distância aos EVU e sintomas de depressão em ambos os sexos.

Palavras Chave: Saúde Mental; Depressão; Espaços Verdes Urbanos; Estatuto Socioeconómico; Meio Ambiente; Sistema de Informação Geográfica.

Abstract

There is growing recognition that the availability of Urban Green Spaces (UGS) may be associated with improved levels of health in the population. Health is, as recommended by the World Health Organization, not just the absence of diseases, but a complete mental and physical wellbeing, determined either by biological and social environment. In recent decades, several studies point to the importance of depressive symptoms in population health. Exposure to UGS has an effect on mental health, but the relationship between access to UGS and depression is less well known. In this work, developed in the context of the EPITeen cohort, the aim is to examine the association between the distances from the residences of 17 years-old adolescents in the city of Port to the UGS and the presence of depressive symptoms measured by the Beck Depression Inventory (BDI). It was considered the existence of depressive symptoms when the BDI score was ≥ 13 and UGS refers to open areas with the presence of vegetation, such as parks and gardens.

A sample of 1431 (53% female) adolescents living in city of Porto was analyzed. The participants were georeferenced from home addresses and the limits of UGS were obtained from digital maps of the Municipality of Porto of satellite imagery from Google Earth and through the use of Global Positioning Systems (GPS). Each adolescent was classified according to the distance of their residence to the nearest green area into three classes: ≤ 100m, > 100m ≤ 200m and > 200m. The logistic regression analysis was used to investigate the association between distance to the UGS and symptoms of depression (adjusted for parental education and parental depression in both sexes and coefficient of location only for boys).

Analyzing depressive symptoms according to parental education for both sexes, the proportion of adolescents with symptoms of depression was higher among adolescents with parents with secondary education. The prevalence of symptoms of depression was higher in smokers than in non-smokers (56.5% vs 43.5%) ($p < 0.05$). After adjustment, and using as reference the adolescents living within 100 meters of a green area, the OR for girls (95% CI) who had symptoms of depression was OR = 1.45 (0.62; 3.42) when they have the green area at a distance greater than 100m but less or equal to 200m and OR = 0.83 (0.37; 1.85) if the distance was greater than 200m. For boys the results were OR = 0.85 (0.35; 2.09) and OR = 0.91 (0.43; 1.93) respectively.

In this study no significant association was found between the distance to the UGS and symptoms of depression in both sexes.

Key Words: Mental Health; Depression; Urban Green Spaces; Socioeconomic Status; Environmental; Geographic Information System.

Chapter 1: Introduction

1 - Introduction

This research project was developed in the context of the Master degree in Epidemiology, from the Medical School of Porto University, and has the title: **Association between Urban Green Spaces and Symptoms of Depression in 17 years-old adolescents in the City of Porto. The EPIteen (**Epidemiological Health Investigation of Teenagers in Porto**) Cohort.**

How natural environments, or green spaces, might affect health and health related behaviour has received substantial attention from a range of disciplines, including epidemiology and psychology (1). It is important to understand how and why humans relate to nature to understand the potential benefits of human health and wellbeing to be gained from interacting with nature (2). Natural or green environments positively influence people's self-perceived health (3-6). Evidence of a positive association between green space and health has been found in England (1,5) and Scotland (7).

Open green spaces are among the most important elements of perceived visual quality. This implies that the people wants to both see and touch greenery (8). Increasing number of people visiting rural areas can improve their quality of life through access to open space and natural amenities (9). Authors have studied the association of natural environmental with human health, in different ways. Research has shown that people tend to perceive natural environment as more restorative than urban environments and people's environmental preferences are influenced by their restoration needs and beliefs about where restoration can best take place (10). Other studies have analysed the health impacts of contact with and access to natural environments (10), and has provided evidence that contact with natural environments can actually promote restoration from attention fatigue (11,12), and stress (13). Besides, stress has been implicated in the aetiology of common chronic physical and mental illnesses (14).

On the other hand, green spaces may benefit health by facilitating social contacts, for example through providing opportunities to meet others or participate in group activities (14, 15). In a study in Netherlands authors found that a lack of social contact partly mediated the association between low green space neighbourhoods and poor health (15).

Several researchers made efforts to measure perceived restorative quality in environment (12,16,17). These studies used comparisons of natural and urban environmental in their validation strategies, and they found that, in general, people did perceive natural environment as more restorative than urban environment (10). Possible causative mechanisms behind the green space and health relationship include the psychologically and

physiologically restorative effects of nature (12), the facilitation of social contacts (15), and the provision of opportunities for physical activity (18).

The relationship between the amount of green space in the living environment and public health has been little investigated (3). There is concern that locational access to health-promoting community resources, such as green space, is lower in socioeconomically deprived areas, and may be contributing to widening geographical inequalities in health (19). There is some evidence that socioeconomically deprived communities have poorer green space availability than more affluent areas (14). Different indicators of green space exposure, with different origins, demonstrated reasonably consistent assessments of exposure overall and evidence of independent associations with mortality and morbidity (20).

Identifying whether health benefits are more strongly associated with usable or total green space will inform the causative mechanism debate and the development of public health policies and intervention strategies (21).

Understand the connection of green space with health could provide knowledge to support the planning of urban green networks as part of a preventive health strategy (13). Demonstrable evidence that living in an area that has walkable green spaces has a positive impact on longevity would constitute key evidence for policy making and could facilitate intersectional collaboration regarding health promoting urban planning (22).

The relationship between residential location and health is important since similar types of people tend to live in similar places, and this is not an individual choice: some groups cannot afford to live elsewhere (23). Place takes account of the meaning of that particular area for a particular individual or group of people (21,23).

Furthermore, societies developed and maintain systems of social stratification along multiple dimensions. Stratification according to socioeconomic conditions is one of the most important (24). Measures of social position used are many and various, and terms such as social class, social status, socioeconomic status are used interchangeably (21). The term socioeconomic status (SES), normally, is used to include class, status and material asset measures and refers to the social and economic factors that influence which positions individuals or groups will hold within the structure of a society (23,25-27).

Interest in SES of individuals is useful to describe and monitor social distribution of disease and to inform the definition of policy objectives and understanding of the extent of progress towards reducing inequalities in health (23). It is important to understand the advantages and disadvantages of different methods for measuring health inequalities and the measures chosen reflect conceptualizations and ethical concerns over what constitutes unequal health and what aspects of inequality are being captured (25,28).

Explaining the causal mechanisms through which SES generates health differences is another common goal of this type of research and often we see the measurement of SES in health-related research as a way to control confounding from socioeconomic circumstances when another exposure is the main focus of interest (23,24,29).

Social advantage is not always associated with better health; these variations and exceptions are crucially important to understand how aspects of social stratification are differentially linked to health across place and time (30,31).

Information on SES is collected in the census and in social surveys using standardized questions which can be used to rank people according to their education, occupation or income (21,23,28). There is no single best indicator, because each indicator will emphasize a particular aspect of social stratification (23). To measure SES, indicators use information relating to individuals, their households and the areas in which they live (21,23). Area-level indicators of SES are used when the object of analysis is the geographical area (23), and they are also called 'deprivation indexes' that serve to characterize areas from deprived to affluent (23,32).

Area level indicators of SES are mainly used to determine the effect that area socioeconomic circumstances have on a health outcome beyond individual SES, and are usually obtained by aggregating individual-level measures of SES to the area level of interest (23).

1.1 - Aims

In this study we aimed to identify the association between proximity to Urban Green Spaces (UGS) and the symptoms of depression in 17 years old adolescents of the Epiteen cohort.

Chapter 2: State of Art

2 – State of Art

2.1- Green areas and natural environments

Green spaces are defined as “open, undeveloped land with natural vegetation” and they include parks, forests, playing fields and river corridors, for example (1).
Humans come into contact with nature by different ways like street trees, people’s gardens, fields and unused lots, courtyards and landscaped areas (11) that constitute important opportunities for experiencing nature and can affect people at the same time (33).

Urban areas have recently experienced a decline in the quality and quantity of their green spaces (4). People generally believe that living in a green environment is good for one’s health. We live in an urbanized world. At present about 75% of the population in developed countries lives in dense urban areas (10), being these people generally found to be less healthy than people living in more rural areas (3). Cities contribute to a large extent to global environmental problems that threaten human life, while at the same time people living in cities are confronted with interrelated local problems such as environmental pollution, and health risks (10).
Living in a green environment was positively related to health indicators and people in highly urban areas tend to have more symptoms and a higher risk of mental illness. It is likely that green areas attract wealthier and thus healthier people (3). Therefore, a good quality of life depends largely on the quality of the urban environment for people living in large and dense cities (34).

Green areas in one’s living environment may lead people to spend a larger part of their spare time outdoors and be more physically active (3). Studies have shown that the urban green space is highly appreciated by residents and an important factor contributing to residential satisfaction (35). Comparing the availability and volume of green space in the residential environment with health, it was found that residents of neighborhoods with abundant green space tend on average, to enjoy a better health condition (13). Natural environments are more often used for recreational walking and cycling than urban environments (3) having these activities a positive health effect (36). On the other hand, even if a natural environment does not enhance outdoor physical activity, people in a greener living environment may become healthier just by being more exposed to natural elements, such as absence of pollution and natural landscape (3).

Less green nature means reduced mental well-being or at least less opportunity to recover from any mental stresses, but green environments have increasingly come under pressure

from development. Natural and built features of the environment affect behavior, interpersonal relationships and actual mental states (37).

Numerous studies have demonstrated that contact with natural environments offers a relatively effective way of obtaining restoration from stress and mental fatigue compared to ordinary outdoor urban environment (10). Contact with nature can provide some immediate relief from the demands of city life, by providing opportunities for the renewal of cognitive resources and psycho physiological response capabilities (11,13). It appears that people in urbanized societies commonly believe that contact with nature provides them with restoration from stress and fatigue and improves their health and well-being. For example, in a nationwide survey among inhabitants of The Netherlands, 95% of the respondents indicated that they believe that a visit to nature is a useful way of obtaining relief from stress. So far, research on restorative values of natural environments has paid little attention to negative health impacts of (chronic) stress that may result from lack of access to natural environments (10).

Well-being is defined as a combination of attributes leading to a mentally and physically comfortable psychological state. Its has been described in the psychological literature as different from the simple psychological and physical benefits, and is related to specific aspects such as favourable thoughts and feelings, satisfaction with life, ability to be self-sufficient and proactive, a sense of happiness, and a positive evaluation of one's life in general (34).

Results from a study conducted in Italy and the UK, focused on the physical and psychological benefits and the general well-being associated with the use of green spaces on people when heat stress episodes are more likely to occur, indicated that longer and frequent visits of green spaces generate significant improvements of the perceived benefits and well-being among users (34).

In a Swedish study it was found a statistically significant association between the use of urban green space and the level of experienced stress, regardless of the individual's age, sex and socioeconomic status. The results suggested that the more often persons visit green spaces, the less stressed they will be (13).

When restoration in natural and urban environments was compared, a restorative advantage of natural environments in the ability to focus attention was reported (38).

Studies indicated that health related experiences and conditions, primarily perceived stress, attentional fatigue, and negative feelings change to more positive states after viewing or visiting a preferred natural place in the everyday environment (39-41). Others studies, on favourite places, indicate that people visit particular places, often natural settings, for regulation of their self-experience and feelings (16,42,43). The antecedent conditions for

visiting favourite places are primarily events threatening self-experience such as personal disappointments or quarrels, or negative emotions such as distress, fatigue or anxiety. The evidence suggested that after such events people commonly report relaxing and calming down in their favourite places (42).

The restorative outcomes include greater physiological changes toward relaxation, greater changes toward positively toned self-reported emotions, and faster recovery of attention-demanding cognitive performances in natural environments compared to build environments without natural elements (12,40). People with health complaints benefited more in emotional terms from their visits to the favourite. The change toward positive feelings was associated in particular with nature favourite places and relaxing in them (44). Contact with nature reduces the incidence of negative feelings such as anger, fear, anxiety, and frustration, and induces peace of mind. It also reduces the magnitude of the psychological response to stress and enhances the ability to cope with and recover from stressful episodes, by inducing a state of relaxation. Contact with nature is effective in alleviating the symptoms of anxiety, depression, and psychosomatic illness (including irritability, insomnia, tension and headaches) (33).

The relevance of natural environment for health is supported by few studies that have shown a relationship between presence of greenery and health indicators (10). For example, two large-scale epidemiological studies in The Netherlands (3,4) have revealed that residents of neighbourhoods with abundant green space tend, on average, to self-report fewer health problems. These health benefits of green space were found not only with respect to green space close to home, but also with respect to greenery somewhat further away (1–3 kilometres from home) (10). The distance to the nearest public green space is documented to be of great importance for the use of such spaces (45), and the frequency of visits to green areas was affected by the distance between the dwelling and green areas (13). The authors suggested that improving access to green spaces could be an effective component of a preventive health strategy (45).

In general health seems to be better in people living in a greener environment. In areas where 90% of the environment around the home was green, only 10.2% of the residents felt unhealthy, as compared with areas on which 10% of the environment was green (15,5% of the residents felt unhealthy). The relation was equally strong for the 1 Km and the 3 Km of distance to green areas (4). In a study with the aim to determine the association between the percentage of greenspace in an area and the standardised rate of self-reported “not good” health, confirmed that a higher proportion of green space was generally associated with better population health (5).

The relationship of individuals with nature is a fundamental component of building and sustaining good health. Many studies have shown significant health gains for those in contact with nature (46). Studies have shown that contact either visual or by presence with green spaces can be psychologically restorative, reducing blood pressure and stress levels, and possible promoting faster healing in patients after surgical intervention (1). One study (47) found that patients who were assigned to a hospital room with a view of nature after their gallbladder surgery required fewer strong painkillers compared to those who were assigned to a room with a view of a brick wall. Patients with a view of trees also stood in the hospital for approximately 1 day less than patients with a view of the brick wall, and they received less negative evaluations from the nursing staff. These findings tell of the relevance of restorative effects of viewing nature to clinically important health outcomes.

One study of patients with Alzheimer's disease found that those who lived in houses with gardens had significantly lower levels of aggression and violence than those in those without gardens (48).

Studies demonstrated that office workers experienced lower job stress, higher job satisfaction, and fewer illnesses if they had views of nature than if they did not (11,49). Exposure to nature was shown to reduce mental fatigue, irritability and accidents, and improve problem solving ability and concentration in people from urban areas who were located in a natural environment for few days (50). Literature review into psychological reactions to nature concluded that viewing nature reduces anger and anxiety, sustains attention and interest, and enhances feelings of pleasure (46).

There has been little exploration of whether the associations between green space and health vary between different groups of people (51). It has also been documented that green areas and daylight are beneficial for children, adults and elderly people (13). For example, contact view to green landscape from home, plus nearby nature in which to play, had a positive effect on the cognitive functioning of children and their capacity to think (37). One study from the Netherlands suggested that the health of young people, the elderly, housewives and those with low socioeconomic status benefited more from residential green space than other groups (3,4). This was attributed to the greater amount of time that these groups spent in their residential area and thus their greater exposure to green spaces (51).

A study was conducted to understand whether walkable green spaces provide a supportive environment that promotes the health of senior citizens in densely populated urban areas. In a cohort of older people, the association between walkable green spaces near the residence and the longevity of senior citizens in a densely populated, was investigated and the results showed that living in these areas positively influenced the longevity of urban senior citizens independent of their age, sex, marital status, baseline functional status and socioeconomic

condition, particularly because green spaces facilitates activities outside a person's residence (22).

Gender differences in exposure to or use of green space have been suggested by several studies, although some studies leads to contradictory hypotheses about how these differences might manifest themselves in health associations. Study of the relationship between urban green space and health, to investigate gender differences in this relationship, found a clear protective association of ward-level urban green space coverage with cardiovascular disease and respiratory disease mortality for men, but not for women (51).
The strength of the association between the amount of green space in people living environments and perceived general health was investigated, for different socioeconomic and age groups. Results showed that the association was likely to be stronger for groups that spent more time in the vicinity of their homes, like youth and the elderly as compared with adults, and people with lower socioeconomic status as compared with people a high socioeconomic status (4).

Interacting with nature is good for human health and wellbeing and is the subject of research in diverse disciplines such as psychology, environmental health and medicine (33).

2.2- Place and Health

Describing area-based differences in health outcomes has a long history (52). Many studies have shown that the place has importance in health (38-41,45,51) and health need to be understood within the socioeconomic context of individuals (53-55).
Medical geographers and medical sociologists are interest to know where people live and the relationship between area of residence and the chances of good or bad health. Different types of between area health differences are important because they imply different responses for their improvement. Similar groups of people tend to live in similar places. Often this is not so much a matter of individual choice, but because they could not afford to live elsewhere. Because of increasing urbanization combined with a special planning policy of densification, more people are living in residential environments with fewer green resources (56).
In a study conducted by the Netherlands Institute for Health Services Research in 1987 and 1988, the first Dutch National Survey of Morbidity and Interventions in General Practice, concluded that the effect of living in a more natural environment may vary according to SES (3). It is well known that lower SES groups are less healthy; thereby creating greater

possibilities for health improvement by health promotion measures can bring benefits to such population (57).

The greener environment seemed to have a significant beneficial effect in all educational groups, although people with a secondary education level benefit most from green space, and the relation between green space and health is stronger for people with a lower SES as compared with people with a higher SES, and it is stronger for youth and elderly compared with adults (4).

There is a widespread research and policy interest in understanding and reducing health inequalities across social groups characterized by their socioeconomic position and geographic location. Many countries now have explicit public health goals related to reducing or even eliminating social inequalities in health, but there appears to be a lack of consensus about how health inequalities should be defined and how they should be measured (23).

Where the chances of good or bad health are not evenly distributed among groups of people (defined either by the area in which they live or work or by some other common characteristic) there is health inequality (56). The meaning of health inequalities varies between countries and changes over time. In Europe health inequalities are more likely to refer to inequalities in the health of socioeconomic groups. The terms “health inequality” and “health inequalities” tend to be used interchangeably in national and international policy debates. The pluralized form “health inequalities” is used to signal that both social inequalities and the dimensions of health with which they are associated are multiple. Health inequalities are health differences associated with social inequalities (21). Health disparities refer to health differences between social groups who have different levels of underlying social advantage/disadvantage, that is, different positions in a social hierarchy (58).

In most countries, health inequalities are defined in terms of socioeconomic inequalities in health, whether measured at the individual level (by a person’s education or occupation, for example) or the area level (for instance, by the level of deprivation in the neighbourhood in which they live). Health inequality is seen as a normative concept and cannot, therefore, be directly measured. Data on length of life and rates of death are combined with information on people socioeconomic circumstances to map inequalities in their health. Socioeconomic inequalities are captured in a range of indicators of socioeconomic position, like occupational status and income. For some health outcomes and for some age and gender groups, health inequalities take the form of a steady gradient, with each step down the socioeconomic ladler bringing a stepped increase in the prevalence of poor health. Health inequalities do not always take a monotonic form, in some instances; the gradient flattens out at the higher and or lower levels of the socioeconomic hierarchy (21).

Research has shown that the social and economic characteristics of neighbourhoods have an influence on health (55,59). So, if exposure to a deprived area can have a negative influence on health, one hypothesis might be that opportunities to regularly 'escape' from a deprived environment, to socially and physically experience other types of place, could be important in determining the strength of the negative influence which deprivation might exert on health. The physical extent of the deprivation which ''surrounds'' (both within the same area and spatially proximate areas) an individual might be important in determining the degree of influence which deprivation exerts on health (60).

Composite indicators (indexes) are used in other disciplines to present information from multiple variables in an understandable and usable form (61).

A UK example is the Carstairs score which summarises four elements of multiple socioeconomic deprivation: material possessions, employment, living conditions and social class. Socioeconomic deprivation indexes such as the Carstairs score are widely used in epidemiology, and have greatly facilitated research into the relationships between socioeconomic deprivation and health (61,62).

Work exploring the influences of other aspects of residential environment on health has found that effects may vary by residents, gender, age or SES (63). In particular, gender differences in neighbourhood effects on health have been found in a number of studies (51). Social and physical characteristics of the neighbourhood were more strongly associated with women's health than with men's. Authors suggest that the residential environment may be more important for women's health, perhaps because women have greater exposure to their neighbourhood environment, or are more vulnerable to its effects (63,64).

Enormous health inequalities persist among different countries, different parts of the same country, or even different parts of the same city (56).

There are differences in health outcomes between richer and poorer, between men and women, and between those with opportunity-filled lives and those with far fewer opportunities (19). The health inequalities are of considerable concern for governments and for the planning of health services. It is important to explain how these inequalities occur and why they persist. If there is no understanding of how health inequalities are created and maintained, it is not possible to plan effective policies to correct them (56).

2.3- Mental Health

Today´s stress and mental ill are becoming more common and the costs are higher. The Word Health Organization (WHO) (2001) estimates that depression and depression-related illness will become the greatest sources of ill-health by 2020. Stress is now a major problem for people living in modern societies (65).

The Mental Health Priority Area focuses primarily on depression. This is due, firstly, to predictions that depressive disorders will constitute the highest burden of diseases in the developing world and the second largest worldwide by 2020, and secondly because it imposes high social and financial costs to the society. As many depressive symptoms and disorders are treatable as well as preventable, improvements in mental health promotion activities, prevention, and early intervention are likely to have a major impact on the level of depressive symptoms (33).

Health is more than the absence of disease and is a “state of complete physical, mental and social well-being”, according to the WHO’s definition of health. WHO specifically defines mental health as “a state of well-being in which the individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to his or her community” (66). It is the realization of one’s potential and the capacity of individuals and groups to interact with one another and the environment in ways that promote wellbeing, and optimize development. Besides, theory of attention restoration suggests that the contact with nature improves the ability to concentrate and aids recovery from mental fatigue (51).

The word depression is commonly used to describe feelings of sadness and loss, even if these feelings often end within a few hours or a few days and during this time people are able to carry out their normal activities. Although, in depression as a medical disorder, sad feelings are felt much more intensely and for a longer period of time. Common symptoms are disturbed sleep, changes to appetite, physical aches and pain, lack of energy or motivation, irritability and intolerance, feelings of guilt and loss of concentration (66). In a work on establishing a set of mental health indicators for Europe, two dimensions of mental health were conceptualized: the positive (well-being and coping in the face of adversities), and the negative (symptoms and disorders). Positive mental health is therefore not merely absence of negative symptoms such as depression or anxiety, but also includes aspects of self-control and events such as, happiness, social involvement, self-esteem and sociability (67).

Symptoms of depression were measured by The Beck Depression Inventory (BDI) that is a 21-item self-report scale designed to access the severity of a depression in adolescents and adults. Introduced by the Center for Cognitive Therapy of the University of Pennsylvania Medical School in 1971, the revised version is the instrument that has been distributed since 1972 (68).

During the last 26 years, the BDI has become one of the most widely accepted instruments in clinical psychology and psychiatry for assessing the intensity of symptoms of depression in

psychiatric patients. The clinical observations and patient descriptions were systematically consolidated into 21 symptoms and attitudes: Mood, Pessimism, Sense of failure, Self-dissatisfaction, Guilt, Punishment, Self-dislike, Self-accusations, Suicidal ideas, Crying, Irritability, Social withdrawal, Indecisiveness, Body image change, Work difficulty, Insomnia, Fatigability, Loss of appetite, Weight loss, Somatic preoccupation and Loss of libido. Each item requires a response on a 4-point scale, ranging from 0 to 3 (total scores can range from 0 to 63). A score of 10–18 and a score of over 18 separated those participants without symptoms of depression from those with symptoms of subclinical depression from those without symptoms of depression (score between 0 and 9), respectively, in adults (68). In a Portuguese study that validated the BDI in a Portuguese adolescent sample, the optimal cut-off score for a screening test that presenting the best discriminate power is the score of 13 (69). There is general agreement that asking young people to rate their own health in surveys is a reliable and valid method of assessing overall health. This measure also has strong correlation with ratings of mental health (67). Self-reported health is assessed in Health Behaviour in Scholl-aged Children (HBSC) by asking students to rate their health as “excellent”, “good”, “fair” or “poor” (70).
Mental well-being is fundamental to good quality of life. Happy and confident children are most likely to grow into happy and confident adults, who in turn contribute to the health and well-being of nations (70).

Mental health in children and adolescents is a topic of increasing importance. Facing the magnitude of the burden of disease related to child and adolescent mental disorders, WHO declared in its publication caring for children and adolescents with mental disorders, setting WHO directions that child mental health was a “key area of concern” to which professionals and policy-makers must direct their attention (65). The prevalence rate of mental disorders in childhood and adolescence was estimated in 2001 as being between 10% and 20%, based on selected studies from all over the world (71). The final report of the WHO European Ministerial Conference on Mental Health agreed with this estimate, stressing that disorders seem to be increasing and are often recurrent or chronic in nature (71), being the same conclusions achieved in other study (72).
Eastern countries in the WHO European Region tend to have higher rates of poorer health and lower rates of live satisfaction. Southern European countries tend to have higher rates of health complaints across all age groups (70).

Higher prevalence of mental health is found among socially deprived groups, with low SES, having a deleterious effect on existing mental ill health, although these trends are not specific to children and adolescents. The effect of SES in relation to access to treatment has also

been considered (71). Children growing up in disadvantaged circumstances face a range of material and social stressors and challenges, that children from more-affluent backgrounds can avoid (70,73). These stressors and challenges can take a toll on their emotional well-being; children from poorer families often have elevated rates of emotional and behaviours problems, including feeling anxiety and aggressive and finding it harder to concentrate, and to be self-confident (73).

A Slovak study with adolescent's first grade and secondary schools in Kosice, with mean age 15 years, also showed that adolescents with lower SES determined on the basis of parental occupational and type of school attended, achieved significantly lower scores in mental health (74). The US National Longitudinal Study of Youth reported that lower prevalence of depression and emotional disorders was associated with higher socioeconomic status, independent of the definition of socioeconomic status as education or income of the family (72).

Neighbourhood social capital has a significant effect on self-rated health independent of the SES of parents, family affluence and health-related behaviours (75). The neighbourhood social capital acted as a buffer against the negative effects of unfavourable (abusive and or neglectful) environments. Their longitudinal analysis of deprived children found that those with support from their neighbourhoods were more likely to "do well" (76).

Young people who had no involvement in the local community were twice as likely to report poorer health; those who rarely felt safe in the neighbourhood were almost four times as likely to report being unhappy (75). A Dutch study with Maastricht families with children aged approximately 11 years, found that the neighbourhood income inequality, was not associated with mental health-related quality of life in families, but that socioeconomic deprivation had a negative impact. Their results demonstrated the influence of absolute neighbourhood deprivation and lack of influence of neighbourhood inequality, leading them to conclude that the relative income hypothesis does not work at neighbourhood level (77).

2.4- Principal Component Analysis

There are many different types of factor analysis but perhaps the simplest and most widely used is Principal Components Analysis (PCA). Component is another term for factors and the components in PCA are often referred to as factors (78). In PCA, the original variables are transformed into a smaller set of linear combinations; the amount of variance that is to be explained or accounted for is equal to the number of variables (78,79).

The coefficients define each of the new variables, which were chosen so that the derived variables (principal components) explain the maximum variance in the original data and are

not correlated. The principal components are calculated in descending order of importance, the first explains the maximum variance of data, the second maximum variance yet unexplained by the first, and so on. The last component will contribute less to the explanation of the total variance of the data (80). To calculate the proportion of the total variance explained by each factor, it is necessary to square the loadings of the variance of that factor, add the square of the loadings to give the eigenvalue or latent root of that factor, and divide the eigenvalue by the number of variables (78).

2.4.1- Number of principal components to be retained

As there are as many components as variables, we need some criterion to decide how many of the smaller factors we should ignore, as these explain the least amount of the total variance (78).

The number of factors needed can be obtained through one of the following: one of the most commonly used is the Kaiser or Kaiser-Guttman criterion, which defines that only factors with an eigenvalues of one or more should be retained (79,80). As the maximum amount of variance that can be explained by one variable is one, these factors effectively account for no more than the equivalent of the variance of one variable (78).

Another approach than can be used is the scree plot test, which is a plot of variance by the number of components, where the steepest points are indicative of the appropriate number of components to retain and can be used to determine how many factors should be used, and essentially looks for a marker break between the initial big factors that explain the largest proportion of the variance and the later smaller factors that explain very similar and small proportions of the variance (78,80). To determine where this break occurs, the eigenvalue of each factor is represented by the vertical axis of a graph, while the factors are arranged in order of decreasing size of eigenvalue along the horizontal axis (78).

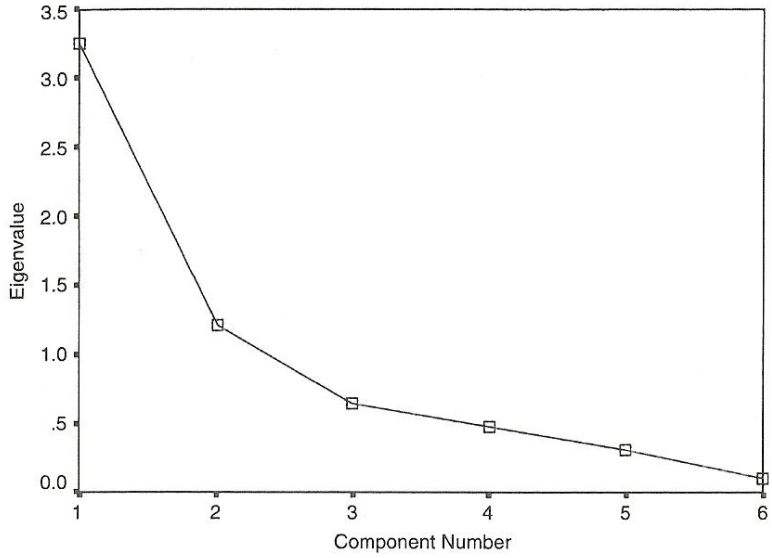

Figure 1 -Scree plot test for six principal components

Sree is a geological term for the debris that lies at the foot of a steep slope and that hides the real base of the slope itself (78). It is recommended to retain all factors above the elbow or break in the plot as these factors contribute the most to the explanation of the variance in the data set. Once the number of factors has been determined, the next step is the interpretation of them. There are various ways in which factors may be rotated. The most common form of rotation is the varimax method, which attempts to minimise the number of variables that have high loadings on each factor (79). Varimax tries to maximize the variance explained by factors by increasing the correlation of variables that correlate highly with these factors and decreasing the correlation of variables that correlate lowly with them (78). The varimax minimizes the number of variables with high loadings on a factor, obtaining a solution in which each principal component approaches 1 (80). The proportion of variance explained by two varimax rotated factors is the sum or eigenvalue of the squared loadings for each factors divided by the number of variables (78).

Another method of rotation is the direct oblimin method, in which the factors are allowed to be correlated or oblique to one another (78). In oblique rotation, the factors are correlated and the interpretation of the solution becomes necessary to consider simultaneously the Pattern Matrix, Structure Matrix and the Component Correlation Matrix. The latter shows the strength of the relationship between the factors. Pattern matrix, is similar to that provided in varimax rotated solution, and it shows the factor loadings of each of the variables and can be interpreted in the same way. The highest loading items on each component is used to

identify and label the component (79). The structured matrix indicates the overall contribution that each variable makes to a factor. If the factors are uncorrelated, these two matrixes should be similar and it would be simpler and more appropriated to carry out a varimax rotation. If the factors are correlated, it is not meaningful to present the amount of the total variance that each factor accounts for, as the pattern matrix will provide an underestimate and the structure matrix on overestimate (78).

2.5- Cluster analysis

It is a multivariate procedure used to detect homogeneous groups in the data; the groups may consist of variables or cases, although it is much less widely used than factor analysis. In cluster analysis the selection of variables to be included in the analysis is crucial. The initial choice of variables determines the characteristics that can be used to identify clusters. Cluster analysis of variables resembles factor analysis because both procedures identify groups of interrelated variables (80).

The first stage in a cluster analysis is to decide how the similarity or proximity between variables is to be measured. On such measure it is a correlation. The more similar the scores are on two variables, the more highly positive those two variables will be correlated. The more dissimilar the scores are, the more highly negative the correlation will be (78). The clusters are formed based on the closest pair of cases according to a chosen distance measure. The algorithm continues step by step, joining pairs of cases, pairs of clusters, or an object in a cluster until all data are in one cluster. The steps are presented in the cluster dendrogram that allow the choice of the optimal number of clusters (80).

One of the most widely used methods for creating clusters is the hierarchical agglomerative clustering. In this method, there are initially as many clusters as there are variables. Forming clusters occurs in a series or hierarchy of stages.
At the first stage, the two variables that have shortest distance between them are grouped together to form one cluster. At the second stage, either a third variable is added to the first cluster containing the two variables or two other variables are grouped together to form a new cluster. At the third stage, two variables may be grouped together, a third variable may be added to an existing group of variables or two groups may be combined. So, at each stage only one new cluster is formed. At the final stage, all the variables are grouped into a unique cluster (78).

There are several methods of creating clusters. If the resulting aggregation differ greatly from method to method it is unlikely that the data has distinct clusters (80). One of the most commonly used methods is the average linkage between groups (78).

At the second stage, the shortest average distance between clusters is used as the criterion for forming the next cluster. The average distance between groups or clusters is the average of the distances of each variable in one cluster paired with every other variable in the other cluster. At each stage one new cluster is formed (78).
One way of presenting graphically the results of a cluster analysis is through the dendrogram. Dendron is the Greek word for tree and the diagram is somewhat like the branches of a tree (78).

Chapter 3: Methods

3 - Methods

To determine the effect that circumstances of socioeconomic area have on a health outcome beyond individual SES, we measured area level SES in a urban area (the city of Porto) using census tracts variables.

We used data from 2001 Portuguese Census selected from the National Statistics Institute (INE), at census tracts level and with variables characterizing buildings, dwellings, families, households, individuals and populations.

Table 1 presents the selected variables that were used to build the profile of socioeconomic categories.

Table 1 - List of selected variables

Individuals
Literacy
Female residents from 20 to 64 years old
Male residents between 20 and 64 years old
Male residents aged 65 or more
Female residents aged 65 or more
Number of individuals, unemployed
Number of individuals, employed
Families
Classic families with people aged 65 or more
Classic families with persons under 15 years old
Pensioner or retired in the family
Family composed by one elderly
Classic families with 1 unemployed
Classic families without unemployed
Population
Resident unemployed individuals looking for new job
Population with skills correspondent to secondary education
Population without compulsory schooling
Population with skills correspondent to basic education
Proportion of senior executives, managers and specialists of intellectual professions
Population with college degree
Low skilled professionals
Unemployment rate
Population dependent on unemployment benefit or the RMG
Dwellings
Dwellings
Dwellings of usual residence with electricity
Dwellings of usual residence and toilet
Dwellings of usual residence with bath
Dwellings of usual residence with sewage
Dwellings of usual residence with water
Average people per room
Bed and heating system
Overcrowded classic dwellings of habitual residence
Average monthly expenditure on housing - owner-occupied housing costs
Buildings
Total classic buildings
Buildings built between 1946 and 1985
Buildings built between 1919 and 1945

Variables were selected in order to characterize socially and economically the population. Proportions were calculated for all variables.

Of the 2064 existing subsections for the council of Porto, 451 were excluded because they were considered "irrelevant" to the desired characteristics, because they had less than two residents or two buildings or two classic families or two households in it.

ANALYSIS

Principal Components Analysis was performed in order to obtain a small number of linear combinations of the original set of variables that retain as much as possible the information contained in these variables. Initially the correlation matrix was examined to identify the variables that were most closely correlated with each other and therefore should be excluded as well as to identify the variables that had the lowest correlation coefficient between them. The variables that have very high correlation coefficients ($r \geq 0.8$) were excluded. Of the initial analysis of 147 variables, 35 were retained. The next step consisted of extracting the principal components. For such, KMO tests were performed to identify if the set of variables selected was suitable for the use of PCA. The result of KMO, 0.839 (Table 2) confirmed that the set of selected variables has quality to develop the analysis (80).

Table 2 - Results of the Bartlett test and KMO

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,839
Bartlett's Test of Sphericity	Approx. Chi-Square	72158,054
	df	595
	Sig.	,000

The selection of the number of principal components to retain was based on the Kaiser method and on the method by which we retain as many components as necessary to achieve a particular desired total variance (78). The total explained variance for these data stood above 70%. The Kaiser method suggests that the best response to the number of components when using the correlation matrix will be given by the number of components whose eigenvalues are greater than or equal to 1 (79). The Scree plot

was also analyzed, and suggested the retention of 6 main components (in accordance with the eigenvalues method).

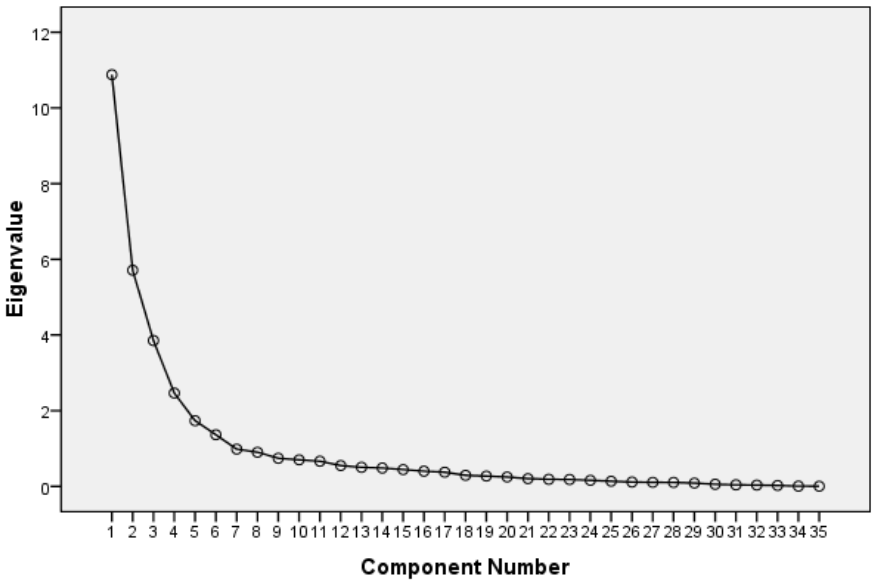

Figure 2 - Scree plot

From the analysis of the Total Variance Explained (Table 3) and based on the methods described above we can see that 6 components explain 74.295% of the total variance.

Table 3 - Total Variance Explained

Component	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	10,879	31,082	31,082
2	5,712	16,320	47,403
3	3,852	11,005	58,407
4	2,464	7,040	65,447
5	1,734	4,955	70,402
6	1,363	3,893	74,295

By analyzing the table of correlations between the components, obtained during the oblique rotation, orthogonal rotations were chosen. Based on this table, the varimax rotation was held.

After their extraction, these principal components were kept as new variables. We then performed a cluster analysis using the extracted factors, so as to group the various subsections in homogeneous areas according to socioeconomic features. Thus, clusters of homogeneous categories were identified with respect to the principal components found. We chose the method of hierarchical clustering, and the Ward's method was chosen for the rule of clustering (78).
Determining the number of clusters was done based on empirical knowledge: seven clusters were determined. We then proceeded to the interpretation and mapping of these clusters.

One of the indicators of the socioeconomic condition of the place of residence was used is the Location Coefficient Assigned (LCA), from the directorate general of taxes of Portuguese financial ministry which assigns a coefficient for each street, according to the price of the land. The figure 3 shows the distribution of the LCA.

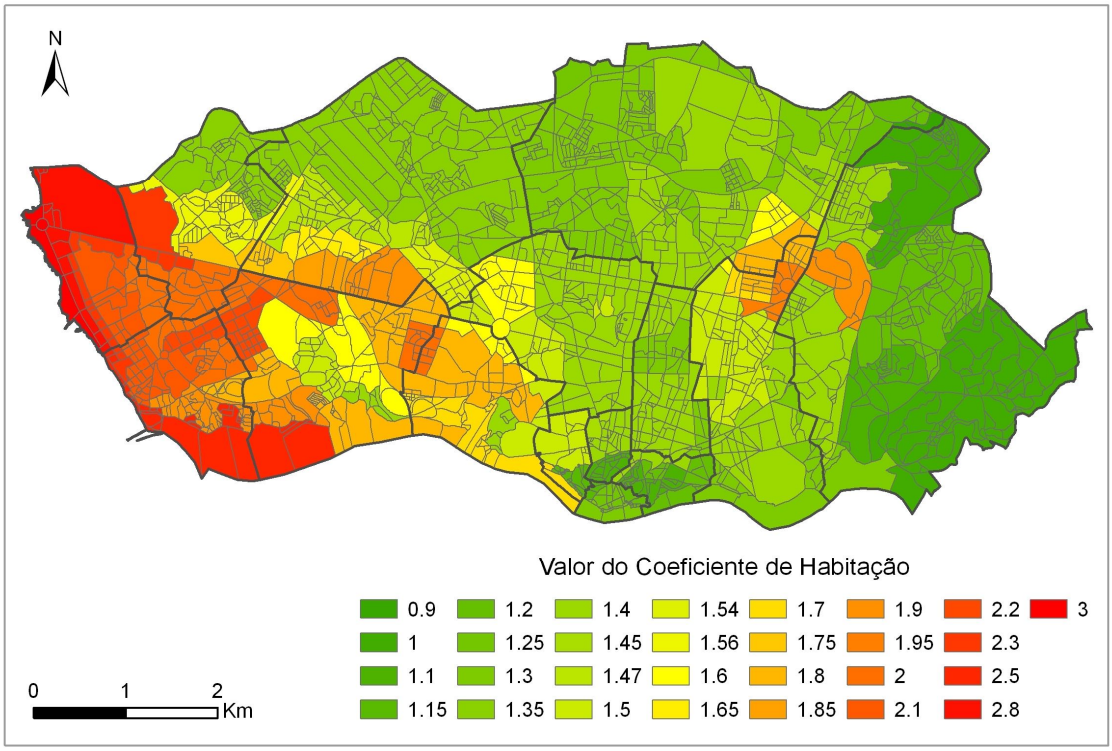

Figure 3 - Location Coefficient Assigned in 2009

The methods used to study the association between depression and the UGS are explained in the article attached.

Chapter 4: Results

4- Results

4.1- Principal Components Analysis

Regarding PCA, the correlation matrix has reduced the initial set of variables, and 35 variables were selected for further analysis. The analysis of the matrix of rotational components enabled us to understand the set of variables that best explains each component, concluding that:

Component 1 is more associated with a higher proportion of people with qualifications correspondent to secondary education, people with skills correspondent to primary education, highest proportion of senior executives, managers and specialists in intellectual professions, people with college degrees, with heating system in their houses, and slightly less proportions with an average of monthly expenditure on housing - owner-occupied housing costs. It relates negatively with population without compulsory education, professionals with low qualifications, average persons per room, overcrowded classic usual residence and the illiteracy rate. In summary this component aggregates mostly educational characteristics and costs and number of inhabitants per home.

Component 2 is more related to subjects living without business, classic families with people aged 65 or more, and pensioner or retired men and women living with 65 or more. It relates negatively with employed living men and women and residents from 20 to 64. This component seems to reflect characteristics of being active vs. retired.

Component 3 is more associated with dwellings of usual residence with sewer, water and electricity. It relates also to the total number of buildings and classic dwellings. It relates a little less with dwellings of usual residence with toilet and bath. It relates negatively with the population dependent on unemployment benefits or minimum warranted wage (social benefit). One can consider that this component is more related to the characteristics of the dwelling.

Component 4 is more closely associated with the rate of unemployment among residents of unemployed seeking a new job and classic families with 1 unemployed. It relates negatively with the classic families without unemployed. This component is clearly pertaining to unemployment.

Component 5 is related to single households consisting of elderly, relating negatively with classic families with persons under 15 years old. Thus, this component is related to elderly index.

Component 6 is related to buildings constructed between 1946 and 1985 and correlates negatively with buildings constructed between 1919 and 1945. This component is related with the age of buildings.

4.2 - Clusters Analysis

After obtaining the principal components, these were used to develop a hierarchical cluster analysis, which led to the formation of seven socioeconomic clusters, from the highest SES (cluster 1) to the lowest SES (cluster 7).The characteristics of each cluster are described bellow:

Cluster 1 (Higher SES)

Cluster 1 aggregated areas with a highest proportion of high educational levels. That is, people with higher qualifications and, inversely, it aggregates less proportions of areas characterized with low qualifications or without compulsory education and illiteracy rate.

This cluster was also characterized by a lowest proportion of single households consisting of elderly and inversely. As for the remaining analysed characteristics, this cluster aggregated median values for all with a low proportion of areas characterized by marked unemployment of their inhabitants.

15% of the Porto subsections were aggregated in this cluster.

Cluster 2

In this cluster, we observed an aggregation of areas characterized by the lowest level of active population and, inversely highest proportion of people living without business. The educational features were observed with mean values and the same applies to the unemployment characteristics.

29% of subsections remained aggregated in this cluster.

Cluster 3

Cluster 3 was characterized by the highest unemployment proportions and the second highest mean value for the high educational characteristics. All the other features can be considered to be at a mean level in this cluster. It aggregates 11% of Porto's subsections.

Cluster 4

In cluster 4 we observed the lowest value for the educational level of population in these

areas and a slightly lowest level for households consisting of elderly, indicating a highest level of classic families with persons under 15 years old. As for the age of buildings, this cluster has the second oldest value for this feature.

13% of subsections were aggregated in this cluster.

Cluster 5

Cluster 5 is characterized by a relatively high educational level of population, and the most marked feature relates to the lowest unemployment value. Is has also a relatively high value for the proportion of single households consisting of elderly. Medium values were observed for all others characteristics and 18% of the city's subsections stayed aggregated in this cluster.

Cluster 6

In cluster 6, we observed a low value pertaining to educational characteristics. Additionally, this cluster aggregated areas characterized by buildings with old ages. Overall, 13% of subsections were aggregated in cluster 6.

Cluster 7 (lowest SES)

This cluster, due to the small number of sections aggregated, showed very wide intervals for all values considered. Nevertheless, the habitation conditions (use of sewer, water and electricity, toilet and bath facilities) were clearly the worst in comparison with the other clusters. 0,4% of subsections stayed aggregated in this cluster.

After principal components analysis, cluster analysis was performed and results were mapped (figure 4).

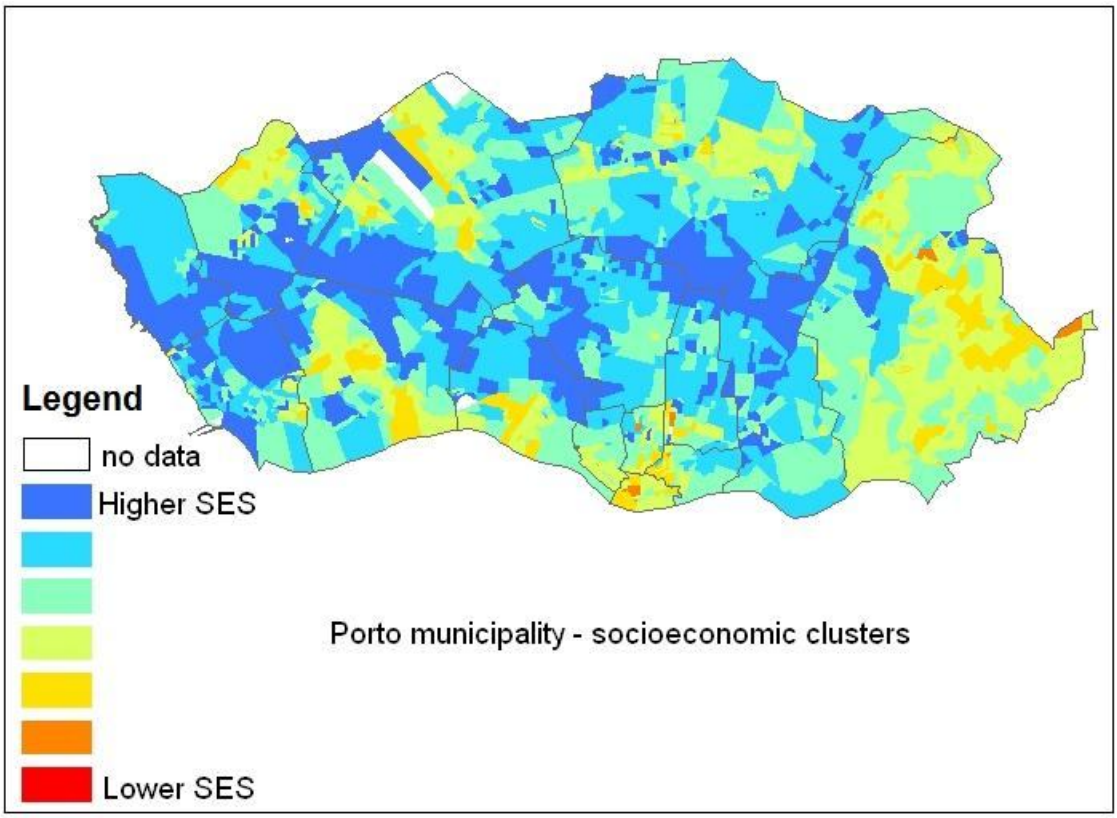

Figure 4 - Socioeconomic clusters

The results of the study of the association between symptoms of depression and the UGS are explained in the article attached.

Chapter 5: Discussion

5- Discussion

When area-level measures of SES are used as proxies for individual-level indicators, the estimate of the association with SES and the health outcomes is likely to be an underestimate of the true individual level effect (32).

If the socioeconomic characteristics of the area have an effect on health outcomes independently of the individual SES, however, the association of individual SES will be overestimated when area-level indicators are used to predict individual level effects, because the area effect will be interpreted as individual-level effect (21). Area level measures of SES are needed when the goal is to investigate whether socioeconomic aspects of the place where people live, over or above individual characteristics, affect that person's health. "Where" a person lives can be a neighbourhood, city, or higher administrative area (country, region, country level, for example) (81).

There are numerous studies of such "area effects" with most of them finding a relatively small independent neighbourhood effect on various health outcomes and health behaviours, in comparison with individual-level variables (55). Limitations may occur with studies that do not explicitly state the mechanisms through which a determined area-level exposure can influence a health outcome (82-84).

The most obvious purpose in measuring SES is to describe and monitor the social distribution of a disease in order to inform health policy, to monitor changes over time or across different geographical regions, social groups and to evaluate whether policy targets to diminish health inequalities have been reached. For descriptive purposes any measure of SES will capture and describe health inequalities if these exist (23,24). But contextual descriptions often help in reaching more informed, responsible public health decisions. This was the surplus of the presented work: using available census tracks variables we intended to portrait a reliable picture of the socioeconomical features of an urban area and for the whole country. The specific methodology used to reach this "simpler" indexes, constitutes an example of how this sort of information can be summarized and later on used in regression models to depict the area influence on several health outcomes. Although common in public health studies, we often observe incomplete measures of area (socioeconomic) characteristics with only one or two variables portraying for a more "advantageous" or "disadvantageous" place in terms of what is measured. Hence, a more profound and sensible characterization is often recommendable, since stakeholders hold for more nuances of their "places", especially when socio-related characterizations are at stake.

The discussion about the study of the association between depression and the green areas are explained in the article attached.

Chapter 6: Scientific Article

Association of distances to Urban Green Spaces with Depression in teenagers of Porto, Portugal

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Abstract

Introduction: Studies have shown that exposure to urban green spaces (UGS) has effect on mental health. Although, the association between access to UGS and depression is poorly studied. **Objective:** To examine the association between symptoms of depression in adolescent´s of a urban area in Portugal and distances from their residences to UGS. **Methods**: Symptoms of depression of 1431 (53% girls) 17-year-old adolescents (EPITeen cohort) were measured by Beck Depression Inventory (BDI). Each adolescent was classified according to the distance of their residence to the nearest green area into three classes: class 1 ≤100m, class 2 > 100m to ≤200m and class 3 > 200m. Association between distances to UGS and symptoms of depression (adjusted to parents' education, parents' depression and Location Coefficient Assigned (LCA)) were measured using odds ratio (OR) and 95% confidence interval (95%IC) using logistic regression analysis. **Results**: Considering class1 as reference, in girls the association between distance to UGS and BDI was 1.45 (0.62; 3.42) for class 2 and 0.83 (0.37; 1.85) for class 3. Among boys, those results were 0.85 (0.35; 2.09) and 0.91 (0.43; 1.93), respectively. Analyzing parents' education, for both sexes, the proportion of adolescents with symptoms of depression is higher among adolescents with parents with secondary school level. **Conclusion:** No significant association was found between the distance to UGS and symptoms of depression in both sexes. Results indicate the importance of parent's education on symptoms of depression in adolescents.

Introduction:

Psychiatric morbidity in adolescents is a concern of major public health importance, the median prevalence estimate worldwide for an impairing mental health condition was 12%, although estimates varied widely (1). Depression is a common problem in adolescents, occurring in up to 10% of youth (2,3) and studies suggest that depressed adolescents may be at particularly high risk for multiple and varied health related risk behaviours (4,5). Without effective treatment, adolescents with mental health difficulties are at increased risk of academic underachievement, smoking, obesity, substance abuse, isolation and suicide (6,7). The incidence of depression dramatically increases from adolescence into early adulthood and prospective epidemiological studies across this age range provide particularly important information (8).

Several studies have shown the importance of the place where people live and the impact of such environmental on their health (9-12). Exposure to nature was shown to reduce mental fatigue, irritability and accidents, and to improve problem solving ability and concentration in people from urban areas who are located in a natural environment for a few days (13). Urban Green Spaces (UGS) typically defined as vegetated areas such as parks, open spaces and playgrounds (14), help to improve health by facilitating the contact with nature and physical activity as well as to promote the social contact with neighbours (15). Studies in The Netherlands have shown that the amount of green space in a neighbourhood was associated with better perceived general health (16, 17). Other studies have found the use of natural environments to be associated with reduce stress levels (18) and with depression (19). Nevertheless, most of the studies focused on the adult population and little is known about the effects of exposure to UGS in adolescence.

The aim of this study was to analyze the association between the distances to green spaces and the symptoms of depression of 17-years old teenager of Porto municipality.

Methodology:

Study area

The study area was the municipality of Porto, which has 41,66km^2 and, in 2007 had 221800 habitants, 23,3% of them ≤ 24 years old (20,21). The UGS selected were areas of land where plant species are present in an urban context as parks and gardens. The city of Porto has some large green areas, the largest being the City Park (22).

Participants

This study was developed in the context of the Epiteen (Epidemiological Health Investigation of Teenagers in Porto) cohort study (23). This cohort was started in 2003/2004 with the objective to evaluate all teenagers born in 1990 and that were studying in one of the schools (private or public) in the city of Porto (24). A second evaluation was done in 2007/2008 being the third evaluation ongoing in 2011/2012. The epiteen project had been approved by the Ethics Committee of the University Hospital of São João. Written information, explaining the purpose and the design of the study were sent to students and parents. Parents and children gave the informed consent (23,24).

At baseline, 2160 adolescents agreed to participate and provided information at least for part of the planned assessment, resulting in a 77.5% participantion. Among the 2160 baseline participants, 1716 participated in the second evaluation of the cohort, resulting in a proportion of re-evaluation of 79.4% and 277 new participants were recruited, corresponding to teenagers that were not studying in a school in Porto, during the baseline, but moved to the city in the meantime. From these 1993 participants, 562 were excluded because they were living in other municipalities. Our final sample had 1431 teenagers, 758 (53%) girls and 673 boys.

Questionnaire

The data were collected using two structured questionnaires, one responded at home with the help of parents, the other responded by the adolescents at school. The home questionnaire inquired information about characteristics of adolescents and the family including information on previous diagnosis of depression in parents. The school questionnaire included information about adolescent medical history, physical activity, smoking and alcohol habits (23). The school questionnaire also included de The Beck Depression Inventory (BDI) to measure depressive symptoms (25).

Two indicators of the socioeconomic condition of the place of residence were used. One, the Socioeconomic Status of the Place of Residence was calculated by principal components analysis, using variables at census tract level from the 2001 Portuguese National Census, with characteristics of buildings, dwellings, families, households, and individuals. After principal components analysis, cluster analysis was performed and census tracts were classified in seven classes of homogeneous Socio Economic Status (SES); More Favoured Class (higher educational levels, better living conditions),

Middle Class (middle educational levels) and Lower Class (Low educational levels and the worst habitation conditions).

The other socioeconomic indicator was the Location Coefficient (LCA), from the directorate general of taxes of Portuguese financial ministry (26) which assigns a coefficient for each street, according to the price of the land. To each census tracts the value of the coefficient of localization was attributed.

Parents education was used as a social indicator, measured in function of the number of years in school, considering the value of the parent with higher school level. To attribute the value of the socioeconomic variables of the place of residence to each adolescent, a weighted average of the value of each census tracts that intersected a circumference of 25 meters around their residence was calculated. This approach allowed correcting for the cartographic error inherent to the georeferencing of residences.

Symptoms of Depression

Symptoms of depression were measured by The BDI that is a 21-item self-report scale designed to access the severity of the symptoms of depression in adolescents and adults. Introduced at the Center for Cognitive Therapy of the University of Pennsylvania Medical School in 1971, the revised version is the instrument that has been distributed since 1972. During the last 26 years, the BDI has become one of the most widely accepted instruments in clinical psychology and psychiatry for assessing the intensity of symptoms of depression in psychiatric patients. The clinical observations and patient descriptions were systematically consolidated into 21 symptoms and attitudes: Mood, Pessimism, Sense of failure, Self-dissatisfaction, Guilt, Punishment, Self-dislike, Self-accusations, Suicidal ideas, Crying, Irritability, Social withdrawal, Indecisiveness, Body image change, work difficulty, Insomnia, Fatigability, Loss of appetite, Weight loss, Somatic preoccupation and Loss of libido (25).

Each item requires a response on a 4-point scale, ranging from 0 to 3 (total scores can range from 0 to 63).

For the analyses, participants were classified into two classes: BDI < 13 and BDI ≥ 13. This division is consistent with the Portuguese study that validated the BDI in a Portuguese adolescent sample, whose optimal cut-off score for a screening test that presenting the best discriminate power is the score of 13 (27).

Parent's Information

Parents Education was used as an indicator of the family's socioeconomic condition, and was determined according to the number of completed years of education. The adolescent was classified according the parent with highest educational level in four categories: until 6th year (Basic Education), until 9th year, secondary school and college. Exposure to parental depression was considered when at least 1 parent reported depression.

Georeferencing

The participant's residences were georeferenced using the addresses within a Geographic Information System (GIS). The digital map with the limits of UGS was obtained from the Municipal Directorate of Information System, from the city Council. The map was updated by satellite images from Google earth and a field survey using a Global Positioning System (GPS) in order to include the UGS from the municipalities who shared a limit with the city of Porto, since the participants living close to the borders can be closer to UGS in neighborhood municipalities.

Each adolescent was classified according to the distance of their residence to the nearest green area into three classes: class 1 ≤100m, class 2 > 100m to ≤200m and class 3 > 200m. Figure 1 show the sample distribution according to the distance of the teenager's residences to UGS.

Statistical analysis

Qui-square tests were used to compare the proportion of categorical variables. Data of Local Coefficient Assigned were analyzed using the nonparametric Mann Whitney test (p<0.05) to compare adolescents according to the presence of depressive symptoms. Odds ratio (OR) and the corresponding 95%Confidence intervals (95%CI) were adjusted to Parents' Education, Parents Depression and LCA when measuring the association with BDI (for girls adjusted only for parents education and parents depression). Each independent variable was included by the "Enter" method to estimate associations with BDI. Separate analyses were performed for boys and girls. Statistical analyses were performed using SPSS version 19.0.

Results

The final sample was composed by 758 girls and 673 boys. The overall prevalence of depressive symptoms in our sample was 14%, with no statistical significant gender differences (12,4% among girls and 15,9% among boys, p>0,05). Regarding distances

to UGS, 20,7% of the girls and 17,7% of the boys were closer than 100m, 24,4% of the girls and 24,5% of the boys were closer than 200m and 54,9% of the girls and 57,8% of the boys were more distant than 200m.

The results regarding BDI according to the distances to UGS and some health and socioeconomic indicators are summarized in table 1. Parent's history of Depression seems to be an important factor associated with the symptoms of depression in adolescents, as well as Parents' Education. Analyzing parents' education, it was observed that, for both sexes, the proportion of adolescents with symptoms of depression is higher among adolescents with parents with secondary school level. Girls with symptoms of depression smoke more (56,5%) than girls without symptoms of depression (43,5%), a statistical significant associations were found. No statistical significant associations were found between BDI and distances to UGS in both sexes, however the proportion of those that have symptoms of depression (BDI > 13) increase as the distance to UGS increase.

Discussion

The principal aim of this study was to analyze the relation between distances from residences to UGS and the symptoms of depression of teenagers living in the city of Porto. In general, our results showed that the proximity of UGS is not determinant for symptoms of depression among adolescents in Porto.

Other studies examined the importance of neighborhood access to UGS or contact with nature and mental health and showed that the amount of green space present in living environments was positively associated with the perceived general health (16,28,29), and mental health (15,30). Access to green spaces also positively affects stress and quality of life (31,32). On the other hand, the association between UGS and better health could depend on the degree of urbanity and level of income deprivation in an area (33).

Our study focused on the distance from the residence to the green areas. It is expected that the frequency of green space use decline with the increasing distance to such spaces (34). In a study about morbidity, the annual prevalence rates of 15 from 24 disease clusters, including for depression, were lower in areas with more green space within a 1 km radius (35). But this is in contrast with other studies which found the relation between self-perceived health and the amount of green space at 1 km and at 3 km radius around people's homes to be equally strong (16,29). About the proximity to green areas, another study showed that natural elements or settings in the view from

the window contribute substantially to resident's satisfaction with their neighborhood and with diverse aspects of their sense of well-being (36). In a study of green space and stressful life events and health, the authors found that green space in a 3-km radius around the home significantly decreased the relationships of stressful life events on perceived mental health. According to the authors, this is because UGS within a 3-km radius usually reflect the presence of large green areas, such as forests (30).
A study in New Zealand did not found association between UGS and health, and authors indicated that in this country green space is more abundant and there is less social and spatial variation in its availability than found in other contexts (37). This could also be an explanation for our results, since Porto is a small urban area with several green areas.
Studies reported that females have higher incidence rates of major depressive disorders when compared to males (38) throughout adolescence and adulthood (39). The duration of the depressive episodes showed a trend towards being lengthier in females and to be associated with numerous biological, social and psychological factors (39). Our study did not find significant statistical differences between the proportion of boys and girls with symptoms of depression. This fact can be related with the lower prevalence of symptoms of depression (14%) in this sample. Some studies indicate that gender differences have the greatest increase between ages 15 to 18 (40), however, other studies suggest that increases in depression may occur most consistently for girls entering adolescence (ages 12-15) rather than the 15-17 year-old age group (41). Non significant decreases in depression scores have been found in other studies (42).

As reported by other studies, we found association between symptoms of depression and smoking, for girls. Some studies have shown little evidence of association between depression and smoking behaviour (43) while others have shown an association; however, the direction of causality remains unclear. Few longitudinal studies have investigated relationships between depression and anxiety symptoms and smoking from their point of onset in adolescence (44). Some of them have shown that smoking behaviour is a consequence of symptoms of depression and anxiety (45). This can be explained by changes in adolescence development.

Our results confirm an association between symptoms of depression and parent's education. Cross-sectional and prospective data indicate that low SES predicts higher levels of depressive and anxiety symptoms among adolescents (43,46), although it also conflicts with other reports (47,48), and others authors that found compelling

evidence of inequalities in depression favouring the higher SES groups (49). On the other hand, some authors claim there is uncertainty in the relationship between SES and depressive disorders (50). In a meta-analysis, 35 from 51 prevalence studies showed statistically significant elevated odds of depression among deprived people. The meta-analysis also showed that inequalities were greater for income than for education. The association with non-employment and income was much stronger than the association with education, and the association with occupation was particularly weak. If it is assumed that a strong association indicates depression both as a cause and an effect of SES, then the stronger association with non-employment and income indicates that depression not only is caused by but also causes non-employment and low-income (49,50). This may explain the fact that the group with secondary school have more risk of developing depressive symptoms in our data.

Adolescents with parent's depression had higher risk of developing symptoms of depression in our sample. Positive family history of psychiatric disorder predicted high depression score amongst females adolescents (51). Research indicates that family history of psychiatric disorders, especially in mothers, plays an important role in initiating adolescent depression (52).

Some limitations should be considered in interpreting the results of our study. All public green areas were included, regardless their size, and the private gardens such as condominium housing were not included. There was no available data about the use of green space by the respondents.

However this study used a large sample and measured objectively, by using GIS, the distance from residences to green areas.

Conclusions

Results showed the importance of parent's education on symptoms of depression in adolescents. There is a significant relationship between depressive symptoms and smoking in adolescents for girls. After adjustments, in both sexes, no significant association was found between the distance to UGS and symptoms of depression.

Table 1 - Prevalence of symptoms of depression to distances to UGS, Health indicators and Socioeconomic Indicators and results of logistic regression examining association between distances and odds of the symptoms of depression

	BDI, n (%)							
	FEMALE				MALE			
	< 13 (87,6%)	≥13 (12,4%)	Crude OR (CI 95%)	Adjusted OR (CI 95%) *	<13 (84,1%)	≥13 (15,9%)	Crude OR (CI 95%)	Adjusted OR (CI 95%)**
Distance to UGS								
≤ 100 m	144 (21,7)	13 (13,8)	Reference		98 (17,3)	21 (19,6)	Reference	
>100m to ≤200m	154 (23,2)	31 (233,0)	2.23 (1.12; 4.43)	1.45 (0.62; 3.42)	140 (24,7)	25 (23,4)	0.83 (0.44; 1.57)	0.85 (0.35; 2.09)
>200m	366 (55,1)	50 (53,2)	1.51 (0.80; 2.87)	0.83 (0.37; 1.85)	328 (58,0)	61 (57,0)	0. 87 (0.50; 1.50)	0.91 (0.43; 1.93)
P-Value	0,057				0,837			
Parents' Education								
Until 6th Year	215 (33,7)	23 (24,5)	Reference		139 (26,1)	26 (24,3)	Reference	
Until 9th Year	139 (21,8)	15 (16,0)	1.01 (0.51; 2.00)	0.33 (0.11; 0.94)	117 (22,0)	12 (11,2)	0.55 (0.27; 1.13)	0.22 (0.08; 0.60)
Secondary School	114 (17,9)	50 (53,2)	4.10(2.38;7.06)	0.69 (0.26; 1.85)	96 (18,0)	59 (55,1)	3.29 (1.94; 5.58)	0.75 (0.32; 1.81)
College	170 (26,6)	6 (6,4)	0.33(0.13;0.83)	1.40 (0.26; 7.60)	180 (33,8)	10 (9,3)	0.30 (0.14; 0.64)	0.75 (0.14; 4.07)
P-Value	< 0,001				< 0, 001			
Parents Depression								
No	297 (72,4)	30 (63,8)	Reference		208 (66,2)	35 (58,3)	Reference	
Yes	113 (27,6)	17 (36,2)	1.49 (0.79; 2.81)	2.68 (1.04; 6.90)	106 (33,8)	25 (41,7)	1.40 (0.80; 2.46)	2.52 (1.10; 5.79)
P-Value	0,215				0,239			
Overweight /Obesity								
No	446 (82,9)	56 (82,4)	Reference		359 (82,2)	63 (84,0)	Reference	
Yes	92 (17,1)	12 (17,6)	1.04 (0.54; 2.02)		78 (17,8)	12 (16,0)	0.88 (0.45; 1.70)	
P-Value	0,910				0,698			
Sports								
No	320 (62,4)	44 (57,9)	Reference		117 (27,8)	23 (27,1)	Reference	
Yes	193 (37,6)	32 (42,1)	1.21(0.74; 1.97)		304 (72,2)	62 (72,9)	1.04 (0.61;1.75)	
P-Value	0,453				0,891			
Breathless Sport								
Class 1	634 (51,5)	96 (47,8)	Reference		325 (35,3)	51 (32,7)	Reference	
Class 2	255 (20,7)	42 (20,9)	0.64 (0.35; 1.19)		255 (27,7)	42 (26,9)	1.38 (0.71; 2.68)	
Class 3	341 (27,7)	63 (31,3)	1.35 (0.80; 2.29)		201 (21,8)	35 (22,4)	0.84 (0.42; 1.68)	
Class 4					140 (15,2)	28 (17,9)	1.02(0.50; 2.10)	
P-Value	0,525				0,812			
Smoking								
No	309 (56,8)	30 (43,5)	Reference		240 (54,5)	37 (48,7)	Reference	
Yes	235 (43,2)	39 (56,5)	1.71(1.03;2.83)		200 (45,5)	39 (51,3)	1.27(0.78; 2.06)	
P-Value	0,036				0,344			
Socioec Cond Pl Res								
High Class	221 (33,3)	36 (38,3)	Reference		206 (36,4)	41 (38,3)	Reference	
Middle Class	326 (49,1)	47 (50,0)	0.89 (0.56; 1.41)		287 (50,7)	51 (47,7)	0.89 (0.57; 1.40)	
Low Class	117 (17,6)	11 (11,7)	0.58 (0.28; 1.18)		73 (12,9)	15 (14,0)	1.03 (0.54; 1.98)	
P-Value	0,312				0,842			
Loc Coef Assign			0,90 (0.73; 1.10)				0.77 (0.38;1.55)	
P-Value	0,683				0,926			

* adjusted to parents' education and parents' depression

** adjusted to parents' education, parents' depression and Location Coefficient Assignment

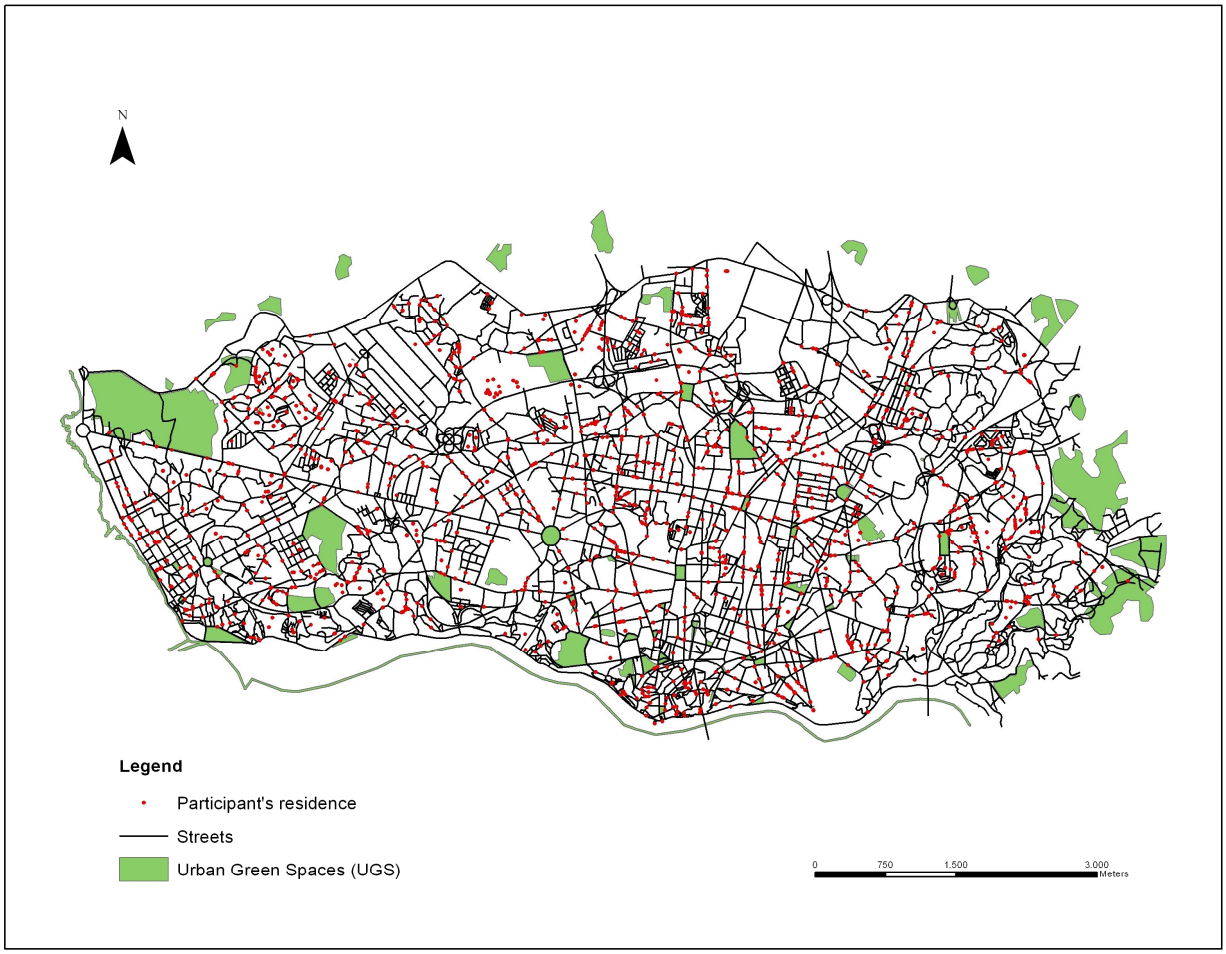

Figure 1 – Distance of the Teenager's Residence to UGS – Sample distribution

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Annexes

Table 4 - Component Transformation Matrix

Component	1	2	3	4	5	6
1	,828	-,295	,311	-,323	-,063	,147
2	,071	,716	,326	-,271	,550	-,013
3	-,318	-,244	,857	,294	-,001	,135
4	,379	,299	-,103	,776	,015	,393
5	-,198	,305	,026	-,348	-,543	,672
6	,158	,398	,226	,113	-,631	-,595

.

Table 5 - Rotated Component Matrix

	Component					
	1	2	3	4	5	6
pop_hab_sec	,924					
pop_s_esc	-,914					
pop_hab_basico	,911					
quad_sup	,879					
pop_hab_sup	,870					
prof_qual_baixas	-,826					
Med_Div	-,781				-,347	
Aloj_c_aquec	,755					
ACRHS	-,744					
Med_desp_hab	,666					
taxaanalf	-,621	,353				
IR_SAC		,877				
IR_EP		-,810		-,301		
HR20_64_P		-,759				
MR20_64_P		-,730				
FCPMA65		,693			,585	
reformado		,650			,556	
HR65_P		,643			,514	
MR65_P		,637			,623	
AFRHES			,906			
AFRHAG			,879			
TTEC			,852			
AFC			,832			
AFRHEL			,802			
AFRHRE	,313		,514			,483
AFRHBN	,448		,485			,482
pop_dep_subD	-,330		-,432			
FCD_0				-,923		
TD				,877		
IRDNE				,872		
FCD_1				,860		
FCPME15					-,873	
fam_uni_idosos		,325			,525	
E_46_85_P						,838
E19_45						-,757

Table 6 - Distribution per sex of the sample by dependent Variables			
Dependent variables	SEX , n (%)		
	Female	Male	p-value
BDI13_FU			
No	664 (87.6)	566 (84,1)	0.057
Yes	94 (12,4)	107 (15,9)	
Parents Depression			0,054
No	267 (35,2)	194 (28,8)	
Yes	130 (17,2)	131 (19,5)	
unknown	60 (7,9)	49 (7,3)	
Missings	301 (39,7)	299 (44,4)	
Sports			< 0.001
No	364 (48)	140 (20,8)	
Yes	225 (29,7)	366 (54,4)	
Missings	169 (22,3)	167 (24,8)	
BMI			0.206
No	502 (66,2)	422 (62,7)	
Yes	104 (13,7)	90 (13,4)	
Missings	152 (20,1)	161 (23,9)	

Table 7 - Distribution of the sample according to the distance of their residence to nearest green area, by sex			
	Class	FEMALE, n (%)	MALE, n (%)
U	d_class1	157 (20,7)	119 (17,7)
G	d_class 2	185 (24,4)	165 (24,5)
S	d_class 3	416 (54,9)	389 (57,8)